Annual Report

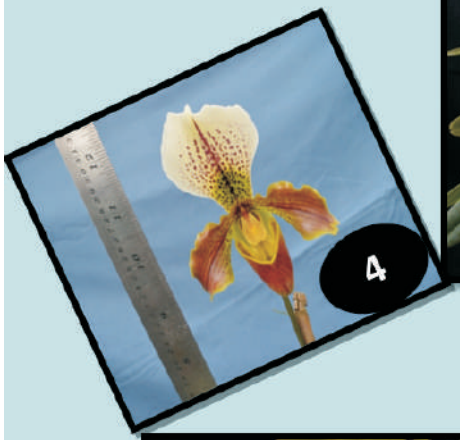
2014 - 15

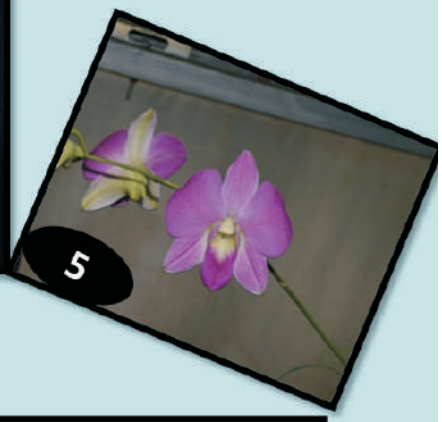
भाकृअनुप
ICAR

ICAR-National Research Centre for Orchids
(Indian Council of Agricultural Research)
Pakyong - 737106, Sikkim, India

NRC Orchids

ICAR-NRCO HYBRIDS





भाकृअनुप
ICAR

Annual Report

2014 - 2015

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

Agrisearch with a human touch

NRC Orchids

ICAR-National Research Centre for Orchids
(Indian Council of Agricultural Research)
Pakyong - 737106, Sikkim, India

ICAR-National Research Centre for Orchids
(Indian Council of Agricultural Research)
Pakyong- 737106, Sikkim

Tele No.	03592 – 257954, 257703, 257289, 257537
Telefax	03592 – 257289, 257282
Email	nrcorchids@rediffmail.com
Website	www.nrcorchids.nic.in
Published by	D. R. Singh, Director
Editorial board	D. R. Singh L. C. De R. Devadas
Compiled & designed by	L. C. De & Geetamani Chhetri

Correct citation

NRCO, 2015. ICAR-National Research Centre for Orchids, Annual Report 2014-15, Pakyong, Sikkim

June, 2015

Cover photographs

Front: *Cymbidium* hybrid, (left to right) *Dendrobium fimbriatum var. oculatum, Cottonia peduncularis, Phaius mishmensis, Phaius flavus, Cymbidium lowianum, Vanda tessellata*

Front (inside): (1) Darjeeling Nymph (2) *Aranda* 'Kunga Gyatso' (3) Darjeeling's Delight (4) NRCO (PlxPw)/10/2013 (5) *Dendrobium* 'V. Nagaraju' (6) NRCO (HxB)/25/2012 (7) NRCO (BxH)/34/2008

Back (inside): ICAR-NRCO Publications.

Back (outside): Standardization *in-vitro* propagation protocol for *Zygopetalum*, *Cymbidium* propagation by backbulbs and division methods.

Printed at
Hindustan Printers
Ground Floor, Gupta Market,
Raja Rammohan Roy Road,
Siliguri - 734 001
Cell : 96790 09688

Preface

It gives me immense pleasure to place before you the Annual Report (2014-15) of the ICAR-National Research Centre for Orchids, Pakyong, Sikkim the nodal institute mandated with planning, execution and coordination of all activities concerned with orchid research and development in the country. Since, its establishment in 1996 by the Indian Council of Agricultural Research (ICAR), NRCO has played a pivotal role in management and sustainable utilization of orchid genetic resources for crop improvement. Sikkim is the 'Botanists' Paradise' due to its greatest floristic diversity located in Eastern Himalayas listed under 32nd 'Hot Spot' of the world. India's rich orchid genetic diversity holds 1,350 species with major share from North-East India.

Taking into account of suggestions from Subject Matter Division, Research Advisory Committee and Institute Management Committee the research projects were planned with priorities *viz.*, Germplasm management, Crop Improvement, Crop Production and Extension activities. Orchids are the precious gift of nature to the human beings. They are adored and loved for their mystique beauty, therapeutic value and long shelf life. The popularity of orchids as cut flowers has increased such that these have now become part of each and every important public, private and social function. At present, a bulk of the demand for orchid cut flowers is met through imports. The import of orchid flowers has risen from 299.9 Lakh during 2008-09 to 2,985.19 Lakh in 2013-14. Import of orchid cut flowers has registered the growth of 159.69 percent over the previous year. There is nearly tenfold increase in import of cut flowers in the last six years, and this demand is expected to increase further. The orchid industry nurtures not only supply of cut flowers and potted orchids, but also other value additions like micropropagated plants, dry flowers, natural dyes & perfumes *etc*. India with its climatic variability and genetic diversity has great potential to emerge as global player in the floriculture market. The efforts in this direction have already began in several states of India.

Since its inception, the centre has made significant progress in conservation of genetic resources, breeding of new varieties, morphological and molecular characterization of wild genetic resources, developing package of practices for cultivation, postharvest and protection management. This document, Annual Report highlights the significant research achievements of various research programmes and other institutional activities for the year 2014-15. During this year, moleculer diversity in *Cymbidium whiteae*, genus *Paphiopedilum*, fragrant & medicinal *Dendrobium* species, *Pleione* and *Otochilus* was studied. One patent for gDNA extraction protocol from orchid leaves that enhances the recovery and quality of gDNA has been filed. The institute is moving towards development of new hybrids which would useful as the cultivars for cut flowers/potted plants or the materials for further improvement programme. Seven hybrid lines belonging to *Cymbidium* and *Paphiopedilum* were developed at institute. Under Crop Production suitable hybrids of Cymbidium, Dendrobium, Vanda, Mokara, Oncidium, Aranda and Cattleya were identified for

commercial cultivation in the region. Improved production technologies of Cymbidium and Dendrobium were standardized. For increasing post harvest life of cut flowers during transit, the efforts were made to standardize harvest stage and chemicals required for pulsing of Cymbidium and Dendrobium cut flowers. New insects like long tailed mealy bug, *Pseudococcus longispinus* and encyrtid wasp, *Anagyrus* sp (Howard) as its parasitoid was reported during the year.

Considering the adverse effect of pesticides, the centre is working on biocontrol of orchid pest and several botanicals were identified for pest management.

DUS test guidelines of another commercial orchid genera *Oncidium*, was finalized and notified. The staff of the centre was encouraged to participate in different HRD programmes for honing their skill. Research findings were disseminated through organizing trainings and demonstrations.

The Institute could attract the attention of the public due to untiring and self-less efforts and energy put by every scientist along with other staff members of the Institute. I want to congratulate all of them for their hard work. I hope this document will be able to depict the various activities of the institute in a focused way and the information contained will be able to help the farmers, researchers and growers engaged in the field of orchid research and development.

I consider it a privilege to place on record the encouragement and support given by Dr. S. Ayyappan, Secretary, DARE & Director General, ICAR. We would have not made such achievement without the support and guidance of Dr. N. K. Krishnakumar, Deputy Director General (Horticulture). We are also grateful to Dr. T. Janakiram, ADG (Hort. I) for all the support and advice given to us time to time. I sincerely thank my predecessor, Dr. R. P. Medhi for his active contributions. I am equally thankful to the Chairman and members of Quinquennial Review Team and Research Advisory committee for their suggestions to reorient our research programmes.

Place: Pakyong, East Sikkim
Dated: June, 2015

(D. R. Singh)
Director

Executive Summary

- There were 50 species of orchid having medicinal properties as reported by BSI. Information on availability of location, flowering period and medicinal values were collected.
- Ex-vitro seed germination was tried in *Calanthe brevicornu, C. puberula*, *C. patchystylix Cymbidium erythraeum, Paphiopedilum insigne* and *P. villosum.*
- A simple, improved and inexpensive method to obtain chloroplast DNA from orchid species was developed by modifying the existing protocols. Analysis of molecular diversity of all native species of the genus *Paphiopedilum* was initiated using RAPD and ISSR markers. Genetic diversity and relationships among 24 medicinal species of *Dendrobium* orchids collected from different geographical regions of India were assessed using RAPD and Inter Simple sequence repeat (ISSR) markers. Genetic diversity of 21 fragrant *Dendrobium* orchids of India was assayed using Inter Simple Sequence Repeats (ISSR) markers. Microsatellite marker development was made from native orchid species *Paphiopedilum fairrieanum* using Library enrichment method. 78 DNA barcode sequences of native *Vanda* species were submitted in Gene Bank.
- Micro-propagation of *Phalaenopsis mannii* an endangered orchid species from leaf, root and flower stalk ex-plant was initiated in MS media containing sucrose (2%) and different combination of NAA and BAP.
- Taxonomic identification was confirmed for NAGS collections *viz.*, *Dendrobium ovatum* (NOAC#324), *Eria tomentosa* (NOAC#757) & *Microperarostrata* (NOAC#1188) and working collection of NAGS germplasm was developed. *Vanilla* sp collected from CPCRI, Mohitnagar and *Calanthe triplicata* re-introduced multiplied through clonal multiplication.
- State & AICRP trial (North-Eastern plain & Hill zone) was initiated for *Aranda* 'Kunga Gyatso'. *In-vitro* plantlets hardening *viz.,* PBX-12-169 (*V.* 'Bernice Miller' x *V. coerulescens*), PBX-11-150 (*Cym.* 'Margaret Thatcher' x *Cym tracyanum*) and PBX-11-155 (*Cym.* Free Style No 3 x *Cym tracyanum*) were done. The characterization of new Cymbidium breeding line, *Cym.* 'September Sunset' x *Cym.* 'Palkibaris', early promising breeding line, PBX-05-29/31 from *Cym.* 'Red Beauty' x *Cym.* 'Golden Elf', two scented lines of PBX-05-772 (*C.* "Concerto" x *C. iridiodes*) and five progeny lines of *Cym. lowianum* based crosses were characterized.
- Seven selected breeding lines (Cymbidium-3 nos. & Paphiopedilum-4 nos.) were proposed for denominations for institutional release.
- Based upon the *maturaseK* (matK) gene sequence available in NCBI databases for the Cymbidium species constituting the hybrids available with us and the species useful for breeding programme, a

dendrogram was constructed based on neighbor joining method.

- Cymbidium plants grown in high night temperature treatment (HNT 25°C) showed higher percentage of increase in number of leaf, plant height, leaf width and most importantly pseudobulb size.

- Phalaenopsis flowered when Day temperature was set at 25°C ± 2° Day and 17°C ± 2° at Night. Flower was inhibited by day temperature > 27°C ± 2°.

- In *Den.* 'Emma White' 1st flower opening was 17 days earlier in HLI and also spike length was 25% longer and number of floral bud recorded was 44% Higher than LLI.

- Out of 50 species and hybrids of orchids, full bloom flowers oven dried at 60°C embedded in sand, *Papilionanthe teres*, *Vanda tessellata*, *Cattleya*, 'Guanamiau City', *Phalaenopsis* 'Casa Blanca', 'Detroit', 'Vienna', 'Taida S. Red', *Dendrobiu mmoschatum*, *Dendrobium*, 'Lervia', 'Madam Pink', 'A. Abraham', *Oncidium*, 'Wildcat Bobcat', 'Taka Yellow', 'Sweet Sugar', *Arundina bamboosifolia*, *Epidendrum* spp., were found successful.

- In *Cym*. 'PCMV', fully open florets had maximum vase life (48 days) followed by half open floret (41 days with 100% opening), loose bud florets (35 days with 50% opening) and tight bud florets (26 days with 25% opening). In *Cym*. 'PCMV', cellophane paper packing of fully open florets had maximum longevity (40 days) over tight bud florets (25 days) whereas in Cym. 'H.C. Aurora', cellophane paper packing of fully open florets had maximum longevity (38 days) over tight bud florets (32 days).

- In *Cattleya* hybrids, longevity of cellophane paper packing of fully open florets ranges from 14 to 45 days over unpacked florets *i.e.* 7 to 11 days. In *Phalaenopsis* hybrids, longevity of cellophane paper packing of fully open florets ranges from 14 days (Phal. 'Boston') to 33 days (Phal. 'Ox Plum Rose x Black Jack').

- New identification and documentation of long tailed mealy bug (*Pseudococcus longispinus*). *Pseudococcus longispinus* has been found to infest the orchids *Dendrobium fimbriatum* and *Dendrobium chrysanthum* with a mean population of 15 numbers of mealy bugs per plant.

- New report of an encyrtid wasp, *Anagyrus* sp (Howard) as a parasitoid of long tailed mealy bug, *Psuedococcus longispinus* and Mealy bug, *Pseudococcus* sp. infesting Orchids from Sikkim, India

- Botanical products from neem *viz.,* azadirachtin (neem oil 0.03% EC) @ 5 ml/L and *Allium sativum* gave effective management of mites under polyhouse conditions with mean population reduction of 86.80 % and 91.16 % respectively.

- Microbial biopesticides, *Metarhizium anisopliae* and *Verticillium lecanii* @ 2 ml/L of water was found effective in reducing the populations of thrips, *Dichromothrips nakahari* on Cymbidium, 'Levis Duke Bella Vista' with mean number of 3.00 and 2.67 thrips/plant after 14 days of treatment respectively.

- Microbial biopesticides, *Metarhizium anisopliae* @ 2 ml/L and *Verticillium*

lecanii @ 2 ml/L gave effective management of scale insect, *Diaspis biosduvalii* under polyhouse conditions.

- Studies on per cent parasitization of cymbidium scale insect, *Lepidosaphes pinnaeformis* (Bouche) by Aphelinid wasp parasitoid *Aphytis* sp under polyhouse conditions.

- Studies on per cent parasitization of soft Brown scale insect, *Coccus hesperidum* Howard by Aphelinid was parasitoid, *Coccophagus ceroplastae* (Howard) under polyhouse conditions.

- DUS Test Guidelines of *Oncidium* published in PVJ of India under PPV & FRA in April 2014 issue and notified for registration by Plant Authority during October, 2014.

- Project is re-initiated for RFS of ICAR Seed Project in 2013 and Rs. 43,525/- was generated as revenue this year. The 12th plan proposal for horticulture component is submitted to CISH, Lucknow.

Contents

Introduction

The National Research Centre for Orchids was established on 5th October 1996 by the Indian Council of Agricultural Research (ICAR), New Delhi to organize research programme on improvement in productivity, quality and commercialization of orchids. The Sikkim state authorities handed over 22.19 acres of land belonging to Regional Agricultural Centre along with all other assets to ICAR for establishment of the centre. In October 1997, the centre also took over the CPRS, Darjeeling from CPRI and established a campus for research on temperate orchids.

In the initial years of establishment the major focus of research was on collection, characterization evaluation,conservation and utilisation of available germplasm in the country in general and north eastern region in particular. With the changing scenario of floriculture in the country, the centre has modified its approach and thrust areas of research to meet the challenges. Today, the focus is on development of marketable varieties/hybrids, molecular characterization, standardization of agro-techniques, post- harvest management, production of quality planting materials through tissue culture and creation of repository of information related to all aspects of orchids in the country. On the basis of recommendations of RACs the research programmes have been modified on the mission oriented research projects on crop improvement, crop production, crop protection and post-harvest management.

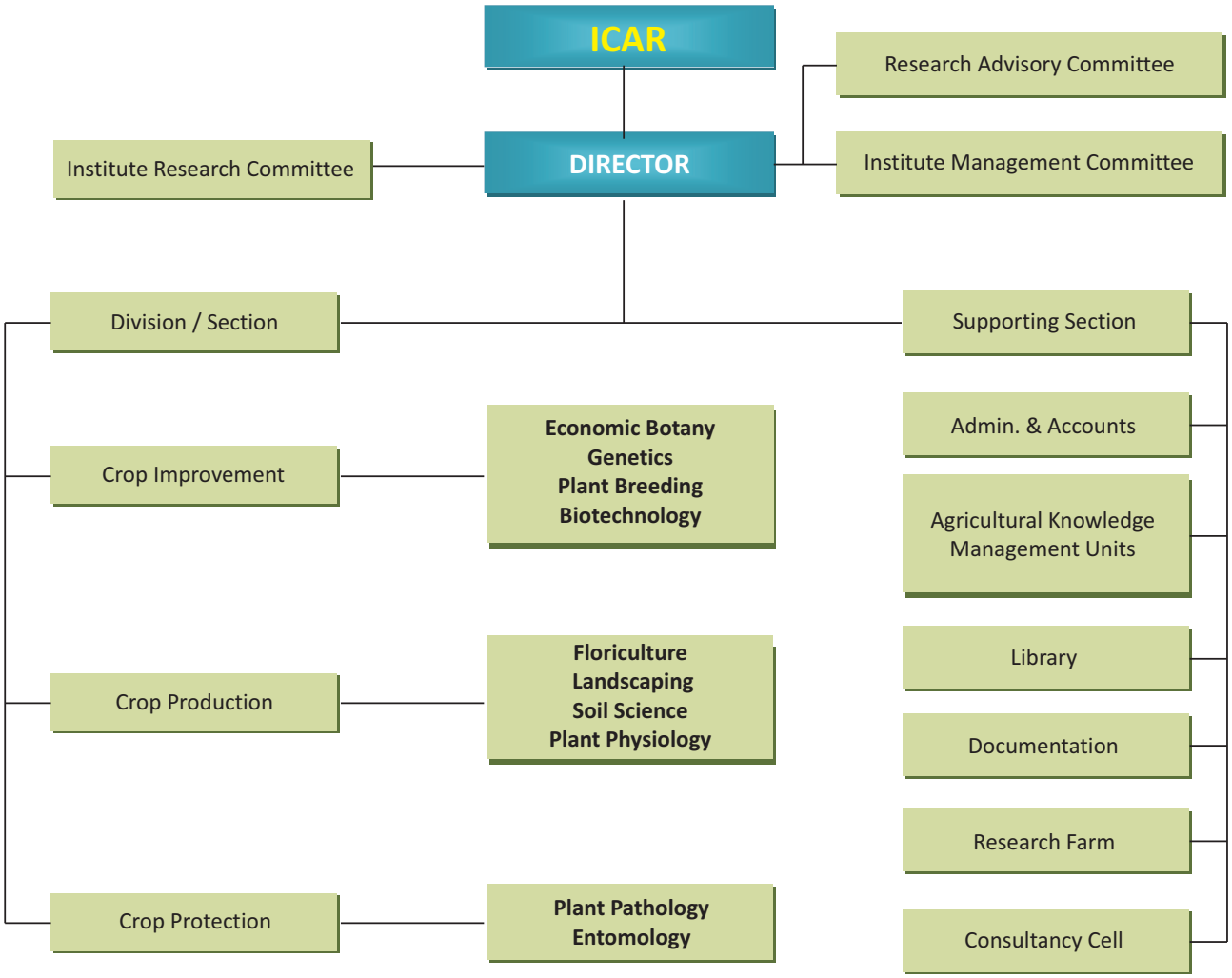
Mandate

- To collect, characterize, evaluate and conserve germplasm of orchids
- Molecular characterization to check biopiracy and IPR protection of orchids
- Development of protocol for mass multiplication
- Production of quality planting materials for large scale cultivation

  To develop hybrids/ varieties suitable for domestic and export market
- To develop production, protection, and post-harvest technologies for orchids
- To act as a national repository of scientific information on mandate crops
- To coordinate research with other scientific organizations and act as a centre for training

The research work is being carried out in 4 main institutional projects. In addition to these, research work is also being carried out under one externally funded projects *viz.*, Central Sector Scheme under PPV & FRA on Distinctiveness, Uniformity and Stability on Orchids (DUS) and two other schemes *viz*. IPR Scheme and DBT – Research Associateship program in Biotechnology and Life Sciences.

