

वार्षिक प्रतिवेदन
Annual Report
2007 - 2008



राष्ट्रीय आर्किड्स अनुसंधान केन्द्र

(भारतीय कृषि अनुसंधान परिषद)

पाक्योंग - ७३७ १०६, सिक्किम

National Research Centre for Orchids

(Indian Council of Agricultural Research)

Pakyong - 737 106, Sikkim, India



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Preface

It gives me an immense pleasure to place before you the Annual Report of National Research Centre for Orchids, Sikkim for the year 2007-08. The Institute has made significant progress in basic and applied research and extension activities during the period of under report. Through this document, an attempt has been made to depict some of achievements in a comprehensive way. The centre has conserved three thousand one hundred and



thirty accessions of orchids belonging to various genera. A significant progress has been made in development of *in vitro* propagation protocols, molecular characterization, production technologies and disease pest management. At Darjeeling campus one hundred and sixty two species of orchids both epiphytic and terrestrial have been conserved. Some promising genotypes of *Liparis bootanensis* and *Paphiopedilum insigne* were identified that can be utilized in crop improvement programme. Linkages with the farmers and NGOs were strengthened by setting demonstration units and providing training to the farmers. A notable progress was made in organizing training programme for the farmers in collaboration with state horticulture department, department of forest and horticultural societies.

A good number of research papers, technical bulletins and extension leaflets were published. The scientists participated in various conferences, meetings and workshops. The liaison with the growers and the entrepreneurs was improved through on campus and off campus trainings.

I must express my sincere thanks and gratitude to Dr. Mangala Rai, Director General, ICAR and Secretary DARE, Govt. of India, Dr. H. P. Singh, Deputy Director General (Horticulture) and Dr. U. Srivastava, Assistant Director General (Hort I and Hort II) for their constant encouragement, guidance and support in executing the mandate of the centre. We are also grateful to the members of RAC and IRC for their guidance in carrying out the programmes of the institute successfully.

I also thankfully acknowledge the contributions made by all the scientists, technical, administrative and supporting staff of this centre.



(R. P. Medhi)

Director

Pakyong

Date : 5th December, 2008

EXECUTIVE SUMMARY

- Assessment of genetic diversity in 10 *Cymbidium* species was studied through RAPD analysis. 160 distinct major bands generated of which 97% were polymorphic. The genetic distance measured based on Squared Euclidean Distance showed low to moderate genetic diversity among the species under study. Species were classified into three clusters by Ward's method cluster analysis
- Phylogenetic relationship of 15 vandaceous species of the family Orchidaceae was studied by using DNA (RAPD) markers. Out of 227 distinct major RAPD bands, 97% were polymorphic that were generated from 15 arbitrary primers. The molecular analysis grouped all the species into 5 groups. The polymorphic patterns generated by RAPD profiles showed different degrees of genetic relationship among the species studied.
- 3,310 accessions of orchid germplasm has been conserved at the centre.
- Thirteen endangered and rare species were characterized.
- Under germplasm status of NAGS, the characterization and evaluation for minor and miniature orchids (*Phalaenopsis lobbi*, *Hygrochilus parishii*, *Dendrobium nobile* var. *alba* etc.) has been done for national registration at NBPGR on priority.
- The hybrids NRCO-42, H X B, *Epidendrum*, NRCO-Freesia-01 and *Paphiopedilum lawrenceanum* X *Paphiopedilum* 'Winston Churchill' cross were characterized.
- Under micro – propagation, it was found that Plb's cultured on MS +AC 1.5 g/l + IBA 1mg/l showed faster increase in number of leaves and roots of *Cymbidium whiteae*.
- Nitsch media with carbon sources of 40 g/l is suitable for conservation of *Cymbidium* hybrid 'Sleeping Nymph'. MS media with activated charcoal and sucrose @ 20 & 30 g/l found suitable for faster multiplication of Plbs.
- The combine effect of BAP and NAA (MS +AC 1.5 g/l + BAP 0.05 mg /l + NAA(0.25 mg/l) was found suitable for faster multiplication of Plb's of *Cymbidium* Pineclash 'Moon Venus'.
- 75% shade and 50% water level through out the year enhanced the growth and development of *Cymbidiums* under mid hill situation (4500 ft msl).
- Application of NPK (19:19:19) at a concentration of 0.3% at weekly interval boosted the vegetative growth of 1 year old hardened tissue cultured plants .
- Anthracnose disease, caused by *Collectotrichum gloeosporioides*, was found to infect large number of orchid genera during the year. The telomorph stage of the fungus, *Glomerella cingulata*, which is very destructive, was reported from *Cymbidium* sp. and *Phaius tankervilleae*.
- Metalaxyl (0.1%) was found effective for controlling black rot disease of *Cymbidium*.

- A plant pathogenic nematode was found causing root necrosis and twisting disease in *Cymbidium* hybrids for the first time in India.
- *Cymbidium* mosaic virus (CymMV) and Odontoglossum ringspot virus (ORSV) were found in most of the orchid species. The incidence of ORSV was higher than CymMV in orchid germplasm at NRCO as revealed by DAS- ELISA test.
- Based on survey, mites, thrips, scales insects, shoot borer, slugs and mealy bugs were reported to infest the orchids. To control the shoot borer, Achook (NSKE) 1500 ppm (5ml/l.) was found most effective against the pest of *Dendrobium nobile*.
- The basal application of graded dose of N : P : K 10:25:25, 10:20:20, 10:20:25 @ 100 gm/m² found suitable for development of *Lilium* bulblets.
- The externally funded projects like MM-I, DUS and Mega Seed Project work continued to support the core projects.
- Total quality planting material production under MM-I was 6,355 during the reported year.
- Characterization of 14 numbers of orchid species and hybrids of *Dendrobium*, *Vanda* and *Cymbidium* was carried to fulfill the DUS guidelines.
- 6500 mericlones of *Cymbidium*, 8448 corms of gladiolus and 3000 bulbs of *Lilium* were produced under the Mega Seed Project.
- Five promising variants of *Paphiopedilum insigne* and one variant of *Liparis bootanesis* were identified and studied.

कार्यकारी सारांश

- आर.ए.पी.डी विश्लेषण द्वारा 10 सिम्बीडियम प्रजातियों में आनुवांशिक विविधता का मूल्यांकन किया गया। जिनमें 160 सुस्पष्ट पंक्टिकाएं (बैड्स) प्राप्त हुईं। जिनमें से 97 प्रतिशत बहुरूपी पाई गयी। स्कवेर्यड यूक्लीडियन डिस्टेंस के आधार पर आनुवांशिक दूरी का आमापन किया गया जो अध्ययन की गयी प्रजातियों के मध्य क्रम से मध्यमस्तर की आनुवांशिक विविधता दर्शाती हैं। वार्ड की समूह विश्लेषण विधि द्वारा 10 प्रजातियों को तीन समूहों में वर्गीकृत किया गया।
- आर्किडिसी कुल की 15 वंडासियस प्रजातियों के जातिवृत्तीय सहसंबंधों के अध्ययनार्थ डी.एन.ए. (आर ए पी डी) मार्करों का प्रयोग किया गया। 15 यादृच्छिक प्राइमरों से कुल 227 सुस्पष्ट मुख्य आर.ए.पी.डी. बैंड उत्पन्न हुए। जिनमें 97 प्रतिशत बहुरूपी थे। आणविक विश्लेषण से सभी प्रजातियों को समूहों में समूहीकृत किया गया। आर.ए.पी.डी. प्रोफाइल द्वारा उत्पन्न बहुरूपी ढंग से अध्ययन की गयी प्रजातियों के मध्य विभिन्न स्तर के आनुवांशिक संबंध को दर्शाया गया है।
- विगत वर्ष पूर्वोत्तर राज्यों से आर्किड जननद्रव्यों का संकलन किया गया। केन्द्र में कुल जननद्रव्यों की संख्या तीन हजार तीन सौ दस हो गई है।
- आर्किड की 13 लुप्तप्रायः एवं दुर्लभ प्रजातियों का अभिलक्षणन किया गया।
- पैफियोपीडिलम इनसिगनी के 5 फार्मस का पता लगाया गया जो अपनी सामान्य प्रजाति से भिन्न पाये गये। इन फार्मस का संकलन एवं अनुलक्षणन किया गया।
- लीपारिस बूटानेन्सिस के वैरिएन्टस का संकलन एवं अनुलक्षणन किया गया।
- एन.ए.जी.एस. में जननद्रव्य के महत्व के अन्तर्गत कम महत्व वाले एवं लघुरूपी आर्किड्स जैसे फेलेनोप्सिस लोबाई, हाईड्रोकाइलस पारिसाई, डेन्ड्रोबियम नोबिली वैराइटी एल्वा का नेशनल ब्यूरो आफ प्लान्ट जैनेटिक रिसोर्सेज, नई दिल्ली में राष्ट्रीय पंजीकरण कराया गया।
- संकर, एन आर सी ओ - 42, एच x बी, इपिडेन्ड्रम, एन आर सी ओ - फ्रीसिया-10 और पैफियोपेडिलम लारेन्सियानम x पैफियोपेडिलम विन्सटन चर्चिल अभिलक्षित किये गये।
- सिम्बीडियम व्हाइटी के प्रोटोकॉर्म्स को एम एस मीडिया में 1.5 ग्रा/ली० एकटीवेटेड चारकोल एवं आई बी ए 1 ग्रा/ली० मिलाकर कल्चर करने से उनमें पत्तियों एवं जड़ों का विकास पाया गया।
- संकर सिम्बीडियम 'स्लीपिंग निम्फ' के प्रोटोकॉर्म्स के संरक्षण हेतु निश्च माध्यम में 40 ग्रा०/ली० कार्वन श्रोत उचित पाया गया। एम एस माध्यम में एकटीवेटेड चारकोल तथा 20 या 30 ग्रा०/ली शर्करा का प्रयोग पीएलवीज के विकास के लिए उचित पाया गया।

- बी ए पी एवं एन ए ए (एम एस + ए सी 1.5 ग्रा/ली0 + वी ए पी 0.05 मीग्रा/ली + एन ए ए (0.25 मिग्रा/ली) को संयुक्त रूप में प्रयोग करने से, सिम्बीडियम पाइनक्लाश 'मूनवीनश' के पीएलवी प्रगुणन के लिए उपयुक्त पाया गया।
- सिम्बीडियम के पौधों को वर्ष भर 75 प्रतिशत छाया एवं 50 प्रतिशत जलस्तर प्रदान करने पर कणियों के उत्पादन एवं पौधों के विकास में वृद्धि पाई गयी।
- एक वर्षीय ऊतक संबर्धन द्वारा स्थापित पौधों में एन पी के (19:19:19) की 0.3 प्रतिशत सांद्रता वाले घोल के अनुप्रयोग से पौधों की कायिक वृद्धि में अभिवर्धन देखा गया।
- विगत वर्ष में बहुत अधिक संख्या में आर्किड जेनेरा के पौधे काँलेटो ट्राईकम ग्लोइयोरुपोटियोइडिस नामक कवक द्वारा उत्पन्न एंथ्रेकनोज रोग से संक्रमित पाये गये। सिम्बीडियम प्रजाति एवं फायस टेंकरविली से कवक की टीलोमार्फ अवस्था सूचित की गयी जो अत्यन्त विनाशकारी है।
- सिम्बीडियम के ब्लैक रॉट रोग के नियंत्रण हेतु 0.10 प्रतिशत मेटालेक्सिल अत्यंत प्रभावी पाया गया।
- भारतवर्ष में पहलीबार सिम्बीडियम संकरों में रुटनेक्रोसिज एवं पर्णऐंठन उत्पन्न करने वाला एक पादप रोगजनक सूतकृमि पाया गया है।
- अधिकांश आर्किड प्रजातियों में सिम्बीडियम मोजिक विषाणु (सी वाई एम एम वी) एवं ओडोन्टाग्लोसम वलय लक्ष्य विषाणु (ओर आर एस वी) डी ए एस ई एल आई एस ए विधि द्वारा टेस्ट करने पर पाजिटिव पाये गये हैं। एन आर सी ओ के आर्किड जननद्रव्य में सी वाई एम एम वी की अपेक्षा ओ आर एस वी का आपतन अधिक पाया गया।
- सर्वेक्षण से यह मालूम हुआ कि माईट, थ्रिप्स, स्केलकीट, शूटवेधक, स्लग्स एवं मिलिबग आर्किड को नुकसान पहुँचाने वाले प्रमुख कीट हैं। डेन्ड्रोबियम नोबिली के शूटवेधक कीट के नियंत्रण हेतु अचूक (एन एस के ई) 1500 पी पी एम (5 मिली/ली0) सबसे अधिक प्रभावशाली पाया गया।
- एन पी के 10:25:25 या 10:20:20 या 10:20:25 को 100 ग्राम/वर्ग मीटर की दर से प्रयोग करने पर लिलीयम के बल्बलेट्स के ताजा भार एवं व्यास सर्वाधिक वृद्धि पायी गयी।
- केन्द्र द्वारा चलाई जाने वाली प्रमुख परियोजनाओं की सहायता के लिए वाहररूप से वित्तपोषित परियोजनाएं जैसे एम एम-1, डस परीक्षण, मेगा सीडप्रोजेक्ट निरन्तर सहायक सिद्ध हो रही हैं।
- विगत वर्ष में एम एम:1 परियोजना के अन्तर्गत कुल गुणवत्ता वाले रोपण पदार्थ (पौधों) का उत्पादन 6335 रहा।
- डस परीक्षण के अन्तर्गत 14 आर्किड जातियों एवं डेन्ड्रोबियम, वन्डा और सिम्बीडियम संकरों का अभिलक्षणन किया गया।
- मेगासीड प्रोजेक्ट के अन्तर्गत सिम्बीडियम, ग्लेडियोलस कंदों और लिलीयम बल्बों का उत्पादन क्रमशः 6500, 8448 तथा 3000 रहा।

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Introduction

The Institute

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 for improvement in productivity, quality and utility 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 the establishment of the centre. In October 1997, the centre also took over the Darjeeling campus from C.P.R.I. and established a sub centre for research on temperate orchids and ornamental bulbous crops.

In the initial years of the establishment the major focus of research was on collection, characterization, evaluation and utilization of available germplasm in the north eastern region in particular, and in the country in general. 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 material through tissue culture and creation of repository of information related to all aspects of orchids. On the recommendations of consecutive RACs all the research projects have been modified on the mission oriented research programme on crop improvement, crop production, crop protection and post harvest management.



Fig. 1 : Laboratory and administrative Building of the institute

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 bulbous ornamental crops
- To act as national repository for scientific information on mandate flower crops
- To coordinate research with other scientific organizations and act as centre for training

The research work is being carried out under 09 projects. In addition to these, research work is also carried out under externally funded projects- Technology Mission on Integrated Development of Horticulture in North Eastern States including Sikkim, Uttranchal, Himachal Pradesh and Jammu & Kashmir (Mini-Mission and Network Projects on Distinctiveness, Uniformity and Stability (DUS) on orchids and Mega Seed Project - Seed Production in Agricultural Crops and Fisheries.

Organisation

The Director is the administrative head of the institute. The Institute Management Committee, Research Advisory Committee and Institute Research Council assist the Director in matters relating to management and research activities of the institute (Fig.1).

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.

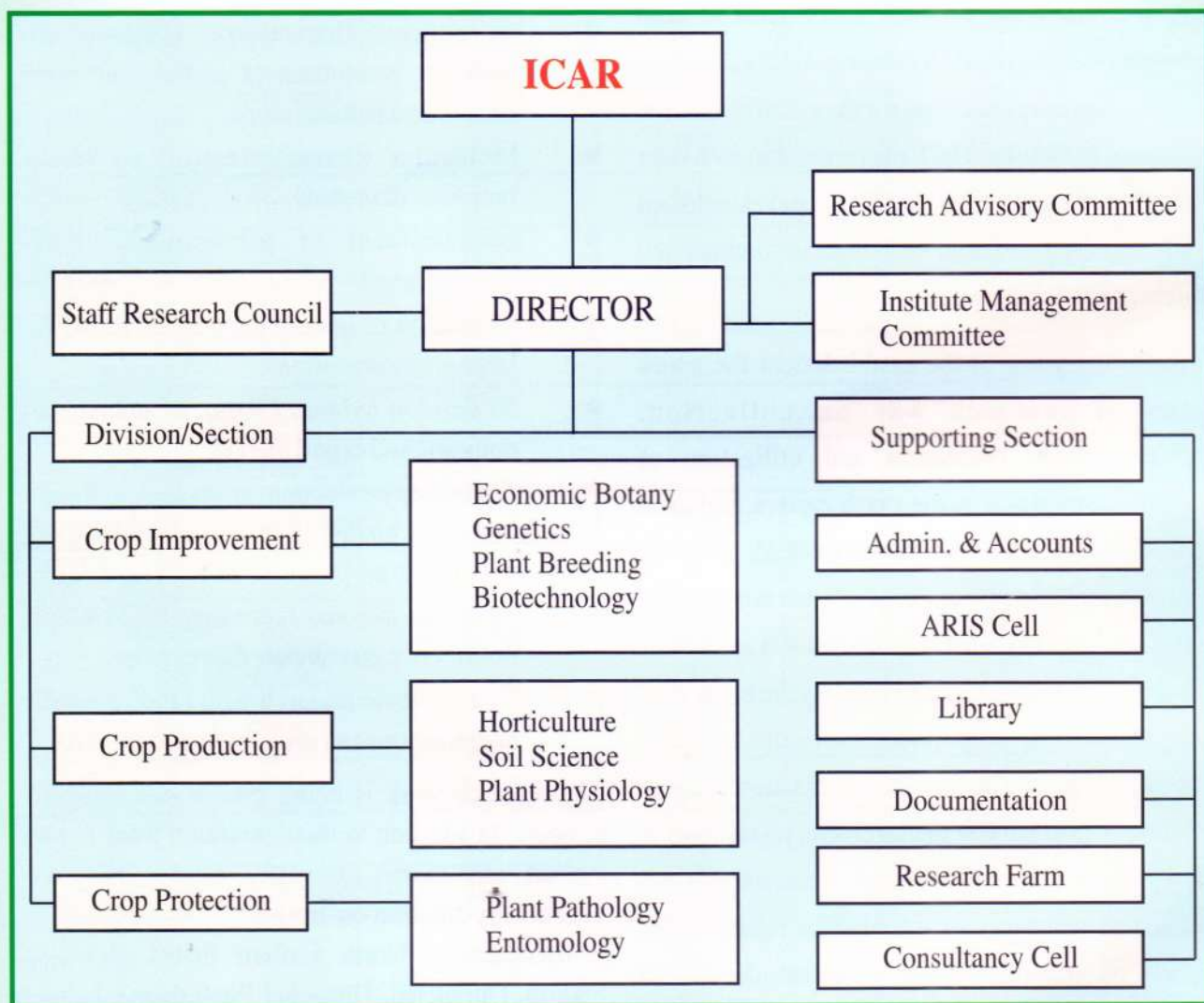


Fig. 1. Organisation of NRCO

Budget

The total budget of the institute was Rs. 229 lakhs under Plan and 79 lakhs under Non Plan (Table 1). during the year which included Rs. 150 lakhs under

Table 1. Budget of the institute

Head of Account	Amount (Lakh Rupees)			
	Non-Plan		Plan	
	Sanctioned	Utilized	Sanctioned	Utilized
Establishment charges	64.00	62.06		
Labour wages	-	-	-	-
Traveling allowances	29.50	16.81	70.00	67.62
Other charges	10.55	10.08	107.50	105.75
Works	14.50	0.39	34.50	31.46
HRD	-	-	1.00	0.54
Total	79.00	74.21	150.00	144.51

Revenue generation

The institute generated Rs. 1,64,973 as revenue through the sale of farm produce, tender forms, trainings etc. The break-up of revenue receipt is presented in table 2.

