



Annual Report

2013 - 2014



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

AgriSearch with a human touch



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Cover photographs

Front : *Cattlya denlee*

Front (inside) : Glimpses of last 5 years Institute annual Reports

Back (inside) : Glimpses of Krishi Mela

Back (outside) :

Center – Hybrids developed by NRCO

Right – Paintings of open drawing competition during Independence Day celebration

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Preface

Orchids have emerged as one of the most important and vibrant component in world floriculture market. In home too, popularity of orchids as cut flowers increased such that these have now become part of each and every important public, private and social functions. Presently, bulk of the demand for orchid cut flowers is met through the imports. The import of orchid flowers has risen from 299.9 lakhs during 2008-09 to 1149.53 lakhs in 2012-13. There is nearly 4 fold increase in import of orchid cut flowers in the last five years and this demand is further expected to increase



further. These figures indicate huge and expanding market of orchid cut flowers in India. This is only a tip of ice berg in the sea of floriculture market. The orchid industry does not rest on cut flowers of *Dendrobium*. It also includes cut flowers and pot plants of other commercially cultivated genera like *Cymbidium*, *Vanda*, *Oncidium*, *Paphiopedilum*, *Phalaenopsis* etc., micropropagated plants, dry flowers, and extraction of biomolecules and perfumes.

India is rich in orchid genetic resource and about 1,300 species are known to occur across length and breadth of the country. The National Research Centre for Orchids came into being in 1996 to provide research support for upcoming orchid industry in the country on one hand and conserving depleting orchid genetic resources on the other. Since its inception, the centre has made significant progress in conservation genetic resources, breeding of new varieties, molecular characterization of wild genetic resources, developing package of practices for cultivation and postharvest management. This document, Annual Report highlights the significant research achievements of various research programmes and other institutional activities for the year 2013-14. During this year, diversity in *Cymbidium whiteae*, *Dendrobium* species was analysed and barcode for *Vanda* species was developed. A patent for gDNA extraction protocol from orchid leaves that enhances the recovery and quality of gDNA was filed. The institute is striving towards development of new hybrids which would be useful as the cultivars for cut flowers/potted plants or the materials for further improvement programme. Three hybrids, one each of *Cymbidium*, *Aranda* and *Dendrobium* have been 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. 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. Several new insects like diaspid scale insect, *Lepidosaphes pinneformis*, Aphid, *Aulacorthum circumflexum*, false spider mites were reported for the first time to infest orchids. Parasitoids, aphelinid wasp, *Aphytis* sp. of *Cymbidium* scale were 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 two commercial orchid genera viz., *Phalaenopsis* and *Cattleya* were 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 Kishi Mela, Stakeholder's meet and conducting demonstrations.

In order to review, monitor and evaluate the research programmes and development activities of the Centre, RAC, IRC, IMC and Stakeholders' meeting were conducted.

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 here-in will be able to help the farmers, researchers and planners 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. S. K. Malhotra, ADG (Hort. II) for all the support and advice given to us time to time. I am equally thankful to the Chairman and members of Research Advisory committee for their suggestions to reorient our research programmes. Last but not the least, I am thankful to Dr. J. Poorani (Principal Scientist) and Dr. Sunil Joshi (Principal Scientist) of National Bureau of Agriculturally Important Insects, Bangalore for identifying and confirming of the insect and parasitoid species whenever my scientist approached them.



(R. P. Medhi)
Director

Place: Pakyong, East Sikkim.
Dated: 30th April, 2014

Executive Summary

- 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 Darjeelig 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.
- Genetic diversity analysis in a small population of *Cymbidium whiteae*, a rare & endangered orchid species of Sikkim Himalaya was done using RAPD markers and found higher percentage of polymorphism within the population. All the 20 plants were distributed into two major clusters and similarity between two clusters was only 31 %, suggesting the possibility of sub-groups within small population. To confirm reliability, the results from two different clusters were tested with other 22 *Cymbidium* species of India.
- Simple sequence repeat (SSR) markers were used to determine the genetic relationship among 20 species of medicinal *Dendrobium* orchids. Four SSR primer 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.
- Genetic divergence of some native wild species of *Dendrobium* orchids having unique floral traits was determined using two extensively used simple molecular techniques RAPD and ISSR. Genetic similarities of some species are same in both RAPD and ISSR. The result of the present study provides important information about the genetic distance of among species and helps to select distant parents for breeding programme.
- Twenty decamer primers of RAPD were tested to study the genetic variability in 12 samples of *Dendrobium anceps*. The results showed monomorphic bands in all the samples, which indicates that there was no genetic variability among the samples and the morphological variations might result due to environment.
- 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°C and water temperature ranges within 4-5°C.
- 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°C.
- In *Phalaenopsis*, Brother & White, Kaleidoscope, Maki Watanabe, Ox Prince Thunder, Strawberry, Memoria Francis Hunter, ChianXen Magpie and Hsing Ying Fortunewere found promising almost round the year except December and January.
- In *Phalaenopsis*, Detroit, among five impregnation treatments, CoCl₂ (1000 ppm) for 45 minutes had maximum vase life (75.6 days) followed by 1000 ppm NiCl₂ for 45 minutes (62 days) over control (45 days.)
- In *Cym.* 'PCMV', packing of loose bud stage cut spikes with cellophane paper had maximum vase life (60 days) over control (49 days)
- Morphological descriptors of *Paphiopedilum* (76) finalized and DUS Test Guidelines of *Oncidium* was submitted to the Plant Authority for registration.
- 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. Diaspidid scale insect, *Lepidosaphes pinnaeformis* (Bouche) reported as pest of several *Cymbidium* species and hybrids.
- Aphid, *Aulacorthum circumflexum* commonly called lily aphid or mottled arum aphid reported as pest of *Cymbidium* hybrids 'Baltic Elegans' and Winter Beach 'Sea Green'. False spider mite reported as pest of around 12 orchid species and hybrids.
- *Coccophagus ceroplastae* (Howard), an aphelinid wasp reported as a parasitoid of soft brown scale, *Coccus hesperidum* infesting Orchids from Sikkim. Aphelinid wasps, *Aphytis* sp. and *Pteroptrix* sp. reported as parasitoid (biocontrol agent) of *Cymbidium* Scale, *Lepidosaphes pinnaeformis* (Bouche) infesting *Cymbidium* orchids.

- The bio-pesticide 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* under laboratory and polyhouse conditions.
- Culturing of scale insect (*Lepidosaphes*

pinnaeformis) on pumpkins was initiated to develop stock culture for carrying out several experiments on its biological control, using its natural enemies. An attempt was also made for culturing Lily aphid, *Macrosiphum luteum* on pea plants under laboratory conditions.

Contents

Preface	
Executive Summary	
Introduction	1
Mandate	1
Organisational setup	2
Financial statement	3
Staff position	4
Past achievements	4
Research Achievements	7
2.1 NRC(O), Main Centre	9
2.2 NRC(O), Darjeeling Campus	27
Technology Assessed and Transferred	39
Education and Training	41
Linkages and Collaboration	43
List of Publications	44
List of Ongoing & Completed Projects	49
RAC, IRC and IMC - Major Recommendations and RFD 2013-14	51
Participation of Scientists in Conferences, Meetings, Symposia, Seminars etc. in India and Abroad	56
Distinguished Visitors	58
Personnel	59
Other Information	61
Annexure	69
Annexure-I: Result Framework Document	71

Acronym

BAP	Benzyl Amino Purine
CoCl ₂	Cobalt Chloride
CTAB	Cetyl Trimethyl Ammonium Bromide
DMA	Dry Matter Accumulation
DNA	Deoxyribonucleic Acid
DUS	Distinctiveness, Uniformity and Stability
EC	Electrical Conductivity
FRA	Farmers Right Authority
IBA	Indole-3- Butyric Acid
IMC	Institute Management Committee
IRC	Institute Research Committee
ISSR	Inter Simple Sequence Repeat
MS	Murashige and Skoog's
MLT	Multi Location Trial
NAGS	National Active Germplasm Site
NCBI	National Centre For Biological Information
NiCl ₂	Nickel Chloride
NAA	α -Naphthalene Acetic Acid
PCMV	Pine Clash Moon Venus
PLB	Protocorm Like Body
PIC	Polymorphic Information Content
PPV	Protection of Plant Variety
RAC	Research Advisory Committee
RAPD	Random Amplified Polymorphic DNA
RWC	Relative Water Content
SSR	Simple Sequence Repeat
SCAR	Sequence Characterized Amplified Region
TBARS	Thiobarbituric Acid Reactive Substances
TDZ	Thidiazuron
UPGMA	Unweighted Pair Group Method with Arithmetic Mean

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.

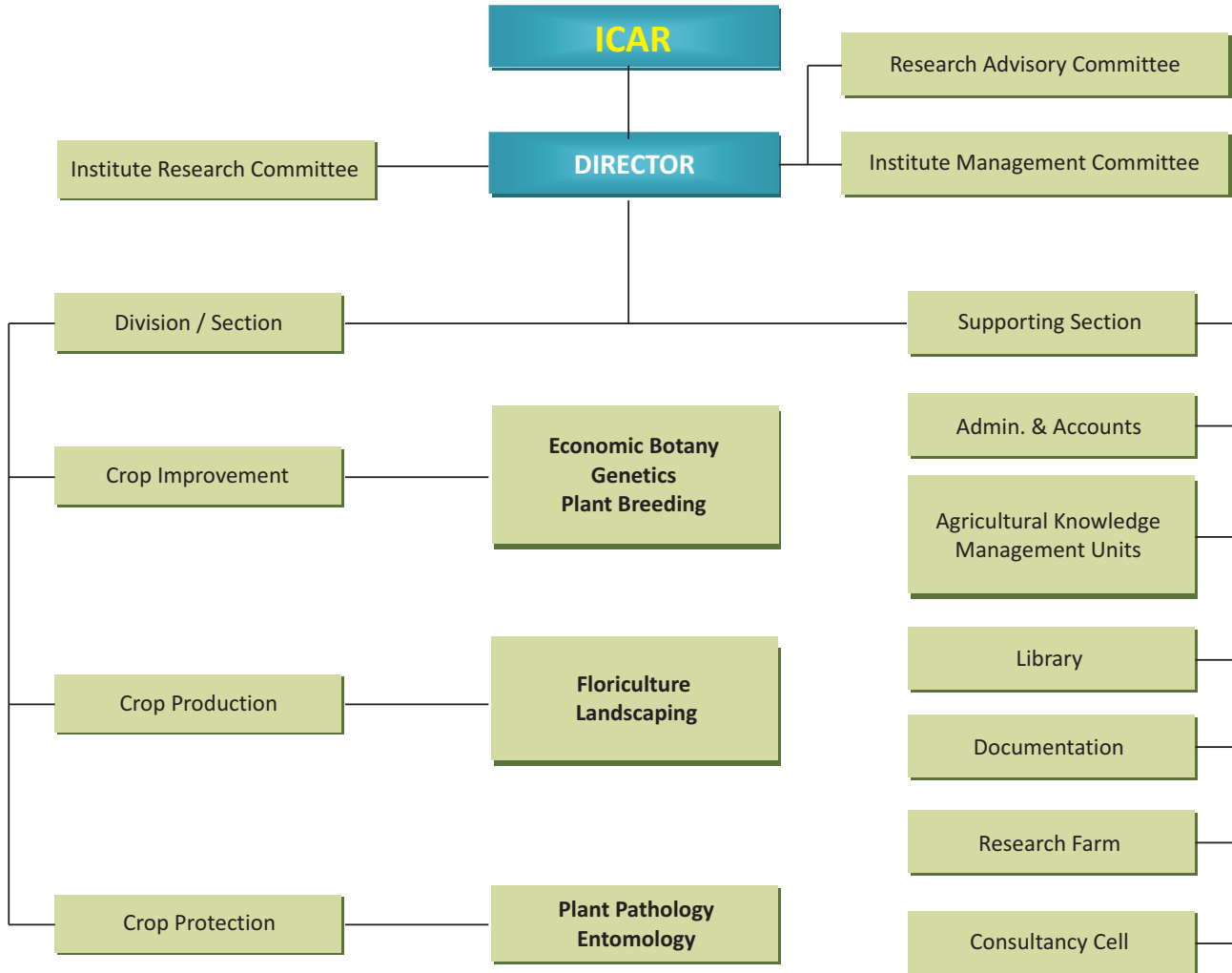
In the initial years of establishment the major focus of research was on collection, characterization evaluation, conservation and utilisation of available germplasm in the country in general and north eastern region in particular. With the changing scenario of floriculture in the country, the centre 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 11 different institutional projects. In addition to these, research work is also being carried out under 4 externally funded projects viz. Horticulture Mission for Northeast and Himalayan States (HMNEH), Network Projects on Distinctiveness, Uniformity and Stability on Orchids (DUS), DBT funded project on 'Development of Protocol for Commercialization of Paphiopedilum orchids in NE states' and NAIP's A Value Chain on Selected Aromatic Plants of North East India.

Organizational setup



Organogram of 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	221.95	203.41
Labour wages	0	0	23.00	19.79
Traveling allowances	10.00	9.88	3.88	3.87
Other charges	220.00	209.29	45.28	44.00
Works	50.00	0	0	0
HRD	10.00	9.97	0	0
Total	290.00	229.14	294.11	271.07

Revenue generation

Amount (Rupees)	
Particulars	Total Amount
Sale of farm produce	3,300.00
Sale of tender form	21,500.00
Training	18,000.00
Others	4,59,464.00
Total	5,05,264.00

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	6*	03
	Sr. Scientist	03	2**	01
	Principal Scientist	01	02	-
Total		15	11	04
3.	Technical Staff			
	Category - I	05	05	-
	Category - II	02	02	-
	Category - III	-	-	-
Total		07	07	-
4.	Administrative Post			
	Administrative Officer	01	-	01
	Asstt. Fin. & Account Officer	01	01	-
	Asstt. Admn. Officer	01	01	-
	Assistant	03	02	01
	PA to Director	01	01	-
	U.D.C/Sr. Clerk	01	01	-
	L.D.C/Jr. Clerk	02	02	-
Total		10	08	02
5.	Supporting Staff (SSG-I, II, III, IV)	08	07	1***

* One Scientist promoted to Sr. Scientist through CAS

** One Sr. Scientist (PB) posted against the post of Scientist (PB)

*** One post has been redeployed to CAZRI, Jodhpur for regularization of SSG till the vacation of the post as per Council order.

Past achievements

A total of 182 accessions belonging to 51 species were collected from Darjeeling and Sikkim Himalaya and conserved. A natural habitat of the endangered terrestrial species *Cymbidium lancifolium* was found during the exploration. A

1st generation primary hybrid was developed using native species *C. lowianum* x *C. tigrinum* (Pedigree code, PBX-05-56). A commercial breeding line for potted plant was identified, developed from PBX-05-29/2012-3 & 4 (C. "Red

Beauty" x C. "Golden Elf"). An inter-generic hybrid was developed from *Arachnis clarkei* x *Vanda coerulea* was evaluated for 2nd time (Mar' 2013). To strengthen the plant breeder rights, the DUS test guidelines on *Cattleya* and *Phalaenopsis* were developed and finalized.

Eight native *Aerides* were evaluated to study the diversity and genetic relationship using 65 RAPD primers. Cluster analysis identified seven species in a major cluster and one species separated as an outlier, indicating RAPD markers as powerful molecular tool for assessment of diversity in *Aerides* species. The PIC value ranges from 0.587 to 0.946, indicating that all primers were capable of detecting polymorphism very efficiently.

Genetic diversity among 18 native species of genus *Vanda* was analysed using ISSR markers. Phylogenetic tree grouped all the species in two major clusters C1 and C2 and one single species *Vanda spathulata* was separated as an outlier. RAPD analysis was performed in *Vanda cristata*, using 37 decamer primers also indicated genetic variability within the species. Twenty four accessions of *Cymbidium tracyanum* were evaluated with 65 RAPD markers were grouped in two major clusters.

A simple modified CTAB method for isolation of high quality genomic DNA from fresh and matured leaves of orchids was developed. Both the quantity and quality of isolated DNA was higher when compared with the DNA isolated by the other methods and was applied for patent. Similarly, NRCO developed in-vitro flowering in *Cymbidium dayanum* through hormonal manipulations in experimentation.

Effect of culture media and cytokinin (BAP) on germination of crosses of *Cymbidium* revealed that no single medium is suitable for germinating

all the crosses, but the addition of BAP enhanced the germination. In *Aerides odorata*, MS media without BAP took least days for swelling (70 days), globule formation (75 days), first leaf initiation (94 days), first root initiation (115 days) and seedling development (161 days). For fresh induction of plbs, MS media enriched with the combination of 0.5 mg l⁻¹ BAP and 0.2 mg l⁻¹ NAA found suitable for whole leaf culture of *Vanda coerulea*.

Cymbidium Winter Beach 'Sea Green' was identified as suitable variety for Integrated Floriculture Enterprise. The cost benefit ratio of three demonstration farms plots was recorded 1.56, 1.60 and 1.43 respectively, and the cost benefit ratio of the study was found 1.80.

Application of water @ 150 ml/pot increased production of spike (8.5/pot) as compared to control (5.5/pot). Same treatment also produced longer spike (40.2 cm) in Den. 'Emma White'. In *Cymbidium* hybrid 'PCMV', treatment with 2% sucrose + 100 ppm salicylic acid showed maximum longevity (63 days) of cut spikes in fully opened stage.

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 survey, about 62 species of orchids in northern Himalayan region were found severely infested by a number of insect pests round the year. *Scimnus* sp. reported as bio control agent of coccids and mealy bug on orchids under protected conditions. Among nine bio pesticides tested against aphid on *Dendrobium nobile*, econeem 3000 ppm @ 3 ml/l was found most effective. Out of seven IPM modules, M-4 (Nirma solution 3g/l + econeem 3000 ppm @ 3ml/lit + imidacloprid 17.8 SL 0.003%) was found most effective against boisduval scale, whereas, M-3 (tobacco extract 5% + econeem 3000 ppm @ 3 ml/l + imidacloprid 0.003%) was most effective against aphid on *Cymbidium*.

Organized the “National Dialogue on Orchid Conservation & Sustainable Development for Community Development - 2013” (NDOCSDCCL 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, Bangalore, 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.

2.1 Research Achievements NRC(O), Main Centre



CROP IMPROVEMENT

Hybrid/Varietal Development Programme for Orchids

Genetic Resources:

Survey of Wild orchids of Kodagu, Karnataka

Kodagu sits amidst the lush green grandeur of the Western Ghats and offers a wide diversity of natural flora including orchids. A survey was carried out during June to August, 2013 on wild orchids of Kodagu. The survey area included are Madikeri, Abbe falls, Bhagmandala, Appangla, Galibeddu, Bettakeri, Napklu, Kakabe, Santahalli, Koothy reserve forest, lower reach of Pushpagiri hills, Mallali falls, Abborkatte, Kushalnagar, Kauveri nishargadham, Shuntikoppa, Chettali, Rangasamudra, Anekadu, Ponnampet, Pollibetta, Gonikoppal. A total of 40 orchid species were recorded during the survey (fig 1a and 1b).