Organizational setup



Organogram of ICAR-NRC Orchids

Organization

The Director is the administrative head of the Institute. The Institute Management Committee, Research Advisory Committee and Institute Research Council assist the Director in the matters relating to management and research activities of the Institute. Research on various aspects of mandate crops is conducted in three areas namely Crop Improvement, Crop Production and Crop Protection. The supporting sections include Administration & Accounts, AKMU, Library, Documentation and Consultancy Cell.

Financial statement

Amount (Rs. in Lakhs)

Head of Account	Plan		Non-Plan	
	Sanctioned	Utilized	Sanctioned	Utilized
Establishment charges	0	0	252.29	243.58
Labour wages	0	0	16.00	15.88
Traveling allowances	10.20	10.20	6.00	6.00
Other charges	105.58	105.58	43.71	43.71
Works	30.00	30.00	0	0
HRD	2.22	2.22	0	0
Total	**148.00**	**148.00**	**318.00**	**309.17**

Revenue generation

Amount (Rupees)

Particulars	Total Amount
Sale of farm produce	7,000.00
Sale of tender form	5,000.00
Training	00
Others	3,94,646.00
Total	**4,06,646.00**

Staff position of the Institute (as on 31.03.2014)

Sl. No.	Category	Sanctioned strength	In position	Vacant
1.	Director	01	01	-
2.	**Scientific Post**			
	Scientist	10	06	03
	Sr. Scientist	03	02	01
	Principal Scientist	01	02	-
Total		**15**	**11**	**04**
3.	**Technical Staff**			
	Category - I	05	05	-
	Category - II	02	01	01
	Category - III	-	-	-
Total		**07**	**06**	**01**
4.	**Administrative Post**			
	Administrative Officer	01	-	01
	Asstt. Fin. & Account Officer	01	01	-
	Asstt. Admn. Officer	01	00	01
	Assistant	03	01	02
	PA to Director	01	01	-
	U.D.C/Sr. Clerk	01	01	-
	L.D.C/Jr. Clerk	02	02	-
Total		**10**	**06**	**04**
5.	**Supporting Staff (SSG-I, II, III, IV)**	08	07	1

Past achievements

A survey was carried out at Kodagu region of Western Ghats during June to August and 40 species were recorded. The collections were added to NAGS (Orchids) for conservation. Three varieties *viz.,Cymbidium* 'B. S. Basnet', *Aranda* 'Kunga Gyatso' and *Dendrobium* 'V. Nagaraju' were released at institute level.

Two *Cymbidium* crosses have been registered with International Cultivar Registration Authority for Orchid Hybrids, Royal Horticultural Society as 'Darjeeling Nymph' and

'Darjeeling's Delight'. Ten clones from these crosses suitable for cut flower and pot plant have been selected for multiplication.

Total 10 superior breeding lines were identified after selection from crosses *viz.*, PBX-05-772, PBX-05-751, NRCO/HxB, NRCO/BxH and NRCO/PlxPw. The *in-vitro* seed germination protocol for seed crosses of *Phalaenopsis* (PBX-12-99) and *Paphiopedilum* (PBX-11-162 & 165) was standardized.

Simple sequence repeat (SSR) markers were used to determine the genetic relationship among 20 species of medicinal *Dendrobium* orchids. Four SSR primers sets had amplified a total of 149 loci and produced total 75 polymorphic bands; with high Rp and PIC value indicating the efficiency of primers capable of detecting polymorphism.

DNA Barcoding of native 18 *Vanda* species was done using 6 microsatellite markers (bar code primers) and the results are to be submitted in NCBI. Sequence characterized amplified regions (SCAR) method was used to study 24 native species of *Cymbidium* orchids as SCAR markers reactions provided more polymorphic markers on a per reaction basis than RAPD.

One patent filed under Indian Patent Application No.826/KOL/2013 of 11.07.2013 in the name of INDIAN COUNCIL OF AGRICULTURAL RESEARCH on a simple modified CTAB method for isolation of high quality genomic DNA from fresh matured leaves of orchids.

The mesophyll cell collapse of *Phalaenopsis* caused by low temperature occurred in severe winter, when the air temperature goes down below 10^0C and water temperature ranges within 4-5^0C. Water content of plant parts of *Dendrobium* 'Thongchai Gold' deteriorate drastically after withheld of 20th day of emergence of flower spike. The normal growth can be recovered after 60 days of emergence.

Cocopeat is a better growing media for hardening tissue cultured plantlets of *Zygopetalum*as compared to sand, moss and leaf mould. High radical scavenging activity was observed in the stem of *Aerides odoratum*. The optimum temperature for hardening is 25^0C.

In *Phalaenopsis*, Brother & White, Kaleidoscope, Maki Watanabe, Ox Prince Thunder, Strawberry, Memoria Francis Hunter, ChianXen Magpie and Hsing Ying Fortune were found promising almost round the year except December and January.

Potting mixtures for *Cymbidium* (Cocochips + Cocopeat + Brick pieces + Slow release fertilizer (3:1:1:1 g), *Dendrobium* (Coco peat + brick pieces + tree bark (1:1:1) and *Cattleya* (Cocochips + brick piece + leaf mould/leaf fern (1:1:1) standardized. Techniques for round the year cultivation of *Dendrobium* and *Phalaenopsis* developed by selecting different hybrids. Herbarium for 60 endangered orchid species prepared in conventional way.

Chemical preservatives for pulsing (5% sucrose), impregnation (1000 ppm $CoCl_2$), bud opening (4% sugar + 200 ppm salicylic acid), vase solutions (2% sucrose + 200 ppm 8-HQS) and packaging materials (Cellophane papers) of *Cymbidium* and *Dendrobium* orchids identified for enhanced vase life.

Virus indexing results revealed that *Cymbidium* and other hybrids were contaminated with CymMV and ORSV while orchid species collected from natural habitats are found free from viruses. Orchid fleck virus (OFV) has been

reported from many orchid species from Sikkim and Darjeeling hills.The etiology of black leaf spot disease of *Aranda* and *Mokara* hybrids has been established. The disease found to be caused by *Pestalotia disseminata.* The efficacy of the different chemicals against the pathogen has been assayed *in-vitro* and found that Mancozeb (75% WP) at 100 ppm inhibit 100% growth of the fungus.

Based on monitoring several pests like mites, aphids, thrips, scale insects, shoot borer and other minor pests like grasshoppers, snails and slugs were found to infest different species and hybrids of orchids under polyhouse conditions. Diaspid scale insect, *Lepidosaphes pinnaeformis* reported as pest of several Cymbidium species and hybrids. Aphid, *Aulocorthum circumflexum* commonly called lily aphid reported as pest around 12 orchid species and hybrids. *Coccophagus ceroplastae*, an aphelinid wasp reported as a parasitoid of soft brown scale, *Coccus hesperidium* infesting orchids from Sikkim. Aphelinid wasp, *Aphytis* spp and *Pteroptrix* spp. Reported as parasitoid of Cymbidium scale, *Lepidosaphes pinnaeformis*. The biopesticide treatments *viz*., neem oil (0.03 EC (5%) with highest mortality (75%) of mites followed by *Allium sativum* @ 5% (72%) were found effective on *Cymbidium*.

In recent years, the centre has organized two (2) National Level Seminar on *'National Consultation for Production & Utilization of Orchids*' during 19-21st February, 2011and '*National Dialogue on Orchid Conservation & Sustainable Development for Community Development – 2013'* (NDOCSDCL 2013) held on March 8 – 9, 2013 at Gangtok (Sikkim) in collaboration with TOSI, Chandigarh.

The centre has also organized one short course on current trends in commercial floriculture and one training-cum Awareness programme on PPV & FRA for officers and scientists of ICAR and SAU to promote orchid research and development in the region. The centre has developed a library that plays an important role in serving scientific information specially orchids and other ornamental crops. During the year near about 115 reference books related to different subjects were purchased for strengthening the library facilities for scientists, technical staff and research scholars. Currently, the centre is subscribing for 17 journals including 6 foreign journals and 11 national magazines. The institute's publications were made available to more than 200 different organizations in the country.

The Center has established a strong linkages with DAC, Ministry of Agriculture; DBT, Ministry of S&T, New Delhi; IIHR, Bengalore, CITH, Srinagar, NBPGR New Delhi, IARI New Delhi, VPKAS, Almora, ICAR Research Complex for NEH Region, Barapani, HPKV, Palampur, CPCRI, Regional Centre, Kahikuchi, UHF, Solan, CPRI Regional Station Shillong, SKUAST (J) & (K), Srinagar, CAU, Imphal & Gangtok and AAU, Assam.

Research Achievements

Conservation, characterization and sustainable use of diversity in orchids

A comparative study of asymbiotic and symbiotic germination in selected species and hybrids of *Calanthe*, *Cymbidium* and *Paphiopedilum*

Ex vitro seed germination in orchids

The seeds of different orchid species belonging to genus *Calanthe*, *Paphiopedilum* and *Cymbidium* were packed and placed in their substratum or in the substratum of other species belonging to same genus for seed germination during the September 2014. The data on germination was recorded every three-month interval.

The seeds of *Calanthe brevicornu, C. puberula*, *C. patchystylix*, when germinated in its substratum, the swelling of embryo were recorded in all the species. However, it was accompanied by invasion of pests eating developing embryo or drying of embryo probably due to drop in temperature. In second observations, the swelling, splitting of testa cells, the formation of rhizoids and primordial leaf was recorded in *C. pachystylix* and *C. trulliformis* (Fig 1). In other species either swelling of the embryo or both swelling or splitting of testa cells was recorded.

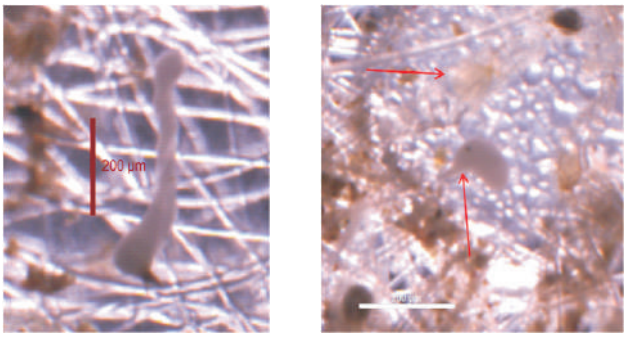


Fig 1. Ex vitro Seed germination in (a) C. pachystylis (b) C. trulliformis

The seed of *C. mannii in* the substratum of *C. brevicornu* and *C. trulliformis* showed embryo enlargement in the substratum of *C. brevicornu* while embryo growth, splitting of testa and formation of shoot primordia in *C. trulliformis*. Similarly, when the seed of *C. brevicornu* were grown in the substratum of *C. trulliformis*, *C. manniii*, *C. yuksomnensis* showed swelling of embryos, breaking of testa cells and formation of protocorm (Fig 2). The best germination of *C. brevicornu* seeds was observed in the substratum from *C. yuksomnensis*.

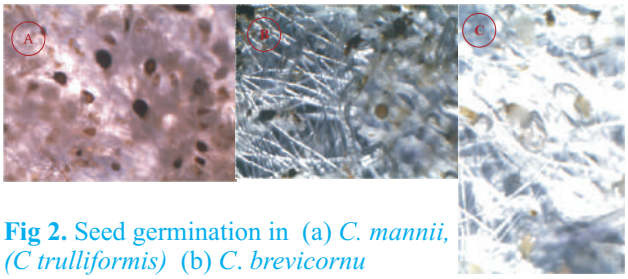


Fig 2. Seed germination in (a) *C. mannii, (C trulliformis)* (b) *C. brevicornu* (C. *trulliformis)* (c) *C.brecornu* (C. *yuksomnensis*)

The seeds of *Cymbidium erythraeum* when germinated on its own substratum the embryos swelled, testa split and the developed in to protocorms (Fig 3). However, seeds of *Paphiopedilum insigne* were germinated in its own substrate or *P. villosum* only swelling and split of testa was recorded. No further growth was observed during the period of study.

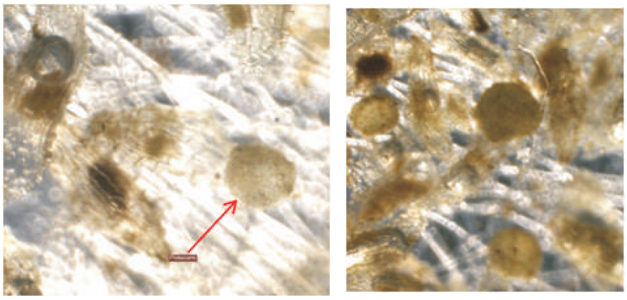


Fig 3. Seed germination in *Cymbidium erythraeum* in its substratum

The mature seeds of *Paphiopedilum* species and crosses were cultured on modified Nitsch & Nitsch medium. The stages of seed germination

and seedling development were recorded. The splitting of testa was observed 15-20 days after culture. The protocorm formation and initiation of primordial leaf varied between 28-46 days and 60-68 days respectively.

The mature seeds of *Cymbidium* and its crosses (10) were cultured on Mitra *et al.* medium and the stages of development were recorded. The swelling of embryos occurred 15-20 and the formation rhizoids were observed 28-42 days after culture. The formation of protocorm occured 45-60 days after the culture.

There were 50 species of orchid having medicinal properties as reported by BSI. Information on availability of location, flowering period and medicinal values were collected. The listed orchids are as follows.

Medicinal Plants of Sikkim

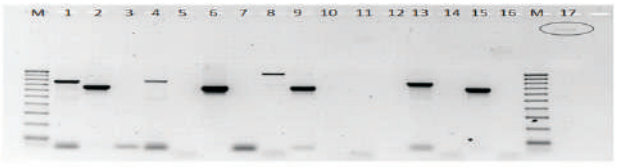
1. *Acampe papillosa* 2. *Aerides multiflora* 3. *Aerides odorata* 4. *Aorchis roborowskii* 5. *Aorchis spathulata* 6. *Arundina graminifolia* 7. *Bulbophyllum cariniflorum* 8. *Calanthe puberula* 9. *Calanthe tricarinata* 10. *Chusua nana* 11. *Coelogyne assamica* 12. *Coelogyne corymbosa* 13. *Coelogyne fuscescens* 14. *Coelogyne ovalis* 15. *Cymbidium longifolium* 16. *Dactylorhiza hatagirea* 17. *Dendrobium aphyllum* 18. *Dendrobium nobile* 19. *Epipactis helleborine* 20. *Eria amica* 21. *Eria bambusifolia* 22. *Eria muscicola* 23. *Eria pannea* 24. *Eria spicata* 25. *Eulophia dabia* 26. *Eulophia spectabilis* 27. *Flickingeria fugax* 28. *Geodorum densiflorum* 29. *Goodyera repens* 30. *Gymnadenia orchidis* 31. *Herminium lanceum* 32. *Liparis odorata* 33. *Luisia trichorrhiza* 34. *Malaxis acuminata* 35. *Malaxis muscifera* 36. *Nervilia aragoana* 37. *Papilionanthe teres* 38. *Pholidota articulate* 39. *Pholidota imbricate* 40. *Platanthera clavigera* 41. *Platanthera edgeworthii* 42. *Platanthera sikkimensis* 43. *Pleione maculata* 44. *Rhynchostylis retusa* 45. *Satyrium nepalense* 46. *Spiranthes sinensis* 47. *Tropidia curculigoides* 48. *Vanda cristata* 49. *Vanda testacea* 50. *Zeuxine flava*

Important medicinal species, which are rare and threatened like *Aorchis roborowskii, Chusua nana, Epipactis helleborine, Goodyera repens, Gymnadenia orchidis, Platanthera sikkimensis, Platanthera edgeworthii, Satyrium nepalense Spiranthes sinensis* were found at a range of 2,000 to 4,500 m altitude; *Aerides multiflora, Aerides odorata, Eulophia dabia, Eulophia spectabilis, Luisia trichorrhiza, Papilionanthe teres, Pholidota imbricata Vanda testacea, Zeuxine flava* are available at a range 200 to1,000 m altitude.

DNA Fingerprinting of Commercially Important Orchids

A simple improved protocol for isolation of Chloroplast DNA from orchids

A simple, improved and inexpensive method to obtain chloroplast DNA from orchid species was developed by modifying the existing protocols. Many protocols for extracting chloroplast DNA are not suitable for orchids having high secondary metabolites and do not produce sufficiently pure yields for High throughput sequencing from orchids (HTS). Moreover, the process require an ultracentrifugation step to efficiently separate chloroplast DNA from nuclear DNA. The developed method does not require an ultracentrifuge and produced high quality chloroplast DNA for High throughput sequencing (HTS).



Agarose gel showing PCR amplified cpDNA using ITS, rbcL and mat k primers (1 -16). M denotes 100 bp step ladder and lane 17 showing intact cpDNA.

Molecular Diversity analysis of native *Paphiopedilum* species using molecular markers

Analysis of molecular diversity of all native species of the genus *Paphiopedilum* was initiated using RAPD and ISSR markers (Fig 4).