Table 2. Revenue generation of the institute

Revenue generation	
Particulars	Amount (Rupees)
Sale of farm produce	11,825
Sale of tender form	4,900
Training	82,400
Others	65,848
Total	1,64,973

Staff

The institute has sanctioned strength of 15 scientific, 7 administrative, 7 technical and 7 supporting staff (Table 3)

Table 3. Staff position of the institute (as on 31.03.2008)

Sl. No.	Category	Sanctioned strength	In position	Vacant
1.	Director	1	1	-
2.	Scientific Post			
	Scientist	9	5	4
	Sr. Scientist	5	3	2
	Principal Scientist	1	1	-
Total		15	9	6
3.	Technical Staff			
	Category - I	5	4	1
	Category - II	2	2	-
	Category - III	-	-	-
Total		7	6	1
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	5	2
5.	Supporting Staff(SSG-I, II, III, IV)			
		7	7	-

Past Achievements

Surveys were conducted for collection of orchid germplasm to 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 m) while the accessions of temperate species were conserved at Darjeeling campus (altitude, 2150 m). The germplasm was characterised for various

useful traits. The molecular characterisation of germplasm is also in progress.

Protocols for micropropagation 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 requirement for nutrient, media, water, light, shade etc were standardized for the *Cymbidium* orchids standardized.

The surveys were conducted for disease and insect-pests causing damage in the farmers' field as well as in the orchid conservatories at the centre. The diseases causing damage to the orchids were identified, epidemiology was studied, casual organisms were isolated and their control measures were suggested. Similarly, insects-pests causing damage to the orchids were also identified and their nature of damage studied and the control measures were suggested. Several pathogens and insect-pests were reported for the first time in the causing damage to the crop.

The centre organized training programmes for extension workers and farmers regularly. The quality planting material of orchids and other floriculture crops was produced and distributed to the farmers to

promote orchid cultivation in the region. The demonstrations were conducted at the farmers' field to encourage farmers for adopting orchid cultivation as a vocation.

The centre has developed a library that plays an important role in serving scientific information in the area of horticulture specially orchids and other ornamental crops. During the year near about 100 books related to different subjects and 13 Hindi books were purchased for the library. Thirty eight journals including ten foreign journals were procured through subscriptions. Institute's publications were provided to more than 200 different organizations.

The center established linkages with DAC, Ministry of Agriculture, New Delhi, IIHR, Bangalore, CIMAP, Pantnagar Centre, CITH, Srinagar, NBPGR New Delhi and Regional Centre at Shillong and Shimla, IARI Regional station Katrain, GBPUA&T, Pantnagar, VPKAS, Almora, ICAR Research Complex for NEH region, Barapani and its Regional Centers, HPKV, Palampur, CPCRI, Regional Centre Kahikuchi, UHF, Solan, CPRI Regional station Shillong, SKUAST(J) & (K), Srinagar, CAU, Imphal and AAU, Assam.

Research Achievements

2



CROP IMPROVEMENT

Molecular Characterisation of Orchids

RAPD analysis of *Cymbidium* orchids

Random amplified polymorphic DNA (RAPD) markers were used to study the genetic diversity of 10 *Cymbidium* species of the family Orchidaceae. Out of 20 decamer primers 10 arbitrary primers produced a total of 160 distinct major bands of which 97% were polymorphic. The number of bands generated per primer ranged from 3 (Primer A-10) to 22 (Primer K-10 and N-17) with a mean of 16.33 bands per primer. The primer resolving power was found to range between 2.00 (prime A-10) and 13.36 (primer K-10) when all the species under study were taken into account. The genetic distance measured based on Squared Euclidean Distance showed low to moderate genetic diversity among the species under study. By Ward's method of cluster analysis 10 species were classified into three clusters. The species *C. eburneum*, *C. giganteum*, *C. grandiflorum* and *C. aloifolium* are closely related to each others showing similar banding patterns and grouped in cluster - 1. The species *C. lowianum*, *C. tigrinum* and *C. pendulum* are closely related to each other and belongs to cluster - 2. The other three species of *Cymbidiums* - *munronianum*, *whiteae* and *tracyanum* are related to each other and belongs to other group, cluster - 3. The polymorphic patterns generated by RAPD profiles showed different degrees of genetic relationship among the species studied and the RAPD marker were found to be an useful tool for detecting genetic variation between the species.

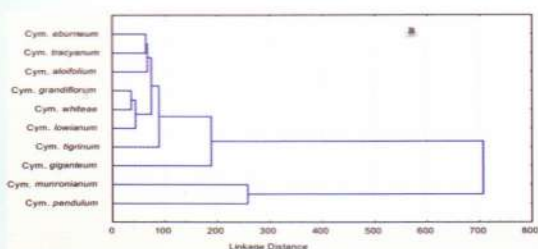


Fig. 1. Genetic relationship (dendrogram) among ten *Cymbidium* species

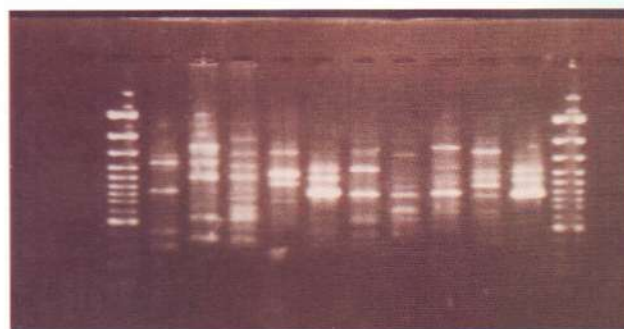


Fig. 2. RAPD banding pattern generated by primer OPO-16

RAPD analysis of vandaceous orchids to study the phylogenetic relationship

Random amplified polymorphic DNA (RAPD) markers were used to study the phylogenetic relationship of 15 vandaceous species of the family Orchidaceae. A total of 227 distinct major RAPD bands were obtained from 15 arbitrary primers of which 97% were polymorphic. The number of bands generated per primer ranged from 3 (Primer A-10) to 22 (Primer K-10 and N-17) with a mean of 14.8 bands per primer. The molecular analysis grouped all the species into 5 groups. The polymorphic patterns generated by RAPD profiles showed different degrees of genetic relationship among the species studied.

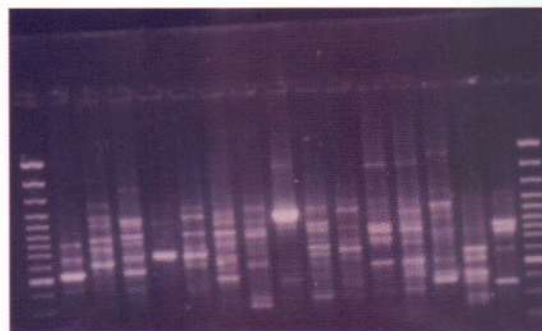


Fig. 1. RAPD banding pattern generated by primer OPW-11

Germplasm collection

3,310 accessions of orchid germplasm has been conserved at the centre. During the year a mutant of *Spathoglottis plicata* Blume along with mother plants were received from the University of Kalyani, for the germplasm repository under NAGS. A few collection of orchids were made from ICAR

Research Complex for NEH Region, Meghalaya and near by markets. Approximately, two hundred forest plants were procured from the Department of Wild Life and Forestry, Government of Sikkim and were planted in the institute forest area to develop a site for *ex situ* conservation.

Characterization and evaluation

The characterization done on the some of the orchid species of endangered and minor category are given below.

Phalaenopsis lobbi (Rechib.f.) H.R. Sweet

Plants are small sized with stout stem, 2.5 cm in height. The leaf shape is ovate and dark green in colour. Inflorescence is basal, flowers 1-2 in numbers per inflorescence. The peduncle is erect or semi-erect 1.2 - 2.9 cm in length. Sepals and petals are ovate and narrow ovate respectively and pure white in colour. Lip possesses spots of grayed orange colour with apical and lateral lobes. Flowers bloom generally in the month of April.



Entire plant



General appearance of flower

Hygrochilus parishii (Veitch & Reichb.f.) Pfitz

Plants are medium sized, 23 cm height, having a stout & horizontal pseudo stem. The leaves are elliptical, medium green in colour, 15.5 cm length and 5.4 breadth respectively. Inflorescence*raceme type is with 8-10 numbers of flowers. Flower stalk measure about 25.6 cm in length. The number of spikes/plant is one. The dorsal sepal and petals are elliptical and lateral sepals are ovate in shape, yellow green colour with grayed orange colour spots. Lip triangular, purple in colour. Flowering time April - May.



Entire plant



General appearance of flower

Dendrobium secundum Wall.

Plant tall, height of 60-65 cm. Leaves are ovate, light green in colour. Flowers 1-3 number per spike. The sepals and petals are linear in shape and white in colour. The mentum is 0.5 cm in length and 0.4 cm in width, white in colour. The shape of the lip is elliptical with light yellow shading. The plant flowers during April - May.



Entire plant



Colour & shape of leaf

Cattleya maxima

Plants are small, 12 cm height and 18 cm spread. The stem nature is stout and pseudostem is semi-erect. The leaf elliptical, light green in colour. The flower arises directly from the base of leaf with pedicel of 8 cm long and 0.2 cm in thickness having purple in colour. The sepals are lanceolate, but petals are oblong and margin undulated. The lip shape is elliptical and margin undulated, white in colour with yellow and purple striped in the middle part. The plant blooms during April-May.



Entire plant



Colour & shape of leaf

Dendrobium nobile var. *alba*

A rare endangered species, medium size plants, height 47.5 cm. Leafs are medium green, 10.6 cm length and 2.1 cm width. Spike emerges from the basal part of the plant. The Peduncle is horizontal and number of flowers ranges from 5-20 per inflorescence. The flowers are extremely attractive white colour having mentum length of 0.7 cm. The lip is yellow coloured with transverse elliptic shape. The colour of anther cap is green and generally flowers in the month of March-April.



Entire plant



Colour & shape of leaf

Dendrobium primulinum Lindl.

Plant height 14 cm, inflorescence is racemose bearing 2-5 flowers. The mentum 0.4 cm length and 0.4 cm width which is the typical character of the plant. The shape of sepals and petal are elliptic-narrow elliptical and light purple in colour. Flower blooms generally during April-May.



Entire plant



Inflorescence position of flower

Dendrobium aphyllum Roxb.

Plants are medium sized, inflorescence/pseudo-stem ranges 3-4 and number of flowers with a record of 2-23. The mentum measures 3.5 cm in length and 5.6 cm in breadth. The number of spikes per plant is 4. The sepals are narrow ovate and petal elliptic in shape. The main colour of sepal and petal is red purple and white with striped (red purple) colour

pattern. The lip length is 3.9 cm and breadth with 3.4 cm. Flower blooms generally during March-April.



Entire plant

Dendrobium anceps (Sw.) Lindl.

Plant small, 15 cm height, leaves are narrow ovate and light green in colour. Presence of small mentum is the typical character of flowers. Single flower arises from the base of the leaves, pedicel 0.5 cm long and 0.1 cm broad. The shape of sepal is obovate and petal is lanceolate. The flower is yellow in colour and lip shape is narrow elliptical and bifurcates at apex. Flowers generally during late March-early April.



Entire plant



General appearance of flower

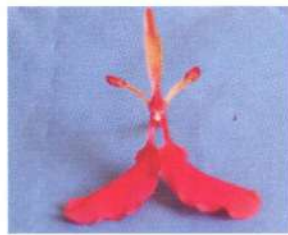
Renanthera imschootiana Rolfe

Plant height usually ranges from 52-55 cm or more, leaf shape is linear. The peduncle is semi erect having recorded length of 26.2 cm length and 0.3 cm thick. Inflorescence is racemes, bearing 5-7 flowers, borne along the peduncle. The dorsal sepal is lanceolate and lateral sepals are oblong in shape. The colour of dorsal sepal is grayed orange (164 C) and lateral sepal is red purple (60 A). The petals are spatulate in shape, grayed orange in colour with colour spots. The lip length is of 0.6 cm & width of recorded 0.2 cm, bearing lateral lobe with having a distinct apical lobe, which is triangular in shape. The colour of lip is

red purple with presence of callus. The anther cap is heart shaped and yellow in colour. Generally blooms in the month of December–June.



Entire plant



General appearance of flower

Arachnis rubra

Plant 35.9 cm long, having linear shaped leaves. The peduncle measures 33.5 cm long and 0.2 cm thick, semi drooping. Inflorescence, raceme bearing 7-8 number of flowers, sepals are linear in shape, length of 1.7 cm and breadth 0.3 cm. The lip shape is narrow triangular (apical lobe, narrow pointed) and yellow in colour. Flowers bloom generally during August.



Entire plant



General appearance of flower

Liparis bootanensis Griff.

Small sized plants, height- 28 cm, pseudo bulb size- 4.5 cm length and 1.3 cm breadth. Leaves narrow-elliptical, peduncle flat and drooping. The number of flowers/inflorescence ranges from 1-9, flowers are minute. The sepals and petals are lanceolate in shape with yellow orange and orange colour respectively. Column length 0.3 cm. The flowers generally bloom during late August to early September.



Entire plant



General appearance of flower

Eria spicata D. Don.

Plant grows up to a height of 30 cm with semi-drooping pseudo stem. The leaves are dark green in colour and the flowers are fragrant. The dorsal sepal is ovate, 0.6 cm length and 0.2 cm breadth. Flowers are white in colour, lip triangular in shape. Flower blooms generally in the month of August.



Entire plant



General appearance of flower

Crossing programme

Based on the summary of the earlier two years data on crossings, limited and targeted crosses were made between species belonging to genera of *Dendrobium*, *Cymbidium* and *Vanda*. The results showed 60% pod formation.

New hybrid lines identified from F₁ progeny

NRCO-42 (New *Dendrobium* hybrid developed)

The F₁ progeny of (*Dendrobium* 'Emma White' x *Dendrobium* 'Pompador') small sized plants with an average height of 32 cm, semi erect pseudo stem with 20 cm in length and 1.5 cm in thickness in linear and angular in cross section, respectively were recorded for flowering and other floral traits. The leaves are dark green and narrow elliptic with recorded length of length 19 cm and 2.9 cm width. The Inflorescence emerged from top part of pseudostem bearing 5-7 flowers. The general appearance of sepals and petals are reflexed type. The flower measures about 6.9 cm in length and 7.7 cm in breath with purple in colour (RHS N78 A) with medium white shading at proximal ends. The dorsal and lateral sepal shape is ovate which measures the length of 4 cm & 4.4 cm and breadth of 1.8 cm & 2 cm respectively. The petals are obovate and recorded length of 4.4 cm and width of 3.8 cm. The lip length is

of 3.5cm & width recorded for 1.7 cm, with a typical lateral lobe and elliptic apical lobe in purple colour. This purple coloured lip having a shaded and netted colour pattern is distinct from the Dendrobium pompadour. The colour of lip throat is of white - whitish pink with fine fringing of margin. The callus is present on lip. Column colour of anther cap is of white, with length of 1.8cm. First time the progeny flowered during the month of December, 2007.



Entire plant (F₁)



General appearance of hybrid flower



Side view showing mentum

HXB

Plants were medium sized with height of about 50-55 cm and spread area of 60 cm, bearing linear shape leaves with acute symmetric apex and medium green coloured. The length of the leaf is recorded with 49-50 cm and width of 1.6 cm. The inflorescence is raceme type with 5-6 flowers & semi-erect peduncle possessing medium to large bract. The shape of sepals and petals are oblong-obovate and elliptic respectively and yellowish green (145 B) coloured. The lip possesses elliptic apical lobe and trapezoid lateral lobes, with yellow green and off white colour having red (46, A) colour spots in apical lobe. The lip callus is distinct and is yellow green in colour. The anther cap white in colour. First time the progeny flowered during Feb - March, 2008.



General appearance of flower



Entire plant

Embryo culture and present status of F₁ hybrids under hardening

The F₁ population of different crosses made during past years is at various stages of development. The F₁ population is contentiously monitored and evaluated for their growth and development. The selections would be made from the population of these crosses for identifying the best F₁ lines for registration and variety proposals. The list of the crosses and their stages of development are mentioned as below. (Table 1.)

Evaluation and bulking selected crosses

Epidendrum cross (3rd Year)

The F₁ progeny derived from *Epidendrum radiacans* and *Epidendrum xanthinum* were evaluated for 3rd year for bulking of the material through vegetative multiplication. The continuous year round flowering was observed for the lines of the cross.

Progeny evaluation of *Paphiopedilum* cross

The promising *Paphiopedilum* cross (*P. lawrenceanum* x *P. 'Winston Churchill'*) was evaluated for morphological traits.

NRCO - Freesia hybrid - 01

The new hybrid line was multiplied for bulking during this 3rd year. The evaluation has been done for morphological characterization and proposed for multi-location trail through AICRP (Floriculture). The parental lines are also bulked for selection and purification.