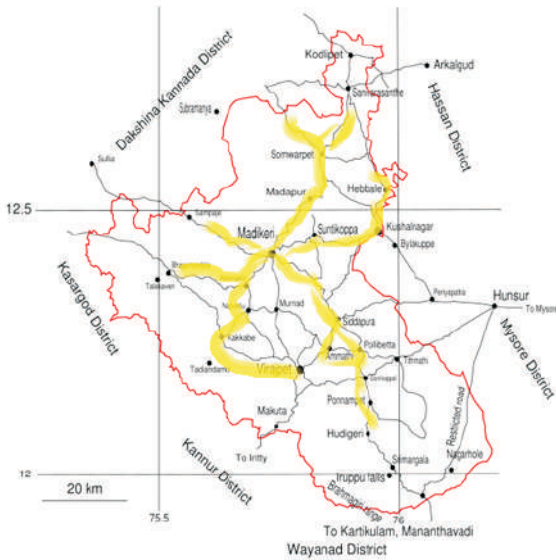


Fig. 1 a. The survey route



Fig 1b. A few species of Kodugu

Hybridization Programme:

More than 400 pollinations between species vs species, hybrids vs species and hybrids vs hybrids of *Dendrobium*, *Vanda*, *Phalaenopsis*, *Renanthera*, *Phaphiopedilum* and *Coelogyne* were done to assess the compatibility and success of pod setting. Pod setting success ranges from 0.08 to 50 % for direct crosses and 0.08 to 88.8% in reciprocal crosses in *Dendrobium* and 69 to 100% in *Vanda* group.



Fig. 2a. Pod setting in *Zygopetalum* (PBX-12-200)



Fig. 2b. Pod Setting in *Cymbidium* (PBX-12-221)

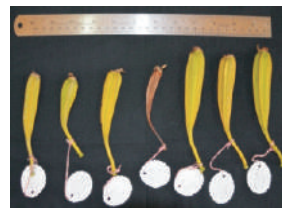


Fig. 2c. Pod Setting in *Vanda* (PBX-12-169)



Fig. 2d. *Dendrobium ovatum*



Fig. 2e. *Tylostylis discolor*



Fig. 2f. *Dendrobium macrostachyum*

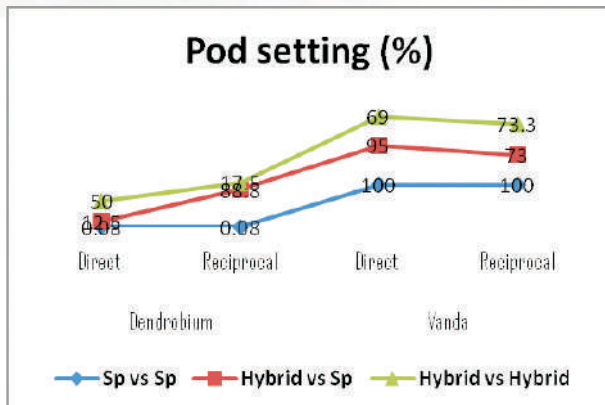


Fig. 2g. Success of pod setting

Fig. 3. *Cymbidium* 'B. S. Basnet'Fig 4. *Aranda* 'Kunga Gyatso'

New hybrids released (2013-14)

- 1. *Cymbidium* 'B. S. Basnet':** Historical cross PBX-05-56 using native species of India (*Cym. Lowianum* x *C. tigrinum*), which was re-invented after 110 years initially reported (RHS, UK) is released at institute level after two year station trial (Fig. 3).
- 2. *Aranda* 'Kunga Gyatso':** The first inter generic hybrid of *Arachnis clarkei* x *V. coerulea* was released at institute level after station trial and the hybrid has been proposed for multi-locational trial (MLT). The variety is suitable for sub-tropical and tropical cultivation (Fig. 4).
- 3. *Dendrobium* 'V. Nagaraju':** The cross (D. 'Emma White' x D. 'Pompadour') developed at institute is released at institutional level based on two years data (Fig. 5).

Fig 5. *Dendrobium* 'V. Nagaraju'

New NRCO hybrids evaluated during flowering (2013-14)

- a. PBX-05-772/2013:** The flowering progeny of cross (*Cymbidium* 'Concerto' x *C. iridiodes*) was recorded during September (2nd WK) to December. Progeny lines were early flowering and scented nature. Flowers are medium sized and predominantly yellow green group with modern lip size and pigmentation and two lines (66 & 126) were selected (Fig 6a & 6b).
- b. PBX-05-751/2013:** The cross (*Cymbidium* 'Nonina Paleface' x *Cymbidium iridiodes*) was flowered (4th week of Sept) with more number of florets (12). The lip size was 3.2 x 1.8 (cm) with red purple spots (RHS 59B) with yellow orange throat (Fig. 7).



c. NRCO-H x B/2013: Progeny of cross (*Cymbidium lowianum* x *C.* 'Show Girl') was evaluated for 2nd consecutive year and two breeding lines viz., 17 & 25 were selected among the seven lines evaluated for morpho-floral attributes. It flowers from mid to late season and flowers are mildly scented (Fig 8a & 8b).



Fig 7. (PBX-05-751/2012)



Fig 8a. (NRCO_HxB/2013-25)

d. NRCO-BxH/2013: The flowering progeny of cross (*Cymbidium* 'Showgirl' x *C. lowianum*) was characterized. These progeny lines were mid season flowering (Jan-Mar) with larger colour gradient between both the parents. Two lines were selected (34 & 35) from seven flowering progeny (Fig 9a & 9b).



Fig. 8b. NRCO_HxB/2013-17



Fig. 9a. NRCO_BxH/2008-34

e. NRCO-PlxPw/2014: The 15 progeny lines of cross (*Paphiopedilum lawrenceanum* x *P.* 'Winstone Churchill') were evaluated for all floral traits for further selection (fig. 10).

f. Flowering progeny recorded with malformation in NRCO-05-34 that lacks full expression of characters and spikes of PBX-05-29 withering before flower opening.



Fig 6a (PBX-05-772-2013-66)



Fig 6b (PBX-05-772-2013-126)



Fig. 9b. NRCO_BxH/2014-35



Fig. 10 NRCO-PLxPW-2013-37

Effect of culture media and lower concentration of BAP on seed germination of different crosses

In vitro cultures were established with 103 crosses and 19 selfings in different basal media (MS, Gamborg B5 and Nitsch). Total 24 crosses

(23.3 %) responded with germination. Seeds from capsules, PBX-12-099 {*Phal.* 'Brother & Sister' x *Phal.* 'Rousserole'}, PBX-11-162 (*P. insigne* x *P. venustum*) and PBX-11-165 (*P. insigne* x *P. villosum*) were harvested after 10 to 12 months of pollination. The harvested capsules were cultured in different media viz., MS, Gamborg (B5) and Nitsch media supplemented with 2% sucrose, BAP_(0.2-2 mg/l) and with or without activated charcoal. Crossed seeds from PBX-12-099 and PBX-11-165 responded faster to Gamborg media with BAP_{0.2 mg/l} and activated charcoal which took less number of days for swelling (22 & 53), greening (26 & 90) and germination (49 & 100) (Fig. 11). Cross PBX-11-162 responded faster to Nitsch media which took less number of days for swelling (36), greening (42) (Fig 12) . The status of other seed cultures for success of germination is indicated in table. Among the 19 selfed seed cultures, only 6 were responded with germination.



Fig 11. Seed germination in PBX-11-99

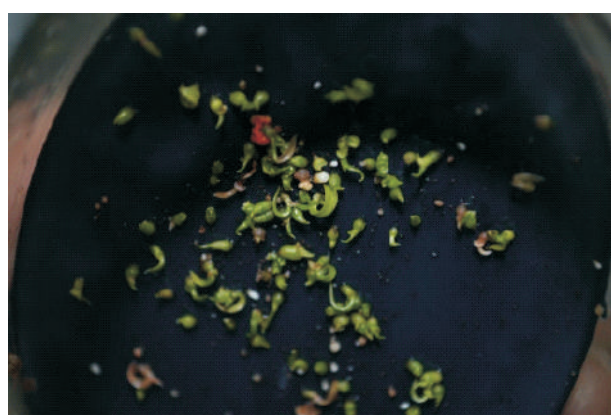


Fig. 12. Seed germination in PBX-11-162

Table 1. Seed germination in seeds from crossed and selfed capsules during the current year

S. no	Code	Pedigree
1	PBX-11-162	<i>P. insigne</i> x <i>P. venustum</i>
2	PBX-11-165	<i>P. insigne</i> x <i>P. villosum</i>
3	PBX-12-099	<i>Phal. Af</i> x <i>Phal. Aa</i> (Rousserole)
4	PBX-12-152(1)	<i>V. 'Motes Indigo'</i> x <i>V. coerulescens</i>
5	PBX-12-158(1)	<i>V. coerulescens</i> x <i>V. stangeana</i>
6	PBX-12-159	<i>V. stangeana</i> x <i>V. coerulescens</i>
7	PBX-12-169(1)	<i>V. 'Bernice Miller'</i> x <i>V. coerulescens</i>
8	PBX-12-169(2)	<i>V. 'Bernice Miller'</i> x <i>V. coerulescens</i>
9	PBX-12-169(3)	<i>V. 'Bernice Miller'</i> x <i>V. coerulescens</i>
10	PBX-12-171(2)	<i>V. 'Bernice Miller'</i> x <i>V. cristata</i>
11	PBX-12-172(1)	<i>V. cristata</i> x <i>V. 'Bernice Miller'</i>
12	PBX-12-180(1)	(<i>V. Madame Rattana</i> x <i>V. Manuvadee</i>) x <i>V. 'Bernice Miller'</i>
13	PBX-12-180(2)	(<i>V. Madame Rattana</i> x <i>V. Manuvadee</i>) x <i>V. 'Bernice Miller'</i>
14	PBX-12-181(1)	<i>V. 'Bernice Miller'</i> x (<i>V. Madame Rattana</i> x <i>V. Manuvadee</i>)
15	PBX-12-187(1)	<i>Z. intermedium</i> x <i>C. tracyanum</i>
16	PBX-12-187(2)	<i>Z. intermedium</i> x <i>C. tracyanum</i>
17	PBX-12-189(1)	(PBX-05-29/2013-2) x <i>C. tracyanum</i>

18	PBX-12-199(1)	<i>C. tracyanum</i> x <i>Z. intermedium</i>
19	PBX-12-199(2)	<i>C. tracyanum</i> x <i>Z. intermedium</i>
20	PBX-12-199(3)	<i>C. tracyanum</i> x <i>Z. intermedium</i>
21	PBX-12-200(2)	(<i>ZI. PBS-05-593</i>) x <i>C. tracyanum</i>
22	PBX-12-240	(<i>Zi PBS-05-593</i>) x <i>Coelogyne barbata</i>
23	<i>Coe. elata</i>	-
24	<i>C. graminifolia</i>	-
25	PBS(x)-13-148	<i>Z. intermedium</i>
26	PBS(x)-13-149	<i>D. moschatum</i>
27	PBS-11-120	<i>P. insigne</i>
28	PBS-11-160	<i>P. insigne</i>

DNA Fingerprinting of Commercially Important Orchids

Genetic diversity analysis in *Cymbidium whiteae* a rare, endangered, endemic orchid species of Sikkim Himalaya

RAPD technique was used to analyse the genetic diversity of a small population of endangered and endemic orchid species-*Cymbidium whiteae* from Rumtek of Sikkim Himalaya where this species was rediscovered after a long period. The plants collected from this region did not show any morphological variations but molecular analysis showed higher percentage of polymorphism within the population (Fig. 13). Resolving power of the primers ranged from 1.8 to 21.7, with an average of 8.07 which suggested that the primers with high Rp values are able to distinguish the samples under study. Diversity index ranged from 0.33 to 0.87 with an average of 0.63. In Dendrogram, all 20 plants were distributed into two major clusters, where in major cluster C1, 7 plants were grouped and in major cluster C2, 13 plants were grouped. Similarity between two clusters was only 31 %, suggesting that two different evolutionary tract within this small population. To confirm the reliability of the results samples from these two different clusters were tested with other 22 *Cymbidium* species of

India and observed that the samples are different from others (Fig 14).

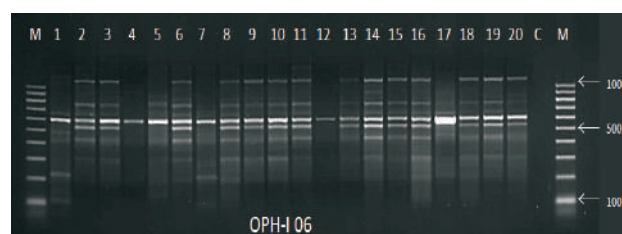


Fig. 13. RAPD banding pattern of 20 plants of *Cym. whiteae* obtained by primer OPH-I-06

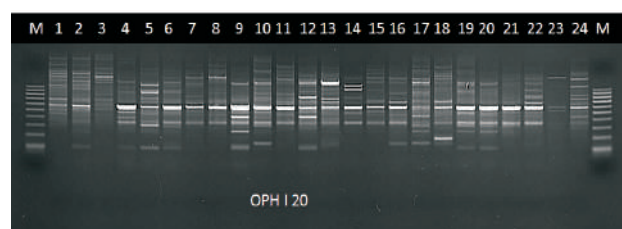


Fig. 14. RAPD banding pattern of *Cym. whiteae* and other *Cymbidium* species

Diversity analysis of some medicinal *Dendrobium* orchids using Microsatellite markers

Simple sequence repeat (SSR) markers were used to determine the genetic relationship among 20 species of medicinal *Dendrobium* orchids collected from different geographical regions of India. Four SSR primers sets had amplified a total of 149 loci and produced total 75 polymorphic bands (Fig 15). The number of bands per primer ranged from 10-30 with an average of 18.75 and size ranged from 70-2900

bp. The average Rp value was 3.75, which indicates that the primers are able to distinguish the genotypes. The PIC value ranged from 0.56 to 0.95 with an average of 0.72 also indicated that all primers were capable of detecting polymorphism efficiently. Maximum Discrimination power (D) was found 0.99 in primer set DR-49 and least was 0.59 found in primer sets DR-12 and DR-30 with an average of 0.76 for all primer sets. The cluster analysis based on UPGMA method grouped all species into three different clusters.

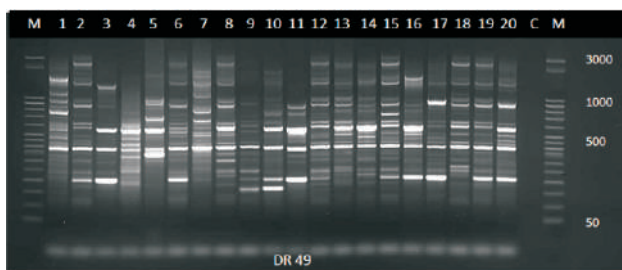


Fig. 15. Banding pattern generated by SSR markers

Molecular markers for assessment of genetic diversity and relatedness of some important *Dendrobium* orchid species of India

Genetic divergence of some native wild species of *Dendrobium* orchids having unique floral traits was determined using two extensively used simple molecular techniques-RAPD and ISSR for selection of donor for breeding programme. High level of polymorphism was recorded both in ISSR and RAPD. Genetic similarities of some species are same in both RAPD and ISSR. The results of the present study provide important clue about the genetic variations of the species and may assist to select donor to develop novel hybrids

Intra specific variability analysis of *Dendrobium anceps* using RAPD markers

Morphological variation was observed in the species *Dendrobium anceps* from the existing collections of NRC for Orchids. To study the

genetic variability of 12 samples of the species RAPD analysis was performed using 20 decamer primers which produced distinct bands. The results showed monomorphic bands in all the samples, which indicates that there was no genetic variability among the samples and the morphological variations may be due to some environmental factors (Fig 16).



Fig.16. Monomorphic bands generated by primer OPK03

DNA bar coding of native *Vanda* species

Identification of species at vegetative phase is difficult in orchids. DNA Barcoding is a method which helps in species identification. Barcoding of native 18 *Vanda* species were done using 6 microsatellite markers (bar code) primers (Fig 17). The results are to be submitted in NCBI.

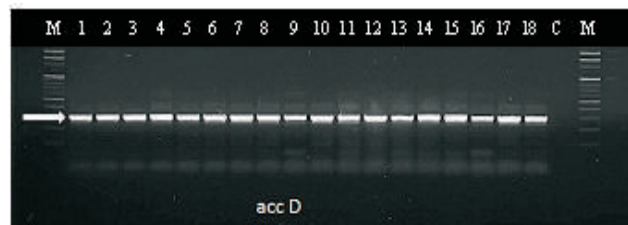


Fig. 17. Banding patterns of *Vanda* (primer accD)

SCAR analysis of *Cymbidium* species

Molecular analysis of species of *Cymbidium* genus of India revealed a specific sequence which can be used to prepare a sequence characterized amplified regions (SCAR) marker. SCAR method was used to study 24 native species of *Cymbidium* orchids (Fig 18). The sequence of interest from all the *Cymbidium* species has been amplified, separated on gel, extracted from gel and subjected to sequencing. The sequencing result will be used to prepare markers.

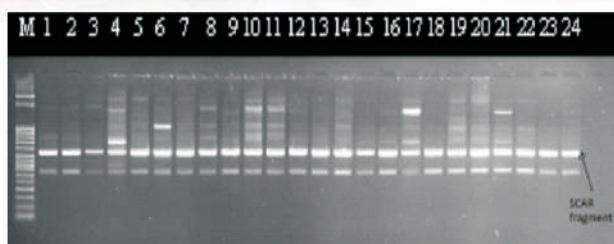


Fig. 18. Banding patterns in SCAR

Tissue Culture

Differentiation of plantlets from plbs of *Cymbidium* 'Soul Hunt'

Differentiation of plantlets from PLBs of *Cymbidium* 'Soul Hunt' was studied using auxins and cytokinins at different concentrations with and without sucrose and without activate charcoal. Plb clumps of 10-15 numbers were cultured on different concentration of MS (full, half, one forth and three forth concentration) basal media with and without 2% sucrose supplemented with different concentrations of auxins and cytokinins like BAP (6-Benzylaminopurine), NAA (α -Naphthalene Acetic Acid), kinetin (6-Furfurylaminopurine), IBA (Indole-3-Butyric Acid) and IAA (Indole-3-Acetic Acid). Experiment consisted of 40 different treatments in random manner with five replications each. PLBs in MS supplemented with 2% Sucrose showed least number of days for greening, callusing and PLB formation (7.2, 22.6 & 52 days). The presence of 2% sucrose enhanced browning of media. MS media supplemented with 2% (Sucrose) and 0.05 mg/l (BAP) showed least number of days for plantlet initiation (99.5 days). The percentage of plantlet formation in responding treatments was few. The mass of PLB proliferation was higher in the treatments with 2% Sucrose and lower in treatments without 2% Sucrose. Number of shootlet initiation in the responding culture bottles was very few (19 a & 19b).



Fig 19 a & b. 40 different treatments with five replications each of *Cymbidium* "Soul Hunt"

Subculturing of plbs using different level of cytokinins from *Cymbidium* "Soul Hunt"

In order to initiate shootlets from PLBs of *Cymbidium* "Soul Hunt" a sub-culturing experiment was set up taking half strength Nitsch as basal media with different treatments of lower concentrations of cytokinins (BAP and Kinetin) with or without 2% sucrose and without activated charcoal. The experiment consisted of 13 different treatments with five replications each. Different parameters callusing, PLB formation and shootlet initiation were recorded. Due to phenol exudates, browning of media took place within 30 days of inoculation and the same was sub cultured on fresh media containing the same treatments. The explants in $\frac{1}{2}$ N with 2% sucrose and 0.25 mg/l (BAP) resulted callusing phase from plbs in 32.5 days and mature PLB formation in 50.6 days.

Role of auxins on shootlet initiation of *Cymbidium* "Soul Hunt"

An experiment was set up from PLBs of previous year cultures of *Cymbidium* 'Soul Hunt'. PLBs as explants were cultured on MS basal media with different concentrations of NAA (α -Naphthalene Acetic Acid) with and without 2% sucrose and activated charcoal. MS media with 2% sucrose and 0.1 mg/l (NAA) with activated charcoal resulted shoot primordial initiation in 43 days and shootlet initiation in 49.7 days.

