ANNUAL REPORT
2001-2002

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ICAR

NATIONAL RESEARCH CENTRE FOR ORCHIDS
(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)
PAKYONG, SIKKIM 737 106

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Preface

The National Research Centre for Orchids, established in 1996, is actively engaged in carrying out basic and applied research on orchids and bulbous flowers to cater the needs of farmers of the North Eastern Region. The Centre is trying hard in collecting available orchid germplasm from all over India, its maintenance, conservation and propagation by conventional as well as by advanced methods. Useful technologies for the commercial production of cut flowers of orchids and bulbous flowers are being developed with the financial and technical support by ICAR. Further, the Centre is in the process of strengthening its infrastructure facilities by adding sophisticated instruments to laboratories and expediting construction of laboratory cum administrative building and staff quarters.

The research activities of the Centre are modified with the changing scenario of agriculture in the recent past. Research projects are formulated under three broad sections such (1) crop improvement (2) crop production and (3) crop protection. The research achievements are expected to report under these programmes. In addition, 3 NATP projects and one Central sponsored Scheme under Mini Mission-I funded by the Government of India for the integrated development of Horticulture in the North Eastern states including Sikkim are in progress on various aspects of orchids and bulbous flowers. With the whole hearted support and hard work of my scientists, I am sure, we will be able to fulfill the mandate of the Centre and deliver technologies to the farmers of this region.

I take this opportunity in expressing my gratitude to Dr. Panjab Singh, Director General, ICAR, and Secretary, DARE, Government of India for his support in the development of this Centre. I am extremely thankful to Dr. G. Kalloo, DDG (Hort.), ICAR for his encouragement, technical guidance and help. I acknowledge the help and support extended by Dr. B. S. Dhankar, ADG (VC), ICAR for all round development of the Centre. I will be fail to my duty unless appreciate the dedicated efforts made by Drs. T. K Bag, S. P. Das and V. S. Nagrare in bringing out this report in presentable

form. I thank all my scientific, administrative, technical and supporting staff for their dedicated hard work and co-operation.

I am presenting with pride the annual report 2001-2002 with detailed findings by the scientists and other related information about the Centre.

R. C. UPADHYAYA
Director

Pakyong
26th December, 2002

Executive Summary

Orchids are one of the most important flowers of world floriculture trade. The abundant natural wealth of orchids in India is lying unexploited. North Eastern Himalayan region particularly, is rich in genetic resources for flowering plants. The resources from this region are to be surveyed and genetic material is to be preserved.

The Centre has made significant headway in research with respect to collection of indigenous orchid germplasm, indigenous and exotic hybrids of orchids, *in vitro* germination and micro propagation using immature embryos of hybrids/rare orchids, hardening and transferring of *in vitro* regenerated plants to pots.

CROP IMPROVEMENT

Tissue culture

Embryos from mature green but unbursted pods of *Zygopetallum intermedium,* and *Zygopetallum intermedium* X *Arachnanthe cathcartii* in MS and Nitsch media supplemented with various plant growth substances and activated charcoal indicated that the embryos took 66-74 days for swelling and developed protocorms in 81-95 days and readily formed organs in four media tried.

Protocorms of *Cymbidium* hybrids HXB, Lunavian Atlas, BXH and FXH supplemented with colchicine responded differently for various morphological characters.

The use of media and plant growth substances on PLBs, root and leaf segments showed that all the explants remained green initially for 5-6 weeks, there after, gradual leaf and root explants discolored.

The mean influence of media on PLBs indicated variation for different morphological characters. The weight of PLBs and their size was higher on Nitsch, but maximum number of protocorms was obtained on MS medium. Supplementation of AC in the medium stimulated growth and produced healthy plantlets. AC in the media also stimulated early rooting. The roots were longer, heavier and thicker in the presence of AC.

Protocorm excised aseptically from *in vitro* cultures of *Cymbidium* hybrid Lunavian Atlas, *Cymbidium* hybrids H X B, B X H and *Cattleya maxima* when cultured in Murashige and Skoog's media supplemented with sucrose, after 6 and 9 months indicated variation on various morphological characters. Presence of sucrose resulted protocorm enlargement and proliferation, while in the absence of sucrose gradual discoloration of protocorm after 5-6 months of culture in Lunvian Atlas and *Cattleya maxima* observed. While in H X B and B X H, about

50% of the explants were greenish even after 8 months of culture and in 30% of the cultures 1-2 new protocorm was formed.

The media supplemented with BAP, AC, Triacontanol and silver nitrate on morphogenetic response of protocorms showed that the culture weight 21.19 mg in half strength MS with 0.5 mg/l BAP, 1 g/l AC and 0.5 mg/l triacontanol to 118.19 mg/l in half strength Nitsch 0.5 mg/l BAP, 1 g/l activated charcoal and 0.5 mg/l triacontanol.

Genetics

Research work on studies of the banding pattern of chromosomes has been initiated on commercially important genera viz., *Cymbidium, Dendrobium* and *Vanda*.. Also Studies on the *in vitro* germination of pollen, pollen tube growth, viability, storage ability etc. initiated.

Breeding

Several crosses were carried out among orchids with special emphasis on *Cymbidium*. Selected cross combinations were cultured *in vitro* for germination and progeny raising.

Observations on the different post fertilization phenomenon in orchids like crossability, days for column swelling, flower withering, capsule swelling and capsule splitting or pod abortion were recorded. An attempt was initiated to study the viability of pollen in storage.

Media containing sand as one of the component helped in quick germination but at latter stage the media with FYM as one of the component showed better growth in pseudobulb of orchids.

Morphological characterization of 79 orchid species was completed. Observations on 46 characters were recorded on regular basis. Besides morphological characters, spatial characterization of flowering habit of the orchid species was also studied.

Considering the scope and potential of Freesia as cut flower owing to its highly scented flowers a breeding programme has been initiated in freesia. Depending on the colour and the length of spikes, collected materials were grouped into six different groups. Crosses were made in all possible combination among these groups. A new superior line has been identified.

A breeding programme with the objective to find out the most suitable breeding methodology in breeding superior cultivars in gladiolus has been initiated. So far crosses are being made in half diallel and line x tester fashion. Crossed seeds were sown to raise the cormels of the crosses.

In total 771 varieties of gladiolus were evaluated, out of which 42 were evaluated in the normal growing season and about 29 varieties were evaluated for off season production of cut flowers to find out the most suitable varieties for this region.

CROP PRODUCTION

Horticulture

Spraying of NPK at different concentration significantly enhanced plant height and length of leaves in *Cymbidium* hybrid var. Cooks Bridge.

Application of organic manure at fortnightly

intervals influenced significantly the growth of plants. Maximum plant height and length of leaves were recorded at application of fish meal followed by mustard oil cake. However, number of pseudobulbs and leaves did not respond significantly due to application of organic manures, although maximum was recorded at plant sprayed with fish meal.

Planting of *Cymbidium* in raised bed comprised of brick chips, FYM, charcoal, Loam soil (1: 1: 1: 1) and rotten log and moss(1: 1) were equally better for overall growth and flowering of *Cymbidium* and significantly influenced height of plant, length of leaves & length of spike. The maximum height of plant, length of leaves, number of pseudobulbs, length of spike and number of flower/spike were recorded in raised bed.

In *Cymbidium* hybrid, plant height and length of leaves increased with increasing rate of application of Gold-N nitrogen up to 60mg/plant thereafter both the parameter decreased with increasing rate. The number of leaves also followed similar trend of development. Maximum plant height, leaf length and number of leaves were recorded at the application of 60 mg/plant.

Application of GA_3 200ppm increased the length of leaves and pseudobulbs as compared to other treatments. However, IAA 250ppm improved the number of leaves and IAA 500ppm increased the number of pseudobulbs in *Cymbidium* hybrid Cook's Bridge.

NPK (20: 10: 10) at 0.1% concentration enhanced length and width of leaves however, maximum number of pseudobulbs were recorded in plants sprayed with NPK (10: 30: 10) at 0.2% concentration in *Cymbidium* hybrid Cook's bridge.

Application of potassium significantly influenced days to bud as well as spike emergence in Gladiolus cv. Jester. Application of 150kg potassium per hectare produced maximum weight (44.55g) where as larger size of corm (6.99cm) were produced by application of potassium 50kg /ha.

Application of different doses of potassium and density of planting significantly influenced length of spike, weight and diameter of corm; number and weight of cormels in Gladiolus cv. Jester. Planting of corms at 20x10cm spacing (50corm/m^2) with 300 kg potassium/ha produced longest plant (159.14cm) and spike (122.87cm).

CROP PROTECTION

Plant Pathology

Survey and collection of disease samples was carried out from Darjeeling, Mirik and Sukhia Pokhri of Darjeeling District (W.B.) and Pakyong of East Sikkim. From the collected disease samples, fungi were isolated and purified. Fungi were identified up to the genus level.

Sclerotium rolfsii causes wilt in *Spathoglottis, Eria coronaria*, *Cattleya* sp., *Dendrobium* sp., *Aerides* sp., *Cymbidium lowainum, Cymbidium* sp., *Habanaria* sp. This fungus was also recorded to infect several other *Cymbidium* hybrids like Berta, Yankee lila, Forest King, Show girl X Cold Stream, Coral Sea, Evening Star, R.D. Susan Huges, Sayunara Blazing Gold and UK-14.

Among *Phaius maculatas, P. wallichi. P. mishmensis, P. tankervalliae* and *P. densiflora*, only P. *maculatus* was recorded to be infected with *Uredo* sp. of rust.

Inflorescence tip blight/ rot caused by *Fusarium* was found on *Aerides multiflora and Aerides fieldingi.*

Colletotrichum gloeosporiodes has been isolated, purified and identified on many orchid hosts viz., *Coelogyne barbata, Otochillus* sp., *Liparis plantaginea, Paphiopedilum venustum, Cymbidium devonianum, Calanthe sp., Zeuxine* sp. *Bulbophyllum* sp, *Cattleya* sp.

Entomology

Mites (*Tetranechus utricae*) observed on *Cymbidiums.* Both the nymphs and adults of spider mites under humid conditions feed on leaves by sucking the sap from epidermal layer. The affected leaves get weakened and exhibited severe mottling and wilting. Growth of plant stunted and loss of foliage occured in the infected plant. Mites are more prevalent at maximum temperature and minimum humidity during month of May and June.

Aphids, both nymph and adults suck the sap from new spike and foliage in *Epidendron.* They execrate honeydew on which sooty mold attracted. High humidity and cloudy weather fasten the population build up. Affected plant showed poor growth and flower quality affected.

Scales, both armored and soft, causeed damage to orchids. Armored scales were the most serious and persistent pests. They are yellowish brown, tan or dark brown, oval to circular, objects that affix on leaves, petals, petioles, pseudobulbs and sometimes rhizome and roots.

Shoot borer infestation on all available 42 *Dendrobium* spp. maintained at the centre recorded for their host suitability. It was observed that shoot borer mainly infest *D. chrysanthemum, D. gratissimum* and *D. perardii* during rainy season and disappear after the season is over.

In *Hedychium* out of 300 plant shoot inspected in the field of the centre it was observed that more than 65% were eaten and distorted, 51% of them scratched by weevil and 34% flowers were damage by the ants by filling mud into the flower.

Darjeeling campus

About 30 species of orchids and 35 new *Cymbidium* hybrids have been added to the previous collection.

To utilize trees in campus and zero down the cost on maintenance of orchid germplasm, a programme for creation of artificial habitat was started. Orchids like *Coelogyne cristata, Coelogyne nitida, Epigenium amplum, Otochilus albus, Otochilus fuscus, Vandopsis undulata* etc. were fastened on the trees and now these have established themselves on host trees and were started to grow well.

NATP PROJECTS

Sustainable management of plant biodiversity

During the year, 5 explorations were carried out in different parts of Arunachal Pradesh, Assam,

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Mizoram and Darjeeling District of West Bengal, covering 5 districts namely West Siang, Dibang Valley, Lohit Valley, Changlang and Tirap Disticts of Arunachal Pradesh, Northern districts of Assam, Blue Mountain region of Mizoram and Darjeeling hills of West Bengal. Around 300 accessions of plant germplasm were collected during these collection trips.

Morphological characterization of the flowering orchids and bulbous flowers was carried out in the centre. Altogether there were 74 species of orchids and 10 species of bulbous flowering plants were characterized for important morphological traits.

The germplasm of *Hedychium* spp. evaluated for various morphological and floral characters. Wide diversity among the species for various floral and morphological attributes was recorded.

Survey on existing pre & post harvest handling, storage, packaging, transportation and marketing systems for orchids in domestic and global level

The survey was conducted through three preformulated questionnaires. Area covered under the survey includes parts of Sikkim, Darjeeling district of West Bengal, parts of Kerala, parts of Tamil Nadu, parts of Karnataka, parts of Maharashtra. It was observed that awareness or promotion of orchid culture was not up to the desired level. Proper marketing support was lacking. Development of our own hybrids/ varieties is top priority. Availability of quality and disease free planting material was not up to the desired level.

Protected cultivation of vegetables & flowers in Plains & Hills

The experiment was initiated with 11 modules to study the growth and flowering of *Cymbidium*. The observations on growth parameter are being taken regularly.

The preliminary observations revealed that module (Soil+Compost+Cocopeat-2: 1: 1) showed better vegetative growth followed by module (Soil+Compost+Sawdust-2: 1: 1) out of 13 module being tested in rose.

Technology Mission for integrated development of Horticulture in the North Eastern Region. (Mini Mission I)

Protocorms of *Cymbidium* hybrid, 'Soul Hunt – I' regenerated using meristem culture in half strength Murashige and Skoog media supplemented with BAP 0.5 mg/l + 2,4-D 2.5 mg/l and BAP 0.5mg/l +NAA 2.5 mg/l for regeneration and differentiation.

Experiment was under taken with three Cymbidium hybrids viz. Cymbidium LA, Golden Girl and H X B from *in vitro* grown cultures to find out suitable protocol for *ex vitro* growth and maximum survival of *in vitro* propagated plantlets. After initial hardening under *in vitro* conditions plantlets were planted on 7 different media.

Cultures were initiated using axillary buds excised from cormel explants of Gladiolus cv. Jester and Ice Gold. Sprouts obtained were separated and sub cultured on MS supplemented with BAP 0.25mg /l + NAA 0.1mg /l.; BAP 0.5mg /l + NAA 0.1mg /l and BAP 0.75mg /l + NAA 0.1mg /l.

Contents

Introduction

1

HISTORICAL PERSPECTIVE

India has unparalleled natural wealth of orchid flora in the world. Orchids are one of the most important flowers of world floriculture trade. In the absence of comprehensive and systematic research support, the abundant natural wealth of orchids in India is lying unexploited. Several species of orchids in wild are facing extinction. North Eastern Himalayan region particularly, is rich in genetic resources for flowering plants. Therefore, the resources are to be surveyed and genetic material is to be preserved. Since the region is in remote area it requires special attention which will help to boost up the economy of the North-Eastern Hill people.

Bulbous crops like anthurium, lilium, gladiolus can be comfortably grown in this region along with orchids to support the orchid farming. There is need to develop technology for rapid multiplication of orchids and bulbous flowers which at present lacking. The already available technologies for production have to be refined. There is very negligible information available on post-harvest technology of orchids in the country. Basic information on genetical, physiological and biochemical aspects is deficient which would be very important and useful for improvement work.

