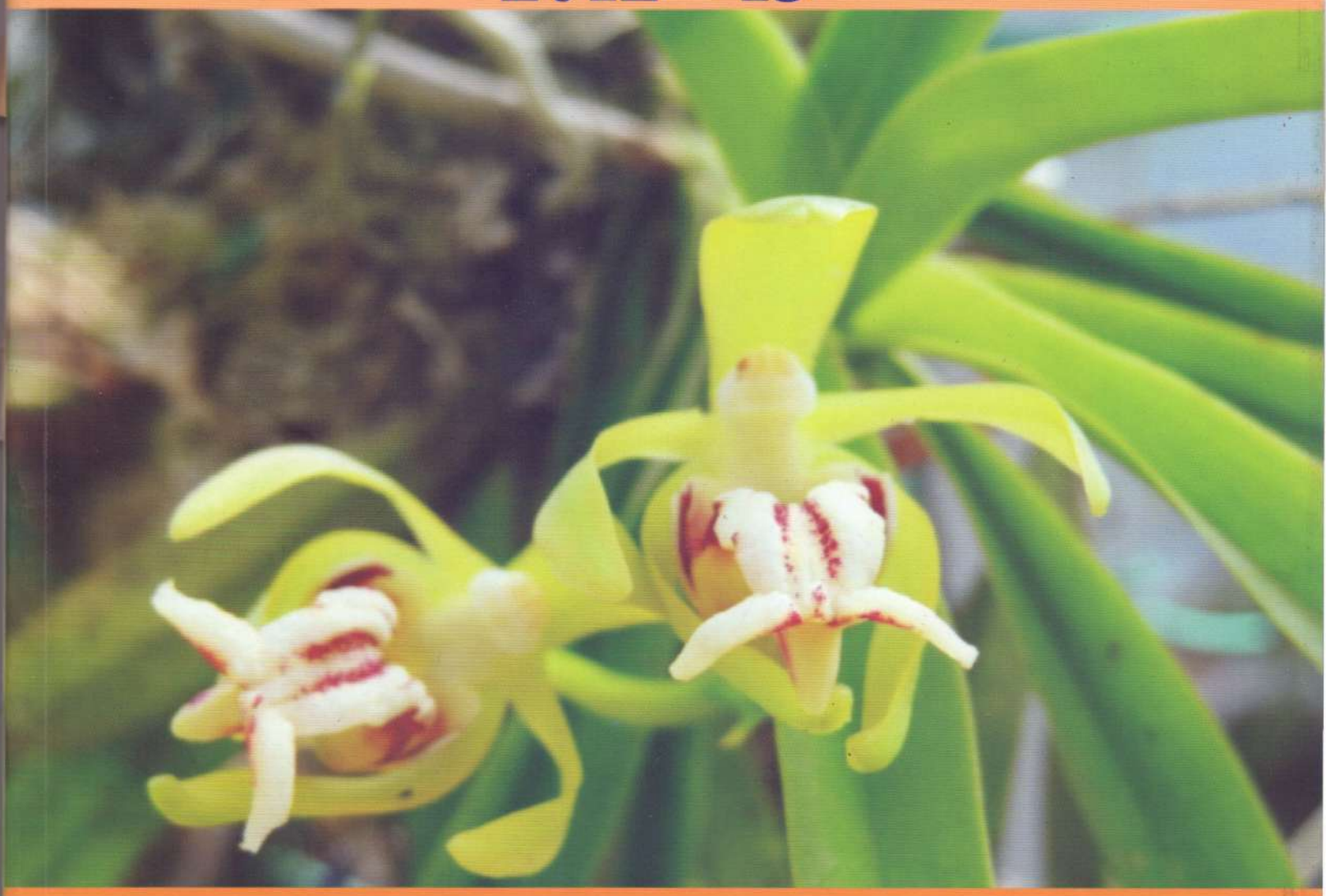
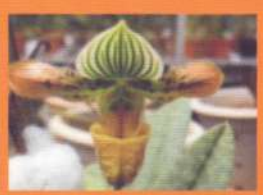
Annual Report

2012 - 13










राष्ट्रीय आर्किड् अनुसंधान केन्द्र
(भारतीय कृषि अनुसंधान परिषद्)
पाक्योंग - ७३७ १०६, सिक्किम
National Research Centre for Orchids
(Indian Council of Agricultural Research)
Pakyong - 737 106, Sikkim, India

Glimpses of last 5 years Institute Annual Reports

भाकृअनुप
ICAR

Annual Report

2012 - 2013

With Best compliments from

DIRECTOR

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NRC Orchids

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May, 2013.

Cover photographs

Front : *Vanda pumila* (Cover photo)

Row photo : (left to right) - *Dendrobium nobile, Paphiopedilum venustum, Dendrobium primulinum, Lusia zeylanica, Paphiopedilum hirsutissimum, Dendrobium draconis*

Back (inside) : Glimpses from the National Dialogue on Orchid Conservation & Sustainable Development for Community Livelihood, March 8-9, 2013

Back (outside) : *In-vitro* flowering of *Cymbidium dayanum*

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Preface

It is my proud privilege to place this document of Annual Report of Institute depicting the various activities of the year 2012-13. This report highlights the significant research achievements of various research programmes and other institutional activities. The orchid breeding programme initiated by the institute has started showing results, ten promising clones has been selected suitable for cut flowers and potted plant production. These would be multiplied for multi-location trials under AICRP on Floriculture. DUS testing guidelines for *Cymbidium*, *Dendrobium* and *Vanda* has been finalized and notified in Gazette of India. The institute has also made significant progress in molecular characterization of native orchid species especially *Aerides* and *Vanda* species using RAPD and ISSR markers. About 182 accessions from various parts of the country have been collected and conserved during the year. Under crop production, suitable hybrids of *Dendrobium, Vanda*, *Mokara, Oncidium, Aranda* and *Cattleya* were identified for commercial cultivation in the region. Production technologies of *Cymbidium* and *Dendrobium* were refined. 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. The centre is taking keen interest for developing dip stick technique for easy detection of orchid viruses at farmer's level. Considering the adverse effect of pesticides, the centre is working on biocontrol of orchid pest and several botanicals were identified for pest management.

During the current year the centre organized National Dialogue on 'Orchid Conservation and Sustainable Development for Community Livelihood', from which several useful recommendations were emerged. The recommendations would be helpful in formulating research programmes of the Institute.

The staff of the centre was encouraged to participate in different HRD programmes for honing their skill. To promote Raj Bhasha as an official language, Hindi Karyashala was organized and 3 scientists and 4 administrative staff were deputed for training. Research findings were disseminated through organizing trainings, Krishi Diwas and conducting demonstrations.

In order to review, monitor and evaluate the research programmes and development activities of the centre, RAC, IRC and IMC 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 former and present, Deputy Director Generals (Horticulture), Dr. H. P. Singh and Dr. N. K. Krishna Kumar. We are also grateful to Dr. Umesh Srivastava, 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.

Place: Pakyong, East Sikkim. (R. P. Medhi)
Dated: 30th May, 2013 Director

Executive Summary

- A total of 182 accessions belonging to 51 species were collected from Darjeeling and Sikkim Himalaya and conserved at Pakyong and Darjeeling Campus. A natural habitat of the endangered terrestrial species *Cymbidium lancifolium* was found during the exploration. Soil samples of this habitat were collected and were analyzed for primary soil properties.

- Eight native *Aerides* were evaluated to study the diversity and genetic relationship using 65 RAPD primers. A total of 877 bands were obtained of which 99.77% were polymorphic and only one monomorphic band was found. The cluster analysis grouped 7 species in 1 major cluster and one species separated as outlier. The results indicate that RAPD as a powerful molecular tool for assessment of *Aerides* species diversity and helpful for selection of parents for hybridization programme.

- In all native 18 *Vanda* species, 42 RAPD primers had amplified a total of 2794 loci and produced 724 total bands, of which 2.1 % were monomorphic and 97.9 % were polymorphic in nature. The PIC value ranges from 0.587 to 0.946. All primers used in this study had the PIC value more than 0.5 which indicates that all primers were capable of detecting polymorphism very efficiently.

- Genetic diversity and relatedness of 18 native species of genus *Vanda* were analysed using ISSR markers. 20 ISSR primers had amplified total 1349 loci and produced 443 total bands, of which 0.46% were monomorphic and 99.54% were polymorphic in nature. Phylogenetic tree grouped all the species in two major clusters C1 and C2 and one single species *Vanda spathulata* was separated as outlier.

- RAPD analysis was performed to study the genetic variability in *Vanda cristata,* using 37 decamer primers. A total of 351 bands generated by the primers of which 14.24 % were monomorphic and 85.76 % were polymorphic in nature. Huge percentage of polymorphic bands indicates genetic variability within the species.

- Twenty four accessions of *Cymbidium tracyanum* were evaluated with 65 RAPD markers and two major clusters were formed by these 24 accessions. One RAPD primer, namely 'OPHE-05' displayed a very unique banding pattern of only two amplified loci.

- A simple modified CTAB method for isolation of high quality genomic DNA from fresh and matured leaves of orchids has been developed. Modifications of chemical components of extraction buffer helped in the removal of polysaccharides

and secondary metabolites from the DNA. Both the quantity and quality of isolated DNA was higher when compared with the DNA isolated by the other methods.

- A total of 15 crosses were attempted among different hybrids, hybrids and species and different species for cut and pot flower types and observations are now being recorded for cross compatibility among the combinations.

- F1 progenies of several crosses flowered during the year. These were characterized and evaluated. Among them 10 have been found suitable for cut flower or potted flowering plants or as genetic material for further breeding programme. These would be multiplied for multilocational trials under AICRP on Floriculture.

- 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. Hence, a careful selection may be made before germinating the seeds of crossed material. The addition of BAP enhanced the germination.

- MS media without BAP took least days for swelling (70 days), globule formation (75days), first leaf initiation (94 days), first root initiation (115 days) and seedling development (161 days) in *Aerides odorata*.

- 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*. The explants cultured only in the presence of BAP at any concentration did not respond. The presences of both BAP and NAA in the cultured media seem to be necessary for PLB's production.

- Among the hybrids cultivated under Integrated Floriculture Enterprise, the Winter Beach Sea Green produced maximum flower 1.45 spike/pot. The cost benefit ratio **of** 3 farms in Assam Lingjay were 1.56, 1.60 and 1.43 whereas the cost benefit ratio of the study was found 1.80.

- Application of water @ 150ml/pot increased production of spike (8.5/pot) as compared to control (5.5/pot).Same treatment also produced longer spike (40.2cm) of *Den*. Emma White.

- Major amount of phenols and flavonoids were determined in stem of *Aerides odoratum* followed by stem of *Acampe papillosa*. High radical scavenging activity was observed in the stem of *Aerides odoratum*.

- 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 are contaminated with CymMV and ORSV while orchid species collected from natural habitats are found free from viruses. This showed that the hybrids are main source of infection.

- 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 as *Pestalotia disseminata*. The efficacy of the different chemicals against the pathogen has been assayed *in-vitro*. It was found that Mancozeb (75% WP) was found best chemical even at 100 ppm and inhibited 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 agent of coccids and mealybug on orchids under protected conditions.
- Among nine bio pesticides tested against aphid on *Dendrobium nobile*, econeem 3000ppm @ 3ml/lit was found most effective.
- Among seven IPM modules, M-4 (Nirma solution 3g/lit + econeem 3000ppm @ 3ml/lit + imidacloprid 17.8 SL 0.003%) was found most effective against boisduval scale, whereas, M-3 (tobacco extract 5% + econeem 3000ppm @ 3ml/lit + imidacloprid 0.003%) was most effective against aphid on *Cymbidium*.
- Two neem products (econeem 3000ppm and neem oil 0.03% EC) had no phytotoxic effect on flowers of *Den.* Thongchai Gold when applied up to 5ml/lit.
- DUS test guidelines for *Cattleya* and *Phalaenopsis* completed and submitted.

Contents

Introduction

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

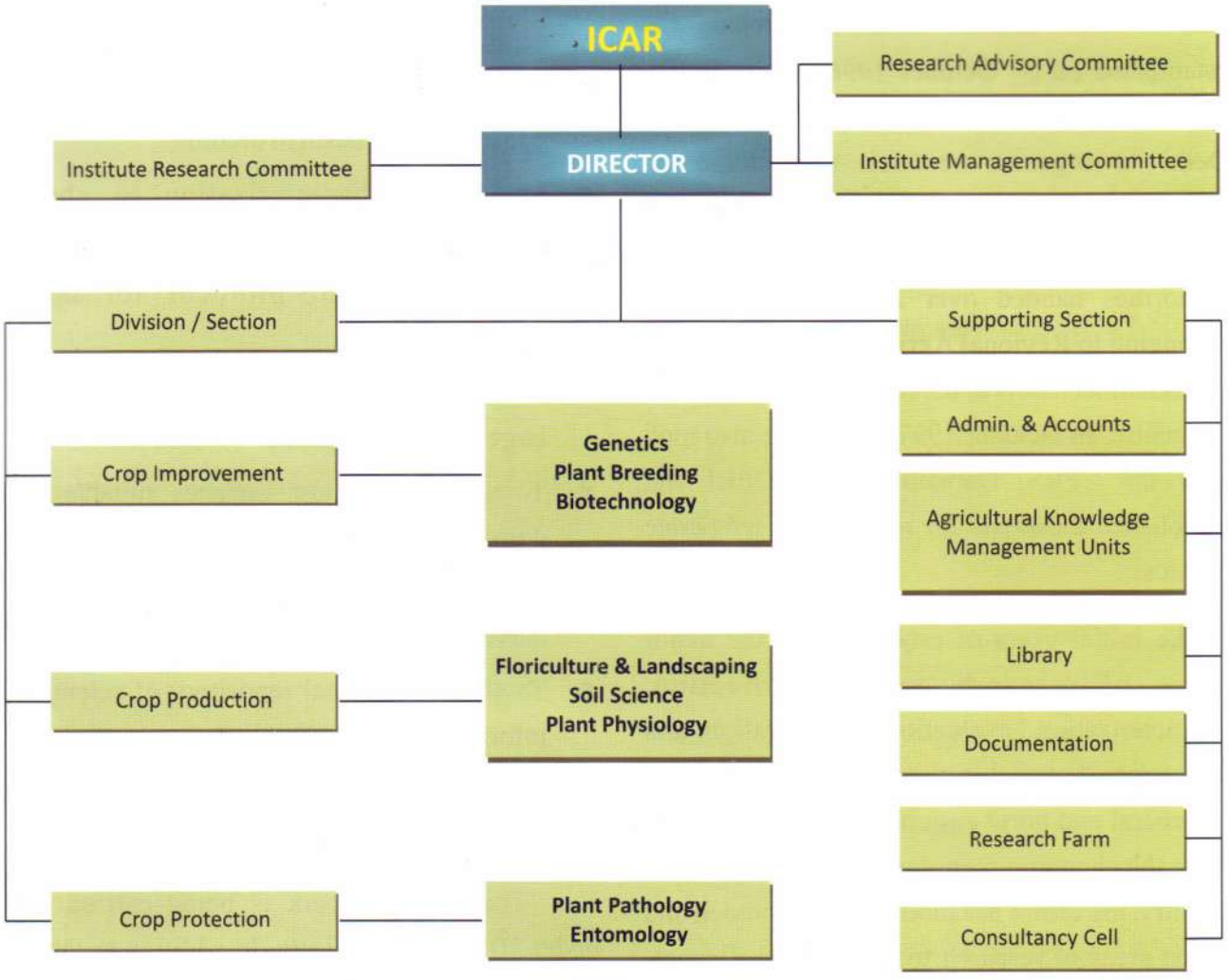
In the initial years of establishment the major focus of research was on collection, characterization, evaluation, conservation and utilisation of available germplasm in the country in general and north eastern region in particular. With the changing scenario of floriculture in the country, the centre has modified its approach and thrust areas of research to meet the challenges. Today, the focus is on development of exportable 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. 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 under 10 institute projects. In addition to these, research work is also being carried out under 5 externally funded projects viz. Horticulture Mission for Northeast and Himalayan States (HMNEH), Network Projects on Distinctiveness, Uniformity and Stability on Orchids (DUS), DBT's Mission for Production of Quality Planting Material and Utilisation for the North East, 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 Committee assist the Director in the matters relating to management and research activities of the Institute. Research on various aspects of mandate crop is conducted in three divisions namely Crop Improvement, Crop Production and Crop Protection. The supporting sections include Administration & Accounts, Agricultural Knowledge Management Units (earlier known to be ARIS Cell), Library, Documentation and Consultancy Cell.

Financial statement

Amount (Rupees)

Head of Account	Plan		Non-Plan	
	Sanctioned	Utilized	Sanctioned	Utilized
Establishment charges	0	0	2,07,58,000.00	2,00,92,951.00
Labour wages	0	0	0	0
Traveling allowances	10,00,000.00	9,99,413.00	2,70,000.00	2,69,959.00
Other charges	1,89,51,000.00	1,89,48,567.00	30,72,000.00	30,49,089.00
Works	95,56,000.00	95,55,638.00	0	0
HRD	4,93,000.00	4,92,932.00	0	0
Total	**3,00,00,000.00**	**2,99,96,550.00**	**2,97,44,000.00**	**2,90,55,999.00**

Revenue generation

Amount (Rupees)

Particulars	Total Amount
Sale of farm produce	6,21,500.00
Sale of tender form	6,000.00
Training	39,000.00
Others	11,97,728.00
Total	**18,64,228.00**

Staff position of the Institute (as on 31.03.2013)

Sl. No.	Category	Sanctioned strength	In position	Vacant
1.	Director	01	01	-
2.	**Scientific Post**			
	Scientist	10	3*	05
	Sr. Scientist	03	4**	-
	Principal Scientist	01	02	-
Total		**15**	**10**	**05**
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**	**09**	**01**
5.	**Supporting Staff (SSG-I, II, III, IV)**	08	06	2***

* One Scientists promoted to Sr. Scientist through CAS & One Sr. Scientist (PB) posted against the post of Scientist (PB)
** One Sr. Scientist promoted to Pr. Scientist through CAS
*** One post has been redeployed to CAZRI, Jodhpur for regularization of SSG till the vacation of the post as per Council order.

Past achievements

Explorations for collection of orchids were conducted in different parts of Darjeeling district of West Bengal and altogether 86 accessions belonging to the genera *Oberonia*, *Dendrobium*, *Pleione*, *Cymbidium*, *Erria*, *Malaxis*, *Tania*, *Liparis*, *Calanthe*, *Bulbophyllum*, *Gastrochilus*, *Coelogyne*, *Plantanthera*, *Odontochilus*, *Neogyne*, *Pholidota*, and *Peristylis* were collected. Apart from collecting orchids from natural habitat, *Paphiopedilum villosum*, *P. villosum* var. boxallii, *P. venustum*, *P. fairrieanum*, *P. hirsutissimum* were procured

from the nurseries located in Darjeeling district of West Bengal and in Shillong, Meghalaya. Five hybrids of *Paphiopedilum* namely *Paph*. Jolly Green Jem Mikkabi x Okayama Fresh 'Fast River', Pacific Ocean Ann x Small World, *Paph* Helas Jim x Vallarrow 'Red Challenge' *Paph*. Silouette 'Chanson' and Startler x Hamana Emy x Teafor Twa were also procured during the year. The molecular characterization of *Vandaceous* orchids collected from different part of country was carried out and 3 species collected from unexplored areas in Darjeeling district of West Bengal have been identified as *Calanthe mannii* Hook f. *Calanthe yucksomnensis* Lucksum, and *Cymbidium cyperifolium* Lindl., which are not recorded earlier from the state and hence they have been reported as new records to the state.

DUS test guidelines of three commercial orchids, *Cymbidium, Dendrobium* and *Vanda* were finalized and notified.

Protocols for micropropagation of orchid species and hybrids were standardized. The improved vegetative propagation methods were developed for rapid multiplication of *Cymbidium* planting stock. The optimum requirement for nutrients, media, water, light, shade etc. were standardized for the *Cymbidium* cut flower production.

The surveys were conducted for the diseases and insect-pests causing damage in the farmer's field as well as in the orchid germplasm at the centre. The causal organisms were identified, epidemiology was studied and control measures were suggested. Similarly, insect-pests causing damage to crops were studied and the management practices were suggested.

The centre has regularly organized training programmes for state govt. officials, extension workers and farmers. The quality planting material of orchids was produced and distributed to the farmers to promote orchid cultivation in the region. The demonstrations were conducted at the farmer's field to encourage farmers for adopting orchid cultivation as a vocation. Nine training programmes on cultivation of orchids were conducted for the orchid growers of Sikkim, Kalimpong and Shillong. The farmers were exposed to latest technology on cultivation and management of orchids particularly *Cymbidium* orchids.

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 127 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 16 journals including 5 foreign journals and 11 national magazines. The institute's publications were made available to more than 200 different organizations in the country.

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

2.1 Research Achievements NRC(O), Main Centre

CROP IMPROVEMENT

DNA Fingerprinting of Commercially Important Orchids

Diversity and genetic relationship analysis of 08 native *Aerides* species using RAPD markers

Eight native *Aerides* species were evaluated to study the diversity and genetic relationship using 65 RAPD primers. A total of 877 bands were obtained of which 99.77% were polymorphic, and only one was monomorphic. The binary data obtained from RAPD were analyzed using NTYSYS software (Fig. 1.), the similarity matrix showed that *Aerides affine* and *Aerides multiforum* are closely related, and *Aerides raceneformis* is distant from rest of the species. The maximum dissimilarity was found between *Aerides affine* and *Aerides raceneformis*. The cluster analysis grouped 7 species in 1 major cluster named C1 and one species separated from other species and form a single cluster C2. The major cluster again forms 2 minor clusters named MC1 and MC2. The minor cluster I (MC1) includes *Aerides affine*, *Aerides multiforum* *Aerides fieldingii* and *Aerides williamsonni*. Minor cluster 2 (MC2) includes *Aerides longicornu* and *Aerides odoratum*. The single species *Aerides ringens* forms a separate cluster. The resolving power of the primers were ranged from 5 – 11.25, the maximum resolving power was 11.25 for the primer OPH C13, the minimum was 5 for the primer OPH D06, the average resolving power was 7.59, the maximum PIC was 0.875, the average PIC was 0.8686. The results indicates that RAPD as a powerful molecular tool for assessment of *Aerides* species diversity and helpful for selection of parents for hybridization programme.