In-vitro flowering of *Cymbidium*

In order to induce flowering in *Cymbidium dayanum* by *in-vitro* techniques the experiment was set up in the consecutive year to shorten the juvenility in species. Two years old plantlets of *Cymbidium dayanum* were cultured in MS media supplemented with different concentration of Paclobutrazol, BAP and ABA alone or in different combinations, 2% sucrose and 1.5 mg/l activated charcoal. The plantlets in all the treatments showed ageing and profuse growth.

Induction of shoot lets from PLBs of *Dendrobium* 'Emma White'

An experiment was set up from PLBs obtained from the previous year cultures of *Dendrobium* 'Emma White'. The explants (PLBs) were cultured on Nitsch and Gamborg media supplemented with different concentrations of BAP and NAA alone and in different combinations. Nitsch media supplemented with 0.25 mg/l of NAA and 0.25 mg/l of BAP along with 2% sucrose and activated charcoal found suitable for proliferations of PLBs. However, shootlet initiation occurred in Gamborg media supplemented with 1.0 mg/l of BAP within 88 days of inoculation. Completely developed plantlets were obtained in 196 days of inoculation

in Gamborg media containing 1.0 mg/l BAP.



Fig 20a. PLB proliferation from shoot tip of *Den.* 'Emma White'



Fig. 20b. Shootlet initiation from PLBs of *Den.* 'Emma White'



Fig. 20c *In-vitro* hardening plantlets of *Den.* 'Emma White'

Report on *in-vitro* pseudobulbs in *Coelogyne flaccida*

Seeds from matured seed pods of *Coelogyne flaccida* were cultured *in vitro* and seedlings were obtained on Gamborg B5 media. Six months old seedlings were inoculated in Gamborg B5 media

supplemented with 0.2 mg/l BAP , 20 gm/l sucrose, 1.5 gm/l activated charcoal and 4 gm/l agar. The plantlets developed pseudobulbs within 3 months after inoculation. It took 68 days for pseudobulb initiation till complete development. The hairy roots were tremendously long and slender with a single pseudobulb. The pseudobulbs produced were 1-2.5 cm in length, 0.5-0.8 cm girth and weighing around 0.3-0.4 gm. The report on *in-vitro* rhizome formation may help in increasing survival in hardening conditions and other physiological studies (Fig 21).

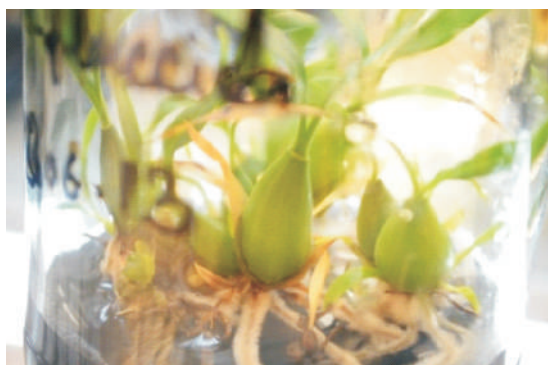


Fig. 21. *In-vitro* pseudobulbs of *C. flaccida*

CROP PRODUCTION

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 (500sq.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. The yield of different hybrids is shown below (Fig.1). It was recorded more yield in all hybrids as compared to previous year. Further, hybrids 'Pine Class Moon Venus', 'Soul-Hunt', and 'Valley Legend Steffi' yielded spike of 60 cm and above; hybrids 'Enshikhan', 'Winter Beach Sea Green', and 'Sleeping Nymph' produced spike of 45 to 60 cm length and 'Korean -4' produced spike below 30 cm length.

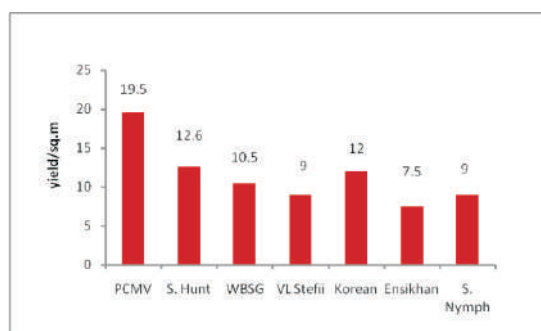


Fig.1 Flower production of different hybrids

Production Management of Tropical and Sub-tropical Orchids

Evaluation of tropical and subtropical hybrids of commercially grown orchids

In *Aranda* group of hybrids viz., 'Propine Spot',

'Sayan A.B. Gold', 'Majula Ren. Storier', 'AKV Fuch's Delight', 'Propine White' and 'Thailand Sunspot'; in *Mokara* group viz., 'Happy Beauty', 'Walter Ouame White', 'Khan Piak Swan Rasri Gold', 'Chark Kuan Orange' & 'Madame Pani' and in *Oncidium* group Colm. 'Wildcat Bobcat', 'Wildcat Carmera', 'Pixie Ruth', Onc. 'Sweet Sugar', Onc. 'Sharry Baby Sweet Fragrance', 'Taka Yellow', 'Popki Red', 'J. R. Pink Spot', 'J. R. Orange Red', 'J. R. Yellow Brown' were continued to be found promising. In *Vanda* group of hybrids viz., 'KS.S.D', 'Prao Sky Blue', 'Pures Wax', 'RBSD Black', 'PAT-D', 'Sansai Blue', 'Motes Indigo Pakchong Blue' and 'Ratch Blue Star' were found as promising. In *Dendrobium* group, it was possible to get blooms round the year of varying quality with the utilization of 14 number of hybrids. In *Cattleya* group of hybrids viz, 'Queen Sirikhit', 'Chinese Beauty Orchid Queen', 'Ahmad Seikhi' and in *Phalaenopsis*, 'Brother & White', 'Kaleidoscope', 'Maki Watanabe', 'Ox Prince Thunder', 'Strawberry', 'Memoria Francis Hunter', 'Chian Xen Magpie' and 'Hsing Ying Fortune' were found promising for round the year, except December and January.

Pre- harvest treatments on growth, flowering and post-harvest life of *Cym.* 'Valley Legend Steff'

In *Cymbidium* hybrid 'Valley Legend Steff', pre-harvest spraying with lower doses of paclobutrazol (50-200 ppm) improved pseudobulb size, spike length, number of florets per spike and chlorophyll content, whereas higher doses (250-300 ppm) increased only number of spikes per plant.

Effect of pot and potting mixture (organic) on plant growth and flowering of *Cym* 'Levis Duke Bella Vista'

Out of seven potting mixture and three types of

pots, plastic pot with a mixture of cocochips + cocopeat + brick pieces + slow release fertilizer (3: 3: 1: 1 g) showed maximum pseudobulb diameter (5.00 cm), longest leaf length (69 cm) and maximum number of bulbs (5).

Effect of potting mixture on growth, flowering and longevity of *Cattleya* 'Queen Sirikhit'

In *Cattleya* 'Queen Sirikhit', out of 12 potting media, the mixture containing cocochips + brick pieces + leaf mould (1:1:1) and cocochips + brick pieces + leaf fern (1:1:1) were found equally best. Longest inflorescence length (27 cm) highest number of flowers/peduncle (6.0) and maximum number of spikes (4)/plant were recorded with cocochips + brick peces + leaf fern (1:1:1)

Effect of potting mixture on growth, flowering and post-harvest life of *Dendrobium* hybrids

Out of twelve *Dendrobium* hybrids and four potting mixtures, the combination of cocopeat + brick pieces + tree bark (1:1:1) was found best, followed by cocopeat + brick pieces + leaf fern (1:1:1) and cocochips + brick pieces + tree bark (1:1:1).

Evaluation of terrestrial orchid species

Out of sixteen orchid species under ground culture, *Paphiopedilum* spp, *Arundina bamboosifolia*, *Phaius tankervillea*, *Tainia hookeriana*, *Dendrobium nobile*, *Vanda teres* and *Epidendrum* spp. came into flowering. Flowering period recorded in different species were *Tainia hookeriana* (Feb-April), *Phaius tankervilleae* (March-May), *Dendrobium nobile* (April-May), *Epidendrum xanthimum* (January-July), *Arundina graminifolia* (June to August) and *Vanda teres* (April-July). *Phaius flavus* and *Phaius mishmensis* were added to trial.



Post-harvest Technology of Orchids

Evaluation of *Phalaenopsis* hybrids for their vase life

Eleven *Phalaenopsis* hybrids were evaluated for their vase life. Amongst them 'Manchester' had highest vase life (62.2 days). In *Phalaenopsis*, Detroit, out of five impregnation treatments, CoCl₂ (1000 ppm) for 45 minutes had maximum vase life (75.6 days) followed by 1000 ppm NiCl₂ (62 days) over control (45 days).

Evaluation of *Mokara* hybrids for vase life

In *Mokara*, 'Walter Oumae White' cut flowers harvested at all florets opened except top 4-5 buds had maximum vase life (18.5 days) followed by all florets opened except one bud (17 days) and all florets opened (13 days).

Evaluation of terrestrial orchids for vase life

In *Phaius tankervillea*, out of seven harvest stages, cut flowers of loose bud stage had maximum vase life (33 days) and minimum at 9 buds opened stage (20 days). In *Epidendrum*, cut flowers harvested at all florets opened stage except 5 buds showed maximum vase life (28 days) followed by all florets opened stage except top 10 buds (22 days).

Effect of packaging materials on longevity of *Cymbidium* hybrids

In *Cym.* 'Sun Gold', packing of 25% bud open stage cut spikes with cellophane paper had maximum vase life (48 days) followed by 50% bud open stage (46 days). In *Cymbidium* 'Pine Clash Moon Venus', packing of loose bud stage cut spikes with cellophane paper had maximum vase life (60 days) over control (49 days).

Stress physiology of Orchids

Effect of water stress on *Cym.* Pine Clash 'Moon Venus'

Water stress is the single most limiting factor governing the growth and survivability of plants. To study short duration of drought exposure, 2 years old PCMV seedlings were subjected to water stress by withholding irrigation for 15 days. The growth parameters recorded did not show any significant difference between stressed and non-stressed plants. Drought stress causes physiological changes in short term. Water content of stressed plants leaves were reduced considerably. Decrease of 12 % water content in stressed plants as compared to non-stressed plants was observed. Superoxide radicals (O₂⁻) production was comparatively high in stressed plants. Stressed plants produced 25 % higher Superoxide radicals. Lipid peroxidation was measured in terms of thiobarbituric acid reactive substances (TBARS) contents. 22.61 n mol of TBARS g⁻¹ FW was recorded in stressed plants which showed 25 % higher in TBARS content, as compared to the non-stressed plants.

Comparative studies on effect of Water and temperature stress on *Cymbidium* Hybrid 'Pine Clash Moon Venus' mature plants

Stress was induced by withholding irrigation (W) for 60 Days (D) and high temperature (T) treatment (35°C ± 2). Water and temperature stress reduced relative water content (RWC) and dry matter accumulation (DMA). Reduced in RWC by 81.32 %, 55.15 % and 83.60 % in W, T and W+T was recorded respectively. DMA was reduced by 13.9% in W+T stress plants as compared to control after 60D. While ROS and TBARS production increased in all the stressed plants irrespective of treatment. W+T stress

treatment bring about highest production of TBARS at 60D. Except plants under combination of W+T stress for 60 Days, other plants recovered after removal of stress for 20D. Temperature stress can be reduced to certain extend by watering twice a week (Fig. 2).

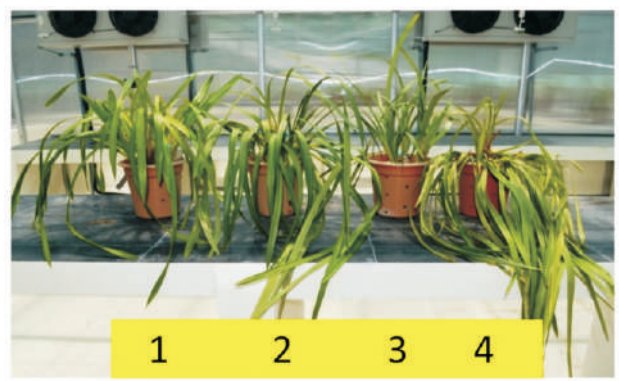


Fig.2 Effect of water and temperature stress on *Cym. Pine Clash 'Moon Venus'*. 1. control, 2. water, 3. Temperature and 4. water + Temperature

Comparative studies on the effect of temperature stress on C3 and CAM Orchids

To compare the effect of high temperature stress on C3 and CAM orchids, *Cymbidium* hybrid, a C3 plant with a pseudobulb and *Phalaenopsis* hybrid, CAM orchid were exposed to $35^{\circ}\text{C} \pm 2^{\circ}\text{C}$ for 40D. DMA and RWC was much lower in C3, depicting CAM have higher water use efficiency under high temperature. Pigment, such as, Chll 'a', Chll 'b' and carotenoids were higher in C3. Both O_2^- and TBARS production were higher in C3 and membrane stability index was 74% lower in C3. CAM orchids can perform better than C3 orchids with a storage organ under high temperature.

CROP PROTECTION

Ecofriendly Pest Management in Orchids

Monitoring of pest infestation on orchids

The constant observations were recorded at weekly intervals for natural pest infestation on orchid germplasm maintained at the National Research Centre for Orchids, Pakyong under naturally ventilated polyhouses. The following observations have been recorded.

- The infestation of “two-spotted” spider mite, *Tetranychus urticae* was reported on below mentioned orchids. Its infestation was present throughout the year at different levels and its incidence being negligible during extreme winters (December-January). It was recorded on host plants: *Coelogyne fuscescens*, *Cymbidium iridioides*, *C. devonianum*, *C. lowianum*, *C. dayanum*, *Cym. Pine Clash 'Moon Venus'*, *Cym. Winter Beach 'Sea Green'*, *Cym. 'Fire Storm Blaze'*, *Dendrobium fimbriatum*, and *D. moschatum* and *Thunia marshiliana*.
- Five species of scale insects (ti-scale, *Pinnaspis buxi*; soft brown scale, *Coccus hesperidum*; boisduval scale, *Diaspis boisduvali*; lecanium scale, *Lecanium* sp. and Florida red scale, *Chrysomphalus aonidum*) were reported to infest on many species and hybrids of orchids. Their incidences were noticed throughout the year at different levels. All plants (90) of *Cym. Pine Clash 'Moon Venus'* were infested. Out of 59 plants of *Epidendrum* sp., 34 plants were infested by *Diaspis boisduvali* which indicated the

susceptibility.

- Thrips, *Dichromothrips nakahari* was reported to infest on many species and hybrids of *Cymbidium*, *Dendrobium* and many other orchids from vegetative to reproductive stage. Its infestation was found on the flowers of *Cymbidium* species and hybrids during the months of January in low populations. In *Dendrobium*, it was also observed on *D. nobile*, *D. densiflorum*, *D. aggregatum*, *D. fimbriatum* and *D. wardianum*. Out of 42 plants of *D. densiflorum*, 40 plants were infested with thrips with an average population of 1.8 thrips/flower.
- Aphids, *Macrosiphum luteum* and *Toxoptera auranti* were recorded on *Cymbidium* hybrids Winter Beach 'Sea Green', Baltic Elegans and Pine Clash 'Moon Venus'.
- Shoot borer, *Peridaedala* sp. was reported to damage on many species of orchids i.e., *Dendrobium nobile*, *D. fimbriatum*, *D. aphyllum*, *D. chrysanthum*, *D. moschatum*, *D. densiflorum*, *D. chrysotoxum* and hybrids like 'Thongchai Gold', 'Emma White', 'Madam Pink', 'A. Abraham', 'Bangkok Blue', *Arundina bamboosifolia*, *Epidendrum* sp and *Acampe rigida*. Its infestation started with the onset of monsoon in middle of May and continued till September at different damaging levels. The highest infestation was recorded in *D. nobile* (80.5%).

New Identifications and reports

New report of pests

First report on diaspid scale insect, *Lepidosaphes pinnaeformis* (Bouche) on *Cymbidium* spp. and hybrids

The diaspidid scale, *Lepidosaphes pinnaeformis* (Bouche) has been found to infest the leaves, leaf sheath and pseudobulbs of many *Cymbidium* species and hybrids round the year. The adult female cover is oyster-shell shaped, usually curved, moderately convex, brown often with lighter periphery; shed skins marginal, orange or tan (Fig.1. a). Adult males with one pair of wings, male cover shorter, narrower than female cover, same color and texture; shed skin marginal orange or tan (Fig.1. b). Body of adult female white to light violet; eggs and crawlers probably white to pinkish color. The newly hatched crawlers move about for a short while, select a suitable place and starts feeding. The nymphs and adults insert the needle like stylets and suck the sap and devoid the cell of its contents which results in yellowing of the infested portions (Fig.2).

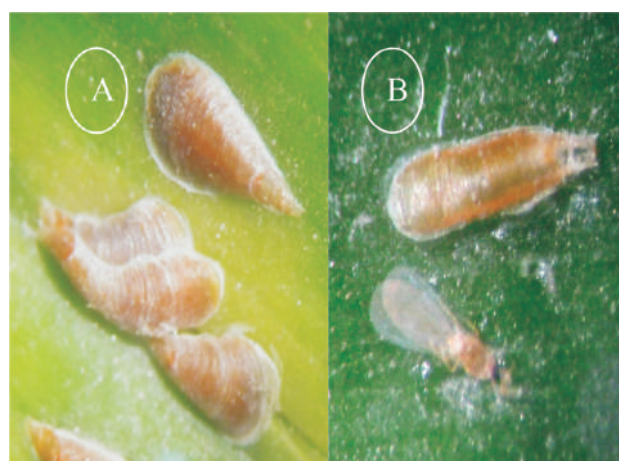


Fig. 1. (a) Female scale (b) Male scale insect with shellcover



Fig. 2. Adult female & Egg

Fig. 3. Scale infested leaves

Fig. 4b. Wingless adult

Fig. 4c. Winged adult

False spider mites on Orchids (A new report)

New report of Aphid, *Aulacorthum circumflexum* on *Cym. Baltic Elegans* and *Cym. Winter Beach 'Sea Green'*

Another aphid, *Aulacorthum circumflexum* also called, Lily or mottled arum aphid has been found to infest the unopened buds and opened flowers of *Cymbidium* hybrids Winter Beach 'Sea Green' and Baltic Elegans from the month of January upto April 1st week onwards. Out of 30 spikes, infestations were found on 15 floral spikes with their number varying from 5-30/floral bud. Both nymphs and adults congregate and suck the cell sap from the plants. The infested flowers looked shrivelled and pale. The nymphs are light green in colour with no markings. The adult wingless female are green with a characteristic U- shaped marking on the dorsum of abdomen and the thorax is marked with transverse bar or dorso lateral patches. The adult winged females are darker in colour with several bands coalescing to form a single band.

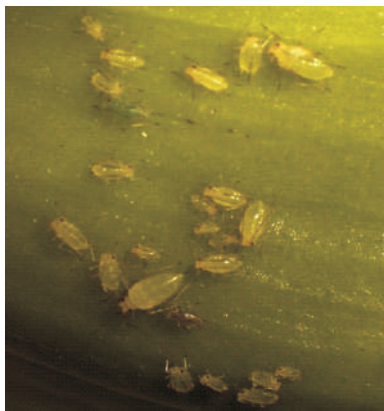


Fig. 4a. Nymphs

False spider mites, also known as flat mites, are related to spider mites, but do not spin webs. They are slow-moving and are usually seen on the undersides of leaves and on leaf stalks in dry weather in summer. The adults are flat, reddish with black patterns and about 0.25 mm long, with two pairs of short legs at the front of the body and two pairs of short legs flanking the narrow abdomen (Fig. 5a). Nymphs are similar in shape to the adults. The eggs are red and oval, and usually laid singly near the main veins on the undersides of leaves (Fig. 5b). Damage is caused by both the nymphs and adults by sucking the cell sap which causes chlorosis of leaves. The injury due to feeding is seen as silvery white blotches which gradually reddens and blacken. False spider mites have been found to attack *Coelogyne* sp., *Eria* sp., *Liparis longipes*, *Dendrobium nobile*, *D. loddigasii*, *D. kingianum*, *Cymbidium hookerianum*, *C. tracyanum*, *Coelogyne punctulata*, *Arundina bamboosifolia*, *Ione* sp., *Oberonia* spp. and in *Cym. Pine Clash 'Moon Venus'*.