Keeping in view of the export potential of orchids, anthurium, liliums and gladiolus based on the recommendations of the Planning Commission, the Indian Council of Agricultural Research (ICAR) established a National Research Centre for Orchids during VIIIth Five Year Plan at Pakyong (Sikkim) since Oct. 1996. The state of Sikkim has handed over 22.19 acres of land with all other assets belonging to Regional Agricultural Centre at Pakyong on lease basis for 99 years. The Director General, ICAR, New Delhi visited (5th October, 1996) Gangtok to attend Regional Committee meeting zone III. In October 1997 the centre also took over the Darjeeling centre of C.P.R.I. Since then the centre is undertaking mission oriented research programmes on Crop improvement, Crop production and Crop protection.

The main activities of this Centre are collection, evaluation, characterization and utilization of available orchid germplasm in the region in particular, and in the country in general; development of exportable varieties, standardization of agro-techniques, post harvest management, production of quality planting material and creation of repository of information related to all aspects of orchids. Considering the economic potential of different flowering bulbous crops in the region, gladiolus, anthurium, lilium, iris etc. are also included in the activity of the centre.

PAST ACHIEVEMENTS

The Centre has made significant headway in research with respect to collection of indigenous orchid germplasm, indigenous and exotic hybrids of orchids, *in vitro* germination and micro propagation using immature embryos of hybrids/rare orchids, hardening and transferring of *in vitro* regenerated plants to pots.

Germplasm collection: About 450 species of 93 genera are collected. Besides species, about 70 *Cymbidium*, 5 *Dendrobium*, 2 *Aranda* and 1 *Vanda* hybrids were also collected for further evaluation, utilization in improvement programme.

Molecular Characterization of orchids: Fifteen species of 3 genera characterized by RAPD. A total 227 distinct major RAPD bands of which 97 % were polymorphic were generated from 15 randomly selected primers.

Diseases: Orchid wilt caused by *Sclerotium rolfsii* was reported to infect pseudobulbs of *Coelogyne corymbosa, Spathoglottis, Eria coronaria, Cattleya sp., Dendrobium sp., Aerides* sp.,, *Cymbidium lowainum, Cymbidium sp., Habaenaria sp* causing pseudobulb rot and death of entire plant in the community pot.

Darjeeling Campus: About 160 species of temperate orchids collected and maintained.

MANDATE

For resolving major constraints in production of orchids and other bulbous ornamentals in major growing belt, the Centre has mission mode approach with following mandate:

- To collect, evaluate, characterize and conserve germplasm of orchids and other bulbous flowering plants.
- To develop hybrids/ varieties suitable for domestic and export market.
- To develop production, protection, and post-harvest technologies for orchids and flowering bulbous plants.
- To act as a national repository for scientific information on mandate flower crops.
- To coordinate research with other scientific organizations and act as centre for training.

To fulfill the above mandate, priorities and thrust areas identified as:

1. Survey, collection, evaluation and conservation of germplasm.
2. Introduction of exotic commercial varieties and hybrids to enrich genetic resources to build up world repository of germplasm.
3. Hybridization to develop outstanding hybrids and varieties suitable for domestic and International trade.

4. *In-vitro* propagation, standardisation for mass multiplication of outstanding hybrids and endangered species.
5. Standardization of post-harvest handling of cut flowers for export.
6. Development of production technology with special reference to *Cymbidium* hybrids.
7. Standardization of design of the low cost polyhouse.

INFRASTRUCTURE

The Centre is making steady progress in creating infrastructure facilities required to fulfill the mandate.

Laboratories

There is no permanent laboratory building for the centre. The laboratories have been established in very old quarters handed over by the State Government. Tissue culture and genetics laboratories with minimum facilities have started functioning. Some of the basic equipments and other minor equipments have been procured.

ARIS Cell

The Centre has satisfactory computer facilities. V-SAT has been installed to provide Internet facility. Presently, this facility is being used for word processing, statistical analysis, cataloguing and maintenance of relevant information, besides pay bill preparation and accounting.

Library

With the enrichment of laboratory facilities, library information systems were also strengthened with the procurement of about 90 new books. The library has subscribed 10 Indian and 14 foreign research and popular article journals during the period covering Horticulture, Plant Physiology, Genetics and Plant Breeding, Plant Biotechnology, Agriculture Entomology, Plant Pathology. Library also subscribed Agris CD, Hort CD from 1973 onward and procured 1 server computer system, 2 computer system, 1 colour monitor, 1 Hp laser jet printer and 1 line interactive 2KVA UPS during 2001-2002.

Farm

The Centre has 9.98 hectares of terraced land. The fencing of the farm has been done and broadening of the narrow terraces is in progress. One fibre glass house and two poly houses (180 m^2 each) with micro-irrigation and temperature control system are constructed under Protectnet scheme. Another net house has also been constructed for the maintenance of ever-increasing orchid germplasm, besides already existing two net houses. Two low cost poly tunnels using bamboo were also constructed to study the suitability of such low cost structures for commercial cultivation of orchids. Total 800 square meter area is under different types of structures.

Buildings

Construction of laboratory- cum- administrative building started in April.

Darjeeling Campus

Building: The renovation of building which was taken up in phased manner, both first and second phases of renovation of building has been completed.

Land boundaries: The work for fencing of land boundaries which was in progress but could not complete in full due to some unavoidable circumstances, the only half work has been finished and the rest half is likely to be taken up during 10th plan period.

Land-terracing: The terraces were small and uneven; hence it was understood, without proper

terracing no field crops either in open or in shade/poly houses would be possible to grow. Hence, work for broadening of terraces was initiated; however, a few terraces are yet to be developed.

Protected Area: About 400 m^2 protected area has been created for protected cultivation of orchids and conservation of germplasm. The aforementioned area includes both permanent and temporary type of shade/poly houses.

Laboratory: A laboratory which was likely to be set-up at the campus with minimum common facilities could not be set up. However, a few instrument namely an incubator, distillation set and hot plate have been purchased. Recently a laminar flow has been purchased for establishing a tissue culture laboratory.

Library: A small library with about 30 books has been created at the campus.

FINANCIAL OUTLAY FOR 2001-02

	Sanctioned	Utilized
Non Plan	52	51
Plan	175	175
Total	227	226

STAFF POSITION AS ON 31.03.2002

Staff	IX plan	
	Sanctioned	Filled
Scientific	16	8
Technical	4	4
Administrative	8	3
Supporting	4	4
Total	32	19

Research Achievements

1

CROP IMPROVEMENT

Biotechnology

Green pod culture of orchid species and hybrids

V. NAGARAJU

Cultures of crossed embryos over 60 orchid species and hybrids have been initiated using embryos excised from green pod on MS, Nitsch, Gambourg, Knudson's C, Street, White media supplemented with BAP, kinetin, triacontanol, paclobutrazol, NAA, activated charcoal, peptone, sucrose, banana pulp, coconut water etc. Protocorms obtained *in vitro* were further sub cultured on MS and Nitsch media containing BAP, NAA, and triacontanol and with or without activated charcoal (AC). The days taken among the species and hybrids for swelling varied from 8 days in *Calanthe masuca* to 204 days in *Habenaria* for swelling of the embryo followed by formation of globular structures and protocorms. Plantlets of *Zygopetallum intermedium* X *Arachnanthe cathcartii,* and selfed pod of *Zygopetallum intermedium* and other crosses were again transferred on MS and Nitsch media with paclobutrazol, BAP, NAA, triacontanol and with or without AC. Plantlets having 4-5 leaves with roots were transferred to culture jars containing suitable potting mixture.

In vitro regeneration of *Zygopetallum intermedium,* and *Zygopetallum intermedium* × *Arachnanthe cathcarti*

V. NAGARAJU

Studies were carried out using embryos from mature green but unbursted pods of *Zygopetallum intermedium,* and *Zygopetallum intermedium* X *Arachnanthe cathcartii* on MS and Nitsch media supplemented with various plant growth substances and activated charcoal. The observations indicated that the embryos took 66-74 days for swelling and developed protocorms in 81-95 days and readily formed organs in all the four media tried (MS sucrose 6%, half MS with NAA 0.1 mg/l, half MS with NAA 0.1 and BAP 0.25 mg/l, half MS with NAA 0.1 and paclobutrazol 0.25 mg/l and also 1.5 g/l activated charcoal in all the media except in MS with 6% sucrose) except in half MS with paclobutrazol 0.25 and AC 1.5. The embryos of *Zygopetallum intermedium* X *Arachnanthe cathcarti* cultured in Nitsch with BAP (0.25 mg/l), Nitsch with 0.5 mg/l BAP, Nitsch with 1.0 mg/l BAP and Nitsch with 1.5 g/l AC and 0.25 mg/l BAP and Nitsch with 1.5 g/l AC and BAP 1.0 mg/l. Among the media the days

taken for swelling varied from 39 to 43 days and in 53 to 70 days protocorms were formed. However, absence of activated charcoal in the media failed to form organs. While in media containing 1.5 g/l activated charcoal resulted in development of first, second and third leaf in 74-79 days.

Response of protocorms of orchid hybrids to colchicine in *in vitro*

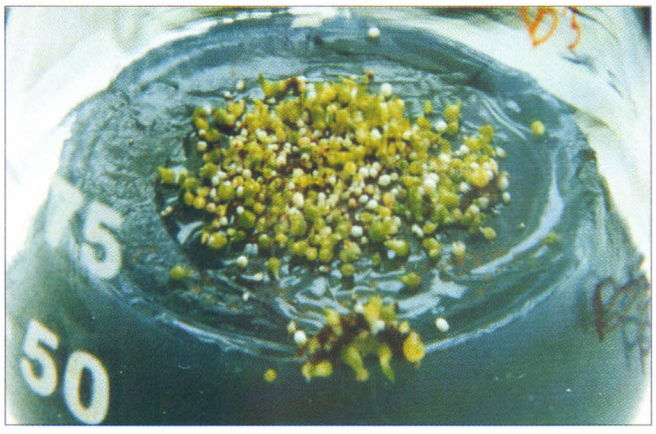
V. NAGARAJU

Protocorms of *Cymbidium* hybrids HXB, Lunavian Atlas, BXH and FXH were cultured in MS medium supplemented with colchicine (0, 0.04, 0.1 and 0.2 mg/l). The *Cymbidium* hybrids responded differently for various morphological characters. In Lunavian Atlas, differentiation of shoot and root was early. Similarly leaf development was also rapid. However, BXH required maximum number of days for shoot, leaf and root development. There was no variation among the different concentrations of chemical in the medium for various morphological characters.

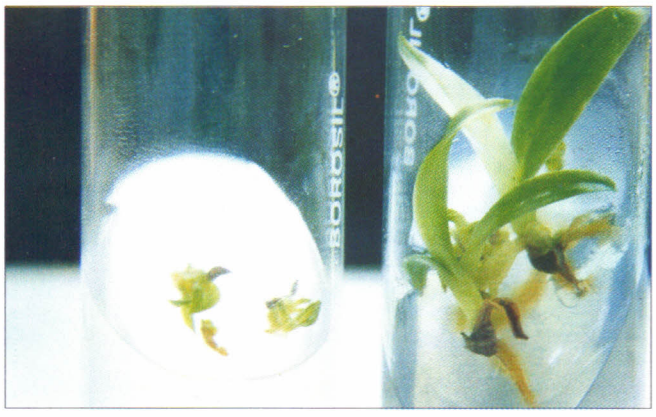
In vitro regeneration of *Paphiopedilum lawrenceanum* × *P.* Winston Churchill

V. NAGARAJU

Green pods of *Paphiopedilum lawrenceanum* × *P.* Winston Churchill harvested when the embryos were mature, but green and cultured on Nitsch, Burgeffs N3f, Street, White and Vacin and Went media with or without activated charcoal (AC), BAP and NAA. The days for swelling among (Table 1) the media varied from 21 to 34 days followed by globule formation in 27 to 69 days from the embryos incubated in light. Addition of BAP to the media promoted early swelling (23 and 29 at 1 mg/l and 0.5 mg/l BAP respectively) and globule formation (32 days at 0.5 mg/l). While addition of activated charcoal to the media delayed the process of germination, however it enhanced the growth rate of shoot as well as root. Protocorm and shoot explants obtained *in vitro* were further cultured (Fig. 2) on MS and Nitsch with BAP, triacontanol and silver nitrate. BAP at 0.5 mg/l with 1.5 g/l AC resulted in leaf initiation (78 and 89 days respectively for first and second leaf). But at higher concentration of BAP (1 mg/l), even supplementation of AC to the media inhibited leaf development. AC stimulated shoots and root initiation.



1. *In vitro* germination and Protocorm formation



2. Plantlet differentiation of *Paphiopedillum* hybrid

Table 1. Effect of media on germination and differentiation of *Paphiopedilum* hybrid

Media	AC(g/l)	NAA (mg/l)	BAP	Swelling (Days)	Days taken for formation of Globules	PLB's	First leaf	Second leaf
B_3f				25.3	52	64.7	123.5	218
B_3f	3			21	27	80	95	150
Street		0.25	0.5	28	33	133.5	217	-
Street	1.5	0.25	0.5	32	31	80	217	-
White	0	0.25	0.5	28	63	217	-	-
White	1.5	0.25	0.5	27	82	215.5	-	-
Nitsch			0.5	29	32	59	87	125
Nitsch	1.5		0.5	33	59	69	78	89
Nitsch			1.0	23	45.5	55.5	97.5	107
Nitsch	1.5		1.0	29	57	69	134	153
B_3f				31.5	60	78	-	-
B_3f	3			28.5	54.2	-	-	-
VW	1.5	0.25		34	57	-	-	-
VW	1.5	0.25	0.5	32	69			-

Among the media, Nitsch and Burgeffs N3f responded better by recording maximum germination.

Response of various explants of orchids to media and growth substances *in vitro*

V. NAGARAJU

The effect of media and plant growth substances on PLBs, root and leaf segments showed that all the explants remained green initially for 5-6 weeks, there after, gradual discoloration of leaf and root explants noticed. Interestingly cluster of nodular mosses were produced early from PLB segments followed by differentiation into protocorm like bodies. Regeneration from root explants was selective and slow. About 9.98% of root explants, 31.6% of leaf explants and 86.97% of PLB explants regenerated protocorms (Fig 1). BAP in the media promoted smaller sized protocorms. BAP also enhanced proliferation rate and at low concentration promoted plantlet differentiation. However, supplementation of

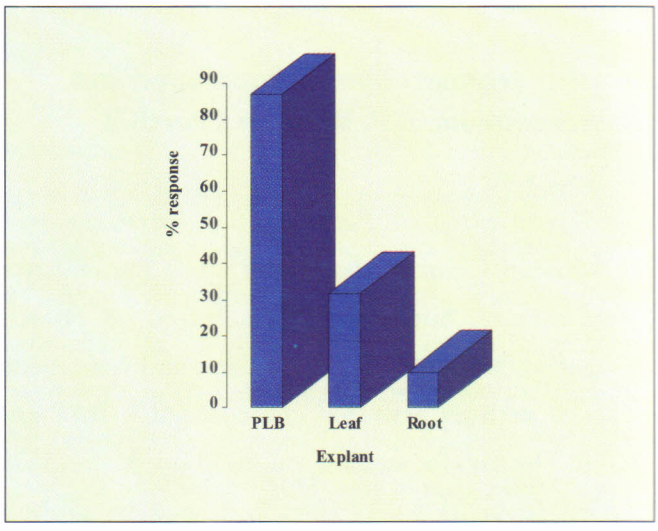


Fig. 1. Response of different explants of *Cymbidium in vitro*

high concentration of BAP along with 2, 4-D inhibited protocorm development.

