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2009-10



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Cover photographs

Front : *Dendrobium chrysanthum* Lindl.

Back (inside) : *Dendrobium thyrsiflorum* Reichb. f.

Back (outside) : Dense Forests around Triveni - natural habitat of many orchids

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Preface

This is my proud privilege to place this valuable document of Annual Report of National Research Centre for Orchids, Sikkim for the year 2009 – 2010. During the period of under report several significant achievements were made in various fields of research in orchids which is a prospective crop for export from North Eastern Region of the country. Through this document an attempt has been made to highlight various achievements of this centre.



The information generated in the centre could be used in conservation and commercialization of orchids in the country.

In the field of molecular characterization vital database of threatened and endangered species of *Cymbidium*, *Dendrobium*, *Vanda* has been generated which could be useful in checking biopiracy, studying genetic diversity and species relatedness. The efforts are also being made to develop new cultivars suitable for commerce. The protocol for commercially important hybrids has been standardized and being used for mass multiplication. Apart from commercially important orchids, *in vitro* protocols for rare and endangered species are also being developed.

Several experiments were conducted to standardize potting media and nutritional doses for growth and flowering of commercially important orchids. Valuable information has been generated which could be useful in commercialization of orchids. The cultivars of *Cymbidium*, *Dendrobium*, *Vanda*, *Oncidium* and *Phalaenopsis* were identified for cut flower as well as potted flowering plant production. The chemicals required for the pulsing of cut flowers for prolonging their vase life were standardized. The centre has also realized the importance of organic cultivation and several organic formulations were tested and found suitable for enhancing quality and yield of orchids.

Healthy planting material and subsequently saving them from various anomalies during cultivation is an important step for realizing full economic potential of a crop. Viruses are serious pathogens of orchids and indexing results have shown that most of the orchid species and hybrids are infected by viruses. The sensitive diagnostics like ELISA & RT – PCR have been standardized and are in place for the detection of viruses in the planting materials. Based on the results obtained from various experiments the methods for sanitary and phytosanitary have been evolved and are being practiced for the management of various pathogens.

Creating awareness about quality planting material and expanding area under cultivation of *Cymbidium*, 20,000 plantlets have been provided to the growers. For exploiting commercial potential

Executive Summary

- RAPD technique was used for analyzing 10 endangered *Dendrobium* species. Total 458 distinct bands were generated, of which 98.9 % were polymorphic. The molecular analysis grouped all the 10 species into 3 distinct clusters.
- Molecular relationship of 16 Vandaceous orchid species was determined using ISSR primers (UBC) and the results showed multi band patterns.
- 7 *Coelogyne* species were characterized using 16 ISSR markers which generated total 238 bands of which 96.63 % were polymorphic. The molecular analysis grouped all the 7 species into 2 distinct clusters.
- Molecular analysis of rare and endangered *Dendrobium* orchids were done using STM markers. 18 STM primers were optimized for 2 important parameters of PCR i.e. annealing temperature of primers and $MgCl_2$ concentration.
- Molecular analysis of 10 *Vanda* species was done using STM markers. 28 STM primers were optimized for two important parameters of PCR i.e. annealing temperature of primers and $MgCl_2$ concentration.
- 6 crosses involving species of *Cymbidium* and its hybrids and 2 crosses involving species of *Calanthe* were made and seed pods from 6 crosses made during the year 2008 were cultured in vitro.
- 90 accessions of orchids belonging to 24 genera were collected and conserved at Darjeeling Campus of NRCO.
- NPK 20:10:10 at 0.2% and BA 200 ppm produced maximum number of vegetative shoots whereas NPK 10:10:10 at 0.1% and BA 100 ppm initiated flowering in *Cym.* 'Black Magic'.
- Bangkok Blue', 'Larvia', 'Madam Pompadour', 'Big White' of *Dendrobium* and 'Robert Delight Blue' of *Vanda* hybrids were found suitable for cultivation in Sikkim at an altitudes ranging from 1500–4500 feet.
- Application of GA_3 at 50 ppm increased the spike length and BA 100 ppm increased number of spike in *Dendrobium* hybrid 'Thongchai Gold'
- Out of 7 hybrids of *Phalaenopsis* evaluated only 'Brother and Sister' was found promising for cultivation in Sikkim.
- Pre-harvest foliar sprays with micronutrient mixture (0.05 %), glucose (0.1 %) and mustard cake (1 kg/50 litres of water) were found promising for increasing number of spikes/plant and flower number /spike in *Cym.* 'Pine Clash Moon Venus'.
- In *Cattleya*, out of 5 potting mixtures, cocochips + tree bark + cocopeat + brick pieces (4:2:2:2) produced maximum number of flowers /plant and out of 9 hybrids, C. 'Queen Sirikhit' had highest number of florets/spike.
- Out of 16 hybrids of *Dendrobium* evaluated

- for on plant flower spike longevity, 'Madam Pompadour' (50 days) recorded the highest longevity.
- Post harvest treatments with 4 % sucrose + 1 % $\text{Ca}(\text{NO}_3)_2$, 4 % sucrose + 100 ppm salicylic acid and 4 % sucrose + $\text{Al}_2(\text{SO}_4)_3$ improved opening of flower buds, declined flower bud drop and increased vase life in *Cym.* 'Ensikhan'.
 - Impregnating cut spikes of *Cym.* 'Baltic Glaciers' with CoCl_2 (1000ppm) for 15 minutes recorded highest longevity (46 days) over control (39 days).
 - Under DUS testing, characterization and digitalization of 8 hybrids and 2 species of *Vanda*, 12 hybrids and 3 species of *Cymbidium* and 2 hybrids and 13 species of *Dendrobium* were done and morphological descriptor for *Cymbidium*, *Dendrobium* and *Vanda* for DUS testing under National Testing Guidelines (NTG) were finalized.
 - Fertilizer solution having electrical conductivity of 1.5 mS/cm recorded highest growth parameter like plant height, leaf length, pseudobulb length and girth of *Cym.* 'Sleeping Nymph'. Further EC of fertilizer solution 1 mS/cm with NPK 12:30:10 registered highest number of spikes/plant and number of floret/spike.
 - Application of NPK at 12:30:10 resulted in maximum pseudobulb length and girth of *Cym.* 'Sleeping Nymph'. Similarly, the application of Ca at 100ppm + Mg at 100 ppm resulted in highest plant height, leaf length, leaf number, pseudobulb number/plant in *Cym.* Levis Duke 'Bella Vista'.
 - Application of panchgavya at 1 : 20 (panchgavya : water) recorded highest plant height, leaf length, leaf number/plant, pseudobulb length, pseudobulb girth in *Cym.* Levis Duke 'Bella Vista'.
 - RT- PCR of ORSV has been standardized and being used for the detection of ORSV from the planting material.
 - *CymMV* was found positive from seed culture raised plantlets of *C. pendulum* and *C. dayanum* and hybrid PBX – 08 – 31 indicated the possibility of the seed transmission of the virus. .
 - Ciprofloxacin hydrochloride (400 ppm) and tetracycline hydrochloride (1000 ppm) were found sensitive against soft rot bacterium of *Cymbidium* hybrids.
 - Mycelial growth of *Colletotrichum gloeosporioides* was found best on PDA medium whereas for conidial growth OMA medium was found best.
 - Among 9 insecticides and bio - pesticides tested against two spotted red spider mite, imidacloprid 17.8 SL @ 0.3 ml/lit was found best for the control of mite population
 - The maximum percent reduction in scale's crawler population (98.72%) was reported in neem oil 0.03% EC (5ml l⁻¹) followed by ahook 1500 ppm (5 ml l⁻¹)
 - The minimum shoot borer infestation (4.37 %) was recorded on the plants of *Cymbidium* treated with B.t. (dipel) @ 0.012% 7 days after second treatments.

कार्यकारी सारांश

- आर० ए० पी० डी० तकनीक द्वारा डेन्ड्रोवियम की 10 लुप्त प्रायः प्रजातियों का विश्लेषण करने पर 458 सुस्पष्ट पट्टिकाएं पायी गयी। आणविक विश्लेषण द्वारा सभी 10 प्रजातियों को 3 सुस्पष्ट झुंडों में वर्गीकृत किया गया।
- वान्डा की 16 प्रजातियों में आणविक सम्बन्ध निर्धारण करने के लिए आई० एस० एस० आर० प्रवशिकाएं (यू० वी० सी०) का प्रयोग करने पर अनेक पट्टिकाएं प्राप्त हुई।
- सिलोगायनी की 7 प्रजातियों को 16 आई० एस० एस० आर० प्राईमर द्वारा अभिलक्षणन किया गया तथा 238 सुस्पष्ट पट्टिकाएं प्राप्त हुई जिनमें से 96.33 प्रतिशत बहुरूपी थे। आणविक विश्लेषण करने पर समस्त सात प्रजातियों को 2 विभिन्न झुंडों में वर्गीकृत किया गया।
- डेन्ड्रोवियम प्रजाति के लुप्तप्रायः एवं दुर्लभ आर्किड का आणविक विश्लेषण एस० टी० एम० मार्कर द्वारा किया गया जिसमें 8 एस० टी० एम० प्राईमर प्रयोग में लाये गये तथा पी० सी० आर० तकनीक के लिए दो महत्वपूर्ण मापदण्डों जैसे अनीलिंग तापमान और मैगनिशियम क्लोराइड की सांद्रता का निर्धारण किया गया।
- वान्डा आर्किड की 10 प्रजातियों का आणविक विश्लेषण एस० टी० एम० मार्कर द्वारा किया गया तथा पी० सी० आर० तकनीक के लिए दो
- महत्वपूर्ण मापदण्डों जैसे अनीलिंग तापमान और मैगनिशियम क्लोराइड की सांद्रता का निर्धारण किया गया।
- सिम्बीडियम की प्रजातियों के संकरण से 6 तथा कैलान्थ प्राजातियों के दो संकरणों से कैप्सूल प्राप्त किये गए। सन् 2008 के उत्पादित 6 संकरों से प्राप्त बीजों को प्रयोगशाला में सफलता पूर्वक उगाया गया।
- राष्ट्रीय आर्किड अनुसंधान केन्द्र, दार्जीलिंग परिसर में विगत वर्ष के दौरान आर्किड के विभिन्न प्राजातियों के 90 जननद्रव्य क्रमांक संरक्षित किये गये।
- सिम्बीडियम संकर ब्लैक मेजिक में एन० पी० के० को 20:10:10 के अनुपात में (0.2 प्रतिशत) तथा बी० ए० 200 पी० पी० एम० के प्रयोग से प्ररोहों की संख्या में वृद्धि दर्ज की गयी हालांकि पुष्पण के लिए एन० पी० के० को 10:10:10 अनुपात में (0.1 प्रतिशत) और बी० ए० 100 पी० पी० एम० उपयुक्त पाया गया।
- डेन्ड्रोवियम संकरों - बैकाक ब्लू, लारविया, मेडम पम्पाडोर और बिग हवाईट एवं वान्डा के संकर राबर्ट डिलार्ड ब्लू, सिक्किम में 1500 से 4500 फीट की ऊंचाई में पुष्पण के लिए उपयुक्त पाये गये।
- डेन्ड्रोवियम संकर थॉगचाई गोल्ड में 50 पी०

- पी० एम०, जी० ए० 3 का प्रयोग करने पर कणियों (स्पाईक) की लम्बाई एवं संख्या में वृद्धि पायी गयी।
- फैलेनोपसिस के 7 संकरों का मूल्यांकन करने पर, संकर - ब्रादर एवं सिस्टर, सिक्किम में खेती करने के लिए उपयुक्त पाया गया।
- सिम्बीडियम संकर पाइन क्लैश मून वेनस में सूक्ष्म पोषक तत्वों का मिश्रण (0.5 प्रतिशत), ग्लोकोज (0.1 प्रतिशत) और सरसों की खली (1 किग्रा० / 50 लीटर पानी में) प्रयोग करने पर प्रति पौधा पुष्पों की संख्या एवं कणियों की संख्या में आशाजनक वृद्धि पायी गयी।
- केटलिया के 9 संकरों में 5 प्रकार के पोर्टिंग मिश्रणों, कोकोचिप + पेड़ की छाल + ईट के टुकड़े (4:2:2:2) अनुपात में मिलाने पर संकर, सी० क्वीन सिरिख्रीट में सर्वाधिक पुष्प प्रतिपादप एवं सर्वाधिक कणियों की संख्या पायी गयी।
- डेन्ड्रोवियम के 16 संकरों में पुष्पों की उच्चतम दीर्घायु, संकर - डी० मैडम पम्पाडोर (50 दिन) तत्पश्चात डी बिग ह्वाइट जम्बो और डी० लरविया में (48 दिन) पायी गयी।
- सिम्बीडियम संकर, इनसिखान में 4 प्रतिशत सर्करा, 1 प्रतिशत कैल्सियम नाइट्रेट, 4 प्रतिशत सर्करा, 100 पी० पी० एम० सेलीसिलिक अम्ल और 4 प्रतिशत सर्करा एवं एल्यूमिनियम सल्फेट का प्रयोग करने पर फूलों की कलियों में खिलने में सुधार और फूलों के गिरने में कमी तथा कटाई के उपरांत जीवनकाल (27 दिन) पाया गया।
- सिम्बीडियम संकर, वाल्टिक ग्लेसियर में पुष्प कणियों में 1000 पी० पी० एम० कोवाल्ड क्लोराइड 15 मिनट प्रयोग करने पर इनकी उच्चतम दीर्घायु (46 दिन) पायी गयी।
- इस परीक्षण में वन्डा के 8 संकरों एवं 2 प्रजातियों, सिम्बीडियम के 12 संकरों एवं 3 प्रजातियों, डेन्ड्रोवियम के 2 संकरों एवं 13 प्रजातियों का अभिलक्षणन एवं डिजीटलीकरण किया गया तथा डेन्ड्रोवियम वन्डा एवं सिम्बीडियम के सभी प्रजातियों का आकारीकी वर्णन राष्ट्रीय दिशानिर्देशन (एन० टी० जी०) के अन्तर्गत परीक्षण किया गया।
- सिम्बीडियम संकर, स्लीपिंग निम्फ में उर्वरक की वैद्युत चालकता में 1.5 एम० एस०/से०मी० होने पर पौधों, पत्तियों एवं शल्ककन्दों की लम्बाई सबसे अधिक दर्ज की गयी। इसके अतिरिक्त उर्वरक घोल में वैद्युत चालकता 1 एम० एस० प्रति से० मी० तथा एन० पी० के० 12:30:10 के अनुपात में मिलाने पर पौधों में उच्चतम कणियों एवं फूलों की संख्या अधिकतम दर्ज की गयी।
- सिम्बीडियम संकर स्लीपिंग निम्फ में एन० पी० के० 12:30:10 के अनुपात में डालने पर शल्ककन्दों की सर्वाधिक लम्बाई एवं मोटाई दर्ज की गयी। इसी प्रकार सिम्बीडियम संकर लेवेस डियूक वेला विस्टा में कैल्शियम 100 पी० पी० एम० एवं मेगनिसियम 100 पी० पी० एम० मिलाने पर सर्वाधिक पादप ऊंचाई, पत्तियों की लम्बाई, पत्तियों की संख्या तथा शल्ककन्दों की संख्या में वृद्धि पायी गयी।
- सिम्बीडियम संकर लेवेस डियूक वेला विस्टा में

- पंचगव्य का प्रयोग 1:20 (पंचगव्य : पानी) करने पर उच्चतम पादप ऊर्चाई, पत्तियों की लम्बाई, पत्तियों की संख्या, शल्ककन्दों की लम्बाई एवं मोटाई में वृद्धि पायी गयी।
- आर्किड में ओडेन्टोग्लोसम रिंग स्पोट विषाणु का आर० टी० - पी० सी० आर० तकनीक का प्रयोग किया गया जिसका उपयोग पौधों में इस विषाणु का परीक्षण करने के लिए किया जा रहा है।
 - विषाणुजनित सिम्बीडियम के 2 प्रजातियों - पेन्डुलम, डेयानम एवं एक संकर पी० बी० एक्स० - ०८-३१ को बीज द्वारा उगाने पर उसमें सिम्बीडियम मोजेक विषाणु पाया गया है। जिससे इस विषाणु की बीज द्वारा संक्रमित होने की सम्भावनाओं का पता चलता है।
 - सिप्रोफ्लोकसेसिन हाईड्रोक्लोराइड (४०० पी० पी० एम०) एवं टेट्रासाइक्लिन हाईड्रोक्लोराइड (१००० पी० पी० एम०) सिम्बीडियम आर्किड के संकरों में सोफ्टरोट बेक्टीरिया के लिए संवेदनशील पाई गई है
 - कलिटोट्राईकम गिलियोस्पोरोयडिज के माईसिलियम वृद्धि पी० डी० ए० माध्यम तथा कोनिडियल वृद्धि ओट मील अगर माध्यम में अधिकतम पाई गई है।
 - नौ परीक्षण किये गये कीटनाशको एवं जीव कीट नाशकों में इमिडाक्लोप्रिड १७.८ एस० एल० ०.३ मि०ली० / ली० का प्रयोग रेडस्पार्डर माईट की रोकथाम के लिए सर्वोत्तम पाया गया।
 - स्केल क्राउलर की जनसंख्या में अधिकतम कमी (९८.७२ प्रतिशत), नीम का तेल ०.०३ प्रतिशत ई० सी० (५ मि०ली/ली०) तथा अचूक १५०० पी० पी० एम० प्रयोग करने पर पायी गयी।
 - सिम्बीडियम आर्किड में वी० टी० (डाईपेल) ०.०१२ प्रतिशत का ७ दिन के पश्चात दूसरा छिड़काव करने पर सूट वोररों के प्रकोप में कमी पाई गयी।

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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 and bulbous flowering crops. 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 and other bulbous flowering crops.