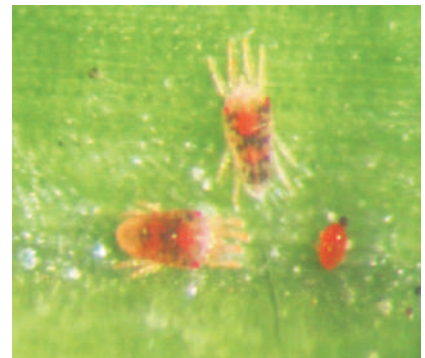


Fig. 5a. Adult mites

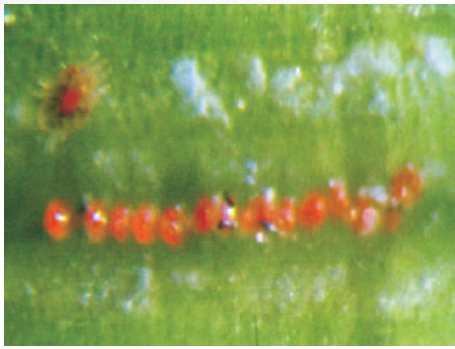


Fig. 5b. Eggs

Leaf folder in *Cymbidium*

Leaf folder was recorded in *Cymbidium* plants in the month of February. Few leaves of *Cymbidium* hybrids like Winter Beach 'Sea Green' and Pine Clash 'Moon Venus' were infested with this insect. The caterpillar roll the leaves and feed on the leaf tissue by staying inside. The caterpillar are green in colour with a brown head and measures about 4-5 cm (Fig. 6a). The moths are brown in colour with patterns of dark and light brown markings on the wings (Fig. 6b). The specimen is yet to be identified for confirmation.



Fig. 6a. Larva of leaf folder



Fig. 6b. Adult moth of Leaf folder

New report of natural enemies

New report of an aphelinid wasp, *Coccophagus ceroplastae* (Howard) as parasitoid

The aphelinid wasp, *Coccophagus ceroplastae* (Howard) was found to parasitize the soft brown scales especially the younger stages. The females of this wasp deposited egg into the body of the scales and the larval and pupal development took place within the body (Fig.7a & 7b). The adults

black in colour emerged by making a circular hole on the scale cover (Fig. 8 & 9).

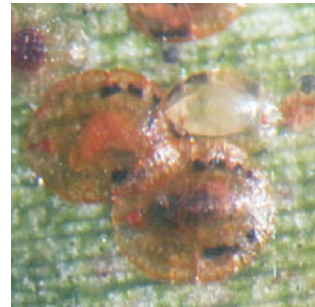


Fig. 7a. Developing larvae inside the scale body

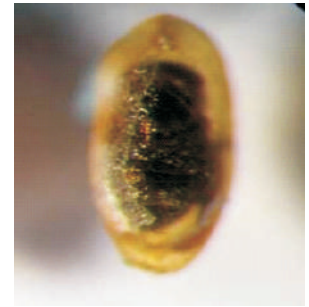


Fig. 7b. Developed pupa inside the scale body

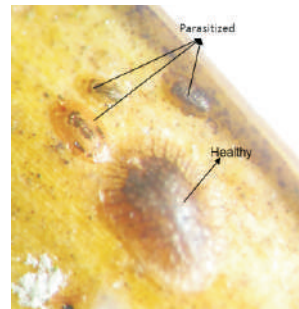


Fig. 8. Parasitized & healthy scale



Fig. 9. Adult of *C. ceroplastae*

New report of *Aphytis* sp. as parasitoid of *Cymbidium* Scale, *Lepidosaphes pinnaeformis* (Bouche)

The aphelinid wasp, *Aphytis* sp. was found to parasitize the *Cymbidium* scale insect, *Lepidosaphes pinnaeformis* infesting *Cymbidium* orchids under polyhouse conditions throughout the year. The adults of *Aphytis* sp. were found foraging on the leaves. The females deposit their eggs on the body of the scale; the larval and pupal development taking place by consuming the body contents of the scale insect (Fig. 10 & 11). The adults emerged by making a circular hole on the shell (Fig. 12 & 13). The parasitized scales appeared flat and darker in colour. The activity of this parasitoid was found from April to first week of December. However, its activity decreased and suffered high mortality, due to reduction in temperature during winter.



Fig. 10. Pupa of *Aphytis* sp. (Scale cover removed)

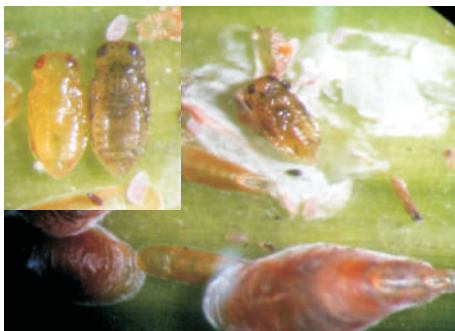


Fig. 11. Pupa of *Aphytis* sp. (Scale cover removed)

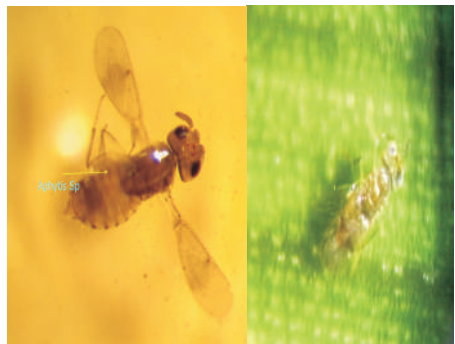


Fig. 12. Adult of *Aphytis* sp



Fig. 14. Emergence holes on shell cover

New report of an aphelinid wasp, *Pteroptrix* sp. as a parasitoid on scale insects

The aphelinid wasp, *Pteroptrix* sp was found to parasitize the Cymbidium scale, *Lepidosaphes pinnaeformis* under open polyhouse conditions. The adults were found foraging on the leaves in groups; some looking for healthy scales for parasitization and some feeding on the body fluids of these scale insects (Fig. 14.)

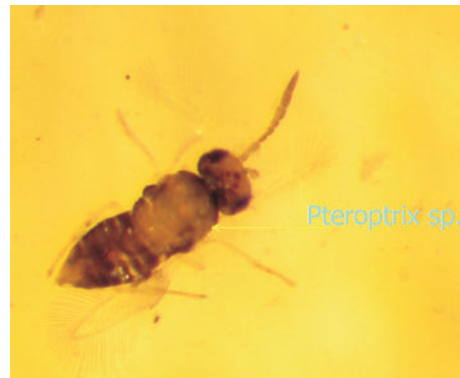
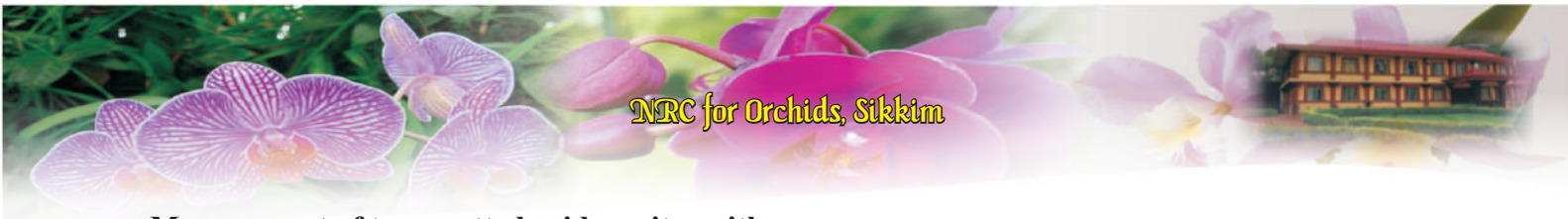


Fig. 14. Adult *Pteroptrix* sp.

Test of new molecules of biopesticides and botanicals against insect-pests

Management of two spotted spider mites with botanical pesticides

An experiment was conducted to evaluate the bioefficacy of botanical pesticides against two spotted spider mite, *Tetranychus urticae* on Cymbidium plants under polyhouse conditions. Eight treatments viz., *Ageratum conizoides* (10 %), *Eupatorium odoratum* (10 %), *Lantana camara* (10 %), *Allium cepa* (5 %), *Allium sativum* (5 %), Neem oil 0.03 EC (5 %) and miticide Propargite 57 EC (0.05 %) were evaluated. The results showed that all botanicals were effective in reducing the mite population. The highest mortality (96 %) of mites was recorded with Propargite followed by neem oil (75 %) and *Allium sativum* (72 %), respectively.



Management of two spotted spider mites with botanical pesticides (lab conditions)

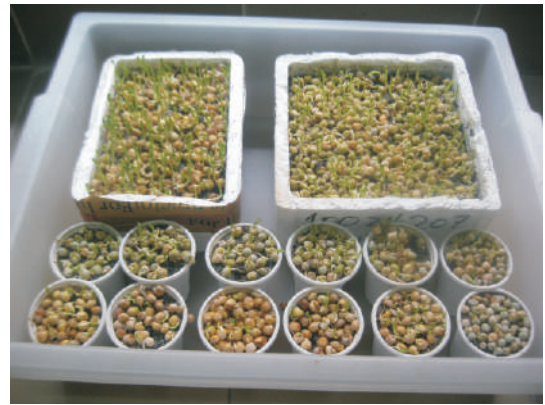


Fig. 15. Germinating pea seeds

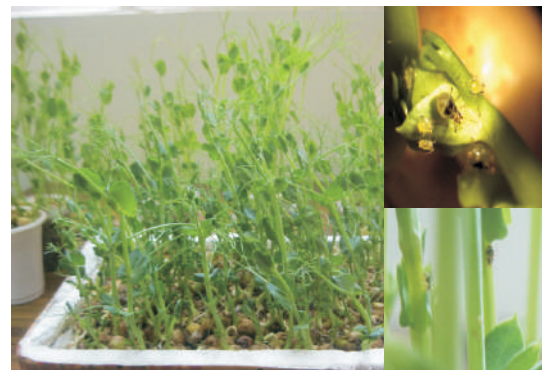


Fig. 16. Culture of aphids on pea seedlings



2.2 Research Achievements NRC(O), Darjeeling Campus

A Comparative Study of Symbiotic and Asymbiotic Germination in Selected Species and Hybrids of *Calanthe*, *Cymbidium* and *Paphiopedilum*

Collection of plant material

The plants and substratum of six species from the natural habitats in Darjeeling district of West Bengal were collected. The collected species includes *Calanthe puberula*, *C. herbacea*, *C. yucksomnensis*, *Cymbidium erythraeum*, *C. lancifolium* and *C. cyperifolium*. The species were planted in substratum collected from the original place of their growing. Apart from naturally occurring species, *Paphiopedilum fairriaenum* was procured from a local nursery located in Mirik.

Sib mating and crossing of species for seed setting

The species of selected genera conserved in orchidaria of Darjeeling were sib mated for seed setting to obtain the seeds for symbiotic and asymbiotic germination studies. The species *Cymbidium lowianum*, *C. erythraeum*, *C. elegans*, *C. lancifolium*, *Calanthe yucksomnensis*, *C. brevicornu*, *C. puberula* were sib mated and crossed with another species or hybrids in case of *Cymbidiums*. The seeds obtained from sib mating and crossing would be used for seed germination studies.

Isolation of mycorrhiza

The seeds of orchids are minute and devoid of functional endosperm. Hence, association of mycorrhizal fungi is required to mobilize the food reserves during germination process. We collected the substratum from the natural habitats and examined it for the presence of germinating seeds of *Cymbidium erythraeum* (Fig 1a) and

Coelogyne nitida (Fig 1b.). Various stages of growth like non-germinated seeds, protorms, and seedling were recorded. The histological studies revealed presence of micorrhizae in protocorms and roots of seedlings. It could be one of the source of isolation of mycorrhizal fungi. In nature, seed germination is limited by various biotic and abiotic factors. A mite was found associated with germinating (Fig 2.) orchid seeds.

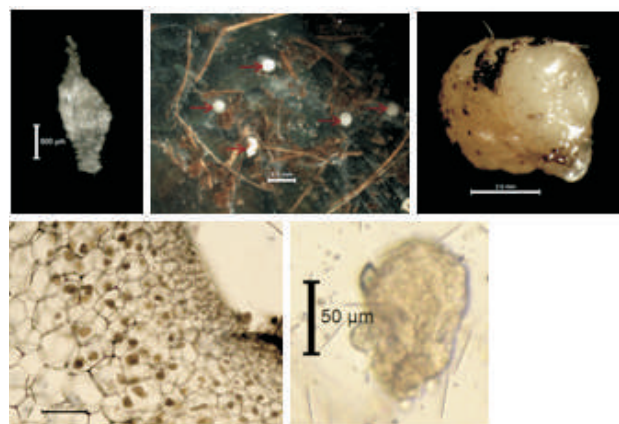


Fig. 1a. Symbiotic seed germination and endosymbionts (natural habitats) in *Cymbidium erythraeum*

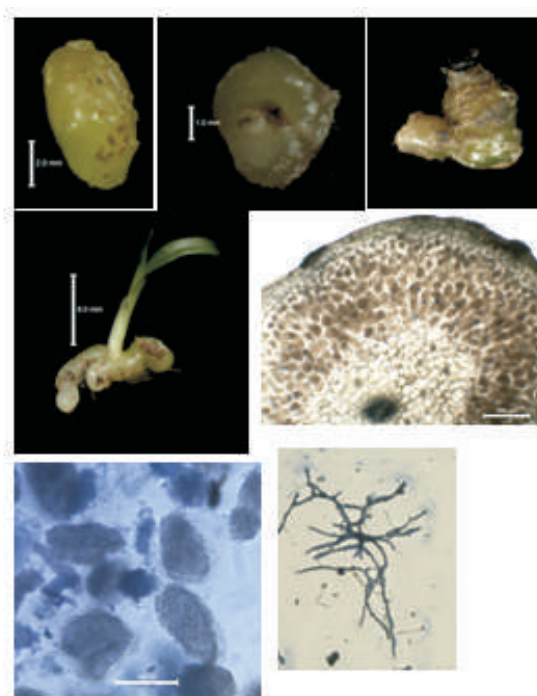


Fig. 1b. Symbiotic seed germination and endosymbionts (natural habitat) in *Coelogyne nitida*

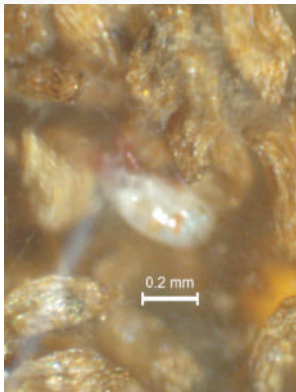


Fig. 2. An unidentified mite was found associated with germinating orchid seeds

Asymbiotic seed germination:

The seeds were collected from the orchids growing in conservatory were packed in packets (Fig. 3) and placed in substratum collected from the natural habitat. The plants and substratum collected from the natural habitat to isolate and trap the micorhiza and study the symbiotic seed germination.

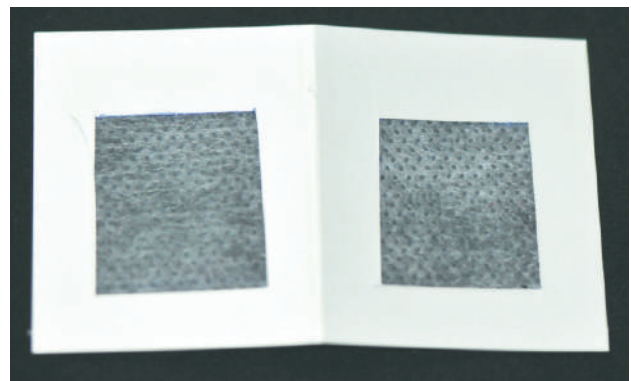


Fig. 3. Packets used in symbiotic seed germination study

Five new selections from a cross between *Cymbidium Sleeping Nymph* x *Cymbidium lowianum*

Three hundred twenty two progenies of cross between *Cymbidium* 'Sleeping Nymph' and *Cymbidium lowianum* flowered during the current year. Of which five clones were selected on the basis qualitative as well as quantitative characters. This cross has been registered with the International Cultivar Registration Authority for Orchid Hybrids International Orchid, Registration, Royal Horticultural Society as Darjeeling Nymph. The details of some of qualitative as well as quantitative characters are given in Table.1. The description of selected clones given as below:



Table 1. Morphological description of selected clones from a cross between *Cymbidium* 'Sleeping Nymph' and *Cymbidium lowianum*

Characters	NRCODC/ CMYH/1/6/262	NRCODC/ CMYH/1/6/298	NRCODC/ CMYH/1/6/91	NRCODC /CMYH/1/6/204	NRCODC/ CMYH/1/6/154
Plant height (cm)	47.4	61.8	52.9	76.4	70.2
Pseudobulb length (cm)	9.8	8.1	9	12.4	11.8
Pseudobulb width(cm)	9.8	3.9	3.76	5.19	4.69
Leaf number	9	5	4	10	10
Leaf length (cm)	75.2	63.2	75.1	77.2	75.1
leaf width (cm)	3.4	2.8	2.9	3.1	2.9
Leaf colour (RHS)	N137B	N137C	N137B	N147A	N137B
Bract number	5	9	8	10	9
Inflorescence length (cm)	77	27.5	31.5	57.6	50.2
Stalk colour (RHS)	146 B	146A	146C	146B	146D
Receme length (cm)	42	15.4	25.2	25.6	20.3
Flower number	15	5	8	8	6
Flower size (cm)	9.68	11.4	11.54	12.46	10.5
Petal & sepal colour	152D	10B	153D	153A	N144A
Lip colour (RHS)	10B	10C	11C	1A	2D
Lip marking (RHS)	171B	59A	171C	6A	60A

NRCODC/CMYH/1/6/262: Medium sized plants with straight and sturdy flower spikes, front facing flowers, flower spikes with very good flower balance, flowers intermediate in size, yellow green and lip marked with red purple (Fig. 5a).

NRCODC/CMYH/1/6/298: Medium sized plants, yellow green flowers on straight flower spike, flowers are front facing with beautifully red purple banded lip (Fig. 5b).

NRCODC/CMYH/1/6/91: Medium sized plants with straight flower spikes, spike needs supporting, front facing and yellow green in colour, sepals and petals are lightly tinged with brown at apex, apical lobe of the lip is marked with red purple. The clone is suitable for cut flower as well as potted plant (Fig. 5c).

NRCODC/CMYH/1/6/204: Medium sized plant with straight flower spikes, but needed staking. The clone has good flower balance, yellow green flowers with the lip banded with red purple. The clone suitable for cut flower as well as potted plant (Fig. 5d)

NRCODC/CMYH/1/6/154: Medium sized plants, with apple green beautiful flowers, flower spikes need training, lip apex marked with red purple (Fig. 5e)



5a



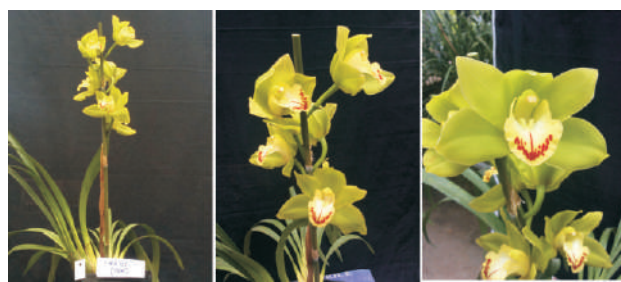
5b



5d



5c



5e

Fig 5a to 5e. Showing selected clone of *Darjeeling Nymph* (*Cym. Sleeping Nymph* x *Cymbidium lowianum*)

New selection from cross between *Cymbidium lowianum* and *Cym Showgirl 'Cooksbridge'*

A clone from a cross between *Cymbidium lowianum* and *Cym Showgirl 'Cooksbridge'* NRCODC/CMYH/2/6/2 was selected. It is medium in size, with attractive flowers and well

presented on flower spikes. The flower spike has very good flower balance (Fig 6). The details are given in Table 2. This cross has been registered with the International Cultivar Registration Authority for Orchid Hybrids International Orchid, Registration, Royal Horticultural Society as *Darjeeling's Delight*.