The regenerated protocorms were smaller (1.4 mm) in media supplemented with 1 mg/l BAP and 0.5 mg/l 2, 4-D, while supplementation of 1 mg/l 2, 4-D resulted in development of large protocorm (5.25 mm) from PLB segment. From leaf explant, largest protocorm of 7.5 mm was obtained on media containing 5 mg/l NAA and 0.25 mg/l BAP. Supplementation of NAA (2.5 mg) resulted in large sized protocorms (5.5 mm) from the root explants. Among the root segments, only the juvenile root with poorly developed root cap responded. The extent of response on media containing a combination of auxin and cytokinin was higher as compared to their effect when used alone. The rate of differentiation was higher in the presence of BAP and 2, 4-D as compared to NAA and BAP. Addition of 1 mg/l 2, 4-D to culture medium induced maximum number of shoots, while 1 mg/l 2, 4-D along with 0.25 mg/l BAP in the media resulted in better differentiation. PLBs upon prolonged culture in the medium differentiated into complete plantlets.

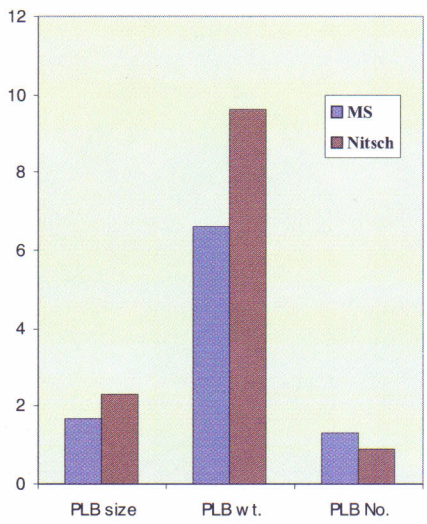


Fig. 2. Influence of media on multiplication of protocorms *in vitro*

The mean influence of media on PLB's indicated variation for different morphological characters (Fig. 2). The weight of PLBs and their size was higher on Nitsch, but maximum number of protocorms was obtained on MS medium. Supplementation of AC in the medium stimulated growth and produced healthy plantlets. AC in the media also stimulated early rooting. The roots were longer, heavier and thicker in the presence of AC. While absence of AC resulted in discoloration of media and hindered further growth.

Morphogenetic response of protocorm of *Cymbidium* hybrids and *Cattleya maxima* to sucrose

V. NAGARAJU

Protocorm excised aseptically from *in vitro* cultures of *Cymbidium* hybrid Lunavian Atlas, *Cymbidium* hybrids H X B, B X H and *Cattleya maxima* were cultured in Murashige and Skoog's media supplemented with sucrose (0, 10, 15, 20, 25, 30, 35, 40, 50 and 60 g/l). The observations after 6 and 9 months indicated variation of various morphological characters. Presence of sucrose resulted protocorm enlargement and proliferation, while in the absence of sucrose gradual discoloration of protocorm after 5-6 months of culture in Lunvian Atlas and *Cattleya maxima*. While in H X B and B X H, about 50% of the explants were greenish even after 8 months of culture and in 30% of the cultures 1-2 new protocorm was formed. At lower concentrations, prolific protocorms were observed in 20-50% of *Cattleya*. Supplementation of sucrose beyond 40%

sucrose resulted in retard growth in *Cattleya maxima,* and gradual discoloration of plantlets after 8 months. While at lower concentration, 10-30% of the cultures started wilting after 6-7 months of incubation. The cultures even after one year of subculture remained green in 25% of the cultures. Hence, MS supplemented with 2-4% sucrose found optimum for proliferation as well as short-term conservation of cultures *in vitro* for over 10-12 months in *Cymbidium* hybrids and *Cattleya*. The technique could be utilized for conservation of some of the rare, endangered and nearly extinct species and important hybrids of Cymbidiums.

Morphogenetic response of orchids to triacontanol *in vitro*

V. NAGARAJU

Shoots from *in vitro* grown cultures of *Ascocentrum ampullaceum*, *Dendrobium nobile* Lindl. and *Cattleya maxima* were tested for their response to Nitsch media supplemented with Triaqontinol (0, 1, 2 and 3 mg/l). *Cattleya maxima* showed better response with higher culture weight (333.9 mg) and maximum number of shoots (9.2) and differentiated into complete plantlets, whereas in *A. ampullaceum* better shoot growth (15.6 mm) was recorded. Out of three species, *C. maxima* have been found to be more responsive than *A. ampullaceum* for culture growth and proliferation. Among the four concentrations tested, addition of 2 mg/l produced noteworthy values for the culture growth and number of plantlets; number of shoots and leaves per shoot. Thus, supplementation of 2 mg/l triacontanol was found to be optimum for shoot multiplication and growth.

Morphogenetic response of protocorms of *Paphiopedilum* hybrid to media, BAP, Silver Nitrate, Triacontanol and Activated charcoal *in vitro*

V. NAGARAJU

The effect of media supplemented with BAP, AC, Triacontanol and silver nitrate on morphogenetic response of protocorms showed that the culture weight was 21.19 mg in half strength MS with 0.5 mg/l BAP, 1 g/l AC and 0.5 mg/l triacontanol to 118.19 mg/l in half strength Nitsch 0.5 mg/l BAP, 1 g/l activated charcoal and 0.5 mg/l triacontanol. Maximum shoot, leaf and root growth was recorded in half strength Nitsch with BAP (1 mg/l). However, addition of triacontanol to the culture media improved the overall growth. Among the media, the response for all the morphological characters was better in Nitsch as compared to MS except for root number.

Protocorm obtained *in vitro* were cultured in

3. Acclimatized plants of Paphiopedilum hybrid

Nitsch media supplemented with AC (1.0 g/l), BAP (0.5 mg/l), Triacontanol (0.5 mg/l) and 0.25 mg/l $AgNO_3$. The observations, 2 months after culture showed the development of shoot as well as root in Nitsch supplemented with AC and in the absence of AC, formation of multiple shoots were recorded in Nitsch with BAP (0.5). Similarly in MS with BAP (0.5 and 1.0 mg/l) and 0.25 mg/l $AgNO_3$, multiple shoot formation was recorded.

In vitro acclimatization of orchid species and hybrids

V. NAGARAJU

Studies have been taken up for developing protocol for hardening of *in vitro* regenerated plants of *Cymbidium* Lunavian Atlas, *C.* Golden Girl, *Dendrobium nobile* X *D. nobile* var Alba, *Dendrobium heterocarpam* X *D. nobile, D. chrysotosum*, *Bletilla hyacintha*, *Vanda* hybrids, *Paphiopedillum* hybrids, HXB, BXH, BXB, FXH of orchids. Shoots and plantlets were transferred to media with reduced strengths of salts and various levels of sucrose as well as media supplemented with BAP, triacontanol and paclobutrazol. The plants of various sizes were transferred to pots containing potting mixture of leaf mould, sphagnum moss, brick pieces, charcoal and FYM. Acclimatized plantlets were transferred to poly house. The acclimatized plantlets again transferred to pots containing 7 potting mixtures, of which coco pith and sand was found to be ideal for survival and further growth of terrestrial orchids, while for epiphytes such as *Dendrobium* hybrids, *Cattleya maxima*, *Vanda* hybrids potting mixture of brick pieces, charcoal and tree fern found to be ideal.

Cytological work on orchids

S. CHAKRABARTI

Research work on Studies of the banding pattern of Chromosomes has been initiated on commercially important genera viz., *Cymbidium, Dendrobium* and *Vanda.* Work is in progress.

In vitro study of Pollen biology

S. CHAKRABARTI

Study on the *in vitro* germination of pollen, pollen tube growth, viability, storage ability etc initiated. Methods have been standardized for the study.

Breeding in Orchids

S. P. DAS

Several crosses were carried out among orchids with special emphasis on *Cymbidium.* Selected cross combinations were cultured *in vitro* for germination and progeny raising (Table 2).

Studies on breeding behaviour of Orchids

S. P. DAS

Observations were recorded on the different post fertilization phenomenon in orchids. Observations like crossability, days for column swelling, flower withering, capsule swelling, and capsule splitting or pod abortion (physical) were taken on the crosses made. This helped in better understanding of the breeding behaviour of the different species or hybrids.

Table 2. *In vitro* germination of breeding material of orchids: Present Status

Sl.No.	Cross Combination	Present Status
1.	C. *lowanium* × C. Showgirl	Shifted for hardening
2.	C. Showgirl × C. *lowanium*	Shifted for hardening
3.	C. Bertha Pattershot X C. Showgirl	Plantlet stage
4.	C. Showgirl (Selfed)	Plantlet stage
5.	C. Pal Barkis × C. *lowanium*	2-3 leaf stage
6.	C. Rivulux × C. Coral Sea	2-3 leaf stage
7.	Close Melody Freakout × Showgirl	Plantlet stage
8.	Show Girl × Amsebury	Protocorms
9.	September Sunset × Pal Barkis	4 leaf stage
10.	Show Girl × Sipi	Protocorms
11.	Amsebury × Anngreen	Protocorms
12.	C. Tracyanum × Fantasia Delma	3-4 leaf stage
13.	C. *eberneum* (selfed)	Protocorms
14.	Amsebury × CGBH	Protocorms
15.	Anngreen × C. *tracyanum*	3 leaf stage
16.	Hawtescence × PalBarkis	3 leaf stage
17.	Grimer (selfed)	3 leaf stage
18.	*Fantasia Delma* × C. *tracyanum*	3 leaf stage
19.	C-8 × C. tracyanum	Protocorms
20.	Hawtescence × C. *tracyanum*	3 leaf stage
21.	C.*tracyanum* × September Sunset	3 leaf stage
22.	September Sunset × C. *elegans*	Shoot initiation stage
23.	Showgirl × Anngreen	Globule form
24.	September Sunset × Pal Barkis	3 leaf stage
25.	April Bush × CGBH	2 leaf stage
26.	Show girl × Red star	Shoot emergence
27.	Golden girl × C. *irridioides*	2 leaf stage
28.	Golden girl × C. *longifolium*	2 leaf stage
29.	Golden Girl (selfed)	Protocorms
30.	Grimer × September Sunset	Protocorms
31.	Hawtescence × September Sunset	Protocorms
32.	Hawtescence × C. *tracyanum*	Globule form
33.	Amsebury × C. *longifolium*	Globule form
34.	Amsebury × Showgirl	Shoot emergence
35.	Amsebury × C. *irridiodis*	Shoot emergence
36.	Showgirl (selfed)	Shoot emergence
37.	Showgirl × C. *longifolium*	Protocorms
38.	Ritimretewar × C. *tracyanum*	Protocorms
39.	*Sipi* × Show Girl	Protocorms
40.	*Vanda teres var.* Candida (selfed)	Swelling stage
41.	*Dendrobium nobile* × *Dendrobium nobile (Alba)*	Shifted for hardening
42.	*Renanthera imschootiana* × *Vanda coerulescens*	2-3 leaf stage,
43.	*Dendrobium nobile* × *Dendrobium heterocarpum*	Plantlet stage
44.	*Vanda coerulescens* (Selfed)	2 leaf stage
45.	*Cymbidium gammieanum*	Protocorm stage
46.	*Epidendrum zanthum* × *E. radiacum*	2 leaf stage, Protocorm stage
47.	*Den chrysotoxum* (selfed)	Plantlet stage
48.	*Vanda coerulescens* (selfed)	Plantlet and protocorm stage
49.	*Zygopetallum intermedium* (selfed)	Embryo stage
50.	*Zygopetallum intermedium* × *Arachnanthe cathcartii*	Plantlet stage
51.	*Paphiopedilum fairieanum* × *P. Insigni*	No response
52.	*P. fairieanum* (selfed)	Protocorms
53.	*P. venestum* (selfed)	Plantlets
54.	*Arachnanthe cathcartii* × *Vanda coerulescence*	No response
55.	*Pleione preacox*	Globule stage
56.	*Phalaenopsis manii* (selfed)	2 leaf stage
57.	*Dendrobium wardianum* (selfed)	Protocorm stage
58.	*Paphilionanthe vandarum*	Swelling stage
59.	*Cymbidium gammieanum* (selfed)	2 leaf stage
60.	*Vanda scornopsis* (selfed)	Plantlet stage

Studies on Pollen viability in storage

S. P. Das

A study was initiated to study the viability of pollen in storage. Pollen from different selected orchid species were stored at room temperature, at 4 degrees and at minus 5 degrees centigrade. In total pollen of 43 orchid species or hybrids were stored. However, the experiment on the viability of pollens in storage was severely affected due to very erratic power supply conditions. Sometime there was no electricity for two days continuously.

Standardization of growing media for shoot initiation and growth from *Cymbidium* pseudobulbs

S. P. Das

An experiment was conducted to standardize the growing media for shoot initiation and better growth from *Cymbidium* pseudobulbs. In total 14 growing media were used. Results suggested significant differences among the media. The results indicated that media containing sand as one of the component helped in quick germination but at latter stage the media with FYM as one of the component showed better growth.

Finding an alternative method for shoot initiation from backbulbs

S. P. Das

An experiment was carried out to find an alternative method for shoot initiation from backbulbs in orchids. In this method the back bulbs were placed inside plastic bags instead of putting them into media. The plastic bags were hanged in shaded condition. The method produced better result than the conventional method of germinating backbulbs.

Morphological characterization of orchid species

S. P. Das

Taking care of Morphological characterization of all orchid germplasm, Observations on 46 characters were recorded on regular basis. Besides morphological characters, spatial characterization of flowering habit of the orchid species was also carried out. These sorts of observation were not available on orchids and would help in the better understanding of the flowering behaviour of the orchid species. Morphological characterization of 79 orchid species was carried out during the period under report.

Breeding in Freesia

S. P. Das

Considering the scope and potential of Freesia as cut flower owing to its highly scented flowers a breeding programme has been initiated. Depending on the colour and the length of spikes collected materials were grouped into six different groups. Crosses were made in all possible combination among these groups. Harvested crossed seeds sown to raise the progeny. Some lines from the seed grown progeny were selected. One of the lines seems to be very promising in terms of flower colour and size. Effort is on to multiply the corms of this line to form the Breeder's stock. The line may be subjected to extensive testing after having sufficient number of corms.

Breeding in Gladiolus

S. P. Das

A breeding programme with the objective to find out the most suitable breeding methodology in breeding superior cultivars in gladiolus has been initiated. So far crosses are being made in half diallel and line x tester fashion. Crossed seeds were sown to raise the cormels of the crosses. Second generation cormels were re-sown to raise the flowering size corms. Some of the cormels initiated flower spike showing variability. Full range of variability could be studied in next season. Promising lines would be selected. Present germplasm holding with us is 83 varieties of gladiolus.

Evaluation of Gladiolus

S. P. Das

In total 71 varieties were evaluated out of which 42 were evaluated in the normal growing season to find out the most suitable varieties for this region. These are Ice Gold, Loveen, Blue Mountain, Charm Glow, Chirag, Enchentrosh, Gunjan, White, Prosperity, Archana, Jester, Legend, Summer Pearl, Eight Wonder, Novalux, Scarlet Queen, Friendship, Chantiler, Trijuna, Priscila, Dixy, Apple Blossom, Green Willow, Tropic Sea, American Beaty, Summer Rose, Shringarika, Thumborlina, Interpid, Shagun, Snow Princes, Charmflow, Wing Sanction, Planttert, Sanjeevani, Candyman, Peciifica, High Style, The Queen, Red Majesty, Sweta, Royal, Supreme, Her Majesty. It was observed that Loveen required least number of days for spike emergence (54.9 days), whereas Ice Gold took highest number of days (79.2 days). Plant height was maximum in Summer pearl (162.4cm) and minimum for Thumborlina(67.2cm). Spike length was maximum for the variety Summer pearl (118cm) and shortest for Her Majesty (61cm). Chirag produced highest number of flowers/plant (23.5) and Charm Glow produced lowest number of leaves (13.4). Number of corms /plant was highest (3.8) in Legend. Highest number of cormels 119.2/ plant was produced by Candyman.