Parental stocks of Freesia (Sikkim local) under selection

Table - 1. Status of crosses maintained at the centre

Cymbidium crosses			
Parentage	Under in vitro hardening (TC Lab)	Under ex-vitro hardening (Hardening house)	No of Plantlets in the hardening house (in pots & beds)
<i>Cym. Oriental Legand</i> X <i>Cym 'Showgirl Cooksbridge'</i> (AB X SG)	15	34	402
<i>Cym. Amesbury</i> X <i>Cym. 'Showgirl Cooksbridge'</i> (Cym-A)	45	245	123
<i>Cym. 'Fancy Free'</i> X <i>Cym 'Tetraploid Oklahama'</i> (PBX-05-10)	-	30	228
<i>Cym. 'Red Star'</i> X <i>Cym. 'Fancy Free'</i> (PBX-05-34)	10	55	240
<i>Cym. 'Golden elf'</i> X <i>Cym. 'Red Beauty'</i> (PBX-05-29)	-	-	204
<i>Cymbidium lowianum</i> X <i>Cymbidium tigrinum</i> (PBX-05-56)	-	-	20
<i>Cym 'Amesbury'</i> X <i>Cym 'Red Beauty'</i> (PB X - 05 - 67)	-	-	6
<i>Cymbidium tigrinum</i> X <i>Cymbidium lowianum</i> (PBX-05-61)	-	-	10
<i>Cym. 'Golden Elf'</i> X <i>Cym. 'Red Star'</i> (PBX-05-55)	-	-	26
<i>Cym. 'Nonina paletale'</i> X <i>Cym 'Iridoides'</i> (PBX-751)	-	-	8
<i>Cym. 'Show girl'</i> X <i>Cym. 'Red Star'</i> (PBX-05-884)	-	310	53
<i>Cymbidium gammieanum</i> X <i>Cymbidium dayanum</i> (PBX-05-490)	-	-	44
<i>Cymbidium tracyanum</i> X <i>Cym 'Fency Free'</i> (PBX-05-21)	105	1,509	130
<i>Cym. 'Fency Free'</i> X <i>Cym. 'Red Star'</i> (PBX-05-41)	5	52	34
<i>Cym. 'Red Star'</i> X <i>Cym. 'Fency Free'</i> (PBX-05-39)	-	-	25
<i>Zygopetalum intermedium</i> X <i>Peristeries elata</i> (PBX-05-01)	-	-	544
<i>Epidendrum xanthinum</i> X <i>Renanthera imschootiana</i> , (PBX-05 -178)	-	83	386
<i>Dendrobium embryo</i> brought from Himalayan Flora & Biotech, Gangtok (MD-01)	133	566	57
NRC (O)	-	-	6
NRCO-42	-	-	15
<i>Ascocentrum King P Kultana</i> (KPK)	-	-	3
Total	313	2,884	2,564
GRAND TOTAL 313+2,884+2,564 = 5,761			

In-vitro Propagation of Orchids

Effect of various strength of basal media in combination with growth hormone on multiplication and growth of *Cymbidium whiteae*

The Plbs of *Cymbidium whiteae* were cultured on various strength of MS media incorporated with IBA 1mg/l. The result showed that the media of 3/4th strength influenced faster Plbs proliferation, while early shoot and root differentiation was observed best on 1/2 strength MS media. The plantlets of 2-3 leaves of 2 cm height were sub-cultured in the same media formulations. The notable growth was observed in terms of height, number of leaves, roots and root diameter. The plantlets cultured in MS + AC 1.5 g/l + IBA 1 mg/l showed faster increase in number of leaves and roots.

Influence of carbon sources on in-vitro multiplication and conservation of *Cymbidium 'Sleeping Nymph'*

The protocorms of *Cymbidium 'Sleeping Nymph'* were cultured in two different media, viz. Murashige and Skoog (MS) and Nitsch with and without activated charcoal (1 g/l) and supplemented with sucrose, glucose and mannitol (20, 30 & 40 g/l). After six months significant variations were observed in various growth parameters among cultures done in the two different media supplemented with different concentration of carbon sources. The observations revealed that Nitsch media showed the slowest rate of multiplication and differentiation in comparison to MS media. The fastest rate of protocorm proliferation was observed in MS media with activated charcoal (1 g/l) with sucrose (20 g/l). Browning was observed in the cultures done in media without activated charcoal. The early shoot and root emergence was also observed in MS media supplemented with sucrose, glucose and mannitol. However, the multiplication and differentiation rate of protocorms were observed to be lower at higher concentration of carbon

sources. The optimal dose of sucrose has showed generation of good rooting without rooting media. Those plantlets with 5-6 leaves with roots grown in MS media supplemented with activated charcoal and sucrose (20 & 30 g/l), glucose (20 & 30 g/l) and mannitol (20 g/l & 30 g/l) were transferred to community pot with pre-standardized potting mixture. The cultures done with Nitsch media supplemented with sucrose, glucose and mannitol were at the same protocorm and differentiation stages even after 100 days. Hence, it was observed that Nitsch media with carbon sources of 40 g/l is suitable for conservation of *Cymbidium 'Sleeping Nymph'*, while for faster multiplication of Plb's the MS media with activated charcoal and sucrose (20 & 30 g/l) is suitable.

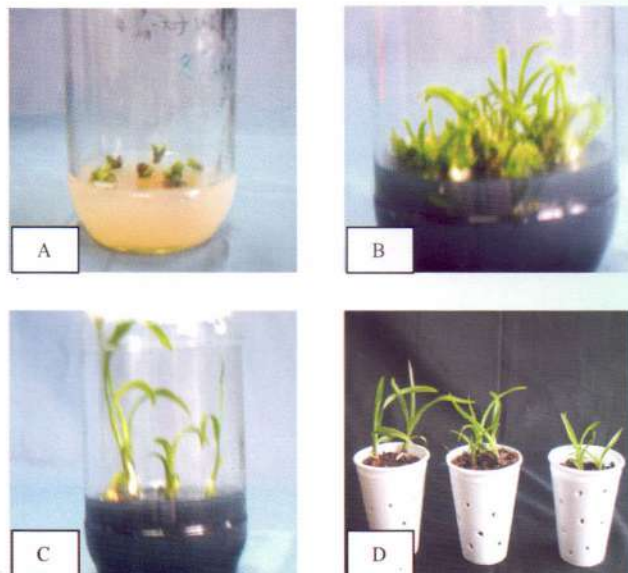


Fig: A- Browning of media in absence of activated charcoal; B-Plb's differentiation stage; C- Growth of plantlets on Nitsch media; D- Plantlet at hardening stage

Effect of different basal media in combination with activated charcoal and growth hormones on different ex-plants of *Dendrobium nobile var. alba*

Effect of different basal media (MS, Nitsch, Gamborg & Knudson C) in combination with activated charcoal (1.5 g/l), BAP (0.5 mg/l) and

NAA (0.25 mg/l) on different explants (root tip, meristem, anther, node) of *Dendrobium nobile* var. alba was studied. The root tip cultured on Nitsch + AC (1.5 g/l) + BAP (0.5 mg/l) + NAA (0.25 mg/l) and meristem culture with MS + AC (1.5 g/l) + BAP (0.5 mg/l) + NAA (0.25 mg/l) showed early response. The response of anther and nodal explants to different basal media was also recorded insignificant differences.

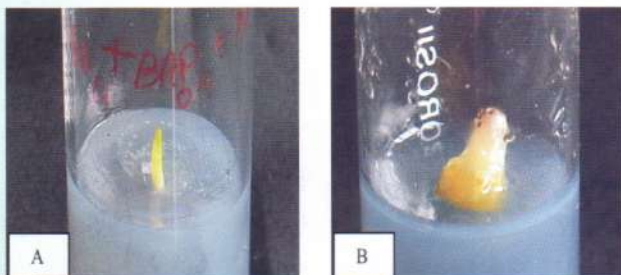


Fig A: Root tip culture in NA + AC (1.5 g/l)
Fig B: Meristem culture in MS + AC (1.5 g/l) + BAP (0.5 mg/l) + NAA (0.25 mg/l) + BAP (0.5 mg/l) + NAA (0.25 mg/l)

Proliferation studies on Plb's using charcoal and hormones with Murashige and Skoog media of *Cymbidium Pineclash 'Moon Venus'*

Influence of single hormone at various concentrations as well as in combinations of the two hormones (BAP & NAA) on Plbs multiplication of *Cymbidium Pineclash 'Moon Venus'* was studied to assess impact on the rate of proliferation. The influence of in-vitro cultures of Plbs with MS medium containing AC supplemented with various concentrations with combination of BAP and NAA showed significant variation in respect of Plbs multiplication. The MS media supplemented with 1.5 g/l activated charcoal and BAP resulted in better multiplication of protocorm, while MS media supplemented with 1.5 g/l activated charcoal and NAA (0.5 mg/l) influenced better differentiation. It was also observed that BAP at a concentration of 0.5 mg/l resulted better Plbs multiplication than 1.0 mg/l BAP. The study on the combination effect of BAP and NAA showed that MS + AC 1.5 g/l + BAP 0.5 mg/l + NAA 0.25 mg/l was most suitable for faster Plb's multiplication. The early shoot and root

emergence and more number of shoot and root differentiation was observed for MS + AC 1.5 g/l + BAP 0.1 mg/l + NAA 0.5 mg/l.

Influence of organic substances on in-vitro multiplication of *Cymbidium 'Soul Hunt-1'*

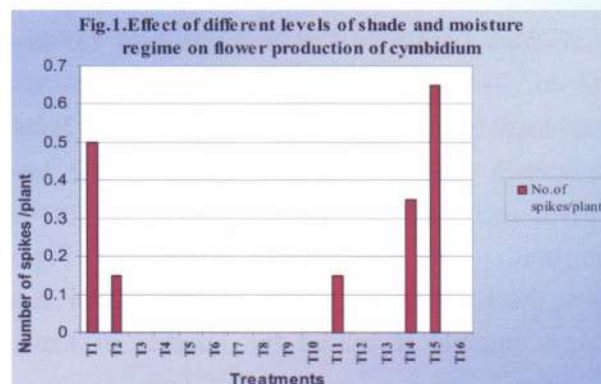
To find out the suitable organic substances and their optimum concentration, Plbs of *Cymbidium 'Soul Hunt-1'* were cultured on MS media with and without AC 1.0 g/l and supplemented with peptone, malt extract, yeast extract (1, 2 & 3 g/l). The Plbs are at proliferation state.

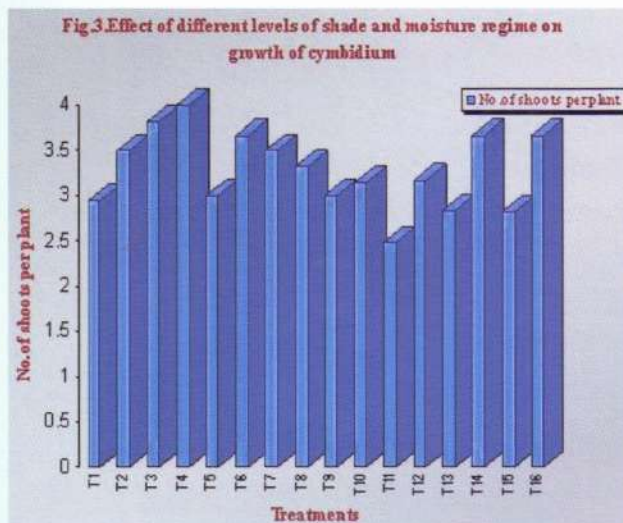
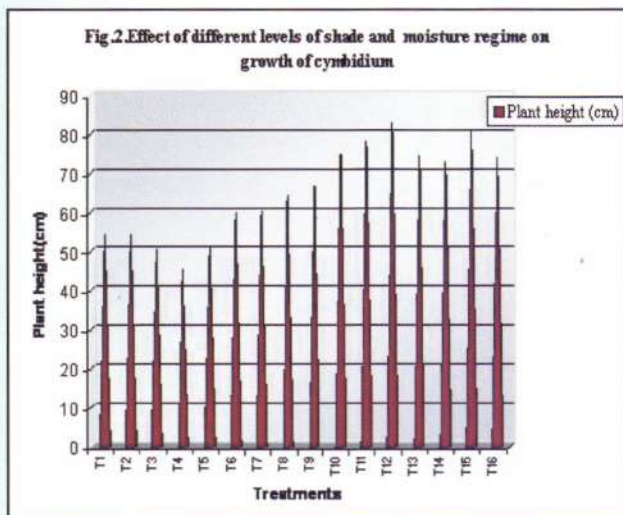
CROP PRODUCTION

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

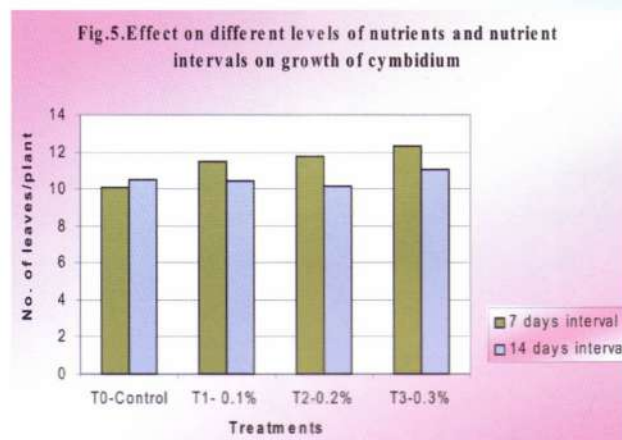
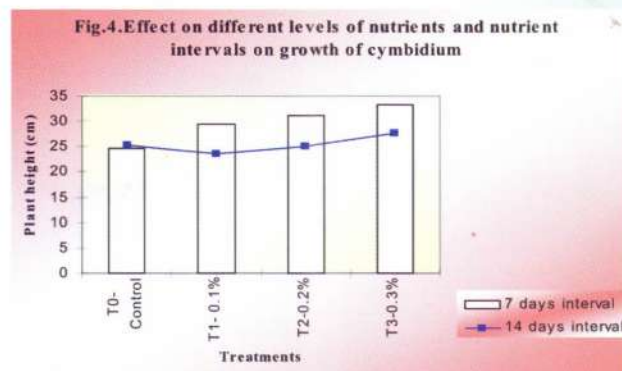
Standardisation of shade requirement and moisture regime for growth and flowering of *Cymbidium*

Out of four shade levels (0%, 30%, 50% and 75%) and four moisture regimes (25 %, 50%, 75% and 100 %), tested for growth and flowering of *Cymbidium*, 75% shade with 50% moisture regime produced maximum number of spikes (0.65)/ plant followed by 75% shade with 75 % moisture regime (0.35). The maximum plant height (82.80 cm) was recorded with 50% shade with 25% moisture regime followed by 50% shade with 50% of moisture regime (72.95 cm). Lowest plant height was recorded in 0% shade with 25% moisture regime (45 cm) (Fig. 1, 2 & 3).





(12.33). It was followed by 0.2% 19:19:19 of N, P, K (11.73). However, in 15 days interval number of leaves was maximum in 0.3% 19:19:19 of N, P, K (11.07). Control plants recorded the lowest number of leaves 10.07 and 10.47, respectively.



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

Out of four concentrations of N, P, K @ 19:19:19 (0%, 0.1%, 0.2% and 0.3%) and two foliar spray intervals (7 days and 15 days). 0.3% 19:19:19 of N, P, K at 7 days interval increased the plant height of *Cymbidium* (33.33cm) as compared to 15 days interval (27.67cm). However, in both intervals the plant height was lesser in control (Fig. 4). Foliar application of 0.3% 19:19:19 of N, P, K at 7 days interval increased the leaf length (32.67 cm) as compared to 15 days interval (26.80cm). Fig.5. shows that foliar spray of 0.3% 19:19:19 of N, P, K at 7 days interval increased the number of leaves

Post harvest technology of orchids

An experiment was carried out to standardize the harvesting stage for *Cymbidium* Helly's Comet 'Aurora'. The flower spikes were harvested when 100%, 75% and 50% flowers were opened and placed in bud opening solution containing 8-HQ 200 ppm + Sucrose 6%. In the entire treatments 100 per cent opening of flowers was noticed. But the vase life of the flowers was considerably influenced by the stage of harvesting. Vase life was maximum in 100% opened flowers whereas water uptake was higher in 50% opened flower when compared to 100% opened flowers; it was followed by 75% opened flowers.

Nutrient Management in Orchids

Effect of different graded doses of N-P-K on growth of *Cym. 'Spring King'*

Two years pot culture experiment was conducted to study the effect of different graded doses of N-P-K on growth of *Cym. 'Spring King'*. The treatments comprising of $T_1 = N_{20} : P_{10} : K_{10}$ @ 0.1% as Media application; $T_2 = N_{20} : P_{20} : K_{20}$ @ 0.1% as Media application; $T_3 = N_{20} : P_{30} : K_{30}$ @ 0.1% as Media application; $T_4 = N_{30} : P_{10} : K_{10}$ @ 0.1% as Media application; $T_5 = N_{30} : P_{20} : K_{20}$ @ 0.1% as Media application; $T_6 = N_{30} : P_{30} : K_{30}$ @ 0.1% as Media application; $T_7 = N_{40} : P_{10} : K_{10}$ @ 0.1% as Media application; $T_8 = N_{40} : P_{20} : K_{20}$ @ 0.1% as Media application; $T_9 = N_{40} : P_{30} : K_{30}$ @ 0.1% as Media application; T_{10} = Farmer's practice (Control). It was observed that for young plants (1 year old), NPK ratio of 30:10:10 @ 0.1% (T_4) was found to be best in terms of growth attributes like leaf length (27.93cm), leaf width (1.33cm), pseudobulb length (2.05cm), pseudobulb girth (1.48cm) of *Cymbidium* hybrid. However, for intermediate growth stage (two year old), the NPK ratio of 20:20:20 @ 0.1% (T_2) was found suitable for growth attributes like leaf length (31.45cm), leaf width (1.66cm), pseudobulb length (2.42cm), pseudobulb girth (1.78cm) of *Cym. 'Spring King'* (Figure 1 and 2).

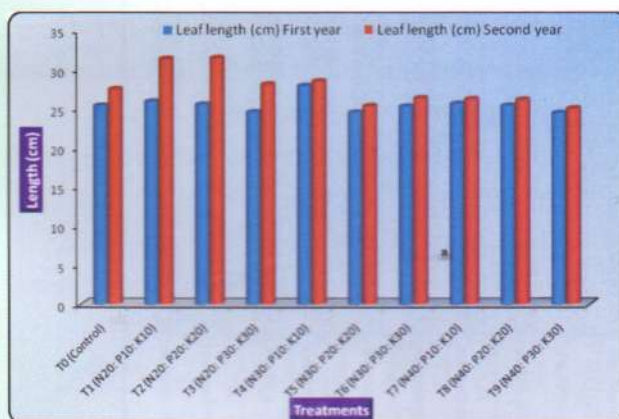


Fig. 1 : Effect of different graded doses of N-P-K on leaf length of *Cym. 'Spring King'*.

