

# PRODUCTION TECHNOLOGY OF PHALAENOPSIS



**L.C. De, D. Barman, R.P. Medhi  
Geetamani Chhetri and H. Pokhrel**

**National Research Centre for Orchids  
(Indian Council of Agricultural Research)  
Pakyong – 737 106,  
Sikkim, India**



Technical Bulletin No. 15

# PRODUCTION TECHNOLOGY OF PHALAENOPSIS

L.C. De  
D. Barman  
R.P. Medhi  
Geetamani Chhetri  
H. Pokhrel



**National Research Centre for Orchids**  
(Indian Council of Agricultural Research)  
Pakyong – 737 106,  
Sikkim, India



# **Production Technology of Phalaenopsis**

National Research Centre for Orchids  
Pakyong - 737106, Sikkim

Copyright @ 2013 National Research Centre for Orchids

**Compiled and Edited by**

L.C. De and D. Barman

**Published by**

R.P. Medhi and L.C. De  
National Research Centre for Orchids  
Pakyong-737106, Sikkim

**Cover Photographs**

**Front:** Glimpses of Phalaenopsis orchids

**Back:** Post harvest evaluation of Phalaenopsis hybrids

**Printed**  
June, 2013

## PREFACE

Phalaenopsis is the second most valuable and popular flowering potted plant and cut flower around the world due to their easy cultural practices, diversity in flower color, size and shape, year round availability, delicacy and lengthy vase life. Phalaenopsis is commercially grown in Germany, Japan, The Netherlands, Taiwan and the United States. In the United States, 75% of all orchids purchased are phalaenopsis and about 13,500,000 phalaenopsis were sold in 2005 in United States. The export value of phalaenopsis from Taiwan to the United States increased from \$8 million in 2005 to \$ 13 million in 2006. Worldwide turnover of Taiwanese phalaenopsis increased from \$ 27.5 million to \$ 35.4 million from 2005 to 2006.

The present technical publication '*Production Technology of Phalaenopsis*' covers the wide aspects of Phalaenopsis orchids starting from botanical description, valuable species, common commercial hybrids for pot plants and cut flowers, environmental factors, growth phases, propagation, cultivation techniques, harvest and post harvest management and insect pests and diseases.

I hope that it will be an useful handy reference technical bulletin for amateur and professional orchid growers, small and big orchid farmers, orchid entrepreneurs, extension workers, exporters and students.

(Lakshman Chandra De)

## Contents

1.	Introduction	1
2.	Botanical description	1
3.	Species	4
4.	Hybrids	5
5.	Environmental factors	10
6.	Phases of growth	13
7.	Propagation	15
8.	Cultivation	17
9.	Harvest and post-harvest management	24
10.	Insects Pests and Diseases	24

## **Introduction**

*Phalaenopsis* called as 'Moth Orchid' because when the *amabilis* species was first observed in its natural habitat, the long inflorescences of pendulous white flowers that festooned the jungle tree tops were thought to be clusters of moths. This orchid has originated from jungles of South and Southeast Asia, Indonesia, Malaysia and the Philippines. *Phalaenopsis* is commonly used as pot plants and cut flowers and are suitable in hotel arrangements, hanging arrangements, households, boutique stores, weddings, funerals, birthdays, etc. The purity and brightness of the *Phalaenopsis* make an especial appeal for weddings and corsages.

## **Botanical description**

*Phalaenopsis* consists of 70 species of monopodial orchids distributed in Asia, Philippines, Indonesia, Malaysia, Australia and New Guinea. They are commonly known as 'Moth Orchids'. The plants are pseudobulbless with short stems covered by the clasping leaves. The leaves are leathery, thick. The inflorescence arises from the axil of leaves, drooping or erect bearing spikes of 50cm-100cm length. The flowers are spectacular, long lasting and white, pink, yellow or mottled. *Phalaenopsis* has two types. In the first type, leaves are thick and fleshy, elongate-elliptic and obtuse in apex. The flowers petals are broader than the sepals and the lip possesses two attractive centre lobes and appendages. The flowering stem is upto 60 cm long and bears 15 or more blooms. Species belonging this group are *Phalaenopsis parishii*, *P. aphrodite*, *P. stuartiana*, *P. schilleriana* and *P. sanderiana*. In the second

type, plants are short stemmed bearing fewer blooms. The flowers are smaller with equal sizes of sepals and petals and without any appendages. Species belonging this group are *Phalaenopsis cormi-cervi*, *P. leuddemanniana*, *P. equestris* and *P. manni*.