A total of 29 varieties were evaluated for off season production of cut flowers. The varieties tested were Mohini, Sukanya, Sweta, High Fashion, Gold Dust, Bindiya, Gunjan, Sheher Zuela, Shagun, Shringarika, Kamini, Urmil, Novalux, Sylphide, Rose Delight, Rangmahal, Bis –Bis, Day dream, Chandni, Sanjeevani, Anglia, George Mazure, Lohit, Planttard, Dhanwantari, Chirag, Swapnil, Archana. Plant height was highest in Sukanya (151.1cm) and lowest in Gold dust (69.3cm). Lohit produced longest spike (135cm) and Gold dust only produced shortest spike (43cm) Swapnil produced highest number of flowers /plant (16). Though in off season expression for the morphological characters reduced in comparison to the normal season but corm production/plant was significantly higher. Majority of the varieties produced reasonably long spikes, which could fetch very good price in off season.

Effect of rhizome size and Growth regulators on growth and flowering of *Zantedeschia aethiopica* under open and protected condition

S. P. Das

Treatments were taken with all possible

combinations considering Size (Big-S1, Medium-S2, Small-S3); Growth regulators (Paclobutrazol-G1, IBA-G2, GA-G3); Concentration of Growth regulators (200ppm-C1, 400ppm-C2, 800ppm-C3).

Under open condition plants produced more number of shoots /plant (2.37) in comparison to the plants under poly house (1.75). However for other characters like plant height, Total number of leaves, average length of leaves, average width of leaves and spike length, plant grown under poly house produced higher expression. The observed values for these characters under poly house were 62.4, 9.6 cm, 18.4 cm, 12.2 cm, and 55.6 cm, respectively. In open condition average spike length was only 40.4 cm.

Under protected condition effects of growth regulators and different sizes of rhizome were significantly different for majority of the characters. G3 produced maximum plant height (66.2cm). S1 produced a plant height of 72.3cm, whereas S3 produced only 50.1cm. The interaction of G3S1 produced height of 83.2cm, which also produced highest girth of plant at base (4.4cm). However G2 produced maximum number of leaves (6.912). G3 and S1 were responsible for longest leaves. The interaction of G3S1 also produced longest spike (70.7cm). Considering the above results it is evident that GA can be effectively used for enhancing growth and flower production in Calla lily.

Effect of Bulb size and Growth regulators on growth and flowering of *Lilium longiflorum* under protected condition

S. P. Das

Treatments were taken with all possible combinations considering Size (Big-S1, Medium-S2, Small-S3); Growth regulators (Paclobutrazol-G1, IBA-G2, GA-G3); Concentration of Growth regulators (200ppm-C1, 400ppm-C2, 800ppm-C3).

Effect of size of bulb significantly affected all the characters studied. Growth regulators also significantly effected number of characters. Number of shoots per plant ranged from 1.61 (in S1) to 1.16 (in S3). Average length of leaves varied from 14.6cm (S1) to 10.8cm (S3). G1 produced longest leaves (13.56cm) among the growth regulators. Plant height was 88.87cm for S1, whereas, for S3 it was only 41.79cm. The interaction of G3S1 produced 95.24cm plant height. G3S1 also produced highest number of leaves/plant (141). Highest number of flowers /plant was (5) was also due to G3S1. However G2 produced highest number of bulbs. G3 produced biggest bulb size. In this experiment also it was observed that GA was beneficial for plant growth and flowering.

Collection of germplasm

S. P. Das

A total of 449 accessions of orchid species and 42 varieties of gladiolus were collected during the period under report.

CROP PRODUCTION

Effect of nutrients spray on growth and pre-blooming period of *Cymbidium* hybrid

R. C. Upadhyaya and D. Barman

The study was carried out on four years old plant

to know the influence of foliar application of NPK on growth and pre-blooming period of *Cymbidium* hybrid var. Cooks Bridge. The different nutrients combination was sprayed at fortnightly intervals. The treatment combinations were T_1- $N_5P_5K_5$-0.1%, T_2- $N_5P_5K_5$5-0.2%, T_3- $N_5P_5K_5$-0.3%, T_4- $N_{10}P_5K_5$-0.1%, T_5- $N_{10}P_5K_5$-0.2%, T_6- $N_{10}P_5K_5$-0.3%, T_7- $N_{15}P_5K_5$-0.1%, T_8- $N_{15}P_5K_5$-0.2%, T_9- $N_{15}P_5K_5$-0.3%, T_{10}- $N_{20}P_5K_5$-0.1%, T_{11}- $N_{20}P_5K_5$-0.2%, T_{12}- $N_{20}P_5K_5$-0.3%, T_{13}- control. The results indicated that spraying of NPK at different concentration significantly enhanced plant height and length of leaves. The maximum height of plant (70.30cm) and length of leaves (65.10cm) were recorded at NPK (T8) 15: 5: 5-0.2% concentration followed by NPK (T12) 20: 5: 5- 0.3% (Fig. 3).

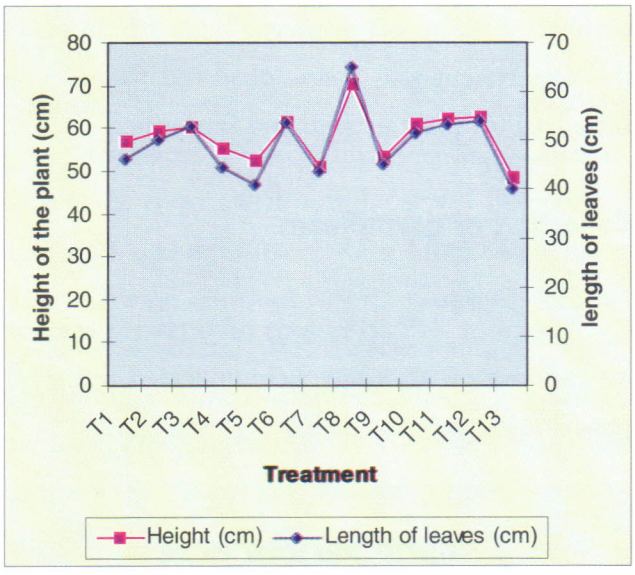


Fig. 3. Showing variation of plant height and length of leaves at different concentration of NPK

Effect of organic manure on growth and flowering of *Cymbidium* hybrid

R. C. Upadhyaya and D. Barman

The investigations were undertaken to study the effect of organic manure on growth and development of *Cymbidium* hybrid. The supernatant solution (1.25dilution) was sprayed at fortnightly intervals.

It has been observed that application of organic manure at fortnightly intervals influenced significantly the growth of plants. Maximum plant height (75.15cm) and length of leaves (64.75cm) were recorded at application of fish meal followed by mustard oil cake (Table 3). However, number of pseudobulbs and leaves did not respond significantly due to application of organic manures, although maximum was recorded at plant sprayed with fish meal.

Table 3. Effect of organic manure on *Cymbidium* hybrid.

Treatment	Plant height (cm)	No. of pseudo bulbs/pot	Length of leaves (cm)	No. of leaves
Poultry manure	61.35	2.10	52.75	6.85
Goat manure	62.85	2.85	53.10	7.20
Mustard oil cake	70.30	3.15	62.10	8.35
Fish meal	75.15	3.40	64.75	9.00
Neem cake	60.15	1.75	55.35	6.35
Control	51.40	1.50	42.35	5.80
CD at 5%	15.25	NS	10.38	NS

Studies on the media and system of planting of *Cymbidium tracyanum*

R. C. Upadhyaya and D. Barman

The investigations were carried out to study the effect of media and system of planting on growth and flowering of *Cymbidium* in open type low cost polyhouse. The experiment was carried taking 11 treatments combinations of media and plants in soil

Table 4. Effect of media and planting system on *Cymbidium traecyanum*

Treatment*	Plant height (cm)	No. of leaves/ plant	Length of leaves (cm)	No. of Pseudo bulbs	Length of spike	Diameter of flower (cm)	No. of flower/ spike
T_1	89.35	10.5	74.98	7.5	95.75	10.65	9.5
T_2	96.95	11.5	79.40	7.8	79.25	10.35	10.5
T_3	99.9	10.6	81.80	7.0	80.00	10.20	10.00
T_4	94.5	12.5	83.25	6.5	100.50	11.35	11.5
T_5	111.30	13.65	98.95	13.0	102.75	11.50	12.50
T_6	110.60	13.50	96.25	10.5	104.30	12.85	13.50
T_7	88.60	11.20	70.28	7.0	74.90	12.15	9.25
T_8	90.60	7.5	62.65	9.5	95.35	10.50	10.5
T_9	101.25	12.5	74.70	8.5	76.45	10.85	15.5
T_{10}	104.75	10.5	77.90	10.5	75.20	12.05	12.50
T_{11}	87.00	11.0	75.90	9.60	55.25	11.00	12.00
CD 5%	12.25	NS	7.15	NS	15.35	NS	NS

*T_1- Rotten logs+ bricks+ FYM+ Charcoal (1:1:1:1), T_2- Rotten logs+Moss (1:1), T_3- Rotten logs+ FYM(1:1), T_4- Bricks+FYM+ Charcoal+ Loam Soil (1:1:1:1), T_5- Bricks+FYM+ Charcoal+ Loam Soil (1:1:1:1)(Raised bed), T_6- Rotten logs+ Moss (1:1)(Raised bed, T_7- Leaf mould+Bricks+Sand+ Charcoal (1:1:1:1), T_8- Leaf mould+Saw dust+ stone chips+ FYM (1:1:1:1), T_9- Leaf mould+Charcoal Bricks+ Coconut husk(1:1:1:1), T_{10}- Leaf mould+Bricks+Saw dust+ stone chips(1:1:1:1), T_{11}- Leaf mould+Charcoal + Coconut husk+Stone chips+ Sand+Saw dust +Soil+FYM(1:1:1:1:1:1:1:1).

as well as in raised bed. The result showed (Table 4) that planting of *Cymbidium* in raised bed comprised of brick chips, FYM, Charcoal, Loam soil (1: 1: 1: 1) and rotten log and moss(1: 1) were equally better for overall growth and flowering of Cymbidium and significantly influenced height of plant, length of leaves & length of spike. The maximum height of plant (111.30cm), length of leaves (98.95cm) and number of pseudobulbs (13.0) were recorded at raised bed (T_5) and length of spike (104.30) and number of flower/spike (13.50) were recorded at raised bed (T_6).

Studies on the effects of organic nitrogen on growth of *Cymbidium* hybrid-Wembat yolande

R. C. Upadhyaya and D. Barman

The experiment was undertaken to study the effect of Gold –N nitrogen on growth of *Cymbidium* hybrid. The experiment consisted of 10 treatment i.e 0, 10,

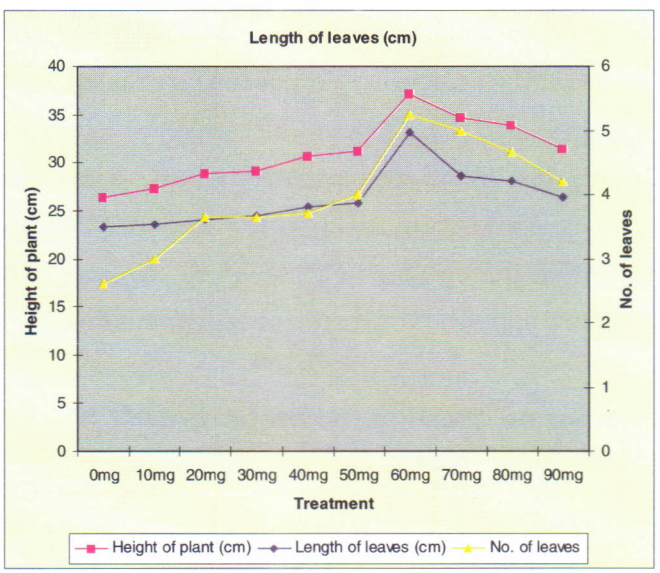


Fig. 4. Effects of organic nitrogen on growth of Cymbidium hybrid

20, 30, 40, 50, 60, 70, 80 & 90mg /plant replicated five times in CRD. The results indicated that plant height and length of leaves increased with increasing rate of application up to 60mg/plant thereafter both the parameter decreased with increasing rate of Gold-N nitrogen (Fig. 4). The number of leaves also followed similar trend of development. Maximum plant height (37.10cm), leaf length (33.18cm) and number of leaves (5.25) were recorded at the application of 60 mg/plant.

Effect of growth regulators on growth and pre-blooming period of *Cymbidium* hybrid Cook's Bridge

R. C. Upadhyaya and D. Barman

The experiment was laid out using various concentration of IBA (100, 200 and 300ppm), GA3 (100, 200 and 300ppm) and IAA (250, 500 and 750ppm) to study their effect on growth and flowering of Cymbidium hybrid Cook's Bridge. The treatments were replicated five times in a complete randomized block design and plant growth regulators were sprayed at monthly intervals. The results revealed that application of GA_3 200ppm increased the length of leaves (54.04cm) and pseudobulbs (4.24cm) as compared to other treatments. However, IAA 250ppm improved the number of leaves (5.44 cm) and IAA 500ppm increased the number of pseudobulbs (6).

Studies on growing media for growth of *Cymbidium* hybrid Japanese 'YY

R. C. Upadhyaya and D.Barman

The experiment was carried out to standardize media for *Cymbidium* hybrid (Japaneses YY). There were 10 treatment combinations and five replications. It was observed that potting media significantly influenced height of plant. The media comprised of Leaf mould+FYM+Charcoal+River sand+Loam soil enhanced better plant growth in terms of plant height (27.64cm), number of leaves (8.27), length of leaves (21.66cm) (Table 5).

Table 5. Effect of growing media for growth of Cymbidium hybrid Japanese 'YY'

Treatment	Plant height (cm)	No. of leaves	Length of leaves (cm)	Width of leaves (cm)
T1	22.63	6.80	17.37	0.90
T2	21.77	7.55	17.19	0.86
T3	27.64	8.27	21.66	0.97
T4	25.08	7.60	16.26	0.85
T5	24.50	6.80	18.71	0.87
T6	21.39	6.37	16.67	0.79
T7	15.66	5.00	12.25	0.73
T8	24.90	6.60	18.90	0.85
T9	20.11	5.20	15.98	0.79
T10	14.79	3.83	12.07	0.68
CD	5.85	NS	NS	NS

Effect of NPK on growth and flowering of *Cymbidium* hybrid'Cook's Bridge

R. C. Upadhyaya and D. Barman

NPK at different concentrations were sprayed at fortnightly intervals to study the vegetative growth and flowering attributes. The experiment consisted of 19 treatment combinations including control. It showed that spraying of NPK20: 10: 10-0.1% concentration enhanced length (55.60cm) and width of leaves (6.12cm) as compared to control. However, maximum number of pseudobulbs (8.66) was

recorded at plants sprayed with NPK10: 30: 10 – 0.2% concentration.