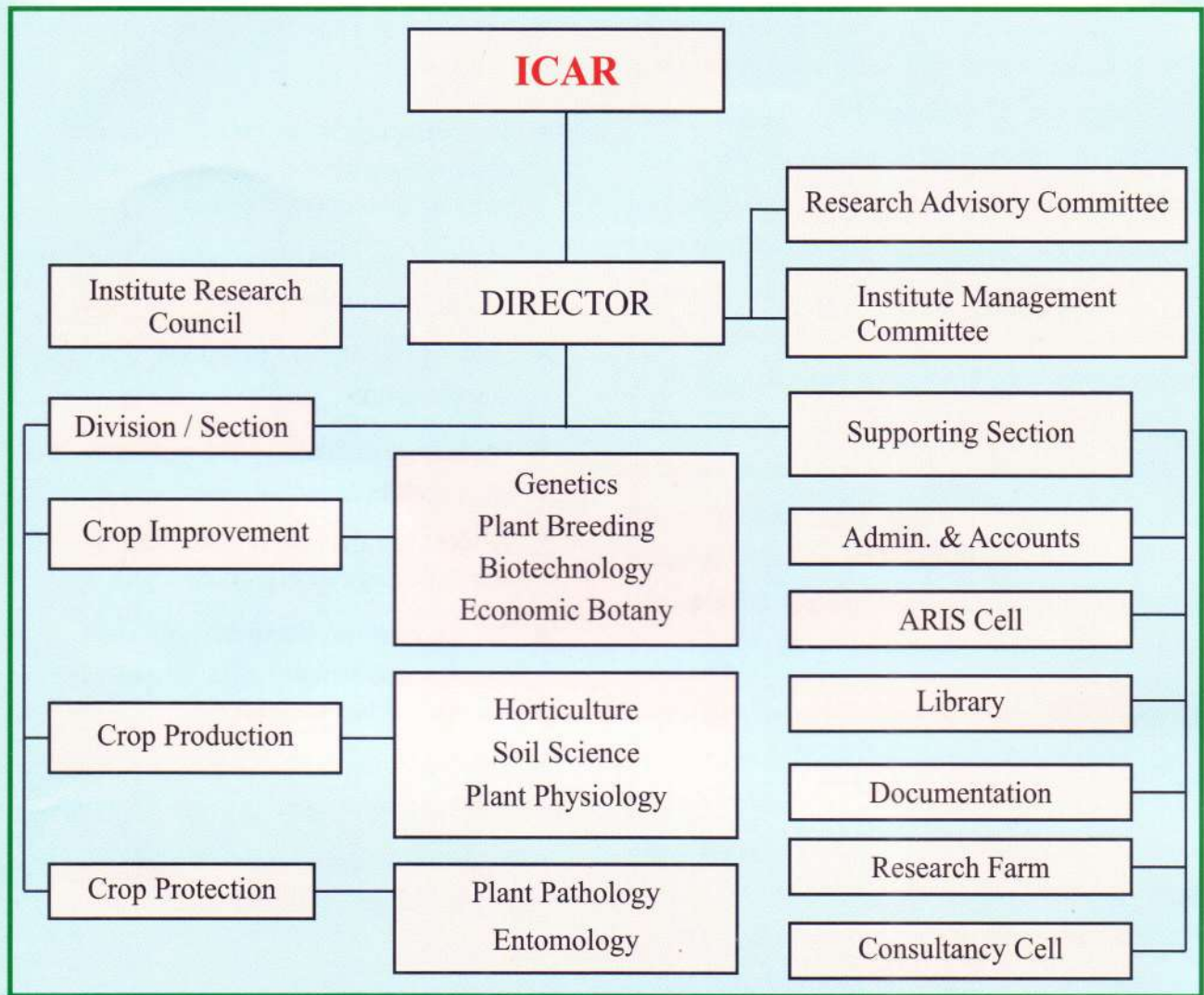
In the initial years of establishment the major focus of research was on collection, conservation evaluation, characterization and utilization of available germplasm in the country in general and north eastern region in particular. With the changing scenario of floriculture in the country, the centre 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 and other ornamental bulbous crops
- Molecular characterization to check biopiracy 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 and ornamental bulbous crops
- 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 12 projects. In addition to these, research work is also being carried out under 4 externally funded projects *viz.* Technology Mission on Integrated Development of Horticulture in North Eastern States including Sikkim, Network Projects on Distinctiveness, Uniformity and Stability on Orchids, DBT's Mission for North-East for Quality Planting Material and Utilization for the North East and NAIP's A Value Chain on Selected Aromatic Plants of North East India

Organizational setup



Organogram of NRC Orchids

Organization

The Director is the administrative head of the Institute. The Institute Management Committee, Research Advisory Committee and Institute Research Council assist the Director in the matters relating to management and research activities of the Institute. Research on various

aspects of mandate crops is conducted in three divisions/sections namely Crop Improvement, Crop Production and Crop Protection. The supporting sections include Administration & Accounts, ARIS Cell, Library, Documentation and Consultancy Cell.

Financial statement

Amount (Rupees)				
Head of Account	Non-Plan		Plan	
	Sanctioned	Utilized	Sanctioned	Utilized
Establishment charges	1,68,69,638.00	1,68,69,638.00		
Labour wages	-	-	-	-
Traveling allowances	1,60,186.00	1,60,186.00	8,00,018.00	8,00,018.00
Other charges	5,48,916.00	5,48,916.00	1,46,30,527.00	1,46,30,527.00
Works	54,440.00	54,440.00	45,00,068.00	45,00,068.00
HRD	-	-	69,387.00	69,387.00
Total	1,76,33,180.00	1,76,33,180.00	2,00,00,000.00	2,00,00,000.00

Revenue generation

Amount (Rupees)			
Particulars	Institute	Project	Total Amount
Sale of farm produce	15,537.00	7,34,055.00	7,49,592.00
Sale of tender form	5,550.00		5,550.00
Training	6,000.00		6,000.00
Others	1,44,830.00		1,44,830.00
Total	1,17,917.00		9,05,972.00

Table 3. Staff position of the institute (as on 31.03.2009)

Sl. No.	Category	Sanctioned strength	In position	Vacant
1.	Director	1	1	-
2.	Scientific Post			
	Scientist	9	4	5
	Sr. Scientist	5	3	2
	Principal Scientist	1	1	-
	Total	16	9	7
3.	Technical Staff			
	Category - I	5	5	-
	Category - II	2	2	-
	Category - III	-	-	-
	Total	7	7	-
4.	Administrative Post			
	Asstt. Admn. Officer	1	1	-
	Asstt. Fin. & Account Officer	1	1	-
	Assistant	1	1	-
	U.D.C/Sr. Clerk	1	1	-
	L.D.C/Jr. Clerk	3	3	-
	Total	7	7	-
5.	Supporting Staff (SSG-I, II, III, IV)	7	6	1

Past achievements

Surveys were conducted for collection of orchid germplasm at various parts of the country. The collected accessions were conserved in conservatories. The accessions of tropical and sub tropical species were conserved at Pakyong (altitude, 1300 msl) while the accessions of temperate species were conserved at Darjeeling campus (altitude, 2150 msl). The germplasm was

characterized for various useful traits. The molecular characterization of germplasm and virus indexing on orchids have been initiated.

Protocols for micropropagation of orchid species and hybrids were standardized. The improved vegetative propagation methods were developed in *Cymbidium*, *Lilium* and gladiolus for rapid multiplication of planting stock. The optimum

Research Achievements

2



Crop Improvement

Molecular Characterization of Orchids

Genetic diversity analysis of some endangered *Dendrobium* orchids using RAPD markers

RAPD technique was used for analyzing the genetic material of ten endangered *Dendrobium* species of Himalayan region. 40 arbitrary primers (Operon 10 mer kit) generated a total of 458 distinct bands of which 98.9 % were polymorphic. The number of bands generated per primer ranged from 8.0 (primer OPI06) to 18.0 (primer OPA03). The molecular analysis grouped all the ten species into 3 distinct clusters - 4 species viz. *D. capillipes*, *D. infundibulum*, *D. chrysotoxum* and *D. pendulum* in cluster I and 3 species viz. *D. bensoniae*, *D. parishii* and *D. thyrsoflorum* in cluster II and 3 species viz. *D. chrysanthum*, *D. densiflorum* and *D. secundum* in cluster III.

The polymorphic patterns generated by RAPD profiles showed different degrees of genetic relationship among the species studied and the RAPD markers were found a useful tool for detecting genetic variation within the species. (Fig. 1)



Fig.1. RAPD banding pattern of *Dendrobium* species using primer OPA02

Molecular variation and fingerprinting of Vandaceous orchids using ISSR markers

16 selected ISSR primers (UBC) were used to differentiate sixteen Vandaceous orchids (ten *Vanda* species, three *Aerides*, one *Ascocentrum*, one *Renanthera* and one *Rhynchostylis* species) to determine their molecular relationship. The results showed multi band patterns and indicated ISSR profiling as a powerful method for assessment of molecular diversity in orchids (Fig. 2)



Fig. 2. ISSR banding pattern of Vandaceous species using primer UBC 858

Molecular analysis of *Coelogyne* orchids using ISSR markers

To study the genetic relationship of 7 *Coelogyne* species 16 ISSR (UBC) markers were used. 16 primers generated total 238 bands of which 96.63% were polymorphic. The molecular analysis grouped all the seven species into 2 distinct clusters - 4 species viz. *C. nitida*, *C. ovalis*, *C. corymbosa* and *C. fuscescens* were closely related to each other showing similar banding patterns and grouped in cluster I. Similarly 3 species viz. *C. flaccida*, *C. graminifolia* and *C. corymbosa* were closely related to each other and belongs to cluster II (Fig. 3).

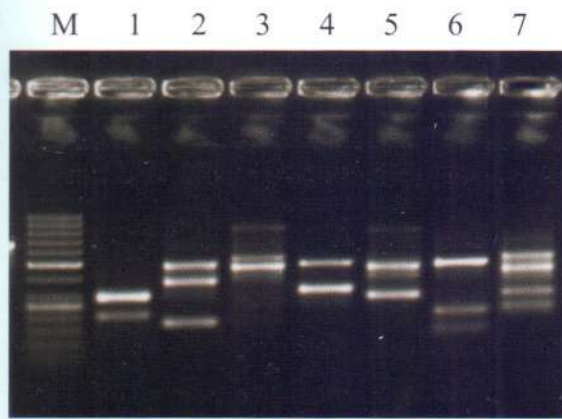


Fig.3. ISSR Banding pattern of *Coelogyne* species using primer UBC841

Molecular analysis of some endangered *Dendrobium* orchids using ISSR markers

16 selected ISSR primers (UBC) were used to differentiate ten endangered *Dendrobium* species to determine their molecular relationship. The results showed multi band patterns and total 289 bands generated from 16 primers of which 99.3% were polymorphic. Cluster analysis grouped all ten species in three distinct clusters – 04 species viz. *D. capillipes*, *D. infundibulum*, *D. thyrsiflorum* and *D. bensoniae* in cluster I, 3 species *D. chrysanthum*, *D. pendulum* and *D. parishii* in cluster II and *D. densiflorum*, *D. chrysotoxum* and *D. secundum* in cluster III (Fig. 4).

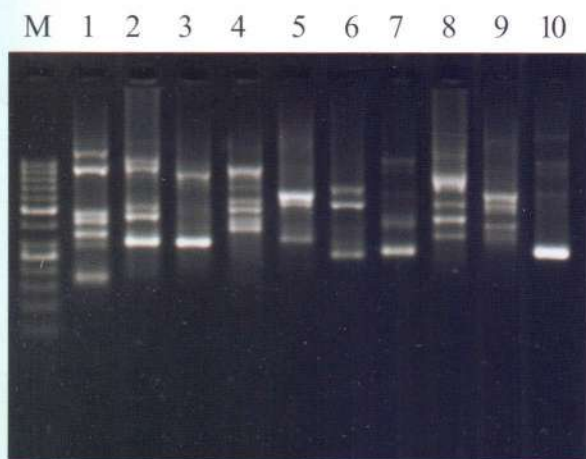


Fig.4. ISSR banding pattern of *Dendrobium* species using primer UBC 889

Molecular analysis of rare and endangered *Dendrobium* species using STM markers

Micro satellite markers are widely used as genetic markers in molecular breeding and genetic diversity assessment as these markers are co-dominant, multiallelic, highly polymorphic and easily scored by PCR. So molecular analysis using available developed micro satellite markers from various species of orchids were constructed to study the genetic variability in rare and endangered *Dendrobium* orchids.

In this study a set of 18 STM primers were optimized for two important parameters of PCR i.e. annealing temperature of primers and $MgCl_2$ conc. The result of PCR amplification of all the primers in ten species indicated high potential to study the genetic variability among and within species (Fig. 5).

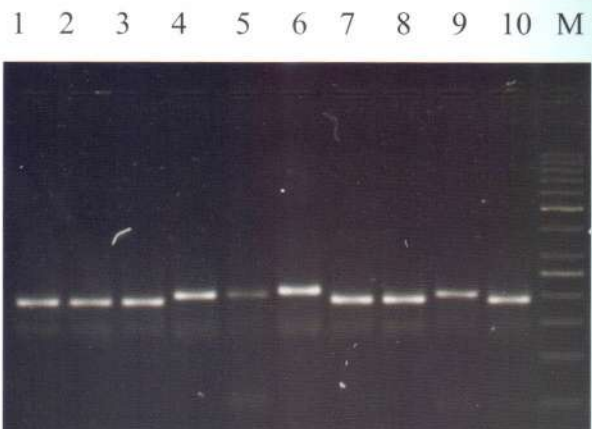


Fig. 5. STMs Banding pattern of *Vanda* species using primer LSPE11

Molecular analysis of *Vanda* using STM markers

In this study a set of 28 STM primers were optimized for two important parameters of PCR i.e. annealing temperature of primers and $MgCl_2$ conc. The result of PCR amplification of all the

primers in ten species indicated high potential to study the genetic variability. The results are the preliminary work (Fig. 6).

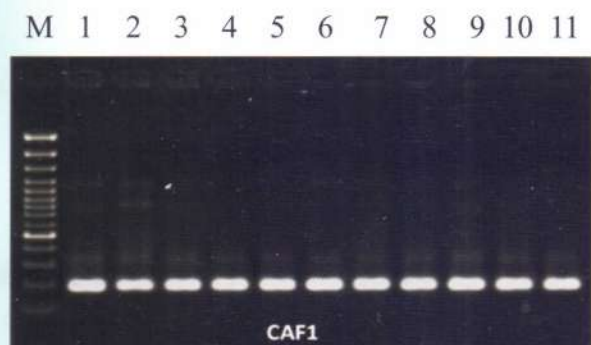


Fig. 6. STMs banding pattern of *Vanda* species using primer CAF1

Molecular phylogeny study of Vandaceous orchids using SSR/micro satellite markers

The genus *Vanda* and the allied genera *Aerides*, *Ascocentrum*, *Renanthera* and *Rhynchostylis* of family Orchidaceae are belong to subfamily Epidendroideae, tribe Vandae and sub tribe Sarcantinea and commonly known as Vandaceous orchids. Vandaceous orchids are commercially important group of orchids, as species of *Vanda* and allied genera have been successfully hybridized among each other to develop many commercial hybrids. Despite the commercial significance, information on molecular genetic relationships between these groups is limited. Moreover, the existing molecular evidence for genetic relationships among Vandaceous orchids are itself inadequate. Therefore, in the present investigation, phylogenetic relationships were analysed among selected Vandaceous orchids of Himalayan region based on DNA sequence polymorphism. Combined DNA sequence data from three nuclear (ITS) and ten plastid loci were employed to extract evolutionary information at multiple loci. Phylogenetic trees were constructed from

each data set considering maximum parsimony (MP) and maximum likelihood (ML) with PAUP software. Results are interpreted in the light of existing knowledge about the Indian Vandaceous species. Overall, the molecular findings provide an improved understanding of the intergeneric relationship of *Vanda* with *Aerides*, *Ascocentrum*, *Renanthera* and *Rhynchostylis*.

Improvement of Orchids

Germplasm collection

Registration proposal for NRCO – 42 has been submitted to NBPGR. Indian Collection identity was given as IC 574581. During this year 7 different species namely. *Dendrobium haemoglossum*, *Dendrobium* species (unidentified), *Cleisotoma tenuifolium*, *Cleisotoma* species (unidentified), *Flickingeria nodosa*, *Cymbidium* species (unidentified) and one unidentified species were collected from M.S. Swaminathan Research Foundation, Kalpeta, Kerela and were inducted to germplasm.

New hybrid lines identified from F1 progeny

Out of twenty five progenies (F1) of a cross between AB X SG only one flowered in this year. The progenies is under study for various morphological characters (Fig. 7).



Fig. 7. Flower of cross AB X SG

In vitro propagation of orchids

The PLBs of *Cymbidium* hybrids were cultured on MS media supplemented with different levels of BAP, Kinetin and IBA. The results revealed that MS + AC + BAP (0.5 mg l⁻¹) resulted faster PLBs proliferation while combined effect of both hormones BAP (0.5mg l⁻¹) + IBA (0.5mg l⁻¹) was best for PLB proliferation.

Effect of different media and hormone levels on germination of crossed embryos of different species and hybrids.

A total of 59 selfed as well as crossed capsules of different *Cymbidium*, *Dendrobium*, *Vanda*, *Zygopetalum*, *Aerides*, *Rhynchostylis*, *Hygrochilus*, *Oncidium*, *Epidendrum*, *Renanthera*, *Papilionanthe*, *Phaius*, *Acampae*, *Arachnis*, *Calanthe*, *Paphiopedilum*, *Eria*, *Kingidium* and *Phalaenopsis* were harvested at 6 - 7 months after pollination. The harvested capsules were sterilized and aseptically cultured on different culture media, viz. MS (Murashige and Skoog), Gamborg's B5 medium (B5), Heller's medium (H), White's medium, Knudson's C medium, Linderman and different treatments of Nistch (NC) media supplemented with or without activated charcoal and sucrose. The different parameters like swelling, greening, globule formation and germination were observed. Germinated seeds were further sub-cultured into different media for their proliferation and differentiation.

Among 59 crossed/selfed species, embryos from 27 crosses responded and protocorms formed while others did not respond to any media. The media and its supplements had played an important role for early swelling, germination

and protocorm development.

The protocorms were sub-cultured on different media using MS with activated charcoal and supplemented with plant growth substances (BAP, Kinetin, NAA and IBA). The presence of BAP and kinetin, in the media resulted in early swelling, globular formation and shoot initiation. The addition of activated charcoal in the media improved plantlet growth and established better when cultured on MS media with 1.5 mg activated charcoal recorded the fastest multiplication of protocorms.

Effect of different media on germination of PBX-08-30

It is observed from the experiment on effect of different media on germination of seeds of PBX-08-30, Nistch media proved the best media for seed germination which took least no. of days for greening (26), globule formation (35) and first PLB's formation (51) compared to other media like MS, Heller, B5, Linderman, Knudson's C and White's medium (Fig. 8).

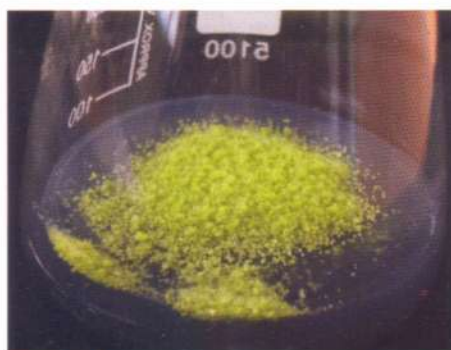


Fig. 8. Seed germination in Nistch media

Impact of growing media on growth of hardened plantlets of *Cymbidium* hybrid 'Sleeping Nymph'

Significant results were obtained from 100 % leaf mould in terms of highest survival rate (100 %), plant height (36.2 cm), number of leaves (12.3),

width of leaves (1.6 cm) and girth of bulb (1.9cm) as compared to other growing media within six months of growing period. Early initiation (30 days) of vegetative shoots were recorded at 100 % sand . However, in another trial 66 % survivability was recorded in 50 % leaf mould + 50 % perlite (Fig. 9, 10 & 11).



Fig. 9. Comparison of different *ex-vitro* growing media



Fig.10. Showing plants in 100% leaf mould



Fig. 11. Showing early initiation of vegetative shoots in 100% sand

In vitro flowering in PBX-05-177

To develop a complete protocol for *in-vitro* flowering in hybridized crosses and screening of intergeneric hybrids for desirable traits an experiment was set up by using Nitsch media supplemented with N:P:K in different ratios. Eight treatments with or without root trimming were studied along with different hormone levels (BAP, GA, ABA). It was observed that plant growth was enormous in case of all the treatment within a month. A large number of roots developed in root trimmed treatment within 20 days (Fig. 12).



Fig. 12. In-vitro flowering experiment

In vitro propagation technique for protocol development of *Cymbidium* hybrids

In order to get complete protocol of *Cymbidium* hybrids from meristem culture, an experiment was set up with basal media as MS medium combined with different hormones like NAA (0.1, 0.2, 0.3 mg l⁻¹), BAP (0.2, 0.4, 0.6 mg l⁻¹). Various hybrids like Baltic Glacier 'Mint Ice', Valley Zenith 'Concorde' & Tracy Reddway 'Sun Gold' were taken for the same. Development of 1st plb in Baltic Glacier 'Mint Ice' took place within 28 days of inoculation. A mass of protocorms have developed within 90 days (Fig. 13).