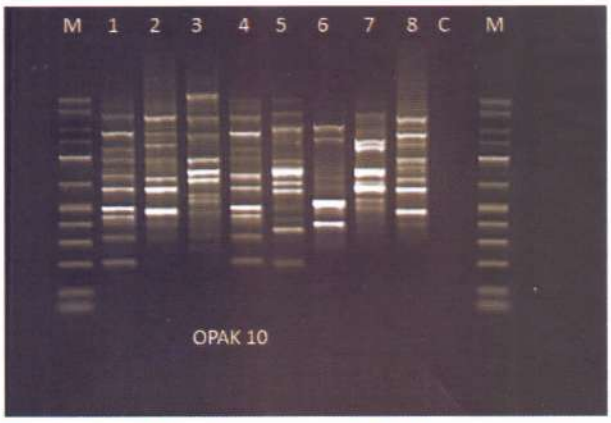


Fig. 1. RAPD Banding pattern of *Aerides* species using primer OPAK-10

Analysis of diversity and genetic relatedness of native *Vanda* species of India using RAPD markers

In all native 18 *Vanda* species, 42 RAPD primers had amplified a total of 2794 loci and produced 724 total bands of which 2.10 % i.e. 11 were monomorphic and 97.90% i.e. 713 were polymorphic in nature. Each species gave uniform amplification to distinguish them and 6-29 bands were scored per primer with an average of 17.23. The PIC value ranges from 0.587 to 0.946. All primers used in this study had the PIC value more than 0.5 which indicates the primers were capable of detecting polymorphism very efficiently (Fig. 2.).

Fig. 2. RAPD Banding pattern of native *Vanda* species using primer OHC-20

Molecular variation and relationship among all native *Vanda* species of India using ISSR markers

Genetic diversity and relatedness of 18 native species of genus *Vanda* were analysed using Inter Simple Sequence Repeats DNA (ISSR) markers. 20 ISSR primers had amplified total 1349 loci and produced 443 bands. Among the bands 0.46% i.e. 2 were monomorphic and 99.54% i.e. 441 were polymorphic in nature. Huge percentage of polymorphic bands indicates the genetic diversity in genus *Vanda* (Fig. 3.). Cluster analysis of all the genotypes was performed using NTSYS software. Maximum genetic similarity *i.e.* 76.99% was recorded between *Vanda cristata* and *Vanda cristata* var. *multiflora* and minimum similarity 4.8% was seen between *Vanda pumila* and *Vanda parishii*. A phylogenetic tree was prepared by using data generated by ISSR scoring and the tree grouped all species in two major clusters C1 and C2 and one single species *Vanda spathulata* was separated from others and formed a separate cluster C3. In major cluster C1, 7 species were grouped whereas in cluster C2, 10 species were grouped. The major clusters were sub divided into four minor clusters MC, MC2, MC3 and MC4. Cluster C1 had 2 minor clusters named MC1 and MC2. In minor cluster MC1, *Vanda alpina, Vanda cristata, Vanda cristata* var. *multiflora, Vanda griffithi* and *Vanda pumila* were grouped and in MC2 *Vanda thwaitesii* and *Vanda weightii* were grouped. The minor cluster MC3 again divided into two sub clusters SC1 and SC2 and one species like *Vanda amesiana* was separated from others. *Vanda parishii, Vanda testacea, Vanda stangeana* and *Vanda roxburghii* were grouped in SC1 and terete leaved *Vandas*, i.e. *Vanda teres* and *Vanda teres var candida* were grouped in SC2. In minor cluster MC4 *Vanda bicolor*, *Vanda coerulea* and *Vanda coerulescens* were laid. The study conclude that, species having same floral characters were grouped in the same cluster and ISSR primers were helpful for to differentiate closely related species.

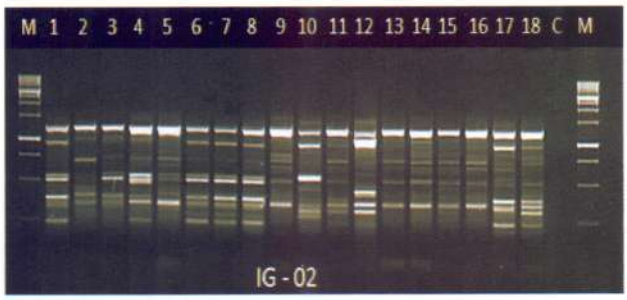


Fig. 3. ISSR Banding pattern of native *Vanda* species using primer IG-02

Intra specific variability analysis of *Vanda cristata* by using RAPD markers

Vanda cristata is an important species of the genus *Vanda* which has been used as parent for developing many hybrids having high commercial value. Intra species floral variability was observed in the population of *Vanda cristata* (Fig. 4.). To study the genetic variability RAPD analysis was performed using 37 decamer primers which produced distinct bands. A total of 351 bands generated by the primers of which 14.24 % i.e. 50 were monomorphic and 85.76 % i.e. 301 were polymorphic in nature. Huge percentage of polymorphic bands indicates genetic variability within the species. RAPD analysis can be applied for determination of intra species genetic variation in Orchids.

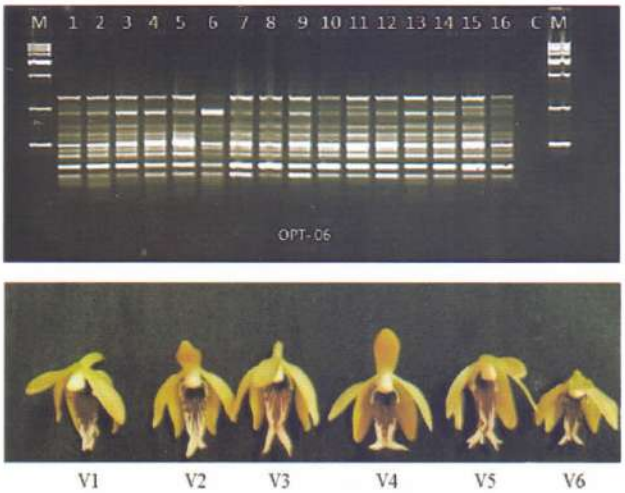


Fig. 4. RAPD Banding pattern of *Vanda cristata* species using primer OPT-06 and floral variation

Modified CTAB method for genomic DNA isolation from fresh matured leaves

A simple low cost modified CTAB method for isolation of high quality genomic DNA from fresh matured leaves of orchids has been developed using 2.5% CTAB and β marcaptoethanol, 1.7% PVP and 1.4M NaCl. Modifications of chemical components of extraction buffer helped in the removal of polysaccharides and secondary metabolites from the DNA. Both the quantity and quality of isolated DNA was higher when compared with the DNA isolated by other available 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.

Hybrid / Varietal Development Programme for Orchids

Genetic enhancement

For generating new variability through hybridization 500 pollinations for 300 crosses were made. The emphasis was given for *Phalaenopsis, Vanda, Renanthera, Coelogyne* and *Cymbidium* (Fig. 5a, 5b, 5c & 5d.). A separate breeding model was attempted using modern hybrids of *Vanda*, *Dendrobium* and *Cymbidium* with native species. A crossing programme for developing scented orchid varieties through breeding methods was also initiated. Among new collections under NAGS the species *Cottonia pendulata*, *Dendrobium heterocarpum* (NAOC#2571), *C. eburneum* (#766) and *C. lancifolium* (#767) were identified.

Fig. 5a. Pod setting in *Dendrobium* crosses

Fig. 5b. Pod setting in *Phalaenopsis* crosses

Fig. 5c. Pod setting in *Vanda* crosses

Fig. 5d. Pod setting in *Cymbidium* crosses

New NRCO hybrids flowered

a. PBX-05-29/2012: The progeny of a cross (*Cymbidium* 'Red Beauty' x *Cymbidium* 'Golden Elf') flowered during September (4th WK) to December, 2012 (Fig. 6 & 7.). It is early flowering and suitable for a potted plant. The plants are medium in size (33.3 to 62.5 cm.) and spike length ranges from 21.5 to 32 cm. Flowers are mildly fragrant and miniature in size of (7 cm x 7.1 cm.). The colour of flower is predominantly greyed orange (RHS 164C to 166B).

Fig. 6. *Cymbidium* 'Red Beauty' x *Cymbidium* 'Golden Elf' (PBX-05-29-2012-2)

Fig. 7. *Cymbidium* 'Red Beauty' x *Cymbidium* 'Golden Elf' (PBX-05-29-2012-4)

b. PBX-05-10/2012: The cross (*Cymbidium* 'Fancy Free' x *Cymbidium* 'Tetraploid Oklahama') flowered during 2nd week of December' 2012 (Fig. 8.). It is suitable for mid season cultivation. The progeny line is uniform and has predominantly white flower colour. The plant height is 45 cm. with inflorescence of 54 cm. Flower size was recorded 9.6 cm. x 9 cm. (sepal to sepal across). The lip size was 4.5 cm. x 3.5 cm. with red purple spots (RHS 59A) with throat colour yellow orange (RHS 14B).

Fig. 8. *Cym.* 'Fancy Free' x *Cym.* 'Tetraploid Oklahama' (PBX-05-10/2012)

c. PBX-05-34/2012: The progeny of cross (*Cymbidium* 'Red Star' x *Cymbidium* 'Fency Free') with variation in colour pattern of yellow to whitish pink flowered during 1st week of February' 2012 (Fig. 9.). The plant height (cm) was observed with a range of 44 - 45 cm with inflorescence length of 47 cm - 55 cm range. Flower size was recorded 8.5 cm x 9 cm (sepal to sepal across). The lip size was 5 cm x 3.4 cm with red purple stripped spots (RHS 60A) with yellow callus.

Fig. 9. *Cym.* 'Red Star' x *Cym.* 'Fancy Free' (PBX-05-34/2013-64)

d. PBX-05-884/2012: The progeny of cross (*Cymbidium* 'Show Girl' x *Cymbidium* 'Red Star') flowered from December to February. This progeny line is mid season

flowering having more number of flowers than other hybrids. The plant height (cm.) ranges between 43 to 47 cm. The plants are medium in size with spike length ranges from 46 to 48 cm. Flowers are mildly fragrant and size of 4 cm. x 3.9 cm. (sepal to sepal across). The flowers are predominantly greyed purple (RHS 185D) to Red group (RHS 54B) with red purple spots (RHS 59A) and yellow callus (Fig. 10a & 10b.).

Fig. 10a.
PBX-05-884/2012-01

Fig. 10b.
PBX-05-884/2012-02

e. PBX-05-57/2012: The cross (*Cymbidium lowianum* x *Cymbidium tigrinum* was flowered during 2nd week of March' 2013, which is similar cross reported earlier (PBx-05-56).

f. The F1 progeny of *A. cathcarthii* x *V. coerulea* flowered during this year, after a gap of one year. The flower observations from both mature plants and keikis were recorded. It was observed that up to 50 % flowers drop during different stages of growth. Out of seven spikes, three dried and the rest were found fresh. The flower size recorded 10.5 cm x 10.5 cm on mature plant and 9.5 cm x 9.5 cm on keikis. The flower were purple violet group (RHS N 80B).

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

Seeds of *Cymbidium tracyanum* x *Cym. elegans* (PBX-11-135 & 138), *Cym.* Pine Clash 'Moon Venus' x *Cym. tracyanum (PBX-11-144), Cym.* Margaret Thatcher x *Cym. tracyanum* (PBX-11-150 & 151), *Cym.* Free Style 'No.3' x *Cym. tracyanum* (PBX-11-154 & 155) were harvested after 11 to 12 months after pollination and cultured on different media *viz.*, MS (Murashige and Skoog), Gamborg (B5), Nitsch (N), Knudson (K) and Linderman supplemented with sucrose (2 %) and BAP (0.2mg/l). The experiment consisted of 15 treatments with 4 replications. The different parameters like days taken for swelling, greening, globule formation and germination were recorded. *Cym. tracyanum* x *Cym. elegans* (PBX-11-135 and 138) responded faster to Nitsch media semi liquid containing 0.2 mg/l BAP which took least number of days for swelling (19 & 18), greening (29 & 27), globule formation (48 & 58) and germination (60 & 75 days) (Fig. 11.). It was concluded that cytokinins at lower concentration are necessary for the better germination of PBX-11-135 and 138.

Cym. Pine Clash 'Moon Venus' x *Cym. tracyanum* (PBX-11-144) responded faster to semi liquid Knudson media supplemented with 2 % Sucrose. The best results with regard to number of days required for swelling (40.5), greening (46.5),

globule formation (62) and germination (72) were recorded on this treatment.

Cym. Margaret Thatcher x *Cym. tracyanum* (PBX-11-150 & 151) responded faster to semi liquid Gamborg's B5 medium supplemented with 2% Sucrose, 0.2 mg/l BAP. The least number of days for swelling (32.5 & 24.5), greening (42 & 29), globule formation (44.5 & 35.5) and germination (53.2 & 42.5) were recorded on this medium (Fig. 12.). The browning of seeds was observed after globule formation in the seeds cultured on Knudson and Linderman media.

Cym. Free Style 'No.3' x *Cym. tracyanum* (PBX-11-154 & 155) responded faster to semi liquid Gamborg's B5 media supplemented with 2% Sucrose + 0.2 mg/l BAP. Thye least number of days for swelling (20 & 23.5), greening (24 & 30), globule formation (30.5 & 36.5) and germination (34 & 49.5) on this medium. Culturing of seeds on Linderman medum delayed seed germination and the turned brown after swelling stage.

Fig. 11. *C. tracyanum X C. elegans* (PBX-11-135) in 15 treatments of different media and hormonal combinations

Fig. 12. *C. "Margarat Thatcher" x C. tracyanum* (PBX-11-151) in 15 treatments with 5 replications each.

Seed cultures of crossed and selfed seed capsules

Seed capsules obtained by crossing (29) and selfing (8) were cultured on different basal media (MS, B5 and Nitsch). Out of total 29 crosses, 14 responded to different culture media and germinated while the rest did not responded to any basal media. Among eight selfed capsules, only four germinated on the selected media while the other did not respond to any media.

Induction of protocorm like bodies (PLBs) from different explants of *Cymbidium* hybrids

Various explants like shoot tips, root tips and leaf sections of seven *Cymbidium* hybrids *viz., Cym.* Soul Hunt-I, *Cym.* Golden Girl, *Cym.* Lunavian Atlas, *Cym.* Sleeping Nymph, *Cym.* Showgirl 'Cooks bridge', *Cym.* Pine Clash 'Moon Venus' and *Cym.* Star Guard 'Mc Angel' were cultured on MS basal media supplemented with 1 mg/l BAP and 0.1 mg/l NAA alone and in combinations. Shoot tip explants showed least number of days required for swelling, greening, callusing and plb induction in MS media supplemented with 0.1 mg/l NAA for *Cym.* Soul Hunt-I, (9, 11, 15 & 19), *Cym.* Golden Girl, (7.5, 11, 16 & 26.5), *Cym.*

Showgirl 'Cooks bridge' (8, 9, 24 & 25), *Cym.* Pine Clash 'Moon Venus' (9, 15, 19 & 30) and *Cym.* Star Guard 'Mc Angel' (7, 16, 14 & 20). However shoot tip explants of *Cym.* Lunavian Atlas (19, 20.5, 21.5 & 27.5) and *Cym.* Sleeping Nymph (10, 12.5, 19 & 32.5) took least number of days for swelling, greening, callusing and plb induction in MS media. .

Leaf explants showed swelling at the basal portion and mass of PLB was formed within 60 days of culture on MS media in *Cym.* Pine Clash 'Moon Venus' However, in other hybrids, the explants turned yellow within one to two weeks of inoculation. Root tip explants procured from *Cym.* Golden Girl, *Cym.* Lunavian Atlas, *Cym.* Showgirl 'Cooksbridge', *Cym.* Pine Clash 'Moon Venus' and *Cym.* Star Guard 'Mc Angel' showed profuse elongation in MS media (Fig. 13.). Root tip explants turned brown in case of *Cym.* Soul Hunt-I and *Cym.* Sleeping Nymph (Fig. 15.). The shoot tip explants gave the best results among explants for plb induction in media supplemented with lower concentrations of auxins (Fig. 14.).

Fig. 13. Profuse elongation of *Cymbidium* 'Soul Hunt' root tips

Fig. 14. Fresh Plbs of *Cymbidium* 'Soul Hunt' from shoot tips used as explants

Fig. 15. Yellowing of *Cymbidium* 'Sleeping Nymph' leaves used as explants

In-vitro flowering in *Cymbidiums dayanum*

In vitro flowering was induced in temperate orchid, *Cymbidium dayanum* for the first time in India. The *in-vitro* flowering plantlets were about 6-10 cm tall, with 3 to 5 leaves. Plantlets produced one inflorescence with an average of 1-2 flowers per inflorescence. The size of flower was found to be about 2 x 2.5 cm. Petals and sepals are clear with a reddish purple column and whitish yellow anther. The 70% of flowering plantlets produced a single flower whereas the remaining produced double flowers. The flowers produced by *in-vitro* techniques are smaller than the normal flowers (Fig. 16a, 16b & 16c.).

Fig. 16a. Conventionally propagated *Cymbidium dayanum*

Fig. 16b. *In-vitro* propagated flower of *Cymbidium dayanum*

Fig. 16c. *In-vitro* flower culture of *Cymbidium dayanum*

Induction of plantlets by sub-culturing PLBs of *Cymbidium* 'Soul Hunt'

In order to induce plantlets from PLBs of *Cymbidium* 'Soul Hunt' a sub-culturing experiment was set up taking MS and VW as basal media with different treatments of lower concentrations of cytokinins (BAP and Kinetin) with or without 2 % sucrose and 4 g/l of gelling agent. The experiment consisted of ten different treatments in a random manner with five replications each. Different parameters like leaf and root primordial initiation; leaflet and rootlet initiation were recorded. The explants in ½ MS with 2% sucrose showed least number of days for leaf primordial initiation (23.4), leaflet initiation (29.6) and root primordial initiation (38.6) and rootlet initiation (42.3).

Means of propagation from internodal sections of flower stalk of different orchid hybrids and species

In order to develop *in-vitro* micropropagation techniques, flower stalks of *Phaius tankervilleae, Renanthera imschootiana, Dendrobium* 'Thongchi gold', *Dendrobium* 'Emma white', *Phalaenopsis* 'AL.AF', *Vanda* 'Bernice Miller' and *Vanda cristata* were used as explants. The explants were cultured on MS media with 2 % sucrose, 4 gm/l Agar supplemented with 1 to 3 mg/l BAP (and 0.1 mg/l NAA alone and with combinations. Out of all the hybrids and species, *Phalaenopsis* 'AL. AF' responded in MS media giving rise to callus like structure at the internode of a single explant (Fig. 17 & 18.). The callus successfully developed into few plbs. Subsequently the plb developed in to plantlet within 68 days of culture initiation.

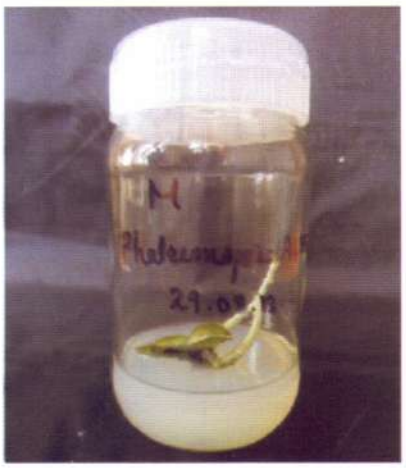


Fig. 17. Development of plantlet from flower stalk of *Phalaenopsis* 'AL.AF'

Fig. 18. Phalaenopsis AL. AF. in-vitro plantlet developed

Induction of shoot lets from *Cymbidium* 'Baltic Glacier Mint Ice'

The PLBs of *Cymbidium* 'Baltic Glacier Mint Ice' were used as explants and cultured on MS basal media with different concentrations of BAP and NAA. The experiment consisted of three different treatments with 3 replications. Profuse root formation took place in case of MS semi-liquid media supplemented with 0.2 mg/l of NAA and 0.05 mg/l of BAP within 23 days of inoculation (Fig. 19.). Shoot primordial (20 days) formation took place in MS media supplemented with 0.5 mg/l NAA and 0.1 mg/l of BAP. The plantlet were developed within 50 days of inoculation in MS media supplemented 0.5 mg/l NAA and 0.1 mg/l of BAP (Fig. 20.).

Fig. 19. Profuse root formation in *Cymbidium* 'Baltic Glacier Mint Ice'

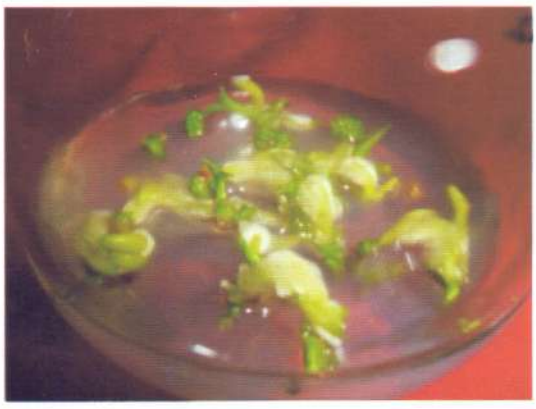


Fig. 20. Shoot initiation in *Cymbidium* 'Baltic Glacier Mint Ice'

In vitro production of Protocorm Like Bodies (PLBs) and multiple shoots from leaf explants culture in an endangered orchid Blue *Vanda* (*Vanda coerulea* Griff ex. Lindl).