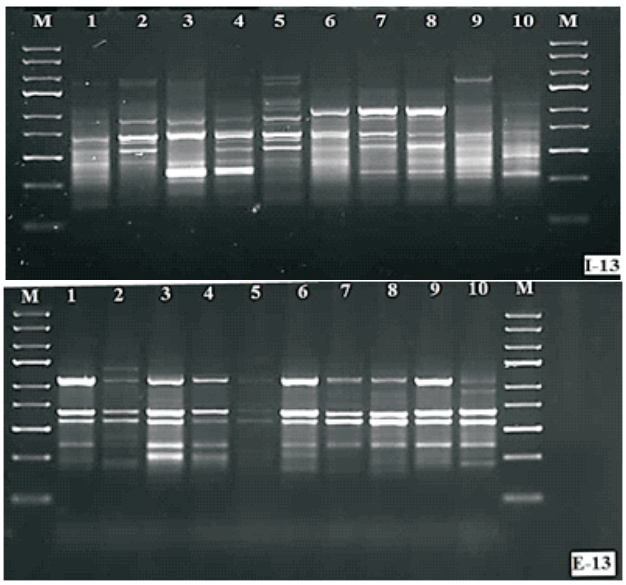
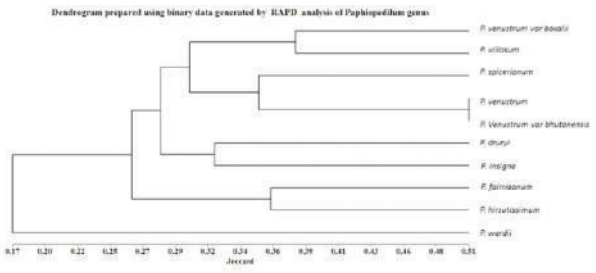


Fig 4. Banding pattern of 10 *Paphiopedilum* species generated using OPH I 13 and OPH E 13



Molecular Diversity analysis of native *Otochilus* species using molecular markers

Fingerprinting and diversity analysis of Indian *Otochilus* species were done using RAPD, ISSR and SSR markers (Fig 5, 6 & 7). 14 samples belonging to three Indian *Otochilus* species *viz*., *Otochilus albus, Otochilus fuscus* and *Otochilus lancilabius* were analysed for better resolution of inter and intra specific diversity within the genus. Total 40 RAPD, 24 ISSR and 30 SSR primers were used in this study and 26 RAPD, 16 ISSR and 12 SSR primers were selected, which produced promising, unbiased, reproducible bands. RAPD primers generated 328 polymorphic and 41 monomorphic and ISSR primers produced 190 bands of which 166 were polymorphic. Total 105 bands were reported form SSR study out of which 2 were monomorphic. Dendrogram was prepared using binary data retrieved from respective studies and it was found that the results on the minor cluster level were almost similar in all the marker systems. RAPD and SSR analysis shown promising similarity in results but results of ISSR analysis was different in the terms of properties of major cluster. A cumulative dendrogram was also produced using combined binary data produced from all the marker system and it was observed that the cumulative analysis resembled with the results of ISSR analysis suggesting high potential of ISSR primers in the area of fingerprinting and diversity analysis.

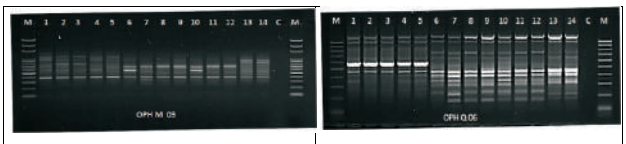


Fig 5. RAPD banding pattern of species of genus *Otochilus*

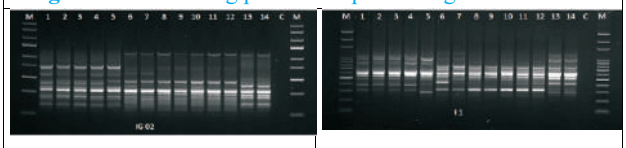


Fig 6. ISSR banding pattern of species of genus *Otochilus*

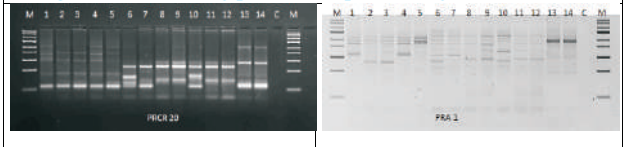
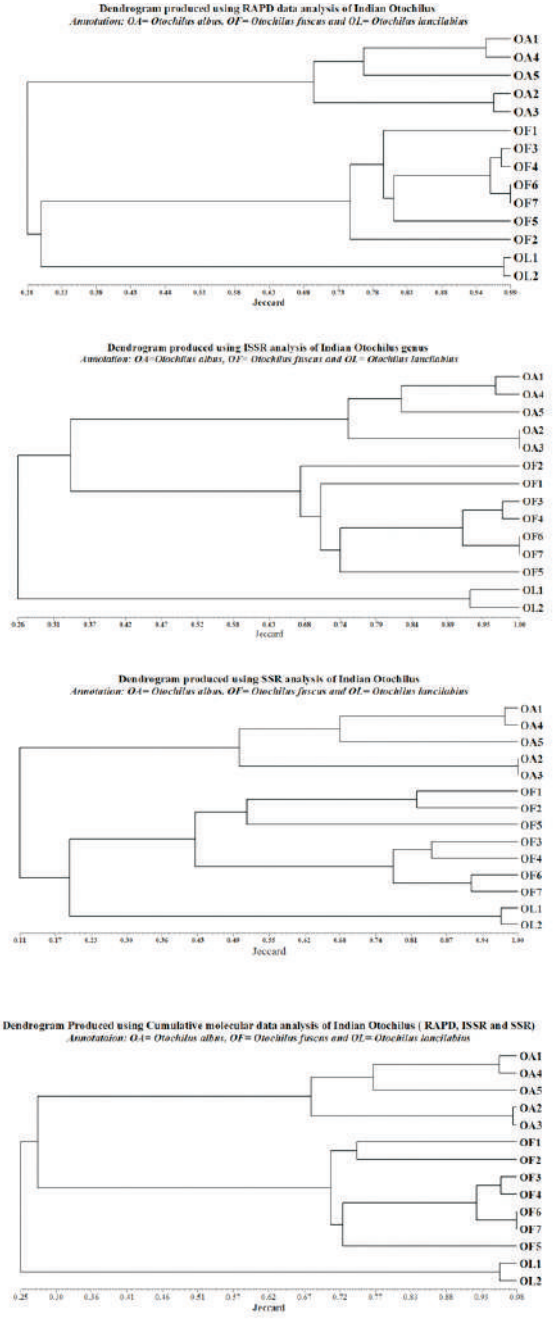


Fig7. SSR banding pattern of species of genus *Otochilus*



Molecular Diversity analysis of native medicinal *Dendrobium* species using molecular markers

Genetic diversity and relationships among 24 medicinal species of *Dendrobium* orchids collected from different geographical regions of India were assessed using (RAPD and ISSR) markers (Fig 8, 9 & 10).

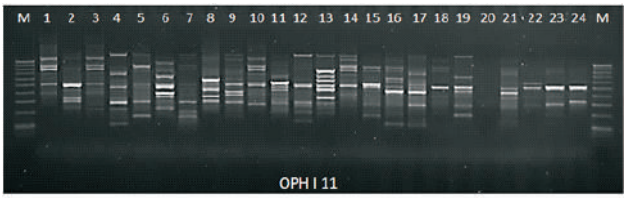


Fig 8. Banding pattern of 24 medicinal *Dendrobium* species generated by OPH I 11

Fourteen selected RAPD and 18 ISSR primers had amplified a total of 190 bands in RAPD of which all bands are polymorphic. ISSR markers generated 353 total bands of which 0.39 % *i.e.* 1 was monomorphic and 99.61 % *i.e.* 352 were polymorphic in nature. The size of the DNA fragments ranged from 50 – 2500 bp. A huge percentage of polymorphic bands indicated significant diversity within the genus. The average number of RAPD and ISSR bands generated per primer was very high showing high efficiency of both the techniques. Unweighted Pair Group Method with Arithmetic Mean (UPGMA) clustered all the species into three different major clusters.

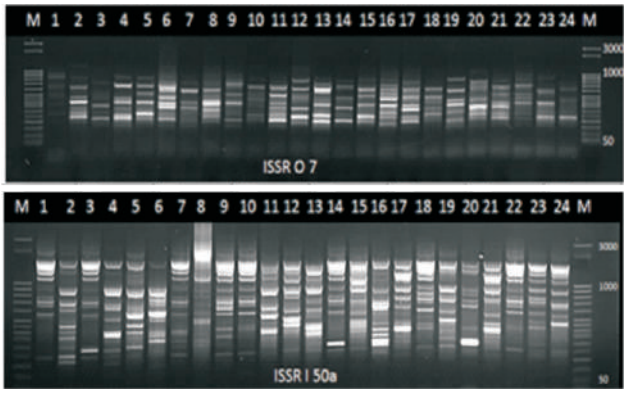


Fig 9. Banding pattern of 24 medicinal *Dendrobium* species generated by ISSR 07 and I50a

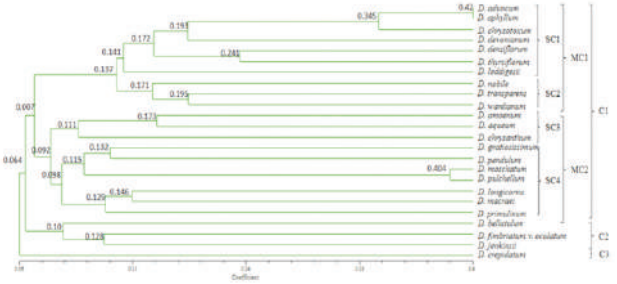


Fig 10. Dendrogram using binary data retrieved from ISSR banding pattern of 24 medicinal *Dendrobium* species

Molecular Analysis of some Fragrant *Dendrobium* Orchids of India Using ISSR Markers

Genetic diversity of 21 fragrant *Dendrobium* orchids of India was assayed using Inter Simple Sequence Repeats (ISSR) markers (Fig 11 & 12). Total of 1,631 loci were generated by 19 ISSR markers resulting from 233 bands indicating 93.7% polymorphism. The average heterozygosity or Polymorphic Information Content (PIC) was found to be 0.89 showing maximum allelic variation. The average resolving power (Rp) was also high indicating that all the primers used in this study were capable of detecting polymorphism very efficiently. The cluster analysis based on ISSR markers by using UPGMA method grouped the 21 *Dendrobium* Species into two major Clusters, The species *Dendrobium chrysanthum* formed a single cluster whereas the rest 20 *Dendrobium* species formed other cluster. The maximum diversity was observed between *Dendrobium chrysanthum* and *Dendrobium chrysotoxum* and minimum diversity or maximum similarity was observed between *Dendrobium aduncum* and *Dendrobium aphyllum.* The UPGMA dendrogram and the principal coordinate analysis revealed a clear differentiation between the species which reflects that ISSR profiling a powerful molecular method to determine the genetic relationship and diversity.

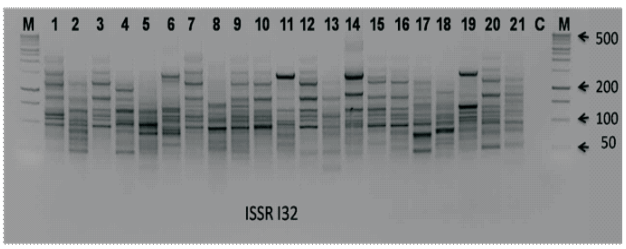


Fig 11. Banding pattern of 21 fragrant *Dendrobium* species generated using ISSR I 32

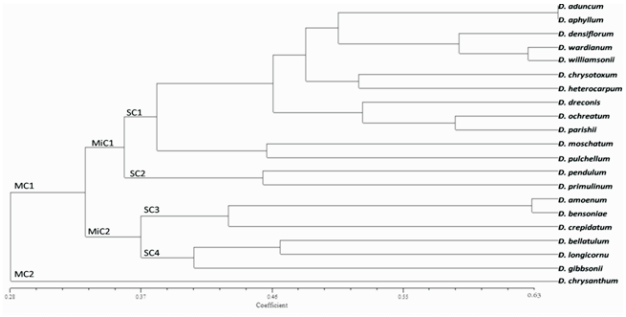


Fig 12 . Dendrogram retrieved from ISSR banding pattern of 21fragrant *Dendrobium* species

Assessment of Molecular Diversity of Native *Pleione*Orchids of India for breeding using RAPD and ISSR Markers

Pleione is a small group of commercially important genus occupied a significant position in ornamental orchids. Apart from ornamental value some wild species of *Pleione* orchids are used in traditional medicine for therapeutic value for many centuries in Asian countries. The genetic diversity of Indian *Pleione*is an unexploited resource for orchid breeding and the knowledge is very limited. Therefore, an attempt was made to know the genetic diversity and relatedness among 4 wild species of *Pleione* orchids of India for parent selection in breeding programme for development of commercial hybrids. Forty two RAPD and 15 selected ISSR markers generated a total of 363 RAPD and 101 ISSR fragments. In RAPD out of 363 bands, 7 bands were monomorphic and rest 356 were polymorphic, whereas in ISSR 97 were polymorphic and 04 were monomorphic. The size of the DNA fragments ranged in both markers ranged from 200 – 3000 bp in all species under study.

The average resolving power (Rp) and Polymorphism Information Content (PIC) value were very high, which indicate that all the primers used in this study were capable of detecting polymorphism very efficiently. The UPGMA

dendrogram grouped all four species in two distinct clusters (Fig 13).

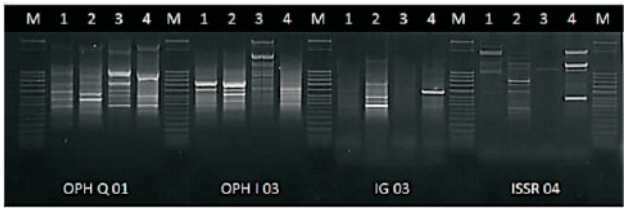
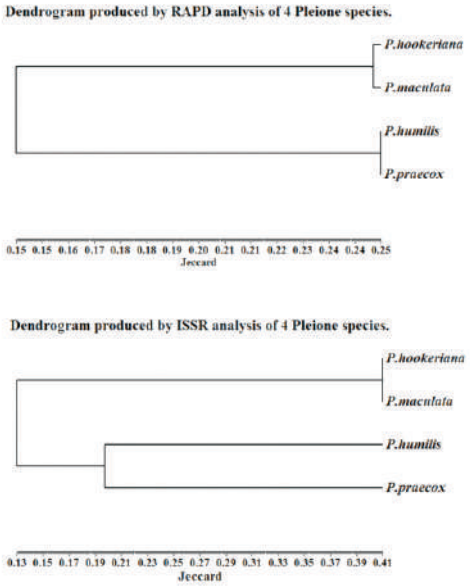


Fig 13. Banding pattern of 4 *Pleione* species by RAPD (First two) and ISSR (Last two) markers.



Genetic diversity analysis in *Cymbidium whiteae*, an rare endangered endemic orchid species of Sikkim Himalaya using ISSR markers

ISSR technique was used to analyse the genetic diversity of a very small population of endangered and endemic orchid species- *Cymbidium whiteae* from one location Rumtek of Sikkim Himalaya from where this species was rediscovered after a long period (Fig 14). The plants collected from this region did not show any morphological variations, but molecular analysis showed higher percentage of polymorphism within the population. Resolving power of the primers was high which suggested that the primers with high Rp values are able to distinguish the samples under study.

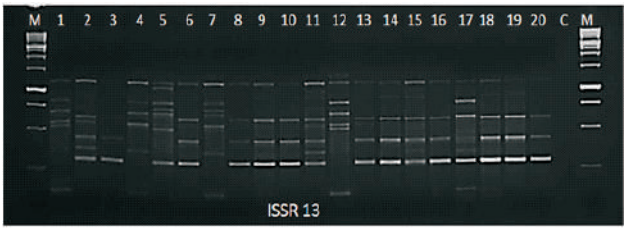


Fig 14. ISSR banding pattern of accession of *Cymbidium whiteae*

Intra -specific variability analysis of Himalayan orchid species *Smitinandia micrantha.*

Two variants having different flower colour (pink and white) was observed in *Smitinandia micrantha* which were collected from Dooars area of West Bengal. To study the differences in genetic level 40 RAPD primers were used.The results of the RAPD analysis did not reveal any significant difference among the variants and it may be stated that the alba flowers may be developed due to minor mutations, which is difficult to assess through RAPD technique.

Intra specific variability analysis of *Vanda cristata.*

Six types of phenotypic variations were observed within the collected samples of *Vanda cristata*. Some samples have bigger flowers than normal with pungent smell. RAPD analysis of 13 samples revealed variability within the species but phenotypic grouping was not supported by the genotypic analysis (Fig 15). All studied samples grouped into different clusters irrespective to their phenotypic grouping. It may be concluded that huge genotypic and phenotypic variations are exists within the species and a care should be taken while selecting parental line for development of hybrids.

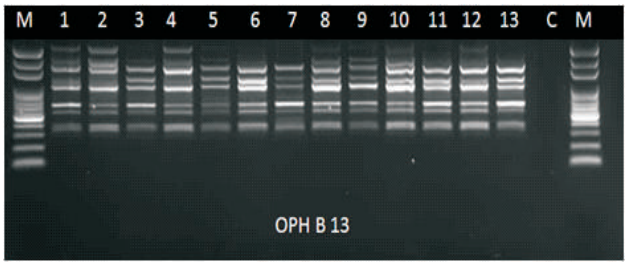


Fig 15. Banding pattern of 13 accessions of *Vanda cristata* generated using OPH B 13

Intra- specific variability analysis of *Coelogyne ovalis*

RAPD method was used to study the variation of four phenotypically variable samples of *Coelogyne ovalis*. Out of 20 primers, 18 had produced recordable results. Data analysis revealed two major clusters with 64% similarity suggesting a close ancestral relationship between two major types of genome under study (Fig 16). The Major cluster 1 had three individuals and within this major cluster sample a and sample c had shown 100% similarity, whereas 75% similarity was observed in sample b. Sample no. d had formed a different major cluster 2. Cause of dissimilarity within the major cluster may be due to the cross-pollinated nature of orchids.