Fig .13. Plb proliferation stage

Crop Production

Development of Agro – Techniques for Commercial Scale Production of Orchids in Protected Condition.

Experiment on shade requirement and moisture regime for growth and flowering of *Cym. HC 'Aurora'*.

The experiment consisted of four shade levels (0 %, 30 %, 50 % and 75 %) and four moisture regimes (25 %, 50 %, 75 % and 100 %). The moisture level of the media calculated on the basis of water holding capacity and the water was applied at 10 – 15 days interval depending on the weather and moisture content. The experimental results showed that growing of *Cymbidium* under 75 % shade with 100 % moisture regime produced significantly maximum length of leaves (87.82cm) but number of leaves was maximum (52.22) under 0 % shade with 100 % moisture regime when compared to other treatments. Pseudobulb production was maximum (4.72) under 50 % shade with 50 % moisture regime whereas back bulb production was highest in 0 % shade with 0 % moisture regime. Maximum plant height (91.23 cm) and number of new shoots (5.95) were maximum in 75 % shade with 100 %

moisture regime and 50 % shade with 75 % moisture regime respectively.

Optimization of nutrient requirement for *Cymbidium* plants (6 months-old) under hardening

The experiment consisted four concentrations of N, P, K @ 19:19:19 (0 %, 0.1 %, 0.2 % and 0.3 %) and two spray intervals (7 and 15 days). Nutrient solution was given as foliar applications. It was recorded that spraying of nutrient N, P, K 19:19:19 @ 0.1% concentration at an interval of 7 days produced maximum number of shoots (4.07) and higher girth of pseudobulb (2.57cm) while same nutrient at 0.3% concentration at 7 days interval improved plant height (67.79cm) and number of leaves (14.4). Spraying at 15 days interval did not show any remarkable improvement of growth.

Effect of inorganic nutrients and growth regulators on reducing pre-blooming in *Cymbidium* hybrid 'Black Magic'

Inorganic nutrients NPK 10:10:10, 20:10:10 and 30:10:10 were given at two different concentrations at 0.1 % and 0.2 % and growth regulators BA and GA₃ of different concentrations 100 ppm, 200 ppm each and combination of GA₃ 100 ppm + BA 100 ppm and GA₃ 100 ppm + BA 200 ppm were applied as foliar spray. Nutrient spray was given weekly once and growth regulators were given at monthly intervals. The result reveals that foliar application of inorganic nutrient 10:10:10 NPK and BA 200 ppm increased the number of leaves 22.76 and 27.90 respectively. Plant height and leaf length was highest in 20:10:10 NPK at 0.1 % (55.07 and 53.34cm) and BA 200 ppm (52.74 and 50.57 cm). Number of shoots were recorded

maximum in 20:10:10 NPK at 0.2 % (4.09) and BA 200 ppm (4.67). Number of pseudobulbs was found maximum in 30:10:10 NPK at 0.2 % (2.76) and BA 200 ppm (2.67). Flowering was noticed in foliar application nutrient 10:10:10 NPK of 0.1 % concentration with BA 100 ppm.

Evaluation of growth and yield behaviour of *Dendrobium* and *Vanda* in different altitudes of Sikkim

Thirteen hybrids of *Dendrobium* and eight hybrids of *Vanda* were evaluated under different altitudes viz, Pakyong (4500 feet), Ranipool (3000 feet) and Jorathang (1500 feet). Under Pakyong conditions (at altitude of 4500 feet), *Dendrobium* hybrid 'Bangkok Blue' produced more number of pseudobulbs (4.40) and leaves (21.20) followed by 'Lervia' and 'Madam Pampodur'. Number of flower spikes was highest in 'Madam Pink' (3.0/plant), 'Bangkok Blue' (2.0/plant), 'Madam Pampodour' (1.0/plant), and 'Big White' (1.0/plant). Flowering was not observed in following varieties like 'July', 'Fatima', 'Channel', 'Dang Saard' and 'Katingdang'.

Out of eight *Vanda* hybrids in Pakyong (4500 feet), 'Robert Delight Blue' is performing well. Highest plant height (8.66 cm) and number of leaves (10.10) was recorded in 'Robert Delight Blue'. Leaf size (40.67 cm) was recorded maximum in 'Dr. Anek'. Flowering was noticed in 'Robert Delight Blue' and 'Mimi Polcumer' and flowering was not noticed in other varieties like 'Charles Good Fellow', 'Kultana Gold', 'Dr. Anek', 'Thongchai Gold', 'Gorden Dillion Pink' and 'Adisak'.

Among the thirteen *Dendrobium* hybrids in the

Ranipool condition (altitude 3000 feet), Plant height was recorded maximum in 'Lervia' (16.94 cm) followed by 'Madam Pink' (15.63 cm) and lowest in 'Fatima' (6.9 cm). Number of pseudo bulbs was observed more in 'Lervia' (3.3) followed by 'Big White 4 N' (3.2) and 'Bangkok Blue' (3.0). Number of back bulbs were maximum in 'Fatima' (4.4) and minimum in 'Lervia' (1.3). Flower production was more in 'Lervia' and 'Madame Pampadour' (2 flowers/plant each) followed by 'July' and 'Big White 4N' (1.5 and 1.3/plant respectively). Out of eight *Vanda* hybrids 'Robert Delight Blue' is performing well and produced flower.

In Jorethang condition, all the hybrids of *Dendrobium* showed better vegetative growth in terms of height of plant, number of leaves, and number of pseudobulbs. Flower production is more in 'Madam Pink' (4.0/plant), 'Big White' (5.0/plant) and 'Fatima' (4.0/plant). However, in case of *Vanda* only 'Robert Delight Blue' hybrid produced flowers (1.0 spike/plant).

Influence of frequency and mode of application of different growth regulators on *Dendrobium* hybrid 'Thongchai Gold'

Growth regulators like GA₃ (50,100,200 ppm) and BA (50, 100 ppm) were applied in two frequencies (morning and evening spray) and in two different modes like foliar spraying and drenching. Number of canes (6.42) and leaves (13.89) were recorded maximum in GA₃ 50 ppm. Further number of canes and leaves was observed maximum in drenching (6.58 & 13.65) followed by morning spray (6.26 & 10.28) respectively. Fig 1. shows that foliar application of BA at 100 ppm recorded more number of spikes per plant

(2.77 spikes / plant) and spray of growth regulators at morning increased the number of spikes (4 spikes / plant) when compared to other treatments. Application of BA at 100 ppm recorded more number of deformed spikes which is unsuitable for marketing. It was found that deformed spikes were more in drenching when compared to morning and evening spray. Application of GA₃ 50 ppm increase the spike length (48.79 cm)

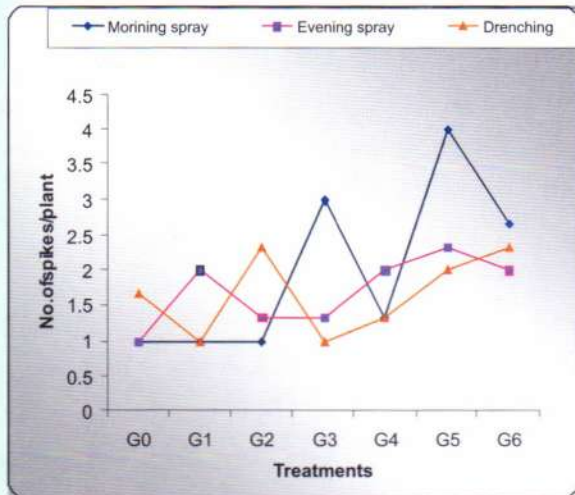


Fig. 1. Influence of frequency and mode of application of different growth regulators on spike production of *Dendrobium* hybrid 'Thongchai Gold'

Influence of drenching and spraying of inorganic nutrients in *Cymbidium* hybrid Levis Duke 'Bella Vista'

Experiment on drenching and spraying of inorganic nutrients in *Cymbidium* hybrid has been carried out with three inorganic nutrients like 30:10:10, 20:20:20, and 15:30:30 NPK at two different concentrations viz, 0.05% and 0.1%. Among the two mode of application, spraying with 0.1% of 30: 10:10 NPK significantly increased the number of leaves (6.20) and plant height (5.56 cm) as compared to other treatment.

Evaluation of growth and flowering of

imported hybrids of *Cymbidium* at Pakyong

Fifteen hybrids of tissue cultured *Cymbidium* were evaluated for their growth at Pakyong condition in two different media namely leaf mould + coco chips + brick pieces (1: 0.5: 0.5) and coco chips + coco peat + brick pieces (1:0.5:0.5). Among the two different medium the plant height and leaf length were noticed maximum in 'Margaret Thatcher Diplomat' (25.46 & 24.71 cm respectively) followed by 'Break Out Flame' (24.10 & 23.34 cm) and number of leaves (8.00) in Valley Inspiration 'Crystal' in leaf mould + coco chips + brick pieces (1:0.5:0.5).

Evaluation of *Phalaenopsis* hybrids for growth and flowering

Phalaenopsis hybrids namely 'Brother and Sister', 'Raman Holiday', 'Taisuco Pixerot', 'Rousserole', 'Taisuco Kochdain', 'Amber Delite X Princess Kaiulani' and 'Thaida Show' were evaluated for their adaptability, performance, growth and flowering behavior under mid hills of Sikkim Himalaya. Among the above hybrids number of leaves per plant (6.60) was higher in 'Brother and Sister' and lowest in 'Thaida Show' (4.4). Plant height was noticed maximum in 'Rousserole'(4.58 cm) and lowest in 'Thaida Show' (3.62 cm). Leaf length was recorded maximum in 'Taisuco Kochdain (67.67 cm) and minimum in 'Thaida Show' (42.36 cm). Flowering was observed in all the hybrids of *Phalaenopsis*.

Effect of NPK on growth and flowering of *Phalaenopsis* hybrid 'Brother and Sister'

Phalaenopsis hybrid 'Brother and Sister' was subjected to three different inorganic nutrients

like 10:20:10, 20:10:20 and 10:20:30 NPK at two different concentrations 0.1% and 0.2%. Among the different treatments foliar application of 10:20:10 NPK at 0.2 % significantly increased the plant height and number of leaves (8.70 cm and 6.33) as compared to other treatments.

Effect of BA and GA₃ on growth and flowering of different *Phalaenopsis* hybrids

Phalaenopsis hybrids namely 'Brother and Sister', 'Taisuco Kochidian', 'Raman Holiday', 'Thaida show', 'Rousserole' and 'Amber Delite X Princess Kaiulani' were treated with different concentrations of BA and GA₃ (25 and 50 ppm each) and distilled water as control. Foliar application of BA 25 ppm increased the plant height and number of leaves in the following *Phalaenopsis* hybrids namely 'Raman Holiday' (7.73 cm and 2.75) 'Rousserole' (9.23 cm and 4.33) and 'Amber Delite X Princess Kaiulani' (7.32 cm and 7.4) as compared to other treatments. However GA₃ @ 50ppm was found effective for production of spikes (2.0/plant) in 'Raman Holiday' hybrid while GA₃ 25 ppm in 'Brother Sister' (1.5/plant).

Development of Integrated Floriculture Enterprise

Five varieties of *Cymbidium* hybrids namely Pine Clash 'Moon Venus', Soul Hunt, Ensikhan, Valley Legend 'Stefi', Winter Beach 'Sea Green' and No.39 were selected for this enterprise. Among these varieties 'Ensikhan' produced flower spikes (1-2 spikes / plant) from September to November and during the March to June (1- 6 spikes/ plant.). Hybrid Pine Clash 'Moon Venus' produced 2 flower spike/plant. Further it produced more number of shoots (2.5 /plant) as compared to

other hybrids.

Four varieties of *Alstroemeria* namely Pink Surprise, Venus, Golden Eye and Passion were grown. Maximum numbers of marketable spike were recorded as 'Golden Eye' (180/m²), 'Pink Surprise' (100/m²), 'Passion' (80/m²) and 'Venus' (60/m²). Three varieties of *Lilium* namely Voltage, Timaru and Solaila were grown. Among them Voltage produced maximum length of spike (75cm) with 4-6 floret/spike. Among the house plants Thuja and Ferns are coming up well.

Production and Post-production Management of Tropical and Sub-tropical Orchids

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

Out of nine treatments, pre-harvest foliar sprays with micronutrient mixture (0.05%), glucose (0.1%) and mustard cake (1 kg/50 litres of water) were found promising in terms of number of inflorescence/plant (1 to 2) and number of flowers/spike (8 to 10) followed by GA₃ (50 ppm) and cow urine (1:20).

Effect of different potting mixture on growth, flowering and longevity of *Cattleya* hybrids

The five potting mixtures (P₁: Coco chips + Coco peat + Tree barks + Brick pieces (4:2:2:2), P₂: Coco chips + Tree Barks + Leaf mould + Brick pieces (4: 2: 2: 2), P₃: Coco chips + Tree Barks + Brick pieces (4: 4: 2), P₄: Coco chips + Coco peat + Brick pieces (4: 4: 2), P₅: Coco chips + Leaf mould + Brick pieces (4: 4: 2) were tested for growth, flowering and longevity of *Cattleya* hybrids. Out of eight hybrids (H₁: B/c Guanmiau City, H₂: B/c Chinese Beauty Orchid Queen, H₃:

L/c Purple Cascade Fragrant Beauty, H₄: B/c Pamela x L/c Raiwan, H₅: C. Queen Sirikhit, H₆: B/c Chalin New City, H₇: L/c Ahmod Sheikhi produced maximum number of flowers /plant on P₁ treatment whereas H₈: B/c Hsinging, C. 'Queen Sirikhit' had highest number of florets/spike (4).

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

Out of sixteen hybrids of *Dendrobium*, D. 'Big White Jumbo' and D. 'Emma White' had earliest floral spike initiation, D. 'Ear Sakul' had maximum spike length (37.5cm), D. 'Dangsaard' had highest number of flowers/spike (14) and D. 'Emma White' showed maximum flower diameter (9.8cm). The maximum longevity of flowers on the plants was recorded in D. 'Madam Pompadour' (50 days). Potting mixtures, cocochips + cocopeat + leaf mould + cow dung + brick pieces (4:2:1:1:2), cocochips + leaf mould + cowdung (5:4:1) and cocochips + leaf mould + cow dung + brick pieces (4:1:2:3) had shown promising effect on earliness in spike emergence, spike length, number of florets /spike and floret diameter.

Post-harvest life of *Cymbidium* hybrid 'PCMV' as influenced by impregnation

In the experiment on impregnation of cut spikes of *Cym.*'Baltic Glaciers', maximum water uptake was recorded with CoCl₂ (1000ppm) for 15 minutes (38ml) followed by CoCl₂ (1500ppm) for 15 minutes (35 ml). Highest longevity was recorded with CoCl₂ (1000ppm) for 15 minutes (46 days) followed by CoCl₂ (1500ppm) for 15 minutes (44days) over control (39 days).

Evaluation of *Cymbidium* hybrids for their vase life

Cymbidium hybrids cut flowers namely 'Baltic Glacier Mint Ice', 'Sleeping Nymph', and 'Valley Pink Inspiration' and 'Valley Flower Powder Puff' were evaluated for their post harvest life. Among the hybrids highest vase life was recorded in 'Sleeping Nymph' (56.90 days) followed by 'Valley Flower Powder Puff' (52.86 days).

Standardization of harvesting stage for *Cymbidium* hybrids

Cymbidium hybrids namely 'Pine Clash Moon Venus', 'Valley Legend Stefi', 'Pure Inca Gold' flower spikes were harvested at four stages like Fully open, 75% open, 50% open and 25% open to standardize the stage of harvesting. Among the four harvesting stages, vase life was noticed highest in 75 % open stage.

Influence of chemical preservatives on bud opening of *Cymbidium* hybrid 'Ensikhan'

Flowers were harvested at bud stage and subjected to different chemical treatments. Treatment combinations of 4% Sucrose + 1% CaNO₃; 4% Sucrose +100 ppm Salicylic acid and 4% Sucrose + Al₂(SO₄)₃ were found effective for opening of maximum number of buds, least bud drop and highest vase life (27days) over control(19 days in distilled water).

Macronutrient Management in Orchids

Effect of electrical conductivity of nutrient solution and fertilization regime on growth of *Cymbidium* 'Sleeping Nymph'.

Three nutrition doses (N₁ - 20:20:20 (NPK), N₂ - 15:5:25 and N₃ - 12:30:10) and four electrical

conductivity ($E_1 - 0.5 \text{ mScm}^{-1}$, $E_2 - 1.0 \text{ mScm}^{-1}$, $E_3 - 1.5 \text{ mScm}^{-1}$ and $E_4 - 2.0 \text{ mScm}^{-1}$) of the fertilizer solution were studied. The results showed that the leaf length gradually increased with the progress of crop growth and recorded highest length with the EC levels of E_3 throughout the growth season under study (Fig. 3). Among the NPK doses, the N_1 recorded highest leaf length throughout the crop growth season and followed the trend, $N_1 > N_3 > N_2$ (Fig. 4). The leaf number/plant was observed highest in the treatment of E_3 throughout the growth season while the nutrition dose of N_1 was highest and followed the trend, $N_1 > N_2 > N_3$.

The pseudo bulb length gradually increased with the progress of crop growth and recorded highest length in E_3 throughout the crop growth season and followed the trend, $E_3 > E_4 > E_2 > E_1$ (Fig. 5). N_3 was better in the early stages of crop growth (Fig. 6). Further, the pseudobulb girth was highest in the treatment of E_3 and followed the trend, $E_3 > E_4 > E_2 > E_1$ (Fig. 7). Among the NPK doses, the girth was recorded highest in the treatment of N_3 and followed the trend, $N_3 > N_1 > N_2$ upto the growth period of Sept - Nov. (Fig. 8). At the early stages of crop growth pseudobulb number/plant recorded highest value in the treatment of E_3 , but at the later stages, it was found highest in E_4 . Among the nutrition doses, the treatment N_1 and N_3 are at par on pseudobulb number/plant. The treatment E_3 recorded highest plant height at the early stage but at the later stages E_4 registered highest plant height followed by E_3 (Fig. 9). The nutrition dose of N_1 (20:20:20) performed better than other doses in terms of plant height throughout the crop growth season under study

(Fig. 10).

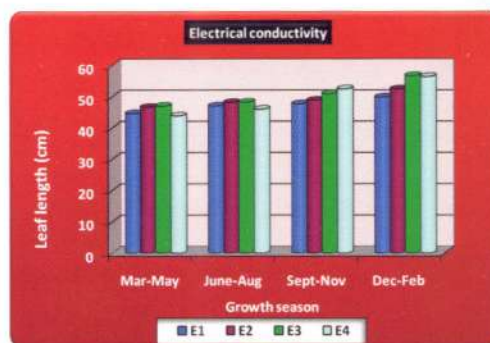


Fig. 3. Mean effect of electrical conductivity of fertilizer solution on leaf length of *Cym. 'Sleeping Nymph'*

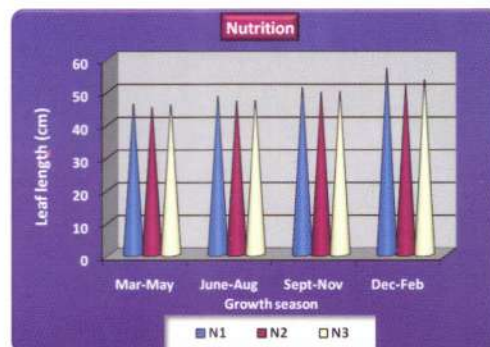


Fig. 4. Mean effect of NPK levels on leaf length of *Cym. 'Sleeping Nymph'*

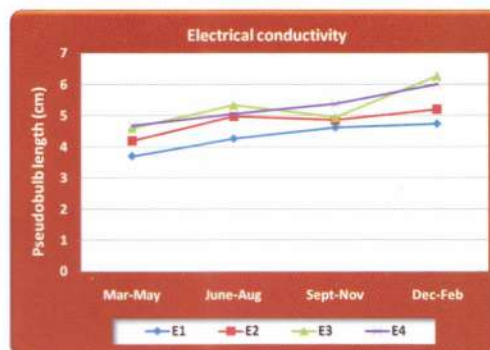


Fig. 5. Mean effect of electrical conductivity of fertilizer solution on pseudobulb length of *Cym. 'Sleeping Nymph'*.