To study the effects of BAP and NAA on induction of PLBs from the leaf explants (Fig. 21.), the whole leaf were from 8-month-old axenic seedlings were cultured in solid and liquid MS media supplemented with various concentration of BAP (0.5, 1.0 and 2.0 mg l^{-1}) and NAA (0.2, 0.5 and 1.0 mg l^{-1}) alone or in combinations. The swelling in leaf explants base was observed in 5-9 weeks in all the treatments, however, formation of PLB's occurred only in solid MS media which varied from 9-12 weeks among different treatments. Explants cultured in liquid media swelled but turn brown and died after 60 days. Best result was recorded in solid MS media enriched with the combination of 0.5 mg l^{-1} BAP and 0.2 mg l^{-1} NAA. The results observed the possibility of BAP: NAA in 2:1 ratio enhancing PLB's formation and proliferation. Explants with BAP at any concentration did not respond. The presences of both BAP and NAA in the cultured media seem to be necessary for

PLB's production in blue *vanda* leaf culture. Only BAP:NAA 0.5:0.2 combination treatment gave rise to multiple shoots from the leaf culture (Fig. 22). The rest of treatment showed yellowing and died out.

Fig. 21. PLBs formed at the leafbase of Blue *Vanda* leaf culture

Fig. 22. PLBs formed at the leafbase of Blue *Vanda* leaf culture

CROP PRODUCTION

Development of Integrated Floriculture Enterprise

Seven hybrids of *Cymbidium* namely PCMV, Soul Hunt-6, Ensikhan, Valley Legend Stefi, Sleeping Nymph, Winter Beach Sea Green and Korean-4 (pot plant) are under this experiment. The flowering spike produced by the hybrids as PCMV (1.33) (Fig. 1.), Soul Hunt-6 (1.25), Valley Legend Stefi (1.26), Sleeping Nymph (1.10), Winter Beach Sea Green (1.45) (Fig. 2.), Korean-4 (1.53) and Ensikhan (1.10) per pot. Among the cut flowers the hybrid Valley Legend Stefi produced longer spike (89cm) as compared to others. The potted hybrids Korean -4 produced flower spike of 35cm length. Further, cost benefit ratio of *Cymbidium* cultivation was also calculated and compared with 3 other orchid farms of Assam Lingzey area. The cost benefit ration of NRCO is recorded as 1.80 where as the others ratio was 1.56, 1.60 and 1.43 respectively.

Fig. 1. *Cym.* Winter Beach Sea Green

Fig. 2. *Cym.* Pine Clash 'Moon Venus'

Management of emerging pests in orchids and other flower crops.

Mite, thrips, aphid and two species of scale insect were noticed during growth and flowering of *Cymbidium* hybrids. Among them, aphid and thrips were effectively managed with neem products i.e. neem oil 0.03% EC @ 5ml/lit and NSKE (achook) 1500 ppm @ 5ml/lit whereas, scale insects were managed by alternate application of tobacco extract 5%, econeem 3000ppm 2 ml/lit. and imidacloprid 17.8 SL 0.003%.

Production Management of Tropical and Sub-tropical Orchids

Evaluation of tropical and subtropical hybrids of commercially grown orchids

In *Aranda,* 'Propine Spot', 'Sayan A.B. Gold', 'Majula Ren. Storier', 'AKV Fuch's Delight', Propine White', 'Thailand Sunspot', in *Mokara*, 'Happy Beauty', 'Walter Ouame White', 'Khan Piak Swan Rasri Gold', 'Chark Kuan Orange', 'Madame Pani' and in *Oncidium*, 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,* KS.S.D, Prao Sky Blue, Pures Wax, RBSD Black, PAT-D, Sansai Blue, Motes Indigo Pakchong Blue, Ratch Blue Star were found as promising. In *Dendrobium*, it was possible to get blooms round the year of varying quality with the utilization of 14 number of hybrids. In *Cattleya,* 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, Hsing Ying Fortune were found promising almost round the year except December and January.

Growth, flowering and post-harvest life of *Cymbidium* Pine Clash 'Moon Venus' as influenced by pre- harvest treatments

In *Cymbidium* Pine Clash 'Moon Venus', 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 umber of spikes per plant.

Growth and flowering of *Cymbidium* Levis Duke 'Bella Vista' as affected by pot and potting mixture under organic culture

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: 1g) showed maximum pseudobulb diameter (5.00cm), longest leaf length (69cm) and maximum number of bulbs (5).

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

Out of twelve potting mixtures, cocochips + brick pieces + leaf mould (1:1:1) and cocochips + brick pieces + leaf fern (1:1:1) produced flowers in all plants whereas cocochips + brick pieces + leaf mould (1: 1: 1) yielded maximum number of flowers /peduncle (5) followed by cocochips + brick pieces + rice husk (1: 1: 1) (4).

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

Out of twelve *Dendrobium* hybrids and four potting mixtures, maximum spike length (58cm) and number of florets/spike (22) were recorded with Erika with a potting mixture of cocochips + brick pieces + tree bark (1: 1: 1) followed by 55cm & 15, respectively, in Big White 4N.

Evaluation of terrestrial orchid species

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

Post-harvest Technology of Orchids

Post-harvest life of *Cymbidium* hybrids as affected by different stages of harvest maturity

In *Cymbidium*, out of four different stages of harvest maturity of Miniature hybrid 'Sun Gold', three different stages of standard hybrid 'H.C. Aurora', and three different stages of intermediate hybrid 'PCMV', stage-III (spike length: > 90cm) of standard hybrid had maximum vase life (59 days). Among different types of *Cymbidium* hybrids, vase life ranges from 30-34 days in miniature, 35-37 days in intermediate and 55-59 days in standard hybrids.

Evaluation of *Mokara, Aranda, Vanda* and *Oncidium* Orchid hybrids for vase life

In *Mokara* hybrids, vase life ranges from 17 days (Walter Ouame White) to 58 days (Jitti Orange), *Aranda* from 13 days (Thailand Sunspot) to 45 days (Propine Spot), *Vanda* from 12.5 days (Pat D) to 41 days (*V.* Sirilak x *V.* Thongchai Gold') and in *Oncidium* from 20 days (Taka Yellow) to 38 days (Wild Cat Bob Cat).

Evaluation of *Dendrobium* hybrids at different stages of harvest maturity

At bud stage, out of 12 hybrids of *Dendrobium* evaluated, the maximum vase life was recorded in *D.* Big White Jumbo (45 days) and maximum per cent of fully opened flowers were found in *D.* Kating Dang (45%). At 50 % opened stage, the highest vase life was recorded in *D.* Big White Jumbo (60 days), more than 90% fully opened flowers recorded in *D.* Big White Jumbo, Thongchai Gold and Lervia.

Effect of chemicals on vase life of *Dendrobium* orchids at different stages of harvesting maturity

In *D.* 'Thongchai Gold", at 50% bud opened stage, treatment with 4% sucrose + 100 ppm $Al_2(SO_4)_3$ had maximum vase life (49 days) over control (35 days).

Evaluation of keeping quality of tropical and subtropical orchid hybrids as effected by packing materials (Plastic vials, foam and cotton swabs)

In foam, longevity of cut spikes of *Aranda* ranges from 27 days (Propine spot) to 40 days (Thailand Sunspot), in *Mokara*, from 13 days (Happy

Beauty) to 27 days (Walter Ouame White), in *Oncidium*, 17 days (Taka Yellow), in *Dendrobium*, 9 days (Lervia) to Bangkok Blue (34 days), in *Vanda*, 9 days (Sansai Blue) to Prao Sky Blue (17 days) and in *Cattleya*, 10 days (Queen Sirikhit). In plastic vials, longevity of cut spikes of *Aranda* ranges from 22 days (Propine Spot) to 34 days (Thailand Sunspot), in *Mokara*, from 26 days (Kultana Gold) to 50 days (Happy Beauty), in *Oncidium*, from 20 days (Sweet Fragrance) to 27 days (Taka Yellow), in *Dendrobium*, from 21 days (Erika) to 58 days (Emma White), in *Vanda*, from 27 days (Pat D) to 60 days (Prao Sky Blue) and in *Cattleya* 14 days (Queen Sirikhit).

Effect of packaging materials on post-harvest life of *Cymbidium* hybrid 'PCMV'

Out of five packaging materials used in *Cymbidium* hybrid 'PCMV', highest keeping quality was recorded with cellophane (56 days) followed by 150 gauge polypropylene (54 days) and low density polyethylene (54 days) over control (50 days) without packing. Maximum water uptake was found with control (35ml) followed by newspaper packing (34.2 ml).

Effect of chemicals on longevity of *Cymbidium* hybrids 'PCMV' at different harvest maturity

In *Cymbidium* hybrid, 'PCMV', treatment with 2% sucrose + 100 ppm salicylic acid showed maximum longevity (63 days) of cut spikes in fully opened stage followed by one bud opened stage (62 days) whereas 2% sucrose + 100 ppm $Al_2(SO_4)_3$ had highest longevity of cut spikes (56 days) at two buds opened stage followed by fully opened stage (55.6 days).

CROP PROTECTION

Disease Management of Orchids

Characterization, detection and management of viruses infecting orchids

A. Detection of orchid viruses by reverse transcription polymerase chain reaction (RT-PCR) and Enzyme linked immunosorbent assay (ELISA)

1. Detection of CymMV by RT-PCR

RT-PCR is most widely used technique for the detection of RNA viruses for its high sensitivity and specificity. This technique is thousand time more sensitive than ELISA. 18 *Cymbidium* hybrids suspected with CymMV infection were collected from Ghurpsey, South Sikkim and processed for RT-PCR using the primers designed from CP gene. Total extraction of RNA from infected hybrids was done by standard technique using RNeasy Plant Mini Kit by Qiagen. cDNA synthesis and ds DNA synthesis was performed and PCR amplification was carried out. A single DNA band of about 672 bp was visible in 15 samples after gel electrophoresis, whereas negative samples did not show any visible band. The intensity of the PCR product of various samples varied from faint to bright which may be due to the concentration of viral RNA extracted from the samples (Fig. 1.).

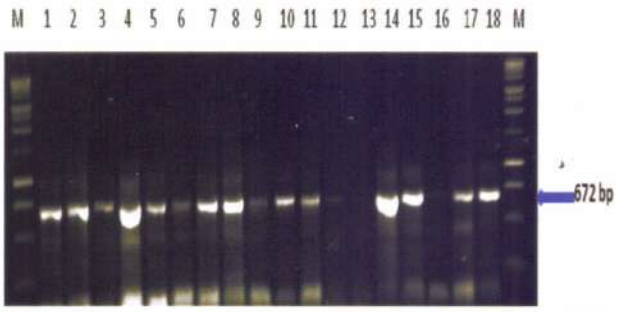


Fig. 1. Agarose gel showing RT-PCR amplification of CP gene of CymMV. M: 1kb ladder, Lane 1 is positive control, Lane 2-12 & 14, 15, 17, 18 are *Cymbidium* hybrids. Lane 13 is negative contro

2. Detection of orchid viruses by ELISA

(i). Survey of *Cymbidium* hybrids for CymMV and ORSV from South Sikkim

A survey was conducted in South Sikkim (Chamchey, Ghurpsey, Damthang, Mainam and Kalikhola) in April 2012 to see the disease and pest problems particularly virus incidence in *Cymbidium* hybrids grown in these areas. Majority of the hybrids grown in these areas were showing mosaic, severe necrosis, black necrotic spots on leaves and flower necrosis. A total 51 samples were collected and checked for CymMV and ORSV by DAS-ELISA test. ELISA results showed that all samples were found positive with CymMV. In addition to this, 10 samples were found positive with mixed infection of CymMV and ORSV. This indicates that majority of the commercial hybrids grown in this region are contaminated with the virus.

(ii). Virus indexing of orchids samples collected from North Sikkim

Twenty nine samples of different orchid species from North Sikkim namely: *Aerides roseum, Arachnanthe clarkei, Bulbophyllum pilulifolium, Calanthe puberula, Coelogyne barbata, C. flaccida, C. nitida, C. viscosa, Cymbidium cochleare, Cym. eburneum, Cym. hookerianum, Cym. pendulum, Cym. whitae, Cym. whitae flower, Dendrobium bicameratum, D. densiflorum, D. gibsonii, D. ochreatum, Eria coronarea, E. vittata, Liparis bistriata, L. lancifolia, Paphiopedellum venustum, Rhynchostylis retusa, Thunia alba, Vanda cristata, V. terrace, Vandopsis* collected in collaboration with BSI, Gangtok, were checked for CymMV and ORSV in ELISA test and the results showed that all the samples were free from viruses.

(iii). Virus indexing of orchid species collected from natural habitat in Rongli, Sikkim

Twenty one orchid species collected from natural habitat from Rongli namely: *Bulbophyllum* sp., *Coelogyne mayeriana, Coelogyne ovalis, Cymbidium pendulum, Dendrobium densiflorum, Gastrochillus acutifolius, Liparis longipes, Papilionanthe* sp. *Pholidota pallid, Rhynchostylis* sp. *Podochilus cultralus* etc. were checked for virus infections. ELISA results showed that *Coelogyne ovalis* and *C. mayeriana* were found positive with CymMV and ORSV respectively while all other samples were found free from viruses.

(iv). Detection of CymMV and ORSV from orchid species collected from Arunachal Pradesh

A survey was conducted in May 2012 to Arunachal Pradesh to collect different orchid species from natural habitats and nurseries. Total 34 samples were collected from different localities and apparently all the samples were

looking healthy and no virus like symptoms were observed. The major species were: *Aerides, Cleisostoma* sp., *Cymbidium pendulum, Dendrobium aphyllum, D. moschatum, D. nobile, Eria* sp., *Luisia* sp., *Rhynchostylis retusa, spathoglottis* sp. etc. DAS – ELISA test confirmed that all the samples were found free from these viruses.

(v). Detection of orchid viruses from orchid samples collected from Mizoram

Orchid species of the genera *Arachnis, Vanda* and *Renanthera* were collected from Mizoram in the month of May 2012 and checked for CymMV and ORSV in DAS-ELISA test. *Arachnis* samples were found free from viruses while *Vanda* and *Renanthera* species were found positive with ORSV.

(vi). Virus indexing of *Phalaenopsis, Vanilla* and *Vanda* hybrids

Ten *Phalaenopsis* hybrids brought from Kerala were indexed for CymMV and ORSV in DAS - ELISA test. The hybrids were: Taida S Red, Ox Prince Thunder, Strawberry, 748 Chain Xen Magpie, Makhi Wantanabe, Memoria Francis Hunter, Ox Plum Rose x Ox Black Jack, Hsin Ying Fortune, Shu Shu Long 1st love and Kaleidoscope. ELISA results showed that hybrid Ox Prince thunder, Hsin Ying Fortune, Shu Shu Long 1st love and Kaleidoscope were infected with CymMV while Taida S Red, Ox Prince Thunder, Strawberry, Makhi Wantanabe, Memoria Francis Hunter, Ox Plum Rose X Ox Black Jack were found positive with ORSV while the hybrid, 748 Chain Xen Magpie was found free from virus infection. Two samples of Vanilla were also checked for viruses in which only samples was found infected with CymMV. Fourteen Vanda hybrids were also checked for viruses in which five samples were infected with the viruses.

3. Studies on orchid fleck virus (OFV) on orchids

Orchid fleck virus (OFV) affected samples of *Coelogyne elata, C. flaccida*, *Pholidota rubra* and some *Cymbidium* sp. collected from Sikkim and Kalimpong (West Bengal), were maintained in polyhouse at NRC orchids, Pakyong, Sikkim. The infected samples were showing chlorotic and necrotic rings and chlorotic flecks on leaves (Fig. 2a & 2b.). The symptomatic leaves were processed for electron microscopy (at IARI, New Delhi) to see the virus particles, if any.

Fig. 2a. Orchid fleck virus (OFV) affected *Coelogyne flaccida* showing chlorotic rings and necrosis

Fig. 2b. *Cymbidium* sp. showing chlorotic flecks due to the infection of OFV

Electron microscopy

Infected leaf samples were prefixed in glutaraldehyde (2.5%) overnight and ground in phosphate buffer (0.07 M, pH-6.5) and microfuged. The leaf extract was placed on carbon coated copper grids (400 mesh) and negatively stained with 2% uranyl acetate (pH-4.5) and examined under Jeol – 1011 transmission electron microscope (TEM).

EM observation showed large number of bacilliform or bullet shaped particle measuring 35 - 40 nm in diameter and 100-140 nm in length from the infected samples. The morphology and structure of these virus particles were similar to that of OFV and OFV- like virions found in several genera of Orchidaceae. Mixed infection of OFV with CymMV and ORSV was also observed (Fig. 3a & 3b.).

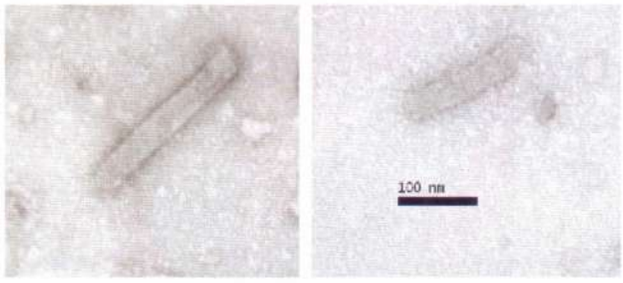


Fig. 3a. EM observation of large numbers of bacilliform particles

Fig. 3b. Electron micrograph showing bullet shaped virus particles of different sizes from *Pholidota rubra*

Mechanical transmission of OFV

Mechanical transmission of OFV was carried out by grinding of infected tissue in 0.01M phosphate buffer (pH- 7.6) in 1:1 ratio (w/v). The extract was filtered through cheese cloth and used for sap inoculation. The test plants used in this experiment were *Datura stramonium, Chenopodium amaranticolor, Nicotiana glutinosa, Dianthus*, *Gazania*, *Antirrhinum*, *Aster* sp. etc.

Nicotiana glutinosa showed veinal flecks and necrotic spots after two week of inoculation. *Datura stramonium* also developed necrotic spots while *Dianthus* sp. showed chlorotic spots (Fig. 4a , 4b & 4c.).

Fig. 4a. Vein flecking and necrotic lesions on *Nicotiana glutinosa* on inoculation with OFV

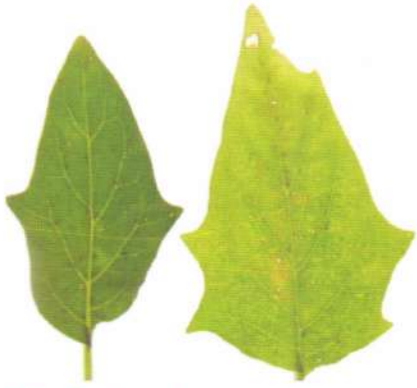


Fig. 4b. Necrotic spots on *Datura stramonium* on inoculation with OFV

Fig. 4c. Chlorotic spots on *Aster* sp

B. Etiology of fungal and other diseases affecting orchids and their Management

1. Characterization and management of black leaf spot disease of *Aranda* and *Mokara* hybrids

Hybrids of *Aranda* and *Mokara* imported from Thailand in 2008-09 to evaluate their performance in Sikkim conditions to exploit them for commercial cultivation. Majority of the hybrids were infected with a black spot disease on leaves and stems. The disease initially appears as small yellow or brown or black spots on the leaves. Under favorable environmental conditions, the spots may enlarge and coalesce to develop blight symptoms on leaves and stem. The incidence of the disease has been recorded from 33 to 100% (Fig. 5a & 5b.).

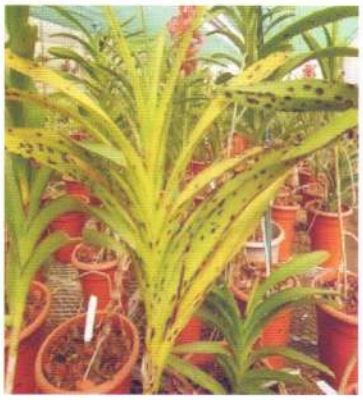


Fig. 5a. *Aranda* hybrid showing black spot and blight symptoms

Fig. 5b. *Aranda* hybrid showing black spot and blight symptoms due to the infection of Pestalotia disseminata

2. Isolation and identification of pathogen

The isolation of the associated fungus was carried out in potato dextrose agar (PDA) medium after proper sterilization of infected leaf discs of 2-3 mm. The fungus was grown in PDA and also on moist filter paper. The cultures as well as specimens were sent to Indian Type Culture Collection (ITCC) at Division of Plant Pathology, Indian Agricultural Research Institute, New Delhi for identification. The pathogen was identified as *Pestalotia disseminata* (I.D. No. 8657.12). The cultural character of the pathogen was observed as light grey coloured mycelium which subsequently turned dark grey (Fig. 6.). The profuse mycelial growth was observed in 25°C ±2. Conidia are multi-celled with usually three darkly pigmented center cells and clear pointed end cells. Conidia are ellipsoid. A diagnostic feature is the two whisker-like appendages arising from the end cell (Fig. 7a, 7b & 7c.).

Fig. 6. Grey coloured mycelia of *Pestalotia disseminata* on PDA

Fig. 7a. Four celled conidia of *Pestalotia disseminata*

Five species of scale insects (ti-scale, *Pinnaspis buxi*; soft brown scale, *Chrysomphalus aonidum*, boisduval scale, *Diaspis boisduvali, lecanium scale, Lecanium* sp. and red scale (*Coccus hesperidum*) were reported to infest on *Cymbidium pendulum, C. aloifolium, C. lancifolium, C. devonianum, C. dayanum* as well as many *Cymbidium* hybrids. Apart from *Cymbidium* it was also noticed on other orchids like *Acampe rigida, Aerides odoratum, Ascocentrum ampullaceum, Bulbophyllum leopardinum, B. elatum, Calanthe triplicata, C. manni, Coelogyne nitida, C. flaccida, C. cristata, C. occhracea, Cleisostoma, Dendrobium nobile, D. aphyllum, D. moschatum, D. chrysotoxum, D. densiflorum, D. thrysiflorum, Liparis, Eria, Papilionanthe, Epidendrum, Phaius, Pholidota, Oncidium, Phalaenopsis* and *Vanda*.

