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ICAR-National Research Centre for Orchids

Pakyong-737 106, Sikkim, India

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रा. आ. अत्तु. के.
NRC Orchids

Presents

Orchid Technologies for Entrepreneurship Development

Raj Kumar • D. R. Singh



Orchid Technologies for Entrepreneurship Development

Raj Kumar
D. R. Singh

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भा.कृ.अनु.प.- राष्ट्रीय आर्किड्स अनुसंधान केंद्र
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ICAR-National Research Centre for Orchids
Pakyong, Sikkim-737106





Technologies for Commercialization

ICAR- National Research Centre for Orchids, Pakyong-737 106, Sikkim

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Introduction

The National Research Centre for Orchids was established on 5th October 1996 by the Indian Council of Agricultural Research (ICAR), New Delhi to organize research programme on improvement in productivity, quality and commercialization of orchids. The Sikkim state authorities handed over 22.19 acres of land belonging to Regional Agricultural Centre

along with all other assets to ICAR for the establishment of the centre. In October 1997, the centre also took over the CPRS, Darjeeling from CPRI and established a campus for research on temperate orchids. In the initial years of establishment the major focus of research was on the collection, characterization evaluation, conservation and utilisation of available germplasm in the country in general and north-eastern region in particular. With the changing scenario of floriculture in the country, the centre has modified its approach and thrust areas of research to meet the challenges. Today, the focus is on the development of marketable varieties/hybrids, molecular characterization, standardization of agro-techniques, post-harvest management, production of quality planting materials through tissue culture and creation of a repository of information related to all

aspects of orchids in the country. On the basis of recommendations of QRTs and RACs, the research programmes have been modified on the mission-oriented research projects on germplasm management, crop improvement, crop production and extension.

Mandate

- Applied and strategic research on conservation, improvement and culture of orchids for enhancing productivity and utilization.
- Transfer of technology and capacity building of stakeholders for enhancing and sustaining productivity of orchids.

Vision

- To act as a premier centre for research and development activities related to orchid commercialization and sustainable utilization.

Mission

- Science and Technology driven development of orchid industry in the country.



Institute Technology Management Unit

It is the novel initiative taken by ICAR to utilize the strengths and innovation of the Institute for the benefit of farmers/society through technology commercialization, development of business potential and public private partnership.

Objectives

- To set an institutional mechanism to protect/manage intellectual property (IP) generated within the ICAR system.
- To implement the incentive system, incorporated in the ICAR guidelines for IP management and technology transfer/commercialization and to encourage greater creativity and rapid innovativeness in the system.
- To maximize technology transfer by ICAR institutes and to generate income/resources through commercialization of IPs.

Activities and Function of the ITMU

- Documentation of the Institute IP assets.
- Advisory role for the Scientists/projects.
- Analysis of the commercial potential of IP assets.
- Technology transfer and commercial ion.
- Reporting and monitoring.

Services

- Documentation, classification and cataloguing of the various technologies developed by the institute.
- Providing platform for public-private partnership.
- Facilitating the patenting process.



Crop Improvement





Darjeeling Nymph (*Cymbidium* hybrid)

It has been developed by crossing a between a hybrids (*Cym* Sleeping Nymph) and a native species (*Cymbidium louianum*). This variety is suitable for cut flowers and recommended for cultivation in Darjeeling, west Bengal and Sikkim. This is first hybrid developed and registered with International Orchid Registration Authority, RHS, London from the Institute. This will produce 1-2 spikes after one year and which is going to increase as the age

& size of plant going to increase. Spike of this variety will fetch rupees 50-100 in the local market. This variety is appreciated by the local farmers of Darjeeling; further large scale production of planting material of this variety is under process for distribution to the farmers. This variety is suitable for the areas of Darjeeling Hills, Kalimpong Hills of West Bengal, Sikkim, Arunachal Pradesh, Himnachel Pradesh and Utrakhland.



Darjeeling Delight (*Cymbidium* hybrid)

It is cross between a native species (*Cymbidium lowianum*) and a intermediate *Cymbidium* hybrid (*Cym* Showgirl 'Cooksbridge'). This is second cross registered with International Registration Authority, Royal Horticultural Society, London as Darjeeling's Delight. This will produce 1-2 spikes after one year and which is going to increase as the age & size of plant going to increase. Spike of this variety will fetch rupees 50-100 in the

local market. This variety is appreciated by the local farmers of Darjeeling; further large scale production of planting material of this variety is under process for distribution to the farmers. This variety is suitable for the areas of Darjeeling Hills, Kalimpong Hills of West Bengal, Sikkim, Arunachal Pradesh, Himachal Pradesh and Utrakhnad.





Sheetal-1 (*Paphiopedilum* hybrid)

Sympodial and erect growth habit, oblong lanceolate & dark green leaves, solitary flower/spike. Medium plant height (17.73 cm), early flowering and more than 4 months potted vase life. Flower colour dominated by dorsal sepal colour in light shiny green colour with white margin, with medium brownish purple colour petals; dorsal sepal funnel shaped with unique moderate purple colour on white background on upper surface.

Flowers during October - Feb/Mar. Faster proliferation for vegetative multiplication, resistant to important diseases (root rot, blight) and insect pests (stem fly, mites & scale insects). Suitable for hilly regions as pot plants and tolerant to biotic stress. This variety is recommended for cultivation in Sikkim, Meghalaya, Arunachal Pradesh, West Bengal (Darjeeling hills and Kalimpong)



SHEETAL 1 (IC 614753)

Plant, flower & floral parts

Apomixis in *Zygopetalum* orchid for true to type planting material production

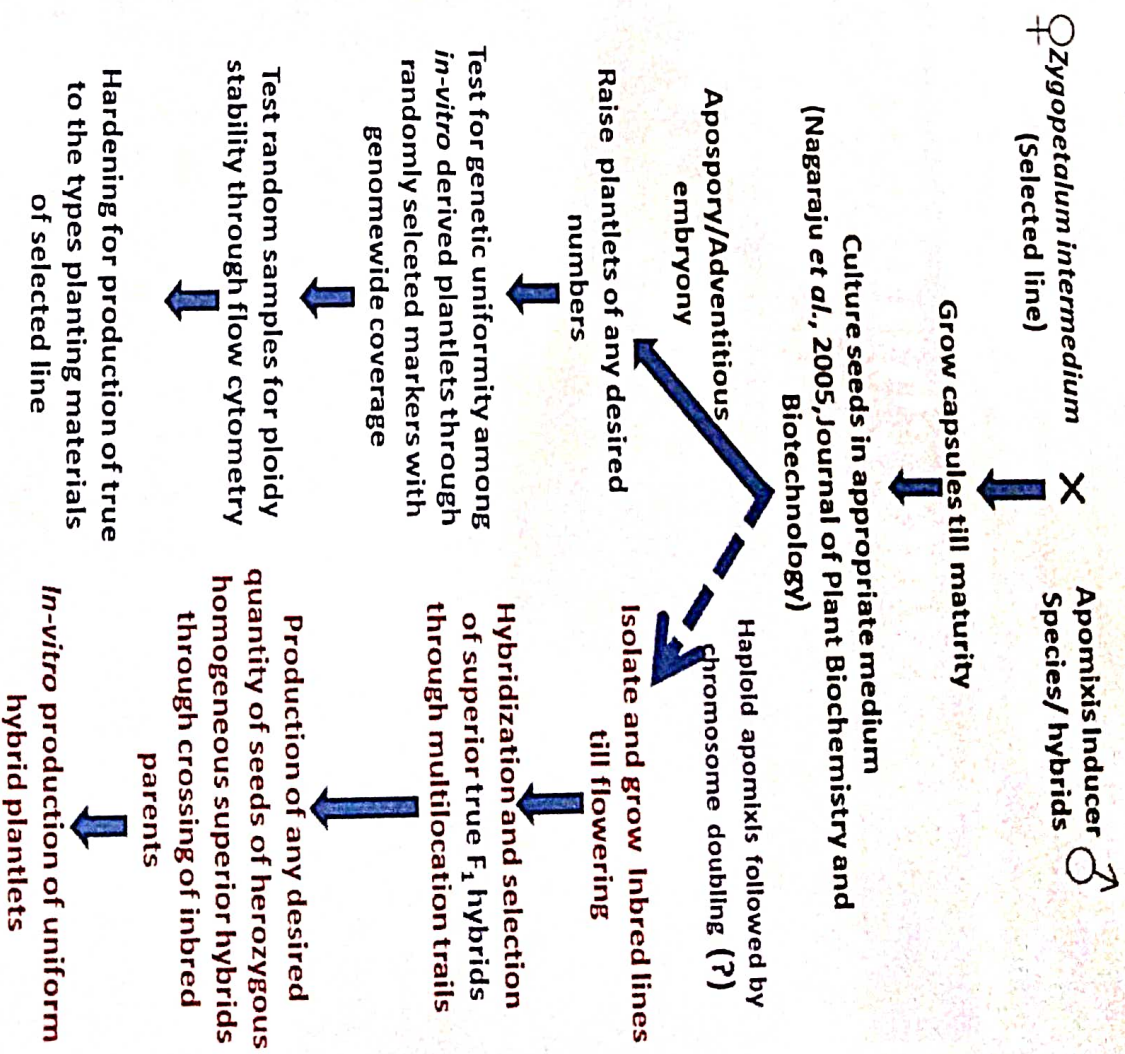
The phenomena of apomixis identified in few genera of Orchids that has potential application for large scale multiplication of plants. It helps in rapid production of seedlings through seed culture. Earlier the plants developed by tissue culture of seeds distributed in the three states of North East India *i.e.* Demaji, Kariblong in Assam (02 locations), Nongsten in Meghalaya (01 location) and Karok, Nanchepong, Yangyan in Sikkim (03 locations). This beautiful scented orchid performs well in all the locations and having very good market value as cut flower as well as pot plant. This will come in flowering during August to December, when there is off season for Cymbidium orchids and fetch very good price in the market. Farmers for Sikkim they are getting rupees 2500/- per plant and rupees 50-100/- per spike during the tourist season at Gangtok, Sikkim. This year our institute set the target for *in vitro* multiplication of 30000 plantlets of *Zygopetalum* and distribution to the farmers of North East India. The schematic representation of apomictic seed production given below:-