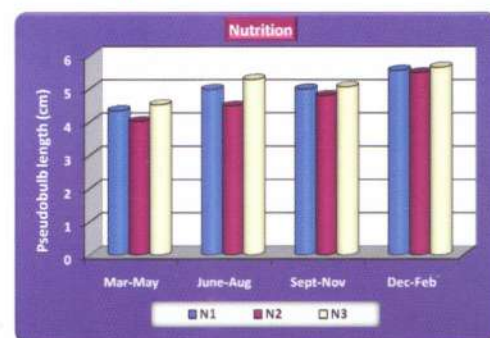


Fig. 6. Mean effect of NPK levels on pseudobulb length of *Cym. 'Sleeping Nymph'*

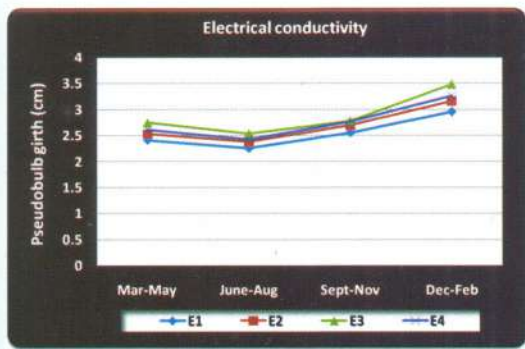


Fig. 7. Mean effect of electrical conductivity of fertilizer solution on pseudobulb girth of *Cym.* 'Sleeping Nymph'

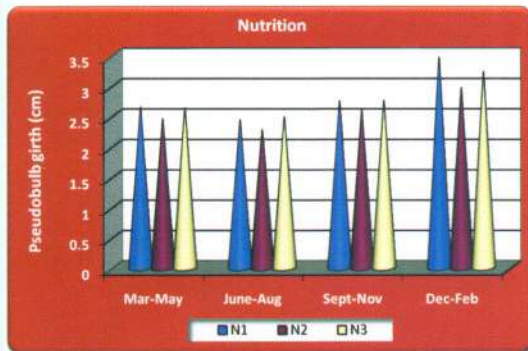


Fig. 8. Mean effect of NPK levels on pseudobulb girth of *Cym.* 'Sleeping Nymph'

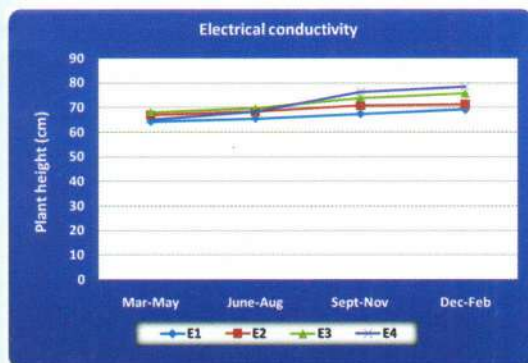


Fig. 9. Mean effect of electrical conductivity of fertilizer solution on plant height of *Cym.* "Sleeping Nymph".

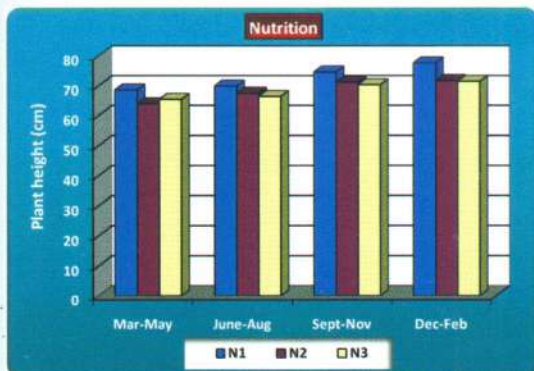


Fig. 10. Mean effect of NPK levels on plant height of *Cym.* 'Sleeping Nymph';

Effect of electrical conductivity of nutrient solution and fertilization regime on flowering of *Cymbidium* 'Sleeping Nymph'



Fig. 11. Spike emergence in *Cym.* 'Sleeping Nymph'



Fig. 12. Floret opening in a single spike of *Cym.* 'Sleeping Nymph'

The effect of different electrical conductivity of fertilizer solution found to have significant influence on various flowering parameters like number of spikes/plant, number of floret/spike, floret length and width, spike length and rachis length (Fig. 11 & 12). The results showed that the number of spikes/plant gradually increased with increasing concentration of fertilizer solution up to 1.5 mS/cm (E_3) and further increase in fertilizer solution leads to no flowering. The NPK dose of 12:30:10 (N_3) was better than 20:20:20 (N_1) and 15:5:25 (N_2) and followed the trend, $N_3 > N_2 > N_1$. The number of spikes/plant was recorded highest of 1.33 and 1.02 with the mean effect of E_3 and N_3 ,

respectively. The number of floret/spike was highest of 10.25 and 8 with the mean effect of E_2 and N_3 , respectively. The number of floret/spike gradually increased up to E_2 and thereafter decreased (Fig. 13). Further the interaction effect shows that the treatment combination of E_2N_3 registered highest number of spikes/plant (1.75) and number of floret/spike (11.25) (Fig. 14).

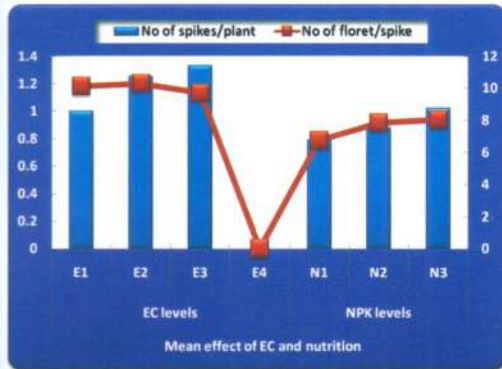


Fig. 13. Mean effect of electrical conductivity of fertilizer solution and NPK levels on number of spikes/plant and number of floret/spike of *Cym. 'Sleeping Nymph'*

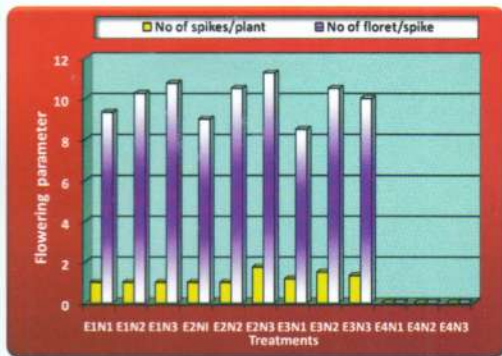


Fig. 14. Interaction effect of electrical conductivity of fertilizer solution and NPK levels on number of spikes/plant and number of floret/spike of *Cym. 'Sleeping Nymph'*

Furthermore, the floret length and width was recorded highest of 4.64 and 6.72 cm, respectively in the fertilizer solution having EC of 0.5 mS/cm (E_1). The NPK levels of 12:30:10 (N_3) was better than 20:20:20 (N_1) and 15:5:25 (N_2) and followed the trend, $N_3 > N_2 > N_1$. The maximum floret length and width was 3.5 and 5.06cm respectively with 12:30:10 NPK (N_3).

The spike length and rachis length was highest of 43 and 21 cm respectively with the application of fertilizer solution having EC of 1 mS/cm (E_2) and followed the trend, $E_2 > E_1 > E_3 > E_4$. The results further shows that the NPK levels of N_3 recorded highest spike and rachis length of 33.43 and 16.03cm, respectively and followed the trend, $N_3 > N_2 > N_1$ (Fig. 15). By comparing the interaction effect, it was observed that the treatment combination of E_1N_3 recorded highest floret length and width of 4.73 and 6.84 cm, respectively. However, the spike length and rachis length was recorded highest of 46.35 and 22 cm, respectively in the treatment of E_2N_3 (Fig. 16).

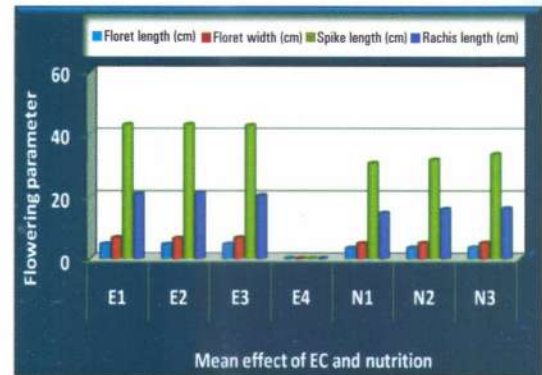


Fig. 15. Mean effect of electrical conductivity of fertilizer solution and NPK levels on flowering parameter of *Cym. 'Sleeping Nymph'*

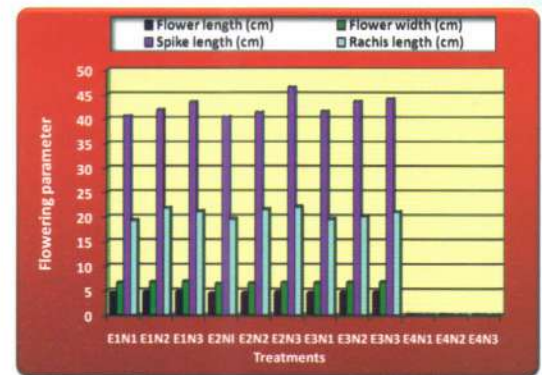


Fig. 16. Interaction effect of electrical conductivity of fertilizer solution and NPK levels on flowering parameter of *Cym. 'Sleeping Nymph'*

Micronutrient Management in Orchids

Effect of calcium and magnesium on growth of *Cymbidium Levis Duke 'Bella Vista'*

The experiment was conducted to study the influence of major and secondary nutrient on growth of *Cym. Levis Duke 'Bella Vista'*. The treatments comprised of T₁: Control; T₂: Ca₁₀₀; T₃: Mg₁₀₀; T₄: Ca₁₀₀+ Mg₁₀₀; T₅: Ca₁₀₀+ Mg₅₀; T₆: Ca₅₀+ Mg₁₀₀ and T₇: Ca₅₀+ Mg₅₀. The recommended doses of NPK were applied to all the treatments. The plants were grown in poly bags containing media of leaf mould + coconut husk + brick pieces (4:2:1) as potting substrate. The results showed that the plant height, leaf length, leaf number, pseudobulb number were highest in T₄ from June 2009 to February 2010. During Dec-Feb, the highest plant height, leaf length, leaf number, pseudobulb number were 34.85cm, 22.1cm, 10.3 and 2, respectively in T₄. (Fig 17).

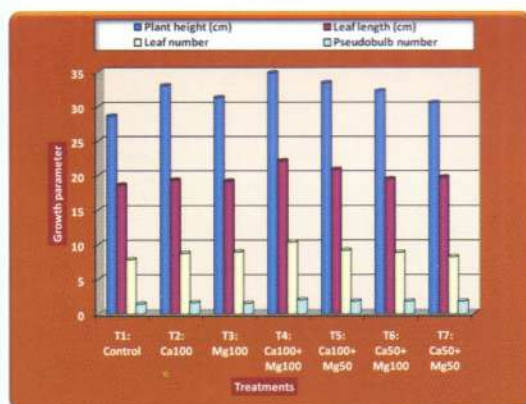


Fig. 17. Effect of Ca and Mg on growth parameter of *Cym. Levis Duke 'Bella Vista'*

Effect of different concentrations of nutrient and growing media on growth of *Cymbidium Levis Duke 'Bella Vista'*

The experiment was conducted to study the influence of calcium and growing media on growth of *Cym. Levis Duke 'Bella Vista'*. The treatments were comprised of four concentrations

of Ca, T₁: Control; T₂: Ca 100ppm, T₃: Ca 200ppm and T₄: Ca 300ppm and four growing media, M₁: leafmould + coconut husk + brick piece (4 :2 :1), M₂: coconut husk + cocopeat + brick piece (4 :2 :1), M₃: leaf mould + cocopeat + brick piece (4 :1 :1) and M₄: coconut husk + vermicompost + brick piece (4 :2 :1). The recommended doses of NPK were applied to all the treatments. Growth parameters like plant height, leaf length, leaf number/plant, pseudobulb number/plant, pseudobulb length and girth were recorded throughout the growth season from June 2009 to February 2010. It was observed that all the growth parameters recorded higher in M₁ followed M₂. Calcium at 200 ppm was found best for the growth of plants. (Fig. 18).

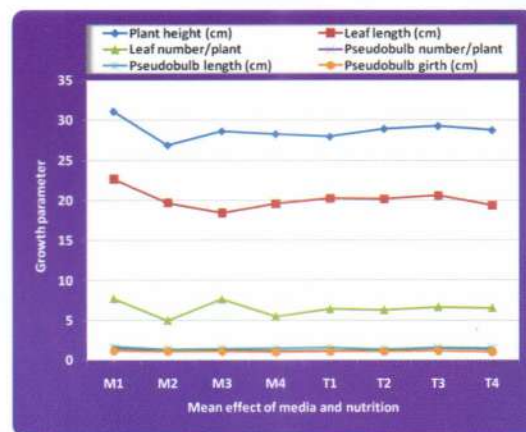


Fig. 18. Influence of growing media and calcium on *Cym. Levis Duke 'Bella Vista'*

Influence of *Panchgavya* on growth of *Cymbidium 'Sleeping Nymph'*

The experiment was conducted to standardise the different concentration of *Panchgavya* for the growth of *Cym. 'Sleeping Nymph'*. The treatments comprised of T₁: Control, T₂: 1 :50 (*Panchgavya*: water) foliar application, T₃: 1 :30 foliar application, T₄: 1 :20 foliar application, T₅: 1 :50 media application, T₆: 1 :30 media

application, T₇ : 1 :20 media application. The results (Fig. 19) show that media application of *Panchgavya* was better than foliar application on different growth parameter like, plant height, leaf length, leaf number, pseudobulb length and girth of *Cym.* 'Sleeping Nymph'. Among the media application, the treatment T₇ recorded highest plant height, leaf length, leaf number/plant, pseudobulb length, pseudobulb girth of 32.32cm, 24.51cm, 10.11, 2.04cm and 1.5 cm, respectively. Among the foliar application the treatment T₄ recorded highest plant height and leaf length of 28.14 and 21.58 cm respectively while the treatment T₃ recorded highest leaf number/plant, pseudobulb length and pseudobulb girth of 9.11, 1.94cm and 1.39cm, respectively.

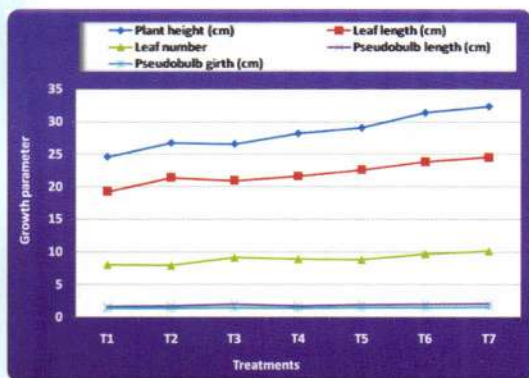


Fig. 19. Effect of difference concentration of *Panchgavya* on growth of *Cym.* 'Sleeping Nymph'

Crop Protection

Disease Management of Orchids

Characterization, detection and management of viruses infecting orchids

Electron microscopy (EM) of orchid sample

The imported *Dendrobium* hybrids namely 'Madam Pink', 'A Abraham' and 'Saard' showing necrotic spots (Fig.1) were examined

under electron microscope. All the hybrids showed very high concentration of flexuous particles (Fig.2). EM observation of *Aerides multiflorum* also showed high concentration of flexuous particles (Fig. 4). However, *Oncidium* hybrids having mild mosaic symptoms, showed very low concentration of spherical particles resembling the particles of Cucumber Mosaic Virus (CMV) (Fig.3).

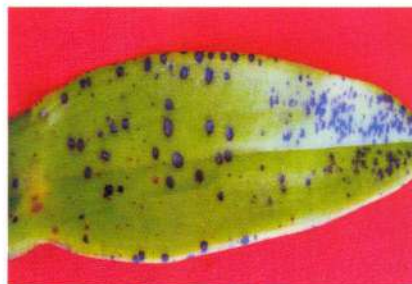


Fig. 1. Leaves of *D.* 'Madam Pink' showing necrotic spots



Fig. 2. EM observation showing flexuous particles from *D.* 'Madam Pink'



Fig. 3. *Oncidium* hybrids showing spherical particle



Fig. 4. *A. multiflorum* showing flexuous particles

Biological indexing

Number of herbaceous plants namely *Datura stramonium*, *Chenopodium amaranticolor*, *C. quinoa*, *Gomphrena globosa*, *Nicotiana glutinosa*, *N. benthamiana*, *N. tabaccum* etc. were mechanically inoculated with CymMV and ORSV from infected orchid species like *Rhynchosstylus retusa*, and *Phalaenopsis* hybrids. The inoculated plants of *Datura stramonium* developed necrotic local lesions 20 days after inoculation (Fig. 5) whereas, *C. amaranticolor* and *Gomphrena globosa* developed local lesions 10 – 15 days after inoculation (Fig.6). *N. benthamiana* developed systemic mosaic symptoms about 10 days after inoculation. All the inoculated plants were further tested for the presence of virus by ELISA and EM.



Fig. 5. *Datura stramonium* showing necrotic lesions on inoculation with CymMV



Fig. 6. Pinkish lesions on *G. globosa* on inoculation with CymMV

RT-PCR of Odontoglossum ringspot virus

Reverse transcription – polymerase chain reaction (RT – PCR) of Odontoglossum ringspot virus was performed using virus specific primers designated from CP sequences from GenBank. The forward and reverse primers designed were 5' GGATCCATGTCTTACTACTATTACAGA-3' and 5'TCTAGATTAGGAAGAGGTCCAAGT-3'. After RT – PCR, 477 bp amplicons of ORSV CP was obtained (Fig.7) and gel purified using the QIAquick Gel Extraction kit (Qiagen,USA) and sequenced.

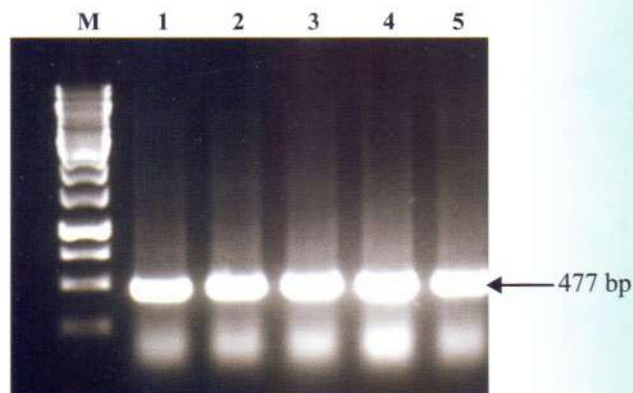


Fig. 7. RTPCR of orchid samples (1-5) showing 477 bp of ORSV coat protein

Virus indexing of commercial hybrids of Cymbidium

A total of 66 commercial hybrids of *Cymbidium* were selected from Sikkim Himalayan Orchids, Assam Lingzey for virus indexing against CymMV and ORSV. It was found that out of 66 hybrids, 15 hybrids were infected with CymMV and 6 hybrids were infected with ORSV in ELISA test.