Studies on the root regeneration of bamboo orchids (*Arundina graminifolia*)

R. C. Upadhyaya and D. Barman

The experiment was conducted on Keikis of three different age viz., current year growth, one year old and two year old dipped for 10 seconds in five concentration of IBA-0, 250, 500, 1000 and 2000ppm and planted in the pots consisted of equal proportion of sand, soil and leaf mould.The results (Table 6) revealed that age of Keikis had significant effect on root regeneration in terms of primary and secondary roots. Maximum numbers of primary roots were observed in case of one year old growth, while current year growth produced highest number of secondary roots. Regeneration of root was also influenced by different concentration of IBA. IBA at 2000ppm showed highest percentage of rooting, no. of primary roots, secondary roots & the longest roots.

Table 6. Effect of age of Keikis and different concentration of IBA on regeneration of roots

Treatment	% Rooting	No of primary roots	No of secondary roots	Root length (cm)	Root diameter
Current year growth	20.00	2.79	2.53	1.34	0.14
One year old	16.00	3.68	2.29	1.05	0.10
Two year old.	16.00	2.29	1.77	1.27	0.11
Sem±	3.00	0.29	0.27	0.26	0.01
CD(5%)	NS	0.62	0.58	NS	NS
IBA 0 ppm	16.00	2.37	1.71	1.02	0.10
IBA 250 ppm	21.11	2.55	1.95	0.79	0.07
IBA 500 ppm	22.15	2.86	1.28	1.32	0.10
IBA 1000 ppm	24.22	3.17	2.97	1.13	0.17
IBA 2000 ppm	28.36	3.62	3.06	1.84	0.15
SEM±	3.56	0.31	0.33	0.32	0.02
CD (5%)	7.28	0.69	0.72	0.65	NS

Effect of Potassium on growth, flowering and corm production of *Gladiolus* cv. Jester

R. C. Upadhyaya and D. Barman

The experiment consisted seven doses of Potassium viz 0, 50, 100, 150, 200, 250 and 300Kg/ha was replicated thrice in RBD. All intercultural operations were carried out as and when required. The results indicated that application of Potassium significantly

Table 7. Effect of Potassium on growth, flowering and corm production of *Gladiolus* cv. Jester.

K_2O (kg/ha)	Plant height (cm)	Bud emergence (days)	Spike emergence (days)	Length of spike (cm)	No. of flower/ spike	No. of corms	Weight of corms (g)	Diameter of corms (cm)	No. of cormels
0	149.74	86.6	77.26	109.52	19.53	1.0	41.35	5.51	23.55
50	142.92	83.93	77.80	109.60	20.40	1.2	34.56	6.99	22.92
100	143.57	83.20	74.80	114.30	20.47	1.0	38.00	5.30	40.85
150	156.92	85.26	77.33	122.24	20.73	1.0	44.55	6.44	39.48
200	142.91	85.80	76.86	112.70	20.06	1.0	39.13	5.30	43.42
250	142.58	89.60	80.20	114.59	20.46	1.0	38.64	5.34	25.62
300	141.12	87.73	78.66	112.26	22.13	1.0	43.48	5.40	26.27
CD (5%)	NS	4.86	3.962	NS	NS	NS	Ns	NS	NS

influenced days of bud as well as spike emergence (Table 7). Application of 150kg Potassium per hectare produced maximum weight (44.55g) where as larger size of corm (6.99cm) were produced by application of Potassium 50kg/ha.

Studies on the high density planting and potassium on corm and cormel productions of *Gladiolus* cv. Jester

R. C. Upadhyaya and D. Barman

The experiment was conducted with 12 treatment combinations replicated thrice in FRBD. The treatments comprised of three planting densities (D_1- 50corm/m², D_2- 33corm/m² and D_3-25corm/m²) and four doses of Potassium (K_1—0,K_2- 100, K_3- 200 and K_4-300kg/ha).The data (Table 8) revealed that application of different doses of potassium and density of planting significantly influenced length of spike, weight and diameter of corm; number and weight of cormels. Planting of corms at 20x10cm spacing (50corm/m²) with 300 kg Potassium/ha produced longest plant (159.14cm) and spike (122.87cm). The maximum weight of corm (58.66g) and diameter (6.17cm) were recorded at the density of 50corms/m² and 100 kg potassium/ha. However, application of 100kg potassium/ha at the density of 33corm/m² produced more number of cormels (30.53).

Table 8. Studies on the high density planting and Potassium on corms and cormel productions of Gladiolus cv Jester

Treatment	Plant height (cm)	Length of spike (cm)	Days of bud emergence	No. of flowers/ spike	No. of corms/ plant	Weight of corms (g)	Diameter of corms (cm)	No. of cormels/ plant	Weight of cormels (g)
D_1K_1	153.43	104.62	89.00	22.80	1.00	44.42	5.54	20.77	4.25
D_2K_1	156.62	100.05	90.33	21.26	1.40	49.34	5.85	20.24	3.56
D_3K_1	149.09	115.04	89.86	21.40	1.20	51.52	5.79	17.05	3.58
D_1K_2	154.61	114.88	90.00	22.93	1.40	58.66	6.17	12.60	2.37
D_2K_2	153.78	117.62	90.00	23.46	1.13	43.00	5.73	30.53	5.15
D_3K_2	151.46	117.72	90.53	22.26	1.26	48.42	5.87	28.75	5.12
D_1K_3	145.87	115.50	90.66	20.80	1.40	48.26	5.66	28.63	3.13
D_2K_3	149.26	116.38	91.20	23.40	1.60	54.10	6.04	18.13	2.64
D_3K_3	148.59	117.39	92.93	21.13	1.33	51.18	5.67	19.63	3.19
D_1K_4	159.14	122.87	89.20	21.86	1.26	50.06	5.66	19.88	3.45
D_2K_4	136.50	108.15	94.26	22.06	1.20	48.86	5.79	29.38	4.76
D_3K_4	152.53	111.57	90.8	21.40	1.46	52.02	5.52	18.78	3.78
CD (5%)	NS	3.08*	NS	NS	NS	0.55	0.39	0.57	0.346

Studies on planting date on vegetative and flowering attribute of *Gladiolus* cv. Jester

R. C. Upadhyaya and D. Barman

The experiment included 10 dates of planting (D_1-1/3, D_2-15/3, D_3-30/5, D_4-15/4, D_5-30/4, D_6-15/5, D_7-30/5, D_8-15/6, D_9-30/6 & D_{10}-15/7) and replicated thrice in RBD. The corms were planted in

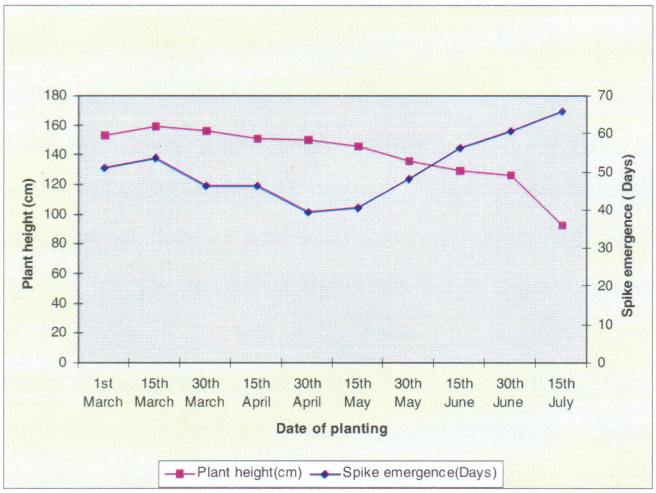


Fig. 5. Effect of date of planting on plant height and days for spike emergence

20×25cm spacing. The standard dose of fertilizers was applied before planting. The data presented (Fig. 5) indicated that height of plants were at par from March to April planting. Thereafter, heights were decreased with delayed planting. Maximum height (158.82cm) was recorded at 15th march planting.The emergence of spikes delayed at later planting. However, minimum days for emergence of spike was recorded at 30th April planting followed by 15th May planting.

PLANT PROTECTION

Survey, Collection, isolation and identification of diseases

T. K. Bag

Survey and collection of disease samples was carried out from Darjeeling, Mirik and Sukhia Pokhri of Darjeeling District (W.B.) and Pakyong of East Sikkim. From the collected disease samples, fungi were isolated and purified. Fungi were identified up to the genus levels with the help of available laboratory facilities. These fungal cultures were sent to the Indian Type Culture Collection (ITCC), Division of Plant Pathology, IARI, New Delhi 12 for identification up to the species level. The identified funguses with host are given below.

Orchid host	Disease caused	Fungal genus identified
Catteleya sp	Black rot on leaf	*Colletotrichum gloeosporioides*
Bulhophyllum sp.	Leaf spot/ anthracnose	*Colletotrichum gloeosporioides*
Phiaus maculatus	Leaf rust	*Uredo*
Cymbidium sp.	Flower spot	*Botrytis cinerea*
Ione scariosa	Black leaf spot	*Colletotrichum gloeosporioides*
Zeuxine sp.	Stem anthracnose	*Colletotrichum gloeosporioides*

Studies on the Occurrence of orchid wilt (*Sclerotium rolfsii*) on important Orchids

T. K. Bag

During regular observation on orchids at the centre some destructive sclerotial diseases were noticed. Isolation and purification of the disease-

4. Orchid wilt on *Coelogyne corymbosa*

causing organism was done from all types of infected plants. The causal organism was identified as *Sclerotium rolfsii* based on the visible characters. The disease was first found to infect pseudobulbs of *Coelogyne corymbosa* causing pseudobulb rot and death of entire plant in the community pot in the month of June 2001.

***Host range**: Spathoglottis, Eria coronaria, Cattleya* sp., *Dendrobium* sp., *Aerides* sp., *Cymbidium lowainum, Cymbidium* sp., *Habanaria* sp. were some of the orchid host recorded to be infected by *Sclerotium rolfsii*. This fungus was also recorded to infect several other *Cymbidium* hybrids in community pots. These were: Barta, Yanke lila, Forest King, Show girl X Cold Stream, Coral Sea, Evening Star, R.D. Susan Huges, Sayunara Bleging Gold and UK- 14.

5. Orchid wilt on *Dendrobium* sp.

Symptoms: The fungus caused basal rot of pseudobulb and leaves become yellow and get detached from the pseudobulbs. Numerous small brown-coloured sclerotia were found on the pseudobulb and leaf base.

Etiology: The fungus was recorded to infect wide range of orchid hosts. The fungus produced white coloured septate mycelia on PDA. It also produced numerous white coloured sclerotia, which at maturity turned into brown colour. It also produced white mycelial growth on host surface as well as sclerotia abundantly. The mycelium has distinct clamp connection.

Spread: The pathogen spread through infested compost or leaf mould. The disease was noticed after the reporting of the plant with newly brought leaf mould mixture. When the leaf mould was boiled and mixed with potting mixture and repotting was done, occurrence of this disease was nil except where the pathogen was chronically well established within the old pseudobulbs or back bulbs. Even there was presence of white mycelial growth and young white and matured brown sclerotia on the leaf mould. This indicated that the fungus *(Sclerotiurn rolfsii)* got their entry into orchid populations in the orchidarium through leaf mould collected from forest or any other sources and further the spread took place through potting mixture.

Epidemiology: The disease was noticed in orchids grown in community pots during warmer period i.e. June-August when temperature rose to 26-29 ° C and RH ranged from 65-78%.

Studies on the Occurrence of Rust on *Phaius maculatus*, its symptoms, etiology, host range and epidemiology

T. K. BAG

Symptoms: The young leaves of on *Phaius maculatus* showed prominent yellow flecks, usually on the lower surface of leaves and later on upper leaf surface also. The flecks increased in size. The disease was identified as rust. The rust pastules varied from 0.5 × 1.0 cm to 1.5 × 1.6 cm. Finally the older spots became dark with large target board effect of numerous rapture small pastules. Sometimes several pastules coalesced and produced larger pastules on leaves. The symptoms rarely found on older leaves, leaf petioles, pseudobulb and flower stalks.

Etiology: The rust fungus was identified as *Uredo* sp. (HCI No. 43760). The fungus produced only urediospores. The spores remained attached on the border of the pastures and the spots continued to increase throughout the year. The fungus was found to survive in active growing conditions within the host. The urediospores were orange coloured, small, thin walled, echinulate, ovate to spherical, measuring from 25-30 × 14-19μ and remained in mass. Frequent cross section of infected leaf pastules confirmed that the pathogen did not produce telia and teliospores and other stages of its life cycle like a typical rust fungus.

***Host range*:** In the germplasm house of the centre 5 *Phaius* species are mentained. Among *Phaius maculatus, P. wallichi. P. minishmensis, P. tankervalliae* and *P. densiflora*, only P. *maculatus* was recorded to be infected with *Uredo* sp. of rust. Even when the

6. *Uredo* rust on *Phaius maculatus*

urediospores from infected plants were inoculated to other species of Phaius in the prevailing weather condition, the disease did not appear. This constituted a new record of orchid rust in India.

***Epidemiology*:** The fungus (*Uredo* sp.) on *Phaius maculatus* preferred shady place with mild to moderate temperature. The disease was found to produce profuse small pastules and also uredio spores during February to April although the disease was recorded to be present on the host in mild to moderately growing conditions throughout the year. The preferable RH for the disease development ranged from 30-73% and temperature ranged from 13-24.66°C.

Preliminary observation on Inflorescence tip blight of *Aerides*

T. K. BAG

Inflorescence tip blight/rot was found on *Aerides multiflora and Aerides fieldingi* in orchid house/poly tunnel grown in raised bed. The fungus was isolated and identified upto the genus level as *Fusarium.*

7. Tip blight of *Aerides* inflorence caused by *Fusarium* sp.

Studies on the orchid hosts of anthracnose pathogen (*Colletotrichum gloeosporioides*)

T. K. Bag

Colletotrichum gloeosporiodes has been isolated, purified and identified on many orchid hosts. The host on which anthracnose was recorded are *Coelogyne barbata, Otochillus* sp., *Liparis plantaginea, Paphiopedilum venustum, Cymbidium devonianum, Calanthe sp., Zeuxine* sp. *Bulbophyllum* sp, *Catteleya* sp.

Studies on *Zeuxine* stem anthracnose

T. K. Bag

Symptoms appeared at the collar region at the soil level. Infected portion first appeared as dark brown sunken lesion with mass of black mycelia with spores. The lesion enlarged gardling the entire circumference of pseudostem and finally the upper portion topple down and get detached from the rest of the plant. On the infected portion the fungus produced numerous small, short cylindrical, single celled, round end (mostly bullet shaped) and brown coloured spores. Infection on pseudobulb also caused large sunken spots with black mass of mycelial growth with acervuli and spores. Roots were also observed to infect in the later stage. In extreme cases, entire root system gets rotted and turned almost dark colour. Mass of spores was also noticed on the infected root surface. Acervuli were subepidermal with dark setae. Acervuli broke out through the surface of the plant tissues. They were found to be disc or cushion shaped, waxy with simple short erect conidiophores.

Seasonal abundance of mites on cymbidiums

V. S. Nagrare

Both the nymphs and adults of spider mites under humid conditions feed on leaves by sucking the sap from epidermal layer. The injuries due to feeding were noticed as silvery marks left in the abaxial surface of leaf which usually turned brown or black after a period of time. The affected leaves get weakened and exhibited severe mottling and wilting. Growth of plant stunted and loss of foliage occured in the infected plant. In heavy infestation webbing appeared on the plant. Observations were recorded during the hot months of the year on 60 plants. Count on the mite population were made at the three spots of leaf; i.e. top, middle and bottom of the leaf. It was observed that mite population was highest at the maximum

8. Mite infestation on young seedlings of *Cymbidium*

temperature and minimum humidity during month of May and June.