Single Flower of *Zygopetalum*

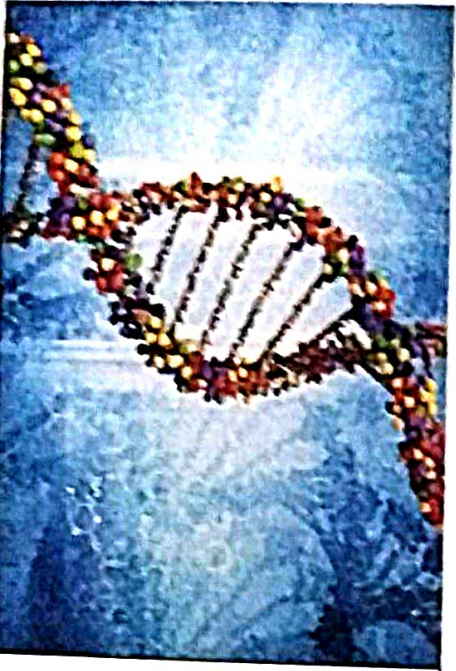


Flowering of *Zygopetalum*





Biotechnology and Tissue culture

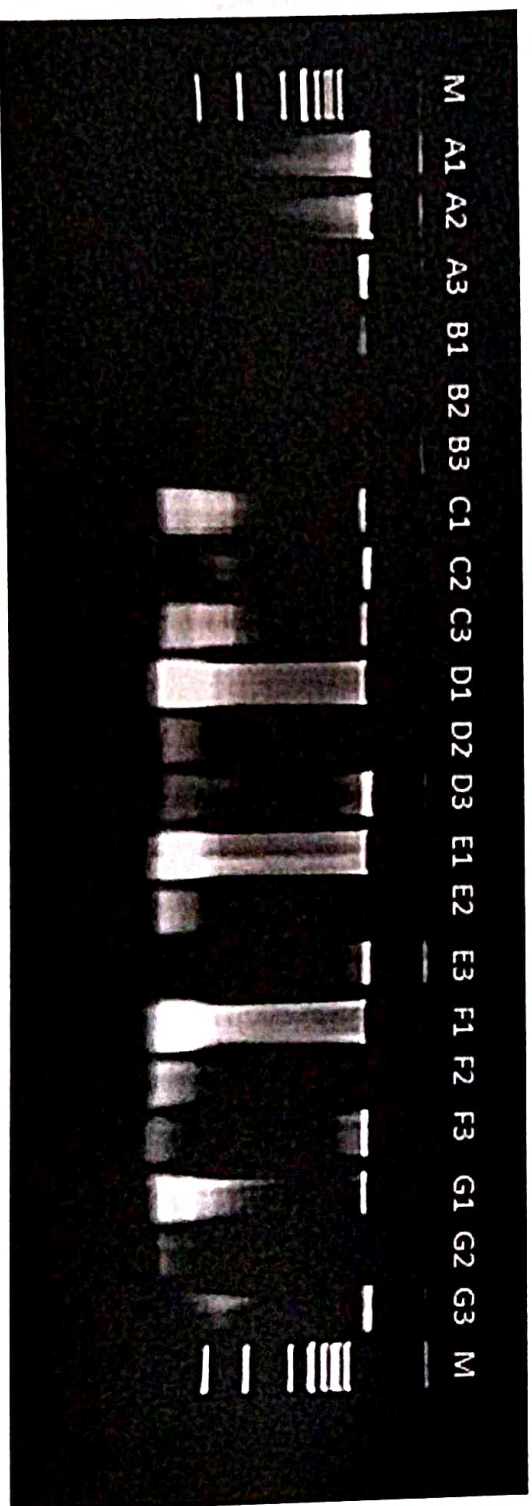




Modified CTAB Method for genomic DNA isolation from fresh matured leaves of orchids

Isolation of quality DNA from thick fleshy leaves of orchids is difficult due to presence secondary metabolites such as phenolic compounds, polysaccharides and DNA degrading endonucleases that hinders the isolation of DNA. Moreover DNA isolation process needs to be very simple, rapid, efficient and inexpensive when large samples are used in the case of population studies, molecular breeding, diversity analysis etc. To overcome this problem it is necessary to develop a protocol for DNA extraction from matured leaf tissue that would give quality DNA suitable for molecular analyses. Several protocols for DNA isolation from

plants were developed but in most of the methods DNA yield was less, time consuming and also showed less purity due to the presence of high amount of polysaccharides, phenolics and other secondary metabolites. Considering the above facts a simple protocol modified CTAB method was developed using CTAB and β mercaptoethanol, and NaCl for efficient DNA extraction from matured orchid leaves which gives yield of high quality DNA suitable for PCR and other molecular analyses. DNA isolation cost for per gram of sample will be Rs. 200.