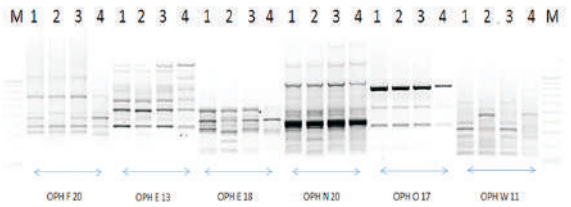
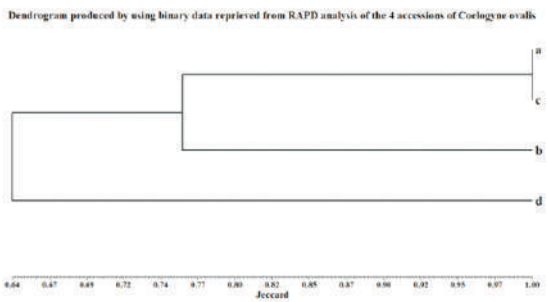


Fig 16. Banding pattern of 4 accessions of *Coelogyneovalis* generated by different RAPD primers



Microsatellite markers developed from Himalayan orchid species *Paphiopedilum fairrieanum*

In orchids very few microsatellite markers have been developed and that markers do not produced reproducible bands in native Indian species. Microsatellite marker development was made from native orchid species *Paphiopedilum fairrieanum* using Library enrichment method. Restriction fragments were obtained by using six combinations of rare and frequent cutters. After library enrichment, PCR cloning was done using pUC19 plasmids. Competent *E. coli* cells were prepared and transformed with cloned plasmids. Positive transformants were selected using selective medium (Ampicillin). Positive colonies were picked and cultured in selective medium and plasmids were isolated. These plasmids will be subjected to sequencing and markers will be developed from sequence data.

DNA bar coding of native *Vanda* species

Seventy eight DNA barcode sequences of native *Vanda* species were submitted in Gen Bank. Among the sequences 31 chloroplast DNA sequences of RNA polymerase C (rpoC1) gene, 27 sequences of RNA polymerase beta subunit (rpoB) gene of chloroplast DNA, 7 matK sequences and 13 sequences of Internal Transcribe Spacer (ITS) of nuclear DNA. A unique identifier number or Accession No from NCBI were received. Most of the DNA barcode sequences were submitted for the first time (novel sequence) in the NCBI.

Tissue Culture

Shootlet differentiation with ABA and 2, 4- D in *Cymbidium* 'Soul Hunt'

An experiment was set up with nine different basal media (MS, G, Kn, N, MI, W, H, OMM & VW) along with ABA (0.2 mg/l) and 2, 4-D (0.5 mg/l), without sucrose and with activated charcoal. Fast response was with Gamborg media along with 2, 4-D (0.5 mg/l) without sucrose and with activated charcoal.

Induction of plbs from different explants of *Den*. 'Emma White'

An experiment was set up with eight different treatments with MS basal media, different concentration of BAP (1-3 mg/l) & NAA (0.5 mg/l) combinations, 2% sucrose and without activated charcoal. Different explants like shoot tip, leaf and roots were used for setting up of the experiment. Explants with shoot tips in MS with BAP 1 mg/l showed earlier swelling (10 days) of inoculation, without callusing gave rise to shootlets within 19 days of inoculation (Fig 17 & 18).

Micro propagation of two important endangered species

Micro-propagation of *Phalaenopsis mannii* an endangered orchid species from leaf, root and flower stalk ex-plant was initiated in MS media containing sucrose (2%) and different combination of NAA and BAP. Shoot proliferation and leaflet initiation was obtained from single node flower stalk explant in media supplemented with BAP within 10 to 20 days of culturing.

Micro-propagation of *Cymbidium ensifolium* and *Cymbidium tigrinum* two endangered species of Cymbidium genera was initiated from leaf explants using MS media with different combination of hormones and supplemented with banana extract or coconut water. The different treatment combinations had little or no effect as the leaf explants of *Cymbidium ensifolium* and *Cymbidium tigrinum* did not show any signs of swelling. The cut ends of the leaves showed browning 20 ± 5 days after culturing.

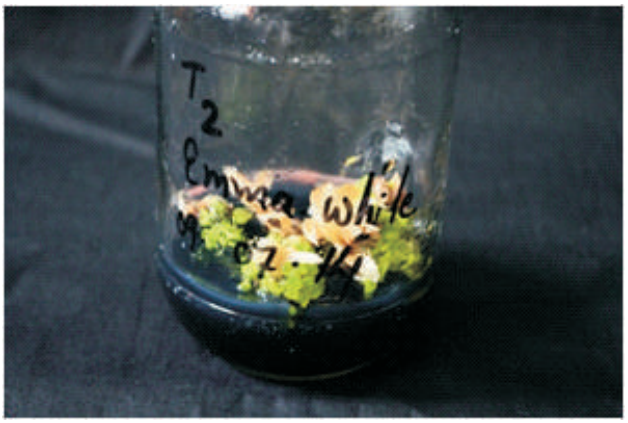


Fig 17. Callusing phase

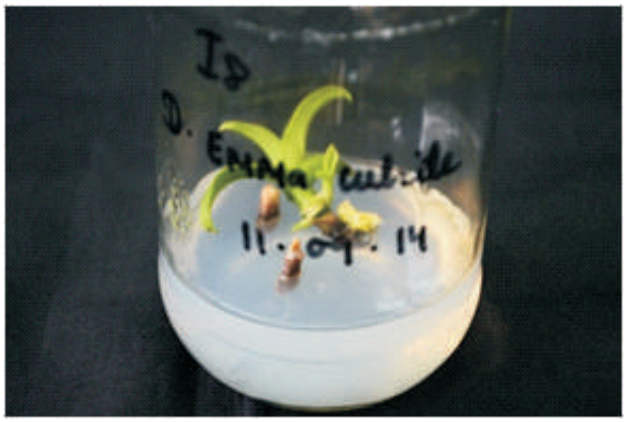


Fig 18. Direct shootlets formation

Genetic improvement of orchids for yield, quality and resistance to biotic and abiotic stresses

Hybrid/Varietal Development Programme for Orchids

Genetic Enhancement

Working collection of NAGS of orchids developed from base collections, *Vanilla* sp collected from CPCRI, Mohitnagar and *Calanthe triplicata* re-introduced multiplied through clonal multiplication. Taxonomic identification of NAGS collections was done *viz.,* NOAC#324 (*Dendrobium ovatum*) (Fig 19), NOAC#757 (*Eria tomentosa*) (Fig 20) & NOAC#1188 (*Micropera rostrata*) (Fig 21) with assistance from BSI, Gangtok. More than 100 NAGS accessions were supplied to Forest Department, Government of Nicobar Islands for 'Greater Nicobar Biosphere Reserve' (**GNBR**) by UNESCO under Man & Biosphere Programme from 2013. MTA is being signed for supply of NAGS accessions with BSI, Gangtok and Mizoram University, Aizwal.

Fig 19. *Dendrobiumovatum* (NOAC#324)

Fig 20. *Eriatomentosa* (NOAC#757)

Fig 21. *Micropera rostrata* (NOAC#1188)

Pod setting in crosses: More than 250 pollinations were done focusing intergeneric crosses, *Dendrobium*, *Vanda*, *Phalaenopsis*, *Renanthera* and *Phaphiopedilum* to assess the compatibility and success of pod setting. Successful pod setting achieved in Vanda group with large number of intergeneric crosses. Pod set development was also recorded with crosses from Kingidium, a closely related to Phalaenopsis genus (Fig 22, 23, 24, 25, 26 & 27).

Fig 22. (*Kingidium taenialis* x *V. coerulescens*)

Fig 23. (*Aranda* 'Kunga Gyatso' x V. *coerulescens*)

Fig 24. (*Den.* 'Bangkok Blue' x *D.* 'V. Nagaraju)

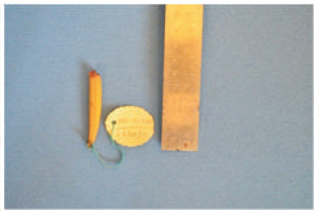


Fig 25. (*Arachnis rubra* x *Acampe rigida*)

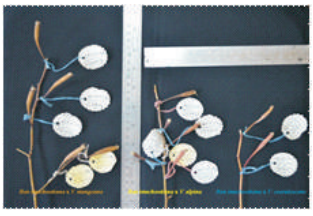


Fig 26. *Renanthera imschootiana* crosses

Fig 27. (*Ren. imschootiana* x *P. teres*)

Successful pod setting inter-generic crosses & Vanda crossing Programme

S. no	*Cross Code*	*Successful IGH & Vanda Crosses (2014-15)*
1	PBX-13-247	*V.* 'Motes Indigo' x *A. rubra*
2	PBX–13-258	*A. rigida* x *V. cristata*
3	PBX–13-134	*V. stangeana x V. alpina*
4	PBX–13-245	*Arachnis rubra* x *V. cristata*
5	PBX–13-234	*V. cristata* x V. 'Bernice Miller'
6	PBX–13-143	*Thunia marshalliana* x *Lycaste crueata*
7	PBX–13-126	*Hygrochilus parishii* x *V. cristata*
8	PBX–13-236	*V.* 'Bernice Miller' x *V. cristata*
9	PBX–13-235	*V. coerulea* x V. 'Bernice Miller'
10	PBX–13-121	*V. cristata* x *R. imschootiana*
11	PBX–13- 297	*Zygopetalum intermedium* x *Coelogyne punctulata*
12	PBX–13-260	*V.* 'Indigo Motes' x *V. cristata*
13	PBX–13-245	*V. cristata* x *A. rubra*
14	PBX-13-166	*R. imschootiana* x *Rhynchostylis retusa*
15	PBX–13-132	*R. imschootiana* x *V. alpina*
16	PBX–13-133	*R. imschootiana* x *V.* 'Bernice Miller'
17	PBX-13-141	*R.imschootiana* x *V. coerulescens*
18	PBX–13-127	*R. imschootiana* x *H. parishii*
19	PBX–13-141	*R.imschootiana* x *V. coerulescens*
20	PBX-13-167	*R.imschootiana* x *Aerides odoratum*
21	PBX-13-129	*R. imschootiana* x *V. stangeana*
22	PBX-13-122	*R. imschootiana* x *V. cristata*
23	PBX–12-320	*V. coerulea* x *V. coerulea*
24	PBX–13-367	*Vanda'* Bangsai Queen' x *Phalaenopsis* 'Brother & Sister'
25	PBX–13-350	*V. coerulescens* x V. 'Golden Dhillon'
26	PBX–13-331	*V. cristata* x *V. coerulea*
27	PBX–13-375	*V.* 'Bangsai Queen' x *V. coerulescens*

Successful pod setting from Back crossing & Top crossing:

S. no	*Cross Code*	*Pedigree*
1	PBX–13-313	(PBX-05-772) x *Cym. cyperifolium*
2	PBX–13-392	(PBX–05-34/61) x *Cym.* 'Star Guard Mc Angel'
3	PBX–12-313	(PBX-05-772) x *Cym. cyperifolium*
4	PBX-14-02	(*Cym* H x B/2013-25) x *C. eburneum*
5	PBX–13-414	(*Cym.* 'SS x PB') x (H x B/25)
6	PBX–13-416	(Cym 'SS x PB') x (H x B/17)
7	PBX-13-422	*Aranda* ´Kunga Gyatso' x *V. coerulescens*
8	PBX–13-391	(PBX-05-34/31) x *Cym.* 'Star Guard Mc Angel'
9	PBX-14-24	*Aranda* 'Kunga Gyatso' x *V. cristata*
10	PBX–13-336	*Cym. mastersii* x (PBX-05-772/116/2013)
11	PBX-13-418	(*Cym.* 'SS x PB') x (*Cym.* H x B/17)
12	PBX-1 3-388	(PBX-05-34/28) x (PBX-05-752/1)
13	PBX–13-340	(PBX-05-751/01/2013) x *Cym. mastersii*
14	PBX–13-335	*Cym. mastersii* x (PBX-05-772/84/2013)
15	PBX–13-338	*Cym.* 'Golden Elf' x (PBx-05-751/01/2013)
16	PBX–13-390	(PBX-05-34/64) x (PBx-05-772/116)
17	PBX–13-393	(PBX-05-772/116) x *Cym.* 'Star Guard Mc Angel'
18	PBX–13–355	*Cym.* 'Sleeping Nymph' x (PBX-05-772/116)
19	PBX–13-389	(PBX- 05-34/28) x (PBX- 05-772/116)

Parental characterization: Nineteen accessions were morphologically characterized for parental data as per standard descriptors (Fig 28, 29, 30 & 31).

Fig 28. *Kingidium taenialis*

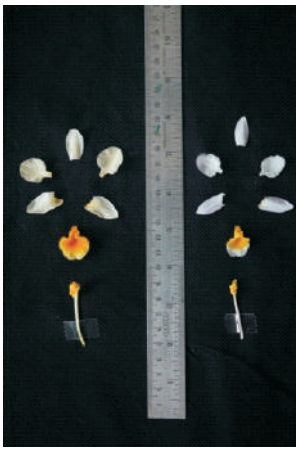


Fig 29. *Den thrysiflorum* vs *D. farmeri*

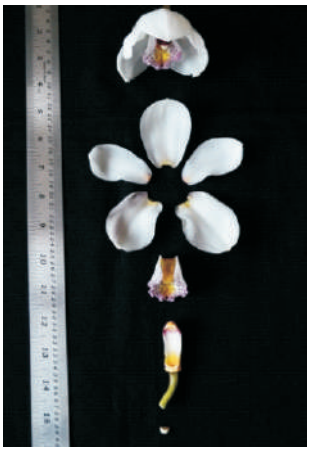


Fig 30. *Cym* 'Star Guard Mc Angel'

Fig 31. *Cymbidium hookerianum*

New hybrids denominations proposed

Based on earlier RAC recommendations and station trial data for 2 - 3 consecutive years evaluation, the following selected lines were proposed for denominations. During 2013-14, three varieties were identified for institutional release.

1. **NRCO (HxB)/25/2012:** Mid to late flowering line suitable for potted variety derived from cross, *Cymbidium lowianum* x *Cym*. 'Show Girl'. The spike length ranges 45 - 48 cm with 9-10 florets with unique deep greyed purple lip color (RHS/187B). The flower size – 6.75 cm x 4.4 cm with dominating yellow-green color (RHS/151B) and with greyed orange color (RHS 177B) towards center & peripheral area of sepals. Potted vase life more 90 days and proposed denomination as ***Cymbidium* 'Neo Basnet-1'** that is consistent in flowering (Fig 32).

2. **NRCO(HxB)/17/2012:** Mid to late flowering line suitable for potted variety derived from cross, *Cymbidium lowianum* x Cym 'Show Girl'. The spike length relatively medium around 45 cm with 11-12 florets opening from top, having red color patch (RHS/53A) at tip of lip. The flower size – 6.2 cm x 5 cm with dominating green-yellow color (RHS/1C), with yellow green color (RHS/N144A) venation suffused with greyed orange color (RHS/177A) towards base. The potted vase life below 90 days and proposed denomination as ***Cymbidium* 'Neo Basnet-2'**, which is consistent in flowering (Fig 33).

3. **NRCO(BxH)/34/2008:** Mid to late flowering potted line derived from reciprocal cross of *Cymbidium lowianum* x Cym 'Show Girl'. The spike length relatively medium around 45 cm with 10 -11dark colored flowers. The flower size – 7.2 cm x 6.5 cm with dominating green-yellow color (RHS/1C) suffused with orange red color (RHS/N34A) present on sepals and petals. The potted vase life around 70 days, and proposed denomination as ***Cymbidium* 'Neo Basnet-3'**, which has alternate flowering habit (Fig 34).

Fig 32. *Cymbidium* 'Neo Basnet-1'

Fig 33. *Cymbidium* 'Neo Basnet-2'

Fig 34. *Cymbidium* 'Neo Basnet-3'

4. **NRCO(PlxPw)/29/2013:** Selected progeny line with early flowering (Nov) highly suitable for potted variety derived from cross, *Paphiopedilum lawrenceanum* x *Paph.* 'Winston Churchill'. The peduncle length measures around 19.75 cm with girth of 0.54 cm in deep shiny purple color. The flower size – 13.7 cm x 13.1 cm with dominating hood shaped dorsal sepal in pure white color from peripheral margin towards basal portion, which is suffused in yellow-green color (RHS/N114C/B) with purple spots (RHSN79B). Petals – prominent, broad and oblong spathulate shape with recurved lobes and 3 pointed dents at tip. The potted vase life > 4 months, and proposed denomination as ***Paphiopedilum*** **'Tara-1'**, which has regular flowering habit (Fig 35).

5. **NRCO(PlxPw)/19/2013:** Selected progeny line with flowering in 2nd Wk of Nov suitable for potted variety derived from cross, *Paphiopedilum lawrenceanum* x *Paph.* 'Winston Churchill'. Peduncle – stout, measures around 18 cm length with girth of 11.30 mm with deep shiny purple hairs on greenish yellow color background. The flower size – 13.2 cm x 13.8 cm with dominating in width. Dorsal sepal dominated by unique watery deep purple color spots of 1 to 4 mm size on veins in the yellow-green color (RHS/151B) middle portion from base. Petals – tan colored, oriented downside with upper & lower margins out curved and 3 pointed dents at tip. The potted vase life > 3 ½ months, and proposed denomination as ***Paphiopedilum*** **'Tara-2'**, which has regular flowering habit (Fig 37).

6. **NRCO(PlxPw)/10/2013:** Selected progeny line with mid flowering in Dec. suitable for potted variety derived from cross, *Paphiopedilum lawrenceanum* x *Paph.* 'Winston Churchill'. Peduncle – stout, measures above 20 cm length and girth of 10.85 mm with deep shiny purple hairs on greenish yellow color background. The flower size – 11 cm x 11.6 cm with dominating width. Dorsal sepal unique with semi-flat nature with prominent central median vein and 1 to 3 mm circular purple color spots run along veins. Petals – greyed orange colored (RHS/165B/A) with yellow-green color margin and curved back & unequal tip. The potted vase life > 3 ½ months, and proposed denomination as ***Paphiopedilum*** **'Lungta'**, which has regular flowering habit (Fig 38).

7. **NRCO(PlxPw)/31-36/2013:** Early flowering progeny (3rdWk, Oct) suitable for potted variety derived from cross, *Paphiopedilum lawrenceanum* x *Paph.* 'Winston Churchill'. Peduncle – thin, measures around 11.72 cm length & girth of 3.95 mm with deep shiny purple hairs on pale greenish color background. The flower size – 9.56 cm x 10.86 cm with dominating width and lip. Dorsal sepal unique with semi-funnel shape and having purple color pigmentation (RHS/N79C-D) on ventral side across. Petals – have deep median vein in brownish purple color (RHS/(B) and extending forward. The potted vase life ranges 5 - 5½ months, and proposed denomination as ***Paphiopedilum*** **'Nongstoin'**, which has profuse side shoot multiplication & regular flowering habit (Fig 36).