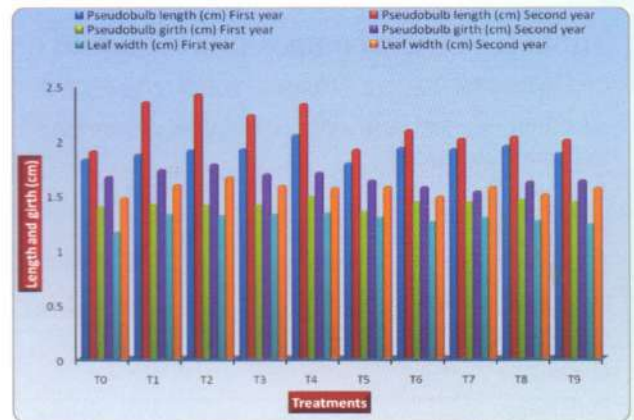


Fig. 2 : Effect of different graded doses of N-P-K on pseudobulb length and girth, leaf width of *Cym. 'Spring King'*.

Distribution of N, P, K, Ca, Mg and S in different orchid species of Sikkim

Different epiphytic orchids viz., *Bulbophyllum* species, *Coelogyne* species, *Dendrobium* species, *Eria* species and *Paphiopedilum* species were collected only from the vegetative stage of orchid plants. The research was conducted to find out the distribution of different nutrients in the leaves of naturally growing plants of various orchid species during active vegetative stage. Most recent fully developed leaves were collected from the plant and analyzed for nutrient composition. The total N content varied from 2.0 to 8.7 with a mean of 3.81g/kg dry matter, total P content varied from 0.3 to 2.3 with a mean of 1.02 g/kg dry matter, total K varied from 3.2 to 14.3 with a mean of 8.66 g/kg dry matter, total Ca varied from 14.3 to 38.3 with a mean of 23.97 g/kg dry matter, total mg varied from 2.4 to 28.4 with a mean of 13.29 g/kg dry matter and total S content varied from 0.16 to 0.86 with a mean of 0.35 g/kg dry matter in the leaves of orchid species. The average N: P: K ratio among the various orchid species found to be 3.73:1:8.5.

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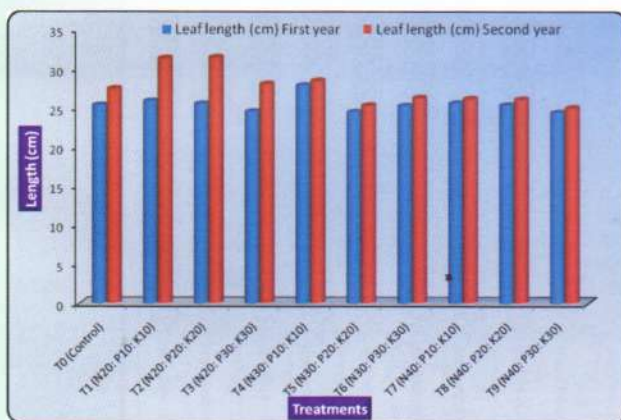


Fig. 1 : Effect of different graded doses of N-P-K on leaf length of *Cym.* 'Spring king'.

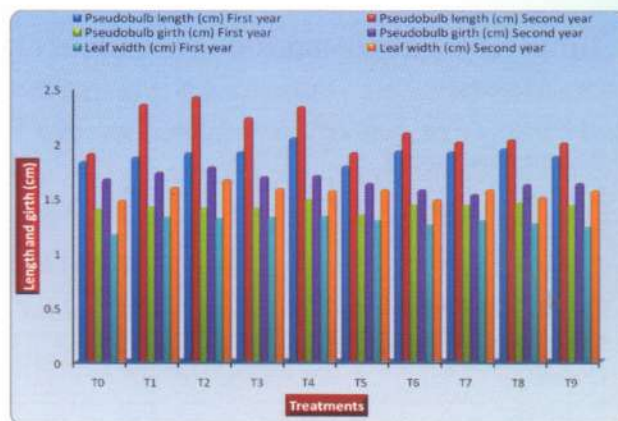


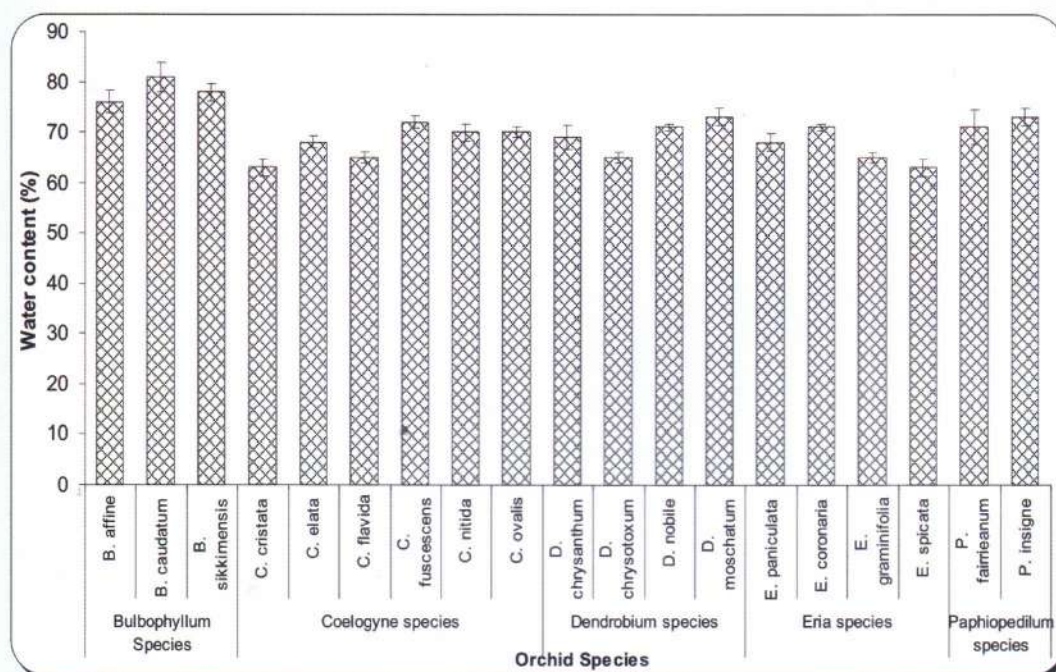
Fig. 2 : Effect of different graded doses of N-P-K on pseudobulb length and girth, leaf width of *Cym.* 'Spring King'.

Distribution of N, P, K, Ca, Mg and S in different orchid species of Sikkim

Different epiphytic orchids viz., *Bulbophyllum* species, *Coelogyne* species, *Dendrobium* species, *Eria* species and *Paphiopedilum* species were collected only from the vegetative stage of orchid plants. The research was conducted to find out the distribution of different nutrients in the leaves of naturally growing plants of various orchid species during active vegetative stage. Most recent fully developed leaves were collected from the plant and analyzed for nutrient composition. The total N content varied from 2.0 to 8.7 with a mean of 3.81g/kg dry matter, total P content varied from 0.3 to 2.3 with a mean of 1.02 g/kg dry matter, total K varied from 3.2 to 14.3 with a mean of 8.66 g/kg dry matter, total Ca varied from 14.3 to 38.3 with a mean of 23.97 g/kg dry matter, total mg varied from 2.4 to 28.4 with a mean of 13.29 g/kg dry matter and total S content varied from 0.16 to 0.86 with a mean of 0.35 g/kg dry matter in the leaves of orchid species. The average N: P: K ratio among the various orchid species found to be 3.73:1:8.5.

Table 1. Nutrient composition of various orchid species

Orchid Species	Nutrient content (g/kg dry matter)					
	N	P	K	Ca	Mg	S
Bulbophyllum species						
<i>B. affine</i>	2.5	0.8	6.5	20.2	11.3	0.24
<i>B. caudatum</i>	3.1	1.3	14.3	38.3	19.7	0.26
<i>B. sikkimanensis</i>	2.0	1.0	8.3	33.3	12.0	0.16
Coelogyne species						
<i>C. cristata</i>	4.2	0.3	3.2	15.0	11.4	0.26
<i>C. elata</i>	3.9	0.8	10.7	25.0	24.0	0.6
<i>C. flavida</i>	3.4	0.3	5.8	17.0	6.6	0.86
<i>C. fuscescens</i>	3.1	0.8	13.1	34.0	22.2	0.26
<i>C. nitida</i>	4.8	0.8	7.7	23.0	13.2	0.6
<i>C. ovalis</i>	2.2	0.7	7.1	22.3	14.2	0.17
Dendrobium species						
<i>D. chrysanthum</i>	8.7	1.5	11.0	23.0	18.0	0.6
<i>D. chrysotoxum</i>	4.2	0.8	7.4	21.0	11.2	0.2
<i>D. nobile</i>	3.9	1.0	12.6	25.0	16.3	0.3
<i>D. moschatum</i>	3.4	0.8	13.3	30.2	28.4	0.27
Eria species						
<i>E. paniculata</i>	2.8	1.5	8.6	18.0	4.8	0.26
<i>E. coronaria</i>	3.6	1.5	8.2	30.0	12.4	0.26
<i>E. graminifolia</i>	5.8	1.1	5.1	14.3	2.4	0.35
<i>E. spicata</i>	5.6	1.5	4.8	15.7	6.2	0.26
Paphiopedilum species						
<i>P. fairrieianum</i>	3.1	1.1	9.0	23.0	10.2	0.24
<i>P. insigne</i>	3.9	2.3	10.0	26.0	13.2	0.60
Grand mean	3.81	1.02	8.66	23.97	13.29	0.35
CD (P=0.05)	0.48	0.26	1.21	2.35	1.54	0.13

Figure 1. Water content (%) on dry weight basis of different orchid species. Bars are \pm s.e of the mean

CROP PROTECTION

Integrated Management of Diseases in Orchids

Orchid germplasm maintained at NRC for Orchids, Pakyong was regularly monitored for the incidence of fungal diseases during 2007-08. Anthracnose followed by Black Rot diseases were found to be the most prevalent fungal diseases affecting orchids in Sikkim.

Monitoring the incidence of Anthracnose

It is a blackening disease which appears on foliage, stem as dark coloured spots. The fungus affects all the aerial parts of the plants but most commonly infects leaves. Initially small oblong to circular, oval, sunken and reddish brown to dark brown and grey coloured spots appears at the tip of the leaf lamina which gradually enlarges and covers large area of the leaf surface. It produces conidia within black acervuli. It produces dieback symptoms which starts from the tip and goes downward. It also affects leaf sheaths and floral spikes.

Isolation and characterization of the fungus

The infected leaf samples were taken from *Phaius tankervilleae*, *Cymbidium* sp., *C. devonianum* and *Cymbidium* hybrids. The infected leaf tissue was surface sterilized in 1% sodium hypochloride (NaOCl) and then washed with distilled water and placed on potato dextrose agar medium (PDA) and incubated at 28°C and observed for growth. The white mycelial growth of fungus appeared after 72 h of incubation which gradually turned grayish. The fungus was sub cultured and sent to Indian Type Culture Collection (ITCC), Division of Plant pathology, IARI, New Delhi-110012, for identification (Table 1).

It was found that most of the species infected with anthracnose disease, *Collectotrichum gloeosporioides* was isolated. The telomorph stage of the fungus, *Glomerella cingulata*, which is very destructive, was also isolated from *Cymbidium* sp. and *Phaius tankervilleae*. *Epicoccum* sp. and

Fusarium moniliformae has also been isolated from *Phaius tankervilleae* and many *Cymbidium* hybrids. The incidence of the Anthracnose disease is given in the Table-2.

Table 1 : Pathogen identified by ITCC, New Delhi

Accession No.	Name of the species	Fungus identified as
6835.07	<i>Phaius tankervilleae</i>	<i>Glomerella cingulata</i>
6916.08	<i>Cymbidium devonianum</i>	<i>Collectotrichum gloeosporioides</i>
6917.08	<i>Cymbidium</i> sp	<i>Glomerella cingulata</i> and <i>C. gloeosporioides</i>
6918.08	<i>Cymbidium</i> hybrid	<i>Epicoccum</i> and <i>Fusarium moniliformae</i>

Black Rot

Black rot was reported from *Cymbidium eburneum*, *C. aloifolium*, *C. devonianum*, *C. pendulum* and many *Cymbidium* hybrids, *Coelogyne* sp. *Dendrobium* sp. in moderate to severe form during the year.

Management of Black Rot of *Cymbidium* by fungicides

Management of black rot of *Cymbidium* was continued using different fungicides. Among five fungicides like metalaxyl (0.1%), indofil (0.2%), dithane Z 78 (0.2%), carbendazim (0.2%), Thiophenate-M (0.1%) applied as soil drenching at an interval of 15 days, the most effective chemicals against Black Rot were 0.1% metalaxyl followed by thiophenate-M and Carbendazim.

First report of association of plant parasitic nematodes from *Cymbidium* hybrids in Sikkim

During a routine survey in 2007 in farmer's field at Raigaon village, about 5 Km from NRC Orchids, Pakyong, *Cymbidium* hybrids were observed with typical symptoms like leaf bending from base, curling, twisting and unusual enlargement of leaves. Roots of such plants were showing severe necrosis and fluffy roots system. These plants were imported by State Department of Agriculture and distributed to

Table-1. List of orchid species infected by *Colletotrichum gloeosporioides*

SI No.	Orchid species	No. of plants infected/no. of plants observed	%infection
1.	<i>Ascocentrum aurantiacum</i>	1/1	100
2.	<i>Bulbophyllum guttulatum</i>	4/7	57.14
3.	<i>B. maculosum</i>	2/4	50
4.	<i>B. sikkimensis</i>	1/1	100
5.	<i>Calanthe</i> sp.	7/10	70
6.	<i>Calanthe herbaceae</i>	1/1	100
7.	<i>Calanthe masuca</i>	1/1	100
8.	<i>Ceratostylis teres</i>	1/1	100
9.	<i>Coelogyne elata</i>	8/9	88.88
10.	<i>Coelogyne flaccida</i> var. <i>crinata</i>	8/10	80
11.	<i>Coelogyne flavida</i>	7/10	70
12.	<i>Coelogyne fuscescense</i>	13/14	92
13.	<i>Coelogyne graminifolia</i>	1/1	100
14.	<i>Coelogyne</i> sp	3/4	25
15.	<i>Cryptochilus sanguinea</i>	1/2	50
16.	<i>Cymbidium gammieanum</i>	1/1	100
17.	<i>Cymbidium</i> hybrid	5/6	83.33
18.	<i>Cymbidium lancifolium</i>	6/10	60
19.	<i>Dendrobium densiflorum</i>	10/39	25.64
20.	<i>Dendrobium fimbriatum</i>	6/6	100
21.	<i>Dendrobium hookerianum</i>	1/1	100
22.	<i>Dendrobium moschatum</i>	3/30	10
23.	<i>Dendrobium nobile</i>	5/21	23.80
24.	<i>Dendrobium thrysifolium</i>	10/18	55.55
25.	<i>Eria amica</i>	2/10	20
26.	<i>Eria acervata</i>	1/1	100
27.	<i>Eria bambusifolia</i>	2/2	100
28.	<i>Eria spicata</i>	2/2	100
29.	<i>Eria. vitata</i>	2/3	66.66
30.	<i>Flickengeria fugax</i>	6/6	100
31.	<i>Liparis bootanensis</i>	1/1	100
32.	<i>L. plantaginea</i>	3/3	100
33.	<i>Liparis</i> sp.	28/28	100
34.	<i>Micropera obtusa</i>	2/5	40
35.	<i>Phaius tankervilleae</i>	11/25	44
36.	<i>Pholidota articulata</i>	2/5	40
37.	<i>Rhynchostylis retusa</i>	8/53	15.09
38.	<i>Vanda</i> sp.	3/14	21.42



Cymbidium hybrid



Cymbidium devonianum



Calanthe triplicata



Phaius tankervilleae



Vanda cristata



Bulbophyllum guttulatum

Anthracnose symptoms on different orchid hosts

the farmers. Such plants were collected for further investigation in the laboratory.

Extraction of nematodes

Extraction of nematode from the infected *Cymbidium* hybrids was done by standard Cobb's Sieving and Decanting method. Microscopic observation revealed the presence of large number of nematode population in the extract. The associated nematodes were plant pathogenic as they were having characteristic stylet as found in most of the plant pathogenic nematodes. The identification of the associated nematodes is under progress.



Nematode infected *Cymbidium* roots showing necrosis, swelling and fluffy root system



Cymbidium hybrids showing twisting and bending of leaves



Morphology of the nematodes associated with root necrosis disease of *Cymbidium* hybrids under microscope

Monitoring and management of virus diseases of orchids

Viruses are widely distributed in vegetatively propagated orchid plantation which detrimentally affects their normal growth and affect the flower quality.

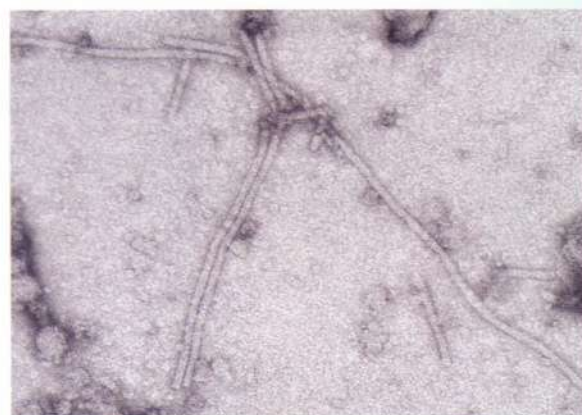
Symptoms: Most of the orchid genera/species at germplasm collection had variety of symptoms like mosaic, chlorotic streaks, necrotic spots, ringspot, chlorotic and necrotic sunken patches on the leaf and flowers. Flowers showed deformed and exhibit colour breaking symptoms. Germplasm collection at NRCO was screened for the presence of viruses.

Detection : For viral pathogen, early detection is considered the best protection. Virus diseases can be easily managed if proper diagnostics methods are available. Following diagnostic methods were followed to detect the viruses from orchid species.

Electron microscopy: It plays vital role for the detection of viruses and gives us an idea of virus morphology, particle shape and size. About 2 mm of infected cymbidium leaves was ground in phosphate buffer (0.07 M, pH-6.5) and extract was microfuged and then placed on carbon coated copper grids and negatively stained with freshly prepared 2% aqueous uranyl acetate and examined in JEM-1011 transmission electron microscope. (This work is performed at Plant Virology Unit, Division of Plant Pathology, Indian Agricultural Research Institute, New Delhi-110012).