Aphid population fluctuation on *Epidendron*

V. S. NAGRARE

Aphids are small insects measuring 2-3 mm in length. They are polyphagous and reproduce very fastly. Both nymph and adults suck the sap from new spike and foliage. They execrate honeydew on which sooty mold attracted. High humidity and cloudy weather fasten the population build up. Affected plant returned growth and flower quality affected.

Scale insects and their host orchids

V. S. NAGRARE

Both armored and soft scales causes damage to orchids. Armored scales are the most serious and persistent pests. They are yellowish brown, tan or dark brown, oval to circular, objects that affix on leaves, petals, petioles, pseudobulbs and sometimes rhizome and roots. The immature/ crawlers are tiny and as difficult to see with naked eye. The nymph and mature scales suck the juice by inducing toxicants into the

DIFFERENT SCALE INSECTS ON ORCHID HOSTS

9. *Cymbidium* sp.

11. *Phaius flavus*

13. *Pahiopedilum hirsuttissimum*

10. *Renanthera imscootiana*

12. *Cymbidium devonianum*

14. *Cymbidium* hybrid

plants. Affected plants loss vigor and become stunted in growth. Scales are active throughout the year but their attack is prominent during summer. Scales are transmitted from infested to clean plants when plants touch each other and the crawlers move from plant to plant. These insects are considered as minor pests.

Shoot borer (moth) infestation on different *Dendrobium* species

V. S. NAGRARE

Shoot borer infestation on all available 42 *Dendrobium* spp. maintained at the centre recorded for their host suitability. It was observed that shoot borer mainly infest *D. chrysanthemum, D. gratissimum* and *D. perardii* during rainy season and disappear after the season is over. (Fig. 6)

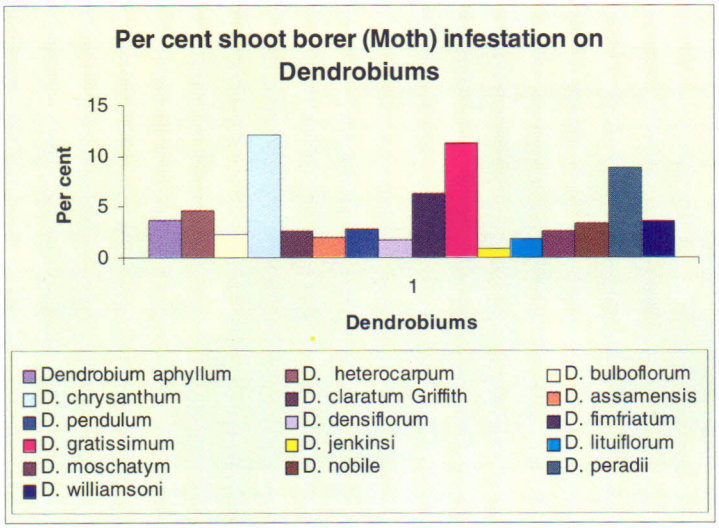


Fig. 6. Shoot borer infestation on Dendrobiums

Pest complex on *Hedychium*

V. S. NAGRARE

Currently *Hedychium* is neglected flower in floriculture trade. However considering the attractive colour and fragrance, in future it will be good marketable produce if its cultivation done on commercial scale. The flower can be sold as a sole flower as well as used in hedging of garden. The flower is mostly prevalent in North Eastern parts of India. Among the different factors in damaging the quality of flower and whole plant, insects contributed substantially. Till date studies on insect pest of this flower is neglected area. In the rainy season of 2001 an attempt was made to record the insect occurrence and the damage caused by them. Among the different pests ants, red weevil and grasshoppers were found

15. Red weevil scratching *Hedychium* leaf

16. *Hedychium*flower filled with mud by ants

to damage the plants and deteriorate the appearance. Out of 300 plant shoot inspected in the field of the centre it was observed that more than 65% were eaten and distorted 51% of them scratched by weevil and 34% flowers were damage by the ants by felling mud into the flower.

Insect occurrence on Orchids and bulbous flowers

V. S. NAGRARE

Orchids species	Mites	Scales	Thrips	Yellow beetle	Black beetle	Shoot borer	Aphids	Ants	Caterpillar	Weevil
Acampe pappilosa							✓			
Cleisostuma micranthum		✓								
Coelogyne barbetum		✓								
C. elata		✓								
Cymbidium eligens		✓								
C. devonianum		✓								
C. Hookerianum	✓	✓								
C. lowianum	✓	✓								
Dendrobium aphyllum						✓				
D. aumeum heterocarpum						✓				
D. bulboflorum						✓				
D. chrysanthum						✓				
D. claratum Griffith						✓				
D. crepidatum assamensis						✓				
D. pendulum						✓				
D. densiflorum			✓	✓	✓	✓	✓			
D. fimfriatum						✓				
D. gratissimum						✓				
D. jenkinsi						✓				
D. lituiflorum						✓				
D. moschatym						✓				
D. nobile				✓		✓				
D. peradii						✓				
D. williamsoni						✓				
Epidendron		✓					✓			
Oncidium		✓								
Paphiopedilum hirsuttissumum		✓								
Phius flavus		✓								
Pholitida		✓								
Renanthera imschootiana		✓								
Vanda cristata		✓								
Bulbous flowers										
Crocosmis aurea	✓									
Gladiolus			✓							
Hedychium								✓	✓	✓
Oriental lily							✓			

DARJEELING CAMPUS

Collection, conservation, characterization and maintenance of High Altitude Orchid Germplasm

RAMPAL

About 30 species of orchids and 35 new *Cymbidium* hybrids have been added to the previous collection.

Collection, Conservation, Multiplication of Bulbous Ornamentals

RAMPAL

No bulbous ornamental crop cultivar has been added this year to the previous collection. However, cultivars from previous collection were multiplied.

Standardization of Bulb Production Technology for Lilium

RAMPAL

The project could not be started due to non-availability of planting material.

Creation of Artificial Habitat of Field Gene bank

RAMPAL

In nature, the epiphytic orchids grow on trees and obtain their nutrition from leachate produced by decaying tree-bark. Darjeeling Campus has large number of trees. To utilize these trees and zero down the cost on maintenance of orchid germplasm, a programme for creation of artificial habitat was started. Orchids like *Coelogyne cristata, coelogyne nitida, Epigenium amplum, Otochilus albus, Otochilus fuscus, Vandopsis undulata* etc. were fastened on the trees and now these have established themselves on host trees and were started to grow well.

EXTERNALLY FUNDED PROJECTS

Sustainable management of plant biodiversity (NATP)

V. NAGARAJU, R. C. UPADHYAYA, S. CHAKRABARTI, D. BARMAN, T. K. BAG, RAMPAL, S. P. DAS, V. S. NAGRARE, G. DAS

During the year, 5 explorations were carried out in different parts of Arunachal Pradesh, Assam, Mizoram and Darjeeling District of West Bengal by Dr. T.K. Bag, Mr. Gyanalok Das, Dr. Vishlesh S. Nagrare, Mr. Rampal and Dr. V. Nagaraju.. During these trips 5 districts namely West Siang, Dibang Valley, Lohit Valley, Changlang and Tirap Disticts of Arunachal Pradesh, Northern districts of Assam, Blue Mountain region of Mizoram and Darjeeling hills of West Bengal were covered. Around 300 accessions of plant germplasm were collected during these collection trips. Besides explorations, the Director and other scientists of the centre also collected germplasm of orchids and other flowers from different places during the official visits. All the germplasm collected were deposited in the repository of NRC for Orchids for further characterization and evaluation. One set of materials collected from Darjeeling district are also

maintained at Darjeeling campus of National Research Centre for Orchids, since the materials collected at higher altitudes of Darjeeling hills may not perform well at Pakyong.

Characterization

V. NAGARAJU AND G. DAS

Morphological characterization of the flowering orchids (Table 9) and bulbous flowers (Table 10) was carried out in the centre. Altogether there were 74 species of orchids and 10 species of bulbous flowering plants were characterized for important morphological

EXPLORATION

Trip	Collaborator	Areas explored	Materials collected			
			No. of Genera	No. of Accessions	Orchids	Other/ Bulbous Flowers
1	NRCO	West Siang (April) AP	12	19	17	2
2	NRCO+NBPGRSL	Dibang and Lohit dist. Assam &AP	44	105	99	6
3	NRCO+NBPGRSL	Blue Mountain-Mizoram	16	37	37	
4	NRCO	Darjeeling, WB	21	34	31	2
5	NRCO+ NBPGRSL	Changlang & Tirap AP	22	100	97	3
	Total			295	282	13

Table 9. Characterization of Orchids for morphological and floral characters

Species name	Plant height	Leaf No.	Leaf Length	Leaf Width	Stalk length	Spike No.	Spike Length	Flowers No.	Flowers Size	Sepal Length	Sepal Width	Petal Length	Petal Width	Lip Length	Lip Width	Flowering duration (days)	Withering period (days)	Flower colour
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Acampe pappilosa	37.0	18	10.75	2.35	1.0	2	4.5	15	0.8	0.83	0.3	0.9	0.3	0.8	0.4	17	29	Apple green
Acampe rigida	67	21	25.0	5.55	5.0	2	16.5	12	1.4	1.3	0.7	1.25	0.5	0.9	0.6	14	22	Yellow with brown spike
Aerides recemiferum	70.5	26	17.95	0.4	1.2	1	34.6	43	0.9	0.5	0.2	0.3	0.1	1.0	0.5			Dull brown
Arachnanthe cathcartii	54.0	11	13.25	2.85	3.5	1	10.7	3	5.5	3.53	1.23	3.5	1.1	3.0	1.3	2	25	Yellow and brown markings
Arundina graminifolia	125.4	24	27.8	2.0	4.8	1	14.4	4	7.6	4.13	1.4	4.25	2.5	5.2	2.9	7	10	White to light purple
Bulbophyllum amplifolium	12.8	7	9.8	1.9	9.5	1	10.0	6	1.5	1.6	2.5	3.1	2.0	0.8	0.5			Yellowish green flowers with fishy smell
Bulbophyllum careyanum	17.0	1	14.5	3.7	1.5	1	55	35	0.6	0.8	0.4	0.3	0.1	0.4	0.2	7	17	Coppery colour
Bulbophyllum davernis	5.0	2	10.7	3.4				1	1.5	0.96	0.76	0.4	0.3	0.8	0.4			Light yellow
Bulbophyllum hirtum	3.0				18.0	2	32.0	61	0.6	0.7	0.3	0.2	0.1	0.4	0.1	9	13	White
Bulbophyllum ornattissimum Bulbophyllum/	4.5	5	17.55	3.65	6.5	1	20.0	6	1.4	1.3	0.63	0.6	0.4	0.6	0.3	2	8	Yellow and brown tinge
Cirropetalum maculosum	6.0	2	15.75	3.1	3.5	2	9.5	6	3.3	1.5	0.8	0.6	0.4	0.7	0.3	4	9	Light green
Calanthe masuca	45.0	7	38.35	10.0	11.5	1	38.0	22	4.5	2.3	1.2	2.0	0.9	5.1	1.4	43	51	Purple
Camarotis manii	10.5	5	9.55	1.0	1.9	1	3.2	4	0.8	0.6	0.3	0.6	0.2	0.6	0.2	6	19	Lemon yellow

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Cleisostoma armigerum	16.2	13	4.8	0.55	0.5	1	1.4	1.3	1.3	0.4	0.2	0.3	0.1	0.5	0.2			Pale straw coloured flushed with pink
Cleisostoma brevipes	15.5	6	10.45	1.55	1.0	1	1.5	6	0.7	0.5	0.2	0.4	0.2	0.7	0.3	15	29	Yellow with broad bands on the mid ribs and edges
Coelogyne barbata	8.5	2	37.5	4.95	17.0	1	33.0	7	6.5	4.0	1.47	3.8	0.5	3.2	0.9	2	32	White and brown hairs on lip
Coelogyne cristata	5.5	2	26.7	3.5	14.3	2	20.0	4	5.0	2.97	0.93	2.7	0.5	2.5	1.5	5	59	Pure white with yellow hairs on lip
Coelogyne elata	53.4	5	28.5	5.3	5.0	1	16.5	12	4.2	2.5	1.0		2.4	0.5	2.1	11	10	White
Coelogyne flaccida	35.4	5	19.4	3.9	14.5	2	24.5	9	5.4	3.2	1.1	2.9	0.5	2.9	1.0	8	17	White
Coelogyne fuscecens	14.0	2	29.2	7.8	8.0	1	21.0	9	4.8	3.77	1.23	3.5	0.4	3.5	1.4	2	16	Apple green to brown
Coelogyne ovalis	12.0	2	9.75	1.6	-	-	-	1	4.0	1.87	0.65	1.8	0.1	1.7	1.0	1	5	Pale yellow to brown
Den. Sharifa Fatima	57.3	11	12.25	3.95	19.0	1	44.0	15	5.5	3.43	1.3	3.4	1.65	3.2	1.6	21	44	
Dendrobium acinaciforme	23.0	8	3.05	0.9	1.5	1	16.2	2	1.2	0.9	0.3	0.5	0.1	0.5	0.6	7		Yellowish white
Dendrobium aphyllum	26.2				0.3			4	3.9	2.5	0.6	2.5	1.0	3.0	1.8	5	6	Pale white
Dendrobium chrysanthum	37	-	13.5	1.95	-			7		2.04	1.12	1.82	1.56	1.8	1.2	45	24	Bright yellow
Dendrobium crepidatum	34							5	4.4	2.3	1.2	2.5	1.4	2.7	2.3	9	6	White tinged with pink
Dendrobium eriaeflorum	26.0	13	6.75	1.85	2.5	10	11.2	18	2.8	1.7	0.25	1.3	0.1	0.5	0.4	5	21	Pale green
Dendrobium fimbriatum	36.0	14	10.8	2.1	2.0	1	5.5	4	4.5	2.8	1.2	3.1	2.0	2.7	2.5	3	2	Orange yellow with fringed lip
Dendrobium kingianum	5.5	2	5.2	1.6	5.5	3	9.5	6	2.5	1.6	1.8	1.4	0.5	1.3	0.8	21	22	Purple
Dendrobium longicornu	14.0	5	2.9	0.7	-	-	-	1	3.0	2.93	1.13	1.7	0.5	4.0	1.5	1	2	White
Dendrobium lutiflorum	85	9	11.05	2.55	0.6	1	1.5	5	6.3	3.5	0.9	3.5	1.6	3.5	2.2	8	6	Dark purple
Dendrobium transparens	33.0	5	5.6	1.4	0.5	1	1.5	5	6.3	3.5	0.9	3.5	1.6	3.5	2.2	6	6	White with purple tinge
Dendrobium wardianum	41.0	10	11.6	2.1	0.5			4	5.5	4.2	1.6	4.1	2.4	3.0	2.2	9	15	White tipped purple
E.V(Vanda Hybrid)	65.5	23	11.6	2.0	17.0	1	28.5	11	2.6	2.6	1.9	2.5	1.4	1.6	0.7	6	29	
Epigenium amplum	28.0	4	18.0	4.4	3.0	-	-	1	5.8	4.87	1.0	4.8	0.5	3.5	2.0	1	8	Greenish brown with dark brown patches
Epigenium rotandatum	8.0	2	6.0	1.45	1.5	1	4.0	1	4.3	2.53	0.76	2.7	0.3	2.7	1.6	1	15	Pale chestnut brown
Eria acervata	30.0	7	11.0	2.15	1.5	3	7.5	10	0.7	0.6	0.4	0.4	0.2	0.5	0.2	8	9	White
Eria bamboosifolia	66.0	12	12.6	3.3	7.0	1	16.5	13	2.6	1.13	0.76	1.1	0.5	1.0	0.8	31	47	Pinkish with purple lines
Eria coronaria	21.5	3	19.0	4.4	7.5	2	26.5	7	3.5	2.27	0.93	2.1	0.7	2.0	0.7	5	25	Light yellow to apple green
Gastrochilus dasypogon	1.8	5	6.64	2.2	1.5	2	1.8	4	2.1	1.17	0.43	1.1	0.4	1.0	0.7	2	16	Yellow with brownish purple spots
Liparis cordifolia	8.5	1	9.1	5.5	6.5	1	10.1	26	2.1	1.1	0.1	1.0	0.1	1.1	1.0	37	40	Green
Liparis longipes	16.0	2	9.0	1.8	5.0	1	8.5	6	1	0.6	0.2	0.8	0.05	0.7	0.5	4	11	Green
Lycasyte cruenta	9.0	5	20.1	4.6	9.5	2	18.0	2	6.5	6.5	2.6	5.4	1.9	6.0	1.8	18		Green
Micropera mannii	22.0	10	6.05	1.15	1.2	1	6.0	1.2	1.2	0.73	0.3	0.6	0.3	0.9	0.2			Pale pink
Micropera obtusa	26.0	12	6.85	1.3	0.5	1	10.5	3.1	1.3	0.9	0.3	0.65	0.3	0.8	0.4			White or pale rose
Micropera rostrata	28.5	9	10.35	1.2	1.3	2	7.4	18	1.1	0.73	0.3	0.7	0.2	0.9	0.2			Pale purple
Nephellaphyllum grandiflorum	5.0	2	9.4	6.8	8.5	1	11.3	6	3.2	1.8	0.5	1.5	0.7	1.8	1.0	14	5	Pale greenish brown with dark brown nerves
Oncidium "Gowremsey"	12	4	29.25	2.9	55.5	1	103.0	13	2.2	1.3	0.4	1.3	0.5	2.3	2.0	17	25	Yellow
Oncidium "Twinkle charm"	4.5	6	7.15	1.5	4.7	3	13.0	14	1.3	0.73	0.4	0.7	0.5	1.5	1.1	3	63	Lemon yellow
Paphiopedilum spiciarinum	7.6	10	19.9	2.25	19.8	1	23.5	1	4.1	13.4	1.6	3.13	1.8	3.7	2.2	1	17	White with central purple stripe and yellow green base
Paphiopedilum venustum	16.5	4	13.5	4.2	10.0	1	17.5	1	7.2	3.4	2.5	4.9	1.7	4.3	2.3	7	7	Light brown
Paphiopedilum villosum	7.0	5	26.35	3.5	18.1	1	24.1	1	4.5	5.1	3.5	5.03	1.67	4.1	2.6	1	89	Bright green with brown colour mixed