Fig 35. *Paphiopedilum* 'Tara-1'

Fig 36. *Paphiopedilum* 'Nongstoin'

Fig 37. *Paphiopedilum* 'Tara-2'

Fig 38. *Paphiopedilum* 'Lungta'

New NRCO progeny lines characterized

a. NRCO-SSxPB/2014: Late flowering progeny line of cross (*Cymbidium* 'September Sunset' x *C.* 'Palkibaris') was characterized. Medium size plant suitable as potted variety having spike length of 26 cm with 6 florets. Flower size – 6 cm x 8 cm in yellow-green color (RHS/150D) with pale red purple color (RHS/59B) median vein on sepals. Anterior lobe o flip has typical dark red purple (RHS/59A) patches and spots.

b. NRCO-BxH/2013: Four flowering progeny lines of cross (*Cymbidium* 'Show Girl' x *C. lowianum*) *viz.*, 16, 35, 12 & 36 were characterized. These progeny lines were mid to late flowering from Feb-Mar with larger colour gradient between both parents.

c. PBX-05-772/2013: Four flowering progeny lines of cross (*Cymbidium* 'Concerto' x *C. iridiodes*) *viz.,* 8, 25 75, 79, 82 & 121 were characterized. These lines have early flowering nature (September' 2nd Wk) and scented nature.

d. PBX-05-29/2014/31: Progeny line of cross (*Cymbidium* 'Golden Elf' x *Cymbidium* 'Red Beauty') flowered (2nd wk of Oct) with attractive red-purple color (RHS/69A) with medium size flowers (8 x 5 cm). Lip – attractive color, modern having typical elongated strips on anterior lobe and spots on side lobes (Fig 39).

e. NRCO-H x B/2013: Three progeny of cross (*Cymbidium lowianum* x *C.* 'Show Girl') were being evaluated and characterized for morpho-floral attributes. The flowering period ranges from mid to late season having mild scented nature.

f. NRCO-PlxPw/2014: The 22 progeny lines of cross (*Paphiopedilum lawrenceanum* x *P.* 'Winstone Churchill') *viz.*, 3, 4, 10, 13, 17, 18, 19, 20, 23, 26, 27, 28, 29, 30, 31, 32, 34, 35, 36, 37, 38 & 39 were evaluated for all floral traits for selection. A set of progeny lines were displayed at White Hall Exhibition Centre, Gangtok during flowering time for selection as per recommendations by 15th RAC meeting (Fig 40).

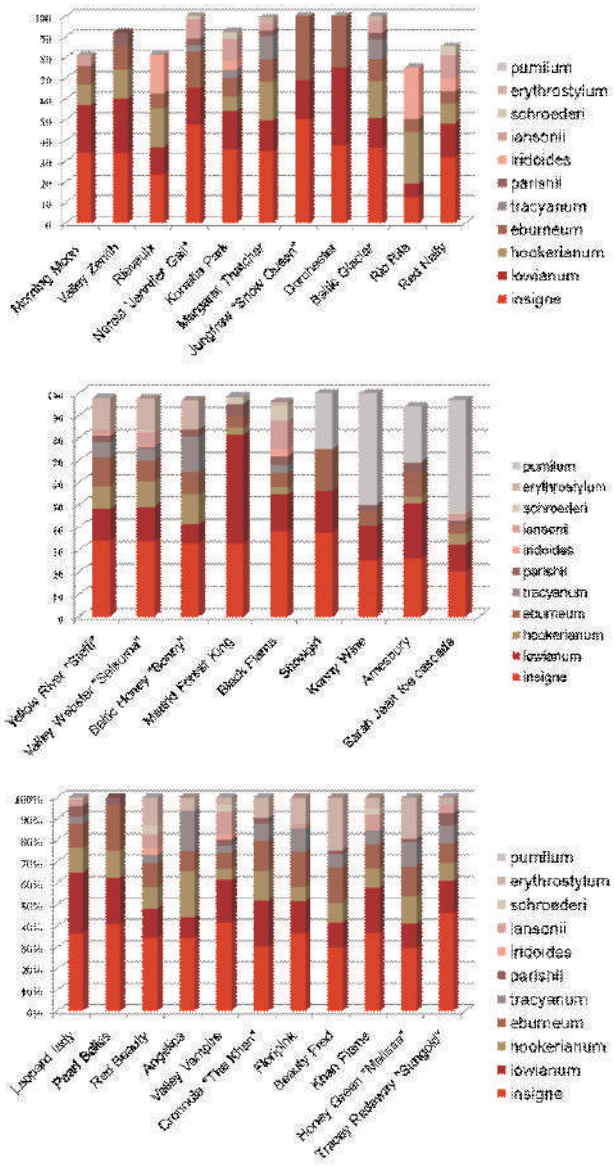
Fig 39. PBX-05-29/2014/31

Fig 40. Display at White hall, Gangtok

Genetic improvement of Cymbidium orchids for cut and pot flower

Characterization of hybrids and selection of parental stocks

Data was recorded for the hybrids which came to flowering during the current year for flowering behavior. Species composition of all the collected hybrids was compiled and compared (Fig 41).



Based upon the *maturaseK (matK)* gene sequence available in NCBI databases for the species constituting the hybrids available with us and the species useful for breeding programme, a dendrogram was constructed based on neighbor joining method. This depicted the relationship as follows (Fig 42):

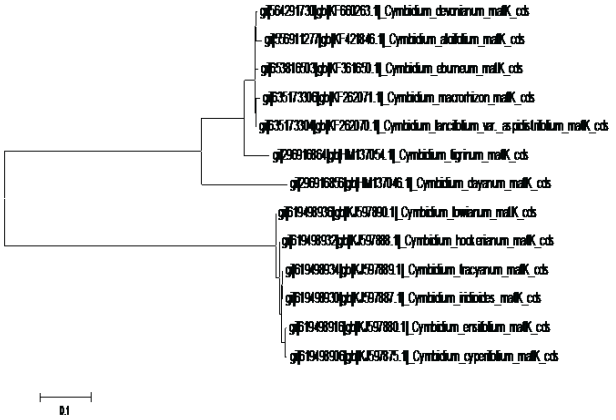


Fig 42. Clustering by neighbor joining for relevant *Cymbidium* species from sequence of *matK* gene

The following conclusions were drawn from the study:

1. Only 10 species of *Cymbidium* have contributed to the development of all the 32 hybrids.

2. For almost all the hybrids, four species have contributed major part of genome (namely *Cym. insigne, C. lowianum, C. eburneum* and C. *hookerianum*). *Cym. pumilum* have major contribution in the four potted type hybrids.

3. Based on phylogenetic analysis and morphological features of some of the available species; *Cym. devonianum, Cym. aloifolium* and *Cym. tigrinum* may be considered as potential species for our breeding programme with the collected stocks.

Crossing between hybrids, hybrids & species and different species

A total of 40 different crosses and selfings were attempted and successful seed setting was obtained only for five. There were 35 incompatible crosses/selfs. Most of the incompatibility reactions were recorded in terms of senescence within two months of crossing. However in many cases, capsule development was successful whereas no seed setting was recorded. The successful crosses have been harvested and submitted for seed culture at tissue culture laboratory of NRCO, Darjeeling Campus. Six crosses with *Cymbidium devonianum* was shown to have capsule development, out of which four did not show any seed setting (Fig 43). Two crosses are still growing.

Fig 43. Crosses of hybrids with *Cymbidiumdevonianum* as pollen parent showing capsule development without seed setting

The seed cultures of crosses of last year are at PLB stage and are expected to be taken for hardening during current year at NRCO, Darjeeling Campus.

Parthenogenesis/parthenocarpy induction and basic studies

A. Hormone induced parthenocarpy induction:

The same concentration and formulation of auxin (0.1 ppm solution) which induced parthenocarpy in *Cymbidium* "Pine Clash Moon Venus" was applied in 10 different hybrids. All the treated flowers displayed reddening, swelling and closing (though callus formation) of the columns and capsule development was obtained in seven of them. However in all the cases capsules were seedless which were similar to incompatible crosses (Fig 44 & 45). During current year, higher dose of hormone treatment in four more hybrids were applied for comparison.

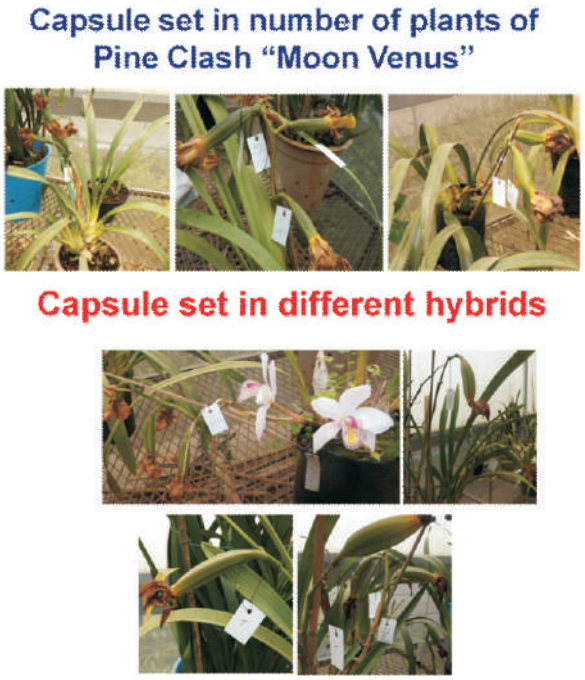


Fig 44. Capsule setting in Cymbidium hybrids without application of pollen and only by hormone treatment.

Fig 45. Capsule setting without seed set in a hormone induced capsule of *Cymbidium* hybrid

Treatments for breaking crossability barrier

During the study of previous two years, it was recorded and reported that successful crosses was not possible with crosses involving *Cymbidium* "Beauty Fred" and *Cymbidium* "Sarah Jeans Ice Cascade" as female parents. However during last year (2014-15) hormone treatment (auxin, 0.1 ppm) after two days (48 hours) of pollination was applied which successfully induced capsule development which is surviving till the date of reporting. After maturity if seed setting is recorded, it will be a useful protocol to break incompatibility of crosses in *Cymbidium*.

Study of mutant for Flower development in Cymbidium

One spontaneous bud mutant in Cymbidium was recorded which is possibly a mutation of "B" and "C" class of homeotic gene in *Cymbidium* hybrid "Soul Hunt-1" leading to development of seven tepals, three lips, three coloumns and three pollinia. Earlier year, we recorded a tentative null mutant for 'B' class homeotic gene where the petals (including lip which is a highly modified petal) were absent in the mutant as compared to wild type, besides absence of pollinia in the gynostemium (Fig 46). These two indicates the applicability of the 'ABCDE' model proposed for flower development in *Arabidopsis thaliana* and many other species in case of *Cymbidium* also.

Fig 46. Mutant type vs. Wild type flowers of *Cym.* hybrid "Soul Hunt-1"

Development and refinement of production and protection technologies for improved productivity, marketing and utilization of orchids

Development of Integrated Floriculture Enterprise

In this integrated approach, along with Cymbidium other high value floriculture crops like Lily, Carnation, Alstroemeria and potted plants were cultivated so that farmers can be benefited from the annual crops. Annual cut flowers were continued till the Cymbidium occupied whole the area (500 sq.m). Seven hybrids namely'Pine Class Moon Venus','Enshikhan', 'Soul-Hunt', 'Valley Legend Steffi' and 'Winter Beach Sea Green', 'Sleeping Nymph' and 'Korean -4' were grown in this experiment.

Production behavior: The production behaviour of the hybrids are PCMV-1.03/pot, Soul Hunt-6-1.00/pot, Valley Legend Stefi-1.00/pot, Sleeping Nymph-1.15/pot, Winter Beach Sea Green-1.15/pot, Korean-4 - 1.05/pot and Ensikhan-1.00/pot. Among the cut flower Valley Legend Stefi produced longer spike (80 cm), however potted hybrid Korean-4 produced spikes of 25 cm.

Planting material Production: 700 plants were propagated by treating back bulbs with Thiourea 5,000 ppm.

Benefit:Cost Ratio= 0.60

Flower drying in orchids

Out of 50 species and hybrids of orchids, full

bloom flowers oven dried at 60°C embedded in sand, *Papilionanthe teres*, *Vanda tessellata*, *Cattleya*, 'Guanamiau City', *Phalaenopsis* 'Casablanca, Detroit, Vienna, Taida S. Red, *Dendrobium moschatum*, *Dendrobium*, 'Lervia', 'Madam Pink', 'A. Abraham', *Oncidium*, 'Wildcat Bobcat', 'Taka Yellow', 'Sweet Sugar', *Arundina bamboosifolia*, *Epidendrum* spp., were found successful.

Post-harvest management of orchid florets

In *Cym*. 'PCMV', fully open florets had maximum vase life (48 days) followed by half open floret (41 days with 100% opening), loose bud florets (35 days with 50% opening) and tight bud florets (26 days with 25% opening). In *Cym*. 'PCMV', cellophane paper packing of fully open florets had maximum longevity (40 days) over tight bud florets (25 days) whereas in Cym. 'H.C. Aurora', cellophane paper packing of fully open florets had maximum longevity (38 days) over tight bud florets (32 days).

In elite *Cymbidium* hybrids, longevity of cellophane paper packing of fully open florets ranges from 15 days (Soul Hunt 6) to 39 days (Caripepper Peachy Keen) over unpacked florets *i.e.* 7 days (Samurai Hee Haw Sagun) to 22 days (Winter Beach Sea Green). In *Cattleya* hybrids, longevity of cellophane paper packing of fully open florets ranges from 14 to 45 days over unpacked florets *i.e.* 7 to 11 days.

In *Phalaenopsis* hybrids, longevity of cellophane paper packing of fully open florets ranges from 14 days (Phal. 'Boston') to 33 days (Phal. 'Ox Plum Rose x Black Jack').

Flower induction in orchids

Effect of Night Temperature on Growth of *Cymbidium* hybrid "Baltic Glacier Mint Ice" seedling

The orchids, like other plants, have resting period during winter, when water and nutrition requirements decrease and ultimately the plants growth ceases. Night temperature dropped down below 10 °C during winter in Pakyong, Sikkim is quite common. A comparative growth study was done between *Cymbidium* hybrid "Baltic Glacier Mint Ice" seedling (2 yrs old) plants grown in ambient temperature (12°C) and treatment night temperature 25°C. Plants grown in high night temperature treatment (HNT 25°C) showed higher percentage of increase in number of leaf, plant height, leaf width and most importantly pseudobulb size as shown in Table. 1

Table 1. Ambient and HNT influenced on growth of Cymbidium "Baltic Glacier Mint Ice seedlings"

Treatment	Plant Height	No. of leaf	Leaf width	Pseudobulb size
Ambient (12°C)	3.00	23.5	7.69	13.34
HNT (25°C)	19.44	24.98	7.89	26.63

Plants have to reach certain age or size to flower and HNT treatment might help the *Cymbidium* seedling to reach optimum size faster.

Effect of Light quantity on Growth of *Cymbidium* hybrid "Baltic Glacier Mint Ice" seedling

To the study the quantity of light required for growth of *Cymbidium* hybrid "Baltic Glacier Mint Ice" seedling, plants were grown for 75 days under 3 conditions *viz.,* 50% shade net (T1), half day under direct sunlight (T2) and under direct sunlight whole day (T3). Light was measured with Lux meter for 75 Days. The average light

received was T1: 29,279 Lux; T2: 50,540Lux and T3: 50, 999 Lux. The growth recorded is shown in Table 2.

Table 2.Vegetative growth of seedlings under different light quantity

Treatment	Plant Height	No. of leaf	Leaf width	Pseudobulb size
T1	5.05	17.39	1.59	6.03
T2	2.07	15.71	5.71	9.21
T3	3.26	10.29	2.01	8.24

Cymbidiums are known to require high light, however, full sunlight which can reached upto 1,00,000 Lux in bright sunny days is detrimental to plants. Exposing few hours to direct sunlight in the morning and protect from mid-day sunlight increased pseudobulb growth.

Flower induction in Phalaenopsis

Phalaenopsis flowered when Day temperature was set at 25°C ±2° Day and 17°C ±2° at Night. Flower was inhibited by day temperature >27°C ±2°.

Comparison of Light intensities on the growth and flowering of Phalaenopsis: Phalaenopsis plants were grown under High Light Intensity (HLI) 7400 Lux and Low Light Intensity (LLI) 1320 Lux and the Day temperature was set at 25°C ±2° and night temperature 20°C ±2°C . LLI plants had longer and wider but lesser leaves, which record 31% longer as compared to HLI. 1st Flower opening was 27 days earlier in HLI and also spike length was 48% longer and number of floral bud recorded was 38% Higher than LLI (Fig 47).

Effect of Light intensities on the growth and flowering of Dendrobium Hybrid (Emma White)

Den. 'Emma White' were grown under High Light Intensity (HLI) 11200 Lux and Low Light Intensity (LLI) 1800 Lux Day temperature was set at 25°C ±2° and night temperature 20°C ±2°C. LLI plants had longer and wider but lesser leaves, which record 9% longer as compared to HLI. 1st Flower opening was 17 days earlier in HLI and also spike length was 25% longer and number of floral bud recorded was 44% Higher than LLI.

Fig 47. Phalaenopsis plants grown under Intensity (HLI) 7400 Lux and Low Light Intensity (LLI) 1320 Lux

Physiological disorder of Orchids

Sun-scald: Phalaenopsis grown under 22,000 Lux, temperature 35 ±2 °C and humidity 50% showed the symptom of Sunscald (Fig 48). High sunlight initially causes leaf yellowing on the exposed foliage and latter turning to a thin white patch with a dark ring. This patch was dry and the damage was contained to this area. In severe case, the damage leaf turned brown and fell from the plants. Sun-scald can be prevented by growing plants under low light (<15,000 Lux), Low temperature <25°C and humidity >50%. The plants can recover again, however once the plant leaf was injured, the damage was irreversible.

Fig 48. Sun-scald in Phalaenopsis hybrid "Nagasaki"

Cold injury/Mesophyll cell collapse

Cold injury caused water-soak in tissues, followed by wilting and browning, surface lesions, pitting, sunken areas, discoloration, damage to the mesophyll cells and increased susceptibility to attack by fungi and bacteria (Fig 49).

Fig 49. Mesophyll cell collapse in *Paphiopedilumconcolor* (left) and Cold injury in Cattleya Hybrid (right)

Cold damage can be prevented by heating or warming the greenhouse, avoiding cold water for irrigation or misting and covering the plants with plastic or insulating wraps. Warm temperature, low light and high humidity should be provided to the injured plants and water shouldn't be given until new growth sprouts.