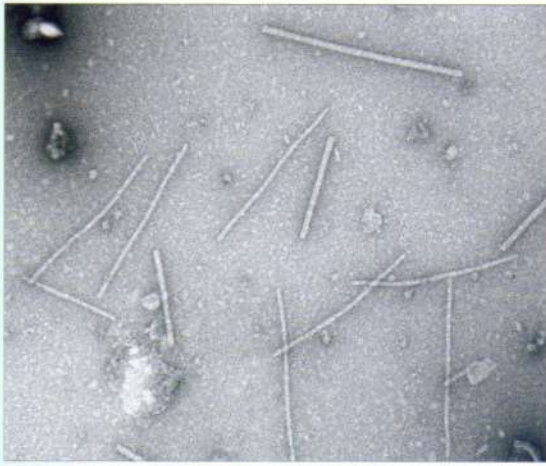
Results : Electron microscopy of infected samples revealed the presence of Cymbidium mosaic virus (CymMV) which is having flexuous filamentous particles measuring about 450-490 nm in species of *Aerides odoratum*, *C. aloifolium*, *C. eburneum*, *C. erythraeum*, *C. hookerianum*, *C. iridoides*, *C. lowianum*, *C. munronianum*, *C. gammieanum*, *C. pendulum*, *Dendrobium nobile*, *Epidendrum sp.*, and *Rhynchostylis retusa*. While species of *C. aloifolium*, *C. iridoides*, *C. lowianum*, *C. pendulum* and *Cattleya sp.* showed presence of both CymMV and rod shaped

virus particles measuring 300x18 nm of Odontoglossum ringspot virus (ORSV). The EM results revealed that CymMV and ORSV commonly found as mixed infections in many orchid species and cause severe damage to the orchid plants.



CymMV infected *Cymbidium aloifolium* (Top) showing yellow mosaic, necrosis on leaves and sunken pits. (Bottom) Electron micrograph showing flexuous particles of CymMV.



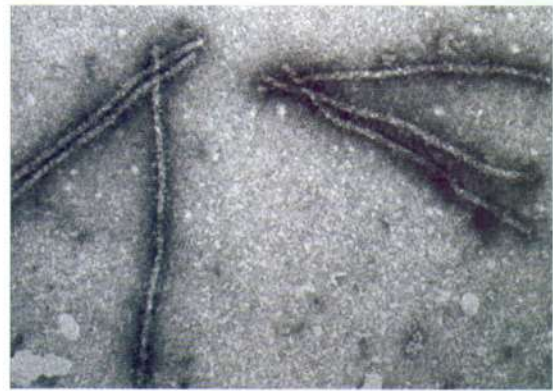


Cymbidium species showing mosaic and severe necrosis due to CymMV and ORSV (previous). Electron micrograph showing mixed infection of CymMV and ORSV

Detection by Immuno-sorbent electron microscopy (ISEM) :

ISEM of virus infected orchid samples was done using antibodies of CymMV. Carbon coated copper grids were coated with CymMV antiserum at a dilution of 1:1000 and incubated for 1 h at 37°C. Grids were washed with phosphate buffer and kept over a drop of virus extract for 30 min at room temperature. One replication of grids were washed with distilled water and stained with 2% uranyl acetate and observed in EM while other replications were simultaneously used for decoration test and placed over a drop of CymMV antiserum (1:50 dilution) for 30 min at room temperature. Finally grids were washed and stained with 2% uranyl acetate and observed under EM.

Immuno-electron microscopy and decoration results revealed the presence of CymMV in Cymbidium species. The number of virus particles were considerably increased after doing IEM and showed clear cut antibody halo around virus particles after decoration test.



Electron micrograph of CymMV showing antibody halo in decoration test with homologous antiserum.

Detection by double antibody sandwich-enzyme linked immuno-sorbent assay (DAS-ELISA) :

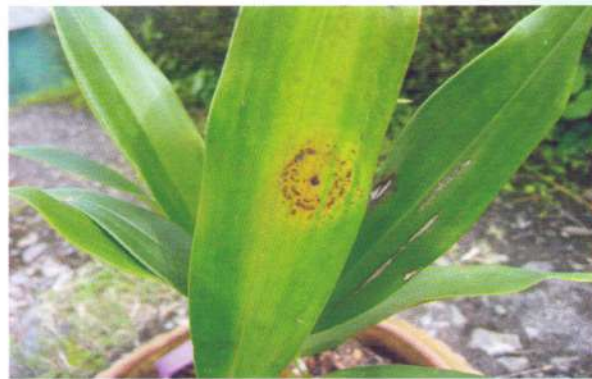
Orchid germplasm was indexed by standard double antibody sandwich ELISA (DAS-ELISA). ELISA kit was purchased from Agdia, USA and followed manufacturers instructions. Coating antibody dilution (1:200) was prepared in coating buffer and 100µl was added to the wells of polystyrene plate. The plate was incubated at 4°C overnight and washed with phosphate buffered saline containing 0.05% Tween-20 (PBST) and added 100µl sample (1:10 dilution) prepared in general extraction buffer (GEB) to each well and kept for 2 h at room temperature. Plate was washed in PBST and 100µl conjugate was added per well at a dilution of 1:200 and incubated 2 h at room temperature. Plate was washed again with PBST and added substrate (pNPP) at a concentration of 1mg/ml and OD value was taken by Bio-Rad ELISA Reader, Model- 680 after 1 h at 405 nm. DAS-ELISA results revealed the mixed infection of CymMV and ORSV in *Acampe multiflorus*, *A. rigida*, *Aerides odoratum*, *Cymbidium aloifolium*, *C. eburneum*, *C. erythraeum*, *C. iridodes*, *C. lowianum*, *C. munronianum*, *C. pendulum*, *Dendrobium acinaciformae*, and *Hygrochillus parishii*. Presence of only CymMV was found in *Bulbophyllum guttulatum*, *Dendrobium nobile*, *Epidendrum sp.* *Eria javanica*, *Rhynchostylis retusa*. ORSV was found strongly positive in *Aceda kultana gold spot*, *Bulbophyllum offline*, *B.helenae*, *Cymbidium*

devonianum, *C. gammieanum*, *C. hookerianum*, *C. tetracyanum*, *C. tigrinum*, 10 different hybrids of *Cymbidium*, *Eria spicata*, *Paphiopedilum sp.*, *Phaius tankervilleae*, *Panisea uniflora*, *Vandopsis undulata*, *Tainia minor* and *Vanda cristata*. ORSV being a member of *tobamovirus* -group is highly contagious and stable virus and probably spreads by the use of contaminated implements and not following stringent sanitary measures in the polyhouses, the incidence of this virus was found more in orchid germplasm.

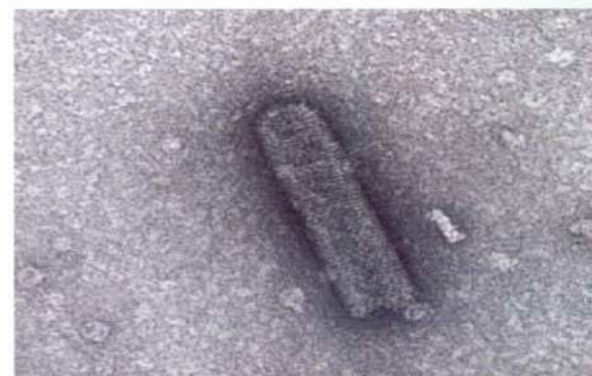
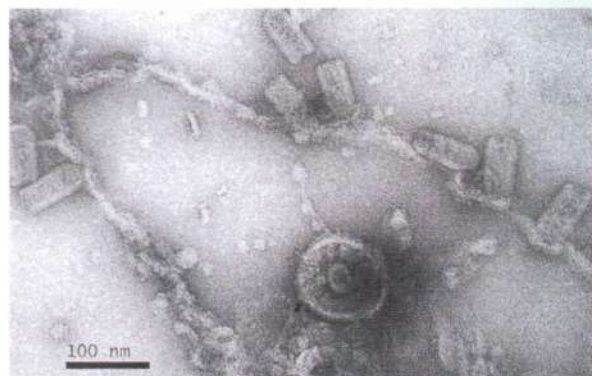
Association of a Rhabdovirus-like particle from *Coelogyne* species from Sikkim and Kalimpong

During the survey in 2007 in Sikkim and Kalimpong area of West Bengal large number of *Coelogyne* species were found showing chlorotic and necrotic flecks on the leaves followed by yellow rings of different sizes. The leaves showing chlorosis and large necrotic rings of about 4-5 mm in diameter were collected and processed for electron microscopic observation. Leaf samples exhibiting various degree of yellowing, ringspot and necrosis were collected and used for electron microscopy. Leaf dip preparations were placed on carbon coated grids and negatively stained with 2% aqueous freshly prepared uranyl acetate (pH-4.5) and examined under JEM- 1011 transmission microscope.

Results : Electron microscopy of negatively stained preparations showed large number bacilliform or bullet shaped, enveloped particles resembling morphologically with plant Rhabdoviruses.



Coelogyne sp. showing yellow rings and necrotic spots on leaves



Electron micrograph showing bullet shaped, enveloped particles from *Coelogyne* sp.

Integrated Pest Management in Orchids

Survey on insects - pests of orchids

A continuous survey on insect - pests associated with orchids germplasm and hybrids at NRC Orchids Sikkim including Darjeeling campus was carried out to know the pests germplasm the farmers field were surveyed to know real problems faced by the farmers and current techniques are being used by them to get

rid off the pests. The outcome from the survey are as follows.

Survey resulted that mites, thrips, scale insects, leaf hoppers, slugs, mealy bugs, were mainly infested the *Cymbidium* whereas, slugs were the pest of *Phalaenopsis* orchid. Mealy bugs were also recorded on *Phaius flavus*, *Phaius tankervilleae*, *Cattleya* hybrids. Shoot borer, *Peridaedala* sp was reported to infest the many orchids among *Dendrobium nobile* was found to be more susceptible to shoot borer. The adult female moth laid eggs on new shoots and emerging larvae bore downward and feed inside the stem/cane by leaving excreta on opening hole. The infected plant show dead shoots, stunted growth and reduce flower production. Mites feeding result in discolouration of leaves and their presence were noticed during February to October. Scales were observed during rainy season and attacked on young shoots. Slugs and snails were found to infest orchids during night feeding on leaves, flower buds and flowers. The yellow aphid was recorded on flower buds and the flowers of *Oncidium*, *Acampe papillosa*, *Dendrobium nobile*, *D. densiflorum* and *vanda coerulea*.

Monitoring pests in orchids

Shoot borer, *Peridaedala* sp

It is observed to cause damage to many orchids like *Dendrobium nobile*, *Acampe rigida*, *Aerides fieldingii*, *Aerides multiflora*, *Aerides odorata* mainly during rainy season and disappeared at the end of the rainy season. Larvae bore downward, feeding on stem/ cane. Due to shoot borer damage, the whole plant growth checked, flower production gets affected and dead shoots produced at the time of severe infestation.

Thrips, *Dichromothrips nakahari*

Thrips were recorded as a major pest of many species of *Cymbidium* and *Dendrobium*. The incidence of thrips was observed throughout the year on *Cymbidium* causing damage by sucking of cell sap from lower surface of leaves. Damaged plants parts

became discoloured and finally turned blackish. These plants showed stunted growth, loss in vigor and ultimately reduced flower quality and quantity. Thrips infestation on *Dendrobium nobile* was recorded mostly during flowering stage. The damage to flower quality was occurred through sucking of cell sap from the flower buds and flowers.



Dendrobium nobile infested by shoot borer



Dendrobium nobile infested by thrips

Black aphid, *Toxoptera aurantii*

Black aphid reported on many species of orchids and cause damage by sucking the shape from buds as well as from open flowers and simultaneously

excreting honey dew which support the growth of black sooty mould an unsightly fungus that mars the beauty of flowers. Honey dew secretions also invite black ants, which clearly indicate aphid infestation. The aphid infestation lowered the marketable price of flowers.



Aphid infestation

Organic control of pest complex of *Dendrobium*

Bio efficacy of botanicals against shoot borer in orchid (*Dendrobium nobile*)

Bio efficacy of some botanical products of *Azadirachta indica*, *Allium sativum*, *Schima walchii*, *Artimesia*, *Nicotiana tabaccum* and *Datura stramonium* against the shoot borer (*Peridaedala*

sp.) of *Dendrobium nobile* was evaluated under polyhouse condntions. The minimum shoot borer infestation was recorded for Achook (NSKE) 1500 ppm and Neem oil 0.03% (~ 4% and ~ 5% respectively), after 7 days of treatment (Fig. 1). Maximum per cent infestation in shoot borer damage was recorded by *Schima walchii* leaf extract 10% (~12% at 7th day after treatment).

Phytotoxicity: The foliar application with botanical products caused no *phytotoxic* symptoms on the flowers or vegetative parts of plants. It was also noticed that the quality of flower (shape, size and colour) was not deteriorated.

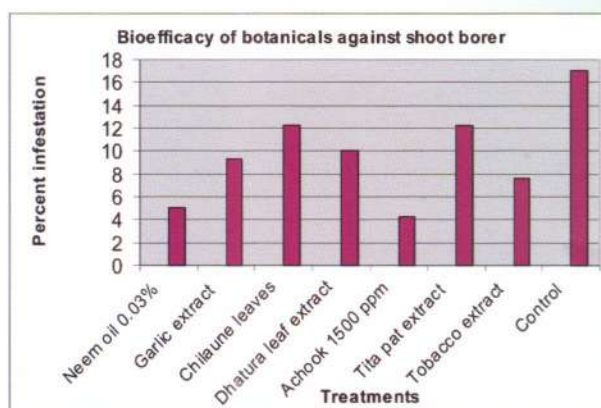


Fig. 1. Bio-efficacy of botanicals



Cymbidium species showing mosaic and severe necrosis due to CymMV and ORSV (previous). Electron micrograph showing mixed infection of CymMV and ORSV

Detection by Immuno-sorbent electron microscopy (ISEM) :

ISEM of virus infected orchid samples was done using antibodies of CymMV. Carbon coated copper grids were coated with CymMV antiserum at a dilution of 1:1000 and incubated for 1 h at 37°C. Grids were washed with phosphate buffer and kept over a drop of virus extract for 30 min at room temperature. One replication of grids were washed with distilled water and stained with 2% uranyl acetate and observed in EM while other replications were simultaneously used for decoration test and placed over a drop of CymMV antiserum (1:50 dilution) for 30 min at room temperature. Finally grids were washed and stained with 2% uranyl acetate and observed under EM.

Immuno-electron microscopy and decoration results revealed the presence of CymMV in Cymbidium species. The number of virus particles were considerably increased after doing IEM and showed clear cut antibody halo around virus particles after decoration test.



Electron micrograph of CymMV showing antibody halo in decoration test with homologous antiserum.

Detection by double antibody sandwich-enzyme linked immuno-sorbent assay (DAS-ELISA) :

Orchid germplasm was indexed by standard double antibody sandwich ELISA (DAS-ELISA). ELISA kit was purchased from Agdia, USA and followed manufacturers instructions. Coating antibody dilution (1:200) was prepared in coating buffer and 100µl was added to the wells of polystyrene plate. The plate was incubated at 4°C overnight and washed with phosphate buffered saline containing 0.05% Tween-20 (PBST) and added 100µl sample (1:10 dilution) prepared in general extraction buffer (GEB) to each well and kept for 2 h at room temperature. Plate was washed in PBST and 100µl conjugate was added per well at a dilution of 1:200 and incubated 2 h at room temperature. Plate was washed again with PBST and added substrate (pNPP) at a concentration of 1mg/ml and OD value was taken by Bio-Rad ELISA Reader, Model- 680 after 1 h at 405 nm. DAS-ELISA results revealed the mixed infection of CymMV and ORSV in *Acampe multiflorus*, *A. rigida*, *Aerides odoratum*, *Cymbidium aloifolium*, *C. eburneum*, *C. erythraeum*, *C. iridodes*, *C. lowianum*, *C. munronianum*, *C. pendulum*, *Dendrobium acinaciformae*, and *Hygrochillus parishii*. Presence of only CymMV was found in *Bulbophyllum guttulatum*, *Dendrobium nobile*, *Epidendrum sp.* *Eria javanica*, *Rhynchostylis retusa*. ORSV was found strongly positive in *Aceda kultana gold spot*, *Bulbophyllum offline*, *B.helenae*, *Cymbidium*

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

Collection of orchid germplasm

Explorations were conducted for collection of orchids to various parts of Darjeeling district of West Bengal. Mangpoo, Sonada, Manebhanjang areas were surveyed. The survey resulted in collection of 86 accessions. The collected accessions belong to *Coelogyne nitida*, *Coelogyne corymbosa*, *Coelogyne cristata*, *Calanthe yucksomnensis*, *Calanthe brevicornu*, *Bulbophyllum leopardianum*, and *Achrochene punctata*. Apart from wild collections the *Cymbidium* hybrids were procured from the local nurseries.

Conservation of wild species and cultivars

The collected species of orchids were grown in pots as well as 'artificial natural habitat'. Orchids in pots required more attention than those tied on trees (artificial natural habitat). The losses of germplasm under artificial natural habitat were almost nil. The artificial natural habitat which aims at providing almost similar conditions as that of nature in which epiphytes were tied on the tree trunks while terrestrial were grown on grounds under the shady locations. The artificial natural habitat method for conservation of orchids reduced the cost on maintenance.

Characterization and evaluation of orchid species

The orchids collected at Darjeeling Campus of NRC (O) are being evaluated for their horticultural traits. Data from 30 orchids species were collected during the reported year. The various useful*traits were identified which can be exploited for improvement. Some of the important orchid species studied during the year include *Cymbidium gammieanum*, *Cymbidium erythraeum*, *Cymbidium lowianum*, *Cymbidium tracyanum*, *Pleione praecox*, *Eria spicata*, *Eria graminifolia*, *Paphiopedilum insigne*,

Paphiopedilum villosum *Calanthe brevicornu*, *Coelogyne corymbosa*, *Coelogyne nitida*, *Coelogyne longipes*.

Cymbidium tracyanum (L.) Castle

Cymbidium tracyanum (L.) Castle is an early flowering, large flowered and scented orchid. Twenty accessions from various parts of Darjeeling district of West Bengal were collected, conserved and studied for various morphological characters. The analysis of observed data showed wide variation with respect to morphological traits like plant height (26.2 – 67.8 cm), plant spread (24.6 – 57.4 cm) pseudobulb length (6.0 – 12.5 cm) pseudobulb girth (12.3 – 18.3 cm) inflorescence length (48.6 – 99.1 cm), inflorescence diameter at base (0.72 – 1.48 cm) and flower count (6.6 – 13.5). The distance among various genotypes was determined by Hierarchical cluster analysis using Euclidian distance. The highest value (76.49) was observed for OCD - 1110 and the lowest (5.85) for OCD – 1135. The dendrogram revealed 4 clusters. The cluster 2 had largest (6) membership followed by cluster 1 and 3 and 4. The genotype OCD – 1110 was not part of any cluster.