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Phaius tankervillae	27.0	7	16.14	4.18	15.0	1	22.5	2	6.0	2.6	1.2	2.6	0.6	4.0	1.4	4	9	Pink
Pholidota rubra	26.6	1	26.1	4.8	16.5	1	18.5	85	0.5	0.56	0.3	0.5	0.1	0.4	0.2	2	10	Dirty white to light brown
Pleione maculata	4.0	-	-	-	2.2	-	-	1	5.7	3.57	0.86	3.3	0.95	3.5	1.3	1	9	White with purple lines on lips
Robiquetia spathulata	10.5	10	11.25	2.4	4.5	1	7.0	18	0.7	0.3	0.2	0.3	0.1	0.7	0.2	14	19	Yellow, mottled, banded and brownish purple
Saccolabium intermedium	29.6	8	5.25	0.8	1.6	1	3.2	8	1.1	0.6	0.3	0.6	0.2	1.0	0.3			Yellow with brownish purple spots
Saccolobium acutiffolium	11.0	7	9.0	2.3	2.5	1	5.5	7.4	2.4	1.23	0.63	0.9	0.5	1.2	1.1	3	38	Yellow lip white with yellow centre
Sarcanthus ependiculata	8.5	10	7.3	0.34	2.5	1	5.3	4	1.6	0.76	0.36	0.5	0.3	1.2	0.5	16	26	Yellow
Sarcanthus pallidus	92	17	33.0	4.35	9.36	2	17.5	42	0.8	0.38	0.16	0.2	0.1	0.8	0.2		41	Brown
Stauropsis undulata	27.5	10	9.4	1.8	10.1	1	15.0	4	4.5	2.2	0.8	2.3	0.7	1.8	0.7	8	8	White
Sunipia scoriosa	16.0	3	12.05	2.25	22.8	1	31.0	9	1.5	2.5	0.95	0.5	0.4	2.1	1.1	39	52	Light purple with purple lines on sepals and petals
Vanda alpina	16.5	11	9.1	1.0	1.8	1	5.5	2	2.2	1.6	0.5	1.4	0.4	1.0	0.9			Greenish
Vanda coerulea	70.2	26	15.25	2.7	29.0	2	72.5	21	6.5	3.53	2.13	3.4	2.0	3.0	0.6	15	37	Glossy purple
Vanda cristata	34.4	19	10.5	1.2	3.0	1	10.0	15	4	2.9	0.8	2.8	0.6	2.6	1.2	11	16	Green
Vanda parviflora	27.5	9	23.75	2.65	16.2	1	40.2	11	3.5	1.87	0.36	1.3	0.3	1.0	0.3	43	41	Yellow with brown spots
Vanda pumila	20.0	10	13.9	1.2				1	2.6	2.4	1.2	2.4	0.7	2.3	1.2			Ochraceous yellow
Vanda scornopsis	52.8	20	16.75	3.2	31.0	1	62.0	15	7.5	4.43	2.8	4.6	2.35	2.5	0.8	13	25	Shining purplish white
Vanda stangeana	29.0	14	15.8	2.7	14.8	1	43.5	10	4.9	2.97	1.73	2.6	1.4	2.5	0.7	9	39	Green tessellated with dark purple brown
Vanda teres var. candida	71.0	15	18.1	0.4	3.6	1	5.5	3	4.0	2.6	1.1	2.6	1.7	3.6	1.1		9	White
Vanda testacea	41.0	15	27.2	3.7	18.0	2	35.1	7	8.1	4.4	1.3	4.5	1.3	2.3	1.2	45	32	Purple
Zygopetalum intermedium	14.0	8	21.5	4.3	36.5	2	61.0	7	7.5	4.13	1.43	3.7	1.0	4.5	3.8	2	37	Green with brown spots

Table 10. Characterization of important bulbous plants for important morphological and floral characters

Sl. No.	Species name	Plant height (cm)	Leaves			Stalk length (cm)	Spike		Flowers		Tepal		Lowering duration (days)	Shelf life (days)	Flower colour
			No.	Length (cm)	Width (cm)		No.	Length (cm)	No.	Size (cm)	Length (cm)	Width (cm)			
1.	*Zantedeshia aethiopica*	58.9	12	21.2	10.82	76.0	1	-	1	16.0	19.0	15.5	2	9	White
2.	*Iris Japonica*	75.3	8	56.72	3.0	35.6	1	51.2	8	5.5	3.45	1.65	5	9	White with dotted lines
3.	*Clivia miniata*	17.5	15	33.1	3.72	16.0	1	13.5	9	6.7	6.4	1.7	5	10	Pink to red
4.	*Cyrtanthus parviflorus*	32.2	5	22.2	0.8	19.5	1	22.5	6	2.0	4.47	0.56	9	17	Red
5.	*Cyrtanthus elatus.*	31.0	3	24.43	0.63	18.0	1	20.5	8	2.0	4.47	0.56	8	14	Pink
6.	*Freesia hybrida*	65.2	9	39.76	1.78	57.0	3	59.0	8	5.1	5.08	2.1	10	27	Mixed
7.	*Ornithogalus sp.*	36.0	6	28.38	1.98	32.2	1	43.8	93	2.1	2.08	0.96	15	18	White
8.	*Hippeastrum reticulatum*	64.5	8	49.44	5.8	4	1	77.0	4	17.5	11.3	8.25	7	12	White with pink stripes
9.	*Eucharis amazonica*	46.5	2	28.25	12.75	-	1	34.2	2	9.5	4.53	2.82	4	8	White
10.	*Iris sp.*	88.0	18	69.76	1.06	58.5	1	86.2	2	9.2	6.9	4.3	5	7	White

traits. Important materials were also conserved as herbariums for future reference. However, we are unable to make good herbarium as the plant materials of orchids are having thick pseudobulbs besides very high rainfall and humidity in the region.

Morphological characterization of *Hedychium* species and *Cautleya spicata*

V. Nagaraju and G. Das

The germplasm of *Hedychium species* evaluated for various morphological and floral characters. Wide diversity among the species for various floral and morphological attributes was recorded. Among the different species of *Hedychium,* the mean plant height among the species varies from 53.23 cm in *Hedychium* sp. to 117.83 cm in *H. densiflorum. Cautleya spicata*, which is closely related to Hedychium, is short (35.23 cm). The spike length among the species varies from 10.5 cm to 57.05 cm. Wide variations was also recorded among the species for various floral characters. *H. coronarium* has maximum spike diameter, while the flowers of *H. spicatum* was 11.37 cm. The rachis length was longer in *H. spicatum* (25.83 cm), while maximum number of florets per spike was recorded in *H. aurantiacum* (55.33) and *H. ellipticum* (53.33). The leaf size among the species varied significantly. The leaves are closely arranged in *H. coronarium* besides the highest leaf number.. The florets of *H. coronarium* are available in white, as well as creamy yellow. Flowers are highly fragrant.

Survey on existing pre & post harvest handling, storage, packaging, transportation and marketing systems for orchids in domestic and global level (NATP)

R. C. Upadhyaya, Rampal and S. P. Das

The survey was conducted through three preformulated questionnaires developed by Shri Rampal, CoPI. Area covered under the survey includes parts of Sikkim, Darjeeling district of West Bengal, parts of Kerala, parts of Tamil Nadu, parts of Karnataka, parts of Maharashtra. Commercial farmers, Nurserymen, hobby growers as well as florist and auction centers were covered. The major points tahat emerged from the survey are as follows.

1. Awareness or promotion of orchid culture was not up to the desired level.
2. Proper marketing support was lacking.
3. Priority should be given on the development of our own hybrids/ varieties.
4. Availability of quality and disease free planting material was not up to the desired level.
5. Low cost production technology standardized under Indian conditions is must and top priority.
6. Up to date market information to growers.
7. Curve on import.
8. Freight charges should be reduced.

Protected cultivation of vegetables & flowers in Plains & Hills (NATP)

D. Barman and Kumari Rajani

Studies on growth and flowering of Cymbidium hybrid (Soul Hunt-6)

The experiment was initiated with 11 modules to study the growth and flowering of Cymbidium. The observations on growth parameter are being taken regularly.

Studies on growth and flowering of Rose cv. First Red

The experiment was carried out to study growth & flowering of Rose. There were 13 module and replicated twice. The preliminary observations revealed that module 2 (Soil+Compost+Cocopeat-2: 1: 1) showed better vegetative growth followed by module 3 (Soil+Compost+Sawdust-2: 1: 1) as compared to other.

Technology Mission for integrated development of Horticulture in the North Eastern Region. (Mini Mission I)

Development of conventional and micropropagation techniques

V. Nagaraju, D. Barman, S. P. Das and S.K. Mani

(a) *Initiation of cultures of orchids in different media*

V. Nagaraju and S.K. Mani

Protocorms of Cymbidium hybrid, 'Soul Hunt – I' regenerated using meristem culture in half strength Murashige and Skoog media supplemented with BAP 0.5 mg/l + 2,4-D 2.5 mg/l and BAP 0.5mg/l +NAA 2.5 mg/l for regeneration and differentiation. After three months of culture protocorms were regenerated from meristem and pseudobulbs segment. These protocorms were separated and sub cultured on MS supplemented with Activated charcoal (AC) 1.5 g/l + BAP 0.5 mg/l and in Nitsch with AC 1.5 g/l + BAP 0.5 mg/l + NAA 0.1mg/l. After two to three months about 20-30 protocorms were obtained, which were again separated and cultured in different media viz. MS supplemented with activated charcoal 1.5g/l+ BAP 0.5mg/l; MS+AC 1.5g/l+ BAP 2.0 mg/l; Nitsch media supplemented with activated charcoal 1.5g /l. + BAP 0.5 mg./l; Nitsch + AC 1.5g /l + BAP 1.0mg /l for further proliferation.

(b) *Hardening of* in vitro *plants*

V. Nagaraju and S.K. Mani

Experiment was under taken with three Cymbidium hybrids viz. Cymbidium LA, Golden Girl and H X B from *in vitro* grown cultures to find out suitable protocol for *ex vitro* growth and maximum survival of *in vitro* propagated plantlets. After initial hardening under *in vitro* conditions plantlets were planted on 7 different media viz. Coco pith (CP), Coco pith + Leaf Mould (CP + LM), Coco pith+ Leaf Mould+ Tree Fern (CP + LM + TF), Coco pith+ Leaf Mould+ Tree Fern+ Bricks pieces (CP + LM + TF + Br.), Coco pith+ Leaf Mould+ Tree Fern+ Bricks pieces+ Charcoal (CP + LM + TF + Br. + Ch.), Coco pith+ Sand (CP + S) and Leaf Mould (LM). Hence coco pith followed by coco pith + sand is the most suitable media for better plant growth as compared to the other media.

(c) *Culture initiation of Gladiolus hybrids*

V. Nagaraju and S.K. Mani

Cultures were initiated using axillary buds excised from cormel explants of Gladiolus cv. Jester and Ice Gold. Sprouts obtained were separated and sub cultured on MS supplemented with BAP 0.25mg /l + NAA 0.1mg /l.; BAP 0.5mg /l + NAA 0.1mg /l and BAP 0.75mg /l + NAA 0.1mg /l. MS+BAP0.55mg /l +NAA0.15mg /l gives the better growth and proliferation of shoots. Higher concentration of BAP in the media resulted in the swelling of the base of the shoots.

Education and Training

3

EDUCATION

The Centre organized a training programme for the state government officials of North Eastern States especially from Horticulture Departments of Sikkim, Meghalaya and Nagaland. All the scientists actively participated and involved in organizing and coordinated the entire training programme entitled "The Production Technology, Micro propagation and Crop Protection of Subtropical and Temperate Orchids" under Technology Mission for Integrated Development of Horticulture in the North Eastern Region, which was held during 14-18th March, 2002.

TRAINING

Scientist	Period	Particulars	Venue
Bag, T. K.	15 May-4June, 2001	Advanced level Training course on the Application of Molecular Techniques in Plant Pathology	IARI, New Delhi
Chakrabarti, S.	12-23 June, 2001	Senior level training programme on "Agricultural Scientist Development for personal and organizational effectiveness"	NAARM, Hyderabad
Nagaraju, V.	5-7 September, 2001	ICAR-IISR Training programme on IPR and WTO Awareness	IISR, Lucknow
Nagaraju, V.	8-31 January, 2002	Trainers Training programme on Plant Genetic Resources management under HRD component of NATP on Sustainable management of Plant Biodiversity	NBPGR, New Delhi

Publications

4

Research Paper

Nagaraju, V. and Upadhyaya, R.C. 2001. *In vitro* morphogenetic response of *Cymbidium* to three basal media and activated charcoal. *J. Orchid Soc. India.* **15**: 57-62.