Ecofriendly Pest Management in Orchids

Monitoring of insect pests on Orchids

The constant observations have been recorded at weekly intervals for natural pest infestation on orchid germplasm and hybrids maintained at the National Research Centre for Orchids, Pakyong under polyhouse conditions. Several insects and non–insect pests like two-spotted spider mite, *Tetranychus urticae,* scale insects (*Lepidosaphes pinnaeformis, Diaspis biosduvalii, Coccus hesperidum, Chrysomphalus aonidum*), Thrips, *Dichromothrips nakahari,* Shoot borer, *Peridaedala* sp. was found to infest different species and hybrids of orchids. The incidence of mealy bugs and sap sucking beetles was also noticed on certain *Dendrobium* orchid species.

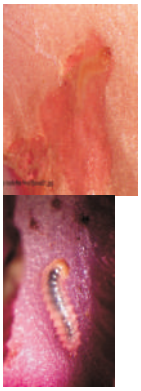


Fig 51. Pupa

Fig 52. Adult

Fig 53. Damage symptoms on flower

Fig 50. Grub of sap sucking beetle

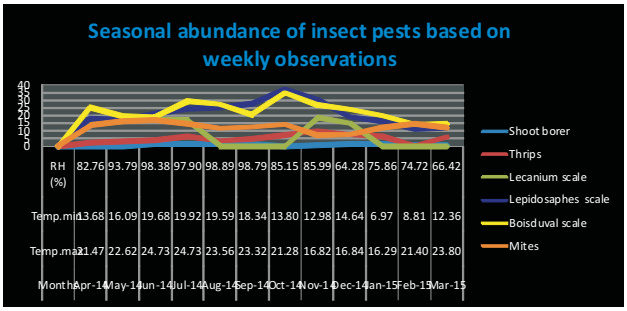


Fig 54. Seasonal abundance of insects pests based on weekly observations

Documentation of insect pests and natural enemies on orchids

Long tailed Mealy bugs

New identification and documentation of long tailed mealy bug (*Pseudococcus longispinus*). *Pseudococcus longispinus* has been found to infest the orchids *Dendrobium fimbriatum* and *Dendrobium chrysanthum* with a mean population of 15 numbers of mealy bugs per plant (Fig 55, 56 & 57).

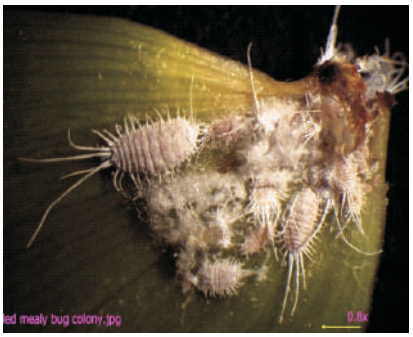


Fig 55. Mealy bug colony

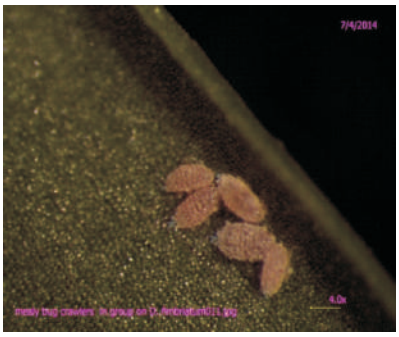


Fig 56. Mealy bug crawlers

Fig 57. Male winged mealy bug

New report of an *encyrtid wasp, Anagyrus sp.* (Howard) as a parasitoid of long tailed mealy bug, *Psuedococcus longispinus* and Mealy bug, *Pseudococcus sp.* infesting Orchids from Sikkim, India

An encyrtid wasp, *Anagyrus* sp. has been found to parasitize long tailed mealy bug, *Psuedococcus longispinus* and Mealy bug, *Pseudococcus* sp. infesting Orchids. The parasitized mealy bugs become mummified and swollen (Fig 58, 59 & 60).

Fig 58. *Pseudococcuslongispinus* colony

Fig 59. Swollen parasitized mealy bugs

Fig 60. Parasitoid *Anagyrus* sp.

Pest management in orchids

Botanical pesticides

An experiment was conducted to evaluate the relative efficacy of botanical products against mites on Cymbidium under polyhouse conditions. Nine treatments *viz.,* Ageratum Extract (10%), *Eupatorium odoratum* (10%), *Lantana camara* extract (10%), *Allium sativum* extract @ 5%, Allium cepa extract @ 5%, neem oil 0.03% EC 5 ml/L @ 5%, *Chlerodendrum viscosum* extract 10%, Miticide, Propargite @ 1 ml/L and control (water) was applied at 10 days interval. Highest mean population reduction in mites population was observed in plants treated with *Allium sativum* and neem oil with mean population reduction of 91.16 % and 86.80 % respectively.

Microbial biopesticides

- Different biopesticides and botanicals were evaluated for the management of thrips, *Dichromothrips nakahari* under polyhouse conditions. Nine treatments *viz*., *Beauveria bassiana* @ 2 ml/L water, *Metarhizium anisopliae* @ 2 ml/L water, *Verticillium lecanii* @ 2 gm/L water, *Chlerodendrum viscosum* extract (10%), *Artimessia* sp. neem oil 0.03% @ 5 ml/L, *Ageratum conizoides* extract (10%), *Lantana camara* extract (10%) and control (water treatment) was applied at 15 days interval. Highest mean reduction in thrips population was observed in plants treated with *Metarhizium anisopliae* @ 2 ml/L and *Verticillium lecanii* @ 2 ml/L with mean number of 3.00 and 2.67 thrips/plant after 14 days of treatment respectively.

- Different biopesticides and botanicals were evaluated for the management of Biosduval scale insect, *Diaspis biosduvalii* under polyhouse conditions. Nine treatments *viz.*, *Beauveria bassiana* @ 2 ml/L water, *Metarhizium anisopliae* @ 2 ml/L water, *Verticillium lecanii* @ 2 gm/L water, *Allium sativum* extract (5%), *Lantana camara* extract (10%), neem oil 0.03% @ 5l/L, *Ageratum conizoides* extract (10 and control (water) was applied at 15 days interval. Highest reduction in crawlers population was observed in plants treated with *Metarhizium anisopliae* @ 2 ml/L and *Verticillium lecanii* @ 2 ml/L with a mean precent reduction of 73.70% and 81.35% respectively.

Studies on per cent parasitization of cymbidium scale insect, *Lepidosaphes pinnaeformis* (Bouche)

The natural parasitization of Cymbidium scale, *Lepidosaphes pinnaeformis* by Aphelinid was parasitoid *Aphytis* sp. under polyhouse conditions was found to range from 6 - 38%.

Studies on per cent parasitization of soft Brown scale insect, *Coccushesperidum* Howard

The natural parasitization of soft Brown scale insect, *Coccus hesperidum* Howard by Aphelinid wasp parasitoid, *Coccophagus ceroplastae* (Howard) under polyhouse conditions was found to range from 5 - 45 %.

EXTERNALLY FUNDED PROJECTS

DUS Testing on Orchids: Preparation for Plant Varieties Protection and DUS Testing through ICAR - SAU System

- 30 hybrids of Cymbidium, 23 hybrids of *Vanda*, 14 hybrids of *Dendrobium*, 10 hybrids of *Oncidium*, 9 hybrids of *Cattleya* and 10 hybrids of *Phalaenopsis* maintained and multiplied under DUS project on Orchids.
- Morphological descriptors of *Paphiopedilum* (76) finalized and preparation of DUS Test Guidelines of *Paphiopedilum* is going on. DUS Test Guidelines of *Oncidium* published in PVJ of India under PPV & FRA in April 2014 issue and notified for registration by Plant Authority during October, 2014.

Other Schemes

Revolving Fund Scheme

Project is re-initiated for RFS of ICAR Seed Project in 2013 and Rs. 63,750/- was generated as revenue during last year. Rs. 43,525/- was generated in 2014-15 from sales of cultivated planting materials. The 12th plan proposal for horticulture component is submitted to CISH, Lucknow.

National Agriculture Innovation Foundation

ITMU unit of ICAR-NRCO is responsible for management of IP generated. Till date, *in-vitro* production protocols for three orchid species/hybrids, a slow release fertilizer, process of plb differentiation, one DNA isolation method, one *in-vitro* hardening protocol, DUS guidelines for three genus, 9 breeding lines and one hybrid variety and 39 novel barcoding sequences has been submitted to this unit from different sections of the institute for management. Technology profile of techniques developed in this institute has been created and is regularly updated. ITM unit has also filed a patent for the technology named a modified DNA isolation method form the leaves of orchids.

DBT-Research Associateship Program in Biotechnology and Life Sciences

Exploration of medicinal orchid species from North East India by using molecular tools

DNA is isolated for 55 medicinally important orchids.

3 Technology Assessed and Transfered

Training Programme

Date	Topic	Number of Participants	Category of Participants	Venue
25/06/2014 to 26/06/2014	Research planning in tissue culture lab	1	Student	ICAR-NRC for Orchids, Pakyong, Sikkim
23/08/2014	Orchid cultivation	10	Farmers (Dzongu)	ICAR-NRCO, Pakyong
05/09/2014	Commercial cut flowers and pot plants	25	Farmers	Upper Ecchay, Kalimpong
26/11/2014 to 29/11/2014	Orchid Cultivation	05	Farmers (Nongstoin West Khasi Hills)	ICAR-NRCO, Pakyong
16/12/2014	Quality Management Systems (ISO 9001-2008)	26	Scientists, Technical, administrative and other staff	ICAR-NRC for Orchids, Pakyong, Sikkim
18/12/2014 to 19/12/2014	Conservation and development Orchids in Darjeeling Himalayan Region	30	Farmers	Krishak Kalyan Sangthan, Kalimpong
29/01/2015	Production Technology of Orchids	30	Farmers	Geyzing, West Sikkim
05/02/2015	Production Technology of Orchids	34	Farmers	Namchi, South Sikkim
03/04/2015 to 05/04/2015	Post-harvest management and packaging of Cymbidium orchids	34	Farmers	ICAR-NRC for Orchids, Pakyong, Sikkim

Demonstration program

- Demonstrated the media preparation and potting in hardening house to Tribal Sub-Plan (TSP) farmers from Dzongu, North Sikkim (Fig 61) and West Khasi Hills District (Fig 62).
- Six offsite farm visits were conducted at Karthok, Assam Lingzey & Sombaria *etc*., for FLD programmes under institute projects.

Fig 61. Dzongu Farmers (23/08/14)

Fig 62. Nongstoin Farmers (Nov 26-29, 2014)

4 Participation of Scientists and other staff in Education & Training

Scientist

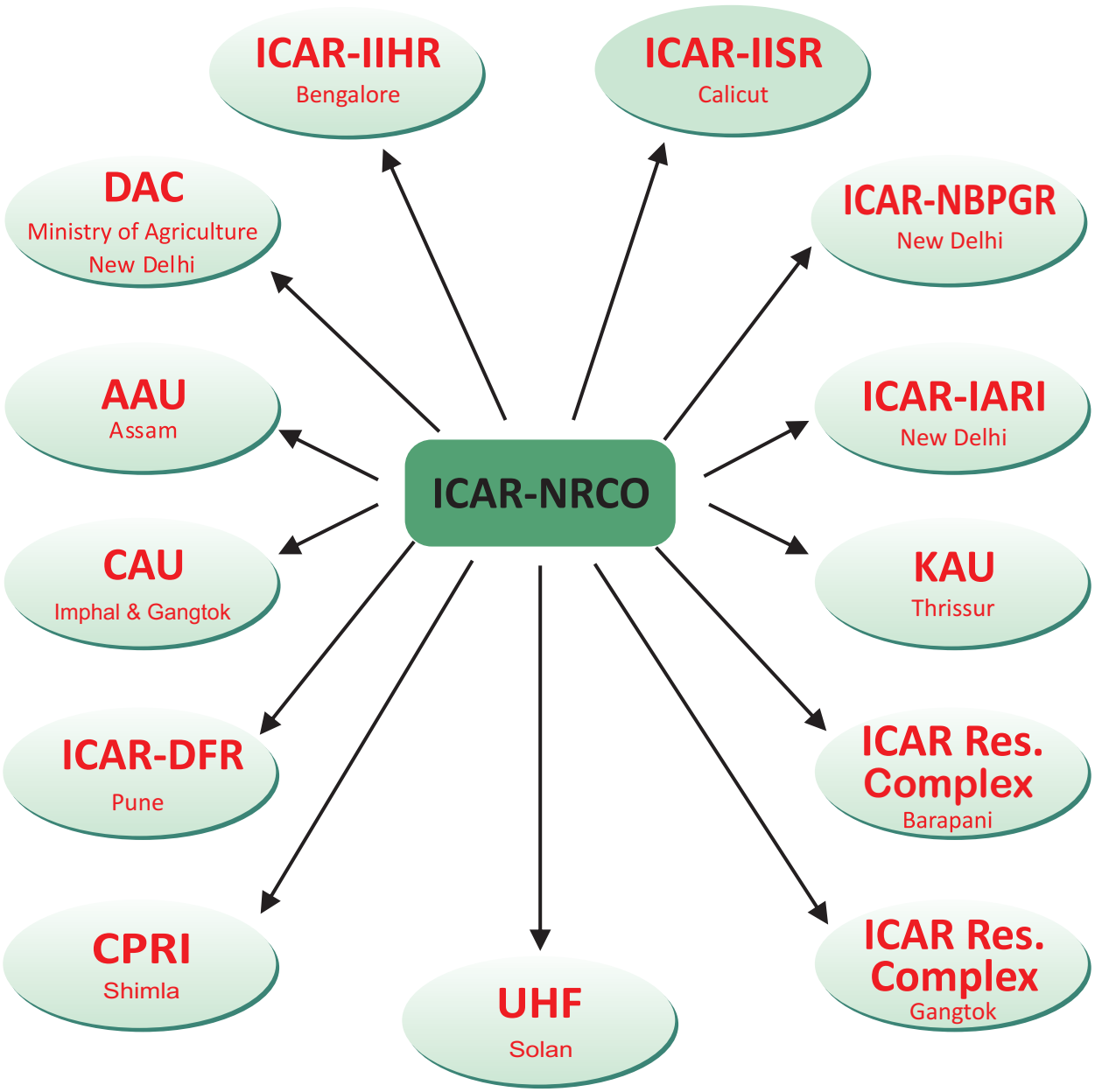
Name of Scientist	Topic	Category of Program	Date	Venue
Dr. M. Chakraborti	Breeding by Design	Summer School	7th-24th August, 2014	Centre for Advance Faculty Training (CAFT) at Punjab Agricultural University (PAU), Panjab
Dr. Raj Kumar	Agriculture Knowledge Management Techniques	Training	16th-26th September, 2014	ICAR-NAARM, Hyderabad
Dr. Raj Kumar	J-Gate plus/cera	Training-cum-workshop	19th November, 2014	ICAR-NRC on Pig, Rani, Assam
Dr. M. Chakraborti	Recent Trends in Bioinformatics and its Applications in Agriculture	Training	2nd-13th January, 2015	ICAR-NAARM, Hyderabad
Dr. S. Chakrabarti	125th Birth Anniversary of Botanical Survey of India	Foundation Day	13th February, 2015	BSI, Gangtok

Administrative

Name of Staff	Topic	Category of program	Date	Venue
Shri Arvind Chauhaan, Assistant	Hindi workshop	Workshop	22nd - 24th July, 2014	Mysore
Mrs. DikiBhutia UDC	ISTM	Training	24th November to 5th December, 2014	New Delhi

Linkages and collaboration 5

The centre has linkages with several universities, research institute and developmental agencies for collaborative research and developmental activities in orchids and other mandate floriculture crops.



List of publications

6

Books/ Book chapter

1. Barman D. and P. Das (2014). *Orchids*. In: Garden Plants: Flowers and Trees in India, R.K Publication, New Delhi.

2. Barman, D. (2014). *Cymbidium*. In: Handbook of organic crop production in Sikkim.

3. De, L. C., Promila Pathak, A. N. Rao and P. K. Rajeevan (2014). *'Commercial Orchids'*. Pp. 300. Published by De Gruyter Open, Warsaw, Polland.

4. De, L. C. and N. Pathak (2014). *Orchids*. In: Managing Postharvest Quality and Losses in Horticultural Crops-Vol. III (Eds. K. L. Chadha and R. K. Pal), Daya Publishing House, New Delhi-110002, pp. 709-725.

Research papers

1. Barman, D., T. Usha Bharathi, H. Pokhrel, S.K. Naik and R. P. Medhi (2014). Influence of concentration and mode of application of different growth regulators on dendrobium hybrid Thongchai Gold. *Journal of Crop and Weed*, 10(2): 223-230.

2. Chakrabarti, Syamali and Sudeep Jain (2015). A method of Isolation of High quality DNA from leaves of orchids. *Patent Office Journal*. January, pg 21381.

3. Chhetri, G., L. C. De and Deepak Rai (2015). Conventional herbarium for rare orchid species. *International Journal of Sciences and Applied Research:* 2(1): 32-40.

4. De, L. C., S. P. Vij and R. P. Medhi (2014). Post-harvest physiology and Technology in Orchids. *J Horticulture* 1:102. doi:10.4172/horticulture. 1000102.

5. De. L. C. and R. P. Medhi (2014). Diversity and conservation of rare and endemic orchids of North East India- A Review. *Indian Journal of Hill Farming*, 27/1: 138-153.

6. De, L. C., Arpita Mandal Khan, Rajkumar and R. P. Medhi (2014). Orchid Farming - A Remunerative Approach for Farmer's Livelihood. *International Journal of Scientific Research*, 3(9): 77-80.

7. De, L. C., A. N. Rao, P. K. Rajeevan, S. R. Dhiman, Manoj Srivastava, R. P. Medhi and Geetamani Chhetri (2014). DUS Test Guidelines in Cattleya orchids. *International Journal of Scientific Research*, 3 (11): 1-6

8. De, L. C., A. N. Rao, P. K. Rajeevan, S. R. Dhiman, ManojSrivastava and Geetamani Chhetri (2014). DUS Test Guidelines in Oncidium orchids. *International Journal of Applied Bioresearch*, 22: 1-8.

9. De, L. C., Raj Kumar, A. M. Khan, Rumki Sangma, N. Sailo and D. Barman

(2014). Tropical and Subtropical Orchids. *International Journal of Sciences and Applied Research*, 1(2): 1-9.