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 its hybrids like *Thongchai Gold, Emma White, Madam Pink, A. Abraham, Bangkok Blue, Arundina* sp., *Epidendrum* sp., *Acampe rigida, Aerides multiflorum, Arachnanthe, Ascocentrum, Chryptochilus, Eria, Gastrochilus* and *Vanda cristata.*

Thrips, *Dichromothrips nakahari* feeds to foliage as well as flowers of many species and hybrids of *Cymbidium* and *Dendrobium, Epigenium, Luisia* and *Phaius* whereas, aphids, *Macrosiphum luteum* and *Toxoptera auranti* were recorded on *Anthogonium* sp., *Acampe rigida, Calanthe triplicata, Coelogyne nitida, Cymbidium* species and hybrids, *Dendrobium nobile, D. densiflorum, D. chrysanthum, D. fimbriatum, Epidendrum* sp., *Phaius tankervilliae, P. flavus* and *Oncidium.* Black weevil, mealybug, lepidopteran caterpillars, grasshopper, yellow beetle and slugs and snails were reported on many orchids during the year in very low population densities. Based on infested material collected, the infestation of above insects was noticed at different level due various abiotic factors during the specified period.

Monitoring of pest infestation on orchids

The constant observations have been recorded at weekly intervals for natural pest infestation on orchid germplasm and hybrids maintained at the National Research Centre for Orchids, Pakyong under controlled conditions in the polyhouses. The following observations have been recorded.

The infestation of "two-spotted" spider mite, *Tetranychus urticae* was reported on above mentioned orchids. Its infestation was present throughout the year at different levels. The maximum population densities of mite were recorded during April- May at most suitable temperature and humidity conditions, whereas, its incidence was negligible during extreme winters (December-January).

Five species of scale insects (ti-scale, *Pinnaspis buxi*; soft brown scale, *Chrysomphalus aonidum*, boisduval scale, *Diaspis boisduvali, lecanium scale, Lecanium* sp. and red scale, *Coccus hesperidum*) were reported to infest on many species and hybrids of orchids. Their incidences were noticed throughout the year at different

levels. Out of 200 plants of *Dendrobium nobile,* 155 plants were found severely infested by *Lecanium* sp. However, 100% infestation by *Diaspis boisduvali* was observed in *Cymbidium* 'WW Wonderous'.

Thrips, *Dichromothrips nakahari* was reported to infest on many species and hybrids of *Cymbidium*, *Dendrobium* and many other orchids from vegetative to full bloom stage. Its incidence was being active throughout the year on orchids grown under controlled conditions. The incidence was more severe during March-August. The total 150 plants of *Cym.* Sleeping Nymph were observed for the infestation of thrips on leaves and it was found that all plants were infested.

Shoot borer infestation was recorded on many orchids i.e. *Dendrobium thrysiflorum, D. nobile, D. aphyllum, D. chrysotoxum, D. moschatum, D. densiflorum* and its hybrids Thongchai Gold, Emma White, Madam Pompadour and Madam Pink at their vegetative stages, which directly affect the flower production and quality. Its infestation was started with the onset of monsoon in middle of May and was continue till September at different damage levels. The total 100 plants of *Dendrobium* hybrid "Thongchai Gold" were observed and 65 plants were found infested, whereas, among 70 plants of "Emma White", 35 plants (50%) were damaged by the insect.

Pest management in *Cymbidium*

Relative efficacy of bio-pesticides based IPM modules against boisduval scale, *Diaspis boisduvali* on *Cymbidium*

The relative efficacy of seven IPM modules against boisduval scale, *Diaspis boisduvali* on *Cymbidium* under polyhouse conditions was evaluated. The seven IPM modules consisting of physical and cultural practices, biopesticides and chemicals *viz.,* M1-sanitation + neem guard 2.5 ml/lit + tobacco extract 5%, M2- garlic extract 5% + ethion 50 EC 0.05% +sanitation, M3-tobacco extract 5% + neem oil 5ml/lit. + fipronil 5 SC 2ml/lit, M4- Nirma solution 3 gm/lit + econeem 3000ppm 3ml/lit. + imidacloprid 17.8 SL 0.003%, M5- datura leaf extract 10% + NSKE (achook) 1500 ppm 5ml/lit. + profenophos 50 EC 1.5 ml/lit, M6- chilaune leaf extract 10% + neem oil 0.03EC 5ml/lit + cow urine 50%, M7- titapat leaf extract 10% + forced water treatment + bifenthrin 10 EC 0.025% were applied at ten days interval from the initiation of pest. Results showed that all the modules were significantly superior over control. The maximum percent reduction (92.55%) in crawler's population was recorded in M4 followed by M3 and M5, whereas M7 was found least effective against this scale.

Relative efficacy of seven IPM modules against aphid infesting *Cymbidium*

The efficacy of seven IPM modules against aphid, *Macrosiphum luteum* in *Cymbidium* under polyhouse condition was evaluated. The seven IPM modules (M1- sanitation + neem guard 2.5ml/lit. + propargite 57 EC 0.25%, M2-sanitation + garlic extract 5% + ethion 50 EC

0.05%, M3- tobacco extract 5% + econeem 3000ppm 2 ml/lit. + imidacloprid 17.8 SL 0.003%, M4- datura leaf extract 10% + NSKE (achook) 1500ppm 5ml/lit. + profenophos 50EC 1.5ml/lit, M5- chilaune leaf extract 10% + neem oil 0.03EC 5ml/lit. + cow urine 50%, M6- titapat extract 10% + forced water treatment + bifenthrin 10 EC 0.25%, and M7- control) were applied at ten days interval from the initiation of aphid on the crop. The results showed that all the modules were found significantly superior over control. Among seven IPM modules, M-3 (tobacco extract 5% + econeem 3000ppm 2 ml/lit. + imidacloprid 17.8 SL 0.003%) was found most effective which reduced 97% aphid population in comparison to rest of the modules. The module M6 was found least effective against aphid.

Evaluation of bio-pesticides against thrips on *Cymbidium*

Eight bio-pesticidal products were tested for the management of thrips, *Dichromothrips nakahari* on *Cymbidium* 'WBSG' under polyhouse conditions. Amongst, two neem products, i.e. neem oil 0.03% EC @ 5ml/lit. and NSKE (achook) 1500 ppm @ 5ml/lit were found most effective, while one wild botanical plant product (chilaune leaf extract) was least effective against this insect.

Organic control of pest complex of *Dendrobium*

Evaluation of bio-pesticides for the management of aphid on *Dendrobium nobile*

A field experiment was conducted to evaluate the relative efficacy of botanical products and biopesticides against aphid on *Dendrobium nobile* under polyhouse conditions. Nine treatments (including control) *viz*., azadirachtin (neem oil) 0.03% EC 5ml/lit., econeem 3000 ppm 2ml/lit., garlic extract 5%, chilaune leaf extract (*Schima wallichii*)10%, datura leaf extract 10%, titapat leaf extract (*Artimessia*) 10%, tobacco extract 5% and cow urine 50% were applied on 6-years old potted plants at 10 days intervals. The results showed that, all the treatments were found significantly superior over control. The highest mortality (78.06%) in aphid population was occurred on the plants treated with econeem 3000 ppm followed by azadirachtin (neem oil) 0.03% EC, whereas, the minimum per cent mortality (42.13%) was recorded on the plants treated with titapat leaf extract (*Artimessia*) 10%. The remaining treatments were found moderately effective against aphid.

Relative efficacy of bio-pesticides against shoot borer, *Peridaedala* sp. on *Dendrobium* 'Thongchai Gold'

The relative efficacy of bio-pesticides against shoots borer, *Peridaedala* sp. on *Dendrobium* hybrid 'Thongchai Gold' was tested under polyhouse conditions. Nine treatments (including control) *viz*., neem oil 0.03% EC 5ml/lit., garlic extract 5%, chilaune leaves extract (*Schima wallichii*) 10%, datura leaf extract 10%, B.t. (Dipel) 0.012%, titapat leaf extract (*Artimessia*) 10%, tobacco extract 5%, and NPV 0.10% were applied on four years old potted plants of *Dendrobium* hybrid 'Thongchai Gold' at ten days interval. The results showed that all the treatments were significantly superior over control. The minimum shoot borer infestation

(5.00%) was recorded on the plants treated with B.t. (Dipel) @ 0.012% followed by neem oil 0.03% EC @ 5 ml/lit and NPV @ 0.10%, whereas, the shoot borer infestations were 7.25 and 7.28 %, respectively at 7 days after second treatments. The treatment of chilaune leaves extract (*Schima wallichii*) and titapat leaf extract (*Artimessia*) were least effective against this insect.

Field evaluation of bio-pesticides against shoot borer, *Peridaedala* sp. on *Dendrobium chrysotoxum*

To evaluate the relative efficacy of bio-pesticides against shoot borer, *Peridaedala* sp. on *Dendrobium chrysotoxum* under polyhouse conditions. Experiment was laid out in Completely Randomized Design (CRD) with three replications. Nine treatments (including control) *viz*., azadirachtin (neem oil) 0.03% EC 5ml/lit., garlic extract 5%, chilaune leaves extract (*Schima wallichii*) 10%, datura leaf extract 10%, B.t. (Dipel) 0.012%, titapat leaf extract (*Artimessia*) 10%, tobacco extract 5%, and NPV 0.10% were applied on potted plants of *Dendrobium chrysotoxum* at ten days interval. The results showed that all the treatments were found significantly superior over control. The minimum shoot borer infestation (6.35%) was recorded on the plants treated with B.t. (Dipel) @ 0.012% followed by neem oil 0.03% EC @ 5 ml/lit and NPV @ 0.10%, whereas the shoot borer infestations were 7.18 and 8.10 per cent, respectively at 7 days after second treatments. The treatment of chilaune leaves extract (*Schima wallichii*) 10% was reported least effective, whereas the remaining treatments were found moderately effective against shoot borer.

Evaluation of botanicals and bio-pesticides against pests of other orchids

Relative efficacy of bio-pesticides and detergent product against lecanium scale, *Lecanium* sp. on *Phalaenopsis* orchid

To test the relative efficacy of bio-pesticides and detergent product against lecanium scale, *Lecanium* sp., nine treatments (including control) *viz*., azadirachtin (neem oil) 0.03% EC 5ml/lit., garlic extract 5%, chilaune leaves extract (*Schima wallichii*) 10%, datura leaf extract 10%, titapat leaf extract (*Artimessia*) 10%, tobacco extract 5%, cow urine 50% and Nirma solution 3gm/lit were applied on *Phalaenopsis* plants at 10 days interval. The results showed that all the treatments are significantly superior over control. The maximum per cent reduction (57.20%) was recorded in the treatment of neem oil 0.03 EC followed by Nirma solution reduced 56.18 per cent crawlers population of this scale, whereas, minimum per cent reduction was reported in titapat leaf extract. Remaining treatments were recorded moderately effective against this insect on orchid.

Phytotoxicity of azadirachtin (neem oil) 0.03% EC on flowers of *Dendrobium* hybrid "Thongchai Gold"

To evaluate the phytotoxicity of different doses of neem oil 0.03% EC @ 2.5, 3.5, 5.0, 7.5 and 10 ml per litre of water on the flowers of *Dendrobium* "Thongchai Gold" at full bloom stage. It was found that, there were no phytotoxic symptoms observed by the neem oil 0.03% EC @ 2.5 to 5.0 ml/litre of water on partially opened and full

bloom flowers. The small irregular shaped burning symptoms were observed on the sepals and patels of flowers, when it applied at higher dose @ 7.5 and 10 ml/litre of water.

Phytotoxicity of Econeem 3000 ppm on flowers of *Dendrobium* hybrid "Thongchai Gold"

To evaluate the phytotoxicity of different doses of econeem 3000 ppm @ 1.0, 2.0, 3.0, 5.0, 7.5 and 10 ml/litre at bud and full bloom stage on *Dendrobium* 'Thongchai Gold' under laboratory conditions. The results showed that, no phytotoxic symptoms were observed by econeem 3000 ppm @ 1.0 to 5.0 ml/lit., however, small irregular shaped, dark brown spots were seen on flowers when applied at higher dose @ 7.5 ml/lit. The application of econeem 3000 ppm @ 10.0 ml/litre was reported complete burning symptoms on whole flower and spoiled earlier than the flowers treated with lower doses.

2.2 Research Achievements
NRC(O), Darjeeling Campus

Collection, Characterization, Evaluation, Multiplication and Conservation, of High Altitude Orchid Germplasm

Germplasm collection

A total of 127 accessions belonging to 51 species were collected from different parts of Darjeeling district during the reported period. The collected species belong to the genera like *Agrostophylum, Aerides, Anoectochilus, Anthogonium, Ascocentrum, Otochilus, Bulbophyllum, Calanthe, Coelogyne, Cymbidium, Dendrobium, Diplomeris, Eria, Gastrochilus, Goodyera, Habenaria, Liparis, Lucia, Microstylis, Oberonia, Phaius, Pleoine, Rhynchostylis, Satyrium, Sunipia, Tania, Vanda, Vandopsis* etc. A natural habitat of the endangered terrestrial species *Cymbidium lancifolium* was found out during the exploration. Soil samples of this habitat were collected and were analyzed for primary soil properties.

Morphological Characterization

The collected species such as *Calanthe yucksomnensis, C. biloba, C. herbacea, C. puberula, C. plantagenea, Coelogyne nitida, C. corymbosa, C. nitida, C. occultata, C. ovalis, C. barbata, Cymbidium elegans, C. cyperifolium, C. erythraeum, C. gammieanum, Spiranthes sinensis, Otochilus albus,* were characterized morphologically for their proper indemnification.

Promising Germplasm Identified

One genotype of *Cymbidium lowianum* has been identified for its floriferoursness (21-33) and sturdy stem (>1 cm) and one genotype of *Paphiopedilum villosum* has been identified as promising parents for future breeding programme for its white margin around the dorsal sepal.

Value addition

Sixty progenies of a cross (*Cym* Sleeping Nymph 'Glacier'x *Cym lowianum*) flowered during the current year of which 3 clones were found to be suitable for cut flower production and 1 as potted flowering plant. These clones were selected for registration (Fig. 1.). The average data of selected clones (first flowering) are given as below:

Morphological characters	NRCODC/CMYH/1/6/21	NRCODC-CMYH/1/6/23	NRCODC-CMYH/1/6/29	NRCODC-CMYH/1/6/11
Plant height (cm)	48.1	55.6	57.6	47.95
Pseudobulb length (cm)	8.85	13.3	11.5	7.35
Pseudobulb diameter (cm)	3.68	6.26	5.03	3.97
Leaf number	6.5	6.5	9	6.5
Leaf length (cm)	74.05	72.5	73.4	70.8
Leaf width (cm)	2.85	2.85	2.8	3.35

Leaf colour	RHS 146 A	RHS 146 A	RHS 135 A	RHS N 137 A
Bract Number	9.5	10	11	9.5
Inflorescence length (cm)	58.6	64.95	79.9	45.9
Inflorescence diam. (mm)	7.57	7.05	8.72	7.65
Stalk colour	RHS 144A	RHS 144A	RHS 153 D	RHS 145 B
Raceme length	21.8	22.15	35.3	15.75
Flower number	6.5	6.5	11	5.5
Flower size (cm)	12.93	12.32	11.92	12.84
Petal & Sepal colour	RHS N144A	RHS N144A	RHS 153 A	RHS 153 C
Lip colour	RHS 150 D	RHS 2C	RHS 153 D	RHS 153 D
Lip markings	RHS 46 A	RHS N 34 A	RHS 46 A	RHS 53 A

Fig. 1. Showing selected clone of a cross *Cym* Sleeping Nymph 'Glacier'x *Cym lowianum* (1),NRCODC/CMYH/1/6/21, (2) NRCODC-CMYH/1/6/23, (3) NRCODC-CMYH/1//6/29 and (4) NRCODC-CMYH/1/6/11

A cross between *Cymbidium lowianum* and *Cym* Showgirl 'Coocksbridge' flowered during the current year (Fig. 2.). The detailed morphological characters of selected cross (NRCODC/CMYH/2/6/2) are given as below:

Plant height (cm)	**Pseudobulb length (cm)**	**Pseudobulb diameter (cm)**	**Leaf number**
38.4	8.2	2.71	7
Leaf length (cm)	**Leaf width (cm)**	**Leaf colour**	**Bract number**
64.7	2.2	RHS 146 A	9.5
Inflor. length (cm)	**Inflor. diameter (mm)**	**Stalk colour**	**Raceme length**
33.5	5.60	RHS 144 A	12.6
Flower number	**Flower size (cm)**	**Petal & sepal colour**	**Lip colour**
5	8.6	RHS 46 A on RHS 150 D background	RHS YG 11C flushed with RHS RPG 65A
Lip markings	-	-	-
RHS 59 A	-	-	-

Fig. 2. Showing selected clone of a cross *Cymbidium lowianum* and *Cym.* Showgirl 'Coocksbridge' (NRCODC/CMYH/2/6/2)

Ex-vitro seed germination in (*Paphiopedilum villosum*)

Fully mature seeds of *Paphiopedilum villosum* were sprinkled around the plants as *ex vitro* terrestrial orchid seed germination. Germinating seeds were photographed and measured during various stages of growth. The histological studies revealed the presence of mycorrhiza in roots and protocorms. The study would lead to isolation and identification of mycorrhiza which would be useful in hardening and further use of mycorrhiza in germination of *Paphiopedilum* orchids where the rate of germination is poor.

Study of variability among *Cymbidium tracyanum* accessions using RAPD markers:

Twenty four accessions of *Cymbidium tracyanum* which were collected from different parts of Darjeeling district of West Bengal were evaluated with 65 RAPD markers. Out of the 65 markers, 17 were monomorphic and 48 markers displayed varying degree of polymorphism. The extent of polymorphism was low to moderate for these 48 primers. Overall genetic dissimilarity among the genotypes was also low. Few accessions were similar for all the primers indicating presence of clones among the accession. For few accessions, unique/rare bands were also identified. Two major clusters were formed by these 24 accessions. One RAPD primer, namely 'OPHE-05' displayed a very unique banding pattern of only two amplified loci and also clearly distinguished the genotypes in two different clusters. The amplified products of this primer need to be cloned and further sequenced for development of reproducible SCAR marker. In earlier studies using morphological and flowering traits, the 24 genotypes were found to belong in three horticultural variant types. The combined information from both the sources may be used for identification of a sub-set of accession of *Cymbidium tracyanum* representing the significant variability (Fig. 3.).

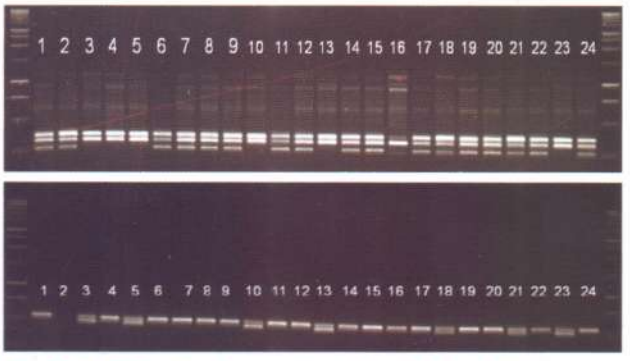


Fig. 3. RAPD gel photographs of the 24 *Cymbidium tracyanum* genotypes represented by HAA-18 and OPHE-05 primers along with DNA ladders at both sides

Collection and introduction of exotic *Cymbidium* hybrids

A total of 30 *Cymbidium* hybrids were collected during the reporting period from the different parts Darjeeling and Sikkim which were already under cultivation among the farmers. These hybrids were also checked for their parentage and 25 of them were found to be registered hybrids as per the denominations available. These will be further utilized in hybridization programme.

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 2012-13	Achievements 2012-13	Short fall (if any)	Reason for Shortfall	Distribution of planting materials
Orchid	Cymbidium (7 hybrids) Cattelya hybrid	Tissue culture	8,000	3,000	5,000	Old PLBs	Distributed during training programmes

Programme II: Standardization of production and protection technologies

1. Water management of orchids (*Dendrobium* 'Emma White')

The experiment was conducted to study the water requirement on growth and flowering of *Den.* Emma White. The treatment consisted of I_1-50 ml/pot, I_2-100 ml/pot, I_3-150 ml/pot, I_4-200 ml/pot, I_5-250 ml/pot and I_6-300 ml/pot (Fig. 1.). The irrigation was applied at 10 days interval. Moisture content of stem, leaf, back bulb, vegetative and flowering characters and vase life were recorded. The maximum moisture content of stem (96%), leaf (94%) and back bulb (97%) was recorded at I_6-300 ml/pot. 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 (40.2cm). The vase life was positively influenced by watering.

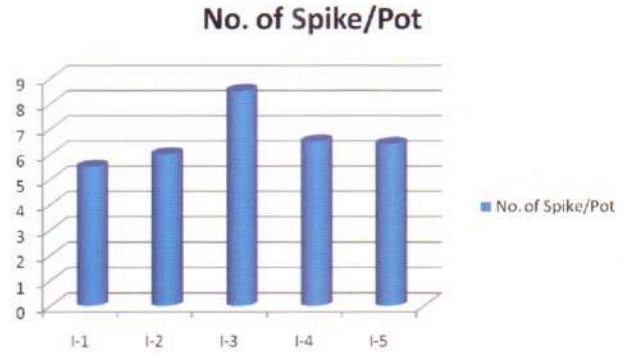


Fig. 1. Effect of watering on flower spike production in *Den.* 'Emma White'

2. Postharvest management of *Den.* Thongchai Gold

The experiment was conducted to increase the post harvest life of *Dendrobium*. The experiment consisted of five treatments with combination of different concentration of Sucrose, $AgNO_3$, STS, $Al_2(SO_4)$ and Hydroxyquinoline Sulphate (8HQS). Uniform spikes (25cm) with 75% opened floret of *D.* Thongchai Gold were selected for the experiment.

It was recorded that spike treated with 4% Sucrose+ 0.05% $AgNO_3$ enhanced the vase life by 5 days as compared to control (16 days). Further, treating with 4% Sucrose+

Programme III: Technology refinement and imparting trainings

Sl. No.	Title of Training/Demonstration	Target 2012-12	Achievements 2012-13	No of participants
1.	On campus & Off campus training	4	3	83
2.	Farmers field demonstration	9	10	172

Fig. 2. Farmers of Sikkim participating in on campus training at the institute

STS (0.01%) and 4% Sucrose+8HQS (0.01%) enhanced the vase life by 4days.