### **Morphological Descriptors**

**Plant:** size

**Leaf:** length, width, shape, shape of apex, symmetry of apex, attitude, anthocyanin coloration

**Inflorescence:** type, length, no of flowers

**Peduncle:** length, thickness, anthocyanin coloration

**Flower:** General appearance, texture, length, width, arrangement of petals, fragrance

**Dorsal sepal:** shape, length, width, curvature, undulation of margin, no of colors, colour pattern, dominant colour, secondary colour

**Lateral sepal:** shape, length, width, no of colors, colour pattern, dominant colour, secondary colour

**Petal:** shape, length, width, curvature, twisting, undulation of margin, no of colors, colour pattern, dominant colour, secondary colour

**Lip:** length of apical lobe, width of apical lobe, presence and length of whiskers, shape of apical lobe, bump and ridge on apical lobe, size, shape and curvature of lateral lobe, no of colours, dominant and colour pattern in apical and lateral lobe, callus, pubescence

**Column:** length, colour of apex, curvature

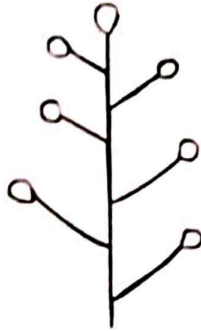
**Flowering season:** Summer, rainy and winter

**Flower longevity on plants:** Short, medium and long

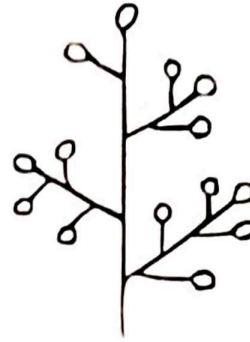
**Inflorescence type**



1  
Solitary



2  
raceme

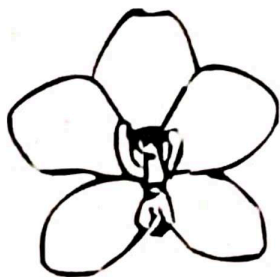


3  
panicle

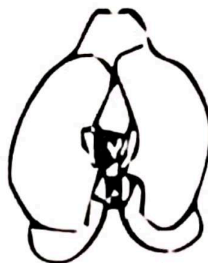
**Inflorescence length**



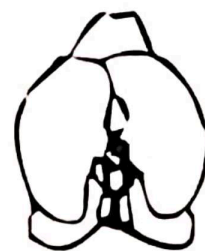
**Flower arrangement of petals**



1  
open



2  
touching



3  
overlapping



## Species

*Phalaenopsis amabilis*: This species is native to Java, Indonesia, Australia and New Guinea. The leaves are fleshy, leathery, obovate and dull green in colour. Inflorescence is slender, arching, 90cm long and 6 to 20 flowered. The flowers are 10cm across, pure white and produced in December-January.

*Phalaenopsis aphrodite*: This species is native to Philippines. The leaves are dark green upper side and purple beneath, obovate. The inflorescence is branched and arched. The flowers are 10cm across, greenish yellow and produced during January-February.

*Phalaenopsis esmeralda*: A Chinese species with dark green leaves, mottled upperside and reddish beneath. Inflorescence is erect, 30cm long bearing 6 to 10 small flowers. Flowers are 2.5cm across, pink with purple lip and produced during summer.

*Phalaenopsis luddemanniana*: This species is native to Philippines. The leaves are bright waxy yellowish green, rigid. Inflorescence is irregular zigzag, short arched and 2 to 7 flowered. The flowers are 3-4.5cm across, scented, long lasting and creamy white in colour marked with violet purple. The flowers are produced in spring season.

*Phalaenopsis parishii*: This species is native to Assam, Sikkim, Meghalaya and Burma. The leaves are dark green, elliptic. The inflorescence is 5 to 9 flowered, racemose, 10cm long. The flowers are white, spotted with purple with yellow lip and produced in March-April.

*Phalaenopsis schilleriana*: This species is native to Philippines. The leaves are large, dark green marked transversely with silver white mottled bands. The inflorescence is very long, 90cm tall, branched, arching and bearing numerous pink flowers. The flowers are 7.5cm across and produced during February-April.

*Phalaenopsis lobbii*: This species is native to Eastern Himalaya to Indo-China. Leaves are 5-10cm long. Inflorescence is 8-12.5cm long and 3 to 7 flowered. Flowers are small, 1.2-2.0cm across, white with larger sepals than petals. The lip is tan colored with a little white stripe. Flowering time is January-March.



*Phalaenopsis lobbii*

*Phalaenopsis mannii*: This species is native to Eastern Nepal to Southern Yunnan. Flowers are deep red and dark golden yellow, the white lip is highlighted by yellow throat markings.



*Phalaenopsis mannii*

## Hybrids

### 1. Bigeneric hybrids:

*Aeridopsis* = *Phalaenopsis* x *Aerides*

*Arachnopsis* = *Phalaenopsis* x *Arachnis*

*Doritaenopsis* = *Phalaenopsis* x *Doritis*

*Phalanetia* = *Phalaenopsis* x *Neofinetia*

*Renanthopsis* = *Phalaenopsis* x *Renanthera*

*Vandaenopsis* = *Phalaenopsis* x *Vanda*

**2. Trigeneric hybrids:**

*Sappanara* = *Phalaenopsis* x *Arachnis* x *Renanthera*

*Trevorara* = *Phalaenopsis* x *Arachnis* x *Vanda*

*Lycokara* = *Phalaenopsis* x *Arachnis* x *Vandopsis*

*Rhyndoropsis* = *Phalaenopsis* x *Doritis* x *Rhyncostylis*

*Moirara* = *Phalaenopsis* x *Renanthera* x *Vanda*

*Yapara* = *Phalaenopsis* x *Rhyncostylis* x *Vanda*

**3. Tetrageneric hybrids:**

*Bogardora* = *Ascocentrum* x *Phalaenopsis* x *Vanda* x *Vandopsis*

*Bokchoonara* = *Arachnis* x *Ascocentrum* x *Phalaenopsis* x *Vanda*

*Edeara* = *Arachnis* x *Phalaenopsis* x *Renanthera* x *Vandopsis*

**4. Pentageneric hybrids:**

*Sutingara* = *Arachnis* x *Ascocentrum* x *Phalaenopsis* x *Vanda* x *Vandopsis*