10. De, L. C., A. N. Rao, P. K. Rajeevan, S. R. Dhiman, Manoj Srivastava and Geetamani Chhetri (2014). Morphological Characterization in Paphiopedilum species. *Electronic Journal of Biosciences*, 2 (3): 131-145.

11. De, L. C., A. N. Rao, P. K. Rajeevan, Manoj Srivastava and Geetamani Chhetri (2014). Morphological Characterization in Cymbidium species. *Journal of Global Biosciences*, 3(7): 1060-1075.

12. De, L. C., A. N. Rao, P. K. Rajeevan, Manoj Srivastava and Geetamani Chhetri (2015). Morphological Characterization inVanda species. *International Journal of Scientific Research*, 4(1): 26-32.

13. De, L. C., A. N. Rao, P. K. Rajeevan, Manoj Srivastava and Geetamani Chhetri (2015). Morphological Characterization in Dendrobium species. *Journal of Global Biosciences*, 4(1): 1198-1215.

14. Raj Kumar, R. Devdas, D. Barman, R. P. Medhi and L.C. De. 2014. Morphological description of Eriatomentosa Hook. f. 1890. *The Mcallen International Orchid Society Journal* , 15 (11): 3-11.

15. Sailo, N. Deepak Rai and L. C. De (2014). Physiology of Tropical and Temperate Orchids-An Overview. *International Journal of Scientific Research*, 3 (12): 3-8.

16. Sangma, R. Ch., N. K. Meena and R. P. Medhi (2014). Parasitism of Cymbidium Scale, Lepidosaphes pinnaeformis (Bouche) infesting Cymbidium Orchids by Aphelinid parasitoid, Aphytis sp. from Sikkim, India. *International Journal of Scientific Research*,Vol 3 (12): 9-10

17. T. Usha Bharathi, D. Barman and S. K. Naik (2014) . Effect of harvesting stages and chemical preservatives on post harvest life of Cymbidium hybrid 'Red Princess'. VEGETOS, 27 (1): 188-194.DOI: 10.5958/j.2229-4473.27.1.029.

Popular articles

1. Chakrabarti, Syamali, D. Barman, L. C. De, Rampal, R. Devadas, Mridul Chakraborty, N. Sailo, Arpita Mandal Khan, Rumki Sangma and Rajkumar (2014). Orchid Diversity in NEH Region and its Entrepreneurial Opportunities. Souvenir : North Eastern Zone Regional Agriculture fair 2014-15 on 9-10 January, 2015 at ICAR Research Complex for NEH Region, Barapani, Meghalaya.

2. Chakrabarti, Syamali (2015). Green House Cultivation of Lady's Slipper Orchids**.** *Indian Farmers Digest*. Vol 48, No1. Jan., 2015.

3. De, L. C., A. N. Rao, P. K. Rajeevan, S. R. Dhiman, Manoj Srivastava and Geetamani Chhetri (2014). Basic features of DUS Test Guidelines in

Oncidium. *Orchid News* (TOSI), 30 (12): 9-10.

Paper presented in Seminar/ Symposia

1. Barman, D., H. Pokhrel and R. P. Medhi. Effect of inorganic nutrients and growth regulators on reducing pre-blooming in Cymbidium hybrid 'Black Magic'. **In:** International Conference on Horticulture for Nutritional Livelihood and Environmental Security in Hills Organised by UBKV at Kalimpong, Darjeeling w.e.f. 22th to 24th May, 2014.

2. Barman, D., H. Pokhrel, A. M. Khan and R. P. Medhi. Possibilities of growing Dendrobium in lower altitudes of hills. **In:** International Conference on Horticulture for Nutritional Livelihood and Environmental Security in Hills Organised by UBKV at Kalimpong, Darjeeling w.e.f. 22th to 24th May, 2014.

3. Barman, D., A. Mandal Khan, Rajkumar, N. Sailo and R. P. Medhi: An approach of Cymbidium production by organic nutrition. **In:** International Seminar on Integrating Agriculture and Allied Research: Prioritizing Future Potentials for Secure Livelihoods. Organised by CWSS (BCKV) at Mohanpur, Nadia, w.e.f. 6th to 9th Nov, 2014 (pp 295).

4. Barman, D., U. Parthasarathi, O. P. Nandakishore, H. Pokhrel and R. P. Medhi: Application of GIS in Dendrobium orchid's conservation programmes in NE region. **In:** 6th Indian Horticulture Congress-2014, Horticulture for inclusive growth. Organised by HSI at TNAU, Coimbatore w.e.f. 6th to 9th Nov, 2015 (pp 37-38).

5. Barman, D. Silver Jubilee Symposium on Strategic Approaches for Horticulture Research, Education and Development-Way Forward. Organised by NAAS, N. Delhi w.e.f. 26-27 Dec, 2014.

6. Barman, D. National Seminar on "Sustainable Horticulture vis-a-vis Changing Environment" at SASRD, Nagaland University, Mediphema. February 26-28, 2015.

7. Barman, D. and D. R. Singh. "Issues related to flower production of orchids and strategies for mitigation" **In:** International Symposium on Commercial Floriculture and Landscape Gardening for Urban and Peri-Urban Horticulture at Sector-34, Exhibition Ground, Chandigarh. February 21-22, 2015.

8. Barman, D. and Raj Kumar. Status and scope of hi-tech cultivation of orchids. **In**: National Seminar on Hi-tech Horticulture for Enhancing Productivity, Quality and Rural Prosperity. Organized by ISSS (NRC on Seed Spices) and ISPC at Ajmer 19th to 20th Jan, 2015 (pp. 33-40).

9. Chakrabarti, S., Sudeep Kumar Jain and R. P. Medhi. Paper presented on Assessment of Molecular Diversity of some Medicinal *Dendrobium* Orchids using ISSR markers in International Conference on Horticulture for

Nutritional Livelihood and Environmental Security in Hills held at Kalimpong, Darjeeling, India on May 22-24, 2014.

10. Chakrabarti, S., Sudeep Kumar Jain, Pradosh Mahadani and R. P. Medhi. Paper presented on Assessment of Molecular Diversity of Native Pleione Orchids of India for breeding using ISSR Markers, in National Seminar on Integrated Approaches in Horticulture for sustainable Development (IAHSD2014), held at Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, Birbhum, West Bengal on 29th to 30th November, 2014.

11. De, L. C., A. N. Rao and P. K. Rajeevan. Breeding approaches for improved genotypes of orchids. In Proceedings of National Symposium on 'Gene conservation of medicinal and horticultural orchids of the north eastern region and their sustainable use through community participation. Organized by Orchid Research and development Centre, Hengbung, Senapati District, Manipur from 5th -6th April, 2014.

12. De, L. C., A. N. Rao, P. K. Rajeevan, S. R. Dhiman, Manoj Srivastava and Geetamani Chhetri. Morphological characterization in Paphiopedilum species. In Proceedings of National Symposium on 'Gene conservation of medicinal and horticultural orchids of the north eastern region and their sustainable use through community participation. Organized by Orchid Research and development Centre, Hengbung, Senapati District, Manipur from 5th - 6th April, 2014.

13. De, L. C. and R. P. Medhi. Orchid-A Diversified Component of Farming Systems for profitability and livelihood security. In Proceedings of"3rd International Conference on Agricultural & Horticultural Sciences" (Agri-2014) held from October 27-29, 2014 at Hyderabad, India

14. De, L. C., A. N. Rao, P. K. Rajeevan, S. R. Dhiman, Manoj Srivastava, R. P. Medhi and G. Chhetri. DUS Testing of cut flower orchids. In Proceedings of 6th Indian Horticulture Congress held at TNAU, Coimbatore from 6th-9th November, 2014.

15. De, L. C., Rampal and A. M. Khan. Orchid diversification, medicinal aspects and conservation. **In:** Proceedings of National Conference on Orchids Science and Commerce: Integration of Medicinal Orchids, Sustaianable Development and Societal Benefits, Katra (Jammu), February 13-15, 2015.

16. De, L. C., A. N. Rao, P. K. Rajeevan and Promila Pathak. Medicinal and aromatic orchids-an overview. **In:** Proceedings of National Conference on Orchids Science and Commerce: Integration of Medicinal Orchids, Sustaianable Development and Societal Benefits, Katra (Jammu), February 13-15, 2015.

17. Devadas, R., S. L. Pattanayak, P. Khatiawara, S. Baruah and D. Barman. Orchid genetic resources in India for

varietal development. **In:** Abstracts and Short Communication, National Symposium on Crop Improvement for Inclusv Sustainable Development, Nov 7-9, 2014 at PAU, Ludhiana, Punjab. Pp 86-869.

18. Geetha, C. K., P. K. Rajeevan, L. C. De, A. N. Rao and Manoj Srivastava. Floral Diversity in Phalaenopsis. **In:** Proceedings of National Conference on Orchids Science and Commerce: Integration of Medicinal Orchids, Sustaianable Development and Societal Benefits, Katra (Jammu), February 13-15, 2015.

19. Khan, A. M., S. Pradhan, D. Barman, L. C. De, N. Sailo and R. P. Medhi. Bio-Molecules in Orchids and their uses in the industry: International Seminar on Integrating Agriculture and Allied Research, Kalyani, West Bengal, 6th to 9th November, 2014.

20. Khan, A. M., D. Barman, L. C. De, and R. P. Medhi. Studies on Phenotypic Correlation between vegetative and Floral characters of Monopodial Orchids. In 6th Horticulture Congress - 2014, Horticulture for Inclusive Growth, November 6-9, Coimbatore.

21. Pattanayak, S. L., Devadas, R., Medhi, R. P. New *in-vitro* technique for Keikis production in *Dendrobium* 'Emma White'. **In**: Abstracts (Poster Papers), 6th Indian Horticulture Congress-2014 (Horticulture for Inclusive Growth), TNAU, Coimbattore, Tamil Nadu, Nov 6 – 9, 2014.

22. Rajeevan, P. K., Valsalakumari and L. C. De. Production Technology and Prospects of Dendrobiums. In Proceedings of National Symposium on 'Gene conservation of medicinal and horticultural orchids of the north eastern region and their sustainable use through community participation. Organized by Orchid Research and development Centre, Hengbung, Senapati District, Manipur from 5th - 6th April, 2014.

23. Sangma, R. Ch. "Occurrence of Diaspidid scale insect, Lepidosaphes pinnaeformis (Bouche) on Cymbidium Orchids", **In:** Proceedings of National Symposium on "Gene Conservation of Medicinal and Horticultural Orchids of the North Eastern Region and their sustainable use through community Participation" organized by Orchid Research and Development Centre, Hengbung, Manipur from 5-6th April, 2014.

Awards/Rewards/Recognition/Bodies acquired during the year

Dr. R. P. Medhi, Director, ICAR-NRC for Orchids, Dr. Ram Pal, Senior Scientist (Horticulture), ICAR-NRC for Orchids, Darjeeling Campus, West Bengal and Dr. N. K. Meena, Scientist (Entomology), NRC on Seed Spices, Ajmer were awarded 'Indira Gandhi Puraskar' on 14th September, 2014 for original book writing on "आर्किड्स परिदृश्य एवं उत्पादन प्रौद्योगिकी" in official language on during the year 2012.

List of ongoing projects 7

Institute Projects

S. No	Research Projects	PI	Co-PI
1.	Conservation, characterization and sustainable use of diversity in orchids	Rampal	S. Chakrabarti, R. Devadas, L. C. De, D. Barman, M. Chakraborti, N. Sailo, A. M. Khan, Raj Kumar, Rumki Sangma
2.	Genetic improvement of orchids for yield, quality and resistance to biotic and abiotic stresses	R. Devadas	M. Chakraborti, Rumki Sangma, Raj Kumar
3.	Development and refinement of production and protection technologies for improved productivity, mark eting and utilization of orchids	L. C. De	D. Barman, Rampal, A. M. Khan, Rumki Sangma, Raj Kumar, N. Sailo
4.	Improvement of knowledge and skill of stakeholders for improving production of orchids	D. Barman	All scientists

Externally Funded Projects (On going)

1. DUS Project

Project title: " DUS testing on orchids: Preparation for Plant Varieties Protection and DUS Testing through ICAR-SAU System"

Nodal Officer: L. C. De
Associate Nodal Officer: R. Devadas

2. DBT - RA Programme in Biotechnology

Title: Exploration of medicinal orchid species from North East India by using molecular tools

Mentor: S. Chakrabarti

3. IPR Scheme

Nodal Officer: S. Chakrabarti

4. Revolving Fund Scheme (RFS/Mega Seed Projects)

Nodal Officer: R. Devadas
Associate Nodal Officer: Raj Kumar

List of Completed projects

Institute projects

S. No	Project title	PI
1.	Cytogenetical research on orchids	S. Chakrabarti
2.	Development of agro-techniques for commercial production of orchids in open and protected conditions.	D. Barman
3.	Production management of tropical and subtropical orchids	L. C. De
4.	Post-harvest technology of orchids	L. C. De
5.	Investigation on fungal diseases of orchids	T. K. Bag
6.	Macronutrient management in orchids	S. K. Naik
7.	Secondary and micronutrient management in orchids	S. K. Naik
8.	Pest management in orchids and bulbous flowering plants	N. K. Meena
9.	Improvement of orchids	D. Barman
10.	Studies on bulb production of lilium	Ram Pal
11.	Collection, conservation, evaluation and multiplication of bulbous ornamental crops.	Rampal
12.	Disease management of orchids	R. P. Pant
13.	Integrated pest management in orchids	N. K. Meena
14.	Collection, conservation, characterization, evaluation and maintenance of high altitude orchid germplasm	Ram Pal

8 Participation of Scientists in Conferences, Meetings, Workshops, Symposia, Seminar etc. in India & Abroad

Name of Scientist	Topic	Category of program	Date	Venue
Rumki C.H. Sangma& Raj Kumar	Gene Conservation of Medicinal and Horticultural Orchids of the North Eastern Region and their sus tainable use through community participation	National Symposium	5th -6th April, 2014	Orchid Research and Development Centre, Hengbung, Manipur
D. Barman & S. Chakrabarti	Horticulture for Nutritional Livelihood and Environmental Security in Hills	International Conference	22nd -24th May, 2014	Kalimpong, Darjeeling, West Bengal
Rumki C.H..Sangma	ICAR Borer Project Launching	Workshop	18th-19th August, 2014	Indian Institute of Horticultural Research, Bengaluru
L. C. De	OMICS- Agri& Horticultural Sciences	3rd International Conference	27th -29th October, 2014	HICC, Hyderabad
D. Barman & L.C. De	Horticulture for inclusive growth	6th IHC	6th -9th November, 2014	TNAU, Coimbatore
Arpita M. Khan	Integrating Agriculture and Allied Research	International Seminar	6th- 9th November, 2014	Kalyani, West Bengal
R. Devadas	Crop improvement for Inclusive Sustainable Development	National Symposium	7th -9th November, 2014	PAU, Ludhiana, Panjab
S. Chakrabarti	Integrated Approaches in Horticulture for sustainable Development	National Seminar	29th-30th November, 2014	PalliSikshaBhavana (Institute of Agriculture), Visva - Bharati, Sriniketan, Birbhum, West Bengal
D. Barman	Commercial Floriculture and Landscape Gardening for Urban and Peri-Urban Horticulture	International Symposium	21st -22nd February, 2015	Sector-34, Exhibition Ground, Chandigarh
D. Barman	Sustainable Horticulture vis - a-vis Changing Environment	National Seminar	26th-28th February, 2015	SASRD, Nagaland University, Medziphema

Distinguished visitors

9

Name & Designation	Date	Remarks
Dr. S. Dam Roy, Director, CARI, Portblair	08/04/2014	Appreciation for the setting up facilities such as collection of orchids, wonderful tissue culture laboratory and hybrids
Dr. B. B. Singh, Visiting Professor & Senior Fellow, USA	16/05/2014	Very impressive work. Wish all the best success.
Dr. N. C. Talukdar, IASST, DST, Guwahati	28/07/2014	Beautiful infrastructure built over the years. It is a previlage to complement the efforts of the scientists.
Dr. P. T. Bhutia, Director of Horticulture, Govt. of Sikkim	01/09/2014	NRC orchid is doing good job by maintaining the germplasm in the greenhouses. He suggested to develop commercial variety and hybrids and also potting mixtures for cymbidium orchids using locally available biomass.
Mr. Kang Jihye, South Korea	18/10/2014	So happy to visit to Sikkim and thanks
Dr. A.G. Sawant, Pune	28/10/2014	It is a pleasant visit to the unique NRC of orchids. The scientists have done really a painstaking job to maintain, grow and develop different orchids
Dr. R. C. Upadhyaya, Chief Consultant (MIDH), DAC, New Delhi	03/11/2014	An excellent effort to develop this centre. Congratulation to Director and his all staff members
Shri Shrinivas Patil, Governor of Sikkim	20/12/2014	I am happy to visit the centre. Knew about how many varieties are here and how centre is working. I wish every success to the researchers.
Dr. R. Krishna Kumar, Professor (Entomology), KAU, Kerala	21/03/2015	Myself along with 100 B.Sc. (Agriculture) students and 4 staff visited NRCO. This is an excellent centre with lots of facilities. I wish all the scientists graet success in all their future endevours.

Honourable Governor, Sikkim Sh. ShrinivasPatil visited ICAR-NRCO on 20/12/2014

Director's Assignment

10

Name: Dr. D. R. Singh, Director

Period: 31st January, 2015 – 31st March, 2015

S. No.	Date	Highlights of visit
1.	09th -11th February, 2015	• For attending a Review Meeting of ICAR Institutes of NEH Region held on 10/02/2015 at College of Veterinary Science, Khanapara, Guwahati.
2.	20th -23rd February, 2015	• Meeting with DDG (Horticultural Sciences) at SMD, ICAR, New Delhi
3.	30th-31st March, 2015	• Visit to Darjeeling Campus

Name: Dr. D. Barman, Director (Acting)

Period: 1st November, 2014 – 30th January, 2015

S. No.	Date	Highlights of Visit
1.	04th-9th November, 2014	• For attending 6th International Horticulture Congress held from 06-07 November, 2014 at Coimbatore.
2.	24th-28th November, 2014	• For attending meeting of QRT of NRC for Orchids and Vision 2050 and other official works with DG and DDG held from 25th - 27th November, 2014 at ICAR, New Delhi.
3.	10th -12th December, 2014	• For presenting as Director in the Interview of CAS of two candidates held on 11th December, 2014 at ARSB, New Delhi.
4.	25th -28th December, 2014	• For attending Symposium on 25th years of Horticultural Research under ICAR held from 26th - 27th December, 2014 at New Delhi.