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

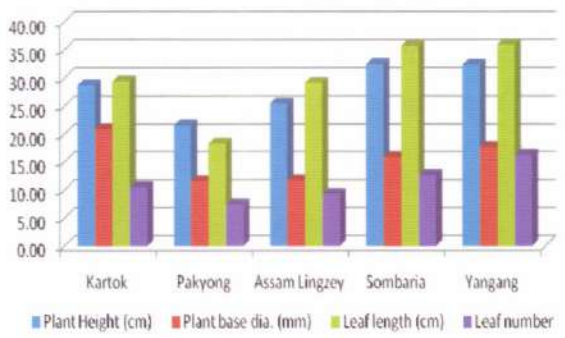
Ten hybrids of *Oncidium*, 8 hybrids of *Cattleya* and 10 hybrids of *Phalaenopsis* maintained under DUS project on orchids. DUS Test guidelines of *Phalaenopsis* and *Cattleya* (Orchid Task Force, 2011) submitted to PPV & FRA during 2012 and published in Plant Variety Journal of India. Morphological descriptors of *Paphiopedilum* (76) and *Oncidium* (60) were also developed.

DBT's Mission for North-East for Quality Planting Material and Utilisation for the North East.

Performance of *Cymbidium* cultivars in different location of Sikkim

Cymbidium 'Levis Duke Bella Vista'

The cultivar showed significant dissimilarity among vegetative as well as reproductive parameters recorded from the plants grown under different locations. The highest plant height, longest leaf length and maximum number of leaves were observed under Yangang conditions followed by Sombaria during two consecutive years. This cultivar performed very poorly under Pakyong conditions. The plants of this cultivar grown under Sombaria and Yagang conditions flowered early (Fig. 3.).



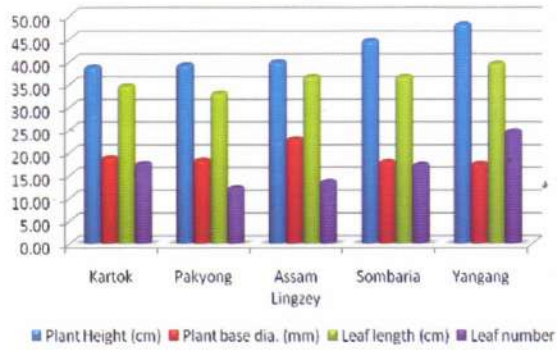


Fig. 3. Plant growth characterstics of Levis Duke 'Bella Vista' under five locations of Sikkim during two consecutive year

Cymbidium 'Burgundian Sydney'

*Cym.*Burgundian Sydney also showed a significant difference in various growth parameters recorded to assess the performance under different locations. The greatest plant height, longest leaf length and maximum leaf number were recorded from the plants grown in Yangang. However, the plant base diameter and length of leaves found highest in the plants grown in Kartok and Sombaria, respectively. During the second year, the plants of this variety grown in Yangang, Sombaria, Assam Lingzey did not so much difference with respect to plant height. But, a significantly less height was observed in plants grown in Kartok. The plant base diameter was found maximum in Assam Lingzey followed by Pakyong. The highest leaf length and number of leaves recorded in plants Yangang, Sombaria and Assam lingzey but did not differ significantly. The leaf number were where maximum grown under Yangang conditions (Fig. 4.).

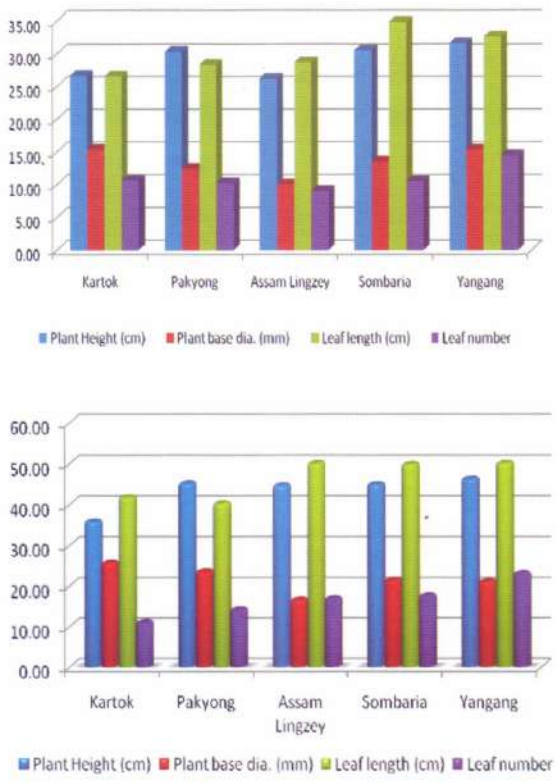


Fig. 4. Plant growth characterstics of *Cym.* Burgundian Sydney under five locations of Sikkim during two consecutive year

Cymbidium Margaret Thatcher

The best performance of this variety was observed in Yanyang. All the vegetative characters like plant height, plant base diameter, leaf length and leaf number were recorded highest in this location as compared with the other locations. During the second year, this variety performed well in Pakyong and Kartok. The performance of this variety in other two locations Assam Lingzey and Sombaria was not very satisfactory. In Yangyang, this variety flowered at the end of third year. Nearly 30% plants flowered, and remaining is expected to flower during the next year (Fig. 5.).

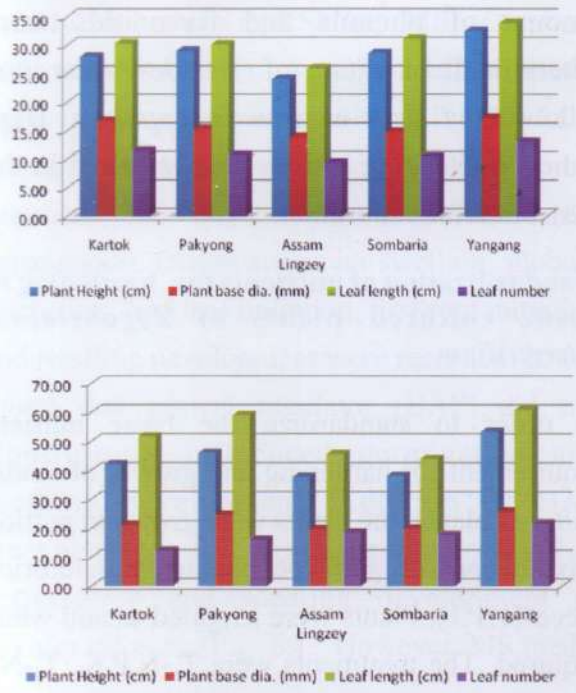


Fig. 5. Plant growth characterstics of *Cym.* Margaret Thatcher under five locations of Sikkim during two consecutive year

Cymbidium Vivacious Super white

Cym. Vivacious 'Super White' also showed a significant difference in various growth parameters recorded to assess the performance under different locations. The greatest plant height, longest leaf length and maximum leaf number were recorded from the plants grown in Yangang. However, the plant base diameter and length of leaves found highest in the plants grown in Kartok and Sombaria, respectively. During the second year, the plants of this variety grown in Yangang, Sombaria, Assam Lingzey did not so much difference with respect to plant height. But, a significantly less height was observed in plants grown in Kartok. The plant base diameter was found maximum in Assam Lingzey followed by Pakyong. The highest leaf length and number of leaves recorded in plants Yangang, Sombaria and Assam lingzey but did not differ significantly. The leaf number were where maximum grown under Yangang conditions (Fig. 6.).

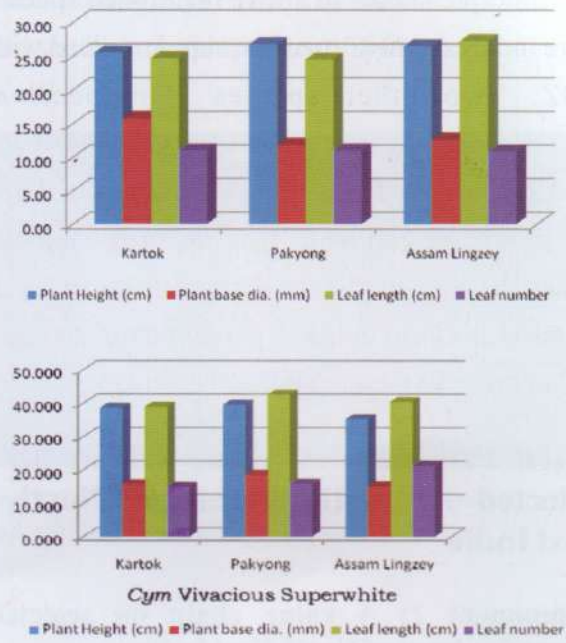


Fig. 6. Plant growth characterstics of *Cym.* Vivacious 'Super White' under five locations of Sikkim during two consecutive year

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

Propagation protocol through seeds for two species of *Paphipedilum* (*insigne* and *villosum*) was established. The seeds of these species can be germinated on BF medium followed by sub culturing them on NC medium supplemented with BAP (0.4 & 0.6 mg/lit) for three months. The obtained plantlets were hardened off on saw dust as potting medium. The meristem derived from the shoot and root tip of in vitro grown produced PLB when cultured on BF (N3) medium supplemented with 5mg/lit NAA and 1 mg/lit BAP. We succeeded in initiating callus from the leaves of *in vitro* grown plantlets, but the callus

could not be maintained on the same medium. Generally *paphs.* do not produce multiple shoots. The multiple shoots in above mentioned species were induced on NC medium supplemented with TDZ. Two other species *Paphipedilum* (*hisutissimum* & *venestum*) were sib mated for seed formation. The seed pods are likely April and would be cultured. The cultures could be initiated using meristem derived from *ex vitro* plantlets because cultures get contaminated and higher doses of sterilant killed the explants.

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

Antioxidant activities of two selected aromatic orchids of India

The present study was undertaken to find the antioxidant activities of two important aromatic orchids of India. Antioxidants have been reported to prevent oxidative damage caused by free radical and can be used in cardiovascular and anti-inflammatory diseases. Methanolic extract from stems and leaves of *Aerides odoratum* and *Acampe papillosa* were evaluated for their total polyphenol, total flavonoid and antioxidant properties. Free radical attenuating abilities of stem extracts were ascertained by 2, 2- diphenyl 1-picryl hydrazyl (DPPH) radical scavenging assay. The DPPH scavenging potential of the aqueous extracts of the plants ranged from 25%-86%. The highest inhibition of DPPH radical was observed in the aqueous extract of *Aerides odoratum* followed by *Acampe papillosa.* Major amount of phenols and flavonoids were determined in stem of *Aerides odoratum* followed by stem of *Acampe papillosa*. High radical scavenging activity was observed in the stem of *Aerides odoratum*.

Standardization of nutrients for hardening of tissue cultured plants of *Zygopetalum intermedium*

In order to standardize the basic nutrient requirement for hardening and growth of *tisuue cultured* plants, the plants were grown in potting mixture consisting of cocopeat:leaf mould:brick pieces(1:1:1). Plants were irrigated as and when required. The treatments were T_0-$N_0P_0K_0$, T_1-N_{25} $P_{10}K_{10}$, T_2-N_{50} $P_{10}K_{10}$, T_3-$N_{75}P_{10}K_{10}$, T_4-$N_{100}P_{10}K_{10}$ and T_5-N_{125} $P_{10}K_{10}$. Nutrients were applied at weekly interval. The highest mortality (47%) was recorded in control whereas it was least (25%) in plants sprayed with N_{75} $P_{10}K_{10}$. It was recorded that application of N_{125} $P_{10}K_{10}$ produced longer plant (6.36cm) and more number of leaves (7.0) (Fig. 7.).

Fig. 7. Effect of nutrient on growth of *Z. intermedium* plantlets

1. Asymbiotic germination of *Aerides odorata*

To standardize culture media for seed germination and seedling development of *Aerides odorata*, three tissue culture media

namely Murashige and Skoog (MS), Gamborg (B5) and Nitsch (N) were studied.The media were supplemented with or without BAP (0.5 and 1.0mg/l) along with sucrose (20g/l). Matured capsule, 150 days old was selected for germination. Observations on swelling, globule formation, first leaf initiation, first root initiation and seedling development were recorded. It was found that growth regulator (BAP) did not significantly influenced germination and seedling development. Addition of BAP irrespective of concentration delayed germination and seedling development of *Aerides odorata* (Fig. 8.). However, MS media without BAP had taken least days for swelling (70 days), globule formation (75days), first leaf initiation (94 days), first root initiation (115 days) and seedling development (161 days).

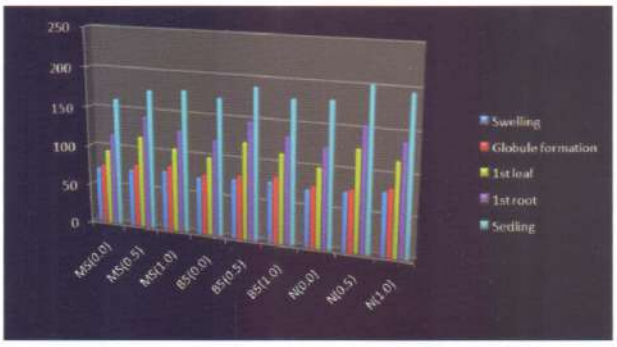


Fig. 8. Effect of media and PGR on seed germination and seedling development of *Aerides odorata*

Technology Assessed and Transfered

3

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

Training Programme

Date	Topic	Number of Participants	Category of Participants	Venue
3rd - 4th May, 2012	1st Meeting of Orchid Task Force for preparation of DUS test guidelines in *Phalaenopsis* and *Cattleya*	-	Chairman, Members, Registrar and Deputy Registrar, PPV & FRA	Regional Office, PPV & FRA, A AU, Khanapara campus
26th - 28th April, 2012	Commercial Cultivation of Orchids	25	Farmers	Krishi Vigyan Kendra, West Siang, ICAR, Basar
3rd - 7th July, 2012	Production and Management of Orchids	16	Officials participated in the training	NRCO
1st Sept. - 31th Dec., 2012	Four months training on "Tissue culture"	01	A student from Kalimpong (West Bengal)	NRCO
17 th - 29th Sept., 2012	Tissue culture in Orchids	02	One Assistant Professor and one SRF from Graphic Era University, Uttarakhand	NRCO
19th - 26th Sept., 2012	Model Training Course on "Conservation of Orchids"	18	Officials from different state	NRCO
26th Nov. - 3rd Dec., 2012	Model Training Course on "I PM in Floriculture"	20	Officials from Chhattisgarh (02), Kerala (02), Meghalaya (02), Mizoram (03), Odisha (03), Uttarakhand (05) and Sikkim (03)	NRCO
1st Jan. - 30th June., 2013	Six month training on "Molecular characterization of orchids"	01	Post Graduate students	NRCO
14th - 18th Jan., 2013	Commercial Cultivation of Orchids	15	Officials including two progressive farmers from Uttarakhand	NRCO
22nd - 24th Jan., 2013	Commercial production and post harvest management of tropical and temperate Orchids	49	Farmers from East, South and West Sikkim	NRCO
21st March, 2013	One Day Training-cum-Awareness Programme on PPV & FR Act, 2001	95	Chairman & Members, Task Force, Scientists of ICAR Manipur Centres, Scientists and Centre for Orchid Gene Conservation of Eastern Himalayan Region, Manipur.	Sylvan KVK/ FEEDS, Senapati Distt. Manipur
26th March, 2013	Kisan Diwas / Farmer's Day	100	Farmers from different parts of Sikkim like Damthang, Kartok, Sombaria, Yangang and Pakyong	NRCO

"Commercial cultivation of orchids" at Basar, A.P.
(26th -28th April, 2012)

"Production and management of orchids"
(3rd to 7th July, 2012)

Model Training Course on 'Conservation of orchids'
(19 – 26th September, 2012)

Model Training Course on "IPM in floriculture"
(26th Nov., – 3rd Dec., 2012)

"Commercial cultivation of orchids"
(14th to 18th January 2013)

"Commercial production and post harvest management of tropical and temperate Orchids"
(22nd to 24th January 2013)

EDUCATION & TRAINING 4

Scientist

Five days training on "MDP in Agricultural Research" at NAARM, Hyderabad from 3 – 7th December, 2012.

D. Barman & L. C. De

Five days training of "387th Gahan Hindi Karyashala" conducted by Department of Official Language, Ministry of Home Affairs, and Government of India" at Prithviraj Road, New Delhi from 4 - 8th February, 2013.

N. K. Meena

Five days training of "Gahan Hindi Karyashala" at Central Hindi Training Institute at New Delhi from 7 – 11th January, 2013.

Rampal

Administrative

Twenty Third Hindi conference & workshop organized by Rajbhasa Avam Prabandhan Vikas Sanstha, New Delhi in Goa from 6-8th November, 2012.

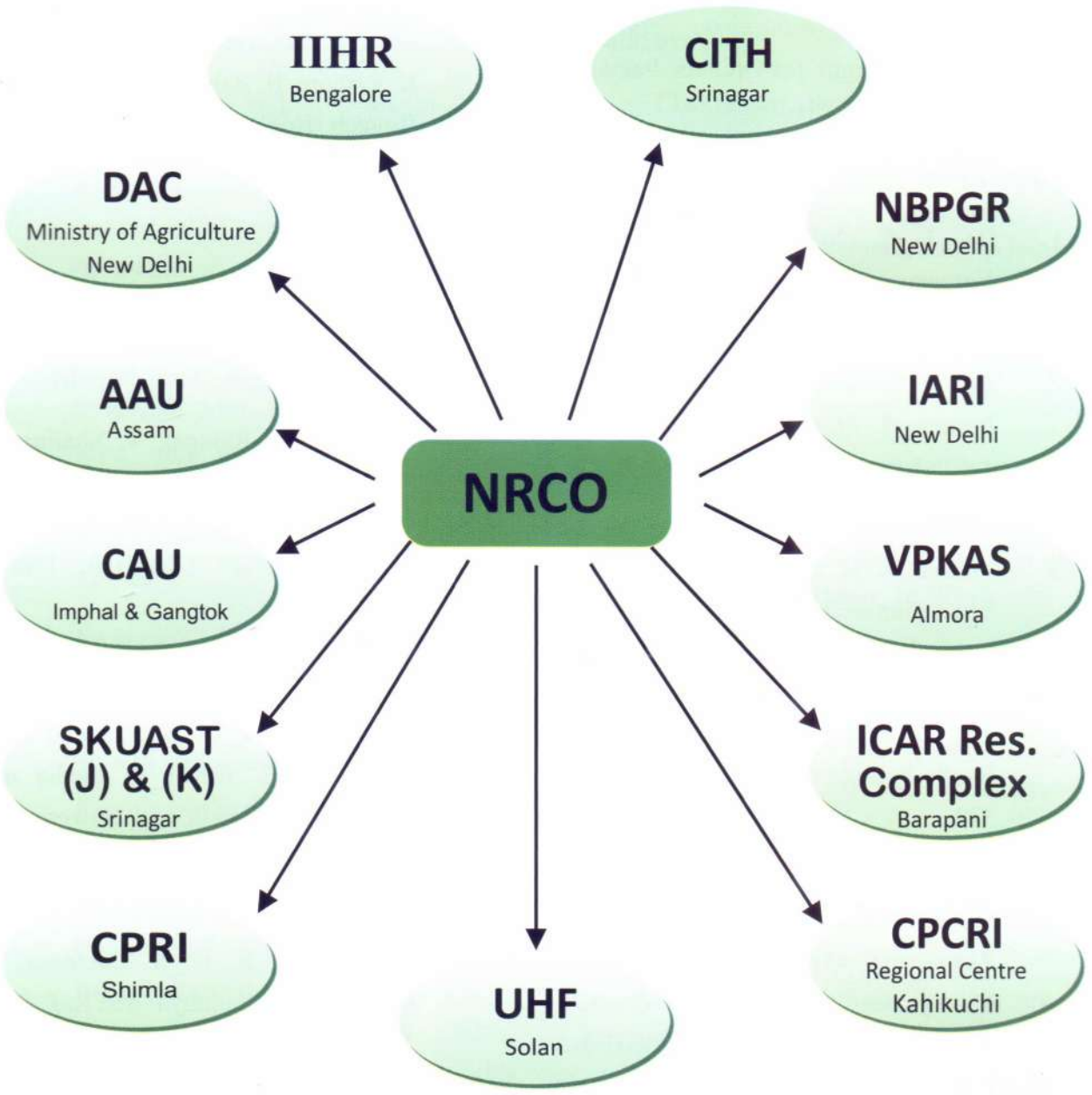
W. Stella Sasa & Sangita Lepcha

Five days training of "387th Gahan Hindi Karyashala" conducted by Department of Official Language, Ministry of Home Affairs, and Government of India" at Prithviraj Road, New Delhi from 4 - 8th February, 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

Books

1. Meena., N. K., R. P. Medhi and Rampal. 2012. *Orchids: Predhashya Avanm Uttapadan Prodhaugiki*. National Research Centre for Orchids, Pakyong, Sikkim, Pp: 1 - 216.

Book chapter

1. De., L. C., 2013. Orchidscaping. In: *Nursery and Landscaping*. Pointer Publisher, Jaipur, Rajasthan. Pp: 248.

2. De., L. C., 2012. Orchid Garden. In: *Handbook of Gardening*. Aavishkar publishers & Distributors, Jaipur, Rajasthan. Pp: 178.

3. Meena., N. K. and R. P. Medhi. 2012. Bio-rational Pests Management in Floricultural Crops. *Biotechnological and Bio-rational Approaches for Pests and Disease Management*. Biotech Books Publisher, New Delhi, Pp: 346-379.

4. Pant., R. P., N. K. Meena and R. P. Medhi. 2012. Emerging Diseases and Pests of Orchids and Their Management. In: *Sikkim Biodiversity, Significance and Sustainability*. (Eds.) P. Tamang, A. K. Srivastava and Sonam Lepcha. Sikkim State Council of Science & Technology, Gangtok, Sikkim. Pp: 110 - 127.

5. Pant., R. P and R. P. Medhi,. 2012. Advances in orchid disease management. In: *Biotechnological and Biorational Approaches for Pest and Disease Management*. (Eds). H. Kalita, K. Kishore, H. Rahman, and L. Chatlod, Biotech Books, Ansari Road, Darya Ganj, Delhi.