Virus indexing of seed cultured plants from infected capsules of Cymbidium

A total nine infected capsules of *Cymbidium* species and hybrid were assayed in ELISA for the presence of CymMV and ORSV. ELISA results revealed that CymMV was found positive in outer, inner wall of capsules and undifferentiated seed mass of *C. pendulum*, *C. dayanum*, *C. aloifolium* and hybrids like *Cym.* 'Redstar', *Cym.* 'Show Girl', *Cym.* hybrid (unidentified) and *Epidendrum* sp and ORSV was also found positive in *Cym.* 'Redstar', *Cym.* 'Show Girl' and *Cym.* hybrid (unidentified). However, capsule of *Cym.* hybrid 'WW Wondrous' and *Cym.* hybrid collected from Berring, South Sikkim were found free from CymMV.

ELISA positive capsules of *C. pendulum* and *C. dayanum* and *Cym* hybrid PBX – 08 – 31 were cultured on Nistch media to study the virus transmission from seeds to young seedlings. After about 4 months of cultured seedlings bearing 2 leaves were tested in ELISA for presence of CymMV and ORSV. Out of 20 seedlings tested of each species, 5 seedlings each of *C. pendulum* and *C. dayanum* and 3 seedlings of hybrid PBX – 08 – 31 were found positive with CymMV. However, ORSV was not found positive in any of the seedling tested.

Etiology of fungal and other diseases affecting orchids

Diseases caused by various fungal pathogens and their incidence on different orchid species and hybrids were monitored regularly at the centre. Anthracnose disease of orchids caused by *Colletotrichum gloeosporioides* was noticed as most prevalent disease in Sikkim.

Monitoring the incidence of anthracnose on various orchid species

Anthracnose was commonly found in various orchid species/hybrids throughout the year in the germplasm of NRC (O) and adjoining farms. The following orchid species were seriously affected by the disease during the year namely: *Calanthe masuca*, *Pholidota articulata*, *Bulbophyllum guttulatum*, *Coelogyne* sp. (NOAC # 1162), *Phaius tankarvillae*, *Eria bamboosifolia*, *Cymbidium gammieanum*, *Vanda Ratch Blue Stars*, *Phaius flavus*, *Liparis longipes* and *Tainia hookerenium*.

Symptom development: Anthracnose produces dark coloured spots on leaves with slightly raised rim. The fungus affects all the aerial parts of the

plants but most commonly it infects leaves. Initially small oblong to circular, oval, sunken and reddish brown to dark brown and gray coloured spots appears on the tip or middle of the leaf lamina, which gradually enlarges and covers large area of the leaf surface. The disease generally starts from tip and move downward which is called dieback symptoms. This is most common in all the orchid species and hybrids. Finally it turns black and covers entire leaf resulting defoliation or death of the leaf. It produces conidia within black acervuli. It also affects leaf sheaths and floral spikes. In nature, it is found mostly in conidial stage and can over winter as mycelium or conidia

Isolation and characterization of the fungus:

Anthracnose infected orchid species were collected from the germplasm at NRCO. The infected leaf tissue was surface sterilized in 0.1% mercuric chloride (HgCl₂) followed by washing with distilled water and placed on potato dextrose agar (PDA) and incubated at 28 °C and observed for growth. The white mycelial growth of fungus appeared after 72 h of incubation that gradually turned grayish in colour.

Growth of *Colletotrichum gloeosporioides* in different media

An experiment was conducted to find out best medium for the growth of the fungus. The growth of the fungus was monitored on different culture media like Potato Dextrose Agar (PDA), Oat Meal Agar (OMA), Lima Bean Agar (LBA) and V-8-Juice Broth + Agar (V-8-JBA). The fungus isolated from *Eria bamboosifolia*, *Liparis longipes* and *Phaius tankervillae* were grown in these media. It was observed that for mycelial growth PDA was the best medium whereas for

conidial growth OMA was found most suitable.

Isolation of *Alternaria* sp. from *Zygopetalum intermedium*

A large population of *Zygopetalum intermedium* was showing black spots with dark patches at the adaxial surface of the leaves at NRCO collection. The infected leaf samples were surface sterilized and plated on PDA. After 48 h, brownish growth of the fungus observed which later turned blackish. Microscopic observation revealed the presence of large number of conidia of *Alternaria* sp. The species of the fungus is under investigation.

Characterization of bacterial soft rot on *Cymbidium* hybrid and species

Severe infections of soft rot were found on *Cymbidium* hybrids, "Winter Beach Sea Green", "WW 'Wondrous'" and species "*Eria pubescence*" during rainy season. The bacterium generally infects young side shoots however, the main bulb remains unaffected in *Cymbidium* hybrids. But in *E. pubescence* the main shoot is also attacked (Fig 8). The infected plants initially showed water soaked lesions that later turned grayish – green and rapidly enlarged. The affected areas became soft, decayed and turned brown in colour. With increasing severity the internal tissue disintegrate and produced foul smell and subsequently the side shoots rotten and collapsed completely. The rotten portion of the leaf was taken and surface sterilized and plated on nutrient agar medium. The bacterial colonies were observed after 48 h of incubation. Bacterial colonies on nutrient agar were creamish white, circular, raised with an entire edge and about 1.0 mm in diameter. Bacteria were small, rod shaped, gram negative with peritrichus flagella (Fig. 9 &

10).

The 72h old culture was dissolved in sterile water and the suspension having OD value 0.40 was injected by hypodermic syringe to 10 healthy plants of *Cym.* 'Winter Beach Sea Green' and *Cym.* 'WW Wondrous'. The control plants were inoculated with sterile water. After inoculation plants were covered with moist polythene. After 72 h same symptoms were observed. On re – isolation same pathogen was isolated and thus proving the pathogenicity of the pathogen.



Fig. 8. Symptoms of bacterial soft rot on *Cym.* 'Winter Beach Sea Green'



Fig. 9. Isolation and purification of bacterial colonies



Fig.10. Electron micrograph of bacterial cells (left) and a single bacterial cell with peritrichus flagella (right)

Antibiotic Sensitivity Test: An experiment was conducted to test the sensitivity of the bacterium against different antibiotics *in-vitro*. Four antibiotics namely, Tetracycline hydrochloride

(HOSTACYCLINE) TH, Streptomycin sulphate (PLANTOMYCIN) SS, Ciprofloxacin hydrochloride (FLOXIP) FL, Cefadroxil monohydrate (CEFADROX) CF were used in concentrations ranging from 150 – 1000 ppm. Ciprofloxacin hydrochloride (400 ppm) was most effective followed by Tetracycline hydrochloride (1000 ppm). Other antibiotics were not effective against the bacteria. This shows that the bacterium is sensitive to Ciprofloxacin hydrochloride and tetracycline hydrochloride.

Leaf spot disease and flower rot of *Phalaenopsis* and *Dendrobium* hybrid

Phalaenopsis and *Dendrobium* hybrids showing water soaked lesions followed by black sunken spots were observed on number of plants during the year. The leaf spots were surface sterilized and inoculated on nutrient agar medium. After 48 h bacterial growth was observed. The characterization of the pathogen is under progress.

Integrated Pest Management in Orchids

Insect–host preference studies in Orchids

Pests of orchids - host range: The survey was undertaken at institute's farm, Kartok village, Upper Namchebong, Pakyong, Assam lingzey, Namligarden and Namchi during the year for pests infestation on orchids. The observations were recorded on samples collected from different places at different time interval. Mite, *Tetranychus urticae* was found to infest 215 species under 44 genera. The observations made at institute's farm revealed that five species and 18 hybrids of *Cymbidium* including other species

of orchid were found infested. Scale insects namely *Pinnaspis buxi*, *Diaspis boisduvali*, *Coccus hesperidum*, *Lecanium* sp. and *Chrysomphalus aonidum* were observed on many species and hybrids. Scale insects generally damage the plants by sucking the cell sap from pseudobulbs, leaves, petioles, flower buds and flowers. Two species of aphids (*Macrosiphum luteum* and *Toxoptera aurantii*), Mealybug, *Pseudococcus maritimus*, shoot borer, *Peridaedala* sp., black weevil, thrips, slugs and snails, grass hopper and lepidopteran caterpillars were found infesting various orchids species during the year.

Monitoring of orchid pests

Shoot borer, *Peridaedala* sp: The total 180 plants of *Dendrobium nobile* were observed at fortnightly interval during May to September and 57 of them were infested by the borer. Adult female laid eggs singly on new shoots subsequently newly emerged larvae bored into shoots downward by making tunnel and feeding inside the stem/ cane. Larval excreta can be seen coming out from the hole made by larvae. Due to shoot borer damage whole plant growth was checked, flower production was affected and some time resulting death of the shoots (Fig. 12).



Fig. 12. *D. nobile* showing shoot borer infestation

Thrips, *Dichromothrips nakahari*: The incidence of thrips, *D. nakahari* was recorded on *Cymbidium* species/hybrids, *Dendrobium*, *Coelogyne* and *Epigonium* throughout the year. The flowers from all 35 plants (100 %) of *Dendrobium densiflorum* were having infestation. The thrips infestation on vegetative parts showed discolouration, stunting with loss of vigor and ultimately poor quality flowers (Fig. 13).



Fig. 13. Thrips infestation on *D. densiflorum* flowers

Two spotted spider mite, *Tetranychus urticae* : It has been recorded on 6 species and 17 hybrids of *Cymbidium* and 7 other species of orchids. Its infestation was observed through out the year. All 150 plants of *Cym* Winter Beach 'Sea Green' understudy were found infested. All active stages (nymph and adult) feed on undersurface of leaves and flowers by sucking the cell sap from epidermal layer, especially along with midrib. The loss of cell sap caused yellowing of leaves and silvery marks were left on both sides of leaves which usually turned brown or black after a period of time. In case of severe infestation, whole plants got weakened, resulting stunted growth and loss of foliage (Fig. 14).



Fig. 14. *Cymbidium* plant showing infestation of spider mite

Yellow aphid, *Macrosiphum luteum* : This insect cause damage by sucking the juice from bud as well as from open flowers and secretes honeydew which invite black ants. The aphid infestation lowers the marketable price of flower (Fig. 15)



Fig. 15. Yellow aphid infestation on *D. nobile*

Seasonal occurrence of two potted spider mite, *Tetranychus urticae*

The study on occurrence of spider mite on orchids under polyhouse conditions showed that insect cause damage through out the year. Its population reached at maximum during second to third week of May when the maximum & minimum temperature, RH and rainfall was 25.10 °C, 11.27 °C, 81% and 30 mm respectively. The maximum

temperature and relative humidity had positive correlation whereas, minimum temperature and rainfall had negative correlation with mite population (Fig. 16).

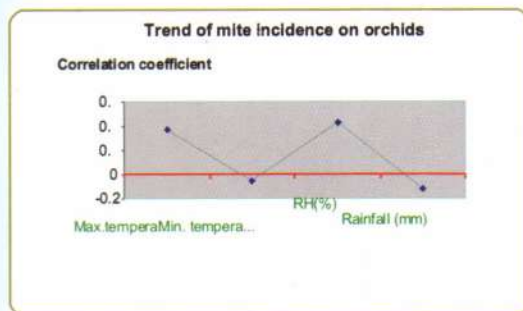


Fig. 16. Trends of mite incidence on orchids

Pests Management in *Cymbidium*

Evaluation of bio-pesticides and insecticides against mite on *Cymbidium*

An experiment was conducted during 2009-10 to evaluate the bio efficacy of some insecticides and bio pesticides against two spotted spider mite, *Tetranychus urticae* on *Cymbidium* under polyhouse conditions. Nine treatments (including control) viz., propargite 57 EC (0.25%), imidacloprid 17.8 SL (0.3 ml/lit), dicofol 18.5 EC (0.05%), bifenthrin 10 EC (0.25%), ethion 50 EC (0.05%), achook (NSKE) 1500 ppm 5ml l⁻¹, neem oil 0.03 EC 5ml l⁻¹ and tobacco extract 5% were applied on three years old potted plants. The experiment was laid out in complete randomized design and each treatment was replicated thrice. The results revealed that all the treatments were significantly effective against mite. The maximum percent reduction (98.67%) in mite population was recorded in the treatment of bifenthrin (Talstar) 10 EC followed by propargite 57 EC (0.05%) and imidacloprid 17.8 SL @ 0.3 ml l⁻¹.

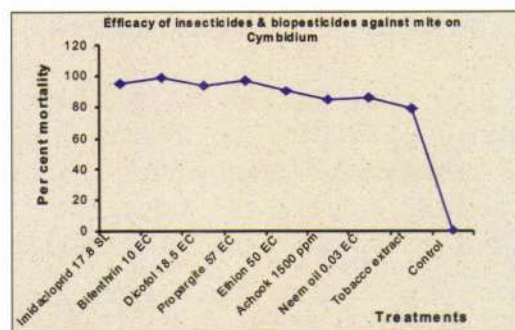


Fig. 17. Efficacy of insecticides & biopesticides against mite on *Cymbidium*

Field evaluation of bio-pesticides against ti scale, *Pinnaspis buxi* on *Cymbidium*

In a pot experiment, the bioefficacy of neem oil 0.03 % EC @ 5 ml l⁻¹, garlic extract 5 %, chilaune leaf extract (*Schima wallichii*) 10 %, dhatura leaf extract 10 %, achook 1500 ppm (NSKE) 5 ml l⁻¹, tita pat extract (*Artemisia*) 10 %, tobacco extract 5 %, B.t. (dipel) 0.012 % and cow urine 50 % were tested against ti scale on *Cymbidium* under protected conditions. All the bio-pesticide were significantly superior over control in reducing the insect population. The maximum percent reduction in scale's crawler population (98.72 %) was found in neem oil 0.03 % EC (5ml l⁻¹) followed by achook 1500 ppm (5 ml l⁻¹).

Trial on efficacy of bio-pesticides against shoot borer, *Peridaedala sp.* on *Epidendrum*

An experiment was carried out to test the efficacy of neem oil 0.03 % EC (5 ml/lit.), garlic extract 5 %, chilaune leaves extract (*Schima wallichii*) 10 %, dhatura leaf extract 10 %, B.t. (Dipel) 0.012 %, tita pat leaf extract (*Artemisia*) 10 %, tobacco extract 5 %, , and NPV 0.10 % against shoot borer. at fortnightly interval. All the treatments were significantly superior over control. The minimum shoot borer infestation (4.37 %) was recorded on the plants treated with B.t. (Dipel) @ 0.012 % followed by neem oil 0.03 % EC @5 ml l⁻¹. and

NPV @ 0.10% at 7 days after second spray.

Screening of botanical products for management of thrips, *Dichromothrips nakahari* on *Dendrobium nobile*

An experiments were conducted to evaluate the botanical products of *Azadirachta indica*, *Allium sativum*, *Schima wallichii*, *Artimesia*, *Nicotiana tobaccum* and *Datura stramonium* against the thrips. on *Dendrobium nobile* under polyhouse conditions. The spray with neem oil 0.03% EC (82.10%) and achool (NSKE) 1500 ppm (81.57%) were found most effective in reducing pest population over control.

Biology of two spotted spider mite (*Tetranychus urticae*) on orchid

Biological studies of two spotted spider mite were carried out in the laboratory under BOD conditions on leaves of *Cymbidium* hybrid "H C Aurora" at average temperature 29.0°C and 71 percent relative humidity during May-June. A stereo zoom trinocular microscope was used for observing the duration of various stages of the mite. It was observed that mite passes through five developmental stages viz., egg, larva,

protonymph, deutonymph and adult. The female laid egg singly which was pearly white, transparent hatch in 2-3 days and larva lasted for 1 day and few hours. Nymphal (proto and deuto) period lasted for 1-2 days and became adult. The total life span of the pest was average of 10-11 day on orchids. (Fig. 18).

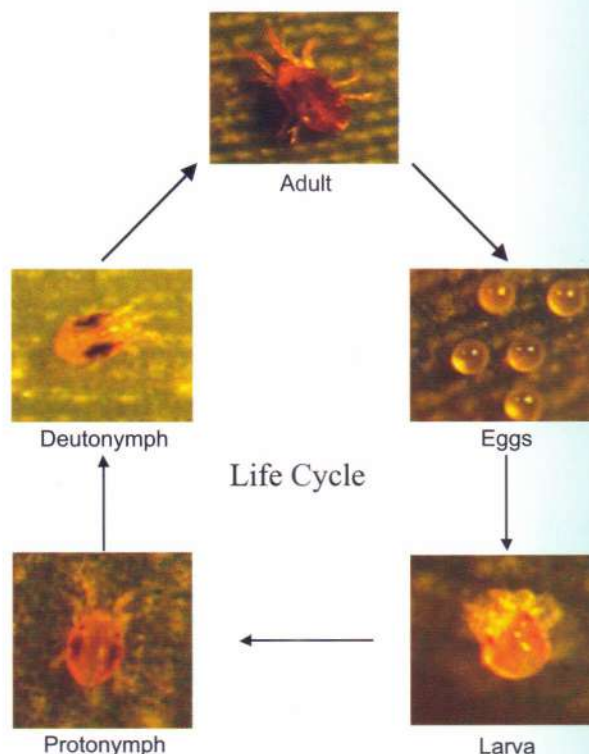


Fig: 18. Life Cycle of Spotted spider mite

Darjeeling Campus

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

Germplasm collection

Explorations were conducted to Chatakpur, Bijanbari, Sukiha, Aloobari forest areas of Darjeeling district of West Bengal. The survey resulted in collection of 90 accessions. These accessions were belonging to genera *Calanthe*, *Coelogyne*, *Cymbidium*, *Pleione*, *Microstylis*, *Satyrium*, *Dendrobium*, *Phaius*, *Eria*, *Anoectochilus*, *Habenaria*, *Spiranthes*, *Anthogonium*, *Cremastera*, *Goodeyera*, *Liparis*, *Bulbophyllum*, *Epigenium*, *Microstylis*, *Eria*, *Herminium*, *Sunipia*, *Agrostophyllum* and *Ritaria*.

Characterization and evaluation of germplasm

The orchids collected at Darjeeling campus of NRCO were evaluated for their horticultural traits. Data from *Cymbidium elegans*, *C. erythraeum*, *C. lowianum*, *C. tracyanum*, *Calanthe yucksomnensis*, *C. brevicornu*, *C. chloroleuca*, *Coelogyne nitida*, *C. corymbosa*, *C. longipes*, *C. elata*, *Paphiopedilum insigne*, *P. villosum* and *Cymbidium* hybrids were collected.

In vitro multiplication

Mature capsules of *Coelogyne nitida* (white variant) were collected from the green house grown plants. The capsules were surface sterilized by immersing them in alcohol (90%) for few seconds and flaming. The surface sterilized capsules were cut open with sterilized

scalpel blade to take out seeds for germination *in vitro* on different media. Approximately 50 seeds were sown in a tube containing 20 ml medium were cultured on eight different culture medium. The cultures were incubated at $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ under 16 hr photoperiod of 3500 lux intensity. The seeds failed to germinate on most of the culture medium and if germinated only 1-4 seeds were developed in to plantlets. The maximum 10 plantlets/ tube were obtained from B5 medium. However, when these plantlets were sub cultured on medium containing 100 ml coconut water produced multiple shoots.