*Macekara* = *Arachnis* x *Phalaenopsis* x *Renanthera* x *Vanda* x *Vandopsis*

*Paulara* = *Ascocentrum* x *Doritis* x *Phalaenopsis* x *Renanthera* x *Vanda*

**5. Natural hybrids:** *Phal. Amphitrita*, *Phal. intermedia*, *Phal. leucorrhoda*, *Phal. rothschildiana*, *Phal. Singulifera*

**6. Inter-specific hybrids:** 'Borneo Belle', 'Cecile', 'Fuscabell', 'Anna', 'T.H. Pearl', 'Renchy's Plastic

Yellow', 'Herman Sweet', 'Gold Veins', 'Amabell', 'Algicora', 'Smiling Tiger'.

7. **Inter-varietal hybrids:** 'Free Gold', 'Durga Ko Dil', 'Popp Queen', 'Red Hot Girl', 'White Ghost', 'White Galaxy', 'Dotted Perfection', 'Hamana Gold', 'Triastar Diamond', 'Tiraster Golden Lip', 'Archie Goodwin', 'Taida Sun Smile', 'Pink Pixie', 'Exotics Plum Red', 'Woodson's Dalmation', 'Walnut Valley Peachy'
8. **Variety-species hybrids:** 'Hemlata and Chris', 'Hama Snow', 'Berry Blossoms', 'Good Time Charlie', 'Stone Trail', 'Taisuco Emperor', 'Taisuco Sumatra', 'Thirty Eight Special'

*Phalaenopsis* have more than thousands of hybrids registered so far of different shape, size, color and those are used for commercial cultivation as potted plants.

**Standard white:** They are larger, flatter, and rounder overlapping petals and sepals, flowers are displayed and spaced better on the inflorescence, flowers are snow white color. Elisabethe, Doris, Alice Gloria, Cast Iron Monarch, Dos Pueblos, Elinor



Brother White Windian

Shaffer, Gladys Read, Grace Palm, Joseph Hampton, Juanita, Palm Beach, Ramona, Richard Shaffer, Sonja, Taisuco Bright, Taisuco Crane, Taisuco Snow, Cygnus, Brother Sister Windian etc.

**Semi - alba Hybrids:** Semi – alba *Phalaenopsis* are white with a colored lip, followed a development time frame similar to that of standard white. Roselle, Ruby Lips, Sally Lowry, Judy

Karleen, Sharon Karleen, Karleen's Wendy, Bright Lights, Devon Michele, Spitfire, Mad Hatter, Rodco's Lady, Lipstick, Career Girl, Show Girl, , Miki Wata Nabe, Memoria Francis Hunter, Dtps. Ox Prince Thunder, Dtps. Chian Xen Magpie etc.



Miki Wata Nabe



Chian Xen Magpie

**Striped Hybrids:** Striped Phalaenopsis are also called as peppermint or candy – striped Phalaenopsis. The flowers are white with stripes of dark pink or red that vary in the intensity, number and thickness of the stripes. Robert W.



Kaleidoscope

Miller, Peppermint, Samba, Barbara Freed Saltzman, Career Girl, Chorus Girl, Ella Freed, Marginata, Kaleidoscope etc.

**Spotted White Hybrids:** White flowers with an even distribution of maroon spots, except for the white margins. Elise de Valec, Rouserrole, Dame de Coeur, Snow Leopard, Marry Krull, Ann Krull, Cabrillo Star, Paifang's Queen etc.



Rouserrole

**Pink Hybrids:** Pink colour with sparkling white lip

sometimes gray lip with larger flower size and shape. Grand Conde, Versailles, Alger, Reve Rose, Zada, Barbara Bread, Ann Marie Beard, Lipperose, German Pinks, Danse, Ida Fukumura etc.

**Standard Yellow:** These hybrids yielded the requisite cream to yellow flowers, but the colors produced were pale and faded within a week, it produces many flowers per inflorescence. Bonnie Vasquez, Sogo Manager 'Nina', Brother Lawrence 'Montclair', Brother Oxford, Brother Passat, Brother Stage, Golden Gift, Goldiana, I- Hsin Sunflower, Misty Green, Sogo Lisa, Taida Lawrence, Taipei Gold, Hsin Yang Fortune, Shih Hua Long First Love, Detroit etc.



Hsin Yang Fortune



Detroit

**Standard Orange:** Orange color can be created by combining a large pink with yellow or vice-versa. It is virtually always in bloom or in spike, lasting flowers, and tendency to bloom throughout the year. Desert Orange, Carnelian Queen, Orange Glow, Orange Beauty, Tangelo, Cinnamon Glow, Brother Sara Gold 'Peach', Zuma creek, Burnished Copper, lawless Red Peppers, Black Ball, Chen, Peachy, Amber, Ember, Bold Beauty etc.