Name: Dr. R. P. Medhi, Director

Period: 1st April, 2014 – 31st October, 2014

S. No.	Date	Highlights of Visit
1.	29th-31st May, 2014	• For attending H-PGR (NABMGR) meeting held on 30.05.2014 at IIHR, Bengaluru.
2.	1st- 4th June, 2014	• For attending Mid Term Review meeting of RCM held on 02.06.2014 at ICAR- RC –NEH, Barapani and to monitor the activities of HMNEH at CPRS, Upper Shillong.
3.	8th -11th July, 2014	• For attending meeting on finalization of XIIth Plan EFC of the Institute at SMD and Council on 9th& 10th July, 2014 respectively.
4.	28th-31st July, 2014	• For attending 86 th Foundation Day and ICAR Award Ceremony and participated in the Vice Chancellors and Director's Conference held on 29th& 30th July, 2014 at NASC, New Delhi.
5.	9th-14th August,2014	• For monitoring of HMNEH activity at CPCRI, Guwahati on 9thAugust, 2014 and visit of Orchids Research Development Centre & KVK, Sylvan, Hengbung in connection with a letter received from HE, Governor of Manipur for setting up of a Regional Floriculture Development andResearch Centre for NE Region at HengbungSenapati District, Manipur from 11th to 13th August, 2014 respectively.
6.	21st -24th August, 2014	• For inauguration of training programme at Bongaon, Udalguri and distributed planting materials of banana under HMNEH organized by TERI Guwahati on 23.08.2014 as the scheduled programme for 22.08.2014 was cancelled due to bandh in Udalguri District.
7.	11th -16th September, 2014	• To attend and received award of Hindi Book "Orchids paridisha abom utpadan prodigiki" at New Delhi. • Official works at KAB-II and Krishi Bhavan. • To attend symposium on "Dynamic of rural labour markets and its implication on Agriculture" at NASC Complex, Pusa, New Delhi.
8.	13th -15th October, 2014	• For organizing First Meeting of QRT (Quinquennial Review Team) of NRC for Orchids held on 14.10.2014 at ICAR -Horticulture Division, KAB-II, New Delhi.
9.	16th -18th October, 2014	• For organizing DPC of ARS Scientists to next higher RGP of Rs. 7,000 under Career Advancement Scheme held on 18.10.2014 at AAU, Khanapara, Guwahati.

Personnel

10

I. Scientific

Dr. R. P. Medhi, Director (Retired on 31st October, 2014)

Dr. D. R. Singh, Director (Joined on 31st January, 2015)

Dr. D. Barman, Principal Scientist (Horticulture)

Dr. L. C. De, Principal Scientist (Horticulture)

Dr. Syamali Chakrabarti, Sr. Scientist (Genetics)

Dr. Rampal, Sr. Scientist (Horticulture)

Dr. Ramgopal Devadas, Sr. Scientist (Plant Breeding)

Dr. M. Chakraborti, Scientist (Plant Breeding)

Dr. N. Sailo, Scientist (Plant Physiology)

Dr. Arpita Mandal Khan, Scientist (Floriculture)

Ms. Rumki Heloise CH. Sangma, Scientist (Agril. Entomology)

Shri Raj Kumar, Scientist (Floriculture)

II. Administration

Shri Rajat Das	Assistant Finance and Account's Officer
Shri Arvind Chauhaan	Assistant
Mrs. W. Stella Sasa	PA to Director
Mrs. Diki Bhutia	Sr. Clerk
Shri. Phigu Tshering Bhutia	Jr. Clerk
Mrs. Sangeeta Lepcha	Jr. Clerk

III. Technical

Shri. Noni Gopal Debnath	Sr. Technical Assistant (Computer Assistant)
Ms. Tshering Chomu Butia	Technical Assistant (Horticulture Assistant)
Shri. Ram Chandra Gurung	Sr. Technical Assistant (Driver)
Shri. Deepak Khattri	Sr. Technician (Driver)
Shri. Manoj Adhikari	Technician (Field/ Farm)
Ms. Meena Kumari Chettri	Technician (Field/ Farm)
Shri Ajay Bushal	Technician (Field/ Farm)

IV. Supporting

Shri. Gopal Brahmin	SSS
Shri. Dawa Bhutia	SSS
Shri.Tularam Dulal	SSS
Shri.Trilok Singh Balmiki	SSS
Shri.Arjun Gurung	SSS
Mrs. Rabin Kala Subba	SSS
Shri Rabin Raj Subba	SSS

V. Appointments

Director

Dr. D. R. Singh joined as Director on 31st January, 2015.

Finance

Shri Rajat Das joined as Assistant Account's & Finance Officer on 30th September, 2014.

Supporting

Shri Rabin Raj Subba joined as supporting staff on 11th September, 2014.

VI. Transfer

Finance

- Shri Rishi Kant Singh, AF & AO transferred to ENCAP, New Delhi on 26th July, 2014

Technical staff

- Shri Noni Gopal Debnath, Technical Staff (T4) transferred to ICAR-Research Complex for NEH Region, Umiam, Meghalaya on 30th October, 2014.

VII. Promotion

Scientist

Dr. Mridul Chakraborti, Scientist (Plant Breeding) promoted to next higher grade of GP 7000/- through DPC on 18th October, 2014 under CAS.

Finance

Shri Rajat Das, Assistant promoted to AFA &O through DPC on 25th September, 2014.

Administrative

Mrs. Stella Sasa, PA (Director), cleared his probation period through DPC on 30th June, 2014.

Shri Arvind Chauhan, Assistant cleared typing test on 30th June, 2014.

Administrative

Sh Gopal Brahmin (SSS), Sh Trilok Singh Balmiki (SSS), Sh Dawa Bhutia (SSS) and Sh Tularam Dulal (SSS) promoted to next higher grade through MACP Scheme under DPC on 27th February, 2015.

Institute commitees

12

Third QRT Committee		
S. No.	**Name & Designation**	**Assignment**
1.	Dr. K. R. Dhiman, Former VC, YSPUH&F, Shimla	Chairman
2.	Dr. A. N. Rao, Director, Centre for Gene Conservation for Eastern Himalaya, Hengbung, Manipur	Member
3.	Dr. S. Ramani, Ex - Project Cordinator, UAS, Bangalore, Karnataka	Member
4.	Dr. Promila Pathak, Professor of Botany, Orchid laboratory, Punjab University	Member
5.	Dr. P. C. Panda, Regional Plant Genetic Resource Centre, Bhubaneswar	Member
6.	Dr. D. R. Singh, Director, ICAR-NRC for Orchids	Member
7.	Dr. Ram Pal, Sr. Scientist (Hort.), ICAR - NRC for Orchids, Darjeeling Campus	Member Secretary
Sixth RAC Committee		
1.	Dr. V. A. Parthasarathy, Former Director, IISR, Kozhikode, Kerala	Chairman
2.	Dr. T. Janakiram, ADG (Hort.-I), ICAR, New Delhi	Member
3.	Dr. A. N. Rao, Centre for Gene Conservation for Eastern Himalaya, Hengbung, Manipur	Member
4.	Shri S. Z. Licksom, Director (R&D), Orchidologist & Former Director, Himalayan Zoological Park, Gangtok	Member
5.	Dr. V. V. Belvadi, Prof & Head, Department of Entomolgy, UAS, GKVK, Bangalore	Member
6.	Dr. Bikash Mandal, Principal Scientist, Division of Plant Pathology, IARI, New Delhi	Member
7.	Dr. D. R. Singh,Director, ICAR-NRC for Orchids	Member
8.	Shri Izmir Tikhak, Changlang District, Arunachal Pradesh	Member
9.	Shri Pempa Sherpa, Kartok, Pakyong, Sikkim	Member
10.	Dr. Ram Pal, Member Secretary, ICAR-NRC for Orchids, Darjeeling Campus	Member Secretary

ISO 9001-2008 Certification Committee		
1.	Dr. L. C. De, Principal Scientist (Hort.)	Chairman
2.	Dr. R. Devadas, Senior Scientist (Plant Breeding)	Member
3.	Dr. N. Sailo, i/c AAO	Member
4.	Shri Rajat Kumar Das, AF & AO	Member
5.	Shri Arvind Chauhaan, Assistant	Member
Standing Purchase Committee		
1.	Dr. S. Chakrabarti, Sr. Scientist (Genetics)	Chairperson
2.	Dr. Ram Pal, Sr. Scientist (Hort), NRCO, Darjeeling Campus	Member
3.	Dr. N. Sailo, Scientist, Plant Physiology	Member
4.	Mr. R. K. Singh, AF & AO	Member
5.	Shri Ajen Lama	Member Sec.
Works Committee		
1.	Dr. R. Devadas, Sr. Scientist (Plant Breeding)	Chairman
2.	Dr. N. Sailo, Scientist (Plant Physiology)	Member
3.	Mr. R. K. Singh, AF & AO	Member
4.	Mr. Ajen Lama, AAO	Member Sec.
Farm Management & Price Fixation Committee		
1.	Dr. D. Barman, Principal Scientist (Hort.)	Chairman
2.	Dr. L. C. De, Principal Scientist (Hort.)	Member
3.	Mr. R. K. Singh, AF & AO	Member Sec.
PME Cell		
1.	Dr. L. C. De, Principal Scientist (Hort.)	Chairman
2.	Dr. M. Chakraborty, Scientist (Plant Breeding), Darjeeling Campus	Member
3.	Ms. Rumki H.C. Sangma, Scientist (Entomology)	Member

RFD Committee		
1.	Dr. R. P. Medhi, Director	Chairman
2.	Dr. L. C. De, Principal Scientist	Nodal Officer
3.	Dr. R. Devadas, Senior Scientist (Plant Breeding)	Member
Technical Cell		
1.	Dr. R. Devadas, Senior Scientist (Plant Breeding)	Chairman
2.	Ms. Rumki H. C. Sangma, Scientist (Entomology)	Member
3.	Shri Ajen Lama, AAO	Member

Other Institutional Activities 13

Swachh Bharat Abhiyan

As per the Council circular F. NO. GAC-21-46/2014-CDN on 03/12/2014 regarding Swachh Bharat Abhiyan (National Sanitation Campaign), on 02/10/2014 all the staff of institute took the cleanliness oath in the presence of Director. Total 14 cleanliness drives were conducted by institute till date. Out of which one awareness cum cleanliness drive was conducted outside at old age home near to Institute. Similar activities of cleanliness drive was also carried out by the staff of ICAR-NRCO, Darjeeling Campus. A Total of 653 man hours were contributed by the staff of ICAR-NRC for orchids.

Awareness cum cleanliness drive organized at Old Age Home under Swachh Bharat Abhiyan

Swachh Bharat Abhiyan at Farm areas, ICAR-NRCO, Pakyong

Farmers training on Post-harvest management and packaging of Cymbidium on 3rd to 5th April, 2014

3rd meeting of 5th Research Advisory Committee held on 12-13th June, 2014

Laboratory visit of ADG- Horticulture during 3rd meeting of 5th RAC

ICAR day celebration on 16th July, 2014

Independence Day celebration on 15th August, 2014

13th meeting of Institute Research Committee held on 1st September, 2014

Hindi Week (Saptah) celebrated on 9th to 15th September, 2014

VigilanceAwarenessWeek

ICAR-NRC for Orchids, Pakyong, Sikkim celebrated the 'Vigilance Awareness Week' with effect from 27th October to 1st Nov.2014 with a theme "Combating Corruption- Technology as an enabler". Like earlier year the institute displayed banner and posters at office premises and prime location of the city areas for creating mass awareness among the public. The staffs of NRC orchids have taken "PLEDGE" at 11 am on 27th October 2014. Further on this occasion, Dr. D. Barman, Principal Scientist and Vigilance officer of this institute has given a lecture on "Combating Corruption- Technology as an enabler".

"PLEDGE"taken by the staff

Celebration of Republic Day on 26/01/2015

Celebration of National Science Day on 28th February 2015 at ICAR-NRCO

30 students and 2 faculties from Department of Applied biology, University of Science and Technology, Meghalaya visited ICAR-NRCO on 17/02/2015

29 students and 2 faculties from Department of Botany, B. N. College, Dhubri, Assam visited ICAR-NRCO on 04/03/2015.

Table 3. Annual Achievement for Result Framework Document (2014-2015)

S. No.	Objective(s)	Weight	Action(s)	Success Indicator(s)	Unit	Weight	Target / Criteria Value					Achievements	Performance		Percent achievements against Target values of 90% Col.	Reasons for shortfalls or excessive achievements, if applicable
							Excellent 100%	Very Good 90%	Good 80%	Fair 70%	Poor 60%		Raw Score	Weighted Score		
1.	Management and utilization of genetic resources for improved productivity	**40**	Collection, conservation of orchid germplasm	Germplasm collected and conserved (RET)	Number	20	70	58	46	34	22	69	**98.5**	**19.7**	**118**	**Vigorous survey of hotspot**
			Characterization of orchids	Molecular and DUS characterization of orchids.	Number	10	29	24	19	14	9	42	**144.8**	**10.0**	**175**	**Recruitment of a RA in a new project**
			Development of improved hybrids	New breeding lines (F1) developed	Number	10	6	5	4	3	2	10	**166.6**	**10.0**	**200**	**Flowering of full grown plants at a time**
2.	Production, protection and post harvest management of orchids	**30**	Integrated production and post-harvestmanagementoforchids	Production and post-harvest technologies developed	Number	12	6	5	4	3	2	6	**100.0**	**12.0**	**120**	**Initiation of a new sub-project on flower drying**
			Production of planting materials	Plantlets produced	Number	10	12000	10000	8000	6000	4000	7400	**61.6**	**6.1**	**74**	**Lack of large sized tissue culture laboratory**
			Insect pests and disease management	New reporting /characterization/ protection measures developed	Number	8	6	5	4	3	2	6	**100.0**	**8.0**	**120**	**Prevalence of new insect pest in reported period**
3.	Dissemination of knowledge	**10**	Transfer of technologies	Training /demonstration/seminar/ Kisanmela/Farmer's Day/ Awareness program conducted	Number	10	17	14	11	8	5	12	**70.5**	**7.0**	**85.7**	--

*	Publication /Documentation	**5**	Publication of research articles in journals having the NAAS rating of 6.0 and above	Research articles published	Number	3	04	03	02	01	00	9	**225.0**	**3.0**	**300**	**Completion of 4 Institute projects and documentation and publication**
			Timely publication of the Institute Annual Report	Annual Report published	Date	2	30/06/2014	02/07/2014	04/07/2014	07/07/2014	09/07/2014	25/06/2014	**100**	**2.0**	**--**	
*	Fiscal resource management	**2**	Utilization of the released plan fund	Plan fund utilized	%	2	98	96	94	92	90	100	**100**	**2.0**	**100**	
*	Efficient Functioning of the RFD system	**3**	Timely submission of Draft RFD (2014-15) for approval	On-time submission	Date	2	15/05/2014	16/05/2014	19/05/2014	20/05/2014	21/05/2014	**09/05/2014**	**100**	**2.0**	**--**	
			Timely submission of Results for RFD (2014-15)	On-time submission	Date	1	01/05/2014	02/05/2014	05/05/2014	06/05/2014	07/05/2014	**30/04/2015**	**100**	**1.0**	**--**	
*	Enhanced Transparency/Improved Service delivery of Ministry /Department	**3**	Rating from Independent Audit of implementation of Client's/Citizen's Charter (CCC)	Degree of implementation of commitments in CCC	%	2	100	95	90	85	80	**100**	**100**	**2.0**	**--**	
			Independent Audit Implementation of Grievance Management (GRM)System	Degree of success in Implementing GRM	%	1	100	95	90	85	80	**90**	**80**	**0.8**	**--**	

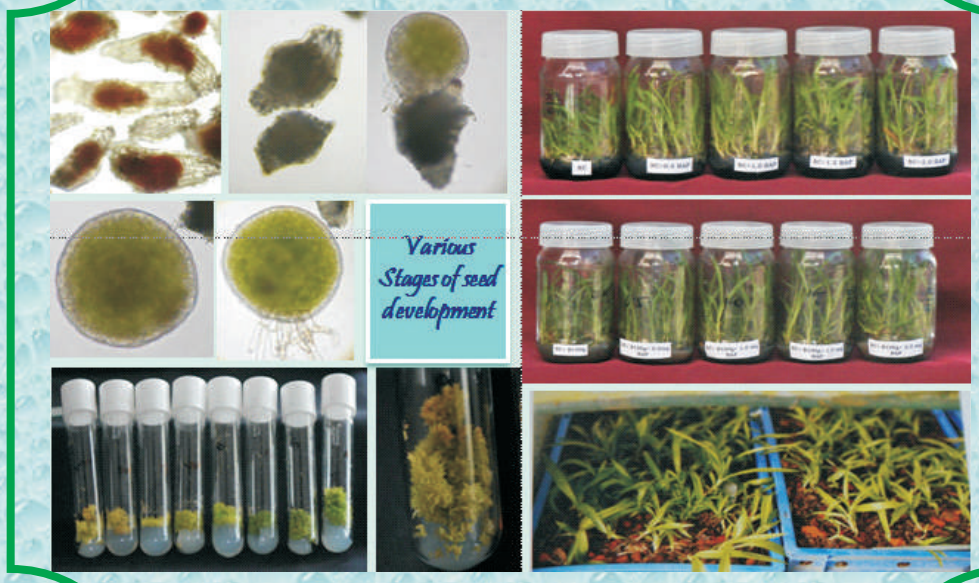
*	Administrative Reforms	7	Update organizational strategy to align with revised priorities	Date	Date	2	01/11/2014	02/11/2014	03/11/2014	04/11/2014	05/11/2014	**18/09/2014**	**100**	**2.0**	--	
			Implementations of agreed milestones of approved Mitigating Strategies for Reduction of potential risk of corruption (MSC)	% of implementations	%	1	100	90	80	70	60	**100**	**100**	**1.0**		
			Implementation of agreed milestones for ISO 9001	% of implementation	%	2	100	95	90	85	80	--	--	--		
			Implementations of milestones of approved Innovation Action Plans (IAP,s)	% of implementation	%	2	100	90	80	70	60	**100**	**100**	**2.0**		

Total Composite Score: 90.6
Rating :Very Good

ICAR–NRCO PUBLICATIONS

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

Agrisearch with a human touch



ICAR-National Research Centre for Orchids
Tele No. 03592-257954, 257703, Telefax: 03592-257289 / 257282
Website : www.nrcorchids.nic.in, Email : nrcorchids@rediffmail.com