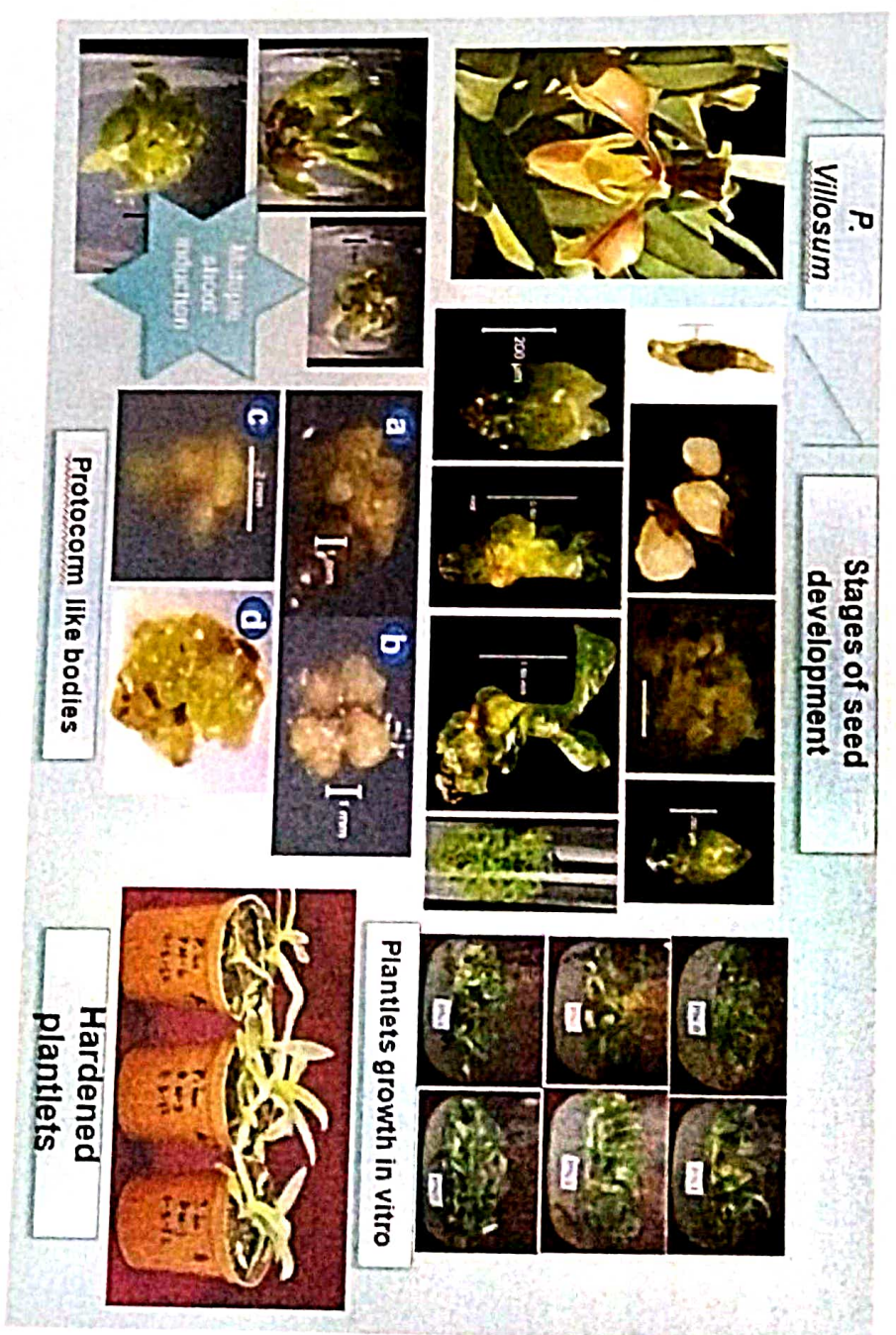


(* Patent Filed by Application No. 826/KOL/2013)



Protocol for *in-vitro* propagation of *Paphiopedilum*

Orchids belonging to *Paphiopedilum* genera, commonly known as Lady's slipper Orchid are very popular as potted plant throughout the world. Nearly 125,000 commercial hybrids have been developed worldwide, which are mostly multispecies hybrids although few primary hybrids are also in demand. Besides the commercial hybrids, many of its natural species are popular among the orchid growers. Nearly 131 species belonging to this genus have been reported worldwide, out of which 09 species are found in different North Eastern States of India. The *in-vitro* multiplication technique of *Paphiopedilum* was developed through asymbiotic seed culture. *Paphiopedilum* species are listed under Red list as per CITES and comes under endangered category. This technology helps for rescue and mass multiplication of *Paphiopedilum* species. This technology is recommended for commercial firms and orchid growers in Sikkim, Meghalaya, Arunachal Pradesh, West Bengal (Darjeeling hills and Kalimpong).





Protocol for *In-vitro* propagation of *Zygopetalum*

Zygopetalum intermedium is a Brazilian species having very beautiful and fragrant flowers. *Zygopetalum* is highly demanded by the farmers of Sikkim and other states of North East India and fetch very handsome price in the market as cut flower and potted plant. The *in-vitro* multiplication technique of *Zygopetalum intermedium* was developed through seed culture. Large number of plant developed by this technique and distributed to farmers of Sikkim, Meghalaya and Assam. They are performing well under mild weather conditions with early flowering. This technology is recommended for commercial firms and Orchid growers at Assam, Arunachal Pradesh, Sikkim, Meghalaya, Nagaland, Manipur and Mizoram.

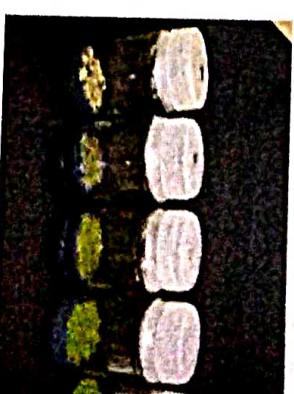


Protocol for *in-vitro* propagation of *Dendrobium nobile*

Dendrobium nobile was not described until 1830, yet has become possibly the most well-known of all dendrobiums, due to its popularity as an ornamental. There are a number of varieties in cultivation, including *Dendrobium nobile* var. *virginale*, which has white flowers with a yellowish green centre to the lip. Another commonly cultivated variety is *Dendrobium nobile* var. *cooksonianum*, in which the petals resemble the lip, each having a rich maroon-purple velvety blotch in the basal half. This species was first known from China and was later imported for cultivation into Europe from India. Many horticultural varieties of this species were named in the 19th century. This species occurs largely in deciduous forests between 1,500 and 2,000 m elevation in the foothills of the Himalayas and surrounding areas. It is recorded from India, Bhutan, Nepal, Myanmar, Thailand, China, Laos and Vietnam. It is also valued in traditional Chinese medicine. It is used to nourish and stimulate the stomach. A tea made from the stems of this and other *Dendrobium* species is taken for complaints such as fever, sunstroke and excessive perspiration. Scientists have isolated several compounds from the stem and leaves, including dendrobine, dendroline, dendrin and other alkaloids. Phenanthrenes from *Dendrobium nobile* have shown anti-tumour activity in laboratory tests on cancer cells. Sesquiterpene glycosides isolated from the stem affect lymphocyte cells, indicating possible immunomodulatory effects. Gigantol isolated from *Dendrobium nobile* has shown antimutagenic properties. This technology is recommended for commercial firms and orchid growers at Silkim, Assam, Arunachal Pradesh, Meghalaya, Manipur and Mizoram.



Dendrobium nobile



Different stages of seed germination



Seed germination



Emergence of shoot

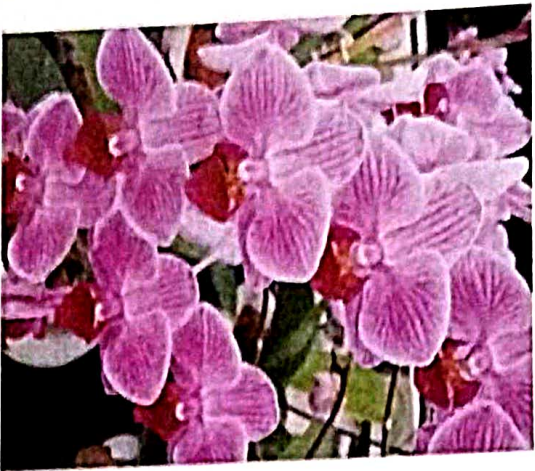
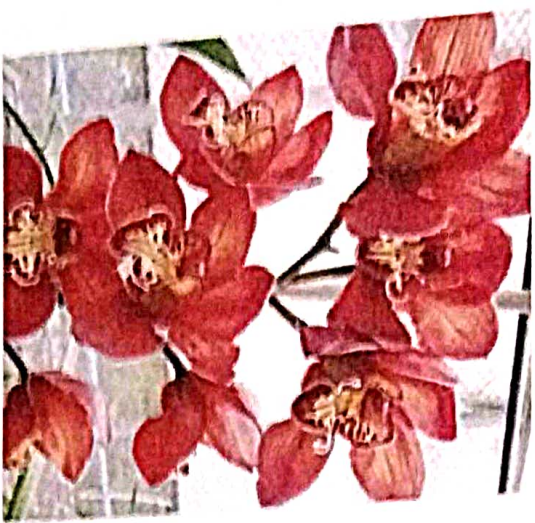


Shoot elongation and rooting



Hardening of plants

Crop Production & Post Harvest Technology





Development of Integrated Floriculture Enterprise

This model was developed for maximizing the return per unit area. As we all know that gestation period is more in case of *Cymbidium* orchids i.e. 5-6 years, by adapting this model the farmers can utilize their spaces sustainably and increase their returns. In this first year farmers can grow five different floriculture crops in 500 meter square area viz., *Cymbidium* orchids, Carnation, Alstromeria, Lilium and Potted plants. From the second year the other flowers crops can be replaced with *Cymbidium* and up to fifth year full area is covered with *Cymbidium* orchids. The benefit cost ratio for this is rupees 1.15.