**Red and Purple Hybrids:** These hybrids have strong and lasting color, good form, attractive flower presentation on the

inflorescence; flowers are not as large as the whites and pink. Engine Red, Cardinal, Ewing, Red Galaxy, Liberty Hill, Imp's Pride, Red Hot Imp, Venimp, Spirit House, Summer Morn, Red Buddha, Mahalo, Tapestry, Orchidland, Bloody Mary,



Strawberry

Dixie Sunset, Peter Lin, Hwa Yuan, Sogo Grape, Taida Salu, Katherine, Ruby Glow, Burgundy Beauty, Purple Gem, Carol, Garnet Beauty, Spotted Beauty, Strawberry, Plum Rose x Ox Black Jack etc.

**Harlequins Hybrids:** In this hybrid flowers on the same inflorescence can each have slightly different markings, as the flower are forming the pigmentation of the spotting and overall flower color is usually fainter, when the light is bright, the spots tends to be smaller. Golden Peoker 'BL', Golden Peoker 'Nan-Cho', Ever Spring King, Beautiful Dreamer, Ever Spring Prince, Ever Spring Light, Ever Spring Pioneer, Carolina Bronze Meteor Montclair, Montclair, Brother Jungle Cat, Nobby, Peacock, Celebration etc.

## Environmental factors

**Light:** Moth orchids do well in indirect light. For this reason, healthy *Phalaenopsis* can be grown indoors in windowsills, sun room, and shaded greenhouses and under artificial lights in most temperate climates. The requirement of light is 1000-1500 foot candles for winter and 800-1200 foot candles in summer. *Phalaenopsis* can be grown under artificial light. *Phalaenopsis* can be grown 9-12 inches under fluorescent lights or 4 to 6 feet under 400 watts high intensity discharge lights or high pressure

sodium lights. If *Phalaenopsis* does not have a flower spike growing by February, move it where it will receive more light. The indication of correct amount of light is that the foliage will appear yellow-green not dark green. Dark green leaves or the new leaf growing longer and narrower than the old leaf indicates the light is too low. Too much light causes white, dried, burned areas on the leaf, and will have short flower spike. Inadequate light results in succulent, floppy, dark green foliage with no flowers. In cloudy winter conditions, artificial light should be supplement, whereas direct sunlight will damage the plant, therefore placing the plant near a bright window is good. In greenhouse, 750-1500 foot candle light is judicious. If grown in indoors, *Phalaenopsis* should be placed in North East window to avoid hot and direct sun. Higher light intensity is recommended for boosting up growth at vegetative stage particularly for growing leaves and roots and flower induction. At flowering, *Phalaenopsis* can tolerate low light intensity (100 foot candle).

**Temperature:** The *Phalaenopsis* is a tropical plant, and consequently temperatures lower than 15°C and 32°C and above should be avoided. For an optimal growth, endeavors should be made to maintain an average temperature of 26-27°C during the growing phase and 19-21°C during the phase of flowering. During winter the temperature must be maintained between 18 to 20°C. A temperature of 18°C is particularly necessary in the event that the induction of buds needs to be enhanced in conditions of inadequate light or high daytime temperatures. Keep in mind that the more air movement, the warmer the plants can be and the higher light levels they will accept without turning yellow, and if it is too cold, the pot stays



too wet and the growth will suffer. Care should be taken to ensure a minimum night time temperature of  $15^{\circ}\text{C}$  -  $20^{\circ}\text{C}$  for the rest of winter. Although they are warm growers, above  $30^{\circ}\text{C}$ , they tend to stop growing and therefore it is necessary to take steps to reduce the temperature by improving ventilation or misting the floor etc. Continued periods of exposure to temperature below  $10^{\circ}\text{C}$  or a rapid drop in temperature can cause chilling injury which ultimately results yellow sunken spots on the leaves. Further, cooler temperature (below recommendation) slows down growth and cause bud falling before blooming. Higher temperature coupled higher humidity will not affect the plant. *Phalaenopsis* can tolerate higher temperature ( $30^{\circ}\text{C}$  to  $35^{\circ}\text{C}$ ) for few hours if sufficient water is in pot. *Phalaenopsis* requires cool temperature for a month at the time of bud development. Higher temperature delays the flowering and aborts the bud at  $28^{\circ}\text{C}$  and more during flower bud development.

**Carbon dioxide:** *Phalaenopsis* is a CAM (Crassulacean Acid Metabolism) plant and it takes  $\text{CO}_2$  at night. Carbon dioxide requirement varies from 600 to 800 ppm.

**Humidity:** Temperature is the main environmental factor which influences the humidity. *Phalaenopsis* can grow better with the humidity of 50% or higher. At sufficient humidity, plants grow lushly and leave looks healthy. Insufficient humidity cause stunting of plant, accelerate premature falling of buds, dehydrated and shriveled leaves, papery texture of flower edges. In greenhouses, the humidity can be easily controlled by watering the foot path, benches or by humidifier. Humidity can be increased sufficiently in the growing area. Keeping of water in plastic tray below the benches is a better

option to maintain the humidity in greenhouse. The tray need to clean time to time to avoid algae or disease. Misting can also help in increasing humidity for limited period, but it causes leaf spot diseases if there is not good air circulation. To increase the humidity level, companion plants like ferns, bromeliads, and other foliage plants can be placed near the *Phalaenopsis* plant in the home. Provide a way for water to constantly evaporate around the plants. Normal humidity levels in the home are sufficient for *Phalaenopsis*. It is also best to place your potted plant over a dish of water with pebbles so that the pot is not directly sitting on water.