Table 2. Morphological description of selected clone from a cross between *Cym. lowianum* and *Cym Showgirl 'Cooksbridge'*

Morphological characters	NRCODC/CMYH/2/6/2
Plant height (cm)	74.6
Pseudobulb length (cm)	10.1
Pseudobulb width(cm)	4.59
Leaf number	6
Leaf length (cm)	72.2
leaf width (cm)	3.2
Leaf colour (RHS)	N131C
Bract number	8
Inflorescence length (cm)	55.7
Stalk colour (RHS)	146B
Receme length (cm)	33.2
Flower number	8
Flower size (cm)	9.38
Petal & sepal colour	157A
Lip colour (RHS)	N66D (shades)
Lip marking (RHS)	61A

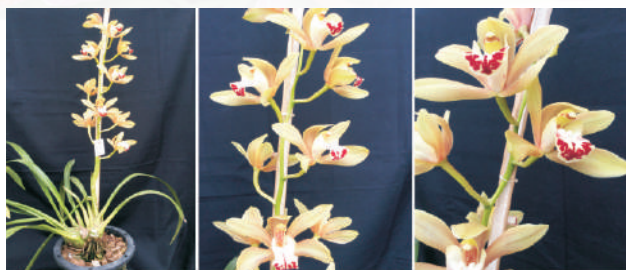
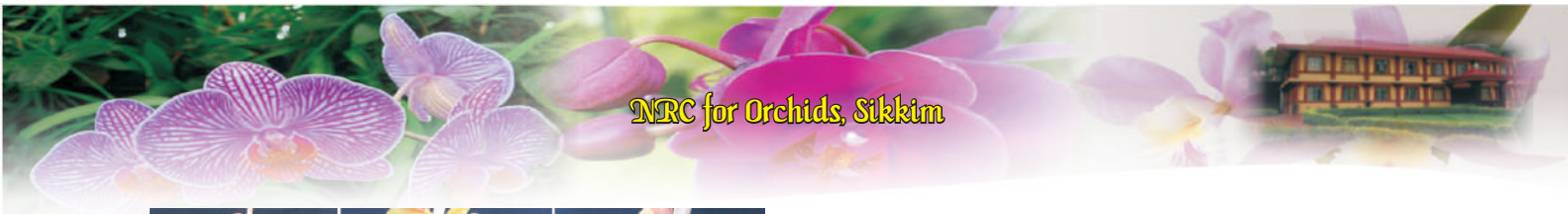


Fig 6. selected clone (NRCODC/CMYH/2/6/2) of *Darjeeling's Delight* (*Cymbidium lowianum* x *Cymbidium Showgirl* 'Cocksbridge')

Genetic Improvement of *Cymbidium* orchid for Cut and Pot Flowers

Collection/Introduction of hybrid:

For the thirty different hybrids that were collected during the last year, information about their pedigree and development year were compiled (using *Orchidwiz 9.1* software) in order to avoid use of non-described parents and IPR protected materials in breeding programme. A compilation of information of *Cymbidium* hybrids introduced and grown in India is also under progress.

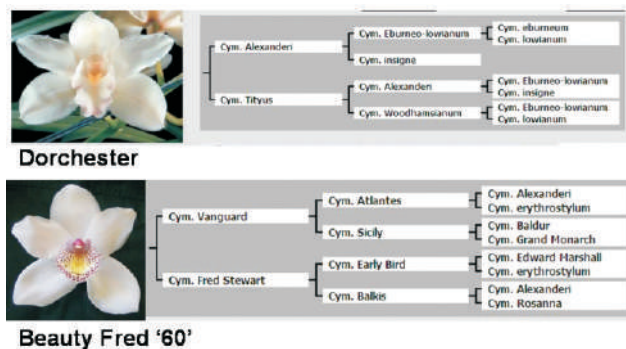


Fig 7. Pedigree details of two hybrids collected from local farmers

Characterization of hybrids and selection of parental stocks

Data was recorded for the hybrids which came to flowering during the current year and grouping was made based on their species composition and flowering time. For the hybrids showing flowering at the same time or species, which was not utilized in the background of those hybrids

were crossed to develop new variants. Hybridization of potted type hybrids directly was not successful due to triploid status of those. Hence from this year, only 'diploid hybrid x diploid hybrid', 'diploid hybrid x potted type species' and 'tetraploid hybrid x potted type species' will be attempted for developing potted type progenies.

Crossing between hybrids, hybrids & species and different species

A total of 20 different crosses were attempted and successful seed setting was obtained for seven combinations. Most of the incompatible combination was recorded in crosses involving the potted types 'Kennywine color' and Sarah Jeans 'Ice Cascade', beside the crosses involving 'Feauty Fred No. 60'. The capsules of the successful crosses were harvested and taken for seed culture.



Fig 8. Successful seed set in four different crosses

Raising of seeds *in-vitro*

The seeds of four of *Cymbidium* crosses viz., Floripink x Valley Vampire, Valley Vampire x Floripink, *Cymbidium tracyanum* x *Cymbidium erythraeum* and Pine Clash 'Moon Venus' x Cronulla 'The Khan' were cultured. No proper seed set was found in Vampire x Floripink and Pine Clash 'Moon Venus' and *Cymbidium tracyanum* crosses.

Attempt haploidy induction and basic studies

Hormone induced ploidy manipulation

though parthenogenesis

In order to induce haploid parthenogenesis in *Cymbidium*, different concentrations and formulation of phytohormones (*details not disclosed*) was tried. Reddening and swelling of gynostemium columns on phytohormone application was recorded which was similar to the response of pollination of emasculated flowers. A particular concentration was found to be effective in inducing capsule development without pollination in emasculated flowers of *Cymbidium* hybrid Pine Clash 'Moon Venus'. Parthenogenesis induction was confirmed through microscopic studies of the capsule where ovule multiplication induction have been recorded. The same concentration and formulation of phytohormone have been applied in 10 different hybrids (up to March) for validation and data recording is in progress. All the treated flowers have shown reddening, swelling and closing (though callus formation) of the columns and signs of capsule development. If successful, this will open new avenue of *Cymbidium* breeding through hybrid sorting or hybrid development from doubled haploid derived inbred lines.

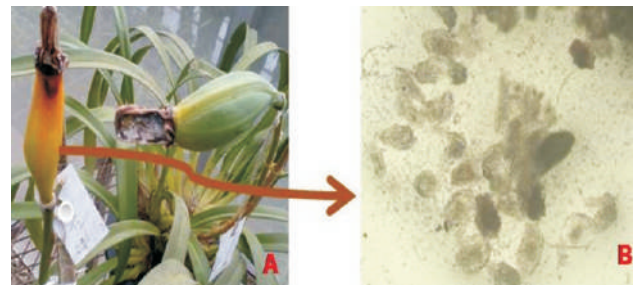


Fig 10. Capsule induction in Cym. PCMV without pollination (left) & Ovule multiplication induction observed in microscopic examination (Parthenogenesis induced) (Right)

Study of mutant for Flower development and male sterility in *Cymbidium*

One spontaneous "Flowering mutant" in *Cymbidium* was recorded which is possibly a null mutation of "B" class of gene for which there is no report available in *Cymbidium*.

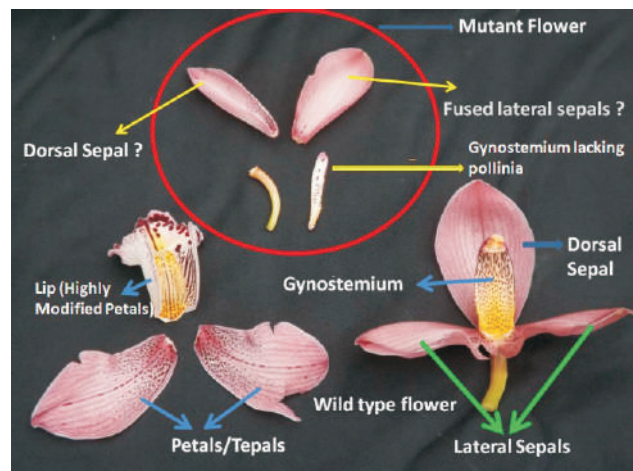
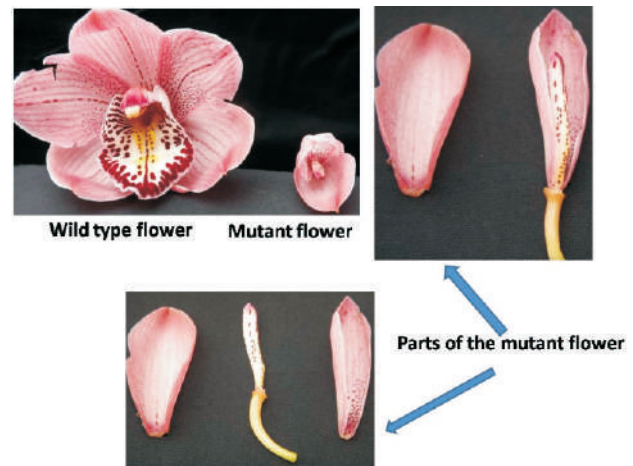


Fig 11. Wild type vs. Mutant flowers and their floral parts

Physiological changes in 'Treatment', 'Pollinated Flower' and 'Control' at 60 days after emasculatation

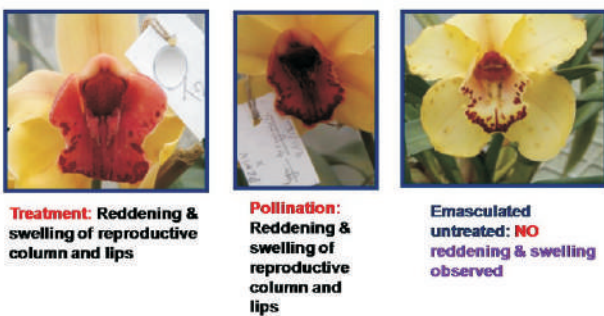


Fig 9. Physiological changes in 'treatment', 'Pollinated Flowers' and 'Control' at 60 days after emasculatation

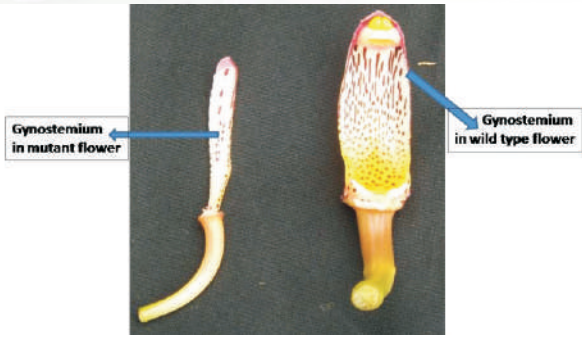


Fig 12. Absence of pollinia in gynostemium of mutant flower (male sterility)

In the 'ABCDE model', the organ identity in each whorl is determined by a unique combination of activities, called A, B, C, D and E, of organ identity genes (Weigel and Meyerowitz 1994, Theissen and Saedler 2001, Zahn *et al.*, 2005). In any one of the four flower whorls, sepals are

specified by A and E activity, petals by A and B and E activity, stamens by B and C and E activity, carpels by C and E activity, and ovules by C, D and E activity. In the spontaneous bud mutant of *Cym.* Hybrid "Black Flame", the petals (including lip which is a highly modified petal) are absent in the mutant as compared to wild type, besides absence of pollinia in the gynostemium. This is possibly a null mutation in "B" class of floral identity gene leading to lack of development of petals and stamen (resulting to male sterility). Molecular characterization of this gene may provide a deeper understanding of developmental regulation of flowering in *Cymbidium*.

EXTERNALLY FUNDED PROJECTS

Horticulture Mission for North East and Himalayan States (Mini Mission– I)

Programme I: Production of nucleus/basic seed and planting materials.

Crop	Variety	Type of planting material	Targets 2013-14	Achievements 2013-14	Short fall (if any)	Reason for Shortfall	Distribution of planting materials
Orchid	Cymbidium (7 hybrids) Cattelya hybrid	Tissue culture	8,000	2,020	5,000	Short fall due to slow multiplication of old plbs by somatic embryogenesis	Distributed during training programmes

Programme II: Standardization of production and protection technologies

1. Water management of *Dendrobium* hybrid "Thongchai Gold"

The experiment was conducted to study the water stress on flowering of *Dendrobium*. The treatment consisted of regular watering at 7 days interval, withheld of watering at the time of spike emergence, withheld of watering after 10, 20, 30, 40, 50 and 60 days of emergence. Moisture content of growing media, root, stem and leaves at different stress period, transpiration, leaf water potential and vase life were recorded. It was found that moisture content of growing media, leaf, back bulb were maximum at regular watering; however water content in studied plant parts reduced as the duration for withholding of watering progressed. The minimum moisture content was recorded at 60 days interval. Withholding of water at less than 60 days reduced the vase life.

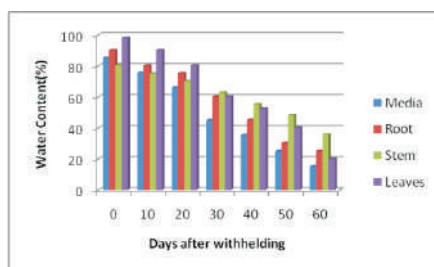


Fig. 1. Water content in growing media and plant parts of *Dendrobium* at different period

2. Effect of Chitosan on flowering of *Dendrobium* hybrid "Emma White"

The experiment was conducted to study the effect of Chitosan on flowering of *Dendrobium* hybrid "Emma White". The treatment consisted of weekly application of Chitosan @ 0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8 and 0.9 g/l. Application of Chitosan did not influenced remarkably production of new shoot, however, at higher concentration spike production increased and maximum (9.5/pot) was recorded at 0.7 g/l (Fig. 2). Maximum length of spike (40.2 cm) was recorded at 0.7g/l concentration.

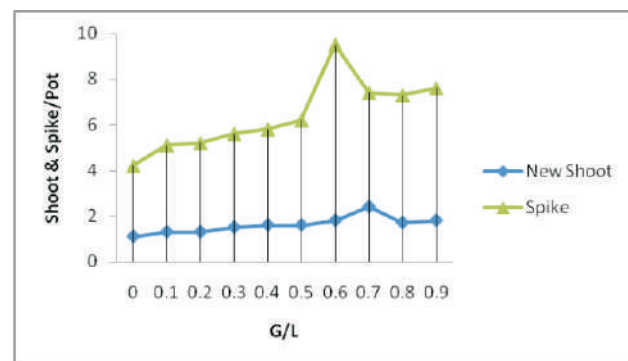


Fig. 2. Shoot and flower spike production due to Chitosan application

Programme III: Technology refinement and imparting trainings

S. No	Title of Training/Demonstration	Target (2013-14)	Achievements (2013-14)	No of participants
1.	On campus & Off campus training	03	02	59
2.	Farmers field demonstration	05	05	72
3.	Kisan Mela	01	01	200



Training programme on “Production Technology of Orchids” at Rongli, East Sikkim. (18th November, 2013)



Training programme on “Protected cultivation of high value cut flowers” at ICAR Res. Complex for NEH Region, Nagaland Centre, Medziphema. (10-12th Dec., 2013)

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

DUS test guidelines of *Cymbidium*, *Dendrobium* and *Vanda* were developed by the National Core Committee in consultation with the Nodal Officer, DUS test centre, NRC for Orchids, Pakyong, Sikkim and Task Force (8/2009) constituted by the PPV & FRA Authority. The three species have been notified for registration at Protection of Plant Variety & Farmers Right Authority under the Act from March, 27, 2012 onwards and the application for registration of extant varieties of the above mentioned crop species will be accepted up to March, 26, 2015. Thirty hybrids of *Cymbidium*, 23 hybrids of *Vanda*, 14 hybrids of *Dendrobium*, 10 hybrids of *Oncidium*, 8 hybrids of *Cattleya* and 10 hybrids of *Phalaenopsis* maintained under DUS project on Orchids since 2008-09. DUS Test guidelines

of *Phalaenopsis* and *Cattleya* Orchids (Orchid Task Force, 2011) submitted to PPV & FRA during 2012 and published in Plant Variety Journal of India during 2012.

DBT Project

Development of Protocol for Mass-multiplication of Paphiopedilum Orchids and their Commercialization in North Eastern States of India

Seed culture protocol for 2 species *Paphiopedilum insigne* and *Paphiopedilum villosum* have been standardized. The BF medium supplemented with NAA (0.5 mg/l) found reduced time taken in germination. Seedlings were cultured on NC medium supplemented with various concentrations of NAA (0.5 -2.0 mg/l) and TDZ (0.5-2.0 mg/l) to induce the multiple shoots in seedlings in both species. The multiple shoots (4-6) were obtained in *P. insigne* on medium

containing NAA (1mg/l) and TDZ (2 mg/l). However, in *P. villosum* the multiple shoots were induced on medium containing TDZ (1 mg/l) and NAA (1 mg/l). Shoot tips were derived from the *in-vitro* grown plantlets of *P. insigne* and *P. villosum* and were cultured on BF (N3) medium supplemented with BAP (0.5 - 2 mg/l). The medium was invariably supplemented with NAA (0.5 mg/l). The PLBs were induced in medium containing BAP (1 to 2 mg/l). However, the best PLB formation was obtained in medium containing 1.0 mg BAP/l. The leaves obtained from *in vitro* grown plantlets were divided in two (upper & lower) and cultured on BF liquid media containing 0.5 to 2.0 mg/l (TDZ) and the medium was invariably supplemented with 5 mg/l (NAA). The cut ends of the leaves formed callus within 20 days after culture. The earliest callus initiation was observed in medium containing 1.5 mg/l (TDZ).

NAIP Project – A Value Chain on Selected Aromatic Plants of North East India

Component 2: A value chain on selected aromatic plants of North East India

Production of *Coelogyne nitida*

Coelogyne nitida plants were sprayed with different concentration of graded fertilizers i.e. $N_{10}P_{10}K_{10}$ -0.1 and 0.2 %, $N_{20}P_{20}K_{20}$ -0.1 and 0.2 %, $N_{10}P_{30}K_{30}$ -0.1 and 0.2 % at weekly interval for maximization of flower production. Micronutrients (1 g/l) were sprayed at monthly interval. It was recorded that that spike production (5.5/pot) with longer spike (22.5 cm) was observed at $N_{10}P_{30}K_{30}$ -0.2 % and least number (1.2/pot) and shorter spike (12.85cm) was recorded at control plants.

Hardening of *Zygopetalum* in different growing media and temperature regime

The first experiment was conducted to standardize the media for hardening of tissue cultured *Zygopetalum intermedium* seedlings. Four types of media were studied *viz.*, Sand, coco-peat, green moss and leaf mold. All agronomical practices remain same. Higher survivality percentage was recorded in coco-peat media (75%) followed by sand (66%) while less than 40% recorded in green moss (Fig.5a). In another experiment, plants grown in moss were provided 20°C, 25°C and 30°C for a period of 3months. It was observed 55 % survivality of *Zygopetalum* at 25°C, while least (43 %) at 30°C (Fig.5b).