Pamphlet / Folder

1. Barman., D., Rampal, V. Shalini, H. Pokhrel and R. P. Medhi. *Fragrant Orchids*. (English, Hindi, Nepali)

2. Barman., D., Rampal, V. Shalini, H. Pokhrel and R. P. Medhi. *Production technology for Dendrobium chrysanthemum* (English, Hindi, Nepali)

Research papers

1. Barman., D., T. U. Bharati and R. P. Medhi. 2012. Effect of media and nutrition on growth and flowering of *Cymbidium* hybrid H.C. Aurora. *Indian J. Hort.* **69(3)**: 395-398.

2. Chowdappa., P., C. S. Chethana, R. Bharghavi, H. Sandhya and R. P. Pant, 2012. Morphological and molecular characterization of *Colletotrichum gloeosporioides (Penz.)* isolates causing anthracnose of orchids in India. *Biotechnol. Bioinf. Bioeng.* 2 (1) 567-572.

3. Devadas., R., D. Barman and P. Khatiwara. 2012. First generation interspecific hybrid of *Cymbidium*. *ICAR News*. **18 (3)**: 8-9.

4. Medhi., R. P., M. Chakraborti and Rampal. 2012. Orchid biodiversity of India: conservation and utilization. *Indian J. Genet.*, **72(2):** 148-156.

5. Meena., N. K and R. P. Medhi. 2012. Evaluation of insecticides and biopesticides for the management of two spotted spider mite, *Tetranychus urticae* in orchid (*Cymbidium* H.C. Aurora). *Pestology*, **36 (10)**: 40-45.

6. Meena., N. K., Rampal, R. P. Pant and R. P. Medhi. 2013. Seasonal incidence of mite and influence of pesticidal application on orchid flower production. *J. of Plant Protection Research*, **53 (2)**: 124-127.

7. Naik., S. K., D. Barman, Rampal and R. P. Medhi. 2013. Evaluation of electrical conductivity of the fertiliser solution on growth and flowering of a Cymbidium hybrid. *South African J. of Plant and Soil*. **30(1)**: 33–39.

8. Pant., R. P., M. Das, M. R. Khan, K. B. Pun and R. P. Medhi,. 2012. Association of an ecto-parasite nematode - *Helicotylenchus microcephalus* Sher, with poor growth of Cymbidium hybrids in Sikkim. *Indian Phytopath*. **65 (2)**: 196-197.

9. Rao., A. N., P. K. Rajeevan, Manoj Srivastava, S. R. Dhiman and L.C. De. 2012. Guidelines for the Conduct of Test for Distinctiveness, Uniformity and Stability on Orchid Cattleya and Phalaenopsis orchids. *Plant Variety J. of India,* **6 (11)***: 7-116.*

Popular articles

1. Chakrabarti., Syamali., Sudeep Jain and R. P. Medhi. 2012. *Khane jogya Orchids Phal Phool*, July-August.

2. Chakrabarti., Syamali., Sudeep Jain and R. P. Medhi. 2012. Vanilla-maslo ke rup me upgyog me anewala ek mulyaban orchid. *Phal Phool*, November-December.

3. De., L.C., and Medhi R. P. 2012. *Cymbidium* - A Diversified High Value Orchid for North Eastern India. *Agrobios Newsletter*, **10**: 30-32.

4. R. P. Medhi and L.C. De. 2012. NRC for Orchids. In: *'Farmer Friendly Technologies in Horticulture'*. 5th IHC from 6-9th Nov., 2012 at PAU, Ludhiana.

Bulletin

1. De, L.C., D. Barman, R. P. Medhi, Geetamani Chhetri and H. Pokhrel. 2013. *Production Technology of Dendrobium*. NRC for Orchids, Pakyong, Sikkim. Pp. 1-30. *(Technical Bulletin No.13)*

2. Pant., R. P., N. K. Meena and R. P. Medhi. 2013. *Important diseases of Orchids and their Management*. NRC for Orchids, Pakyong, Sikkim. Pp. 1-40. *(Technical Bulletin No.09)*

3. Pant., R. P., N. K. Meena and R. P. Medhi. 2013. *Virus diseases of Orchids and their Management*. NRC for Orchids, Pakyong, Sikkim. Pp. 1-34. *(Technical Bulletin No.10)*

4. Rampal., M. Dayamma and R. P. Medhi. 2013. *Manual for Acclimatization of Micro propagated Cymbidiums*. NRC for Orchids, Pakyong, Sikkim. Pp. 1-33. *(Technical Bulletin No.11)*

5. Rampal., R. P. Medhi, M. Dayamma and Parvati Khatiwara. 2013. *Commercialization of Cymbidiums in Sikkim; NRCO turning a dreams into reality*. NRC for Orchids, Pakyong, Sikkim. Pp. 1-33. *(Technical Bulletin No.12)*

Paper presented in Seminar/ Symposia

1. Barman., D., H. Pokhrel and R. P. Medhi. 2013. Effect of inorganic nutrient and growth regulators on reducing pre-blooming in *Cymbidium* hybrid 'Black Magic'. Pp: 167. In: *Abstract cum Souvenir - National Dialogue on orchid conservation and sustainable development for community livelihood* at Gangtok from 8-9th March, 2013 organized by NRC (O) in collaboration with TOSI, Chandigarh.

2. Barman., D., H. Pokhrel and R. P. Medhi. 2013. Optimisation of nutrient requirement for *Cymbidium* plants (6 months old) under hardening. Pp: 168. In: *Abstract cum Souvenir - National Dialogue on orchid conservation and sustainable development for community livelihood* at Gangtok from 8-9th March, 2013 organized by NRC (O) in collaboration with TOSI, Chandigarh.

3. Chakrabarti. Syamali, S. Jain, D. Sinha and R. P. Medhi. 2013. Diversity and Genetic Relationship Analysis of native species using RAPD markers. Pp: 150. In: *Abstract cum Souvenir - National Dialogue on orchid conservation and sustainable development for community livelihood* at Gangtok from 8-9th March, 2013 organized by NRC (O) in collaboration with TOSI, Chandigarh.

4. Chakrabarti., Syamali. 2013. Traditional Knowledge of NE People for Conservation and Utilisation of Orchids. In: *International Conference on - Bio resource and Stress Management* organised by Bose Institute, Kolkata from 6 - 9th Feb., 2013.

5. Chakrabarti., Syamali. 2013. DNA barcoding for Intellectual Protection. Pp: 32-36. In: *Abstract cum Souvenir - National Dialogue on orchid conservation and sustainable development for community livelihood* at Gangtok from 8-9th March, 2013 organized by NRC (O) in collaboration

with TOSI, Chandigarh.

6. Chakraborti., Mridul., Rampal, Syamali Chakrabarti, Sudeep. K. Jain and R. P. Medhi. 2013. Study of variability among Cymbidium tracyanum accessions collected from Darjeeling using RAPD markers. Pp: 152. In: *Abstract cum Souvenir - National Dialogue on orchid conservation and sustainable development for community livelihood* at Gangtok from 8-9th March, 2013 organized by NRC (O) in collaboration with TOSI, Chandigarh.

7. Chhetri., Geetamani, L.C. De and R. P. Medhi. 2013. Studies on morphological characters of Paphiopedilum species of North East India. Pp: 125. In: *Abstract cum Souvenir - National Dialogue on orchid conservation and sustainable development for community livelihood* at Gangtok from 8-9th March, 2013 organized by NRC (O) in collaboration with TOSI, Chandigarh.

8. Chhetri., Geetamani, L. C. De and R. P. Medhi. 2013. Notes on colour analysis in flowers of Dendrobium species of North East India. Pp: 125-126. In: *Abstract cum Souvenir - National Dialogue on orchid conservation and sustainable development for community livelihood* at Gangtok from 8-9th March, 2013 organized by NRC (O) in collaboration with TOSI, Chandigarh.

9. De., L. C. and R. P. Medhi. 2012. Biodiversity and conservation of rare and endemic orchids of North East India. Pp: 12-13. *In: Proceeding of National Seminar on 'Plant Genetic Research for Eastern and North East India'* from 11 -12th May, 2012 at ICAR Research Complex for NEH Region, Umiam, Meghalaya.

10. De., L. C., S. P. Vij and R. P. Medhi. 2012. Post-harvest Technology of Cymbidium Orchids. In: *Proceedings of 5th IHC* from 6-9th November, 2012 at PAU, Ludhiana, Punjab.

11. De., L. C., S. P. Vij and R. P. Medhi. 2012. Impact of climate change on productivity of orchids. In: *Proceedings of 5th IHC* from 6-9th November, 2012 at PAU, Ludhiana, Punjab.

12. De., L. C., S. P. Vij, H. Pohkrel and R. P. Medhi. 2013. Priorities in post-harvest management and value addition in orchids. Pp: 50-60. In: *Abstract cum Souvenir - National Dialogue on orchid conservation and sustainable development for community livelihood* at Gangtok from 8-9th March, 2013 organized by NRC (O) in collaboration with TOSI, Chandigarh.

13. De., L. C., A. N. Rao, P. K. Rajeevan, S. R. Dhiman, Manoj Srivastava and Geetamani Chhetri. 2013. DUS Test Guidelines in Cattleya orchids. Pp: 119. In: *Abstract cum Souvenir - National Dialogue on orchid conservation and*

sustainable development for community livelihood at Gangtok from 8-9th March, 2013 organized by NRC (O) in collaboration with TOSI, Chandigarh.

14. De., L. C., S. P. Vij, R. P. Medhi and Geetamani Chhetri. 2013. Round the year production of commercial orchids. Pp: 166. In: *Abstract cum Souvenir - National Dialogue on orchid conservation and sustainable development for community livelihood* at Gangtok from 8-9th March, 2013 organized by NRC (O) in collaboration with TOSI, Chandigarh.

15. De., L. C., V. Arunachalam, S. P. Vij, N. P. Singh and R. P. Medhi. 2013. Survey and collection of tropical orchids from Goa. Pp: 119-120. In: *Abstract cum Souvenir - National Dialogue on orchid conservation and sustainable development for community livelihood* at Gangtok from 8-9th March, 2013 organized by NRC (O) in collaboration with TOSI, Chandigarh.

16. Devadas., R., S. Pattanayak and N. Sailo. 2013. Induction of protocorm like bodies (plbs) from different explants of seven hybrids of *Cymbidium*. Pp: 149. In: *Abstract cum Souvenir - National Dialogue on orchid conservation and sustainable development for community livelihood* at Gangtok from 8-9th March, 2013 organized by NRC (O) in collaboration with TOSI, Chandigarh.

17. Devadas., R., P. Khatiwara, S. Pattanayak and L. C. De. 2013. Genetic Control of floral traits in *Cymbidium* hybrids (F_1 progenies). Pp: 150-151. In: *Abstract cum Souvenir - National Dialogue on orchid conservation and sustainable development for community livelihood* at Gangtok from 8-9th March, 2013 organized by NRC (O) in collaboration with TOSI, Chandigarh.

18. Devadas., R., *P. Khatiwara, S. Pattanayak* and R. P. Medhi. 2013. New *Cymbidium* Hybrids (2013) of NRCO for Commercialization & Re-invention of Breeding Cycle. Pp: 188-189. In: *Abstract cum Souvenir - National Dialogue on orchid conservation and sustainable development for community livelihood* at Gangtok from 8-9th March, 2013 organized by NRC (O) in collaboration with TOSI, Chandigarh.

19. Gogoi., J., N. K. Meena, B. Hakmaosa, N. Sailo and R. P. Medhi. 2013. Medicinal use of orchids. Pp: 178-179. In: *Abstract cum Souvenir - National Dialogue on orchid conservation and sustainable development for community livelihood* at Gangtok from 8-9th March, 2013 organized by NRC (O) in collaboration with TOSI, Chandigarh.

20. Hakmoasa., B., R. P. Pant, Jaya Gogoi, N. Sailo and R. P. Medhi, 2013. Vanilla- a commercially important orchid. Pp: 188. In: *Abstract cum Souvenir - National Dialogue on orchid*

conservation and sustainable development for community livelihood at Gangtok from 8-9th March, 2013 organized by NRC (O) in collaboration with TOSI, Chandigarh.

21. Medhi., R.P. and M. Chakraborti. 2012. Floriculture development in North Eastern India: challenges, prospects and success stories. Pp: 41-48. *In: State level workshop on 'Bridging Research to Extension: Strategies & Policies'* at Gangtok on October 11, 2012 organized by ICAR Research Complex for NEH Region, Sikkim Centre, Sikkim.

22. Medhi., R. P. and Ram Pal. 2012. Modern methods for conservation of orchid germplasm. In: *Souvenir cum Abstract Book, National Seminar on 'Innovative Technology for Conservation and Sustainable Utilization of Island Biodiversity'* from 20-22nd December, 2012 at CARI, Port Blair.

23. Medhi., R. P. and Ram Pal. 2012. Promoting Orchid Cultivation for Better Livelihood Security and Prosperity of North Eastern States of India. In: *Souvenir cum Abstract Book, National Seminar on 'Innovative Technology for Conservation and Sustainable Utilization of Island Biodiversity'* from 20-22nd December, 2012 at CARI, Port Blair.

24. Meena., N. K., Rampal., R. P. Pant, Jaya Gogoi, and R. P. Medhi. 2013. Pests associated with *Dendrobium* orchid and possible control measures. Pp: 178. In: *Abstract cum Souvenir - National Dialogue on orchid conservation and sustainable development for community livelihood* at Gangtok from 8-9th March, 2013 organized by NRC (O) in collaboration with TOSI, Chandigarh.

25. Meena., N. K and R. P. Medhi. 2013. Pest's scenario on orchids and their management. Pp: 72-79. In: *Abstract cum Souvenir - National Dialogue on orchid conservation and sustainable development for community livelihood* at Gangtok from 8-9th March, 2013 organized by NRC (O) in collaboration with TOSI, Chandigarh.

26. Mohanty., P., D. Barman, J. Das, S. Thapa and R. P. Medhi. 2013. Antioxidant activities of two selected aromatic orchids of India. Pp: 167. In: *Abstract cum Souvenir - National Dialogue on orchid conservation and sustainable development for community livelihood* at Gangtok from 8-9th March, 2013 organized by NRC (O) in collaboration with TOSI, Chandigarh.

27. Pattanayak., S. L., D. Barman, R. Devadas and R. P. Medhi. 2012. Mass multiplication of *Cymbidium* hybrid 'Baltic Glacier Mint Ice' through shoot tip culture. Pp: 14-15. In: *5th Indian Horticulture Congress, An International Meet – Celebrating 70 years of*

Establishment of HIS at Ludhiana, Punjab from November 6 – 9, 2012.

28. *Pattanayak., S., R. Devadas* and *J. Gagoi. 2013.* New innovations: *In-vitro* flowering of *Cymbidiums* for promotion/commercialization. Pp: 187. In: *Abstract cum Souvenir -National Dialogue on orchid conservation and sustainable development for community livelihood* at Gangtok from 8-9th March, 2013 organized by NRC (O) in collaboration with TOSI, Chandigarh.

29. Pant., R. P., Smita Gupta, B. Hakmoasa, N. K. Meena, S. P. Vij and R. P. Medhi. 2013. Status of orchid virus diagnostics and their application in production of virus free planting material. Pp.61-71. In: *Abstract cum Souvenir - National Dialogue on orchid conservation and sustainable development for community livelihood* at Gangtok from 8-9th March, 2013 organized by NRC (O) in collaboration with TOSI, Chandigarh.

30. Pant., R. P., B. Hakmoasa, N. K. Meena, Pramila Devi, T. Mathur, Nita and R. P. Medhi 2013. Studies on leaf spot disease of *Aranda* and *Mokara* hybrids and their management. Pp.178. In: *Abstract cum Souvenir - National Dialogue on orchid conservation and sustainable development for community livelihood* at Gangtok from 8-9th March, 2013 organized by NRC (O) in collaboration with TOSI, Chandigarh.

31. Pant., R. P., P. Chowdappa, Smita Gupta, B. Hakmoasa, N. K. Meena, and R. P. Medhi. 2013. Molecular characterization and management of orchid anthracnose caused by *Colletotrichum gloeosporioides* in India. Pp. 180. In: *Abstract cum Souvenir - National Dialogue on orchid conservation and sustainable development for community livelihood* at Gangtok from 8-9th March, 2013 organized by NRC (O) in collaboration with TOSI, Chandigarh.

32. Pant., R. P and R. P. Medhi. 2012. Virus diseases and development of diagnostics in orchids. Pp: 64 - 78. In: *Proc. of National Conference on Production of Quality Seeds and Planting Material: Health Management in Horticultural Crops at New Delhi from 11 - 14th March, 2010.*

33. Ram Pal, R. P. Medhi and M. Dayamma 2013. Protocol for mass multiplication of *Paphiopedilum villosum* (Lindl.) Pfitz. through seeds: An approach for conservation through commercialization. Pp: 153-154. In: *Abstract cum Souvenir - National Dialogue on orchid conservation and sustainable development for community livelihood* at Gangtok from 8-9th March, 2013 organized by NRC (O) in collaboration with TOSI, Chandigarh.

34. Ram Pal., D. Barman, M. Dayamma and R. P. Medhi. 2013. A symbiotic seed

germination, seedling growth and acclimation of *Zygopetalum intermedium* for commercial cultivation. Pp: 154. In: *Abstract cum Souvenir - National Dialogue on orchid conservation and sustainable development for community livelihood* at Gangtok from 8-9th March, 2013 organized by NRC (O) in collaboration with TOSI, Chandigarh.

35. Sailo., N., D. Barman,. B. Hakmoasa, , Jaya Gogoi, and R. P. Pant. 2013. Effect of water stress on *Cymbidium* hybrid 'Pine clash moon venus' *(PCMV)*. Pp: 180. In: *Abstract cum Souvenir - National Dialogue on orchid conservation and sustainable development for community livelihood* at Gangtok from 8-9th March, 2013 organized by NRC (O) in collaboration with TOSI, Chandigarh.

36. Srivastava., M., V. Chaudhary, R. C. Agrawal , D. S. Pilania and L. C. De. 2013. Role of PPV & FRA for IPR protection of orchids. Pp: 24-31. In: *Abstract cum Souvenir - National Dialogue on orchid conservation and sustainable development for community livelihood* at Gangtok from 8-9th March, 2013 organized by NRC (O) in collaboration with TOSI, Chandigarh.

Awards/Rewards/Recognition/Bodies acquired during the year

1. Dr. Mridul Chakraborti received the 'IJGPB-Best Research Paper Award' from Indian Society of Genetics and Plant Breeding (Certificate and Cash Prize of Rs. 10000) during National Seminar on 'Plant Genetic Research for Eastern and North-Eastern India' jointly organized by Indian Society of Genetics and Plant Breeding and ICAR Research Complex for NEH Region, Umiam, Meghalaya on 11th – 12th May, 2012.

2. NRC for Orchids, Pakyong received the award of 'राजभाषा कार्यान्वयन के लिए सांत्वना पुरस्कार' for the year 2012-13 from Ministry of Home Affairs, Rajbhasha, New Delhi on 29th January, 2013.

3. Participated in the Sikkim International Flower Show, 2013 from 23-27th February, 2013 and bagged 3rd prize in National Stall Competition.

4. Dr. L. C. De, Pr. Scientist (Horticulture) received the HSI Gold Medal award for his contribution in the field of floriculture from Horticulture Science Congress. He also received the best poster award on 'Postharvest technology of Cymbidium Orchid' at the meet at Ludhiana from 6 – 9th November, 2012.

5. Dr. D. Barman, Pr. Scientist (Horticulture) received the Fellow award, Ornamental Soc. of India, 2011-2012 at New Delhi.

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7 LIST OF ONGOING & COMPLETED PROJECTS

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	Collection, conservation, characterization, evaluation and maintenance of high alt. orchid germplasm	Ram Pal
7	Development of protocol for mass multiplication of rare, endangered and threatened orchid species.	N. Sailo
8	Genetic improvement of *Cymbidium* orchid for cut and pot flowers	M. Chakraborti
9	Disease management of orchids	R. P. Pant
10	Integrated pest management in orchids	N. K. Meena

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. P. Medhi , D. Barman
Programme II: Standardization of improved production technologies for horticultural crops	D. Barman, L. C. De, R. P. Pant & N. K. Meena
Progamme III: Technology refinement and imparting of training to extension functionaries	D. Barman, L. C. De, S. Chakrabarti, R. P. Pant, Rampal, N. K. Meena and N. Sailo

2. DUS Testing Project

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

Principal Investigator: L. C. De

3. DBT Project

Project title: " DBT mission for quality planting material production & Utilisation for the North East "

Principal Investigator : R. P. Medhi, Co-Principal Investigator : Rampal

4. 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

5. NAIP Project

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

Co-Principal Investigator : R. P. Medhi, CCPI : D. Barman and Rampal

List of Completed projects

Institute projects

Sl. 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 lilium	Rampal
9.	Collection, conservation, evaluation and multiplication of bulbous ornamental crops.	Rampal

8 RAC / IRC & IMC MEETINGS WITH RECOMMENDATIONS

Proceedings of 1st Meeting of 5th Research Advisory Committee Meeting of National Research Centre for Orchids, Pakyong, Sikkim held on 5 – 6th June, 2012.

The 1st Meeting of 5th RAC (Research Advisory Committee) of NRC Orchids convened on 5th and 6th June 2012 at the Conference Hall under the Chairmanship of DR. S.N. Puri, Vice Chancellor, CAU, Imphal , Manipur and with other following members.