**Ventilation and Air circulation:** It is necessary to provide enough space between plants and to allow air movement (slight breeze) to help in the drying of the leaves. Using an electric fan to induce air movement in indoor gardens is common. Plants should not be left in stagnant air, as bacteria and fungus spores can infect. If it is not possible to improve the natural ventilation, fans should be used constantly to reduce temperature on hot days and to dry plants out for cold nights. In most of the areas where *Phalaenopsis* are found, gentle air blows. Air movement in growing environment ensures good growth and less infestation of diseases and pests. Ceiling and oscillating fans are effective for providing gentle air flow in hobby greenhouse or indoor growing area. Both can cover large areas with a constantly changing air flow pattern without excessive drying the plants.

## **Phases of growth**

The *Phalaenopsis* has to pass through two distinctive phases i.e. vegetative and flowering for production. Plants are grown in

separate greenhouses with different temperatures during these two phases.

**Vegetative phase:** The vegetative phase begins when plants are removed from tissue culture flasks and are transplanted into community trays. 40 to 50 plants from flask can be accommodated into 1300 to 1500cm<sup>2</sup> square or rectangular trays or in 128-cell plug tray. Plants are grown in various media depends on the characteristics of the tray and environmental condition. The vegetative phase again divided in three phases. The first phase comprises pricking out from flask (25-30 weeks), while second phase includes repotting to an intermediate pot (27-32 week) and third phase is to planting in a bigger pot (10-12 week). During vegetative phase, the plants must be grown at 28<sup>o</sup>C or higher to avoid immature inflorescences. The higher temperature will promote rapid growth of leaves. Flowering can be suppressed with a cooler night (25<sup>o</sup>C) of the day temperature sufficient warm (30<sup>o</sup>C). *Phalaenopsis* can tolerate temperatures as 32<sup>o</sup>C, to 35<sup>o</sup>C for few hours per day subject to sufficient moisture in the substrate and good aeration. In general, about 50 weeks are required to cover these phases. During initial stage of growth, first 4 to 8 weeks after transplanting the recommended maximum light intensity is 75μ mol. m<sup>-2</sup>.s<sup>-1</sup> to acclimatize the plants to the greenhouse. Maximum 300μ mol.m<sup>-2</sup>.s<sup>-1</sup> light intensity is maintained during growth phase.

**Flowering phase:** *Phalaenopsis* plants once matured uniformly, developed 4 to 5 large leaves, can be exposed to cooler temperatures to induce the flowering process. Flower induction occurred when exposed to less than 26<sup>o</sup>C temperature during day. Generally, growers use a 25<sup>o</sup>C/20<sup>o</sup>C day night

temperature regime for flower spike initiation. However, plants exposed to constant 25°C temperature, produce spike at faster rate than 26°C. After exposing at this temperature for a period of 4 to 5 week, plants can be grown at 17°C to 26°C to time the flowering at specific date. Inflorescence and flower bud number were greater when *Phalaenopsis* was induced at 14 to 17°C compared to warmer temperature. In warmer region, the flowering can be regulated in air conditioned green houses for year round production.

At favorable environmental condition (28°C) bud initiation occurs after the spikes attain 5 cm in length. However, if a plant with a young inflorescence (less than 10 cm) is subsequently grown at 28°C or higher spike can form 'keiki' instead of flower buds' or buds may abort. During flowering phase, higher temperature may increase spike but number and size of flower may not increase. If the light intensity is excessively low during flowering phase, flowering can be inhibited. Even, the flowering of *Phalaenopsis* was progressively delayed due to prolong darkness.

## Propagation

**Division/ Cuttings:** These types of propagation can be done by using two types of techniques.

- i) *Phalaenopsis* can be propagated asexually by kiekies forming on old flower stalks or on sides of main stem. Top cutting can be done on long drooping plants, and after which, new plants will shoot from the remaining stem. Using lanolin paste with Benzyl adenine (BA) on buds in flower stalk to induce kiekies has given successful

results. Keikies can be planted in clay or plastic pots with chopped charcoal and coconut husk. Stem propagation sometimes also involves the application of keiki paste or similar product to dormant nodes of the flower spike as ideal method for non commercial growers. When the keikis have 2-3 roots, it can be removed, by slicing between the stem and the keikis, or cutting the stem above and below keikis attachment point. The new plant can now be potted up and grown on. If more flowers are desired, cut the stem as above, but do not move the plant.



Propagation through division

- ii) *Phalaenopsis* mother plant is topped and it continues to grow vertically and they discard their lower leaves. The leaves have served as a storage vessel of water and nutrients. New roots are produced above the leafless stem, as the plants continue growing vertically. The stem can be cut below the new roots. The top part, with leaves and roots, can be repotted after proper care of the cut. The remaining stub can be left for a few days/weeks. Soon, new little plants will be found growing out of the old stub. These keikis can be repotted in the media.