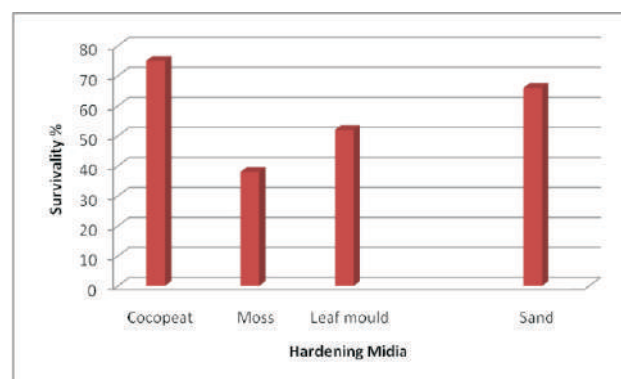


Fig.5a Hardening of plants in different media

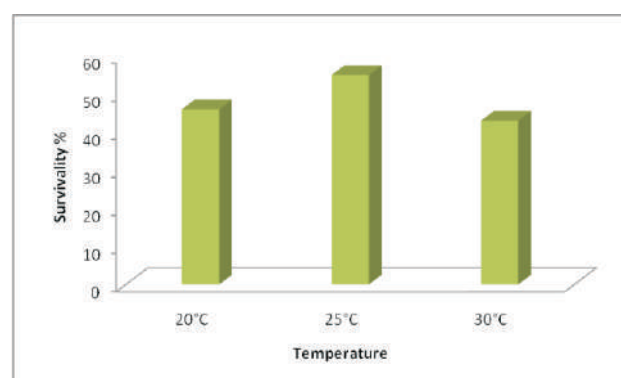


Fig.5b Hardening of plants in different temperature (°C)



Technology Assessed and Transfered

Details of extension/technologies developed or extension methods perfected/
technologies transferred /commercialized etc.

Training Programme

Date	Topic	Number of Participants	Category of Participants	Venue
1 st Jan, 2013 to 30 th June, 2013	Molecular Analysis of Orchids	01	Post Graduate students	NRCO
18 th Nov, 2013	Production Technology of Orchids	37	Beneficiaries of state HCCD Deptt., Govt. of Sikkim	Rongli, East Sikkim
20 th Nov to 17 th Dec, 2013	Organized Job Training	20	XII th class students of vocational stream (Hort) Government Senior Secondary School, Sikkim	NRCO
22-26 th Nov, 2013	Commercial Cultivation of <i>Cymbidium</i> and <i>Lilium</i> for cut flower production	38	Orchid growers of Kalimpong, (West Bengal)	NRCO
10-12 th Dec, 2013	Protected Cultivation of High Value Cut Flowers	34	State officials & farmers	NRCO
19-21 st Dec, 2013	Application of Information and Communication Technology	28	Scientists, Admin. Officers, Technical 's, RAs, SRFs and state officials	NRCO
23-24 th Jan, 2014	Hindi Teaching Classes for Praveen and Provodh	12	Scientists, Admin., Technical 's & Supporting staff of NRCO	NRCO
31 st Jan, 2014	Training cum Awareness Program on Protection of Plant Varieties and Farmers Rights	65	Scientists of ICAR, KVK, CAU, RAs, SRFs & Progressive farmers	NRCO



Skill development of TSM staff
(27th June-3rd July, 2013)



Job training for Class XII vocational Students
(20th Nov. – 17th Dec., 2013)



Training programme on “Commercial cultivation of Cymbidium and Lilium for cut flower production” for the orchid growers of Kalimpong, W.B. (22-26th November, 2013)



Awareness cum Training on ICT (19-21st Dec., 2013)



Hindi Teaching Classes for Praveen and Provodh (23-24th January, 2014)



Awareness cum Training on PPV&FRA (30-31st January, 2014)



EDUCATION & TRAINING

4

Scientist

One month orientation training programme for ARS at NRC for Orchids, Pakyong from 11th Apr – 11th May, 2013.

A. M. Khan & Rumki Ch. Sangma

Three months attachment training on “DNA Barcoding on Insect Pest of Orchids” under the guidance of Dr. G. T. Behere (Sr. Scientist) at ICAR Complex for NEH Region, Barapani, Meghalaya from 13th May-16th August, 2013.

Rumki Ch. Sangma

Three month attachment training programme for ARS at IIHR, Bangalore 14th May – 14th August, 2013.

A. M. Khan

Five days MDP training on “PME of Agricultural Research Projects” at NAARM, Hyderabad from 18 – 22nd June, 2013.

L. C. De

Five days MDP training on “Biotechnology and Intellectual Property Rights” at NAARM, Hyderabad from 8-12th July, 2013

S. Chakrabarti

Seven days Management Development Programme in Consultancy Project Management at NAARM, Hyderabad from 1-7th August, 2013.

R. Devadas

General Management Training for Scientist

sponsored by DST at Administrative Staff College of India (ASCI), Hyderabad from 26th August to 6th September 2013.

Rampal

Basic Molecular techniques in DNA fingerprinting at National Bureau of Agriculturally Important Insects (NBAII), Bangalore from 8-14th September, 2013.

Rampal

Training cum Awareness programme on Climate Resilient Agriculture at ICAR Complex for NEH Region, Sikkim Centre at Tadong on 4th Oct, 2013 .

Rumki Ch. Sangma

NAIP-NABG Subject Matter Training on Bioinformatics: *In vitro* to *In Silico* Approaches In Entomology at National Bureau of Agriculturally important Insects, Hebbal, Bangalore from 18-30th November, 2013.

Rumki Ch. Sangma

Foreign training on Marker assisted selection (Horticulture) at Crop Genetics, Genomics and Breeding Division, Institute of Biological, Environmental and Rural Sciences (IBERS), Aberystwyth University, Dyfed, SY23 3AL, United Kingdom from 1st November, 2013 to 29th January, 2014.

Rampal

Three days awareness cum training programme on “Application of Information and

Communication Technology” at NRC for Orchids from 19-21st Dec. 2013

All Scientists

Brainstorming meet and training programme on cryopreservation and *in-vitro* conservation in Horticulture crops' at IIHR, Bengaluru on 21st February, 2014.

R. Devadas

Administrative

Five days training of “Gahan Hindi Karyashala” conducted by Department of Official Language,

Ministry of Home Affairs, and Government of India at Prithviraj Road, New Delhi from 20 - 24th May, 2013.

Ajen Lama & Arvind Chauhaan

Twelve days training for Assistants at ISTM, New Delhi from 27th May - 7th June, 2013.

Arvind Chauhaan

Five days training programme on “MDP on Financial Issues” at National Institute of Financial Management, Faridabad from 16-20th December, 2013.

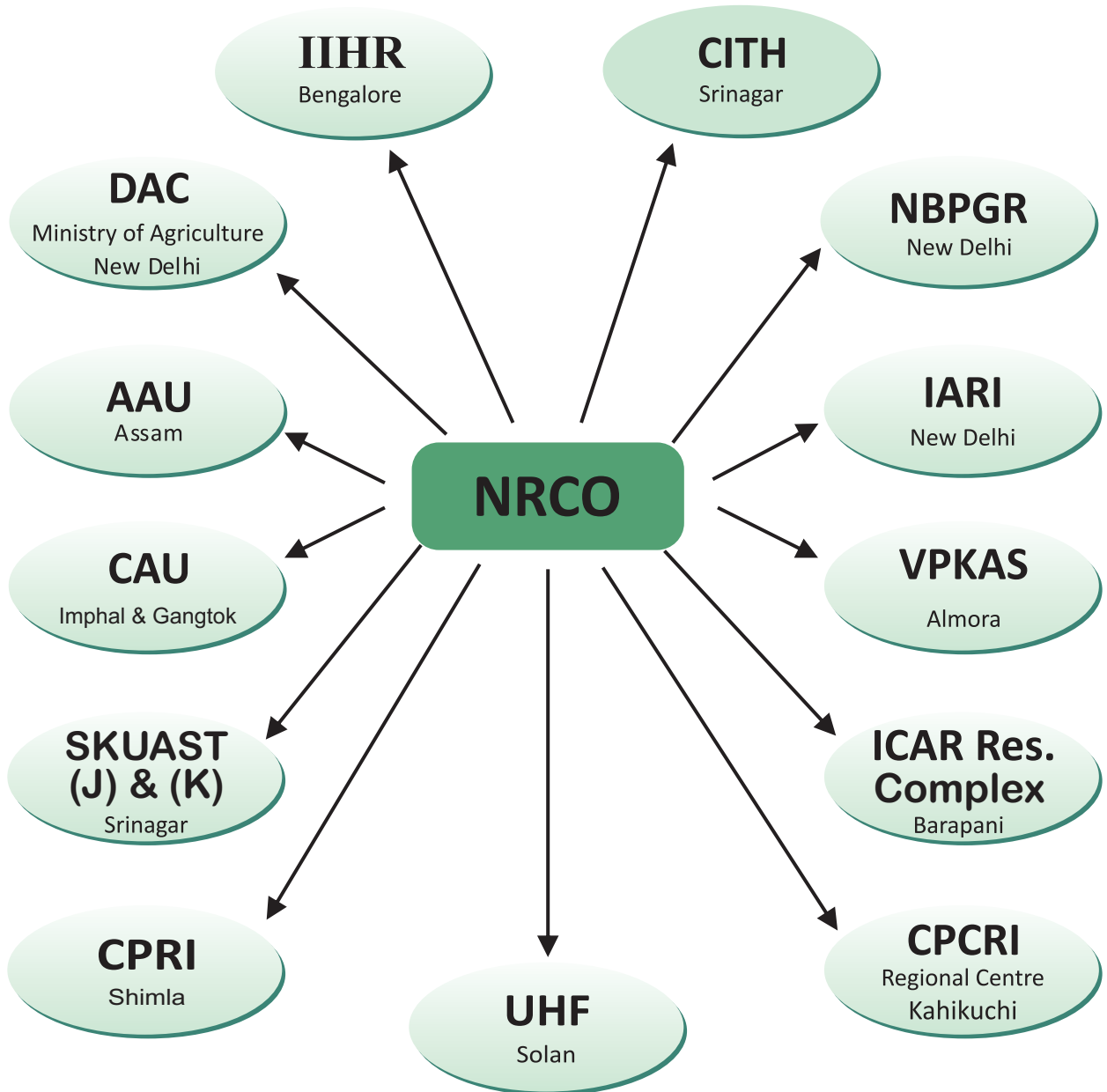
Rishi Kant Singh



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

Book chapter

1. Barman, D.; Mohanty, P.; Medhi, R. P. (2013) Advance in Protected Production Technologies in Orchids. **In:** Advance in Protected Cultivation. (Eds) Brahman Singh, Balraj Singh, Naved Sabir and Murtaza Hasan. (ISBN: 978-93-83305-17-9).pp.169-180.
2. De, L. C. (2014) Production Technology of Commercial Flowers. In: *Cymbidium* (pp.72-80), *Dendrobium* (pp.80-91), *Phalaenopsis* (pp. 91-99), *Cattleya* (pp.100-105), *Oncidium* (pp.105-109), *Paphiopedilum* (pp.109-115), *Vanda* (pp.115-121). Published by Pointer Publisher, Jaipur, and Rajasthan.
3. Meena, N. K.; Barman, D.; Medhi, R. P. (2013) Impact of abiotic factors on the incidence of Mites in Orchids and its potential impact on flower production. **In:** Agroforestry and climate change management. (Eds) A. Arunachalam, J. C. Dagar and A. K. Singh. Pointer Publishers, Jaipur (ISBN-978-81-7132-756-0).pp.116-121.
3. De, L. C.; Rao, A. N.; Rajeevan, P. K.; Rawat, G. S.; Sood, S. K.; Chhetri, Geetamani.; Srivastava, M.; Medhi, R. P. (2013) *DUS Test Guidelines of Commercial Orchids. The Botanica*, 62/63: 76-89.
4. Meena, N. K.; Rampal; Barman, D.; Medhi, R. P. (2013) Biology and seasonal abundance of the two-spotted spider mite, Tetranychusurticae, on orchids and rose. *Phytoparasitica*, DOI 10.1007/s 12600-013-0320-2.
5. Meena, N. K.; Rampal; Pant, R. P.; Medhi, R. P. (2013) Seasonal incidence of mite and influence of pesticidal application on orchid production. *Journal of Plant Protection Research*, Doi: 10.2478/jppr-2013-0018: 124-127.
6. Naik, S. K.; Barman, D.; Rampal; Medhi, R. P. (2013) Evaluation of electrical conductivity of the fertilizer solution on growth and flowering of a *Cymbidium* hybrid. *South African Journal of Plant and Soil* 30(1): 33–39.

Research papers

1. Barman, D.; Devadas, R. (2013) Impact of Climate Change on Orchid Population and Conservation Strategies –A Review. *Journal of Crop and Weed*, 9(2):1-12.
2. Chhetri, G.; De, L. C.; Medhi; R.P. (2013) *Color analysis in some flowers of some Vanda W. Jones ex R. Brown (Orchidaceae) with the help of RHS color chart. Pleione*, 7 (1): 18-22.
7. Naik, S. K.; Barman, D.; Pathak, N. (2013) Response of graded levels of calcium and magnesium on growth and flowering of *Cymbidium* hybrid 'Mint Ice Glacier'. *African Journal of Agricultural Research* 8(17): 1767-1778.

8. Rampal; Dayamma, M.; Meena, N. K.; Barman, D.; Medhi, R. P. (2012) Collection, conservation and characterization of *Cymbidium tracyanum* (L.) Castle from Darjeeling (West Bengal). *Journal of Orchid Society of India* 26(1&2): 69-74.

Popular articles

1. Chakrabarti, Syamali.; Jain, Sudeep.; Medhi, R. P. (2013) *Dendrobium nobile* ekoushdhiya orchid. *Phal Phool*.
2. De, L.C.; Rao, A. N.; Rajeevan, P. K.; Dhiman, S. R.; Srivastava, Manoj.; Chhetri, Geetamani. (2014) DUS Test Guidelines in Cattleya Orchids. *Orchid Newsletter of TOSI*, **29 (12)**: 11-12.
3. Devadas, R.; Pattanayak, S. L. (2014) Scented *Cymbidium* hybrids. *ICAR News*, **20 (1)**: 5-6.

Bulletin

1. Barman, D.; Khan, A. Mandal.; Rajkumar; Medhi, R. P. (2014) Production Technology of Aromatic *Cymbidium* Species. Tech. Bull. No.2 (NATP):1-27.
2. Barman, D.; Khan, A. Mandal.; Rajkumar; Medhi, R. P. (2014) Production Technology of Aromatic *Acampe* and *Bulbophyllum* Species. Tech. Bull. No.3 (NATP):1-29.
3. Barman, D.; Pokhrel, H.; Mohanty, P.; Rampal.; Adhikari, M.; De, L. C.; Sailo, N.; Medhi, R. P. (2013) Production Technology of *Aerides odoratum*, *Coelogynenitida* and *Zygopetalum*

intermedium. Tech. Bull. No.14: 1-40.

4. De, L. C.; Barman, D.; Medhi, R. P.; Chhetri, Geetamani.; Pokhrel, H. (2013) Production Technology of *Phalaenopsis*. Tech. Bull. No.15: 1-26.
5. De, L. C.; Deb, P.; Chhetri, Geetamani.; Medhi, R. P.; Pokhrel, H. (2013) Post-harvest management in orchids. Tech. Bull. No.16: 1-37.
6. De, L. C.; Devadas, R. G.; Chhetri, Geetamani.; Srivastava, Manoj.; Medhi, R. P. (2014) Morphological characterization in *Cymbidium* spp. Tech. Bull. No.17: 1-28.
7. De, L. C.; Devadas, R. G.; Chhetri, Geetamani.; Srivastava, Manoj.; Medhi, R. P. (2014) Morphological characterization in *Dendrobium* spp. Tech. Bull. No. 18: 1-78.
8. De, L. C.; Devadas, R. G.; Chhetri, Geetamani.; Srivastava, Manoj.; Medhi, R. P. (2014) Morphological characterization in *Vanda* spp. Tech. Bull. No. 19: 1-31.

Paper presented in Seminar/ Symposia

1. Barman, D.; Bharathi, T. U.; Khan, Arpita Mandal.; Medhi, R. P. (2013) Impact of Landscape Horticulture on Development of Urban Economy with green Environment and presented paper on “Landscaping with fragrant Orchids” and “Wild Orchids: A Boon to Landscapers (Poster). **In:** 4th International Conference on Landscape and Urban Horticulture at Kolkata from 12-14th Sept., 2013.

2. Barman, D.; Meena, N. K.; Khan, A. Mandal.; Raj Kumar.; Sailo, N.; Medhi, R. P. (2013) Aromatic orchids are good option for value addition in orchid farming. **In:** National Seminar on “Emerging challenges and prospective strategies for hill agriculture in 2050” at ICAR Research Complex for NEH regions, Nagaland Centre, Jharnapani, Nagaland from 23-25th January, 2014.
3. Barman, D.; Meena, N. K.; Khan, A. Mandal.; Raj Kumar.; Sailo, N.; Medhi, R.P. (2014) A comprehensive approach of *cymbidium* production by organic means. **In:** National Seminar on “Emerging challenges and prospective strategies for hill agriculture in 2050” at ICAR Research Complex for NEH regions, Nagaland Centre, Jharnapani, Nagaland from 23-25th January, 2014.
4. Barman, D.; Khan, A. Mandal.; Raj Kumar.; Medhi, R. P. (2014) Fragrant Orchids: an option for livelihood generation. pp 21. **In:** National Conference on Orchids: Conservation, Improvement and Sustainable Development at Thrissur, Kerala from 13-15th March, 2014.
5. Chakrabarti, Syamali.; Jain, Sudeep Kumar.; Sinha, Debasree.; Medhi, R. P. (2013) Paper on Diversity of fragrant Orchids of North eastern India and sustainable utilization for food security”pp:26-30. (*accepted for oral presentation*) **In:** International conference of World Biodiversity Congress (WBC) at Chiang Mai, Thailand. November, 2013.
6. Chakrabarti, Syamali.; Jain, Sudeep Kumar.; Medhi, R. P. (2013) Paper on Molecular markers for assessment of genetic diversity and relatedness of some important *Dendrobium* orchid species of India. (*accepted for oral presentation*) **In:** International Conference on Agriculture and Biotechnology at Kuala Lumpur, Malaysia from 29-30th December, 2013.
7. Chakrabarti, Syamali.; Jain, Sudeep Kumar. (2014) Paper on Genetic diversity analysis in *Cymbidium whiteae*, a rare endangered endemic orchid species of Sikkim Himalaya. (*accepted for oral presentation*) **In:** 2014 Asia-Pacific Conference on Life Science and Engineering at Sanya, Hainan Island, China from 21-23rd February, 2014.
8. Chakrabarti, Syamali.; Jain, Sudeep Kumar. (2014) Paper on Diversity analysis of some medicinal *Dendrobium* orchids using Microsatellite markers. (*accepted for oral presentation*) **In:** International Conference on Agricultural, Ecological and Medical Sciences (AEMS-2014) at Bali, Indonesia from 6-7th February, 2014.
9. De, L. C.; Medhi, R. P.; Mitra, S. K. (2013) Orchid-A diversified flower crop. **In:** Proceedings of 4th International Conferences on Landscape and Urban horticulture held at Kolkata, West Bengal from 12-14th September, 2013.
10. De, L. C.; Chhetri, Geetamani.; Rajkumar.; Medhi, R. P. (2014) Climatic management in commercial cultivation

- of *Cymbidium*. **In:** Proceedings of “Emerging Challenges and Prospective Strategies for Hill Agriculture in 2050” at Jharnapani, Nagaland from scheduled 23-25th January, 2014.
11. De, L. C.; Chhetri, Geetamani.; Rajkumar.; Medhi, R. P. (2014) *Dendrobium*-a diversified orchid for tropical and sub-tropical regions. **In:** Proceedings of “Emerging Challenges and Prospective Strategies for Hill Agriculture in 2050” at Jharnapani, Nagaland from 23-25th January, 2014.
 12. De, L. C.; Medhi, R. P. (2014) Post-harvest physiology and technology in orchids. **In:** Proceedings of 2nd International Conference on Agri. & Horticultural Sciences organized by OMICS Groups at Hyderabad from 3-5th February, 2014.
 13. De, L. C.; Rao, A. N.; Rajeevan, P. K.; Dhiman, S. R.; Srivastava, Manoj.; Chhetri, Geetmani. (2014) DUS Test Guidelines in *Phalaenopsis* orchids. **In:** National Conference on Orchids: Conservation, Improvement and Sustainable Development & Orchid Show Organized by TOSI in collaboration with KAU, Trissur, Kerala from 13-15th March, 2014.
 14. De, L. C.; Medhi, R. P. (2014) Value addition in orchids. **In:** National Conference on Orchids: Conservation, Improvement and Sustainable Development & Orchid Show Organized by TOSI in collaboration with KAU, Trissur, Kerala from 13-15th March, 2014.
 15. De, L. C.; Medhi, R. P. (2014) Commercial cultivation of *cymbidium* orchids. **In:** National Conference on Orchids: Conservation, Improvement and Sustainable Development & Orchid Show Organized by TOSI in collaboration with KAU, Trissur, Kerala from 13-15th March, 2014.
 16. Geetha, C. K.; Rajeevan, P. K.; De, L. C.; Rao, A. N.; Dhiman, S. R.; Srivastava, Manoj.; Kurian, Roshmi. (2014) DUS Test Guidelines for *Oncidium* Orchids. **In:** National Conference on Orchids: Conservation, Improvement and Sustainable Development & Orchid Show Organized by TOSI in collaboration with KAU, Trissur, Kerala from 13-15th March, 2014.
 17. Khan, A. Mandal.; Barman, D.; Pradhan, S.; Raj Kumar; Medhi, R. P. (2014) Conserving orchids in the EON of climate change. pp: 35. **In:** National Conference on Orchids: Conservation, Improvement and Sustainable Development, Thrissur, Kerala from 13-15th March, 2014.
 18. Khan, A. Mandal.; Barman, D.; R. P. Medhi (2013) Wild Orchids a Boon to Landscapers presented **In:** International Conference on 'Impact of Landscape Horticulture on Development of Urban Economy with Green Environment at Kolkata from 12-14th September, 2013
 19. Ram Pal.; Barman, D.; Dayamma, M.; Medhi, R. P. (2014) Asymbiotic seed germination, seedling growth and acclimatization of *Zygopetalum*

intermedium for commercial cultivation. pp 61. **In:** National Conference on Orchids: *Conservation, Improvement and Sustainable Development*, Thrissur, Kerla from 13-15th March, 2014.