Promising genotype

Variegated *Cymbidium*

The variegated *Cymbidiums* have been reported from China. These *Cymbidiums* are highly prized as they possess beautiful variegated leaves as well as flowers. While micropropagating of *Cymbidium* cultivars Levis Duke 'Bella Vista', and Vivacious 'Super White' several types of variegation was observed in the leaves of above mentioned cultivars (Fig 1). The variegated *Cymbidiums* are under the study for their stability.

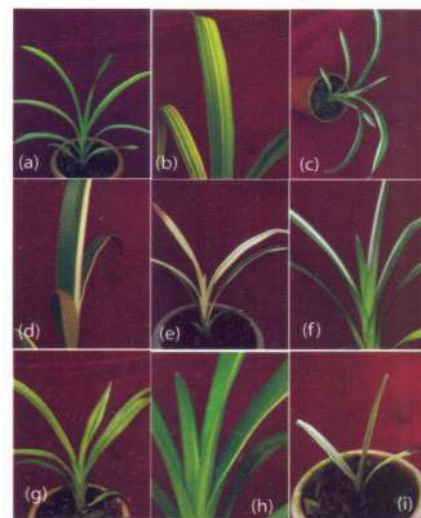


Fig. 1. *Cymbidium* plants showing various types of variegation in leaves

Value addition

A cross (CRS/1/06) was made in 2006. Subsequently, it was cultured *in vitro* in 2007 and the plantlets were hardened grown *ex vitro* in 2008. Nearly 1500 F₁ progenies have been raised and are expected to flower during 2011 – 2012. Seven crosses were made in 2008 to induce variability in existing germplasm. The five of which were involving *Cymbidium* hybrids and species and other two were involving the species of *Coelogyne*. The seeds of *Cymbidium* crosses were germinated on KC (Knudson's C) medium while the crosses of *Coelogyne* were germinated on B5 medium (Fig 2).



Fig. 2. Germination and seedling development in crosses made during 2008

Eight crosses were made during 2009 of which six involved species and hybrids of *Cymbidium* and two involved the species of *Calanthe*. The seed pods of these crosses are in developing phase (Fig 3) and would be cultured in 2010.



Fig. 3. Pod development in crosses of *Cymbidium* and *Calanthe* made during 2009

In vitro Conservation of Orchid Germplasm: *Paphiopedilums*

Green capsules (330 days old) were procured from green house. The capsules were sterilized by immersing pods in alcohol (90 %) for few seconds and flaming. The surface sterilized pods were cut open with sterilized scalpel blade. Approximately, 100 seeds were cultured on 25 x 150 mm test tube containing 20 ml Thomale G D medium supplementing with various concentrations coconut water and peptone. The cultures were incubated in dark for 40 days at 25 °C ± 2°C thereafter brought under 16 hr photoperiod of 3500 lux intensity. The seeds formed white protocorms which turn green afterwards. The medium supplemented with coconut showed early germination and plantlet development than peptone supplemented medium. The raised seedlings would be studied for standardization of *in vitro* conservation methods. (Fig. 4).



Fig. 4. Effects of coconut water and peptone on seed germination and seedling growth *Paphiopedilum villosum*

Externally Funded Projects

Horticulture Mission for North East and Himalayan States (Scheme earlier known as TMNE) (Mini Mission- I)

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

Crop	Variety	Type of planting material	Targets 2009-10	Achievements 2009-10	Shortfall (if any)	Reason for Shortfall	Income generated through sale of planting materials/Free Distribution (mention number and beneficiary)
Orchids	<i>Cymbidium</i> (7 hybrids) <i>Cattelya</i> hybrid	Tissue cultured plants	10000	Total production = 27146 (protocorms, plantlets under <i>in vitro</i> , plantlets in hardening)	-	-	1000 plants distributed to 10 farmers at free of cost Name of the Beneficiaries 1. Hasta Bahadur Thapa, Luing, Parbing 2. Dhan Bahadur Thapa, Luing, Parbing 3. D. B. Subba, Dalapchand 4. Doman Dass, Dalapchand 5. Sai kumar Rai, Assam Lingzey 6. Kishore Rai, Assam Lingzey 7. Rinzing Ongmu Lepcha, Pabyuik 8. Chetra Bdr. Rai, Naitam 9. Soman Dadul Lepcha, Radong 10. Geeta Nepal, Tintek.

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

- Characterization of the following species and hybrids of *Vanda*, *Cymbidium* and *Dendrobium* orchids were done based on common descriptors.
- **Hybrids of *Vanda***
 - ◆ *V.* Sansai Blue, *V.* Ratch Blue Star, *V.* RBV 10 x *V.* Fuchs D, *V.* RBV 10 x *V.* Dr. Anek., *V.* Pakchong Blue', *V.* 'KS'SD, *V.* 'Prao Sky Blue', *V.* 'Pures Wax',
- **Species of *Vanda***
 - ◆ *Vanda coerulescens*
- **Hybrids of *Cymbidium***
 - ◆ *C.* Fire Storm 'Blaze', *C.* Bob Marlin 'Lucky', *C.* WBSG, *C.* Madrid 'Forest King', *C.* 'W.W.W., *C.* 'Red Star', *C.* ' Dos Pueblos', *C.* 'Yankilla', *C.* 'Show Girl', *C.* 'Sun Gold'
- **Species of *Dendrobium***
 - ◆ *D. kingianum*, *D. aphyllum*, *D. pendulum*, *D. primulinum*, *D. ruckerii*

Digitalization of orchid species & hybrids

Vanda coerulescence



General appearance of flower



Color & shape of dorsal & lateral sepals



Color & shape of petal



Color & shape of Lip



Column color & anther cap

Cym. Yankillila



General appearance of flower



Color & shape of dorsal & lateral sepals



Color & shape of petal



Color & shape of Lip



Column color & anther cap

Dendrobium chrysanthum



General appearance of flower



Color & shape of dorsal & lateral sepals



Color & shape of petal



Color & shape of Lip



Column color & anther cap

Mega Seed Project: Seed Production in Agricultural Crops and Fisheries

Targeted production achieved during the year furnished below:

S. No.	Particulars	Achievements (Nos.)
1	Commercial hybrids/ <i>Cymbidium</i> etc., 4 hybrids plantlet through backbulbs	300
2	Gladiolus corms (13 varieties)	5,500
3	Freesia corms	4,000
4	<i>Lilium</i> , 15 hybrids	8,000

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

Selection of beneficiaries

50 beneficiaries residing in 5 different locations were selected, motivated and trained in cultivation *Cymbidium* orchids. The each group in each location has 10 beneficiaries. The selected locations on different altitudes which would provide an opportunity for screening of cultivars suitable for cut flower production in those locations.

Construction of polyhouses

Total 5 polyhouses, one in each location have been constructed. The houses are even span type and made up of galvanized square pipes. The sides of polyhouses have rolling polythene curtains which could be open and close to maintain the temperature and aeration. The each polyhouse has 100 m² area.

Cultivation of *Cymbidium*s

Four cultivars of *Cymbidium* were selected for cultivation and mass multiplied (20000 plant lets), 6 – 8 inch size plantlets of *Cymbidium* orchids have been transferred to demonstration sites. On farm demonstration were carried out for repotting and handling of small plantlets. A technical person has been deputed to guide and advise the beneficiaries in cultivation of orchids. She also acts as a link between experts at the centre and beneficiaries in the field.



Fig. 1. Dr. S. P. Ghosh, Chairman DBT project and Dr. Vibha Dhawan, Exe. Director TERI, Coordinator, DBT project on visit to beneficiaries field

Studies on the performance of *Cymbidium* cultivars

Studies for screening of cultivars suitable for particular location have also been planned. The 4 selected cultivars are being tested in 5 different locations having 3 replication. Each treatment is consists of 10 plants. The data on growth and flowering behavior in different locations would be recorded.



Fig. 2. *Cymbidium* planting material ready for distribution to the farmers



Fig. 3. Awareness programme organized for the beneficiaries of the DBT to motivate them for cultivation of orchids



Fig. 4. Farmers on visit to orchid farm where they received guidance and advise from the experts

Technology Assessed and Transferred

3

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

In vivo multiplication technology developed for multiplication of *Cymbidium* through backbulbs was transferred to the farmers. The farmers were trained and demonstrated for various steps involve in propagation of *Cymbidium* through backbulbs.

Technology transferred through mass media/ trainings/exhibitions

Training Programmes

The centre organized 5 (five) training programmes on various aspects and trained Govt. officials of the state department of agriculture/horticulture and farmers to cater the needs and demands at different time intervals. Details of the training programmes are given in the following table:

Date	Topic	Number of Participants	Category of Participants	Venue
29 -31 st July, 2009	Commercial Cultivation of <i>Cymbidium</i>	23	Farmers from Dalapchand, East Sikkim	NRC (O)
09 - 11 th Aug., 2009	Commercial Cultivation of <i>Cymbidium</i>	43	Farmers from East Sikkim	NRC (O)
16 th Nov., 2009	Awareness programme on "Commercial Cultivation of <i>Cymbidium</i> "	22	DBT beneficiaries from Yangyang, (S. Sikkim) & Sombaria, (W. Sikkim)	NRC (O)
09 th Dec., 2009	Commercial Cultivation of <i>Cymbidium</i>	27	Farmers from Kalimpong, (W. B.)	NRC (O)
24 th June - 15 th July, 2009	DNA Finger Printing & RAPD Analysis	02	B. Tech. (Biotech) Students of Bengal College of Engineering & Technology, Durgapur, (W.B.)	NRC (O)

Model Training Course

Date	Topic	Number of Participants	Category of Participants	Venue
11 - 18 th Jan., 2010	Recent Trends on Floriculture and Improvement	16	State Govt. Officials	NRC (O)

Demonstrations

Date	Topic	Number of Participants	Category of Participants	Venue
10 th July, 2009	Diseases of Orchids	30	Farmers	NRC (O)
12 th Aug., 2009	Pests of Orchids	25	Farmers	NRC (O)
10 th Sept., 2009	Potting Mixture Preparation	30	Farmers	NRC (O)
09 th Oct., 2009	Disease Management of Orchids	25	Farmers	NRC (O)



Farmers' see the sprouted backbulbs on unpacking



Farmers' learn about multiplication of *Cymbidium* through backbulbs



Farmer Exhibition at KVK campus Marchak, ICAR Complex, Tadong, w.e.f. 23-24, November, 2009



Demonstration of Media Preparation

Exhibitions / Participations

Key Recommendations of the Brainstorming Session on 'Orchids-Recent Issues and Strategies' held on 25th May, 2009 at NRC for Orchids, Pakyong, Sikkim

- *In situ* and *ex situ* conservation of endangered and endemic orchid species.
- Refinement of existing tissue culture and automation of tissue culture laboratory.
- Identification of market driven *Cymbidium* hybrids and rapid multiplication of the hybrids and species of orchids considering IPR issues for the supply of disease free quality planting materials.
- Development of own hybrids with potential to compete in international markets.
- Development of database, digital herbarium and electronic library for orchid species and varieties.
- Construction of greenhouses according to latitude and altitude, RH, ventilation and crops grown.
- Development of viable technologies like development of varieties for year round production of *Cymbidium*, reduction of long pre-blooming period in *Cymbidium* orchids and suitable potting media for *Cymbidium*, *Phalaenopsis*, *Vanda*, *Dendrobium* hybrids.
- Studies on climatic requirements for growth and development of *Cymbidium* orchids.



Brainstorming Session on 'Orchids-Recent Issues and Strategies'



1st Meeting of Orchid Task Force for "DUS Testing on Orchids" (24th to 25th February, 2010).

Scientist

Training on 'summer school on entrepreneurship development under sustainable farming system' at ICAR Res. Complex for NEH Region, Sikkim centre, Tadong from 25th May - 14th June, 2009.

Rampal

Training on 'PCR based molecular analysis using microsatellite markers at NRC DNA Fingerprinting' at NBPGR, New Delhi from Aug. - Nov., 2009.

S. Chakrabarti

Training workshop on 'Greenhouse gas emission and its mitigation in relation to soil organic carbon pool' at CRRI, Cuttack from 5 - 25 Jan., 2010.

S. K. Naik

Training on 'Right to Information Act, 2005' at Bhubaneswar, Orissa from 29 - 30 May, 2009.

D. Barman

Administrative Staff

Course on reservation in service at ISTM, New Delhi from 15-18 June, 2009.

A. Lama, R. K. Das

Training on financial management in Govt. for section officer and equivalent officers at ISTM, New Delhi from 13 - 24 July, 2009.

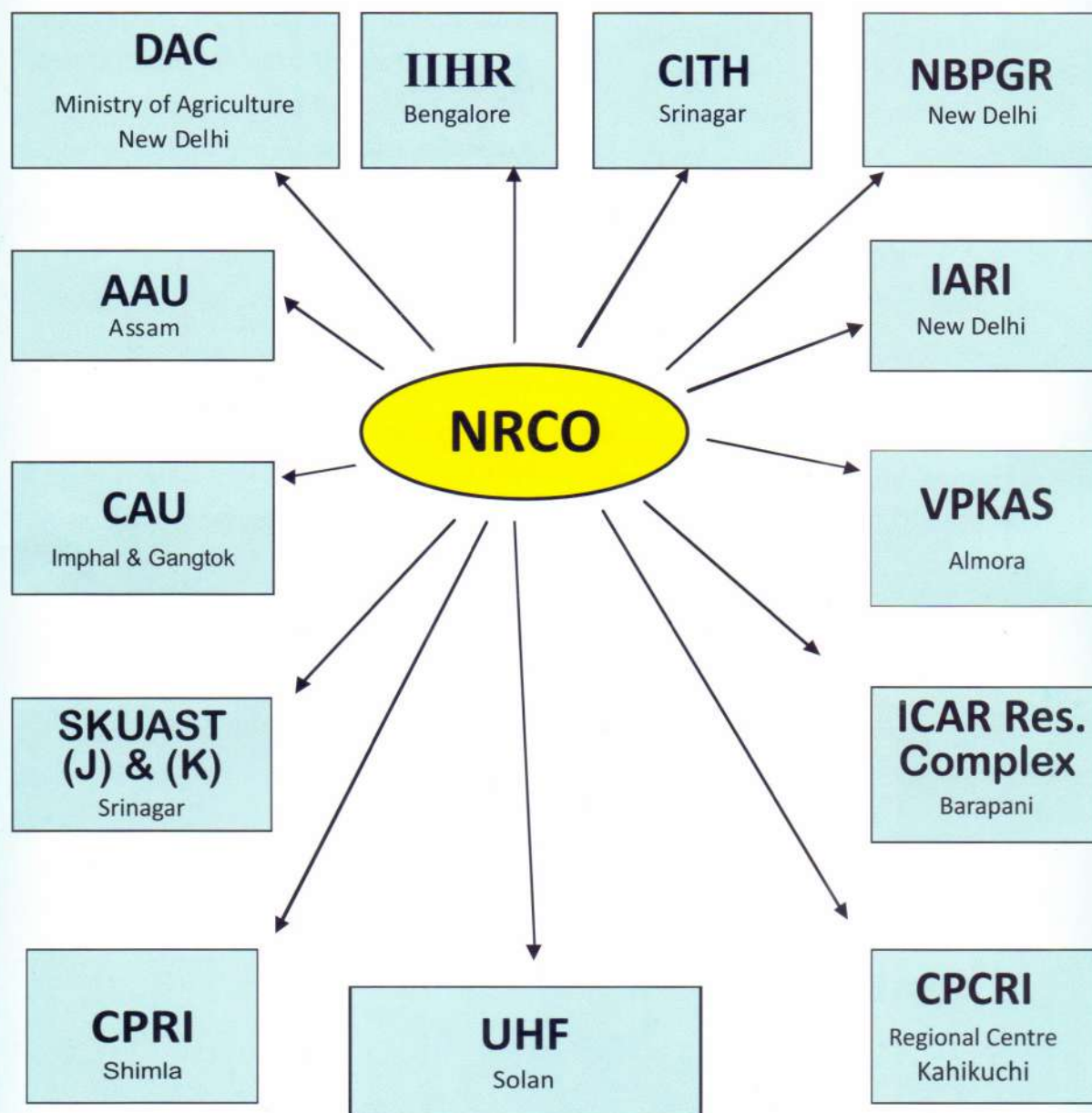
R. K. Singh

Linkages and Collaboration



The centre has linkages with several universities, research institutes and developmental agencies for collaborative research and developmental

activities in orchids and other mandate floriculture crops.



Research papers

1. Devdas, R., P. Khatiwara, D. Barman and S. P. Das 2009. Breeding *Dendrobium phalaenopsis*-cane type hybrid in India: NRCO-42(Den. Emma White x Den. 'Pampadour')- *Indian J. Genet.* **69**: 237-242.
2. Devadas, R., J. Das, S. K. Naik, and R. P. Medhi 2008. Influence of potting mixture on acclimatization and growth of in vitro developed plantlets of *Zygopetalum intermedium*. *J. of Ornam. Hort.*, **11**: 241-247
3. Meena, N. K. 2009. Organic control of shoot borer in orchids (*Dendrobium nobile*) through botanical pesticides, *Indian J. of Applied Entomology* **23**: 63-65.
4. Nagrare, V.S., Ram Pal and D. Barman 2009 Pest associated with *Dendrobium nobile* under mid altitude of Sikkim. *Environment & Ecology* **27**: 560 – 662.
5. Nagrare, V.S. and Ram Pal 2008. Response of acaricides against two – spotted spider mites *Tetranychus urticae* Koch infesting *Cymbidium* under polyhouse in Sikkim. *J. of Ornam. Hort.*, **11**: 104 – 106
6. Naik, S.K., T. Usha Bharathi, D.Barman, R.Devdas, Rampal and R.P.Medhi 2009. Status of mineral nutrient of orchid – A review. *J. Ornam. Hort.* **12**: 01-14.
7. Ram Pal, M. Dayamma, and V. S. Nagrare 2009 Effect of BAP (6 –Benzylaminopurine) on bud break and planlet regeneration from the backbulbs of *Calanthe yucksomnensis* S.Z.Lucksom (Orchidaceae). *Indian J. of Forestry* **32**: 65 – 68.
8. Usha Bharathi, T., D. Barman, N. Buragohain, S.K. Naik, and R. P. Medhi 2009. Effect of different chemicals and growth regulators on vase life of Oriental Lily hybrid Solaila. *J. of Ornam. Hort.* **12**: 73.

Book chapters

1. Medhi, R. P., D. Barman and B. Rai 2009. Climate change and its impact on Orchids. In: Challenge of climate change- Indian Horticulture. P. 131 – 136. (Eds) H. P. Singh, J. P. Singh and S. S. Lal. Westville Pub. House, New Delhi.

Popular articles

1. Chakrabarti, Syamali 2009. The wonder Orchid-*Vanda tessellate*. *Rastriya Krishi*. December **4**: 3-5.
2. Chakrabarti, Syamali 2009. Growing *Cattleya* Orchids in Home. *Rastriya Krishi*. December **4**: 20-21

3. Chakrabarti, Syamali 2009. Cultivation of Epidendrum Orchids *Rastriya Krishi* December **4**: 78-80
4. Chakrabarti, Syamali 2009. Pollination mechanisms in Orchids *Rastriya Krishi*. December **4**: 127-129
5. Chakrabarti, Syamali 2009. Ethno botanical uses of Orchids in India. *Agrobios*. November. **VIII**: 60-62
6. Chakrabarti, Syamali 2009. *Epidendrum*-ideal Orchid to grow as Houseplants. *Farmer's Digest*, November, **42**: 8-11.
7. Ram Pal and R.C. Upadhyaya 2009 Hybrid lilies for more income. *Indian Hort.* **54**: 25–27.