- Dr. S. N. Puri, Vice-Chancellor & Chairman, CAU, Imphal, Manipur
- Dr. Umesh Srivastava, Member, ADG (Hort. II), ICAR, N. Delhi
- Prof. S. P. Vij, Member, Ex Head Deptt. of Botany, Punjab University
- Dr. U.C. Pradhan, Member, Orchid Laboratories, Abhijit Villa, Kalimpong
- Dr. R.D. Rawal, Member, Former Principal Scientist, IIHR, Bangalore
- Dr. R. P. Medhi, Member, Director, NRCO, Pakyong
- Shri Padam Subba, Deputy Director, Horticulture and Cash Crop Development Department, Govt. of Sikkim, Tadong, Gangtok
- Dr. J.G. Varshney, Member IMC, Joint Director ICAR Res. Complex for NEH region, Sikkim Centre
- Dr. N. Pathak, Executive Director, Sikkim Himalaya Flora
- Mr. Nirmal Yonzon, Progressive Orchid Grower, Pakyong, East Sikkim
- Shri Tapan Katham, Progressive Farmer, Kathan Bari, Malbazar
- Shri Sharad Pradhan, Progressive Farmer, Yangyang, South Sikkim
- Dr. L.C. De, Member Secretary and Principal Scientist (Horticulture), NRCO

The following Scientists of NRC Orchids, Pakyong, Sikkim attended the meeting, presented their research achievements and work plan for the future.

- Dr. D. Barman, Principal Scientist (Horticulture)
- Dr. S. Chakrabarti , Senior Scientist (Genetics)
- Dr. R.P. Pant, Senior Scientist, (Plant Pathology)
- Dr. Ramgopal Devdas, Senior Scientist (Plant Breeding)

- Dr. Rampal, Scientist SS (Horticulture) Scientist i/c Darjeeling Campus
- Dr. N.K. Meena, Scientist (Entomology)
- Shri N. Sailo, Scientist (Plant Physiology)
- Dr. Mridul Chakrabarti, Scientist (Plant Breeding)

In addition to above, Research Associates and SRF also participated in the meeting.

Summary of Recommendation

General recommendation

- Books/ Booklets/Technical bulletins of package of practice should be in local language also like Nepali as well on other languages of NE India for the benefit of farmers.
- All new projects should have farmers benefited approach.
- Institute has to come up for a material of commercial use by preparing a road map for next 5 years. Germplasm can be collected from Arunachal Pradesh and Manipur and conserved in collaboration with CAU.
- NRC Orchid should keep only those hybrids whose parentage are known. Without parentage, hybrids may not be used for further improvement.
- The centre should work also on other commercial orchids like *Dendrobium, Phalaenopsis, Oncidium, Cattleya* etc. in addition to *Cymbidium.*
- Scientists should be devoted to develop hybrids as early as possible and to register through NBPGR so that NRCO could capture the demand of domestic market.
- Research should be oriented as per demand of market, as orchids are highly market driven crop. While formulating projects, consumers' preference should also be considered.
- Scientists should visit regularly to farmer's field to collect infected plants and to advocate necessary suggestions for controlling diseases and pests.
- Two publications, one entitled "15 Glorious years of NRCO" and other "NRCO Research Abstracts" may be completed by June 2012 with incorporation of inputs of the Chairman and Members. . Hindi version of the same may also be published.
- Portable meteorological kit, global positioning system (GPS) and DIVA-GIS software are essential for conservation and collection of species wise orchids within country.
- Herbarium and digital herbarium consisting of Indian species and hybrids should be developed within 2 years with inclusion of all possible data bases. BSI's help may be taken up for guidance, if needed.

Crop Improvement

- Cytological studies of 50 orchid species of NRCO including Darjeeling campus should be completed within a time frame and phase wise.
- Due to lack of many planting materials root tips, shoot tips and embryos can be used instead of the whole plant for cytological studies.
- Collection and conservation of species of orchid from other parts of the country.
- A list of species which are endemic and endangered should be prepared state wise with the help of BSI and Orchidologist before starting work on *in-situ* conservation of orchids.
- Development of modern orchid hybrids with specific market driven traits including fragrance.
- Mass multiplication of endangered, rare and threatened orchids using already developed protocols.
- Development of suitable hybrids/varieties of cut flower and pot plant of *Cymbidium*
- Induction of flowering in Cymbidium orchids for value addition process and production management.

Crop Production

- Integrated Nutrition Management of orchids including organic culture
- Varietal identification of commercial orchid genera and their multi-location trials.
- Ways and means to reduce the gestation period of Cymbidium orchids.
- Development of modules for round-the-year production of Orchids is required to generate sustainable income for the grower. The centre may take pro-active role in developing programme for round-the-year production of *Dendrobium* and *Phalaenopsis* (at Pakyong) and *Cymbidium* (at Darjeeling campus).
- Use of locally available cheap material like paddy straw and paddy husk instead of charcoal and green moss etc should be used to bring down the cost in pot experiments
- Developing packing technology of cut flowers for long distance marketing as new experiment and with a separate objective to study the effect of photoperiod and temperature on self life through for external funding.

Crop Protection

- Development of Dipstick method for virus indexing of ORSV from other sources .
- Production of disease free planting material in an insect proof ployhouse. Virus free planting material for at least 5 infected *Dendrobium* and 9 infected

Cattleya hybrids may be made available within a year.

- To find out whether mite is responsible for virus transmission and body part of the mite which carries a particular virus and which are the vectors for virus transmission from orchids to weeds & vice-versa.
- To record humidity and temperature to correlate with high pest population found in the month of April to July.
- Biological control by using minute concentrations of pesticides and release of predators and parasites under protected conditions.

Recommendations of the 11th "Institute Research Committee" (IRC) meeting, National Research Centre for Orchids (ICAR) Pakyong, East Sikkim-737 106

The 11th Institute Research Council meeting of NRC for orchids, Pakyong, Sikkim-737 106 was held on 12th July, 2012 under the Chairmanship of Director, Dr. R. P. Medhi at the Conference Hall of the Institute. Following members were present in the meeting:

1. Dr. R. P. Medhi., Director and Chairman of 11th IRC meeting
2. Dr.V.A.Parthasarathy, Member, RAC
3. Sh. Padam Subba, Deputy .Director, HCCD, Govt. of Sikkim, member
4. Smt. Anuradha Chettri , Farmers Representatives , Kartok, Pakyong Member
5. Smt.Ranmaya Gurung, Farmers Representatives ,Yangang, South Sikkim Member
6. Smt. Namita Rai, Farmers Representatives , Yangang, South Sikkim Member

The following scientists of NRC for Orchids, Sikkim attended the meeting:

1. Dr. D. Barman, Principal Scientist (Horticulture)
2. Dr. L. C. De, Principal Scientist (Horticulture)
3. Dr. S. Chakrabarti, Senior Scientist (Genetics)
4. Dr. R. P. Pant, Senior Scientist (Plant Pathology)
5. Dr.Ramgopal Devadas, Senior Scientist (Plant Breeding)
6. Dr. Rampal, Scientist SS (Horticulture), Darjeeling Campus.
7. Dr. N.K. Meena, Scientist (Entomology)
8. Dr. N. Sailo, Scientist (Plant Physiology)
9. Dr. M. Chakrabarti, Scientist (Plant Breeding)

Dr. S. Chakrabarti, Member Secretary - IRC, presented the recommendations of RAC and IRC, action taken reports and major research findings of the Institute in brief after the formal welcome

address given by the Chairman – IRC, Dr. R. P. Medhi.

Division wise scientists of the centre presented the research progress, plan of work and new project proposal etc. in the meeting.

Expert's Remarks:

- Considering the costs of molecular work a single laboratory facilities should develop in the Institute (Main centre) instead of providing facilities to individual scientist separately
- Breeding objectives must be clear specially for selection of parental lines with proper statistical analysis to identify divergent parents
- Each germplasm must be registered in NBPGR for obtaining the IC and EC number including the collection of State Deptt.
- Efficacy of botanicals for control of pests infestation may be tested in farmers field
- Focused research programme should be taken up on applied research and as per farmers demand – i.e. development of good hybrids/varieties

Summary of Recommendation

Crop Improvement

Genetics

- Dr.S.Chakrabarti, Sr.Scientist (Genetics), presented the progress of Genetics section. For new project proposal –"Development of microsatellite markers from native *Paphiopedilum* orchids" the committee suggested not to submit it as Institutional project as the scientist has huge work to complete and there exists lack of manpower. The project may be submitted to DBT-Twin programme with collaboration with IIHR.

Plant Breeding and Tissue Culture

- Dr. Ramgopal Devadas, Sr. Scientist, Pl. Breeding, presented the work of Plant breeding and tissue culture. For varieties/hybrids the committee suggested to release the developed varieties/hybrids first through State Variety Release Committee and later through Central Variety Release Committee. It is also suggested that Breeder should give special attention in IPR issues at the time of selection of parental lines. Breeding objectives must be clear and specific and the parental lines should be selected through proper biometrical studies .Scientist can do the QTL analysis by using the existing progenies obtained in breeding programmes. For breeding of aromatic orchids, the *Cymbidium* species *munronianum* may be taken as one parent. The tissue culture media with activated charcoal may be used within 24 hrs after preparation

Regional Centre-Darjeeling

- The progress report of Darjeeling Campus was presented by Dr. Rampal, Scientist (SS). He highlighted that for collection of orchids for project work from forests area permission was taken from Biodiversity Board, WB. Dr. Parthasarathy suggested that, there is need to take permission from forest department. For molecular work of Darjeeling campus committee suggested to work in Genetics laboratory in the main centre, Pakyong where facilities are available as molecular work is very expensive. Purchase of instruments/chemicals and other facilities for molecular study of individual scientist is not advisable. The mycorrhizal associations available in the orchid species for natural seed germination may be useful and need to be tested in other orchid species.

Crop Production

Horticulture

- Dr.D.Barman, Principal Scientist (Horticulture) presented his project work – "*Cymbidium* based integrated Floriculture enterprise". Committee suggested to evaluate the programme in farmer's field and cost benefit ratio year wise precisely.
- Dr.L.C.De, Principal Scientist (Horticulture) presented project work on pre and post harvest management. The committee suggested to hand over the plants of promising hybrids of Aranda, Mokara, Phalaenopsis ,Cattleya and Oncidium which were identified through field evaluation to State Deptt.of Horticulture for multiplication and further cultivation.
- Sh. N.Sailo, newly joined scientist (Pl. Physiology) presented the research project proposal as per recommendations of RAC. The new project on stress physiology and induction of flowering was approved by the committee.

Crop Protection

Pathology

- Dr.R.P.Pant, Sr. Scientist (Pl.Pathology) presented project work on orchid diseases and virus indexing of orchid species and hybrids by ELISA and RT-PCR technique and characterization of orchid fleck virus. Committee recommended for screening of virus free plants from the existing orchid germplasms.

Entomology

- Dr. N.K. Meena, Scientist (Entomology) presented the work on pest management of orchids. The committee suggested to test the efficacy of botanicals in farmers field. The new project on eco-friendly management of pests in *Cymbidium* was approved.

Recommendations of the 10th "Institute Management Co mmittee" (IMC) meeting, National Research Centre for Orchids (ICAR) Pakyong, East Sikkim-737 106

The 10th Institute Management Committee Meeting of National Research Centre for Orchids Pakyong, Sikkim was held on 26th July 2012 under the Chairmanship of Dr. R.P. Medhi, Director NRC for Orchids in the conference hall and the following Members/Dignitaries/Officers attended the meeting. Following other members were present in the meeting:

1. Dr. P.K. Srivastava, Dean, Central Agricultural University, Ranipool, Sikkim , Member
2. Dr. H Rahman, Project Director, Project Directorate on Animal Disease Monitoring & Surveillance, Bangalore, Member
3. Shri D.K. Rai, Principal Director, Department of Horticulture & Cash Crops, Govt. of Sikkim, Krishi Bhavan, Tadong, Gangtok (Sikkim), Member
4. Dr. L.C. De, Principal Scientist (Hort,), NRC for Orchids, Pakyong, Member
5. Shri Rampal, Sr.Scientist (Hort.) & Incharge, NRC for Orchids, Darjeeling Campus, A.J.C. Bose Road, Darjeeling, Member
6. Shri Nirmal Tamang, Tashithang, Dikling, Pakyong, Member
7. Shri. Davis Joseph, Administrative Officer, NRC for Orchids, Pakyong, Member Secretary

The following members could not attend the IMC meeting.

1. Director, Department of Horticulture, Government of Meghalaya, Shillong, Meghalaya, Member
2. Director of Farm, Department of Pomology, Uttar Banga Krishi Vishwavidyalaya, Pundibari, Cooch Behar (West Bengal), Member
3. Assistant Director General (H-II), ICAR , Krishi Anusandhan Bhawan-II, PUSA,New Delhi, Member
4. Sr. Finance & Accounts Officer, C. I. F. R. I. Barrackpore, Kolkata., Member
5. Shri Sonam Sherpa, Farmer, Gurbisey, Namchi, South Sikkim, Member

At the outset, Chairman of the IMC & Director, NRC for Orchids welcomed all the members present in the X Institute Management Committee Meeting of the Institute. The meeting started with a presentation from the Director, briefing about the mandate of the Institute and their research activities carried out, along with the various achievements by the Scientists of this Institute since last IMC meeting. This was followed by a brief discussion by all the members of the IMC who appreciated the efforts of the Institute in fulfilling their mandated activities and wished that the research programs being undertaken at present as well as those to be contemplated in future would address not only

the Council's expectation, but also the welfare of the growers of orchids in Sikkim as well as other parts in India.

Then, the Action taken report of the IX. IMC Meeting was presented by the Member Secretary and was passed by the house. The following agenda items were presented for the perusal, discussion and recommendation by the esteemed IMC members.

Sl. No.	Agenda item	Recommendations of IMC	Director's Comments
1.	Construction (Spill over items) Construction of type IV-04 nos. quarters at NRC for Orchids, Pakyong at an estimated cost of Rs.149.94 lakhs	The Committee members recommended the proposal for carrying out the works through CPWD. It was suggested that the spill over works must be reflected in the EFC of XII Plan.	Spill over item. Work approved /sanctioned in the IX Plan period. An amount of Rs. 60.00 lakhs has been deposited with CPWD. The remaining amt of Rs.89.94 lakhs will be spend from the budget allocation of 2012-13
2.	Construction of Trainees Hostel at NRC for Orchids, Pakyong at an estimated cost of Rs.253 lakhs	Recommended for carrying out the work through CPWD. The spill over may be reflected in the EFC of XII Plan.	Spill over item. Work approved / Sanctioned in the IX Plan period. The work was deferred to XII plan to meet the deficit amount for taking up other approved works during XI Plan.
3.	Construction/Renovation of boundary retaining wall along Dikling (damaged/washed away by rain water)	Recommended for carrying out the work through CPWD out Non-Plan budget.	The work has since been completed through CPWD
	Sub Centre-Darjeeling		
4.	Const. of Farm Store, Culture room, Pack house and Type IV quarter-02 nos. at NRC for Orchids, Darjeeling campus at an estimated cost of 183.94 lakhs.	Recommended for carrying out the work through CPWD. The spill over work may be reflected in the EFC of 12 Plan	Spill over item. Work approved / Sanctioned in the XI Plan period. An amount of Rs. 91.97 lakhs has been deposited with CPWD. The remaining amount of Rs. 91.97 will be spend from the budget allocation of 2012-13
	New Construction proposed in XII Plan, Main Centre, Pakyong		
1.	Laboratory cum Auditorium Building – 01 Unit	The IMC Members deliberated on the construction of Laboratory cum Auditorium at NRC Orchid, Pakyong to facilitate for common Laboratory. There is also no Auditorium for organizing different kind of programs. After hearing the view of the Director NRCO, the committee members recommended the proposal.	It is proposed to have a common Laboratory so that expenditure on various can be curtailed. This Instt. do not have an auditorium for organizing various official programs and hence the urgent need for the same.

2.	Type III Quarters including land development – 04 Units	The IMC Members discussed the need for Type III Qtr. and after deliberation, the Members recommended the proposal.	Some of the Staff members are staying in private accommodations due to non-availability of Qtrs. And further private accommodations are not easily available due to remoteness of the place.
	Boundary Wall – 300 cu.mt	The IMC Members deliberated on the proposal and after discussion the IMC members agreed to the proposal and recommended the same.	Presently there exists barbed wire fencing but there is tendency of ICAR land encroachment. In order to safeguard ICAR property and avoid future litigation, it is proposed RCC masonry wall for the entire area of Farm.
	Internal Road – 200 cu. mt.	The IMC Members deliberated on the proposal and after discussion the IMC members agreed to the proposal and recommended the same.	There is muddy road and during rainy seasons it becomes very difficult for the movement, hence the proposal.
	Security Shed – 01 Unit (Residential Campus)	The IMC Members deliberated on the proposal and after discussion the IMC members agreed to the proposal and recommended the same.	There is no shed for the security personnel and it is very difficult during rainy season hence the proposal.
	Pack house – 01 Unit	The IMC Members deliberated on the proposal and after discussion the IMC members agreed to the proposal and recommended the same.	Need is felt for construction of one no. of Pack house. Hence it is proposed in the XII Plan
	Maintenance / minor works	The IMC Members recommended the proposal.	
	Sub Centre-Darjeeling		
	New Office Building Renovation of boundary wall Renovation of footpath Retaining walls Polyhouse and glasshouse – 02 In-vitro conservation facility	The IMC Members deliberated on the proposal and after discussion the IMC members agreed to the proposal and recommended the same.	The Sub-Center at Darjeeling is housed in an old building which was handed over by the CPRI Shimla in the year 1997 and is in bad shape. Repairs have been carried out but now it is not economical and safe for further renovation, hence it is proposed for the new construction. Similarly the boundary wall, retaining wall and foot-path need renovation.

After all the agenda items were thoroughly discussed and deliberated, the Director thanked all the Members individually for their fruitful suggestions and constructive advice in conducting the research programs and other activities of the Institute as well as the proposals for the XII Plan for its efficient functioning. Finally, the meeting ended with a vote of thanks proposed by the Member Secretary.

Result Framework Document

Result Framework Document (RFD) is a Planning Commission Document that takes critical view of yearly performance targets adopted by Central Ministries and departments during 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 2012-2013, 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.

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 and post-harvest management of orchids
3. Insect pests and disease management of orchids
4. Transfer of technology
5. Effective functioning of RFD systems

Functions

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

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

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

XI Agricultural Science Congress - *Agricultural Education: Shaping India's Future"* held at Orissa University of Agriculture and Technology, Bhubaneswar, Odisha from 7-9 February, 2013

Left : Hon'ble DG, ICAR ; **Right:** Hon'ble Agriculture Minister, Govt. of Odisha and VC, OUAT at NRCO Stall

6th DUS Review Meeting and Exhibition from 21st-22nd May, 2012 at NASC Complex, New Delhi.

L. C. De

Steering Committee Meeting of HMNEH from 21-24th June, 2012 at NASC Complex, New Delhi

R. P. Medhi

ICAR Regional Committee – II, at NAARM, Hyderabad held during July 19-20, 2012

Rampal

Directors, Project Coordinators and Leaders of Challenge Programmers of horticulture Division on 23rd July, 2012 at NASC Complex, Pusa Campus, New Delhi.

R. P. Medhi

Board of Management meeting of Central Agricultural University on 6th August, 2012 at Barapani, Meghalaya.

R. P. Medhi

Inaugurated conference of technical committee of HMNEH on 8th August, 2012 at Agartala, Tripura.

R. P. Medhi

Knowledge Meet and Horticulture Divisional meeting of HODs and Project Coordinators of

Hort. Division with DDG (Hort.) from 21-22nd August, 2012 at NASC, New Delhi.

R. P. Medhi

2nd Meeting of Orchid Task Force for preparation of DUS test guidelines in *Phalaenopsis* and *Cattleya* from 21st -22nd August, 2012 at KAU, Trichur

L. C. De

Midterm Review Meeting of the recommendation of the 20th meeting of the regional committee Zone-II on 10th September, 2012 at ICAR RC, Barapani, Meghalya.

R. P. Medhi

Entrepreneurs meet from 25 - 26th September, 2012 at NIRJAFT, Kolkata

D. Barman

214th Academic Council Meeting on 27th September, 2012 at Assam Agricultural University, Jorhat, Assam.

R. P. Medhi

State Level Stakeholders' workshop on Bridging Research to Extension, Strategies & Policies from 11-12th October, 2012 at ICAR Research Complex for NEH Region, Sikkim Centre

R. P. Medhi

Final Meeting of Orchid Task Force for preparation of DUS test guidelines in *Phalaenopsis* and *Cattleya* from 31st October-1st November, 2012 at PPV & FRA, NASC Complex, New Delhi

L. C. De

5th Indian Horticulture Congress from 6th -9th November, 2012 at PAU, Ludhiana, Punjab

L. C. De & R. Devadas

215th Academic Council Meeting on 10th November, 2012 at Assam Agricultural University, Jorhat.

R. P. Medhi

Mid Term Performance of RFD Meeting (2012-13) on 23rd November, 2012 at KAB-II, Pusa, New Delhi-12

L. C. De

Review Workshop of PME Cell on 8th December, 2012 at NDRI, Karnal

L. C. De

National consultation on PGR management of horticultural crops from 17-19th December, 2012 at NBPGR, Pusa, New Delhi.

R. P. Medhi & Rampal

National Seminar on 'Innovative Technology for Conservation and Sustainable Utilization of Island Biodiversity, from 20 - 22nd December, 2012 at CARI, Port Blair.

R. P. Medhi & Rampal

International Conference on "Bio resource and Stress Management" at Bose Institute, Kolkata from 6 – 9th February, 2013.

S. Chakrabarti

RFD (2013-14) Meeting on 16th January, 2013 at NASC Complex, New Delhi

R. P. Medhi & L. C. De

Brain storming and interactive session with stake holders for stream ling of floriculture research and XXII group meeting of AICRP in Floriculture on 29th and 30th January, 2013 at MPKV, Pune.

R. P. Medhi & Rampal

XI Agricultural Science Congress- *Agricultural Education: Shaping India's Future* from 7-9th February, 2013 at Orissa University of Agriculture and Technology, Bhubaneswar, Odisha and organized by National Academy of Agricultural Sciences.

D. Barman & R. P. Pant

International Flower Show Sikkim, 2013 from 23-27th February, 2013 at Saramsa Garden, Organized by Horticulture and Cash Crop Development Department, Govt. of Sikkim.