Propagation through node cuttings

### Tissue Culture

*Phalaenopsis* can be propagated by tissue culture technique

using shoot tip, nodal flower-stalk, intermodal section, leaf tip and root tip in Vacin and Went medium, Murashige-Skoog medium, REM, Knops Solution, Hyponex/Kyoto medium New Dogashima medium.

## Cultivation

**Plant material:** The plants are generally available in flask containing 20 to 25 plants or in nursery tray containing 40-50 plants. The plants require acclimatization for few weeks to the local growing conditions as soon as received. The plants in nursery tray are better as because of less mortality and reduction of cultivation period by 5-7 months.

**Potting:** The mature plant with 2 to 3 leaves and healthy roots are generally shifted to nursery tray from the flask. Generally potting is to be done when roots are actively growing. Once they hardened and leaf attains a span of 10-15 cm size in nursery tray, they can be transplant to pot. The plants need to be sorted out in two grade i.e. bigger and smaller plants before planting. Small plants often require a 3-4 month larger cultivation period than bigger plant. Smaller plants can be kept together in community pot. Each seedling can be planted at 1 cm distance. The potting material should be damped and should be packed firmly, watering is required the seedling gently and thoroughly. The community pot needs to cover with plastic with slightly open. This will provide the seedlings with a humid environment and need to keep the plant in partial condition. In few months the seedlings will be ready for transplanting as like bigger plant.



Field view of *Phalaenopsis*

The young plants should be acclimatized to the local growing condition before planting. The acclimatized plants are held in middle position of the empty pot and recommended growing media is then poured around the plant till it covered  $\frac{3}{4}$ th of the pot. Utmost care is taken that in any case growing tip should not be covered up with medium as it may invites disease. Further, the plants need to be planted at appropriate depth to avoid toppling when grown fully. *Phalaenopsis* requires shallow planting; the base of the plant should be at the level of the potting mix. Growing tip of the young plants should not be pressed or squeezed excessively during potting, since this could result in deformation of the foliage and damage to the growing tip.

**Growing Containers:** The most common pots or container is plastic or clay pot. In general, the orchid pot should have more number of holes and larger size, both at in the bottom and sides for better drainage. *Phalaenopsis* pots are shorter and shallow (10 cm) or larger diameter pot with broader base for more stability. Most of the growers prefer plastic pots over clay pots because of inexpensive, durable, less accumulation rate of salts and easy to clean. Although *Phalaenopsis* root performed less photosynthesis but roots avoid darkness, so more roots can be obtained on transparent pot as compared to opaque pot. Generally white colored transparent pots of 12 to 20 cm sizes are preferred for *Phalaenopsis*.

**Substrates:** Potting material must support the plant, drain out rapidly, retain moisture and should have durability. *Phalaenopsis* cannot withstand long dry spell because they do not have any water storage organ. A good potting mix could be a combination of coconut husk pieces, charcoal or broken pieces

of roofing tile with coconut peat. 25-30% of the media should be charcoal or tile pieces to ensure adequate drainage. *Phalaenopsis* can be potted on clay or plastic pots, with charcoal and coconut husks, or mounted in wooden slabs. Currently, the use of tree fern roots is being discouraged for the conservation of our endangered giant tree ferns. Pre-soaked coconut husk is another good medium for *Phalaenopsis*. Another alternative medium is a 1:1 mixture of sand and coconut charcoal dust. The main thing is not to use a media that turns mushy or breaks down too quickly. For immature or miniature *Phalaenopsis* fine mix of growing media required for healthy growth. The mixture consist of 3 parts coco-peat, 1 part fine charcoal and 1 part perlite and 1 part sphagnum moss in 10 cm size pot. However for standard size plant the growing media consist of 4 part coconut husk, 1 part medium charcoal, 1 part medium size perlite and 1 part medium sphagnum moss.

**Repotting:** Repotting should be done when foliage show wilting, media is loose in the pot, flowers do not last long, brown tips observed on the leaves etc. The plants prefer good aeration around the roots and this is the easiest way to check out the condition of the root system. The *Phalaenopsis* are best repotted after flowering in the late spring or early summer. Repotting should be done about once a year in appropriate sized pot. During repotting, cutting or breaking of the base of the stem is required carefully. Except solid other roots should be cut off and soak the plants and roots in a standard Mancozeb solution for 10 minutes and then the bottom of the stem is sealed with a thick paste of Mancozeb or Thiram. Plants should be air dried before repotting. Growing media should be just like initial potting media.