20. Ram Pal. (2014) Production of quality planting material of orchids. pp 106-106. **In:** Souvenir and Abstract National Conference on orchids: *Conservation, Improvement and Sustainable Development & Orchid Show* organized by TOSI, in Collaboration with KAU, Vellanikkara from 13-15th March, 2014.
21. Ram Pal.; Medhi, R. P.; Dayamma, M. (2014) Protocol for mass multiplication of *Paphiopedilum villosum* (Lindl.) Pftz. through seeds: An approach for conservation through commercialization. pp 64-65. **In:** Souvenir and Abstract National Conference on orchids: *Conservation, Improvement and Sustainable Development & Orchid Show* organized by TOSI, in Collaboration with KAU, Vellanikkara from 13-15th March, 2014.
22. Ram Pal.; Barman, D.; Dayamma, M.; Medhi, R. P. (2014) Protocol for mass multiplication of *Paphiopedilum villosum* (Lindl.) Pftz. through seeds: An approach for conservation through commercialization. pp 64-65. **In:** Souvenir and Abstract National Conference on orchids: *Conservation, Improvement and Sustainable Development & Orchid Show* organized by TOSI, in Collaboration with KAU, Vellanikkara from 13-15th March, 2014.

Awards/Rewards/Recognition/Bodies acquired during the year

1. Awarded 3rd prize in poster presentation for the paper entitled *Fragrant Orchids: an option for livelihood generation* authored by D. Barman, A. Mandal Khan, Raj Kumar and R. P. Medhi in National Conference on Orchids: *Conservation, Improvement and Sustainable Development* at Thrissur, Kerala from 13-15th March, 2014.
2. One patent was filed at 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 has been developed. Both the quantity and quality of isolated DNA was higher when compared with the DNA isolated by other methods. This new protocol can be used for isolation of DNA from fresh leaf tissue of orchids which is highly suitable for various molecular analyses.



LIST OF ONGOING PROJECTS

7

Institute Projects

Sl. No.	Project title	PI
1.	DNA Fingerprinting of Commercially Important Orchids	S. Chakrabarti
2.	Hybrid / Varietal Development of Important Orchids	R. Devadas
3.	Production Management of Tropical and Sub-tropical Orchids	L. C. De
4.	Development of Integrated Floriculture Enterprise	D. Barman
5.	Post harvest Technology of Orchids	L. C. De
6.	Flower Induction in Orchids	N. Sailo
7.	Stress Physiology of Orchids	N. Sailo
8.	Genetic Improvement of Cymbidium orchid for cut and pot flowers	M. Chakraborti
9.	A Comparative Study of Symbiotic and Asymbiotic Germination in Selected Species and Hybrids of <i>Calanthe</i> , <i>Cymbidium</i> and <i>Paphiopedilum</i>	Ram Pal
10.	Ecofriendly Pest Management	Rumki Ch. Sangma
11.	Morphometric and molecular characterization of entomofauna (Pests, natural enemies, pollinators) from orchid ecosystem in Sikkim	Rumki Ch. Sangma

Externally Funded Projects (On going)

1. Mini Mission – I

Project title: “Horticulture Mission for North East and Himalayan States”

Principal Investigator: R. P. Medhi

Programmes of the project

Associated Scientists

Programme I: Production of nucleus/basic seed and planting material of horticultural crops

R. Devadas & Rajkumar

Programme II: Standardization of improved production technologies for horticultural crops

D. Barman, L. C. De,

Programme III: Technology refinement and imparting of training to extension functionaries

D. Barman, L. C. De,
R. Devadas,
S. Chakrabarti,
Rampal and N. Sailo

2. DUS Testing Project

Project title: " DUS testing of orchid varieties /species for development of NTG"

Nodal Officer: L. C. De

Associate Nodal Officer: R. Devadas

3. DBT - II Project

Project title: " Development of protocol for commercialization of paphiopedilum orchids in NE states "

Principal Investigator: R. P. Medhi,

Co-Principal Investigator : Rampal

4. NAIP Project

Project title: " A Value Chain on Selected Aromatic Plants of North East India "

Co-Principal Investigator: R. P. Medhi,

CC-PI: D. Barman and Rampal

5. Revolving Fund Scheme (RFS)/Mega Seed Project:

Nodal Officer (RFS): R. Devadas

6. Tribal Sub-plan (TSP & SCSP) Scheme:

Nodal Officer: R. Devadas

Associate Nodal Officer: N. Sailo

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.	Investigation on Fungal Diseases of Orchids	T. K. Bag
4.	Macronutrient management in orchids	S. K. Naik
5.	Secondary and micronutrient management in orchids	S. K. Naik
6.	Pest management in Orchids and bulbous flowering plants	N. K. Meena
7.	Improvement of orchids	D. Barman
8.	Studies on bulb production of liliium	Rampal
9.	Collection, conservation, evaluation and multiplication of bulbous ornamental crops.	Rampal
10.	Disease management of orchids	R. P. Pant
11.	Integrated pest management in orchids	N. K. Meena
12.	Collection, conservation, characterization, evaluation and maintenance of high alt. orchid germplasm	Ram Pal



RAC / IRC & IMC MAJOR RECOMMENDATIONS

Research Advisory Committee (RAC)

Chairman: Dr. S. N. Puri

Members: Prof. S. P. Vij

Dr. V.A. Parthasarathy

Dr. R. D. Rawal

Dr. M. Jawaharlal

Dr. A. N. Rao

Dr. B. P. Baruah

Dr. R. P. Medhi

Shri D. K. Bhandary

Shri Padam Subba

Shri Nirmal Yonzon

Shri Sharad Pradhan

Member Secretary: Dr. L. C. De

The committee met under the Chairmanship of Dr. S. N. Puri on 23- 24th September 2013 and reviewed the progress of research activities. Some of the major recommendations are presented below:



Summary of Recommendation

- Molecular profile of *Cym. gammiaeaeum* and *C. whiteae* should be worked out to confirm identity of these species. The terrestrial orchids may also be included in molecular studies.
- Liquid culture in media through proper agitation should be used to avoid onset of polarity. ploidy level of F1 progeny of *Cym. Fancy Free* and *Cym. Tetraploid Oklahoma* should be worked out. LED lights should be used in tissue culture for studying critical photoperiod.
- Use of high temperature and low moisture along with anti-transpirants should be promoted for stress studies. Studies on comparative physiology of nutrition and flowering of lithophytic and epiphytic orchids should be taken up.
- For *in-vitro* flowering, RAC advised to try other species/hybrids of orchids also

instead of *Cymbidium* only.

- For *in vitro* propagation, it was advised to try different chemicals so that one need not depend on a single chemical for this. Other chemicals like Kinetin can also be tried as a replacement for Paclobutrazol.
- For round the year production of flowering, free flowering genotypes should be identified and multiplied.
- In post harvest studies, suitable packaging material should be indicated. The package of Post harvest management should include all packages including pre harvest and packaging treatments.
- Considering the demand from the HCCD Department and farmers of the State, efforts should be made to make available the planting materials of the released varieties/hybrids from NRCO.
- RAC recommends that the present level of annual planting material production may be raised from 25,000 to 50,000. Since it is a mandate of NRCO to produce quality planting material, in order to encourage the scientists to take up this work. The Council may give due weightage for the work. There must be provision of sufficient financial support by including horticultural crops as a part of Mega Seed Project.
- The representatives of the farmers as well as line departments of Sikkim Government requested for the package of practices required for organic cultivation of orchids. The NRC should initiate the work in this direction so as to make it available in near future.
- The Chairman emphasized the physiological studies like requirement of day and night temperature, vapour pressure and chilling temperature required for initiating flowering should be given more importance. This information is necessary to ensure flowering during off season in order to get the economic benefit maximum.
- IPR issues are very important because of export component. Due care should be taken to protect newly developed techniques/varieties in view of IPR regime.
- The RAC recommends that the Council should ensure the active help of NBPGR for importing some planting material required by scientist of NRC for their research work. Since, present efforts of NRC scientists did not succeed in getting the necessary material.
- The representative of the farmers requested for continuation of assistance which was available under DBT program. The scientist may approach DBT for the funding the project in order to ensure livelihood security of SC/ST population through biotechnological interventions.
- Incidence of virus is spreading fast and if due precaution is not taken, the complete orchid cultivation in the State will face serious situation. Therefore, to combat viruses creating awareness among the farmers is necessary. The Department of Horticulture may organize awareness programmes for the orchid growers by involving Scientists for higher

productivity of flower spikes from NRC Orchids.

Institute Research Committee (IRC)

Chairman: Director, NRCO, Pakyong, Sikkim

Members: All scientists of the Institute

Member Secretary: Dr. S. Chakrabarti

12th IRC meeting was held on 11th November, 2013 under the Chairmanship of Director NRCO, Pakyong to review the progress of the ongoing research programmes of the institute. The new project proposals were discussed for their approval and important recommendations are as follows:

Summary of Major Recommendation

- New project- DNA bar-coding of commercially important genus may be included in ongoing project as programme –II and revised RPF-I may be submitted (*Action - Dr. S. Chakrabarti*)
- Breeding objectives must be specific and Programme may be taken to develop inter generic hybrids (*Action - Dr. R. Devadas*)
- Procurement of parental lines of Cymbidium help of State HCCD Department may be taken (*Action - Dr. Rampal & Dr. M. Chakraborti, Darjeeling Campus*)
- Facilities to be created in 3-4 locations of the State to demonstrate the Floriculture enterprise; NEH project should be revised considering the feasibility of planting materials; New project proposal should be modified according to the availability of local organic potting media and Focused research programme should be

taken up on climate change (*Action - Dr. D. Barman*)

- Post harvest management should be done considering the different climate condition of the country (*Action - Dr. L. C. De*)
- For stress management mRNA study should be included (*Action - Dr. N. Sailo*)
- Efficacy of botanicals for control of pests infestation may be tested in farmers field (*Action – Ms. Rumki H. Sangma*)

Institute Management Committee (IMC)

Chairman: Dr. R. P. Medhi, Director

Members: Dr. R. C. Srivastava, Joint Director, Botanical Survey of India, Kolkata, West Bengal.

Dr. M. Ghosh, Director of Farm, UBKV, Pundibari, West Bengal

Principal Director, HCCD Dept., Govt. of Sikkim, Sikkim (*State representative*)

Dr. S. K. Borah, Floriculturist, Assam Agricultural University, Assam

Dr. Ramgopal Devadas, Sr. Scientist (PB), NRC for Orchids, Pakyong, Sikkim

Shri. Pema Sherpa, Upper Kartok, Naya Busty, Pakyong, Sikkim

(*Farmer's representative*)

Member Secretary: Shri. Ajen Lama, AAO, NRC for Orchids, Pakyong, Sikkim

12th Institute Management Committee (IMC) meeting of the centre was held under the

Chairmanship, Dr. R. P. Medhi, Director, NRCO, on 18th September, 2013 reviewed the research programmes and activities of institute. The following recommendations were made:

Finalized the list of equipments to be procured and reviewed and finalized the civil works to be taken up at main and Darjeeling campus of NRCO during 12th FYP.



Result Framework Document

Result Framework Document (RFD) is a Planning Commission Document that takes critical view on yearly performance targets adopted by Central Ministries and Departments since 2009. The main purpose of RFD is accountability and adoption of quality management of heads of departments. As per Proceedings of RFD meeting of Horticulture Division held on 30th August, 2012 under the Chairmanship of Dr. N. K. Krishna Kumar, DDG

(Hort.), two (2) units namely RFD Committee and RFD Cell constituted in favour of NRC for Orchids, Pakyong, Sikkim are as follows:

During 2013-2014, RFD of this institute was prepared with the following Vision, Mission, Objectives and Functions (Section-1). Other information of RFD (Section 2, Section 3, Section 4, Section 5 and Section 6) is given in Annexure-I.

RFD Committee	RFD Cell
Dr. R. P. Medhi, Chairman Dr. L. C. De, Pr Scientist & Nodal Officer Dr. R. Devadas, Sr. Scientist & Member Shri. Davis Joseph, AO	Dr. L. C. De, Pr. Scientist & Nodal Officer Dr. R. Devadas, Sr. Scientist & Co- Nodal Officer Shri Davis Joseph, AO

Vision

Harnessing science to increase the productivity, generation of employment, support to the industry for export of the cut flowers, potted plants and planting materials of orchids.

Mission

Sustainable growth of orchids by mission oriented research with a view to develop new varieties and hybrids suitable for export and to develop suitable production technology

Objectives

1. Management and utilization of genetic resources for improved productivity
2. Production, protection and post-harvest management
3. Dissemination of knowledge

Functions

To plan, coordinate, implement and monitor R&D programmes for sustainable production of orchids and resource conservation.



PARTICIPATION OF SCIENTISTS IN CONFERENCES, MEETINGS, WORKSHOPS, SYMPOSIA, SEMINAR ETC. IN INDIA & ABROAD



1st International Assam Agri-Horticultural Show 2014, Guwahati from 8-11th January, 2014

State Level Steering Committee of Small Farmer's Agri-Business Consortium (SFAC) and National Bamboo Mission at Secretariat, Government of Sikkim chaired by Mrs. Rinchen Ongmu, Chief Secretary, Sikkim on 12th April, 2013.

R. Devadas

National Seminar on Biotechnology at IIHR, Bangaluru from 12-15th June, 2013

S. Chakrabarti

Meeting cum field visit of 'Eco park' at army cantonment at '17th Mountain Battalion' at Deorali on 15th June, 2013.

D. Barman & R. Devadas

National Workshop on Conservation of RET

Medicinal plants at IIHR and FRLHT, Bangalore from 19-20th June, 2013

A. M. Khan

Agribusiness Camp organized by ZTM-BPD, NIRJAFT with NRC for Orchids, Pakyong, Sikkim on 24th June, 2013

All scientists

One day awareness programme on "Intellectual property Rights" at NRCO, Pakyong on 24th June, 2013

All scientists

Agribusiness Camp as ITMU In-Charge at CARI, Port Blair from 24-30th July, 2013.

S. Chakrabarti

NEH Programme for 12th Five Year Plan (Collaboration with IIHR) at Rani, Guwahati on 25th July, 2013.

L. C. De

4th International Conferences on 'Impact of Landscape Horticulture on Development of Urban Economy with Green Environment' at Kolkata, West Bengal from 12th-14th September, 2013.

D. Barman, L. C. De & A. M. Khan

Meet of Ministers of Agriculture-Horticulture of North East India at Gangtok, Sikkim on 28th November, 2013.

L. C. De

Exhibition on Orchids from NRCO at CAE & PHT, Ranipool, Sikkim on 30th November, 2013

All scientists

Agribusiness Camp as ITMU In-Charge at NRC Yak, Dirang on 17th December, 2013

S. Chakrabarti

Agribusiness Campaign as ITMU In-Charge at ICAR Research Complex for NEH Region, Barapani, Meghalaya on 21st December, 2013

S. Chakrabarti

National Seminar on “Emerging challenges and prospective strategies for hill agriculture in 2050” at ICAR Research Complex for NEH regions, Nagaland Centre, Jharnapani, Nagaland from 23-25th January, 2014 .

D. Barman and Raj Kumar

Awareness cum training programme on “PPV&FRA” at NRCO, Pakyong on 31st January, 2014.

All Scientists

2nd Stakeholders Meet held at NRC for Orchids, Sikkim at NRCO, Pakyong on 10th March, 2014.

All Scientists

National Conference on Orchids: Conservation, Improvement and Sustainable Development & Orchid Show at KAU, Thrissur from 13-15th March, 2014

L. C. De & A. M. Khan

ICAR Seed Project review meet for XII plan conducted by CISH, Lucknow; DSR, Mau & IIHR, Bengaluru on 22nd February, 2014

R. Devadas



Distinguished visitors

10

Mr. Gowl Polnacl, IAS (Retd.)	23/05/2013
Dr. K. K. Jindal, Director of Research (Retd.), UHF Solan/ CAU Imphal	29/05/2013
Dr. Moa Walling, DHO & PD, ATMA, Nagaland	05/06/2013
Dr. Ramesh Kumar, Director, Directorate of Floricultural Research, Pusa Campus, New Delhi	20/06/2013
Mr. S. Pradhan, Secretary (Agriculture), FS&AAD and HCCD Department, Govt. of Sikkim	10/07/2013
Mr. Naiten Wangchuk, Thimphu, Bhutan	20/01/2014
Shri Dawa Narbu Takarpa, Hon'ble Minister of Agriculture & Horticulture, Govt. of Sikkim	12/02/2014
Dr. D. Anand & Dr. P. Saravanan, Dept. of Plant Biology & Plant Biotechnology, RKM Vivekananda College, Chennai	25/02/2014
Srimati R. S. Patil, 1 st Lady of Sikkim	12/03/2014



Director, NRCO
along with orchid growers of Nagaland



Mr. S. Pradhan
Secretary(Agriculture), FS&AAD and HCCD Department,
Govt. of Sikkim



Shri Dawa Narbu Takarpa
Hon'ble Minister of Agriculture & Horticulture
Govt. of Sikkim



Srimati R. S. Patil
1st Lady of Sikkim

I. Scientific

Dr. R. P. Medhi, Director
 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. Ajen Lama Assistant Administrative Officer
 Shri. Rishi Kant Singh Assistant Finance and Account 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 SSG-IV
 Shri. Dawa Bhutia SSG-II
 Shri. Tularam Dulal SSG-II
 Shri. Trilok Singh Balmiki SSG-II
 Shri. Arjun Gurung SSG-I
 Mrs. Rabin Kala Subba SSG-I

V. Appointments**Scientist**

- Dr. Arpita Mandal Khan joined as Scientist (Floriculture) on 11th April, 2013.
- Ms. Rumki Haloise Ch. Sangma joined as Scientist (Agril. Entomology) on 12th April, 2013.
- Shri. Raj Kumar joined as Scientist (Floriculture) on 8th November, 2013.