1 st Year	<i>Cymbidium</i> (100 sq. meter)	Carnation (100 sq. meter)	Alstromeria (100 sq. meter)	Lilium (100 sq. meter)	Potted plants (100 sq. meter)
2 nd Year	<i>Cymbidium</i> (100 sq. meter)	Carnation (100 sq. meter)	Alstromeria (100 sq. meter)	Lilium (100 sq. meter)	Potted plants (100 sq. meter)
3 rd Year	<i>Cymbidium</i> (100 sq. meter)	<i>Cymbidium</i> (100 sq. meter)	Alstromeria (100 sq. meter)	Lilium (100 sq. meter)	Potted plants (100 sq. meter)
4 th Year	<i>Cymbidium</i> (100 sq. meter)	<i>Cymbidium</i> (100 sq. meter)	Alstromeria (100 sq. meter)	Lilium (100 sq. meter)	Potted plants (100 sq. meter)
5 th Year	<i>Cymbidium</i> (100 sq. meter)	<i>Cymbidium</i> (100 sq. meter)	<i>Cymbidium</i> (100 sq. meter)	<i>Cymbidium</i> (100 sq. meter)	<i>Cymbidium</i> (100 sq. meter)



Multiple crops in Polyhouse



Cymbidium



Lilium



Carnation



Alstromeria



Pot plants

Propagation of *Cymbidium* through Back-bulbs

Cymbidium hybrids are commercially grown in high altitude and temperate areas. The *Cymbidium* seedling multiplication through backbulb method was standardized using different phyto-hormones. In this technique the well cleaned back bulbs of *cymbidium* soaked in the solution of BAP (100 ppm) for 12 hours and put in the bags containing wet saw dust of *Cryptomeria japonica* for 45 days under dark conditions.

After sprouting the sprouted bulbs are planted in the trays for further development of plantlets. When plantlets having 4-5 leaves and 2-4 roots, they are detached from the bulbs and planted in the pots. This method was rapid and able to multiply 15 side shoots from each bulb. It has potential application at farmer's level due low cost involvement. The schematic representation is given below.



Cymbidium Backbulb Propagation Method

A. Cleaning of backbulbs
E. close-up of sprouted backbulbs

B. Soaking in BAP,
F. Plantlet development

C. Packing in sawdust,
G. Removal of plantlets, and

D. sprouted backbulbs
H. Planting

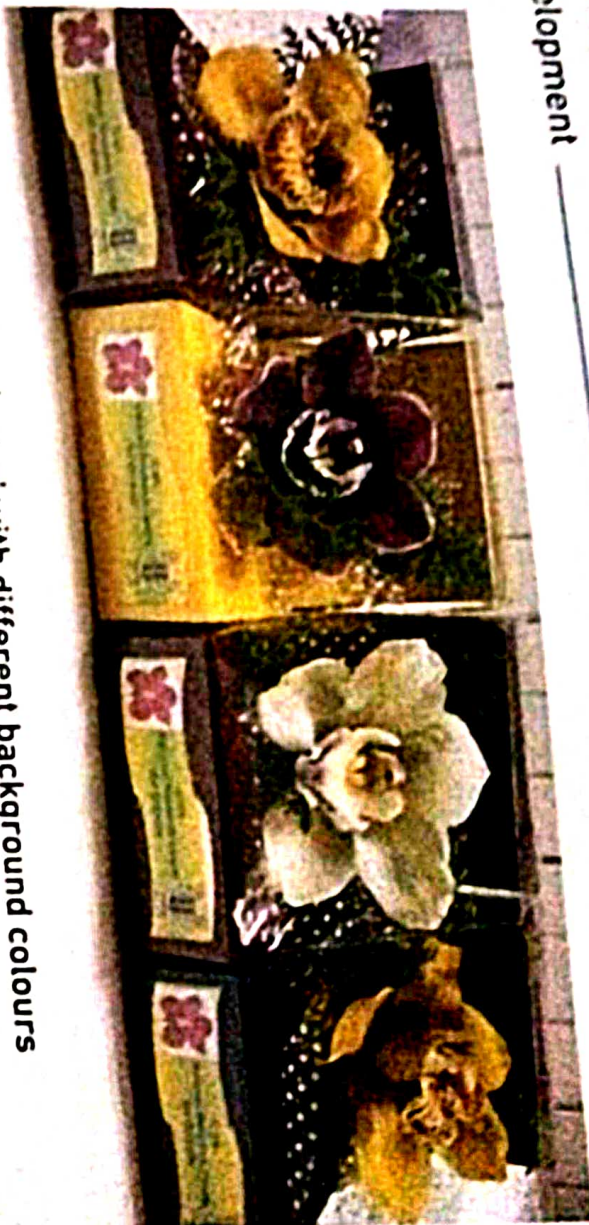
Unique Packaging of Single Florets of *Cymbidium* Orchid

Unique packaging of single *Cymbidium* flowers is a ready to use product for souvenirs or gifts. *Cymbidium* flowers, especially of standard type or intermediate type hybrids that are large and have a long vase life. ICAR-NRCO, Sikkim developed a unique packaging system of these flowers to create attractive floral product. It helps in utilization of unmarketable spikes and increases the profit margin and creates employment among the women entrepreneurs.

Technology of single florets of <i>Cymbidiums</i>	
Harvesting	Harvest at 2-4 days after full-opening
Handling	Harvest at early morning. Break off florets from spike or cut with sharp clean tool. Avoid mechanical injury or pollinia dislodging. Harvest healthy and unfertilized florets only.
Storing	Place florets in clean filtered water after giving a sharp cut at pedicel end and store at cool shade place till packed.
Preparing florets	Wrap pedicel end in wet-cotton swab and cellophane paper or insert it in small water-tube containing 10ml filtered water. Decorate with foliage of choice e.g. Thuja Wrap in decorative cellophane paper.
Design of boxes	Two types of packages - i. Package for single floret and ii. Package of multiple florets were designed
Packing Material used	Clear transparent 125µ or 175µ polyester film, Coloured chart paper/corrugated cardboard box single-ply 2mm.
Colour combination	Colour of box to be made in contrast to flower colour. Eg- yellow- maroon, navy blue - white.
Process of making box	Cut out design of box using stencils and fold to make parts of the box, secure the flower in place and close using cello tapes. Use label.

Economics

Cost of Floret = Rs.5.00 / each	Sale price = Rs.20.00/ unit
Material Cost = Rs.5.00 / box	Net profit = Rs.6.00/unit
Labour charge = Rs.4.00/ box	Capacity 100 boxes per day/manpower
Total cost = Rs.14.00/unit	



Cymbidium florets packed in 'Front facing clear boxes' with different background colours

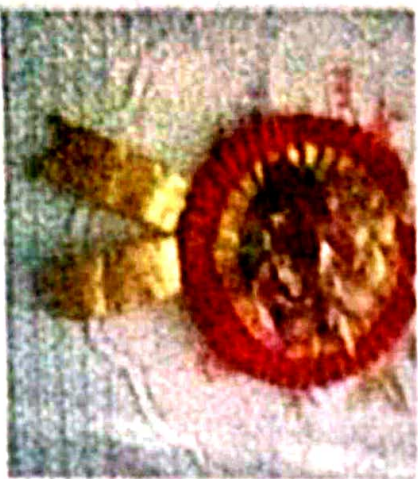
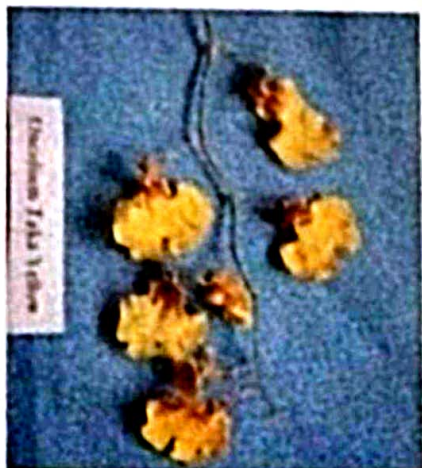
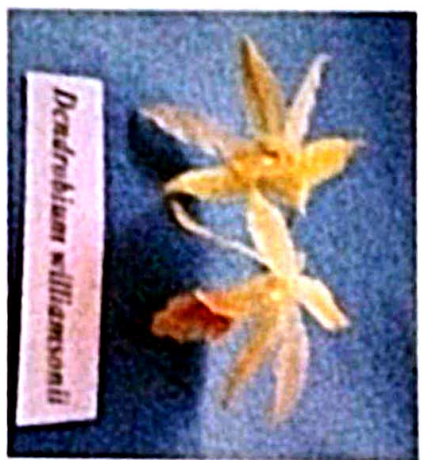
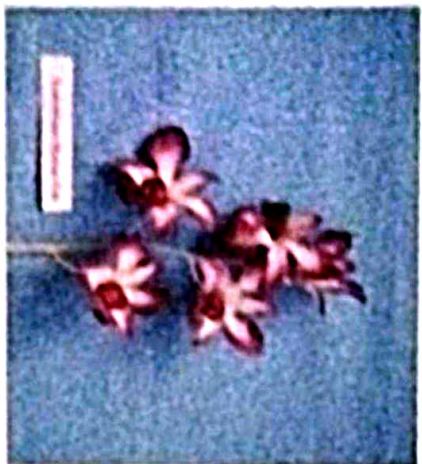