**Watering:** Water requirements are influenced by humidity, potting media, type of pot, size of pot, time of year and the orchid. Over watering is the biggest killer of orchids. *Phalaenopsis* do not like water as most other types of orchid can. Therefore, they are to be kept warm and very slightly on the moist side, but not sopping wet. The pot should not be watered again until very nearly dry. *Phalaenopsis* do not prefer to sit in water. Younger plants require more watering than matured plants. This can be accomplished by misting the plants instead of water sprinkling. Watering is needed twice per day during very hot and dry months, and only 2-3 times per week during wet months or none at all for matured plants. Plants require protection from too much rain. For indoor growing, plants are usually watered by immersing the whole potted plant in a bucket of water and permitted to drip dry. The crown needs to be kept dry. An overgrown or pot bound *Phalaenopsis* will dry out quickly than has plenty space in pot. Plants and potting materials exposed to low humidity dry out quickly than those in humid. Warmer temperature also hastened dry quickly and requires more water. *Phalaenopsis* are grown in cooler region requires less watering as compared to dry or warmer region. The quality of water is an important factor for governing the growth and flowering. Water must be free from chemical and visible contamination. Water for *Phalaenopsis* should not contain excessive harmful elements like sodium, chlorine and bicarbonate. In absence of good quality of water, deionised water can be used as substitute. However, rainwater is the best for all orchids. The ideal water for *Phalaenopsis* contains pH-6.6,  $\text{CaCO}_3$  80-120ppm, Ca-30-50ppm, Fe-1ppm, Na-less than 5ppm, soluble salts- 0.3 to 1.0m mhos/cm, total dissolved solids- 60ppm, S 10-50ppm, Cl 100ppm.

**Fertilizers:** *Phalaenopsis* plants need nutrition twice or once a week. Seedlings could be sprayed with very dilute fertilizer every day after watering. Plants need to be watered heavily once a week to flush excess salts. Plants should be moist before applying of fertilizers. Use of balanced foliar fertilizer with trace elements is always beneficial for orchids. Weak fertilizer applied frequently is better than strong application. Reduction of fertilizers is suggested once flower spikes and during low light conditions. It is important to note that feeding depends upon some other environmental factors, the higher the light the more food is required; the more food is available at the roots the more of water is necessary to prevent salt damage to the roots. Plants grown under lower light and temperature, less water and feed is required. The pH of fertilizer solution needs to maintain between 5.2 and 6.2. The EC of the nutrient solution should lie within the range between 0.8 and 1.2 mS/ cm. Slow release fertilizers like Nutricote (13:13:13) or Osmocote (13:13:13) can be used 1 table spoon/ plant while planting. The most common form of fertilizers used with *Phalaenopsis* is the water soluble type. The water soluble is a 19:19:19 or 20:20:20 NPK with micronutrients which are available in market and users friendly. Generally 1g/l at weekly interval is sufficient for growth. It is better to fertilize the plant frequently with diluted rate. The excess rate or higher concentrations will damage the plant. At active growing stage the *Phalaenopsis* require more nutrition than in winter or inactive phase. In dormant period the fertilizers should be applied with lesser rate (50%). If salt accumulation occurred, it needs to clean with flushing of water. In commercial farm following nutrition are used in fertilizer scheduling.

System: Mixing tank; 1000 litre tanks

Water supply: 100% rain water

A-Solution, a concentration of 100 times

Nutrients	Formula	In 1000 litre
Nitrate of lime	$\text{Ca}(\text{NO}_3)_2$ , 19.0% Ca, 13.5% N	28.0 kg
Ammonium Nitrate (liquid)	$\text{NH}_4\text{NO}_3$ , 18%N (9.0% $\text{NO}_3^-$ and 9.0% $\text{NH}_4^+$ )	21.0 kg
Nitric acid 38%	$\text{HNO}_3$ , 8.4% N, 6.0 mol $\text{H}_2\text{O}^+$ per kg	0.01
Potassium nitrate	$\text{KNO}_3$ , 38.2% K, 13.0% N	0.0 kg
Iron chelate 3%	(DTPA)	3.0 kg

B-Solution, a concentration of 100 times

Nutrients	Formula	In 1000 litre
Phosphoric acid 59%	$\text{H}_3\text{PO}_4$ , 26.8% P, 8.6 mol $\text{H}_2\text{O}^+$ per kg	0.01
Potassium nitrate	$\text{KNO}_3$ , 38.2% K, 13.0% N	20.0 kg
Potassium dehydrate phosphate	$\text{KH}_2\text{PO}_4$ , 28.2% K, 22.3% P	21.0 kg
Potassium sulphate	$\text{K}_2\text{SO}_4$ , 44.8% K, 17.0% S	0.0 kg
Epsom salt	$\text{MgSO}_4$ , 9.9% Mg, 13.0 S	10.0 kg
Manganese sulphate	$\text{MnSO}_4$ , 32.5% Mn	55g
Borax	$\text{Na}_2\text{B}_4\text{O}_7$ , 11.3% B	100g
Zinc sulphate	$\text{ZnSO}_4$ , 22.7% Zn	55g
Copper sulphate	$\text{CuSO}_4$ , 25.5% Cu	50g
Sodium molybdate	$\text{Na}_2\text{MoO}_4$ , 39.6% Mo	25g
Urea	$\text{CO}(\text{NH}_2)_2$	10.0 kg

(Source- Anthura, Netherlands)

**Flower Production:** Mature plant with 5 fully developed expended leaves may be induced to flower. Generally, flower production starts 8 months after planting depending on management practices. It is important that plant should be healthy, large enough and the pots have a good root system to

bear the flowering. *Phalaenopsis* will naturally induce spike when it is fully grown. Flower production can be manipulated by controlling light and temperature regimes. The spikes become ready to harvest when the spike has approximately three unopened buds. New and heavier branch could develop from the plant base after harvesting. The new branch developed will take more time than the development of a branch from bud. These should be at least 12 plants/sq.m and the complete growing period approximately 5 years. On an average the plant produces 2 branches /plant/year.