VI. Transfer

Scientist

- Dr. R. P. Pant, Sr. Scientist (Plant pathology) transferred to CPRS, Modipuram, Meerut, U.P. on 18th May, 2013.
- Dr. N. K. Meena, Scientist SS (Agril. Entomology) transferred to NRC on Seed Spices, Ajmer, Rajasthan on 10th May, 2013.

Administrative

- Shri. Davis Joseph, Administrative Officer transferred to CTCRI, Thiruvananthapuram, Kerala on 13th September, 2013.

VII. Promotion

Scientist

- Dr. Ramgopal Devadas, Sr. Scientist (Plant Breeding) got promoted to next higher grade of GP 9000/- on 7th December, 2013 for the assessment period 29/9/2009 – 28/9/2012.

- Dr. N. Sailo, Scientist (Plant Physiology) cleared his probation period on 18th February, 2014 for the assessment period 27/4/2011 – 26/4/2013.

Technical

- Shri. Noni Gopal Debnath promoted from Technical Assistant (Computer Assistant) to Sr. Technical Assistant (Computer Assistant) on 18th February, 2014 for the assessment period 2/6/2008 – 1/6/2013 through Five year promotion scheme of technical staff.
- Shri. Ram Chandra Gurung promoted from Technical Assistant (Driver) to Sr. Technical Assistant (Driver) on 18th February, 2014 for the assessment period 5/5/2008 – 4/5/2013 through Five year promotion scheme of technical staff.
- Shri. Deepak Khattri promoted from Technician (Driver) to Sr. Technician (Driver) on 18th February, 2014 for the assessment period 27/11/2007 – 26/11/2012 through Five year promotion scheme of technical staff.

Agri Business Camp

ICAR Zonal Technology Management – Business Planning and Development Unit of National Institute of Jute and Allied Fibre Technology, Kolkata in association with National Research Centre for Orchids, ICAR, Pakyong organized an “Agribusiness Camp” on 24th June, 2013 at Chintan Bhawan Gangtok. Shri. P.T. Bhutia, Principal Director, Deptt. of Agriculture, Govt. of Sikkim, graced the occasion as chief guest. Nine ICAR institutes are located in Eastern and Northeastern region of the country. Scientists from these institutes belonging to different disciplines like Agriculture, Animal sciences, Fisheries *etc.* participated in the camp and presented the technologies developed by their institutes. An exhibition of the products and technologies was also organized. Representatives of NHB and Sikkim Chamber of Commerce, Axis bank, Spices Board also participated in the event.



Shri. P.T. Bhutia
Principal Director, Deptt. of Agriculture, Govt. of Sikkim



Participants at the Agri Business Camp

Training for Temporary Mazdoors

In compliance to Government of India, Ministry of Personnel, Public Grievance & Pensions (Department of Personnel & Training) O.M. No. 49011/2008-Estt.(e) Dated 23rd January, 2012 and Council's Endorsement No. 21-32/2008-CDN Dated 31st January, 2012, a six days training programme was organized at the centre from 27th June to 3rd July, 2013 to train five TSM staff. A six day training programme witnessed a series of technical sessions. The course was divided into seven different modules covering behavioral, values and aesthetic, office procedures, basic knowledge of office equipments (practical), consulting library, working in laboratory and field and duties of receptionist and security were covered. All the modules were covered by highly skilled and experienced scientist, technicals and administrative staff of the centre. The participants were also taken out for a field visit to get an exposure of modal demonstration farm. On 3rd July, 2013 all the participants were awarded with certificates on successful completion of the training programme.



Distribution of training kits to the trainees



School childrens participating at the drawing competition



Trainees along with other staff during the closing ceremony



Awardees of the drawing competition

Drawing Competition for Children's

The Centre organized an open drawing competition for children's below 15 years as a part of Independence Day Celebration on 11th of August, 2013. All the participants were divided in to two groups. Group A: Children within 04-10 Years (*Theme: Independence Day Celebration*); Group B: Children within 11-15 Years (*Theme: Your Idea of Freedom*). Five schools nominated their students for the event and 33 enthusiastic children's participated in the competition including the children of staff. The winners of the drawing completion were awarded by the Director of the institute.

18th Foundation Day Celebration

National Research Centre for Orchids (ICAR), Pakyong, Sikkim celebrated its 18th Foundation Day on 5th October, 2013 with the theme "Orchid Diversity of Sikkim and its Conservation". Dr. D. Barman, Pr. Scientist (Hort.) & i/c Director presided over the function. Dr. P. K. Srivastava, Dean, CAE&PHT, Central Agricultural University, Sikkim was the Chief Guest of the function. The winners of the events conducted during Hindi Saptah (9-16th September, 2013) were awarded by the chief guest and several cultural events were organized to mark the celebration.



NRC for Orchids, Sikkim



Distribution of prizes to the winners of Hindi Saptah



Director, NRCO addressing the gathering



Cultural programme during foundation day celebration



Oath on community harmony

National Integration Week (19-25th November, 2013)

National Integration Week for Communal Harmony from 19-25th November, 2013 was observed at the training hall of the institute. A week-long programme was organized in which Flag Day and fund raising for donation were prominent. The function also witnessed the Director along with all staff members taking the oath on community harmony.

Awareness cum training on “Application of ICT”

Three days awareness cum training programme on “Application of Information and Communication Technology (ICT)” was organized at the centre from 19-21st December, 2013. Agricultural Knowledge Management Unit (AKMU) of the centre coordinated the event. Dr. P. Srivastava, Dean, College of Agricultural Engineering & Post Harvest Technology, Central Agricultural University, Ranipool, Sikkim was the chief guest for the inaugural function. Shri. Birendra Chettri, State Informatics Officer, National Informatics Centre, Sikkim Centre, Gangtok was the guest of honour. Dr. R. K. Avasthe, Joint Director, ICAR Res. Complex for

NEH Region, Sikkim Centre, Tadong, Gangtok was also present as the special invitee in the programme. Twenty eight scientists, administrative and technical personnel from different institutes participated in the training programme. Experts from NAARM, Hyderabad were invited to deliver lectures and impart practical knowledge on GIS and SAS 9.3.



Director, NRCO lighting up the lamp



Dr. P. K. Srivastava, Dean, CAU addressing the gathering

Kisan Mela 2014

One day Kisan Mela (Farmers' Fair) was organized on 12th February, 2014 at State Community Hall, Pakyong with joint sponsorship of National Horticulture Board (NHB) for the benefit of the farmers of Sikkim state specially the orchid growers. Shri Dawa

Narbu Takarpa, Hon'ble Minister of Health Care, HS & FW, Food Security & Agriculture Development, Horticulture and Cash Crop Development and Parliamentary Affairs Department, Govt. of Sikkim inaugurated the Mela as chief guest. Shri D. K. Rai, Principal Director cum Secretary, Horticulture and Cash Crop Development and Shri P. T. Bhutia, Principal Director cum Secretary, Agriculture Department were present as guest of honour. Dr. K. K. Sathapathy, Former Director, National Institute of Research for Jute and Allied Fibre Technology (NIRJAFT), Kolkata and Dr. R. K. Avasthe, Joint Director, ICAR Research Complex for NEH Region, Sikkim Centre also present as special guests during this event. Many other dignitaries from Central Govt. organizations and State department like Agriculture, Horticulture and Cash Crop Development, SIMFED etc. attended the programme. Seventeen progressive orchid growers from Kartok, Assam Lingzey and Namchepong exhibited their produce and approximately 150 farmers from different locations of Sikkim participated in Mela. Farm implements were distributed to all the farmers through Hon'ble Minister. In the technical session the scientists of this centre shared their



Shri. Dawa Norbu Takarpa
Hon'ble Agriculture Minister, Govt. of Sikkim
addressing the gathering



knowledge on production, protection and post harvest technologies of orchids.

National Science Day observed

The centre observed National Science Day on 28th February, 2014. Shri O. P. Singh, Vice Principal, Jawahar Navadaya Vidyalaya, Pakyong inaugurated the Science Day celebration as chief guest. Teachers from Puspanjali Vidyalaya and Dickling Senior Secondary School were also present on the occasion. Dr. D. Barman, Pr. Scientist (Horticulture) presented a lecture on energy conservation. The participants were also shown a short documentary film on the “Birth of Earth”. An open quiz competition was also organized for the school student's of class IX & XI . Fifteen students of different school participated in quiz competition. Dr. R. P. Medhi, Director of the centre distributed the trophy along with the certificates of appreciation to the winners of the quiz.



Participants at the kisan Mela



Hon'ble Agriculture Minister distributing the farm implements



Director, NRCO presenting a memento to the Hon'ble Minister



Director, NRCO addressing the gathering



Winners of the open quiz competition

2nd Stakeholders Meet

The '2nd Stakeholders Meet of NRCO' was organized at National Research Centre for Orchids, (ICAR), Pakyong on 10th March 2014. The objectives of the meeting were to share and discuss mutually on technological developments at NRCO and evaluate by taking necessary feedback for preparing future road map with stakeholders in partnership mode. The Dr. R. P. Medhi, Director, NRC for Orchids; Dr. D. K. Agarwal; BSI Shri. P. L. Basnet; Shri. B. B. Gurung, Agro Eco-tourism along with 15 farmers

and DBT beneficiaries from Sikkim and Darjeeling attended the meeting. Dr. R. Devadas, Senior Scientist (Plant Breeding) highlighted the significance and objectives of Stake Holders Meeting. Two new NRCO varieties *Cymbidium* "B. S. Basnet" and *Aranda* "Kunga Gyatso" were also released on this occasion and presented to the State Department and progressive farmers. The house recalled the services and glorious achievements of Late Shri. B. S. Basnet and Late Kunga Gyatso Bhutia, for their contribution towards the welfare of farming community of Sikkim.



Handing over of NRCO varieties *Cymbidium* "B. S. Basnet" to the state officials



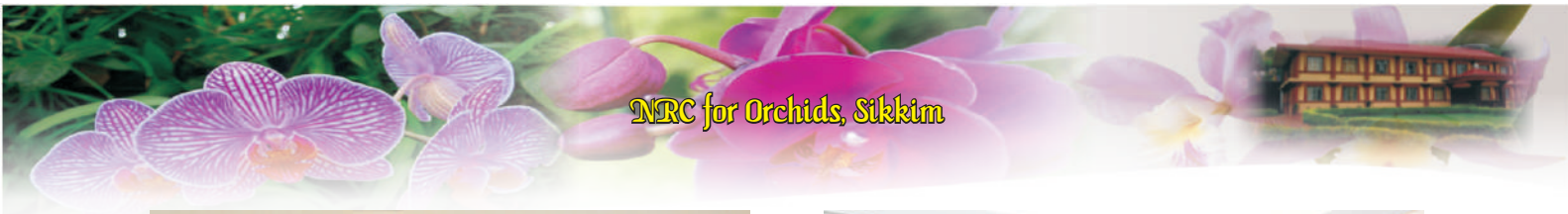
Participants at the 2nd Stateholders Meet



Independence Day Celebration



Cultural programme during Independence Day celebration



NRC for Orchids, Sikkim



Hindi Saptah
(9-16 September 2013)



Vigilance Week celebration
(28th October – 2nd November, 2013)



National Integration Week
(19-25th Nov 2013)



Sadvavna Diwas
(19th November, 2013)



Republic Day Celebration



2nd meeting of Orchid Task Force (3/2012)
(30th January, 2014)



NRC for Orchids, Sikkim

ANNEXURE

Result Framework Document

Section 2: Inter se Priorities among Key Objectives, Success indicators and Targets

Annexure – I

Objectives	Weight	Action	Success Indicators	Unit	Weight	Target/Criteria Value				
						Excellent 100%	Very Good 90%	Good 80%	Fair 70%	Poor 60%
1. Management and utilization of genetic resources for improved productivity	40	Collection, and conservation of orchid germplasm	Germplasm added and conserved	Number	20	60	55	50	45	40
		Characterization of Orchids	Molecular and DUS characterization of orchids	Number	10	25	20	15	10	8
		Development of improved hybrids	New crossings, in-vitro seed culture and new F1 evaluated	Number	10	25	20	15	10	8
2. Production and post harvest management of orchids.	30	Integrated production and post-harvest management of orchids	Production and post-harvest technologies developed	Number	12	6	4	2	1	-
		Production of planting materials	Plantlets produced	Number	10	12000	10000	8000	7000	6000
		Insect-pests and disease management	Protection technologies developed	Number	8	17	14	12	10	7
3. Dissemination of knowledge	19	Transfer of technologies	Training /demonstration/seminar conducted	Number	11	16	13	10	8	6
		IPM for Orchids	Books/bulletins/folders, CD's published etc.	Number	8	10	8	7	6	4
		Timely submission of Draft RFD (2013-14) for approval	On-time submission	Date	2	15/05/2013	16/05/2013	17/05/2013	20/05/2013	21/05/2013
* Effective Functioning of the RFD System	3	Timely submission of Results for RFD (2012-13)	On-time submission	Date	1	01/05/2013	02/05/2013	05/05/2013	06/05/2013	07/05/2013
		Implement ISO 9001 as per the approved action plan	% Implementation	%	2	100	95	90	85	80
* Administrative Reforms	4	Prepare an action plan for Innovation	On-time submission	Date	2	30/07/2013	10/08/2013	20/08/2013	30/08/2013	10/09/2013
		Implementation of Sevottam	Independent Audit of Implementations of Citizen's Charter	%	2	100	95	90	85	80
*Improving internal efficiency/responsiveness/service delivery of Ministry/ Department	4	Timely Submission of results of 2012-13	Independent Audit of Implementation of public grievance redressal system	%	2	100	95	90	85	80

Section 3: Trend Values of the Success Indicators

Objectives	Actions	Success Indicators	Unit	Actual value for FY 11/12	Actual value for FY 12/13	Target Value for FY13/14	Projected Value for FY 14/15	Projected Value for FY 15/16
1. Management and utilization of genetic resources for improved productivity	Collection and conservation of orchid germplasm	Germplasm added and conserved	Number	45	55	55	58	60
	Characterization of orchids	Molecular and DUS characterization of orchids	Number	13	19	20	22	25
	Development of improved hybrids	New crossing, in-vitro seeds culture and new F1 evaluated	Number	20	20	20	25	27
	Integrated production and post-harvest management of orchids	Production and post-harvest technologies developed	Number	4	6	4	6	7
2. Production and post harvest management of orchids.	Production of planting materials	Plantlets produced	Number	9,000	10,000	10,000	10,000	10,000
	Insect pests and disease management	Protection technologies developed	Number	13	10	14	14	14
	Transfer of technologies	Training / demonstration/seminar conducted Books/bulletins/folders/CD's published etc.	Number	13	15	13	14	15
3. Dissemination of knowledge.	Timely submission of Draft RFD (2013-14) for approval	On-time submission	Date			16/05/2013		
	Timely submission of Results for RFD (2012-13)	On-time submission	Date			02/05/2013		
* Efficient functioning of RFD System	Implement ISO 9001 as per the approved action plan	% Implementation	%			95		
	Prepare an action plan for Innovation	On-time submission	Date			10/08/2013		
* Improving Internal Efficiency/responsive ness/service delivery of Ministry/ Department	Implementation of Sevottam	Independent Audit of Implementations of Citizen's Charter	%			95		
		Independent Audit of Implementation of public grievance redressal system	%			95		

Section 4: Acronyms

S.No.	Acronym	Description
1.	NBPGR	National Bureau of Plant Genetic Resources
2.	DUS	Distinctiveness, Uniformity and Stability
3.	CD	Compact Disc
4.	R & D	Research & Development
5.	ISO	International Organization for Standardization
6.	AICRP	All India Coordinated Research Project
7.	DAC	Department of Agriculture & Cooperation
8.	SAU	State Agriculture University
9.	HMNEH	Horticulture Mission for North-eastern States

Section 4: Description and Definition of Success Indicators and proposed Methodology

Sl.No.	Success indicator	Description	Definition	Measurement	General comments
1.	Germplasm added and conserved	Collection and conservation of orchid species	Genetic diversity of orchids in different eco-regions	Number of genotypes	Used for crossing and evaluation programme
2.	Molecular and DUS characterization of orchids	Characterization through molecular markers and DUS test guidelines	Molecular and morphological analysis of species and hybrids	Number of species and hybrids	Used for species level identification and testing of new traits
3.	New crossing, in-vitro seeds culture and new F1 evaluated	Initiation and evaluation of F1 hybrids and segregating population. Testing of new crosses	Performance of new genotypes. Aseptic seed culture.	Number of crosses and new genotypes	Used for development of new hybrids and their multiplication
4.	Production and post-harvest technologies developed	Standardization of production and post-production management of commercial orchids	Agro-techniques for quality flower production and their keeping quality	Number of technologies	Increased production of cut flowers per unit area
5.	Plantlets produced	Production of good quality planting materials of commercial orchids	Mass multiplication through meristem and seed culture	Number of plantlets	Basis for commercial cultivation of orchids
6.	Protection technologies developed	Insect pests and disease management	Integrated controls of insects and diseases including diagnostics and bio-control tools	Number of effective protection techniques	Plant health management for quality flower production
7.	Training / demonstration / seminar conducted	Organization of on-campus and off-campus training and field demonstration on orchid production	Effective extension methods for mass communication	Number of events conducted	Dissemination of knowledge information and technologies
8.	Books/bulletins/folders/CD's published etc	Publication of intellectual assets in soft and hard copies	Documentation of outputs	Number of copies	Knowledge resources

Section 5: Specific Performance Requirements from other Departments

Sl. No.	Location type	State	Organisation type	Organisation name	Relevant Success Indicator	What is your requirement from this organisation	Please quantify your requirement from this organization	What happens if your requirement is not met
1.	Forest area	Sikkim	Public	Forest Department	Germplasm added and conserved	Permission for collection	55	Shortage of genetic resources for crop improvement
2.	Pusa	New Delhi	Public	AICRP on floriculture	New crossing, in-vitro seeds culture and new F1 evaluated	Notification for release of new hybrids	3	Loss of institutional products
3.	Krishi Bhawan	New Delhi	Public	DAC	Plantlets produced	Human resource and infrastructure development	5	Lack of know-how techniques

Section 6: Outcome /Impact of activities of department/ ministry

S. No.	Outcome/Impact of organisation	Jointly responsible for influencing this outcome/impact with the following organisation(s)/ departments/ministry(s)	Success Indicators	Unit	2011-12	2012-13	2013-14	2014-15	2015-16
1.	Production of quality seed and planting materials of orchids	DAC/SAU/HMNEH	Increase in area under commercial orchid cultivation	Percent	1.2	1.3	1.33	1.33	1.33
2.	Technology development for enhancing livelihood security	State line departments	New technologies adopted by orchid growers for enhanced productivity	Number	1	1	2	3	4