Packaging system for multiple florets of Cymbidium

Flower Drying Technology for Orchids

Flowers have always remained an integral part of man's life and love for natural flowers is an inherent instinct. Dried flower products on the other hand are long lasting and retain their aesthetic value irrespective of the season. The art of flower drying is a very age old practice. Earlier dried flowers were in practice in the form of herbarium made by botanists for the purpose of identification of various species. Dry flowers constitute more than two-thirds of the total floriculture exports. The demand for dry flowers is increasing at an impressive rate of 8-10 per cent annually thus offering a lot of opportunities for the Indian entrepreneurs to enter in the global floricultural trade. They can be utilised in the best manner for making decorative floral craft items, greeting cards and covers, wall hangings, floral designs, calendars, floral balls, festive decoration and other creative displays. Floral albums may be prepared with these items for identification of plants for botanical studies. A cottage or small scale industry based on floral crafts using dehydrated flowers, leaves, fruits, pods, seeds and other parts in a distinct possibility.

S. No. Species / varieties of orchids	Recommendations
1. Vanda teres, <i>Dendrobium moschatum</i> , <i>Arundina graminifolia</i> , Den. 'Madam Pink', Den. 'Lervia', Den. 'Abraham', Phal. 'Casa Blanca', Phal. 'Detroit' and <i>Oncidium</i> 'Sweet Sugar'	Embedded drying with borax at 50°C in oven
2. <i>Epidendrum</i> spp., <i>Cattleya bowringiana</i> and <i>Cattleya</i> hybrids, Phal. 'Ox Plum Rose x Black Jack' and Den. 'Big White', <i>Vanda coerulea</i>	Embedded drying with borax at 60°C in oven
3. <i>Coelogyne flaccida</i> , <i>Coelogyne cristata</i> , <i>Dendrobium nobile</i> , <i>Dendrobium williamsonii</i> , <i>Dendrobium aphyllum</i> , Den. 'Erika', Den. 'Big White 4N', Den. 'Bangkok Blue', Phal. 'Nagasaki' and Cym. 'Sungold'.	Embedded drying with borax and silica gel at 55°C in oven
4. <i>Dendrobium</i> , <i>Phalaenopsis</i> , <i>Cattleya</i> , <i>Cymbidium</i> , <i>Aranda</i> , <i>Mokara</i> hybrids	Perlite, Perlite + borax and Perlite + Silica gel under room condition (24-25°C and 75-79% RH)
5. <i>Cattleya</i> 'Guanmian City', <i>Dendrobium</i> 'Phalaenopsis Vienna', <i>Vanda tessellata</i> , 'Taka Yellow', <i>Phalaenopsis</i> 'Taida S. Red'	'Lervia', Embedded drying with sand at 50°C in oven



Different floral arrangements prepared from dry flowers of orchids

Basket From waste *Cymbidium* leaves

The leaves of *Cymbidium* orchids are up to 1 meter long and old pseudo bulbs shed their leaves every year due to their sympodial growth habit. These leaves are very strong. These were utilized for weaving baskets. The baskets made out of these leaves are durable and giving an aesthetic look and degradable. It is useful in reducing farm waste. One full grown plant shed on average 10-12 leaves per year and these leaves go waste, by utilizing these leaves for making baskets farmers they will get the extra income from his farm waste. Framers they will earn rupees 150-200/- per baskets and this will improve the livelihood of women farmers. His Excellency, the Governor of Sikkim lauded the efforts of NRC for orchids in converting this farm waste into useful products. He advised such more efforts needs to be made in using farm waste, which can provide an income to women folk. Baskets being made are organic and can be used for decorative purpose in domestic market. This technology is recommended for adoption in any hilly state especially for city dwellers.



His Excellency, Shri Shrinivas Dadasaheb Patil, Hon'ble Governor of Sikkim with a basket made out of *Cymbidium* orchid leaves at NRCO, Sikkim on dated 19/04/2016

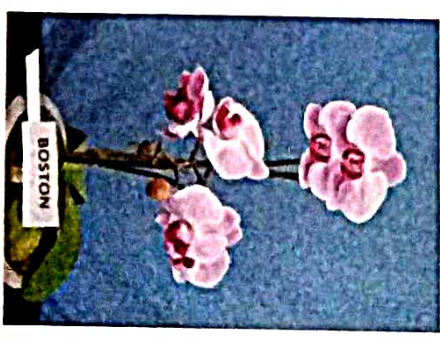
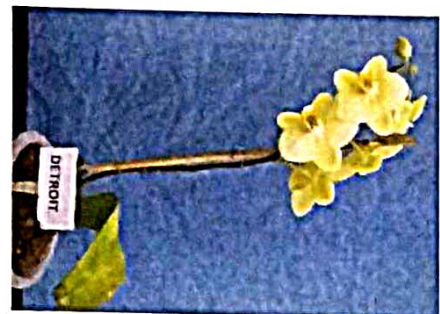
A woman making Baskets from *Cymbidium* orchids leaves





Production Technology of *Phalaenopsis*

Phalaenopsis, also known as moth orchid, is an orchid genus of nature. The clarity and glamour of the *Phalaenopsis* flower makes it ideally approximately 60 species. It is native to the Indo-China region, Southeast Asia, New Guinea and Australia. It is one of the most popular orchids in the trade at present and many hybrids have also been developed. Most are epiphytic, shade loving orchids while some are found to be lithophytic in



Phalaenopsis Varieties



Cym. 'Carlpepper
Peachy Keen'



Cym. 'Red Beauty
Evening Star'



Cym. 'Rocky Creek Pebbles'



Cym. 'Samurai Hee
Saw Sagun'



Cym. 'Sunny Moon'



Cym. 'Bob Marlin Lucky'



Cym. 'Fire Storm Blaze'



Cym. 'Fire Storm Ruby'



Cym. 'Winter Beach Sea Green'



Production Technology of *Dendrobium*

Dendrobium consists of 1600 species of sympodial epiphytic orchids. The genera are characterized by long pseudobulbs or canes with soft leaves on entire length or in some species, pseudobulbs are short or swollen terminating in two coriaceous leaves. *Dendrobiums* are popular for cut flowers and for interiorscaping. They are also valuable as pot plants or hanging baskets. Some species are hanged on the walls or on tree branches to cover the bare walls and branches. The dried stems of *Dendrobium nobile* are used for making herbal medicines.