**Premature flowering:** Sometimes flower spikes emerge before maturity of plant. The premature flowers will need to be removed to boost vegetative growth. At early stage the flower inflorescence or stick is soft enough and can be pinched off easily. During growth phase, maintenance of temperature of 27°C will limit the premature flowering.

**Training of spike:** *Phalaenopsis* is a market driven flower and consumers prefer straight flower spikes with better presentable form. The *Phalaenopsis* flower stem are supported with stick made up with plastic or bamboo or metallic at the time when flower buds begin to swell. Tying of spike should be secure and firm with the stake. Use of twist tie, soft cotton string, small green cable ties and loop tape are better than wire, which could damage the stem. The first tie has to be given on the lower part of the spike close to the first node. Another tie should be given a few inches higher on the flower spike. If necessary more ties can be given at suitable distance. The spikes may be attached to the overhead wires with the help of strings to avoid lodging. The flower sprays are supported with a small hook from the strings when the lower bud started swelling.

## **Harvest and post-harvest management**

**Harvest:** The 40-60 cm long spikes containing at least 8-10 flowers are harvested when all flowers are fully open. Average flower production is 6 to 7 stems / plant / year.

**Post -harvest:** After harvesting, stems are kept in bucket containing water. Chemical like Chrysal is added to water to enhance the vase life. In *Phalaenopsis*, pulsing with 0.5mM STS for 24 hours blocks the deleterious effect of ethylene.

**Storage:** The harvested flowers need to be kept at proper temperatures. In general, *Phalaenopsis* flowers can be stored at 10°C for two weeks. The low temperature helps to slow down respiration and depletion of reserved food materials of petals.

**Packaging:** The *Phalaenopsis* cut flower are packed in a single window gift boxes of 100 cm x 15 cm x 11.5 cm. 25 to 30 flowering stems are packed in a box depending on the number of flowers/ stem. During packing of flower, boxes are cooled at 20°C. Pre-cooled boxes are efficient than packing a box and then placing in a cooler place, a process that requires hours to bring flowers to the optimum temperature range. Cut stems are kept in cooler places prior to packing. It is best to pack in cooled rooms to reduce respiration and condensation build up in the slips.

## **Insect Pests and Diseases**

### **Insect Pests**

**Slugs and snails:** Slugs and snails make round holes in the young plant parts and they can damage large number of plants within short period of time. Application of slug pellets in the

pots and on ground can control them effectively. Metaldehyde 6% @ 0.7 g/sq.m. is also effective.

**Mites:** The red spider mites suck sap from the underside of the leaves and cause slight deformation and silvery discoloration of leaves. Population of mites can be reduced by spraying fresh water. Spraying with Karathane (0.5ml/litre) or Kelthane (1ml/l) is also effective to control them.

**Aphids and scale insects:** Brown scales and wooly aphids attack flowers, leaves and roots. Aphids are identified by whitish deposits on the plants and brown scales are identified by oval lumps on and beneath the leaves. As a result of their infestations, black moulds are developed on plants. These insects are controlled by racking around plants, soil application of Thimet (2g/pot) and spray with Dimethoate (2ml/litre).

### **Diseases**

**Petal blight (*Botrytis cinerea*):** A large number of small brown spots are manifested on the flowers. This disease is severe in high humid conditions. This disease can be controlled by avoiding excess humidity and continuous wetness on the leaves and flowers and spraying with quintal (0.5g/litre of water).

**Fusarium rot:** This disease develops black triangular spot with its edges a yellow reddish discolouration at the base of the old leaf. The leaf falls off. It can be controlled by avoiding excess watering and drenching with Topsin (2g/litre).

**Rhizoctonia rot:** This disease occurs on the media when planting is done very deep and growth is not upto the mark. Young leaves when touches the substrate get affected by the fungus. It also damages roots. Drenching with fungicide (Bavistin or Benomyl (0.2%) @ 3g/litre before planting checks

this disease.

**Sclerotium rot:** Under hot and humid conditions, this fungus damages young plant parts when come in contact with substrate at large extent. White fungus hairs occur in the substrate in which orange brown coloured mustard shaped fungus tissues develops very fast. It can be controlled by drenching with rovril @ 1g/litre.

**Moulds:** Large fluctuation in the moisture content or the EC damages the roots and enables moulds to attack the tissues. In this case, the EC should be maintained at a sufficiently low level, pot temperature should be maintained at sufficiently high level and substrate should temporarily be kept somewhat drier.

**Bacterial wilt (*Pseudomonas cattleyae*):** This disease is characterized by brown patches on the leaves, having oily spots surrounded by yellow rim. This disease can be controlled by use of good and healthy planting material, regular rouging of plants, optimization of nitrogen doses, maintaining proper humidity and spray with Streptomycin @ 0.3 g/litre.

**Bacterial soft rot (*Erwinia carotovora*):** Affected plants produce bad smell from wet spots on leaves which expands rapidly. Ultimately, leaf becomes completely soft and slimy within one or two days. This disease can be controlled by use of good and healthy planting material, regular rouging of plants, spray with 20% hydrogen peroxide @ 5ml/litre and spraying with streptomycin sulphate 200ppm.