Paper presented in seminar/ symposia

1. Barman, D., T. Usha Bharathi, L. C. De and R.P.Medhi 2010. *Phalaenopsis*-Future potential of potted orchid in Indian market. In: *National symposium on lifestyle floriculture: challenges and opportunities* from 19- 21 March, 2010 at Dr. Y S P Univ. of Hort. and Forest., Nauni, Solan.
2. Barman, D., T. Usha Bharathi, V. Shalini, S.K.Naik, L.C.De and R.P.Medhi 2010. Influence of frequency and mode of application of growth regulators on growth and flowering of *Dendrobium* hybrid "Thongchai Gold". In: *National conference on orchids systematics and diversity analysis for conservation and sustainable utilization*. from 19-21 March, 2010 at G.B. Pant Institute of Himalayan Environment and Development, Koshi, Katarmal, Almora, Uttarkhand.
3. Chakrabarti, Syamali, Gaganjyot Singh and Sunil Archak 2009. Genetic Diversity Analysis of some endangered *Dendrobium* orchids based on RAPD markers. In: *National symposium on recent global developments in the management of plant genetic resources* from 17-18 Dec, 2009 at NBPGR ,New Delhi.
4. Chakrabarti, Syamali, Gaganjyot Singh, R.P. Medhi and Sunil Archak 2009. Molecular analysis of some endangered species of the genus *Dendrobium* (family Orchidaceae) using STMs Markers. In: *National symposium on recent global developments in the management of plant genetic resources* from 17-18 Dec, 2009 at NBPGR ,New Delhi.
5. Chakrabarti, Syamali and R. P. Medhi 2010. Orchids as source of medicine – In: *National symposium on new perspectives in plant research* from 29 -.31 Jan, 2010 at Dept. of Plant Physiology, Institute of Agricultural Sciences, Calcutta University, Kolkata.
6. Chakrabarti, Syamali and R. P. Medhi 2010. STMs markers and assessment of genetic variability in *Vanda*. In: *National Conference on Orchids; Systematics and Diversity Analysis for conservation and sustainable utilization* from 19 -21 March, 2010 at G.B. Pant Institute of Himalayan Environment and

- Development, Almora,
7. Chakrabarti, Syamali and R. P. Medhi 2010. Assessment of molecular variation of some rare species of the genus *Dendrobium* using ISSR markers. In: *National symposium on lifestyle floriculture: challenges and opportunities* from 19-21 March, 2010 at Dr. Y S P Univ. of Hort. and Forest. Nauni, Solan,
 8. De, L.C., T.Usha Bharathi and R.P.Medhi 2010. Post harvest handling in orchids. In: *National conference on orchids systematics and diversity analysis for conservation and sustainable utilization.* from 19 -21 March, 2010 at G.B. Pant Institute of Himalayan Environment and Development, Almora,
 9. De, L.C., R.P. Medhi and P. Deb 2010. Techniques for production of quality planting materials in orchids. P. 7. In: *National conference on production of quality seeds and planting material-health management in horticultural crops* from 11 -14 March, 2010 at New Delhi.
 10. De, L.C., T. Usha Bharathi, D. Barman and R.P. Medhi 2010. Production and post-production management in orchids. In: *Proceeding of national symposium on lifestyle floriculture: challenges and opportunities* from 19 -21 March, 2010 at Y.S.P Univ. of Horti. and Forest., Nauni, Solan.
 11. Medhi, R. P. and Ram Pal 2010. Orchid germplasm management: Issue Development and Strategy. P. 40-45. In: *National Seminar on Orchids: Systematics and Diversity Analysis for Conservation and sustainable Utilisation (Eds.) Promila Pathak and Lucky K. Attri* from 19-21 March, 2010 at G. B. Pant Institute of Himalayan Environment and Development, Koshi-Katarmal, Almora .
 12. Meena N. K. and R. P. Medhi 2010. Efficacy of botanical products for the management of thrips, *Dichromothrips nakahari* on orchids (*Dendrobium nobile*). P. 299. In: *National conference on plant protection in agriculture through eco-friendly techniques & traditional farming practices* from 18-20 Feb, 2010 at Department of Entomology, ARS, SKRAU, Durgapura, Jaipur, Rajasthan.
 13. Naik, S. K., and R. P. Medhi 2009. Response of *Cymbidium* hybrid to major nutrient at vegetative stage. P.137. In: *Platinum jubilee symposium on soil science in meeting the challenges to food security and environmental quality* from 22-25 Dec, 2009 at the 74th Annual convention of Indian Society of Soil Science, IARI, New Delhi.
 14. Naik, S. K., R. Devadas and R. P. Medhi 2009. Evaluation of nutrient content of growing media for hardening tissue culture *Cymbidium* "Pine Clash Moon Venus". P. 33. In: *Symposium on maintenance of soil health and food security* from 27-28 November, 2009 at the 42nd Annual convention of Indian Society of Agricultural Chemistry,

15. Ram Pal and R. P. Medhi 2009. Promotion of orchid cultivation through production of quality planting material. P. 153. In: *National conference on production of quality seeds and planting material-health management in horticultural crops* from 11 -14 March, 2010 at New Delhi.
16. Pant, R.P., Rampal, R. Devadas, R.K. Jain, and R. P. Medhi 2009. Studies on seed transmission of *Cymbidium* mosaic virus (CymMV) in some orchid species and hybrids in India. P. 269. In: *5th International conference on plant pathology in the globalized era* from 10-13 Nov, 2009 at Indian Agricultural Research Institute, New Delhi.
17. Pant, R.P. and N. K. Meena 2010. Diseases and Pests of Orchids. P. 71-72. In: *National conference on Orchids: systematics and diversity analysis for conservation and sustainable utilization* from 19-21 March, 2010 at G. B. Pant Institute of Himalayan Environment and Development, Koshi-Katarmal, Almora .
18. Pant, R.P., Smita, Gupta, Nita, Mathur, N. K. Meena and R.P. Medhi 2010. Incidence of anthracnose disease caused by *colletotrichum gloeosporioides* on different species and hybrids of orchids and its management. In: *National symposium on lifestyle floriculture: challenges and opportunities* from 19-21 March, 2010 at Dr. Y S P Univ. of Hort. and Forest., Nauni, Solan.
19. Rani, Pooja, R.P. Pant and R.K. Jain 2009. Serological detection of odontoglossum ringspot virus in orchids using polyclonal antibodies developed against recombinant protein. P. 294. In: *5th International conference on plant pathology in the globalized era* from 10-13 Nov, 2009 at Indian Agricultural Research Institute, New Delhi
20. Pant, R.P. 2010. Development of diagnostics for the production of virus-free planting material of orchids. P. 63-64. In: *National consultative meeting on disease diagnostics for horticultural crops* from 22-24 Jan, 2010 at NRC Banana, Tiruchirapalli.

List of Ongoing Projects

7

Institute Projects

Project title	PI
<i>In vitro</i> propagation of orchid: <i>Cymbidium</i> and important, rare and endangered species	R. P. Medhi & D. Barman
Cytogenetical research on orchids	S. Chakrabarti
Improvement of orchids	D. Barman
Development of agro-techniques for commercial production of orchids in open and protected conditions.	D. Barman
Production and post production management of tropical and sub-tropical orchids	L. C. De
Development of Integrated floriculture enterprise	D. Barman
Macronutrient management in orchids	S. K. Naik
Secondary and micronutrient management in orchids	S. K. Naik
Post harvest technology of orchids	T. Usha Bharathi & L.C. De
Collection, conservation, characterization, evaluation and maintenance of high alt. orchid germplasm	Ram Pal
<i>In vitro</i> conservation of orchids	Ram Pal
Disease management of orchids	R. P. Pant
Integrated pest management in orchids	N. K. Meena

Externally Funded Projects

Mini Mission – I

Project title: Horticulture Mission for North East and Himalayan States (Scheme earlier known as TMNE)

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

DUS Testing Project

Project title: DUS testing of orchid varieties /species for development of NTG
CCPI / Nodal Officer: L. C. De

DBT Project

Project title: DBT mission for quality planting material prodn & utilization for the North East
Principal Investigator : R. P. Medhi, Co-Principal Investigator : Rampal

NAIP Project

Project title: A value chain on selected aromatic plants of North East India
Co-Principal Investigator : R. P. Medhi, CCPI : D. Barman, Rampal

QRT, RAC and IRC Meetings with Recommendations



Recommendations of 2nd QRT Meeting of National Research Centre for Orchids, Pakyong- 737 106, East Sikkim, held on 24th May, 2009

The 2nd QRT (2003-2008) meeting of this centre was held under the chairmanship of Prof. P. Das, The Science Foundation for Tribal and Rural Resource Development, C – 122 (HIG), Orissa Housing Board Colony, Baramunda, Bhubaneswar – 751 003 (Orissa) on 24th May, 2009 at the conference hall of NRC for Orchids. The member secretary Dr. D. Barman, Sr. Scientist (Horticulture) invited all the esteemed members of the QRT and briefed on the significance of the 1st QRT impact. The Director, Dr. R. P. Medhi formally welcomed the Chairman and other members of QRT. Members of the QRT Committee were as follows:

Prof. S. P. Vij, Deptt. Of Botany, Punjab University, Chandigarh – 160 014

Dr. S. N. Hegde, Former Director, State Forest Research Institute, Arunadaya House , Rajiv Gandhi Nagar, Sunkadakatte, Viswanidam Post , Bangalore – 560 091.

Dr. S. K. Dutta, CSIR Emeritus Scientist, Madhyamgram Expl. Farm, Acharya J.C. Bose Biotech Innovation Centre, Bose Institute, Jessore Road, 24 Paraganas (N), Kolkata – 700 129 (WB)

Dr. R. C. Srivastava, Joint Director, Botanical

Survey of India, Senkie View, Post Box: 127, Itanagar (Arunachal Pradesh). PIN – 791 111
Dr. M. N. Khare, Ex- Dean, Professor Emeritus, Plant Pathology, JNAU, JNKVV, 24, Ravindra Nagar, Adhartal, Jabalpur – 482 004 (MP)

Dr. R. P. Medhi, Director, NRC for Orchids, ICAR, Pakyong, Sikkim

QRT Member Secretary: Dr. D. Barman, Sr. Scientist (Horticulture), NRC for Orchids, ICAR, Pakyong, Sikkim-737 106



Summary of Recommendation

Crop Improvement

- **Genetics**
 - ◆ DNA fingerprinting should be completed on priority basis; attempts should be made to complete the fingerprinting work genera wise and not by random pick and choose options.

- **Plant Breeding and Tissue Culture**

- ◆ Even after 12 years of establishment of NRC Orchids not even a single variety could be developed for commercial use. All varieties used in commercial cultivation in this country are imported. It is high time that improvement programmes on orchids be intensified with additional support, if required, including man power to develop new hybrids for commercial cultivation. Only outstanding hybrids should be registered and undesirable hybrids/seedling must be rejected.
- ◆ Presently some orchids hybrids particularly *Cymbidium*, *Dendrobium*, *Phalaenopsis*, *Oncidium*, *Vanda* are under cultivation in various parts of the country. Those outstanding hybrids which are not covered under IPR regime can be mass cloned for commercial flower production. Mass cloning and hardening procedures of *Cymbidium* hybrids were standardized at NRC Orchids. Tissue culture and hardening facilities should be augmented to meet the increasing demand for planting material by orchid growers.

Crop Production and Post Harvest Handling

- **Horticulture**

- ◆ Keeping in view the change in the climatic pattern to climate change, green house technologies particularly with regard to light, temperature and

humidity should be modified for the orchids industry in the likely changing scenario. Studies on orchid media, nutrition for balanced growth and flowering should be one of the thrust areas of crop production division

- ◆ Post harvest handling is an important aspect for prolonging the vase life of orchid growers; hence, studies should be taken up to refine the technologies.

Crop Protection

- **Pathology**

- ◆ Phyto-sanitation and virus indexing of cultivated hybrids should be continued. The disease and pest management in plant houses having orchid germplasm should be strengthened.
- ◆ Plant protection packages along with integrated disease and pest management procedures including use of botanical pesticides and bio-control agents should be developed for farmers.
- ◆ Plants for commercial cultivation must be indexed against viruses before recommending to farmers for cultivation.
- ◆ Association of mycorrhiza and fungi for seed germination and establishment of tissue cultured plants may be studied.

General Recommendations

- ◆ The NRC Orchids was established by ICAR at Pakyong, Sikkim to conserve

diverse orchid species occurring in the North-Eastern region of the country and undertake research for utilization of genetic material to develop hybrids for commercial application by growers. Though some activities on collection, documentation including molecular characterization were initiated at NRCO, much more needed to be done in this direction. Systematic efforts must be taken up to collect, conserve and document many other species that were yet to be collected and studied.

- ◆ Since the green house space was not adequate and all species could not be accommodated under one roof because of the varied climatic requirements, the QRT recommends that a sub-centre be established at lower elevation, Rangpo for conservation of orchids requiring warmer and humid climates.
- ◆ Since the National Research Centre for Orchids has the responsibility to promote orchid culture in the entire country, the QRT recommends for setting up of sub-centres in the tropical parts of the country i.e. Southern (Trivandrum, Kerala), Eastern (Bhubaneshwar, Orissa) and Western (Pune, Maharashtra) regions of the country.
- ◆ The NRC Orchids should develop herbarium solely devoted to orchids of India reportedly 1250 species. Digital herbarium should also be developed using modern methods.
- ◆ NRC Orchids should also develop a database of the entire specimens housed in different Indian as well as foreign herbaria.
- ◆ Since no soil is involved in commercial orchid cultivation, the designation of soil scientist should be suitably re-designated for NRC Orchid only.
- ◆ During the period under report, 16 positions of scientists at different levels were sanctioned out of which only 9 posts were filled up. Since excellent infrastructures have already been created at NRC Orchids with laboratories, green houses, all the sanctioned posts should be filled up as early as possible to make optimum use of the facilities.
- ◆ The QRT members felt that due to frequent vacancies caused by shifting or transfer of staff, research work were badly affected. Since this was a recurring phenomenon, the QRT recommended that adequate number of well qualified technical staff as per ICAR norms be sanctioned for NRC Orchids to continue to support the scientific activity without interruption in the event of vacancies caused due to promotion or transfer of scientists. Qualified and trained persons with M.Sc. or Ph.D degrees may be employed as technical staff who with training and experience will be able to manage the work in temporary / brief absence of scientists.

- ◆ The QRT recommends creation of an additional and separate division for transfer of technologies on commercial cultivation of orchids.
- ◆ Since the ICAR has created excellent laboratory facilities at NRC Orchids in the Sikkim-Darjeeling region, for judicious and optimum utilization of facilities and infrastructure, the NRC Orchids should explore to get recognition from North Bengal University, NEHU, Shillong, Sikkim University, Gangtok and CAU, Manipur to undertake collaborative research programmes on orchids for Ph.D degrees.
- ◆ The QRT recommended training of Scientists at National and International Institutions or better exposure on orchid taxonomy, conservation, improvement and commercial orchid culture.

Recommendations of 10th Research Advisory Committee (RAC) Meeting of National Research Centre for Orchids, Pakyong- 737 106, East Sikkim, held on 29th November 2009



The 10th RAC meeting of this centre was held under the chairmanship of Prof. D. P. Ray, Vice Chancellor, OUAT, Bhubaneswar, Orissa-751003 on 29th Nov. 2009 at the conference hall of NRC for Orchids. The member secretary Dr. D. Barman, Sr. Scientist (Horticulture) invited all the esteemed members of the RAC and also briefed on the significance of the 9th RAC. The Director, Dr. R. P. Medhi formally welcomed the Chairman and other members of RAC.

Participants of the RAC Committee are as follows:

1. Prof. D. P. Ray Chairman
Vice-Chancellor, OUAT, Bhubaneswar, Khurda - 751003.
2. Prof. S. P. Vij Member
FNASc, FPAS, FLS (Member),
Deptt. of Botany, Punjab University,
Chandigarh - 160 014.
3. Dr. S. N. Sinha Member
Head, IARI Regional Station,
Karnal - 132 001, Harayana.
4. Dr. R. D. Rawal Member
Ex-Head, Division of Plant Pathology
No 29, 6th Cross Krishnappa Block,
Ganganagar, Bangalore - 560 032.



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|----|---|--------|
| 5. | Prof. S. K. Mitra
Dean (Horticulture), BCKV,
Mohanpur, Nadia,
West Bengal - 741 252. | Member |
| 6. | Dr. R. P. Medhi
Director, National Research
Centre for Orchids,
ICAR, Pakyong, East Sikkim. | Member |
| 7. | Shri K. K. Singh
IMC Member/Nominee
Principal Director,
HCCD, Krishi Bhawan.
Government of Sikkim, Tadong
Gangtok, East Sikkim | |
| 8. | Dr. H. Kalita
IMC Member/Nominee
Representative of Joint Director,
ICAR Research Complex,
Sikkim Centre, Tadong,
East Sikkim, | |
| 9. | Dr. D. Barman RAC Member Secretary.
Sr. Scientist, NRC for Orchids,
ICAR, Pakyong, East Sikkim. | |

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

1. Dr. L. C. De, Principal Scientist (Horticulture)
2. Dr. S. Chakrabarti, Senior Scientist (Genetics)
3. Dr. R. P. Pant, Senior Scientist (Plant Pathology)
4. Shri. Rampal, Scientist SS (Horticulture), Scientist i/c Darjeeling Campus.
5. Dr. S. K. Naik, Scientist (Soil Science)
6. Dr. N.K. Meena, Scientist (Entomology)
7. Ms. T. Usha Bharathi, Scientist (Floriculture)

Summary of Recommendation

Crop Improvement

• Genetics

- ◆ The primary focus on experiments set under the project 'Molecular Characterization of Orchids' would be the testing of variations or polymorphisms within the species occurring in different regions. It was also suggested to do genus wise characterization of Orchids.
- ◆ For preparation of cDNA libraries, identification of endemic species (to Sikkim) should be prioritized followed by variability studies and testing. Help may be sought from State Departments for collection of germplasm for research activities (New project- Development of cDNA library of orchids).

• Plant Breeding and Tissue Culture

- ◆ NRC should focus in the development of 'Common Descriptor's of Orchids'. These descriptors should be globally accepted in terms of quality and for this the centre may also engage help of National Biodiversity Board. (Project: Improvements of Orchids).
- ◆ Orchids have a long gestation period and takes many years for flowering. In order to ensure correctness of the hybridization work, confirmation of hybridization may be carried out by the genetics division of the centre through DNA profiling of the parentage and the crossings. (Project: Improvements of Orchids).

- ◆ Formulate experiments on in-vitro flowering of important orchid species to assess desired hybridization and continue propagation on large scale there-on. (Project: Improvements of Orchids).
- ◆ NRC Orchids should completely avoid random crossing for development of hybrids. Hybrid development should be market oriented and selection of hybrids should be based on market preferences. A careful study of parentage (beneficial characteristics) may also be ensured before crossing. (Project: Improvements of Orchids).
- ◆ Tissue culturing of orchids is a costly venture. Every experiment set in this line should be well worked out on the cost-benefic ratio. Economically viable technology should be developed for mass multiplication. (Project: *In vitro* propagation of Orchids).
- ◆ Commenting on the experiment on 'Multi-location trials of *Cymbidium* for growth assessment' the committee suggested to conduct trials in selected 3 locations i.e. CPCRI, Mohitnagar, ICAR NEH, Umiam and CPCRI Kahikuchi is practically and economically not viable. It is suggested that growth chambers with controlled temperature, humidity and light should be built within NRCO itself for such type of experiments or trials may be conducted in close collaboration with the State forest/horticulture department at different altitudes within the state of

Sikkim. Considering this the name of the experiment may be suitably changed. (Project: *In-vitro* propagation of Orchids).