Suitable varieties	Emma White, Bangkok Blue, A. Abraham, Kating Dang, Thongchai Gold,	Lervia
Potting Media	Coco peat / cocochips + brick pieces + tree bark (1: 1: 1)	
Temperature	The cool growing <i>Dendrobium</i> orchid group thrives well temperatures ranging between 10 and 24°C. The intermediate <i>Dendrobium</i> orchid prefers a temperature range of 14-26°C whereas the warm growing <i>Dendrobium</i> orchids prefer 16 to 30°C.	
Light	All types of <i>Dendrobium</i> orchids require warm bright light (2500-3000 foot candles). They should get at least 12-14 hours of light each day year round.	
Humidity	50-70%.	
Irrigation	Summer: 2-3 times per week, Autumn: Once or twice per week, Winter: Once per week Spring: As Autumn season.	
Nutrition	0.2 to 0.3 % of 30:10:10 (N: P: K) at vegetative stage 10:20:20 (N: P: K) at blooming stage	
Major Insect pest	Shoot borer: Chlorpyrifos @ 1.5 ml/L	
Major Diseases	Black rot: Mancozeb @ 2g/l	
Spikes/Plant	4-5 spikes	
Market Price	Rs. 20-30/-	



Emma White



Bangkok Blue



A. Abraham



Kating Dang



Thongschai Gold



Lervia

Post-harvest Technology of *Cymbidium* Orchids

SLNo.	Particulars	Recommendations
1.	Evaluation of elite hybrids for vase life	Bob Marlin Lucky (57 days), Fire Strom Blaze (53 days), Hazel Fay Tangerine (50 days), Everett Stockstill Bullai (48 days), Caripepper Peachy Keen (43 days), Hana Akari (41 days), Fire Storm Ruby (36 days)
2.	Spike length and vase life of different classes of <i>Cymbidium</i>	Miniature (30-60cm): 30-34 days Intermediate (60-75cm): 35-37 days Standard (> 75cm): 55-59 days
3.	Optimal stages of harvest of <i>Cymbidium</i> 'PCMV' for maximum vase life	Two buds opened stage (66.8 days)
4.	Best impregnation treatment of <i>Cymbidium</i> 'PCMV' for maximum vase life	CoCl ₂ (1000ppm) for 15 minutes (46 days)
5.	Best pulsing treatment of <i>Cymbidium</i> for maximum vase life	5% sucrose for 8 hours (56 days)
6.	Best pre-harvest spray of <i>Cymbidium</i> for maximum growth and vase life	GA3 (50 ppm) + BA (200 ppm)
7.	Best chemical treatment for opening of tight buds of <i>Cymbidium</i> cutflowers	Sucrose 4% + Salicylic acid 200 ppm with 75% opening and vase life of 45 days
8.	Best holding solution for improved vase life of <i>Cymbidium</i>	2% sucrose + 200 ppm 8-HQS with vase life of 76.6 days
9.	Best packaging material of <i>Cymbidium</i> spikes and florets for improved vase life	Cellophane (56 days)
10.	Best harvesting stage of <i>Cymbidium</i> florets for improved vase life	Fully opened florets with vase life of 48 days.



Cym. 'Bob Marlin Lucky'



Cym. 'Fire Storm Blaze'

Cymbidium hybrids for cut flowers



Cym. "Everett StockstillBullai"



Chemicals for opening of tight buds of
Cymbidium cutflowers



Semi hydroponics in *Zygopetalum*

Zygopetalum are very fragrant orchids and their fragrance can often feel in an entire room. It is very important that planting media should be dry out completely between two waterings. *Zygopetalum* prefer bright but indirect light intensity in order to thrive well and good growth. *Zygopetalum* require cool to intermediate range of temperature. The ideal day time temperatures to grow *Zygopetalum* orchid is between 21.1°C to 26.6°C and night temperatures are between 10°C to 15.6°C. *Zygopetalum* orchids require humidity levels of 40-60 %. During the high humidity levels, it is equally important to maintain proper air movement to prevent orchid diseases. *Zygopetalum* orchids should be fertilized with every watering including a half-strength of Hoagland solution (N-210, P-31, K-235, Ca-200, S- 64, Mg-48, B-0.5, Fe- 0.1, Ma-0.5, Zn- 0.05, Cu-0.02, Mo-0.01 mg L⁻¹) during the active growth period. *Zygopetalum* can be re-potted in Moss or Vermiculite or Coco peat medium in semi hydroponic system. Before repotting orchid, any damaged or rotting roots should be trim away with a sterile cutting tool.



Cleaning of Dead or damaged roots



Division of Plant



Treatments of Plant with Fungicides



Re-potting of Plant



Tying of Plant



Irrigation in Semi-hydroponic Plant



Flowering of Plants under semi hydroponic system

Semi hydroponics in *Zygopetalum*

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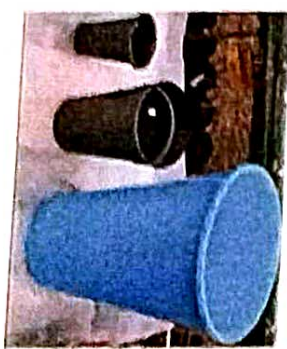


Flowering of Plants under semi hydroponic system



Potting Mixtures of Commercial Orchids

Sl. No.	Commercial orchids	Recommended varieties/hybrids	Potting mixtures
1.	<i>Cymbidium</i>	Cym. Red Beauty Evening Star, Cym. Bob Marlin Lucky, Cym. Fire Storm Ruby, Rocky Greek Pebbles, Cym. Hazel Fay Tangerine, Cym. Fire Storm Blaze, Cym. Sunny Moon, Cym. Samurai Hee Sagun, Cym. Winter Beach See Green, Cym. PCMV, Cym. Ensi Khan, Cym. Everett Stockstill Bullen, Cym. Valley Legend Steff, Cym. Caripepper Peachy Keen, Cym. Soul Hunt	Cocochips + Cocopeat + Brick pieces + Slow release fertilizer (Osmocot) (1: 1: 1: 5g)/dry leaf fern
2.	<i>Dendrobium</i>	Big White 4N, Bangkok Blue, Dang Saard, Big White Jumbo, Erika, Madam Pompadour, Ear Sakul, Thongchai Gold, Madam Pink, Triple Pink, Emma White, Julie, Kating Dang	Coco peat / cocochips + brick pieces + tree bark (1: 1: 1)
3.	<i>Vanda</i>	Prad Sky Blue, Pures Wax, RBSD Black, Pat Delight, Sansai Blue, Roberts Delight Blue, Notes Indigo Blue, V. Sirlak x Thongchai Gold, Pakchong Blue, RBSD Pink, RBV-10 x Fusch's Delight, RBSD Blue, RBV-10 x Dr. Anek, Reich Blue Stars	Cocochips + brick pieces + leaf fern (1:1:1)
4.	<i>Phalaenopsis</i>	Taida S.Red, Kaleidoscope, Strawberry, Maki Watanabe, Hsin-Ying Fortune, Shu Shu Long First Love, Memoria Francis Hunter, Ox Prince Thunder, Chian Xen Maggie, Ox Plum Rose x Ox Black Jack, Detroit, Vienna, Manchester	Cocochips + brick pieces + leaf moulds + green moss (1:1:1:1)
5.	<i>Cattleya</i>	Blic Gusanliu City, Blic Chinese Beauty Orchid Queen, Lc. Purple Cascade 'Fragrant Beauty', C. Queen Srikant, Blic. Hsin ying Catherine, Lc. Ahmad Shiekh, Blic. Mem Ann Balmores 'Conves', Blic Chia Lin New City, Blic. Ab blaze Medal 'U Emperor'	Cocochips + brick piece + leaf mould/ leaf fern (1:1:1)
6.	<i>Oncidium</i>	Colm. Wildcat Bobcat, Colm. Wildcat Carmera, Colm. Pixie Ruth, Sweet Sugar, Gower Ramsay, Sherry Baby Sweet Fragrance, Taka Yellow, Popki Red, Jairak Rainbow Pink Spot, J.R. Orange Red, J.R. Yellow Brown, J.R. Orange Spot	Cocochips + brick pieces + leaf moulds (1:1:1)



Orchid Based Multi Cropping/Vertical Farming and Conservation

Orchids planted in pots are generally kept on top of iron/bamboo benches. Thus, the walls of the polyhouses and and the groundspace underneath the benches remains empty. These spaces can be utilized in many ways for planting of different crops. Keeping this in mind an initiative was taken to utilize the walls of the polyhouses for vertical farming and conservation of orchids, where orchid species planted on wooden logs on mosses are hanged. The space beneath the benches were utilized for planting of spices, vegetables and flower nursery.

Objective: The objective of this system of cropping is to utilize all the side walls of the polyhouse and the ground space more effectively.

Vertical farming

Orchids of different species were planted on wooden logs on mosses and these logs were hanged on to the walls of the polyhouse with the help of iron wires.

Growing of vegetables and spices beneath the iron benches

Bed preparation

First of all, the area under the benches were secured on all the four sides with wooden planks of about 15 cm in height so that it holds the media

together. Bed size is of 1x 1m². The beds were filled with different media like sand and FYM. Flower cuttings root faster in sand.

Selection of crops

Vegetables and spices: Select shallow rooted, short duration and short heighted vegetable crops. Coriander, Methi, Chausur, Mustard (*Toria* sp.), Mustard (Raisak), Garden pea.

Flowers: Rose, Geranium, Fuschia, Poinsettia, Coleus, Bougainvillea, Dahlia, Hibiscus, Nerium, Jasmine, Duranta.