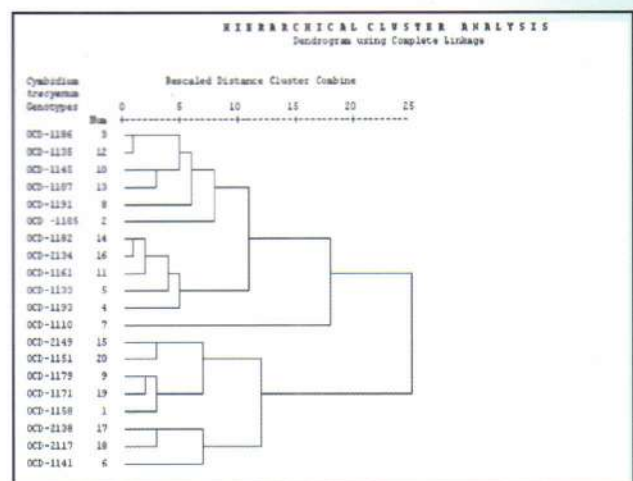


Fig. 1 : Dendrogram illustrating dissimilarity among 20 genotypes of *Cymbidium tracyanum*

Cymbidium elegans Lindl.

Nineteen genotypes of *Cymbidium elegans* Lindl.

environment were recorded. The mean plant height and plant spread found to be 13.31 cm and 8.20 cm respectively. The length of inflorescence varied between 4.60 cm to 15.70 cm. and number of flowers ranged between 8 and 23. The numbers of floral buds on the flower spike were found to be determined by plant height, pseudobulb length, leaf length, inflorescence length, and raceme length. The senescence of flower buds started 12th day after the opening of flower bud and the whole flower spike lasted for 26 days. The opening of flower buds and the senescence go hand in hand.

Evaluation of *Cymbidium* hybrids

The twenty five cultivars of *Cymbidium* were evaluated for their growth and flowering under Darjeeling conditions. The data on 23 morphological characters related to plant, flower spike and flower characters were recorded. The height of the plant ranged 20.70–71.52 cm.



Cym. Soul Hount - 6

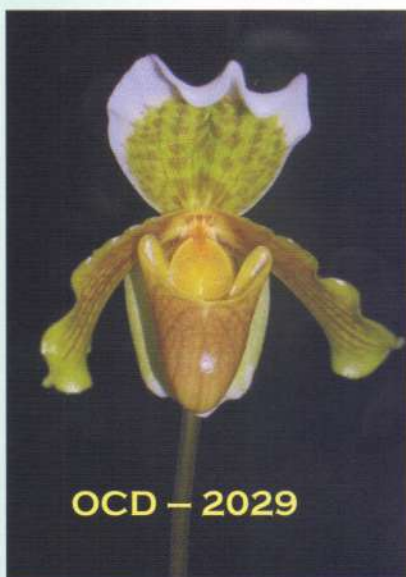
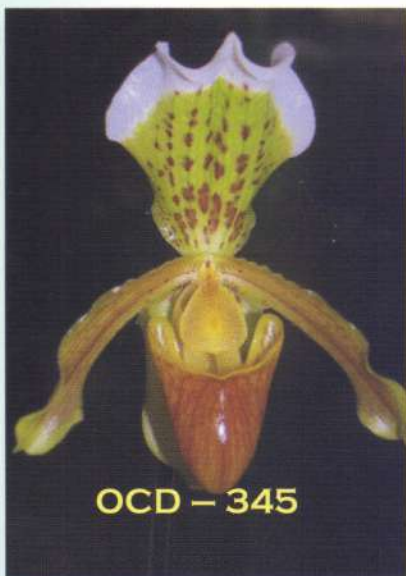
The maximum plant height recorded from *Cym. Levis Duke 'Bellavista'* followed by *Cym. 'Goldengirl'* (44.37 cm) and *Cym Cecil Park* (45.25 cm). The lowest plant height was recorded from *Cym Canniwine Colour*. The maximum plant spread (56.58 cm) was recorded from *Levis Duke 'Bellavista'* followed by *Cym September 'Sunset'* (54.23 cm), *Tahiti* (52.25 cm) and *Amesbury 'Frank Slattery'* (52.5 cm). The length of pseudobulb varied between 5.8 – 12.75 cm. The number of functional leaves were between 3.73 – 11.57. The *Cymbidium* cultivar *April Bush* found to have longest (96.99 cm) inflorescence followed by *Levis*

duke 'Bellavista' (92.98 cm) and *September Sunset* (85.14 cm). The longest raceme (36.45 cm) was observed in *Levis Duke 'Bellavista'* followed by *Cecil Park* (35.63 cm) and *Amesbury 'Frank Slattery'* (35.19). the smallest raceme was observed in *Swallow 'Takarajuki'*. The highest number of florets (32.91) were found in *September 'Sunset'* followed by *Bertha 'Petalshort'* and *Levis Duke 'Bellavista'* (16.5). The least number of florets (5.6) were found in *Sleeping Nymph 'Glacier'*. The maximum flower height (8.31 cm) was recorded from *Princess Elizabeth* followed by *Cecil Park* (7.70 cm), *Christmas Beauty* (7.54 cm) and *Pineclash 'Moon Venus'* (7.46 cm). the smallest flower height was observed in *Golden girl*. The cultivar *Princess Elizabeth* found to have maximum flower width whereas *Christmas Beauty* found to have maximum flower size across.

Promising genotypes identified

Paphiopedilum insigne (Wall ex. Lindl.) Stein

Paphiopedilum insigne (Wall ex. Lindl.) Stein is a valuable potted flowering plant. It has also been an important parent in early artificial hybridization of slipper orchids. The accessions of *P. insigne* were collected from various nurseries and personal collections in Darjeeling district of West Bengal. The accessions showed wide variability with respect to size, colour, and spotting pattern of flowers. The variations were grouped in five forms. The OCD – 4 was identified as *P. insigne* 'Hairfield' while other have not been described yet. The dorsal sepal of *P. insigne* normally curves backward. However, the genotype OCD – 2059 did not show such characteristics. The dorsal sepal remained uncurved throughout its flowering period. This genotype may be useful in overcoming the problems of recurving dorsal sepals. The purple dots on dorsal sepal are dominant character in *P. insigne* and pass on its progeny. Genotype OCD – 2029 found to have very faint dots and may impart colour of *P. insigne* without passing dots to its progeny.



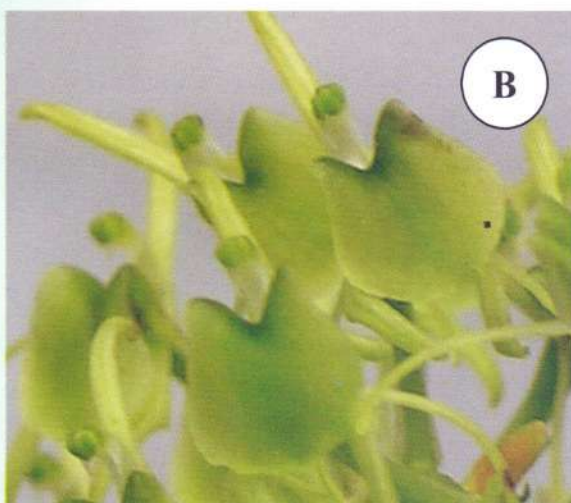
Morphological variations in *Paphiopedilum insigne* OCD - 345 common

***Liparis bootanensis* Griff**

A color variant of *Liparis bootanensis* Griff was collected from Mangpoo, Darjeeling district of West Bengal. It is recorded for the first time from India. The variant is described with the help of photographs. Epiphytic perennial herb 14.5 - 16.4 cm tall, pseudobulbs dark green, narrowly oblong, tapering slightly, 1.9 - 3.8 cm long and 1.06 - 1.42 cm in diameter at the base; the sheath of the new growth lanceolate; acuminate. Leaf solitary arises from near the apex of the pseudobulb, linear-oblong

acute, narrowed to the shortly petiolate base, 12.7 - 13.6 cm long and 2.3 - 2.5 cm broad. The new growth develops from the base of previous year's pseudobulb that carries new leaf and inflorescence in it. Inflorescence 6.5 - 9.5 cm long, normally longer than the leaf, narrowly winged; the peduncle ebracteate and flattened. The raceme 4.0 - 6.5 cm long and carries 13 - 20 green flowers. Floral bracts linear-lanceolate, shorter than filiform stalked ovary. Flowers long, green, their ovaries are little dark green in colour and long. Sepals are green linear-

lanceolate, the dorsal sepal reflexed, and the lateral pair of sepal lying side by side below the lip and projecting outside. The edges of sepals revolve backward. Petals, green, thinner than sepals, linear, blunt greatly decurved, their edges like those of sepals. Lip green, middle part is darker and oblong, deflexed below from the middle, base with two erect calli. The sides are entire; the apex broad, mucronate and erose. Column green and curved, its base is thickened. The apex is dark green. Flowering time July and August.



Photoplate illustrating the difference between common species and variant (A) Full grown plant in flowering (variant) (B) Flowers (variant) (C) Flowers (common form)

Collection, Conservation, Evaluation and Multiplication Bulbous Ornamentals

Collection of Bulbous Ornamental

This year 13 cultivars of *Lilium* were introduced. Out of eleven cultivars 8 were of Oriental and 5 were of Asiatic lily.

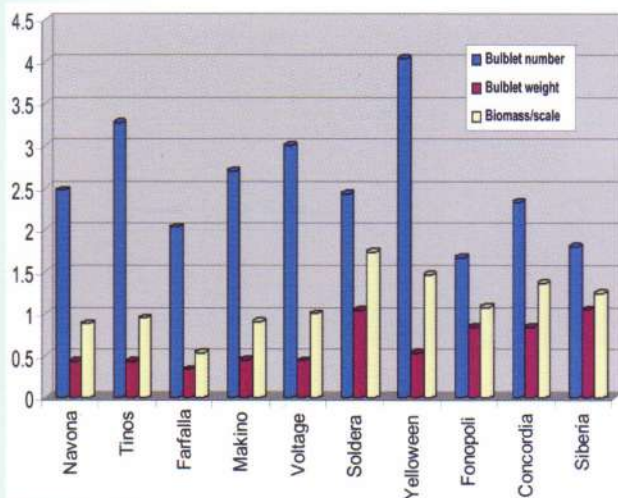
Asiatic	Navona, Gironde, Vermeer, Avelino and Brunello
Oriental	Loborgia, Siberia, Simplon, Casablanca, Crystal Blanca, Balaton, Expression and Mongrian

Studies on Bulb Production of *Lilium*

Reproductive ability of *Lilium* cultivars propagated through bulb scales

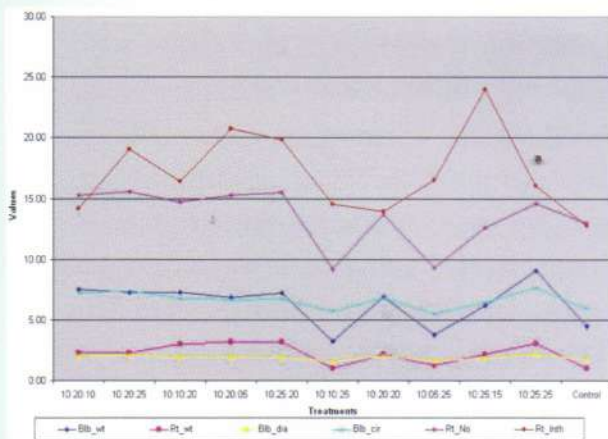
The outer bulb scales of ten *Lilium* cultivars were detached from mother plant and planted in moist saw dust. The data bulblet number per scale, bulblet weight and biomass per scale was recorded after 13 weeks of incubation at room temperature. Yelloween produced significantly highest number of bulblets followed by Tinos and Voltage. The weight of the bulblets also differed significantly. The highest bulb

weight was found in Soldera while the lowest was in case of Farfalla. The maximum biomass per scale was found in Soldera followed by Yelloween.



Effect of NPK on growth & development of *Lilium* bulblets propagated through scales

The ten doses of fertilizers Viz. 10:20:10; 10:20:25; 10:10:20; 10:20:05; 10:25:20; 10:10:25; 10:20:20; 10:05:25; 10:25:15; 10:25:25; were tested for growth & development of Asiatic lily (Nove Cento) bulblets propagated through bulb scales. The nitrogen, phosphorus and potash were applied in the form of Urea, DAP and Murate of Potash. The doses of fertilizers were applied @ 100 gm/sqm. as basal dose. The highest increase in bulblet fresh weight, circumference and bulblet diameter was recorded in the bulblets supplied with 10:25:25 (N: P: K) followed by 10:20:20 and 10:20:25.



Influence of fortification of potting mixture on growth and development *Lilium* bulblets propagated through bulb scales

The outer bulb scales of four *Lilium* cultivars namely Siberia, Voltage, Farfalla and Concordia were planted in sawdust added with two grades NPK (10:20:20 and 10:25:25) at 10, 20, 30 gm per litre. The data on bulblet number per scale, biomass and bulblet weight was recorded after 13 weeks of planting. The addition of fertilizers to the potting mixture had no significant effect on bulblet number, bulblet weight and biomass per scale. However a significant difference in bulblet number, weight and biomass per scale was noticed among the cultivars. It appears that bulblet are produced from the reserved food material in the scales. Though the bulblets form the roots, these roots remain nonfunctional till the bulblets are attached to the scales.

Effect of scale position on regeneration ability of *Lilium* propagated through bulb scales

The outer, middle and inner scales of four *Lilium* cultivar Soldera, Fonopoli, Navona and Tinos were removed from the mother and planted in sawdust. The data on bulblet number, bulblet weight and biomass per scale were recorded after 13 weeks of planting. The position of scales on mother bulb and cultivars found to have significant effect on bulblet number, bulblet weight and biomass per scale. The highest number of bulblets were obtained from outer bulb scales whereas inner scales produced the lowest number of bulblets. The bulblet weight and biomass was also lowest in inner scales. The outer and middle scales are useful in propagation *Lilium* through bulb scales.

EXTERNALLY FUNDED PROJECTS

Technology Mission on Integrated Development of Horticulture in North Eastern States including Sikkim, Uttaranchal, Himachal Pradesh and Jammu & Kashmir (Mini Mission-I)

Activity 1: Production of quality planting materials of orchids under MM-I

S. No.	Hybrids	Protocorms (1)	Plantlets No (2)	Hardened Plants (3)	Total (2+3)
1	<i>Cymbidium</i> 'Soul Hunt-I' (A)	3,098	1,725	645	2,370
2	<i>Cymbidium</i> 'Golden Girl' (B)	651	472	286	758
3	<i>Cymbidium</i> 'Show girl Cooksbridge' (SG)	119	70	85	155
4	<i>Cymbidium</i> 'Lunavian Atlas' (D)	510	239	923	1,162
5	<i>Cymbidium</i> Pineclash 'Moon Venus' (J)	109	83	984	1,067
6	<i>Cymbidium</i> 'Starguard Mcym. Angel' (G)	348	174	330	504
7	<i>Cymbidium</i> 'Sleeping Nymph' (H)	1,026	86	253	339
				Total	6,355

Activity 2: Production of quality planting material other than orchids

Sl. No.	Crop	Type of planting material	2007-08	
			Target	Achievement
1	Annuals	Seeds	10kgs	5kg
2	Chrysanthemum	Cuttings	15000	15000
3	Freesia	Bulbs	2500	4000
4	Gladiolus	Corms	15000	20000
		Cormels	100000	110000
5	Marigold	Seedlings	10000	11000
		Seeds	10kg	9kg

Production Technology

Effect of inorganic nutrients on flowering of *Cymbidium*

Spraying of $N_{10}P_{20}K_{30}$ @ 0.2% improved flowering of *Cymbidium* in terms of number of spike (3)/plant, length of spike (60cm) and number of florets (10)/spike as compared to other treatments.

Effect of different chemicals on post harvest technology of Oriental Lily cv. Solaila

An experiment was carried out to find out the effect of different chemicals on vase life of Oriental lily cv. Solaila. There were six treatments, sucrose 2% (T_1), sucrose 2% + 8 - HQC 150 ppm (T_2), sucrose 2% + 8 - HQC 150 ppm + GA_3 100 ppm (T_3), Citric acid 0.5% (T_4), $AgNO_3$ 50 ppm + sucrose 2% (T_5) and control (T_0). Among the different treatments T_3 increased the vase life of Oriental lily cut flower (14.25 days) when compared to control (12.50). $AgNO_3$ was not effective in increasing the vase life of lily (12.00).

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

Characterization done during the period (2007-08) to fulfill DUS guidelines

Dendrobium species

***Dendrobium aduncum*:** Plant is large (75-85 cm) and drooping in nature. Inflorescence arises along the whole length of pseudo stem. Number of flowers 4-7 borne along the peduncle. Flower length and breadth 2.1-2.5 cm and 2.0-2.2 cm respectively. Sepals and petals purple coloured and shaded. Lip length 1.0-1.2 cm with rhombic apical lobe. Flowering time mid July.

***Dendrobium moschatum*:** Plants are large sized of 120-130 cm. in height. Number of flowers 10-15 borne on the peduncle. General appearance of sepals and petals are incurved and are yellowish-orange coloured. Lip is slipper-shaped, pubescent with two

dark maroon blotches at the base. Colour of anther cap is red-purple. Flowers during the month of August.

***Dendrobium chrysanthum*:** Plants were medium size (30-35 cm) with drooping pseudostem. Inflorescence raceme type emerges along the whole length of pseudostem. The number of flowers per inflorescence varies from 20-30, flower measured about 5.0-5.2 cm in length and breadth, presence of fragrance. Colour of flower is yellowish-orange with strong pubescence on the lip. Lip eye present, anther cap yellow coloured. Blooms in the month of October.

***Dendrobium thrysiflorum*:** Plant is medium size with a height of 30-35 cm. Pseudostem semi-erect to pendulous in nature. Leaves medium green in colour and narrow ovate in shape. General appearance of sepals and petals are some incurving and some reflexed. Flowers off-white in colour and borne along the peduncle which looks very attractive. Lip length is about 2.4-2.6 cm with a strong pubescence. Flowering time early October.

***Dendrobium densiflorum*:** Plant height of about 55-60 cm. Inflorescence dense and drooping, sepals and petals are some incurving and some reflexed. Flowers are yellow-orange in colour. Lip 1.5-2.2 cm in length with ovate lateral lobe and orange coloured throat. Lip pubescence strong. Yellow anther cap yellow. It flowers during the last week of September to First week of October.