Crop Production and Post Harvest Handling

• Horticulture

- ◆ Measures of moisture content, temperature of media should be taken using suitable instruments
- ◆ In pre harvest foliar spraying experiments of *Cymbidium* for better post harvest life BA can be incorporated and mineral water may not be used in experiment on *Cymbidium*.
- ◆ Many farmers are reported, by using the chopped fern leaves and getting wonderful results in different orchids. Therefore, it is advised to use the fern leaves in the growing media of orchids after removal of phenolic compounds.
- ◆ The RAC suggested limiting the number of experiments on media and nutrient management.
- ◆ The RAC suggested adding K_2SO_4 as a treatment in the bud opening experiment and use of 1, MCP for better post harvest life of orchids.
- ◆ Post harvest packaging is one of the most important factors for shipping/send orchid flowers to far off destination to reach the consumers. Hence different experiments on post harvest packaging of different orchids may be conducted in

collaboration with the relevant teaching faculty of College of Agriculture Engineering and Post Harvest Technology, CAU, Sikkim.

- **Soil Science**

- ◆ Experiment relating the use of Panchagavya must be dropped.
- ◆ Soil scientist was suggested to carry out some experiments associated with mycorrhiza.
- ◆ Fertigation and mycorrhizal association may be studied on the hardening media of tissue cultured plants.
- ◆ One integrated nutritional trial with slow release fertilizers (Palates) and Bio-fertilizers with Rhizosporum may be taken.
- ◆ One experiment may be taken up on sand culture/nutrient film technique to characterize the mineral deficiency symptoms with *Cymbidium*.
- ◆ Optimum leaf nutrient standards should be established and results of the media and nutrient experiments should be compared with that one.

Darjeeling Campus

- ◆ For long term *in-vitro* conservation of orchids, work may be carried out in collaboration with NBPGR. (Project: *In-vitro* conservation of Orchids)

Crop Protection

- **Pathology**

- ◆ Pathologist should concentrate more on virus diagnostics, host range and management aspects.
- ◆ Orchids in the wild are known to be virus resistant. Survey may be conducted at different locations to see the viruses in affecting different orchid species in natural habitats.
- ◆ Management of diseases through good hygienic practices and experiment may be set up in these lines.
- ◆ Culture of *Colletotricum gloeosporioides* may be sent to IIHR for molecular diagnosis.
- ◆ In surveys, the symptoms of the diseases, name of the pathogen and host plant should be mentioned with species.
- ◆ In routine management practices available literature may be screened with respect to effective fungicide and also their doses.
- ◆ New experiments may be set to combat damages caused by bacterial pathogens.
- ◆ New project proposal entitled 'In-vitro production of virus free planting material' may be worked out in collaboration with tissue culture section of the Institute.

- **Entomology**

- ◆ In testing of botanicals and biocides, often commercially available neem formulation should be tested to get best

results against major insect pests-under pest management in *Cymbidium*.

- ◆ RAC suggested incorporating best treatments of disease control and insect control in developing and testing integrated pest management in orchids.
- ◆ Polymer can be used for sustained release of nutrient and bio-pesticides and can be used in the trials under way.
- ◆ RAC recommended inclusion of the natural enemies in host preference studies.
- ◆ RAC suggested screening of tissue cultured plants for resistance against insects and pests.

General recommendation

- ◆ RAC suggested maintaining different species of orchids in separate greenhouses according to their temperature preferences instead of maintaining all species in one house.
- ◆ Findings of the institute should be documented in details in form of a book which may be captioned as “Hand Book of Orchids”.
- ◆ While introducing and/or adding to the collection, large number of orchid species for conservation, strict quarantine procedures should be followed.
- ◆ For introduction of exotic hybrids all the information regarding the morphology suitable growing conditions and

parentage should be recorded. Strict quarantine procedure should also be followed for bacterial, fungal and viral diseases and insects.

- ◆ Experiments those are proposed need to be properly justified.
- ◆ Horticulturists and Breeders should collaborate in breeding programmes to combine desirable horticultural traits based on market demand, productivity and economic benefits for farmers.
- ◆ NRC should adopt nearby orchid growing village or progressive farmers for demonstration of technology in addition to awareness programme, training etc.

Recommendations of the 8th “Institute Research Council” (IRC) meeting, National Research Centre for Orchids (ICAR), Pakyong, East Sikkim-737 106



The Institute Research Council meeting of NRC for orchids, Pakyong, Sikkim-737 106 was held on 11th December, 2009 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, NRC for Orchids,
Pakyong – 737 106. | Chairman | 3. | Dr. R. P. Pant, Senior Scientist (Plant
Pathology) |
| 2. | Dr. M. R. Sudharshan
Deputy Director (Res.)
Spices Board, Gangtok | Member | 4. | Shri. Rampal, Scientist SS
(Horticulture), Scientist i/c Darjeeling
Campus. |
| 3. | Dr. S. Senapati
Dean i/c, College of Agricultural
Engineering & Post-harvest
Technology, CAU, Ranipool,
East-Sikkim | Member | 5. | Dr. S. K. Naik, Scientist (Soil Science) |
| 4. | Dr. K.K. Singh
Scientist i/c, G.B.
Pant Institute of Himalayan
Environment & Development,
Sikkim Unit, Post Box No-24,
Panthang, Gangtok | Member | 6. | Dr. N.K. Meena, Scientist (Entomology) |
| 5. | Dr. A. Kumar
Scientist, Horticulture,
ICAR Research Complex for
NEH Region, Tadong,
Sikkim, Member | Member | 7. | Ms. T. Usha Bharathi, Scientist
(Floriculture) |
| 6. | Nirmal Yonzong
Farmer's Representatives | Member | | |
| 7. | Shri Deo Kumar Rai
Farmer's Representatives | Member | | |
| 8. | Dr. L. C. De
Pr. Scientist (Hort.)
NRC for Orchids,
Pakyong – 737 106. | Member
Secretary | | |

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

1. Dr. D. Barman, Senior Scientist (Horticulture)
2. Dr. S. Chakrabarti, Senior Scientist (Genetics)

Summary of Recommendation

Crop Improvement

- **Genetics**

- ◆ Development of molecular markers for two new hybrids. Use of more number of primers along with STM/ISSR markers/ Microsatellite markers for effective reproducible characterization and confirmation of parentage. Studies on stomatal index to correlate hybrids along with parents

- **Plant Breeding and Tissue Culture**

- ◆ Mass multiplication of hybrids 'NRCO-42' and 'H x B'. Characterization of *Dendrobium nobile*, *D. luteiflorum* and *Renanthera imschootiana* using RAPD markers to assess confirmation. Intergeneric and interspecific crosses should be followed only after chromosomal and morphological studies. For in vitro flowering or hardening of tissue culture plants, ABA and Paclobutrazol may be applied. Studies of *Cymbidium* at various locations may be continued to take

temperature advantage on the vegetative growth of plants.

Crop Production and Post Harvest Handling

• Horticulture

- ◆ To schedule experiments on water management of orchids. Selection of shade net based on actual light intensity should be followed. To spray NPK, own fertilizer formulation should be used. Use cow urine from pregnant or milch cows. Before using, cocopeat should be decomposed with the spawn of oyster mushroom to degrade phenols and cellulose. Experiments on organic production system of orchids should be taken up. More emphasize on post-harvest packaging and value addition.

Darjeeling Campus

- ◆ Technologies on liliium production should be handed over to State Govt. officially. Simulated natural habitat may be used instead of artificial natural habitat for conservation of orchids. Work out on common descriptors of orchids. To avoid variability in plants during medium or long term storage conservation

• Soil Science

- ◆ Correlation studies between EC and N₁. Formulation of experiments on variation of pH and EC with varying planting media. Continuation of Panchagavya experiment. Development of package of practices for a single variety only

Crop Protection

• Pathology

- ◆ Virus indexing should be done before tissue culture for multiplication. Collection of planting materials from Arunachal Pradesh or NBPGR for getting virus free stocks

• Entomology

- ◆ NKAЕ (Neem Kernel Aquous Extract) may be taken within the trial against lepidopteran pests, thrips, mites etc. Lady Bird Beetle may be tried against mealy bugs. Application of mineral oil or agrosprays as component against aphids

General Recommendation

- ◆ Complete Package of Practices of *Cymbidium* Orchids, Latest fertilizer schedule, Availability of quality planting materials of five *Cymbidium* hybrids of various colours, publication of leaflet in Nepali for isolation of virus from infected plants of *Cymbidium*.

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

9

Central review steering committee meeting of “Technology mission for integrated development of horticulture in North Eastern states including Sikkim” on 23rd April, 2009 at New Delhi.

R. P. Medhi

Meeting on curriculum development committee on floriculture and horticulture management for the degree of B.Sc. and M.Sc. at Sikkim University at Gangtok from 28 -29 May 2009.

L. C. De

National conference on Technology-led development of horticulture for economic upliftment of rural area at Mahamada, Pusa Samastipur- 848125 (Bihar) from 28-31 May, 2009.

R. P. Medhi, R. P. Pant

Second foundation day celebration of Sikkim University and foundation lecture by Dr. M.S. Swaminathan at Gangtok from 14th August, 2009.

R. P. Medhi, L. C. De

19th Regional Committee Meeting (Zone-III) at Gangtok from 23-24 Oct., 2009.

R.P. Medhi, D. Barman, L. C. De, S. K. Naik

5th International conference on plant pathology in the globalized era at Indian Agricultural Research Institute, New Delhi from 10-13 Nov., 2009.

R. P. Pant

Agriculture Fair at KVK, ICAR, Ranipool on 23-24 Nov., 2009.

R.P. Medhi, D. Barman, S. K. Naik

Interactive meeting on management of mealybug in agricultural and horticultural crops at IIHR, Bangalore from 5-6 Dec., 2009.

N. K. Meena

National symposium on Recent Global Developments in the Management of Plant Genetic Resources organized by Indian Society of Plant Genetic Resources (ISPGR) held at NBPGR, New Delhi from 17-18 Dec., 2009

R. P. Medhi, L. C. De, S. Chakrabarti

Discussion on agrobiodiversity hotspots, farmers rights and international legislations at NASC, New Delhi from 21st Dec., 2009.

L. C. De

74th Annual convention of Indian Society of Soil Science at IARI, New Delhi from 22-25 Dec., 2009.

S. K. Naik

Horticulture fair at CPCRI, Kahikuchi on 5th Jan. 2010

R.P. Medhi, D. Barman,

Management development programme on leadership for innovation in agriculture under NAIP at IIM –Lucknow ,Noida campus from 18 -22 Jan. 2010.

D. Barman

National symposium on new perspectives in plant research at IAS, Calcutta University, Kolkata from 29-31 Jan. 2010.

S. Chakrabarti

National conference on plant protection in agriculture through eco-friendly techniques & traditional farming practices at Durgapura, Jaipur (Raj.) from Feb. 18 - 20, 2010.

N. K. Meena

ICAR Zonal technology management and business planning and development meeting cum workshop at IINRG, Ranchi from 19-20 Feb., 2010.

S. Chakrabarti

Vigilance training at ISSR, Calicut from 22 - 24 Feb., 2010.

D. Barman

Training programme of MM-I at TARI ,Guwahati on 26th Feb., 2010.

R. P. Medhi

National conference on production of quality planting materials – health management in Horticultural crops, from 11-14 March 2010, New Delhi.

R. P. Medhi

National conference on orchids-systematics and diversity analysis for conservation and sustainable utilization at GBPIHED, Almorah from 19 -21 March, 2010.

L. C. De, S. Chakrabarti, R. P. Pant, Rampal

Distinguished Visitors

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Prof. S. P. Viji, NASI Sr. Scientist Platinum Jubilee Fellow, Secretary, The Orchid Society of India, Botany Dept., Punjab University, Chandigarh	24.05.2009
Prof. P. Das, FNA, Chairman, The Science Foundation for Tribal & Rural Resource Development, Bhubaneswar (Orissa)	25.05.2009
Dr. S. K. Datta, CSIR Emeritus Scientist, Bose Institute, Kolkata	25.05.2009
Dr. P. K. Rajeevan, Professor & Head, Dept. of Pomology & Floriculture & Associate Dean, College of Horticulture, KAU, Kerala.	25.05.2009
Dr. R. P. Dua, Coordinator, AICRP (UUC), NBPGR, New Delhi	16.06.2009
Prof. Amitabh Joshi, Chairman, Evolutionary & Organism Biology Unit, JNCASR, Jakkur, Bangalore.	19.06.2009
Shri. Dawcho Lepcha, Honb'le Minister of Agriculture, Govt. of Sikkim, Sikkim.	09.08.2009
Shri. Bek Bahadur Rai, MLA (Namchybung), Govt. of Sikkim, Sikkim.	09.08.2009
Prof. Promod Tandon, Vice Chancellor, North Eastern Hill University, Shillong	12.09.2009
Prof. Dipankar Saha, Professor in the Dept. of Agri. Chem. & Soil Science, BCKV, Mohanpur, Nadia, W.B	12.09.2009
Dr. S. C. Kotur, Pr. Scientist (Soil Science), Indian Institute of Horticultural Research, Hessaraghatta lake, Bangalore (Karnataka)	12.09.2009
Dr. D. K. Baruah, Professor & Head i/c, Deptt. of Plant Breeding & Genetics, Assam Agricultural University, Jorhat - 785 013, Assam.	12.09.2009
Dr. S. Ayyappan, DDG (Fishery), ICAR, New Delhi	26.09.2009
Dr. Bhaskar Barua, Former Secretary, Ministry of Agriculture, Govt. of India	19.10.2009
Dr. S. Mauria, ADG (Intellectual Project & Technology Management), ICAR	24.10.2009
Dr. K. C. Jain, ADG (CC), ICAR	24.10.2009
Dr. K. D. Kokate, DDG (AE), ICAR, New Delhi	24.10.2009
Dr. A. K. Singh, DDG (NRM), ICAR, New Delhi	24.10.2009
Dr. M. M. Pandey, DDG (Engg), ICAR, New Delhi	24.10.2009
Dr. M. Y. Kamal, Former VC (SKVAST), J&K	03.11.2009
Dr. Rajendra Gupta, Ex. P.C. (M & AP), ICAR, Paschim Vihar, New Delhi	07.11.2009
Prof. D. P. Ray, Vice Chancellor, Orissa University of Agriculture & Technology, Bhubaneswar (Orissa)	30.11.2009
Prof. H. W. Pritchard, Royal Botanical Garden, Kew, United Kingdom.	02.02.2010
Dr. D. S. Rathore, Ex-VC, HPKV, Palampur, Lucknow	20.02.2010
Dr. A. K. Malhotra, IFS, Registrar General, Protection of Plant Varieties & Farmers Right Authority, Min. of Agriculture, Govt. of India, New Delhi.	24.02.2010

Prof. S. K. Sood, Dept. of Bioscience, H.P. University, Shimla	25.02.2010
Dr. G. S. Rawat, Scientist– G, Wildlife Institute of India, Dehra Dun.	25.02.2010
Dr. Dr. A. N. Rao, Orchidologist, SFRI, Itanagar, Arunachal Pradesh	25.02.2010
Dr. Manoj Srivastava, Registrar, PPV & FRA, NASC Complex, New Delhi	25.02.2010



Prof. H. W. Pritchard, RBG, Kew, United Kingdom



Dr. D. S. Rathore, Ex-VC, HPKV, Palampur, Lucknow



Dr. S. Ayyappan, DDG (Fishery), interacting with Scientist regarding Research activity



Dr. K. D. Kokate, DDG (AE), **Dr. M. M. Pandey**, DDG (Engg), **Dr. A. K. Singh**, DDG (NRM), ICAR, New Delhi (From L to R)



Dr. M. Y. Kamal, Former VC (SKVAST), J&K



Shri. Dawcho Lepcha, Hon'ble Minister of Agriculture, Govt. of Sikkim., Sikkim

I. Scientific

Dr. R. P. Medhi,	Director
Dr. D. Barman,	Principal Scientist (Horticulture)
Dr. L. C. De,	Principal Scientist (Horticulture)
Dr. Syamali Chakrabarti,	Sr. Scientist (Genetics)
Dr. R. P. Pant	Sr. Scientist (Plant Pathology)
Shri. Rampal,	Scientist S S (Horticulture)
Dr. S. K. Naik,	Scientist (Soil Science)
Dr. N. K. Meena,	Scientist (Agril. Entomology)
Ms. T. Usha Bharathi,	Scientist (Floriculture)

II. Administration

Shri Ajen Lama	Assistant Admn. Officer
Shri. Rishi Kant Singh	Assistant Finance and Account Officer
Shri. Rajat Kumar Das	Assistant
Mrs. Diki Bhutia	Sr. Clerk
Shri. Phigu Tshering Bhutia	Jr. Clerk
Mrs. Prema Nagaraju	Jr. Clerk
Mrs. Sangeeta Lepcha	Jr. Clerk

III. Technical

Shri. Janaki Mandi	Tech. Asstt. (T-3)
Shri Nonigopal Debnath	Computer Asstt. (T-II-3)
Shri. Ram Chandra Gurung	Driver (T-3)
Shri. Manoj Adhikari	Tech. Asstt. (T-1)
Miss. 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

Appointments

Shri. Rishi Kant Singh joined as Assistant Finance and Account Officer (AF&AO) on 27th May, 2009.

Shri Ajay Bushal joined as Technical Asstt. (T-1) on 19th Nov., 2009.

IMC Meeting

The 9th Institute Management Committee Meeting of National Research Centre for Orchids Pakyong, Sikkim was held on 23rd February 2010

under the Chairmanship of Dr. R.P. Medhi, Director, NRC for Orchids. Following IMC members were present in the meeting.

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|----|---|------------------|
| 1. | Dr. R.P. Medhi
Director,
NRC for Orchids, ICAR, Pakyong | Chairman |
| 2. | Shri K.K. Singh
Principal Director,
Department of Horticulture & Cash Crops, Govt. of Sikkim,
Krishi Bhavan, Tadong, Gangtok (Sikkim). | Member |
| 3. | Dr. P.K. Srivastava
Dean, Central Agricultural University,
Ranipool, Sikkim | Member |
| 4. | Dr. L.C. De
Principal Scientist (Hort.),
NRC for Orchids, Pakyong | Member |
| 5. | Shri Rampal
Scientist SS (Hort.) & Incharge,
NRC for Orchids, Darjeeling Campus,
A.J.C. Bose Road, Darjeeling. | Member |
| 6. | Shri Nirmal Taman
Tashithang, Dikling, Pakyong. | Member |
| 7. | Shri Sonam Sherpa
Gurbisey, Namchi, South Sikkim. | Member |
| 8. | Shri. Ajen. Lama
Assistant Administrative Officer,
NRC for Orchids, Pakyong | Member-Secretary |

Celebration of Independence Day at NRC for Orchids



Celebration of Hindi Chetna Samaroh
(5th to 14th September 2009) at NRC for Orchids

Celebration of National Integration week
(19th to 25th November, 2009) at NRC for Orchids



Celebration of Republic Day at NRC for Orchids

Glimses of cultural activities at NRCO







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