Sowing/planting of cuttings

- Seeds of Vegetable and spice crops were sown directly by broadcasting. The seeds were then covered with a little bit of soil.
- 5-6cm healthy cuttings of different flowers with 2-3 vegetative buds were selected and planted directly on the media (sand). 50-80 cuttings of each crop could be planted/m².

Harvesting

Different vegetables and spices were ready for harvesting after a period of about 40-45 days after planting. Thus, 6-7 crops can be harvested within a period of one year. The cuttings were ready to be transplanted to pots after 40 days after planting. Biomass yield incase of vegetables.



Sl. No.	Crop	Biomass yield/m ² (in kg)
1.	Coriander	0.524
2.	Methi	0.285
3.	Chausur (Local name)	0.642
4.	Mustard (<i>Toria</i> sp.)	1.539
5.	Mustard (Raisak)	0.505
6.	Pea	2.63



Vertical farming



Bed preparation



Flower cuttings



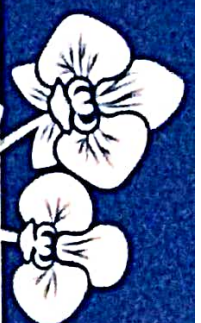
Coriander



Chausur

Protocol for *in-vitro* propagation of *Dendrobium nobile*

Dendrobium nobile was not described until 1830, yet has become possibly the most well-known of all dendrobiums, due to its popularity as an ornamental. There are a number of varieties in cultivation, including *Dendrobium nobile* var. *virginale*, which has white flowers with a yellowish green centre to the lip. Another commonly cultivated variety is *Dendrobium nobile* var. *cocksonianum*, in which the petals resemble the lip, each having a rich maroon-purple velvety blotch in the basal half. This species was first known from China and was later imported for cultivation into Europe from India. Many horticultural varieties of this species were named in the 19th century. This species occurs largely in deciduous forests between 1,500 and 2,000 m elevation in the foothills of the Himalayas and surrounding areas. It is recorded from India, Bhutan, Nepal, Myanmar, Thailand, China, Laos and Vietnam. It is also valued in traditional Chinese medicine. It is used to nourish and stimulate the stomach. A tea made from the stems of this and other *Dendrobium* species is taken for complaints such as fever, sunstroke and excessive perspiration. Scientists have isolated several compounds from the stem and leaves, including dendrobine, dendroxine, dendrin and other alkaloids. Phenanthrenes from *Dendrobium nobile* have shown anti-tumour activity in laboratory tests on cancer cells. Sesquiterpene glycosides isolated from the stem affect lymphocyte cells, indicating possible immunomodulatory effects. Giganol isolated from *Dendrobium nobile* has shown antimutagenic properties. This technology is recommended for commercial firms and orchid growers at Sikkim, Assam, Arunachal Pradesh, Meghalaya, Manipur and Mizoram.



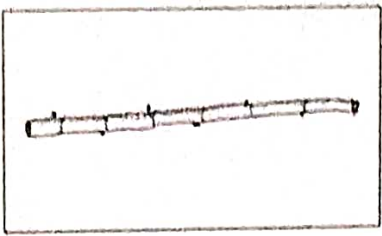
DUS Test Guidelines of Commercial Orchids

Genera	Publication in Plant Variety Journal of India	Gazette Notification No.
<i>Cymbidium</i>	Vol. 05, No. 10, October 03, 2011	S.O. 617 (E), 27/03/2012
<i>Dendrobium</i>	Vol. 05, No. 10, October 03, 2011	S.O. 617(E) 27/03/2012
<i>Vanda</i>	Vol. 05, No. 10, October 03, 2011	S.O. 617(E) 27/03/2012
<i>Phalaenopsis</i>	Vol. 06, No. 11, November 01, 2012	S.O. 1093(E), 15/04/2014
<i>Cattleya</i>	Vol. 06, No. 11, November 01, 2012	S.O. 1093(E), 15/04/2014
<i>Oncidium</i>	Vol. 08, No. 04, April 01, 2014	S.O. 2664 (E), 16/10/2014
<i>Paphiopedilum</i>	Vol. 09, No. 08, August 03, 2015	19/4/2016

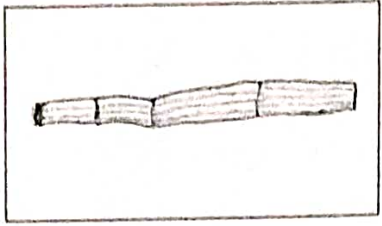


Sl.No.	Genera	No. of hybrids	Total No. of morphological descriptors	Grouping characteristics
1.	<i>Cymbidium</i>	41	66	Pseudobulb shape & size, Inflorescence length, number of flowers/inflorescence, Flower width, Flower duration, Flower predominant color, Lip ornamentation, Blooming time
2.	<i>Dendrobium</i>	14	60	Plant height, Internode length, Inflorescence length, Flower width, Lip colour, Lip ornamentation, Flowering time
3.	<i>Vanda</i>	11	66	Plant type, Internode length, Leaf type, Spike length, Flower number, Inflorescence colour, Sepal & petal ornamentation, Lip: shape, colour, ornamentation, Spur length, Flowering time
4.	<i>Cattleya</i>	9	53	Plant: height, Leaf: number/pseudobulb, Flower width in front view, Petal: predominant colour, Lip predominant colour, Lip colour pattern
5.	<i>Phalaenopsis</i>	50	58	Plant size, Flower width in front view, Petal predominant colour, Petal colour pattern, Lip predominant colour, Lip Predominant colour of apical lobe, Lip colour pattern of apical lobe
6.	<i>Oncidium</i>	40	60	Plant type, Number of basal leaves/pseudobulb, Flower width in front view, Petal main colour, Petal colour pattern, Lip main colour, Lip colour pattern
7.	<i>Paphiopedilum</i>	10	77	Floral bract shape, Flower width in front view, Dorsal sepal colour pattern, Synsepal width, Synsepal main colour, Petal orientation, Lip colour pattern, Column staminode size

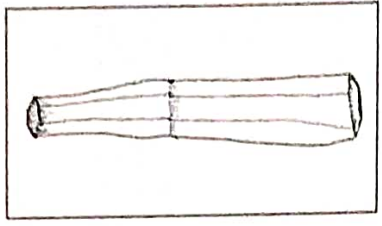
Nature of stem in *Dendrobium*



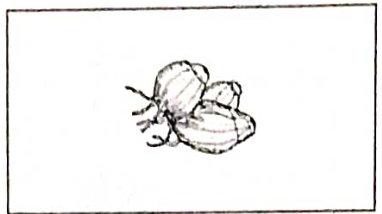
Cane (woody)



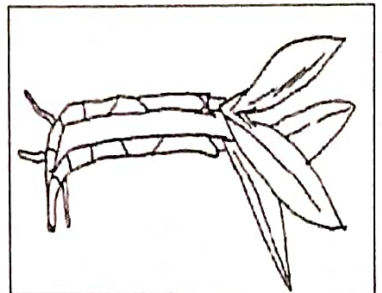
Cane cylindrical (fleshy)



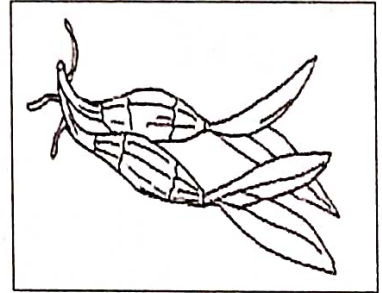
Cane clavate fleshy



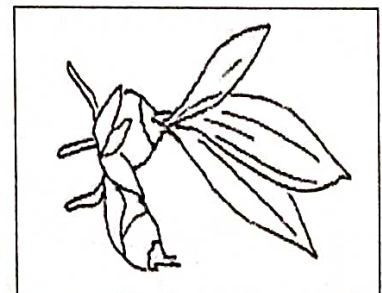
Bulbous (round)