Dendrobium hybrids

***Dendrobium* hybrid "A. Abraham":** Plant measures about 55-60 cm in height, the pseudostem is semi-erect in nature. Leaves are narrow-ovate in shape. Inflorescence arises on the top part of pseudostem. Number of flowers varies from 4-6/inflorescence which is usually raceme type.

General appearance of sepals and petals are all reflexed. Flower length 3.8-5.0 cm and breadth 4.4-6.0 cm, sepals and petals are purple in colour, striped and netted. Lip length 2.3-3.0 cm with ovate lateral lobe. Lip callus is present, anther cap greenish-white. Flowers during September-November.

Dendrobium hybrid "Pompador": Medium size (25-30 cm) plant with erect pseudostem. Number of flowers 5-10 per inflorescence, emerging from the top part of pseudostem. Flower measures 6.0-7.0 cm in length and breadth. Sepals elliptic in shape and purplish in colour with white shade. Petal obovate in shape. Lip callus is prominent, lip eye is absent. Blooms in the month of July.

Dendrobium hybrid "Emma White": Plant size 55-60 cm in height with erect to semi-erect pseudostem of about 25-30 cm long and 6-8 flowered. Sepals and petals are all reflexed and off-white in colour. Lip length of about 2.4-2.8 cm with prominent callus, lip pubescence is absent. Column colour of anther cap is white. Flowering time late October.

Dendrobium hybrid "Burana Stripe": Plant measures about 45-50 cm. Pseudostem erect to semi-erect in attitude with a length of about 20-25 cm. Inflorescence on the top part of pseudostem and 4-6 flowered. Flower length and breadth 7.0-7.2 cm and 7.5-7.9 cm respectively. Sepals and petals are all reflexed, purple in colour. Lip length of about 3.5-3.7 cm with ovate lateral lobe, lip callus present. Flowers during September last to October first week.

Vanda species

Vanda coerulescence: Plant size is medium with height of 30-35 cm, stout in nature. Root shows secondary type of branching habit, strap shaped leaves with emarginated apex. Inflorescence raceme type with 5-7 flowers/inflorescence, floral bract present. General appearance of sepals and petals are some spreading some reflexed, spur conical in shape and 0.4-0.6 cm in length. Flower measures about 6.4-6.6 and 5.2-5.4 cm in length and breadth respectively.

Sepals and petals elliptic to spatulate in shape. Lip 1.5-1.7 cm in length, lobules are present. Column length about 0.8 cm with yellowish orange anther cap. Flowering time September.

Vanda coerulea: Large size plant with a height of 45-60 cm. Plant stout in nature. Roots show secondary branching habit, leaves are 15-17 cm long, strap shaped with emarginated apex. Inflorescence raceme type with as many as 10-20 flowers. Flowers 7.4-7.6 cm in length and borne on a twisted pedicel, presence of bract. Sepals and petals obovate to spatulate, shaded and tessellated with violet colour. Lip length of about 1.5-1.9 cm with lobules present, anther cap brownish violet. Blooms in October.

Vanda hybrids

Vanda mamo X Vanda thongchai: Medium size plant with a height of 28-30 cm, plant is stout in nature. Leaf strap in shape, length 15-17 cm and width 1.8-2.0 cm. Peduncle semi-erect in attitude, floral bract present. Number of flowers/inflorescence 4-6. Flower length 9.5-9.8 cm and breadth 9.2-9.4 cm. Sepals and petals all spreading and purple in colour. Lip shape of lateral lobe is ovate and apical lobe rhombic. Anther cap yellow orange. Blooms in the month of July.

Cymbidium species

Cymbidium dayanum: Plant large size of about 60-70 cm in height, leaf length 60-65 cm. Inflorescence raceme type with 9-10 flowers. Peduncle attitude is pendulous. Sepals and petals are incurved and spreading type. Flower length 4.0-5.0 cm and width 2.0-2.4 cm. Sepal lanceolate in shape and white with a maroon shade and petal shade linear and white in colour. Lip white to yellow in colour with strip in the lateral lobe, anther cap yellow coloured. Flowering time mid August.

Cymbidium aloifolium: Medium size plant with 55-60 cm height. Leaf is linear in shape with emarginated apex. Flower number varies from 25-30

with pendulous peduncle attitude. Single type flower with incurved and spreading sepals and petals. Flower length 2.0-3.0 cm and width 1.5-2.0 cm.

Sepals and petals lanceolate and elliptic in shape. Lip border between colour zones is abrupt Lip stripes present. Flowers during mid July.

Digitalization of orchid species and hybrids

Dendrobium moschatum



General appearance of flower



Colour & shape of dorsal & lateral sepals



Colour & shape of petal



Colour & shape of Lip



Column colour & anther cap

Dendrobium aduncum



General appearance of flower



Colour & shape of dorsal & lateral sepals



Colour & shape of petal



Colour & shape of Lip



Column colour & anther cap

Dendrobium chrysanthum



General appearance of flower



Colour & shape of dorsal & lateral sepals



Colour & shape of petal



Colour & shape of Lip



Column colour & anther cap

Dendrobium thrysiflorum



General appearance of flower



Colour & shape of dorsal & lateral sepals



Colour & shape of petal



Colour & shape of Lip



Column colour & anther cap

Dendrobium "A. Abraham"



General appearance of flower



Colour & shape of dorsal & lateral sepals



Colour & shape of petal



Colour & shape of Lip



Column colour & anther cap

Dendrobium "Emma White"



General appearance of flower



Colour & shape of dorsal & lateral sepals



Colour & shape of petal



Colour & shape of Lip



Column colour & anther cap

Dendrobium "Burana Stripe"



General appearance of flower



Colour & shape of dorsal & lateral sepals



Colour & shape of petal



Colour & shape of Lip



Column colour & anther cap

Vanda coerulescence



General appearance of flower



Colour & shape of dorsal & lateral sepals



Colour & shape of petal



Colour & shape of Lip



Column colour & anther cap

Vanda coerulea



General appearance of flower



Colour & shape of dorsal & lateral sepals



Colour & shape of petal



Colour & shape of Lip



Column colour & anther cap

Cymbidium dayanum



General appearance of flower



Colour & shape of dorsal & lateral sepals



Colour & shape of petal



Colour & shape of Lip



Column colour & anther cap

Mega Seed Project: Seed Production in Agricultural Crops and Fishries

The targeted production achieved during the year is furnished below for the year 2007-08.

Sl. No.	Particulars	Achievements
1	Commercial hybrids/ <i>Cymbidium</i> etc plantlet through tissue culture and other techniques	6,500
2	Gladiolus bulbs	8,448
3	<i>Lilium</i> /Freesia corms	3,000

Technology Assessed and Transferred



The major transfer of technologies taken up by the Centre were

- Frontline extension through training programmes.
- Technology transfer through demonstrations, trials and linkage programmes.
- Promotion of technologies through print media, extension literature.

Training Programmes

The centre organized 11 (eleven) tailor made training programmes on various topics and trained government officials from different states department of Horticulture / Agriculture and farmers to cater the needs and demands.

The details of training programme are given below.

Date	Topic	Number of participants	Category of participants	Venue
10 - 12 April, 2007	Techniques in cultivation of <i>Cymbidium</i> , <i>Lilium</i> and Gerbera	13	Farmer of Darjeeling	NRCO, Darjeeling Campus
22 - 24 June, 2007	Techniques in production and propagation of <i>Cymbidium</i> and <i>Lilium</i> .	14	Farmer of Darjeeling	NRCO, Darjeeling Campus
21 - 29 July, 2007	Production of tropical orchids	56	Self Help Group of Kalimpong.	NRCO, Pakyong
21 Aug., 2007	Production technology of <i>Cymbidium</i>	32	Farmer of Darjeeling	NRCO, Pakyong
18 - 25 Sept., 2007	Advance technologies for production of commercial flower crops under green house condition.	10	Govt. Officers of W.B.	NRCO, Pakyong
7 - 9 Nov., 2007	Techniques in production and propagation of <i>Cymbidium</i> , <i>Lilium</i>	14	Farmer of Darjeeling	NRCO, Darjeeling Campus
23 Nov., 2007	Production technology of orchids	30	Farmers of Raigaon, Sikkim	NRCO, Pakyong
07 Dec., 2007	Nursery management of annuals	62	Farmer of Darjeeling and Sikkim.	NRCO, Pakyong
2 - 4 Jan., 2007	Techniques in production and propagation of <i>Cymbidium</i> , <i>Lilium</i> and Gerbera	10	Farmer of Darjeeling	NRCO, Darjeeling Campus
18 - 20 March, 2007	Techniques in production and propagation of <i>Cymbidium</i> , <i>Lilium</i> and strawberry	14	Farmer of Darjeeling	NRCO, Darjeeling Campus
24 - 26 March, 2007	Techniques in production and propagation of <i>Cymbidium</i> , <i>Lilium</i> and strawberry	13	Farmer of Darjeeling	NRCO, Darjeeling Campus

Demonstration

Sl no.	Topic	No of participants	Category of participants	Venue
1	<i>Cymbidium</i> cultivation	25	All farmers	Sikkim
2		44	-Do-	Assam
3		35	-Do-	Sikkim
4		40	-Do-	Sikkim
5		38	-Do-	Meghalaya

Technology Transfer through Mass Media

Exhibitions/Participations

Sl. No.	Name and place	Date
1	Hort. Expo - Industrialist Farmers Meet, Lucknow	June 14-15 th , 2007
2	Bharat Nirman Campaign 2008, Community hall, Pakyong	19-23 rd Feb., 2008
3	International flori show, 2008, Saramsa Garden, Ranipool, Sikkim	14-16 th March, 2008



Bharat Nirman Campaign, 2008



International Flori Show, 2008



Model Training Course

Education and Training

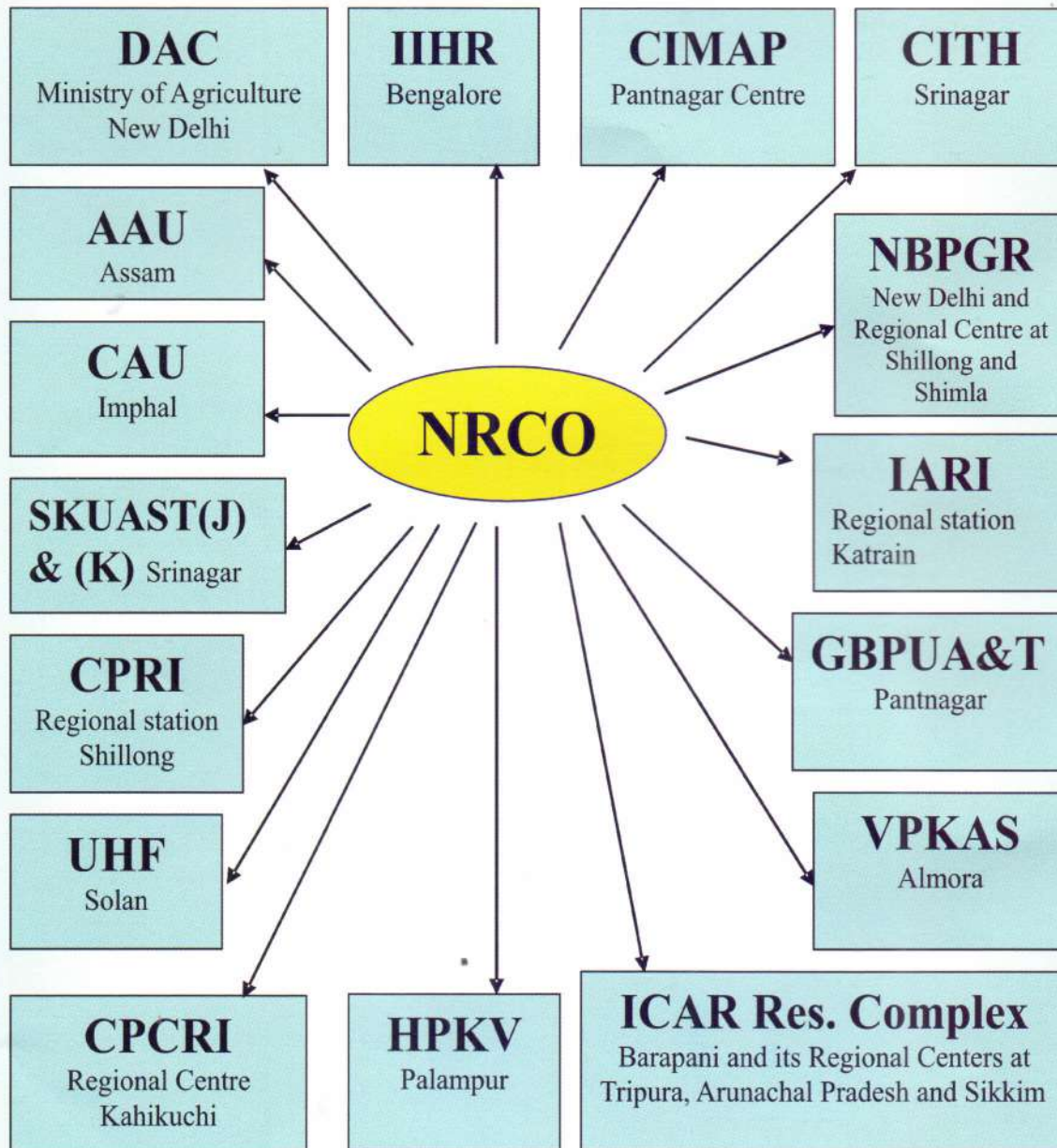


Name	Topic	Duration	Institution
Bharati, T. Usha	Winter school on WTO, GATS and IPR: Implications in Agricultural Research and Education	November 14 th - December 4 th , 2007	National Academy of Agricultural Research and Management, Hyderabad
Chakrabarti, S.	Training programme on Scientific Project Formulation, Implementation and Evaluation of Senior Scientists organized by DST, Govt. of India	April 16 - 27 th , 2007	Administrative staff college of India, Bella Vista, Raj Bhavan Road, Hyderabad - 500082
Medhi, R. P.	Training programme of Eastern Region ICAR Directors on Vigilance Administration and Management.	April 16 - 18 th , 2007	National Academy of Agricultural Research and Management, Hyderabad
Meena, N. K.	Training Programme as Nodal officer (NRC Orchids) on Intelligent Reporting System	September 10 - 11 th , 2007	IASRI, New Delhi
	Winter school training programme on Biological and Biotechnological Approaches to Insect Pest and Disease Control	November 14 th - 4 th December, 2007	Project Directorate of Biological Control (PDBC), Bangalore.

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 mandated floriculture crops (Fig. 1).



List of Publications



Research articles

- Bag, T. K. and Ram Pal 2007. A new rust on *Calanthe* from Darjeeling Hill, India . *Sci. & Cult.* **73**(11-12):405-407
- Barman D. and Rajni K., 2006. Effect of chemicals on post harvest life of cut rose cultivar First Red., *J. Ornamental. Hort.* **9**(4): 262-265.
- Barman D., Basak J., Rai B., Devdas R., Nagraju V. and Medhi R. P. 2007. Performance of *Cymbidium* hybrids in Mid hill situation of Sikkim. *J. Ornamental. Hort.* **10**(1):30-33
- Barman D., Rajni K., Naik S. K. and Upadhyaya R. C. 2008. Production of *Cymbidium* Soul hunt - 6 by manipulating some of the cultural practices under partially modified green house. *Indian J. Hort.* **65**(1):69-72.
- Chakrabarti, S., Rai, B., Sarkar, J. and Das, J. 2007. Estimation of Photosynthetic Pigment Variations in Five Developmental Stages of *Cymbidium whitae* of family Orchidaceae. *Environment and Ecology* **25**(2):270-273.
- Chakrabarti S., Sarkar, J and Rai, B. 2007. Influence of Potting Media on Leaf Morphology and Biochemical Parameters of *Epidendrum* orchid. *Environment and Ecology.* **25**(2):280-283.
- Naik, S. K. and Barman, D. 2006. Response of foliar application of nitrogen on flowering in *Cymbidium* hybrid. *J. Ornamental. Hort.* **9**(4): 270-273.

Popular articles

- Chakrabarti, S. 2007. Commercial Cultivation of Phalaenopsis Orchid. *Farmer's Digest* **40** (5):36-38, 42
- Chakrabarti, S. 2007. North – Eastern India - a hot spot for developing *Cymbidium* cut flowers industry. *Everyman's Science* **42** (3):149-152.
- Chakrabarti, S. 2007. Flower colour in orchids. *Science and Culture* **73** (9-10): 294 - 298
- Chakrabarti, S. 2007. Orchids conservation or smuggling? a controversial issue. *Science and Culture* **74** (3-4): 143-147
- Medhi R. P., Rampal and R. Devadas 2007 *Cymbidium* cultivation in Sikkim Himalayan region-A success story by NRC for Orchids. In: *Technologies for improving agriculture: Role of ICAR for special issue of 'Indian Horticulture' on the occasion of ICAR foundation day* DIPA, ICAR, New Delhi.
- Nagrare, V. S. and Ram Pal 2008. A viable Option - Cultivating Potted orchids fetches more. *Indian Horticulture*, March-April 2008, 24-26
- Pant, R. P. and Barman, D. 2008. Baigyanic Dhang Se *Cymbidium* Utpadan, *Phal Phool* **31** (2): 24-27.
- Ram Pal 2007. Himalayan Giant lily : Gems among Wild Bulbous Ornamentals, *Indian Horticulture* November – December, 12-13

Papers presented in Seminars/Symposia

- Barman, D. Rai, B. and Upadhyaya, R. C. 2007. Cymbidium based floriculture model for entrepreneurial development in Sikkim. *2nd Indian Horticulture Congress - 2007*, April 18-21, 2007, Barapani. p 267-268.
- Chakrabarti, S. 2007. Commercialization of Cymbidium orchids in North Eastern India - present status and future opportunities, *2nd Indian Horticulture Congress 2007*, April 18-21, 2007, Barapani. p 83.
- Chakrabarti, S. 2007. Orchids in traditional medicine in *Bhartiya Vigyan Sammelan-2007* November 23 - 25, 2007. Bhopal.
- Chakrabarti, Syamali. 2008. Medicinal importance of orchids. In : abstract and souvenir, *National Workshop-Grower Industry Linkage for Promotion of Medicinal and Aromatic Plants Cultivation* February 12-13, 2008, Cochin , Kerala. p 95-101.
- Chakrabarti, S. and Sarkar, J. 2008. Diversity Assessment of Dendrobium Orchids. *National Symposium on Recent Advances in Floriculture* March 4-6, 2008. Navsari, Gujarat.
- Chakrabarti, S. 2008. Trade and Marketing of Cymbidium Orchids - Present Status and Future Prospects. *National Symposium on Recent Advances in Floriculture* March 4-6, 2008, Navsari, Gujarat.
- Devadas R. and Baruah S. 2007. Status on tissue culture protocols at NRC Orchids, Sikkim. In: *Horticulture Biotechnology: Present status and future action plan* December 8, 2007, Bangalore.
- Medhi R. P. and Devadas, R. 2007. Orchids- Achievements, Constraints and Opportunities (*Lead paper*). In : *2nd Indian Horticulture Congress-2007* April 18-21, 2007, Barapani, Meghalaya. p. 98.
- Pant, R. P., Das, D. R., Srivastava, M. Tomer, V. K., Singh, Lokendra and Ahlawat, Y. S. 2007. Characterization of a Carlavirus infecting football lily in India. p. 246. In: *International*

Conference on Emerging and Re-Emerging Viral Diseases of the Tropics and Sub- Tropics from December 11-14, 2007, New Delhi

- Pant, R. P., Pun, K. B. and R. P. Medhi. 2007. Status of the orchid viruses occurring in the North Eastern Himalayan Region of India. In: *International Symposium on Viruses of Ornamental and Temperate Fruit Crops from December 17-18, 2007, Palampur*. p. 34.