All Scientists

National Dialogue on 'Orchid Conservation on Sustainable Development for Community Livelihood' from 8 - 9th March, 2013 at Gangtok

All Scientists

1st Meet of Orchid Task Force (3/2012) on 20 - 21st March, 2013 at Centre for Orchid Gene Conservation of Eastern Himalayan Region, Hengbung, Senapati Dist., Manipur for preparation of DUS Test Guidelines of *Paphiopedilum* and *Oncidium* orchids

L. C. De

National Seminar on "Advances in Protected cultivation" at NASC Complex, New Delhi on 21st March, 2013

D. Barman

Distinguished visitors 10

Dr. V. A. Parthasarathy, Emeritus Scientist, IISR, Culicut	12/07/2012
Dr. Jagmohan Singh, Former VC, Dr. Y. S. Parmar University of Horticulture Forestry, Solan, H.P.	02/08/2012
Prof. P. Das FNA, Chairman, The Science Foundation for Tribal & Rural Resource Development, Bhubaneshwar, Odisha	05/10/2012
Shri. Bharat S. Bhajane, General Manager (Business developer), Rise & Shine Biotech Pvt. Ltd., Pune, Maharastra.	23/02/2013
Shri. Keeratikal Sophunsin, Kultan Orchids, Bangkok	23/02/2013
Shri. Yoshi Kazu Moriyama, Managing Director, M. Kat Bio Co. Ltd., Japan	23/02/2013
Dr. K. R. Dhiman, VC, UHF Neruni, Solan, H.P.	24/02/2013
Dr. N. K. Krishna Kumar, DDG (Hort.), ICAR, New Delhi	09/03/2013
Dr. S. M. Virmani (Retd.) Scientist ICRISAT, 811A, Road 41, Jubilee Hills, Hyderabad.	12/03/2013
Mr. Lawsence Hislop, UNEP/GRID-Asendal, Norway	26/03/2013
Mr. Simon Pugh Jones, Writhlington School Orchid Project, Radstak, England.	28/03/2013
Dr. Lawren Gwduis, Royal Botanical Garden, Kew, England	28/03/2013

Prof. P. Das FNA, Chairman
The Science Foundation for Tribal & Rural Resource Development, Bhubaneshwar, Odisha

Shri. Bharat S. Bhajane, Pune;
Shri. Keeratikal Sophunsin, Bangkok and
Shri. Yoshi Kazu Moriyama, Japan

Dr. N. K. Krishna Kumar, DDG (Hort.), ICAR, New Delhi

Students from Writhlington School Orchid Project, Radstak, England.

Personnel

11

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. R. P. Pant, Sr. Scientist (Plant Pathology)

Dr. Rampal, Sr. Scientist (Horticulture)

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

Dr. N. K. Meena, Scientist (Agril. Entomology)

Dr. M. Chakraborti, Scientist (Plant Breeding)

Dr. N. Sailo, Scientist (Plant Physiology)

II. Administration

Shri Davis Joseph	Administrative Officer
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	Computer Assistant (T-II-3)
Ms. Tshering Chomu Butia	Hort. Asstt. (T-II-3)
Shri. Ram Chandra Gurung	Driver (T-3)
Shri. Manoj Adhikari	Tech. Asstt. (T-1)
Ms. Meena Kumari Chettri	Tech. Asstt. (T-1)
Shri. Deepak Khattri	Driver (T-1)
Shri Ajay Bushal	Tech. Asstt. (T-1)

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. Ramgopal Devadas transferred from Directorate of Soybean Research, Indore and joined this Centre as Sr. Scientist (Plant Breeding) against the post of Scientist (Plant Breeding) on 3rd May, 2012.

Administration

Shri. Arvind Chauhaan joined as Assistant on 27th September, 2012.

Technical

Ms. Tshering Chomu Bhutia joined as Horticulture Assistant (T-II-3) on 28th February, 2013.

OTHER INFORMATION 12

Hindi Karyashala

One day Hindi Karyashala (workshop) was organized in National Research Centre for Orchids, Pakyong Sikkim on 21st April 2012 to enhance the efficiency of Rajbhasha of the employees of the Centre. Shri Birendra Chhetri, Director, National Informatics Centre, Gangtok, Dr. B. S. Kholia, Scientist, Botanical Survey of India, Gangtok, Shri O. P. Singh and Shri Ghanshyam , Teachers, Jawahar Navodaya Vidhalaya, Pakyong participated as resource persons.

Hindi Karyashala of NRC for orchids on 21st April, 2012

Technical Session of Hindi Karyashala of NRC for orchids on 21st April, 2012

National Dialogue on Orchid Conservation Organized

The Centre organized a 'National Dialogue on Orchid Conservation and Sustainable Development for Community Livelihood' at Gangtok. Shri Dawa Norbu Takarpa , Agriculture Minister, Sikkim was the Chief Guest during the inaugural function. Dr. S. N. Puri, Vice-Chancellor, CAU (Manipur) presided over the function.

Hon'ble Agriculture Minister, Govt. of Sikkim

Emphasizing on the conservation the 'orchid biodiversity' of the hilly regions, Shri Takarpa said community efforts with scientific conservation methods may be adopted for the purpose. The conservation system should highlight the medicinal and commercial values of important orchids for social upliftment by creating a viable livelihood options by means of commercialization. Other dignitaries like Shri. G. M. Pradhan, Eminent Orchid Specialist, Kalimpong; Prof. A. K. Bhatnagar, Delhi University & Vice-President (TOSI); Dr. S. N. Hegde, Former Director (TIPI) & Member, TOSKAR (Karnataka); Dr. R. P. Medhi, Director

(NRCO) & Organizing Secretary and Prof. Promla Pathak, TOSI (Chandigarh) addressed the delegates during the inaugural function.

Hon'ble DDG (Hort.), ICAR Chairing the plenary session

Orchid specialists, officials from different state departments, delegates across India and farmers participated in the two-day (March 8-9, 2013) National Dialogue and discussed various issues that need to introspect to prepare a road map for commercialization of orchid cultivation in India. The five eminent and renowned orchid specialists were conferred 'Award of Honour' and felicitated during the function for their life time contribution. The abstracts-cum-souvenir and five technical bulletins of NRCO were also released, along with the launching of NRCO website (new) during the meet. Dr. N. K. Krishna Kumar, DDG (Horticulture) also joined the event and chaired the plenary session (2nd day) with critical input to come out with strong recommendations of the themes conducted. During the valedictory function, the awards were presented to the best poster and oral presenters and the farmers participated for orchid exhibition. Dr. D. Barman, Principal Scientist (Horticulture), NRCO proposed vote of thanks. Following recommendations were suggested during the meet.

Session-I: Indigenous orchid resources, evaluation and characterization

- Inventorize and documentation of orchid diversity, identification of species with medicinal values and their conservation with artificial propagation
- Establishment of orchid museum, gene banks, parks, sanctuaries at different altitudes
- Awareness program on biodiversity among young generations
- Enforcement of national and global laws for biodiversity conservation
- Bio-prospecting of medicinal orchids

Session-II: Propagation and genetic improvement through conventional and bio-tech means

- Development of thermo-sensitive and photosensitive hybrids of commercial orchids for large scale production
- Cost-effective and reproducible protocol for species multiplication and hardening
- Identifying few medicinal orchids and development methods for mass multiplication and their cultivation technique to their natural habitat for local entrepreneurs and local communities
- Developing DNA barcodes as molecular diagnostic tools for all 1300 species of orchids to check bio-piracy, illegal

trade, adulterants and substitutions

- Registration of farmers and breeders varieties through PPV & FRA
- Cytological studies of valuable orchid species as basic research

Session-III: Cultivation, Management and Value Addition

- Proper indexing of orchid hybrids and their genetical status and registration
- Development of location and genera specific production system of orchids in collaborative approach of SAU, ICAR and Private Organizations
- Screening of orchid hybrids imported by private growers through strict quarantine measures
- Development of complete protocol of genera specific post-harvest technologies starting from harvest to transport, storage and marketing
- Preparation of value added products including packed items, dry flowers, herbal medicines etc. from wild species

Session-IV: Orchid-Promotion: Public-Private Partnership

- Improvement of orchid promotion through area expansion, varietal upgradation, increase production and productivity by advanced agro-techniques
- Developing entrepreneurship by infrastructure development, capacity and skill development including women empowerment , supply of planting materials, post-harvest management, market linkages, transport subsidies

Plenary Session

- Emphasis on demand and growth of floriculture with special reference to orchids
- Effective conservation methodologies through studies on pollination biology, micro-propagation for sustainable biodiversity development
- Dissemination of novel technologies into commercial venture
- Combination of conference or seminar with painting program to encourage students

Laying of foundation stone and inauguration of Glasshouse at NRC for Orchids, Darjeeling campus

The foundation stone of culture room, pack house and residential quarters of Darjeeling campus of National Research Centre for Orchids was laid on 10th March, 2013 by Dr. N. K. Krishna Kumar, Deputy Director General (Horticulture), ICAR in presence of Dr. R. P. Medhi, Director, National Research Centre for Orchids, Pakyong. A newly built state of the art glasshouse and an innovative water harvesting structure for hill region were also inaugurated by the DDG. He suggested that the commercial potential of orchids needs to be exploited in India through rigorous research efforts coupled with forward and backward

linkage. He interacted with the scientists working at the centre and appreciated the efforts of the campus in conservation of temperate orchid species in multipronged strategies and production of quality planting materials of *Cymbidium* hybrids. He also emphasized the need for developing indigenous hybrids of commercial orchids to reduce the dependence on exotic varieties.

The other dignitaries present on this occasion were Mr. Chandra Pal, Executive Engineer, CPWD, Gangtok, Sikkim.

Dr. N. K. Krishna Kumar, DDG Horticulture, ICAR laying foundation stone at NRC for orchid, Darjeeling Campus

DDG (Hort.), ICAR inaugurating the newly build Water Harvesting Structure & Glasshouse of NRCO, Darjeeling Campus

Kisan Diwas / Farmer's Day

Kisan Diwas / Farmer's Day was observed on 26 March 2013 at NRC for orchids in which about 100 farmers from different parts of Sikkim like Damthang, Kartok, Sombaria, Yangang and Pakyong were participated. The objective of the training programme was to make the farmers aware of all the issues concerning to orchid cultivation. The discussion covered all the aspects on cultivation of orchids including the post harvest management technologies, the marketing opportunities, disease and pest problems and also the various schemes implemented by the government for upliftment of the farmers.

Kisan Diwas/ Farmers Day celebration at NRC (O) on 26th March 2013

Independence Day Celebration (15th August, 2012)

Children's participating at the Drawing Competition (15th August, 2012)

Cultural programme during Independance Day celebration

Celebration of Hindi Saptah (14 – 20th September, 2012)

Foundation Day Celebration (5th October, 2012)

Cultural programme during Foundation Day celebration

National Integration week (19th November, 2012)

Republic Day Celebration (26th January, 2013)

Result Framework Document Annexure-I

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

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	39	Collection, conservation of orchid germplasm.	Germplasm collected.and conserved	Number	19	60	55	45	40	32
		Characterization of Orchids	Molecular and DUS characterization of orchids.	Number	10	25	19	13	10	9
		Development of improved hybrids	New crossing, in-vitro seeds culture & new F1 evaluation	Number	10	25	20	15	10	5
2. Production and post harvest management of orchids.	30	Integrated Production Management of orchids.	Production technology for *Cymbidium, Dendrobium* and *Phalaenopsis* orchids	Number	16	4	3	2	1	-
		Post harvest management	Technology for post harvest management in *Cymbidium*	Number	4	2	1	-	-	-
		Production of planting materials	Plantlets produced	Number	10	12000	10000	8000	7000	6000
3. Insect pests and disease management of orchids.	10	Indexing for viral diseases from different locations	Locations	Number	5	10	9	8	7	6
		IPM for Orchids	Targeted pests & control	Number	5	5	4	4	3	2
4. Transfer of technology	9	Training/ demonstrations	Training	Number	5	11	10	9	8	6
			Demonstration	Number	4	6	5	4	3	2
5.Effective functioning of RFD system	3	Timely submission of RFD system	On time submission	Date	2	March 23, 2012	March 26, 2012	March 27,2012	March 28, 2012	March 29 ,2012
		Timely Submission of results of 2012-13	On time submission	Date	1					

Section 3: Trend Values of the Success Indicators

Objectives	Action	Success Indicators	Unit	Actual value for FY 10/11	Actual value FY 11/12	Actual value FY 12/13	Projected Value FY13/14	Projected Value FY 14/15
1. Management and utilization of genetic resources for improved productivity	Collection, conservation of orchid germplasm.	Germplasm collected and conserved	Number	40	45	55	55	60
	Characterization of orchids	Molecular and DUS characterization orchids.	Number	12	13	19	19	25
	Development of improved hybrids	New crossing, in-vitro seeds culture & new F1 evaluation	Number	-	20	20	20	27
2. Production and post harvest management of orchids.	Integrated production management of orchids.	Production technology for *Cymbidium, Dendrobium* and *Phalaenopsis* orchids	Number	2	3	4	4	4
	Post harvest management	Technology for post harvest management in Cymbidium and Dendrobium	Number	1	1	2	2	3
	Production of planting materials	Plantlets production	Number	8000	9000	10,000	12,000	10,000
3. Insect pests and disease management of orchids.	Indexing for viral diseases from different locations	Locations	Number	7	9	8	9	9
	IPM for orchids	Targeted pests / control Modules	Number	3	4	2	4	4
4. Transfer of Technology	Training/ demonstrations	Training	Number	8	9	10	8	9
		Demonstrations	Number	3	4	5	5	6
5. Efficient Functioning of RFD System	Timely Submission of RFD 2012-13	On time submission	Date	30 March, 2011	23/4/2012	March 26 2012		
	Timely Submission of results of 2012-13	On time submission	Date	30 March, 2011	23/4/2012	May 2 2012		

Section 3: Trend Values of the Success Indicators

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2. Production and post harvest management of orchids.	Integrated production management of orchids.	Production technology for *Cymbidium, Dendrobium* and *Phalaenopsis* orchids	Number	2	3	4	4	4
	Post harvest management	Technology for post harvest management in Cymbidium and Dendrobium	Number	1	1	2	2	3
	Production of planting materials	Plantlets production	Number	8000	9000	10,000	12,000	10,000
3. Insect pests and disease management of orchids.	Indexing for viral diseases from different locations	Locations	Number	7	9	8	9	9
	IPM for orchids	Targeted pests / control Modules	Number	3	4	2	4	4
4. Transfer of Technology	Training/ demonstrations	Training	Number	8	9	10	8	9
		Demonstrations	Number	3	4	5	5	6
5. Efficient Functioning of RFD System	Timely Submission of RFD 2012-13	On time submission	Date	30 March, 2011	23/4/2012	March 26 2012		
	Timely Submission of results of 2012-13	On time submission	Date	30 March, 2011	23/4/2012	May 2 2012		

Section 4:

Description and definition of success indicators and proposed measurement methodology

Objective 1: The genetic diversity of orchid will be collected from different eco-regions, characterized and promising genotypes would be registered with NBPGR. The success will be measured in terms of number of germplasm collected and characterized and number of genotypes registered with NBPGR.

Objective 2: It is essential to study nutrient requirements of orchids for production of quality cut flowers. Post harvest studies to be conducted to get increased quality and vase life of commercial orchids. Production of good quality planting materials of commercial hybrids of orchid is an important mandate of the institute. Quality planting material would be produced through meristem culture (orchid hybrids) and as *in vitro* produced seedlings (species). The success will be measured in terms of number of good quality planting materials produced.

Objective 3: The bio-control agents and disease diagnostics are found to be efficient in experimental studies on insect pests and disease control and plant growth promotion will be identified based on phenotypic and biochemical parameters.

Objective 4: For effective transfer of orchid production technologies, it is proposed to organize various extension activities such as trainings, demonstrations, *kisan melas*, awareness camps, AIR/Doordarshan programmes, Seminars etc. The success will be measured in terms of number of events held.

Section 5:

Specific Performance Requirements from other Departments

- Permission from State Biodiversity Boards for collection of orchids from natural habitats is mandatory for collection of orchid germplasm.

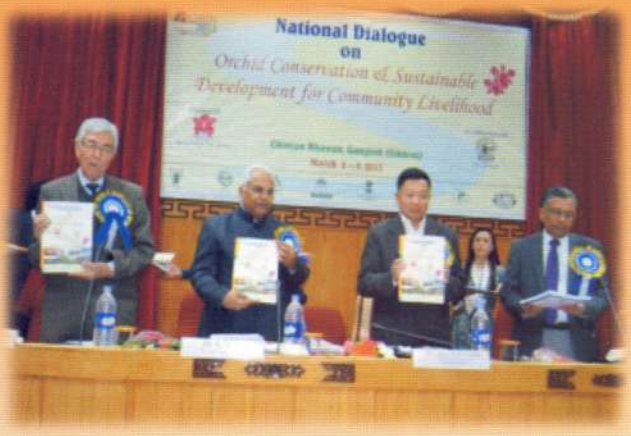
Based on demand from different departments like National Horticulture Board, State departments of Hort./Agriculture, NHM (DAC) and SAU's.

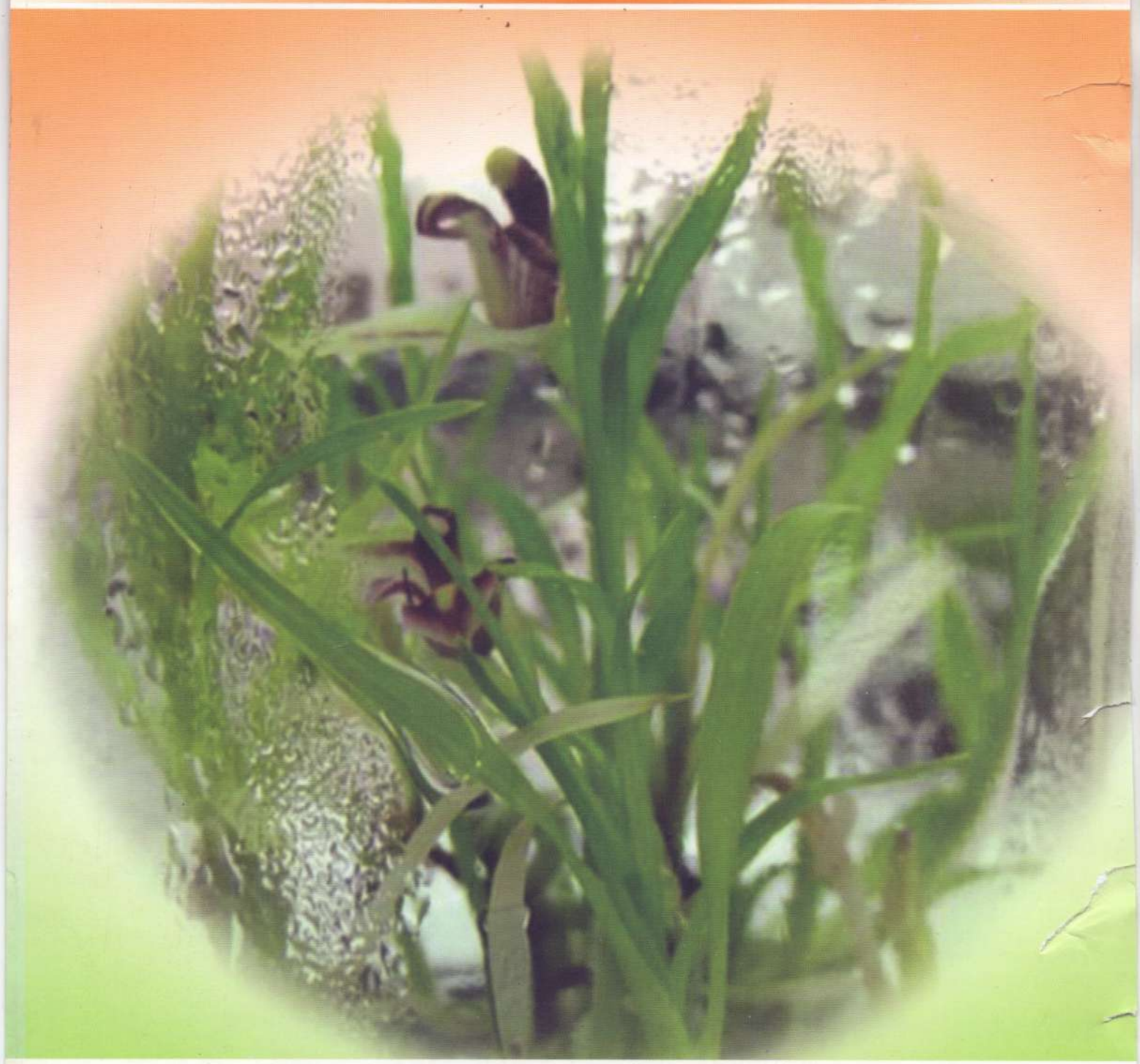
S. No.	Success indicators	Dependence on whom	Dependence for what
1.	Germplasm collection and conservation	National Biodiversity Authority, State Biodiversity Boards, Forest Department, NBPGR	Permission for collection and registration
2.	Release of varieties	AICRP, SVRC, CVRC	Notification
3.	Molecular characterization	Public/private outsourcing agencies	High throughput technical services
4.	DUS characterization	PPV & FRA, NASC Complex, New Delhi	Preparation of DUS test guideline
5.	Plantlets production	DAC, DBT	Human resources and infrastructure development
6.	Training & Demonstration	DAC, NHB, DBT, PPV & FRA, State Departments	Financial assistance and beneficiaries

Section 6: Outcome/Impact of activities of Organisation/ Ministry

S. No.	Outcome/Impact of organisation /RCs	Jointly responsible for influencing this outcome/impact with the following organisation(s)/ departments/ministry(s)	Success Indicators	Unit	FY 2010-11	FY 2011-12	FY 2012-13	FY 2013-14	FY 2014-15
1.	Production of quality seed and planting materials of orchids	DAC/SAU/HMNEH	Increase in commercial production of orchids	Number	1.1	1.2	1.3	1.33	1.33
2.	Technology development for enhancing livelihood security	State line departments	Number of new technologies adopted by orchid growers for enhanced productivity	Number	1	1	1	2	3
3.	Development of improved varieties including value added products	SAU's/ State line departments	Improved varieties and genetic stock	Number	3	3	4	5	5

Glimpses of National Dialogue on Orchids





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