Book chapter

Upadhyaya, R. C. and Das, S. P. 2002. Cymbidiums of North Eastern Himalayas. In Orchids Science and Commerce (ed. P. Pathak *et al.*). Bhishen Singh Mahendra Pal, Dehradun

Popular articles

Nagrare V.S. 2001. World of Orchids. *Employment News* Vol. **XXVI** No. 16, 21-27 July 2001.

Nagrare, V. S. and Bag, T. K. 2001. Under green house-Pest Management in Gerbera. *Krishak Samachar.* **46** (8). 7-8.

Papers presented in Seminar, Symposia, Conferences etc.

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Linkages and Collaboration

5

Programme	Institute/Organization
Collection, characterization, evaluation and documentation of germplasm	NBPGR, New Delhi IIHR, Bangalore IARI New Delhi SAU's in India
Crop improvement	NRCPB, New Delhi NRC DNA Fingerprinting, New Delhi Bose Institute, Calcutta IHBT, Palampur DBT, New Delhi BARC, Mumbai NBRI, Lucknow IISc, Bengalore ICGEB, New Delhi
Production Technology	NBRI, Lucknow IIHR, Bangalore IARI, New Delhi
Integrated Pest and Disease Management	NCIPM, New Delhi PDBC, Bangalore IIHR, Bangalore IARI, New Delhi
Virus studies in Orchids and Bulbous flowering plants	NCL, Pune Uni. of Nottingham, UK
Disease Forecasting	IRSA, Dehradun
Development of software for database of plant diseases and insect pests Integrated Nutrients management	IASRI, New Delhi IISS, Bhopal, CSSRI, Karnal Rothamsted Exp. Station, UK
Packaging and post harvest Technology	CIPHET, Ludhiana

Ongoing Projects

6

Institute Projects	PI	CoPI
Collection, evaluation, characterization, documentation and preservation of genetic resources of orchid and important bulbous flowering plants	R. C. Upadhyaya	V. Nagaraju, S. Chakrabarti, D. Barman, T. K. Bag, Rampal, S. P. Das, V. S. Nagrare
Development of agro-techniques for commercial scale production of orchids and bulbous plants in open and protected condition.	D. Barman	R.C. Upadhyaya, Ram Pal, & S. P. Das
Quality planting material production of orchids and bulbous flowering plants	R.C. Upadhyaya	D. Barman & Rampal
Standardization of bulb production technology for liliums	Rampal	
Biotechnological investigations in orchids and bulbous plants	V. Nagaraju	S. Chakrabarti & S. P. Das
Molecular characterization of commercially important Indian orchids	S. Chakraborty	
Study of Floral biology of Himalayan Orchids.	S. Chakraborty	
Breeding superior hybrids in *Cymbidium* and other important orchids	S.P. Das	V. Nagaraju & S. Chakrabarti
To find the most effective methodology in breeding superior cultivar of gladiolus	S. P. Das	D. Barman & T. K. Bag
Pest Management in Orchids and bulbous flowering Plants	V. S. Nagrare	
Investigations on fungal diseases of orchids	T. K. Bag	

NATP Projects	CCPI	CoCCPI
Sustainable management of plant bio-diversity "Collection, evaluation, maintenance of Orchids and ornamental plants germplasm From NEH Region".	V. Nagaraju	R.C. Upadhyaya, S. Chakrabarti, D. Barman, T. K. Bag, Rampal, S. P. Das, V. S. Nagrare and G. Das
Protected cultivation of vegetables and flowers in plains and hills	D. Barman	
*Survey on existing pre & post harvest handling, storage, packaging, transportation and marketing systems for orchids in domestic and global level.	R. C. Upadhyaya,	Rampal & S.P. Das

*Project terminated in October 2001

Central Sector scheme- Mini Mission-I	PI/CCPI	Associated
Development of conventional and micro-propagation techniques	R.C. Upadhyaya (PI) D. Barman (CCPI)	V. Nagaraju, D. Barman, S. P. Das & S.K. Mani
Production of planting material under low cost poly-houses.		D. Barman, T. K. Bag and V. S. Nagrare
Refinement and transfer of production technologies for commercial production of ornamentals		V. Nagaraju, S. Chakrabarti, T. K. Bag, Rampal, S. P. Das, V. S. Nagrare

RAC, SRC

7

Research Advisory Committee

Chairman

Dr. P. Puspangadan, Director, NBRI, Lucknow

Members

Prof. T. K. Bose, Former Professor, Deptt. Horticulture, B C K V, West Bengal.

Prof. S. P. Vij, Head, Botany Department, Punjab University, Chandigarh

Dr. D. Mukherjee, Consultant, Floriculture Division,IHBT, Palampur, Himachal Pradesh

Dr. B. S. Dhankar, ADG (VC), ICAR, Krishi Bhawan, New Delhi 110001

Dr. R.C. Upadhyaya, Director, NRC for Orchids, Pakyong, Sikkim

Dr. V. Nagaraju, Sr. Scientist (Biotech) NRC for Orchids, Pakyong, Sikkim

Dr. S.P. Das, Scientist (Plant Breeding) NRC for Orchids, Pakyong, Sikkim

Mr. Rampal, Scientist (Hort) & Station Incharge NRC for Orchids, Darjeeling

Dr. S. Chakrabarti, Sr. Scientist (Genetics), NRC for Orchids, Pakyong, Sikkim

Other Scientists of the Institute attended the meeting were,

Dr. D. Barman, Sr. Scientist (Hort.) NRC for Orchids, Pakyong, East Sikkim

Dr. T. K. Bag, Scientist (Plant Pathology)NRC for Orchids, Pakyong, East Sikkim

Dr. V.S. Nagrare, Scientist, Entomology, NRC for Orchids, Pakyong, East Sikkim

Third Research Advisory Committee Meeting was held on 1st December 2001. All the projects were critically reviewed by the committee and suggested necessary modifications. A summary of major recommendations is presented below.

- *In-vitro* multiplication of rare and endangered species and their introduction in natural habitat should also be given priority along with the multiplication of commercial orchids and preparation of protocol for commercial micro-propagation.
- Hardening chamber should be made available and facility for Micro propagation of *Cymbidium* on suspended liquid medium should be created
- Since authentic plant materials are not available in the domestic market for breeding or experiment purposes, few authentic plant materials should be procured from international source and then they could be multiplied in tissue culture to use them in the breeding or other experimental purposes. Existing

hybrids of orchids should also be multiplied and distributed to the farmers/growers.

- One virologist/plant pathologist should be attached with tissue culture programme for indexing of virus. Otherwise virus will also multiply with the micropropogated stocks and whole lot could be virus infected.

  Herbarium should be prepared and maintained at NRC for Orchids. Identification of Collected germplasm should be done in consultation with authentic books, herbarium of other Institute viz. BSI, NBPGR, NBRI etc.
- Taxonomist / botanist should be recruited for identification. If not possible, one existing staff should be trained in the field of taxonomy at BSI, calcatta or other BSI centres or at institutes like TBGRI or at Prof. Vij's lab in Chandigarh. Centre may also consider training a taxonomist/ botanist at Royal Botanical Garden, Kew, UK where the best expertise in orchid taxonomy is available. Prof. Bose suggested to employ a specialist for this purpose. Dr. Pushpangadan suggested to make some working arrangements with TBGRI, Trivandrum where excellent expertise in orchid taxonomy is available. He offered to help in facilitating the same.
- Breeding Programme at the moment should be confined to *Cymbidium* only. To achieve a cymbidium hybrid with a specific traits, parental lines with well known characters such as flower colour, size, blooming period, orientation of flowers on spike should be given due care in breeding programmes.
- RAC also suggested to identify the suitable pollinator.
- Experiments should be set to standardize the water, shade, light, relative humidity and temperature requirement of *Cymbidium*.
- Whatever insect pests observed in orchids should be properly identified. Documentation and database on pests should be prepared. Entomologist will also do works on Nematodes, which is currently a new field of research on orchid pest.
- Focus on mycorrhizal / Rhizobacterial association with orchids should be emphasized. Their role in phosphate solubilization and facilitating uptake of this nutrient to orchid should be studied.
- Separate poly house/ lath house should be made for maintenance of pest and disease infected plants.
- As three posts of plant pathologist (virology, bacteriology and fungal pathology) cannot be created, existing pathologist should extend his work on bacteria and virus through appropriate training.
- Lilium bulb should be procured for the initiation of project submitted by scientist, Darjeeling Centre.

General recommendations

- Monthly seminar should be organized on different aspects of mandate.
- The next meeting of RAC may be convened in March-April when major groups of orchids will be in flowering, so that the RAC members could offer specific comments/suggestions.
- To procure and produce adequate planting material of orchids (*Cymbidium* to start with) for planning new experiments.
- The RAC members observed that since this Orchid Research Centre is of great national importance, in depth study and investigations of both basic and applied nature have to be under taken by the centre and develop improved varieties of orchids of great commercial importance such as *Dendrobium, Vanda, Oncidium, Catteleya* etc. and work out the package of practices for their commercial cultivation.

Staff Research Council

The Staff Research Council meeting was held on 27.11.2001. Sh. G. K. Gurung, Secretary Horticulture, Govt. of Sikkim, Shri. J. R. Subba, Director, Horticulture, Govt. of Sikkim, Dr. A. S. Chauhan, Jt. Director, B. S. I., Gangtok, Shri. D. K. Bhandari Floriculturist, Govt. of Sikkim, Shri. Padam Subba HFRO (Namali), Govt. of Sikkim were participated. All the scientists – Dr. V. Nagaraju, Dr. S. Chakrabarti, Dr. D. Barman, Shri Rampal, Dr. T. K. Bag, Dr. S. P. Das and Dr. V. S. Nagrare were also attended the meeting.

A summary of recommendations is placed below.

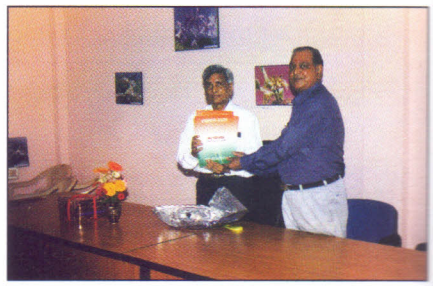
- Studies on the effect of humidity, temperature, etc for early blooming of orchids suggested by Shri. G. K. Gurung.
- Crossing between long X short flower spikes for medium size flower and earliness suggested by Mr. Bhandari.
- Bulb production standardization suggested by Shri. J. R. Subba.
- Studies on critical level of temperature and humidity in different poly structures suggested by Dr. A. S. Chauhan.

Participation in Conferences, Meetings, Workshops, Seminars/Symposia etc. 8

Scientist	Period	Particulars	Venue
Nagaraju V.	18-20 April, 2001	Third National Workshop on Jai Vigyan National Science and Technology Mission on Agro biodiversity, NATP Project on Plant Biodiversity	New Delhi
Nagaraju V.	23-24 April, 2001	National Symposium on Biodiversity Vis-à-vis Resource exploitation: An introspection	CARI, Port Blair
Nagaraju V.	24-26 June, 2001	Protected cultivation of Vegetables and flowers in plain and hills (NATP)	IIHR, Bangalore
Nagaraju V.	2-6 July, 2001	Workshop on Gahan Hindi Prashikshan	NAARM, Hyderabad
Nagaraju V.	1-4 August, 2001	Symposium on Plant Genetic Resources Management: Advances and Challenges	NBPGR, New Delhi
Nagaraju V	18-19 August, 2001	NATP Zonal Group meeting cum orientation programme of NATP Project on Plant Biodiversity	Tadong, Gangtok
Barman, D.& Chakrabarti S.	28-29 Sept., 2001	Institutionalization of priority Assessment in SAUs and ICAR institutes	CRRI, Cuttack
Upadhyaya R.C., Nagaraju V., Bag, T. K., Das, S. P., Rampal & Nagrare, V. S.	11-13 Oct., 2001	The 6th National Seminar on Orchid diversity in India: Science & commerce and orchid show	IHBT, Palampur
Chakrabarti S.	2-9 Nov., 2001	Second orientation course on Biosafety considerations for evaluating transgenic	NBPGR, New Delhi
Nagaraju V.	11 March, 2002	Zonal Workshop on NATP Project on Plant Biodiversity	NBPGR, Barapani, Meghalaya
Nagaraju V.	20-22 March, 2002	Fourth National Workshop on Jai Vigyan National Science and Technology Mission on Agro biodiversity, NATP Project on Plant Biodiversity	NBPGR, New Delhi

9 Distinguished Visitors

Shri P.C. Kukrety, Programme Executive, AIR, Gangtok	07.04.01
Dr. J.S. Bilga, Executive Engineer (HORT) Mph Corporation, Ludhiana-4	08.05.01
Dr. N. Iboton Singh, Dean, College of Agriculture, CAU Imphal	22.05.01
Dr. Y. Jekendra, Head, Deptt. Of Agriculture Engineer Imphal	22.05.01
Shri K.C. Mishra, Manager, NABARD, New Delhi	23.05.01
Shri S. Lama, Former Secretary Agri. Govt of Sikkim	23.06.01
Dr. K.L. Chadha, Chairman, QRT- Floriculture (ICAR), New-Delhi	24.06.01
Prof. S.M.A. RIZVI, Member, QRT- Floriculture, Faizabad	24.06.01
Dr. P. Rengasamy, Member, QRT- Floriculture, TNAU-Coimbatore	24.06.01
Dr. A.P. S. Gill, Member, QRT- Floriculture, Ludhiana	24.06.01
Dr. M.L. Chaudhary, Member, QRT- Floriculture, New-Delhi	24.06.01
Dr. S. K. Pareek, PI NATP (plant Biodiversity)NBPGR, New Delhi	18.08.01
Dr. R.N. Pal, Acting DDG (Hort) ICAR, New-Delhi	01.09.01
Dr. Pitam Chandra, National Phytotron Facility, IARI, New-Delhi	11.09.01
Dr. K. J. Madhusoodanan, Project Officer, Spices Board, Idukki, Kerala	13.09.01
Dr. P. Parvatha Reddy, Director, IIHR, Bangalore	03.11.01
Shri Sudhir Kumar, IAS, Managing Director, SFAC, New-Delhi	03.11.01
Shri G.K. Gurung, Secretary, Horticulture, Govt. of Sikkim, Gangtok	27.11.01
Dr. P. Pushpangadm, Director, NBRI, Lucknow	01.12.01
Prof. T. K. Bose, Former Professor, Horticulture, B C K V, West Bengal.	01.12.01
Prof. S. P. Vij, Head, Botany Department, Punjab University, Chandigarh	01.12.01
Dr. D. Mukherjee, Consultant, Floriculture,IHBT, Palampur,	01.12.01
Dr. B. S. Dhankar, ADG (VC), ICAR, Krishi Bhawan, New Delhi	01.12.01



Dr. R.N. Pal, DDG, Hort (*left*) releasing Vision 2020

QRT on AICFIP

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Scientific Personnel (As on March 31, 2002)

Dr. R.C. Upadhyaya	**Director**
Dr. V. Nagaraju	Sr. Scientist (Biotechnology)
Dr. Syamali Chakrabarti	Sr. Scientist (Genetics)
Dr. D. Barman	Sr. Scientist (Hort.)
Shri Ram Pal	Scientist (Hort.)
Dr. T.K Bag	Scientist, Sr. Scale (Plant Pathology)
Dr. S. P. Das	Scientist (Plant Breeding)
Dr. Vishlesh S. Nagrare	Scientist (Entomology)

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