Technical publications

- Devadas, Ramgopal, R. P. Medhi, Sourav Moktan and P. Khatiwara 2008. Salient features of DUS testing on orchids, published by Director, NRC for Orchids, Pakyong under DUS project. [NRCO/DUS Bulletin - 01/2007 (01)].
- Pant, R. P. and Medhi, R. P. 2008. *Cymbidium phulau ka utpadan*: A leaflet in Hindi
- Pant, R. P. and Medhi, R. P. 2008. *Cymbidium phulharuko kheti*: A leaflet in Nepali
- Ram Pal and R. P. Medhi 2008. *Cymbidium cut Flower Production* : A leaflet in English
- Ram Pal 2008. *Production of Lilium* : A leaflet in English
- Ram Pal. *Lilum Kheti awam Aay Shrot* : A leaflet in Hindi

List of Ongoing Projects



Institute Projects

Project title	Principal Investigator
In vitro propagation of orchid: <i>Cymbidium</i> and important, rare and endangered species	R. P. Medhi
Cytogenetical research on orchids	S. Chakrabarti
Breeding superior hybrids in <i>Cymbidium</i> and other important orchids	Ramgopal Devadas
Development of agro – techniques for commercial scale production of orchids in open and protected condition.	D. Barman
Investigations on fungal diseases of orchids	T. K. Bag / R. P. Pant
Pest management in orchids and bulbous flowering plants	V. S. Nagrare/N. K. Meena
Collection, conservation, characterization, evaluation and maintenance high altitude orchid germplasm	Ram Pal
Collection, conservation, evaluation and multiplication of bulbous ornamental crops	Ram Pal
Studies on bulb production of <i>Lilium</i>	Ram Pal

Externally Funded Projects

Sl No	Project title	Sub project title	Project associates
1	TMOP(MM-1) Integrated Development of Horticulture in North Eastern States including Sikkim, Uttranchal, Himachal Pradesh and Jammu & Kashmir	Development of conventional and micro-propagation techniques Production of planting material under low cost poly-houses Refinement and transfer of production technologies for commercial production of ornamentals through training	D Barman D Barman, T K Bag / R. P. Pant & V S Nagrare / N. K. Meena R. P. Medhi, S. Chakrabarti, D Barman, T K Bag / R. P. Pant , Ram Pal, V S Nagrare / N. K. Meena & R. Devadas
2	Distinctiveness Uniformity & Stability (DUS)	Preparation for plant variety protection and conducting test for distinctness, uniformity and stability for orchids	Ramgopal Devadas
3	Mega Seed Project	Seed production in agricultural crops and fisheries	D. Barman and Ramgopal Devadas

RAC and IRC Meetings with Recommendations



Research Advisory Committee (RAC)

The 8th Research Advisory Committee (RAC) meeting of this centre was held under the chairmanship of Prof. P. Tandon, Vice-Chancellor, North Eastern Hill University, Shillong, Meghalaya on 22nd September, 2007 at the conference hall of NRC for Orchids. The participants of RAC Committee were as follows

1	Prof. P. Tandon Vice-Chancellor North Eastern Hill University Shillong, Meghalaya	Chairman		
2	Dr. Narendra Kumar Director Defence Research & Development Organization (DRDO), New Delhi	Member		
3	Dr. P. K. Rajeevan Associate Dean	Member		
			College of Horticulture, Kerala Agricultural University Trichur, Kerala	
4	Dr. S. K. Dutta Retd. Deputy Director & Head Floriculture Division NBRI, Lucknow, UP			Member
5	Dr. K. V. Ramana ADG (Hort. II) ICAR, New Delhi			Member
6	Dr. R. P. Medhi Director NRC for Orchids, Pakyong East Sikkim, Sikkim			Member
7	Dr. Ramgopal Devadas Scientist (Plant Breeding) NRC for Orchids, Pakyong East Sikkim, Sikkim			Member Secretary



Major Recommendations

Sl. No.	Division	Recommendation	Action Taken
1	Tissue Culture/ Biotechnology	The cost of production involving media, chemicals and manpower in the protocol development and also for mass multiplication should be worked out for commercialization.	Calculated for commercial application point of view
		Emphasis for protocol development specific to meristem culture and seed culture derived from crossing should be evolved separately.	Already in process
2	Genetics	The molecular work on SSR should be started with the help of other national institutes to analyze the sample, instead of till the end of continuing research work on RAPD of Orchids for authenticated protection.	Molecular work on SSR will be started after negotiating with the National Laboratories for the collaborating work. Negotiation is under process.
		Molecular documentation of orchids native to Sikkim, as well other important species should be given the highest priority.	Priority has already given to indigenous species of Sikkim Himalaya for preparation of molecular database.
3	Plant Breeding	The hybrids developed/multiplied like <i>Epidendrum</i> cross (variants), <i>Phaphiopedilum</i> cross and Freesia hybrids (developed through half-sib mating) under different stages of evaluation should be registered and released as variety.	They will be registered after 2-3rd year evaluation and mean while they will be registered with NBPGR
		The chairman suggested collaborating with DST & Department of Agriculture and Horticulture, Sikkim for sharing of research outputs on tissue culture of plants and for development of data base development on Orchids and also to submit a new project proposal to DBT.	New DBT has been approved after submission from DBT
4	Horticulture	The longer studies on understanding the relation between shade and irrigation from the experiment, ' <i>Studies on the shade requirement of and irrigation requirement for growth and flowering of Cymbidium</i> ' should be carried out.	It will be carried out another two years for final recommendation.
		Specific work should be done separately and also with combination of nutrient and hormone for better direction on the experiment, ' <i>Effect of inorganic nutrient and growth hormone reducing the pre-blooming in Cymbidium</i> '.	The work will be started as soon as plant material in hand.

		The project on ' <i>Cymbidium based floriculture model for entrepreneurship development in Sikkim</i> ' should be submitted for external funding through DBT under Women and Rural Development Programme. This will help in popularizing the concept in different pockets of northeast as a livelihood option for employment generation.	The project will be submitted to DBT in due time.
		The proposed two new projects on post-harvest technology should be finalized in consultation with Dr. R. L. Mishra, Project Coordinator (Floriculture).	It was discussed with Dr. R.L. Mishra for conducting experiment.
5	Horticulture (Darjeeling Campus)	NIL	NIL
6	Soil Science	The trial on early seedling growth should be taken up, so as to utilize the exponential and better growth leading to early and more number of spikes rather than doing experimentation on ' <i>Effect of EC of nutrient solution and fertilizer regime on the spike production and quality of Cymbidium</i> '.	The work will be started on young plants.
7	Plant Pathology	The studies on fungal diseases should be continued and the studies on association of OM fungi with tissue culture hardened plantlets should be initiated ['Exploitation of Orchid Mycorrhiza (OM) in the Early Establishment (Hardening) and Growth Promotion of Tissue Cultured Plants of Important Orchids'] with inclusion of bio-agents like Trichoderma, Bacteria <i>etc.</i>	Studies on fungal disease are continued but studies on association will be done on as fungus and viral disease of orchids are main priority.
		The new project on 'Monitoring and Management of Virus Diseases in Orchid' should be continued and the project on ' Diagnostics & Molecular characterization (ELISA, PCR <i>etc</i>) of virus ' should be submitted for external funding	Monitoring and management of virus disease in orchid is started and diagnostic and molecular characterization (ELISA & PCR) of virus to be submitted to DBT in due time.
8	Entomology	NIL	NIL

Institute Research Council (IRC)

The Institute Research Council meeting was held under the chairmanship of Dr. R. P. Medhi, Director, NRC for Orchids, Pakyong, Sikkim on 08.06.2007.

The meeting was attended by following persons.

- 1 Dr. M. R. Sudharshan, Deputy Director (Research), ICRI, Spices Board, Gangtok

2. Dr. A. K. Biswas, Sr. Scientist, ICRI, Spices Board, Gangtok
3. Shri Nirmal Yonjon, Orchid grower, Dikling, Sikkim
4. Dr. S. Chakrabarti, Sr. Scientist (Genetics), NRC for Orchids, Pakyong, Sikkim
5. Dr. D. Barman, Sr. Scientist (Horticulture), NRC for Orchids, Pakyong, Sikkim
6. Dr. R. P. Pant, Sr. Scientist, Plant Pathology, NRC for Orchids, Pakyong, Sikkim
7. Shri Ram Pal, Scientist (Horticulture) & in-charge, NRC for Orchids, Darjeeling Campus, Darjeeling
8. Dr. T. K. Bag, Scientist Sr. Scale (Plant pathology), NRC for Orchids, Pakyong, Sikkim
9. Dr. V. S. Nagrare, Scientist (Entomology), NRC for Orchids, Pakyong, Sikkim
10. Dr. Ramgopal Devadas, Scientist (Plant Breeding), NRC for Orchids, Pakyong, Sikkim
11. Dr. N. K. Meena, Scientist (Entomology), NRC for Orchids, Pakyong, Sikkim
12. Ms. T. Usha Bharati, Scientist (Floriculture), NRC for Orchids, Pakyong, Sikkim

Major Recommendations

	Division	Recommendation	Action Taken
1	Plant Breeding	All the released varieties should be registered with NBPGR, New Delhi	Already in process
		All breeding works should be placed forward for registration under Royal Horticultural Society, London irrespective of setbacks.	Elite hybrids will be done at RHS & Patenting abroad, as higher cost is involved
		Protocols development should be given priority to important orchids	Agreed on the suggestion
2	Genetics	After the initial works on RAPD works on RFLP and SSR/VNTR should be started for more reliability	At present RAPD analysis is going on. Proposal initiated for work with SSR markers with CDFD, Hyderabad
3	Horticulture	Study on relation of hormones to nutrients and relation of nutrients to survival should be included in the projects.	Experiment has been initiated

4	Horticulture (Darjeeling Campus)	'Studies on production and propagation of Tulips under Sikkim Himalayan Conditions' with three experiments has been approved.	-----
5	Plant Pathology	'Diagonostics & Molecular characterization (ELISA, PCR etc) of virus' is the highly important basic work on orchids needed to implement	Linkage has already been established with Plant Virology Unit, IARI, New Delhi
6	Entomology	'Insect - orchid host preference studies in orchids germplasm' to be restricted initially to <i>Cymbidiums</i> only	Insect-Orchid host preference study in orchid germplasm including <i>Cymbidium</i> is in continue due to poly-phagous nature of many insects
7	Soil Science	New formulation of fertilizer from NRC for orchids should be developed for different orchids.	Organic fertilizer was prepared.

Participation of Scientists in Conferences, Meetings, Workshops, Symposia, Seminars etc. in India and Abroad



- **Bharat Nirman Campaign Exhibition at Community Hall, Pakyong from 19 – 23rd February, 2008.**
N. K. Meena
- **Steering Committee Meeting on “Technology Mission for Integrated Development of Horticulture of NE States, Sikkim, Jammu & Kashmir, HP and Uttaranchal” held on 17th May, 2007 at UPKAS, Almora (Uttarakhand).**
R. P. Medhi
- **Meeting on national level consultation on “Agro-biodiversity Hot-spots and Biodiversity Heritage Sites”, organized by PPV & FRA, New Delhi and the BDA, Chennai at NEHU, Shillong, Meghalaya on 1-2nd June, 2007.**
R. Devadas
- **Special interactive workshop on “Administration and Financial Matters for Directors and Administrative and Financial Officers of ICAR” in Barrackpore, Kolkata on 2nd and 3rd August, 2007.**
R. P. Medhi
- **3rd International Flora Expo 2007 held at Pragati Maidan, New Delhi from 12-14th September, 2007.**
N. K. Meena
- **Meeting of Sectorial Committee on Mega Seed Project held on 29-30th June 2007 at CSIH, Lucknow.**
R. Devadas
- **DBT meeting on the proposed project DBT for Northeast on Quality Planting Material Production on 27th November, 2007 at DBT, CGO Complex, New Delhi.**
R. Devadas

Distinguished Visitors



- Mr. John Maxwell
South London Botanical
Institute,
London, UK 11.04.2007 Bathiinda, Punjab
- Dr. S. V. Ngachan
Director
ICAR Research Complex for
NEH Region, Barapani 23.05.2007
- Dr. R. C. Srivastava
Director
CARI, Port Blair 05.06.2007
- Mr. Madan Swarup
Under Secretary (P), ICAR. 27.09.2007
- Dr. Tapan Dutta
Agri. Advisor to
Honable Chief Minister
Assam 08.10.2007
- Rakesh Rathi
President
North India Cotton Association 08.12.2007
- Dr. B. D. Panar
Centre for International Trade in
Agriculture and Agro Based
Industries, New Delhi 01.03.2008
- Dr. K. L. Chadha
Ex-Deputy Director General
(Hort.), ICAR 13.03.2008
- Dr. Kirti Singh
Ex – Chairman
ASRB, New Delhi 13.03.2008
- Dr. L. Shivarama Reddy
Dy. Com. MOA 13.03.2008
- Dr. H. P. Singh
Deputy Director General (Hort.)
ICAR, New Delhi 15.03.2008
- Prof. M. K. Pandit
National University of
Singapore, 10 Kent, Ridge Road,
Singapore-60 23.07.2008



Dr. H. P. Singh, DDG, ICAR (centre) during his visit to the NRC for Orchids & International Flori Show, Saramsa, 2008



Dr. K. L. Chadha, Ex-DDG, ICAR (centre), Dr. Kirti Singh, Ex-ASRB Chairman (right) and Dr. L. Shivarama Reddy, Dy. Com. MOA (left)

Personnel



Scientific

Dr. R. P. Medhi	Director
Dr. Syamali Chakrabarti	Sr. Scientist (Genetics)
Dr. D. Barman	Sr. Scientist (Horticulture)
Dr. R. P. Pant	Sr. Scientist (Plant Pathology)
Shri Rampal	Scientist Sr. Scale (Horticulture)
Shri S. K. Naik	Scientist (Soil Science) (on Study leave)
Dr. Ramgopal Devadas	Scientist (Plant Breeding)
Dr. N. K. Meena	Scientist (Agril. Entomology)
Miss T. Usha Bharathi	Scientist (Hort./Floriculture)

Administration

Miss Lakit Lepcha	Asstt. Administrative Officer
Shri Rajat Kumar Das	Assistant
Mrs. Diki Bhutia	Jr. Clerk
Shri Phigu Tshering Bhutia	Jr. Clerk
Mrs. Prema Nagaraju	Jr. Clerk

Technical

Shri Janaki Mandi	Technical Asstt. (T-3)
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Shri Ram Chandra Gurung	Driver (T-3)
Shri G. B. Mukhia	Farm Technical (T-2)
Shri Manoj Adhikari	Tech. Asstt. (T-1)
Shri Deepak Khattri	Driver (T-1)
Miss Meena Chettri	Tech. Asstt. (T-1)

Supporting

Shri Gopal Brahmin	SSG-III
Shri Dawa Bhutia	SSG-II
Shri Tularam Dulal	SSG-II
Shri Trilok Singh Balmiki	SSG-II
Shri Arjun Gurung	SSG-I
Shri N. K. Biswakarma	SSG-I
Mrs. Rabin Kala Subba	SSG-I

Appointments

- Dr. Rajendra Prasad Pant joined as Senior Scientist (Plant Pathology) on 16th April, 2007.
- Dr. Narottam Kumar Meena joined as Scientist (Agril. Entomology) on 18th May, 2007.
- Miss T. Usha Bharathi joined as Scientist (Hort./Floriculture) on 18th May, 2007.
- Mrs. Prema Nagaraju joined as Junior Clerk/L.D.C. on 2nd April, 2007.
- Shri Arjun Gurung joined as SSG-I (Lab Attended) on 13th September, 2007.
- Shri. Narayan Kazi Biswakarma joined as SSG-I (Chawkidar) on 14th September, 2007.
- Mrs. Robin Kala Subba joined as SSG-I (Peon) on 17th September, 2007.

Promotions

- Miss Lakit Lepcha was promoted from Assistant to A.A.O. on 14th December, 2007.
- Shri R. C. Gurung was promoted from T-2 to T-3 on 5th May, 2007.
- Shri R. K. Das was promoted from Sr. Clerk to Assistant on 28th February, 2008.

Transfers

- Dr. T. K. Bag, Sr. Scientist (Plant Pathology) was transferred to Indian Institute of Vegetable Research, Varanasi on 7th September, 2007.

- Dr. V. S. Nagrare, Scientist Sr. Scale (Entomology) was transferred to Central Institute for Cotton Research, Nagpur on 2nd July, 2007.
- Shri Sunil Kumar Das, Asstt. Finance & Accounts Officer was transferred to N. R. C for Woman in Agriculture, Bhubaneswar on 30th April, 2007.
- Shri Sunil Kumar, Computer Asstt. (T-4) was transferred to Indian Lac Research Institute, Ranchi on 16th April, 2007.

Other Informations



IMC

The meeting of the last Institute Management Committee was held on 12.03.2007 at the institute under the chairmanship of Director, Dr.R.P.Medhi.

Independence Day

National Research Centre for Orchids celebrated Independence Day on 15.08.08. All the staff participated in the flag hoisting ceremony.



Hindi Diwas

Hindi Diwas was celebrated on 14th September, 2007 to promote the use of Rajbhasa. Staff of this centre participated in various competitions. The participants who stood 1st, 2nd and 3rd were honoured by prizes.



Raising Day

The centre celebrated raising day on 6.10.07. The celebration was marked by a number of activities in which the staff participated actively.

Republic Day

Republic Day was celebrated at the centre on 26.01.08





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