Cylindrical



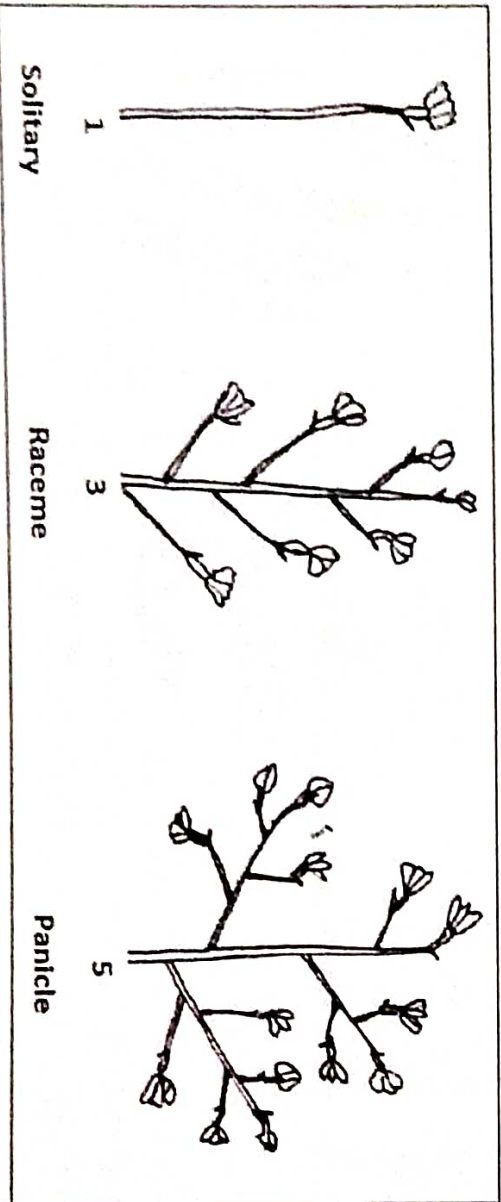
Clavate



Globular/Ovoid

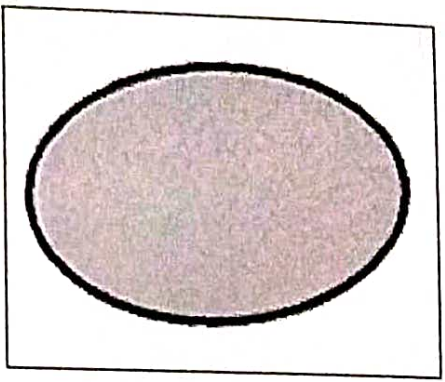
Nature of pseudobulb in *Cattleya*

Inflorescence type in *Phalaenopsis*

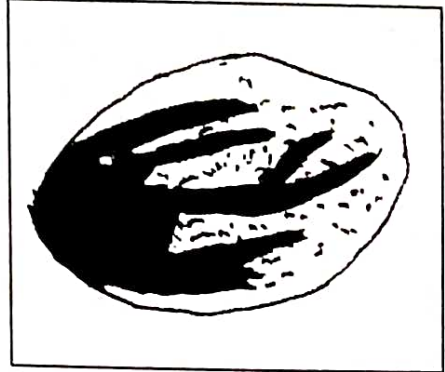




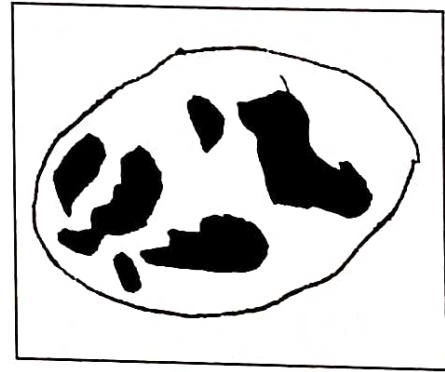
Lip colour pattern in *Oncidium*



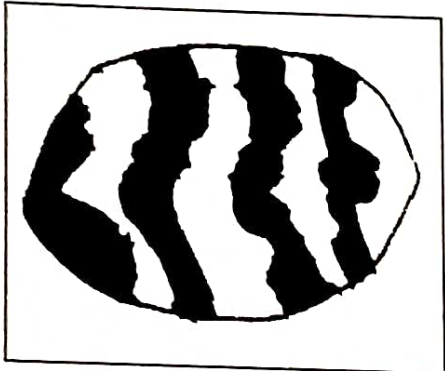
uniform



shaded



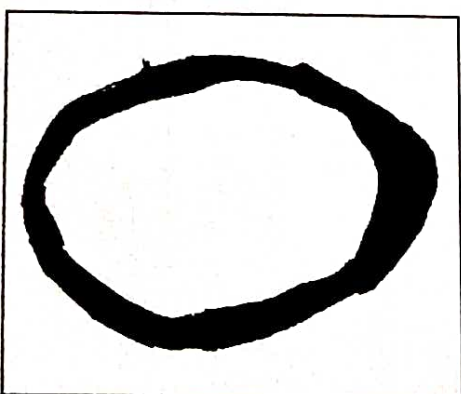
blotched



brindled



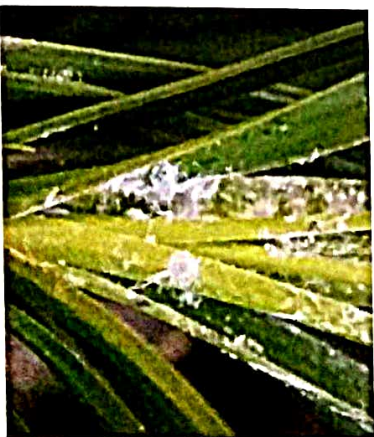
striped



edged



Crop Protection





Bio-pesticides in Insect-Pest Control in Orchids

Many plants have developed natural, biochemical mechanisms to defend themselves from weed competition, insect and fungal attacks. Some of these chemicals discourage feeding by insects and other herbivores. Locally available botanical plants known to have insecticidal properties were evaluated for management of insect pest on orchids. The plants viz. *Ageratum conizoides*, *Eupatorium odoratum*, *Artimessia* sp., *Chlerodendrum viscosum*,

Dhatura sp etc, are collected, washed properly, soaked overnight and the plant extract is taken out with the help of mixer and grinder. The fresh extract is used @ of 10%. They are being evaluated singly or in combination with other pest management practices. Commercial formulations of various neem products like neem oil, Neem Seed Kernel Extract (NSKE) were also evaluated at different concentrations for management of major pests on orchids.



Artimessia sp.



Lantana camara



Schima wallichi

Microbial Pesticides in Orchids

Several entomopathogens are known to cause disease in insects leading to high mortality. Commercial formulations of entomopathogenic fungi like *Beauveria bassiana*, *Metarhizium anisopliae*, *Verticillium lecanii*, *Paecilomyces fumosoroseus* were evaluated at different concentration for the management of Aphids (*Macrosiphum luteum*, *Toxoptera aurantii*), thrips (*Dictriothrips nakahari*) and scale insects (*Diaspis biosduwali*,



Aphid, *Macrosiphum luteum*



Dead aphids after treatment on *Epidendrum radicans*



Long tailed mealy Bug (*Pseudococcus longispinus*)

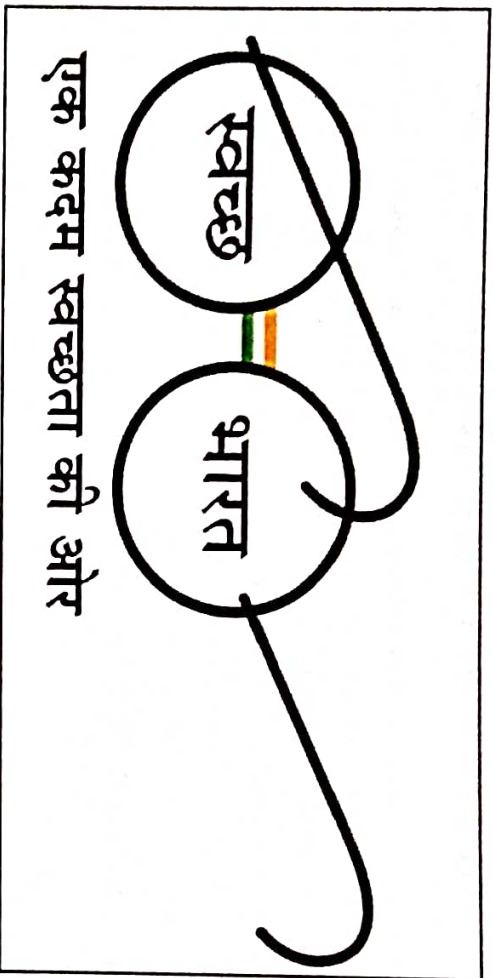


Dead mealy bugs after treatment on *Dendrobium fimbriatum*

Shoot borer, *Peridaadala* sp.



Bt infected larvae of shoot borer



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