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PRODUCTION TECHNOLOGY OF DENDROBIUM

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Technical bulletin

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Cover Photographs

Front: Glimpses of Dendrobium orchids

Back: Post harvest evaluation of Dendrobium hybrids

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PREFACE

Dendrobiums are popular flowering potted plants and cut flowers around the world due to their floriferousness, wide range in flower color, size and shape, year round availability and lengthy vase life. Hawaii, California and Florida are major potted Dendrobium growing regions in the United states. In the Netherlands, production of potted orchids is now 40 to 50 million units with Dendrobium increasing in popularity. Imports from Thailand, the worlds largest exporter of tropical cut orchids and second largest supplier to the EU, accounted for 22% of supplies to the EU. Thailand holds a particularly strong position in Dendrobium orchids.

The present technical publication *'Production Technology of Dendrobium'* covers the wide aspect s of Dendrobium orchids starting from botanical description, useful genetic resources, common commercial hybrids for pot plants and cut flowers, growth and physiology, cultivation techniques and post harvest management including harvest, pre-cooling, pulsing, bud opening, preservatives, grading, packaging , storage and value addition.

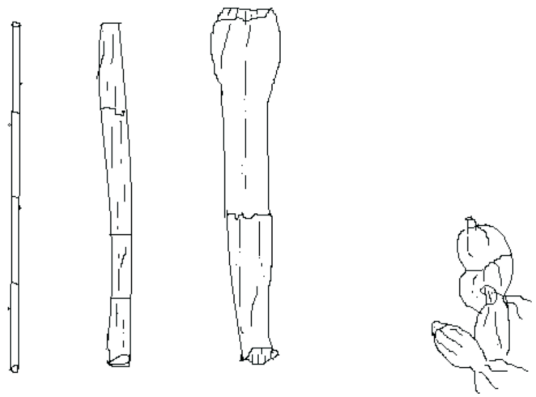
I hope that it will be an useful handy reference technical bulletin for amateur and professional orchid growers, small and big orchid farmers, orchid entrepreneurs, extension workers, exporters and students.

(Lakshman Chandra De)

Contents

Introduction

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. The pseudobulbs are of four types, cane woody (a), cane cylindric (b), cane clavate fleshy (c) and bulbous round (d).



(a) (b) (c) (d)

Table 1: Nature of pseudobulb in Dendrobium

Characteristics	Example Varieties/species
Cane woody	*Den. gibsonii, Den. bensoniae, Den. aphyllum, Den. ruckeri, Den. aduncum, Den. cathcartii*
Cane cylindric fleshy	---
Cane clavate fleshy	*Den. primulinum, Den. nobile, Den. parishii, Den. pendulum, Den. loddigesii,*Den. 'Bangkok Blue', Den. 'Big White Jumbo', 'Den. 'Thongchai Gold', Den. 'Erika', Den. 'Triple Pink', Den. 'Madam Pink'
Bulbous round	*Den. aggregatum, Den. chrysotoxum, Den. jenkensii,* Den. 'Julie'

The leaf size ranges from 2.5cm to 40cm, thick, are deciduous or evergreen. In some groups, the flowers joined in pairs or three on small peduncle on the entire length of the pseudobulbs, with caduceus leaves. In some species, with persistent leaves, the flowers are grouped in pairs or threes or alternately closely set forming erect or pendent thyrses. In another group, flowers are generally solitary and small, arising from the axils of leaves. The inflorescences are terminal or subterminal and arranged with one to several dozens of flowers with extremely diverse dimensions, size and ranges of flower colour.

Dendrobiums are popular for cut flowers and for interioscaping. 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.

Valuable genetic resources:

1. *Dendrobium aggregatum*: Distributed in South China, Burma, Thailand and Laos. The pseudobulbs are short clustered, yellowish, furrowed with persistent fleshy solitary leaves. Inflorescence is pendulous or arching bearing 12 or more flowers. The flowers are yellow, 5cm in diameter, fragrant, long lasting and produced in March-April.
2. *Dendrobium superbum*: Native to Indonesia, Malayasia and the Philippines. The pseudobulbs are pendulous, cane like with small, fleshy, glossy green, leathery leaves. The inflorescence is two flowered. The flowers are highly fragrant, 10cm in diameter and produced in winter-spring season.

3. *Dendrobium bigibbum*: Native to Queensland and new Guinea. The pseudobulbs are erect, slender with leathery, evergreen leaves. Inflorescence is terminal, arching and arranged with 25 or more flowers. The flowers are pure white to rosy mauve and produced during winter and spring season.

4 *Dendrobium chrysotoxum*: Native to Himalayas, Burma, South China, Thailand and Laos. The pseudobulbs are erect, clustered, club shaped with leathery coriaceous leaves. The inflorscences are arching, 30cm long, yellow with orange blotched lip and produced during March-April.

Den. chrysotoxum

5. *Dendrobium densiflorum*: Distributed in Himalayas to Burma. The pseudobulbs are erect, four sided, 30cm long, green and club shaped. The leaves are coriaceous, dark green and persistent. Each pseudobulb produces 2 to 3 inflorescence. The inflorescence is borne from the upper nodes of pseudobulbs, many flowered, pendulous and cylindrical. The flowers are golden yellow with orange lip, scented, 5cm across and produced during April-May.

Den. densiflorum

6. *Dendrobium fimbriatum*: Distributed in Himalayas, Burma, Vietnam, Malay Peninsula and Thailand. The pseudobulbs are stem like, slender, terete, stout, erect or arching. The inflorescence is 8 to 15 flowered, 20 cm long produced from the top of the ripened stem. The flowers are yellow with orange yellow lip, 7.5cm in diameter and produced during March to May.

Den. fimbriatum

7. *Dendrobium formosum*: Native to Himalayas, Burma to Peninsula, Thailand and Andaman Islands. The pseudobulbs are leafy, erect, pendulous with ovate oblong leaves, persistent. Inflorescence is terminal or axillary 3 to 5 flowered in short cluster. The flowers are very large, 10cm in diameter, fragrant, pure white with orange yellow lip.

8. *Dendrobium loddigesii*: Native to China. The pseudobulbs are small, slender, numerous, clump forming with caduceus oblanceolate leaves. The flowers are solitary, pale pink with fringed lip, fragrant, long lasting and 5cm in diameter.

9. *Dendrobium nobile*: Native to South China, Nepal, Himalayas, Thailand, Vietnam, Laos and Formosa. The pseudobulbs are arching or erect, 60-90cm tall with

Den. nobile

caduceus, leathery, glossy green leaves. Inflorescence is 1 to 3 flowered, short and arises from the upper nodes of the old leafless pseudobulbs. The flowers are fragrant, long lasting, 10cm in diameter, waxy, lip with white margin. The flowers are produced during April-May.

10. *Dendrobium pierardii*: Native to Himalayas, Burma, China and India. The pseudobulbs are thin, very elongated, 60-75cm long, stem like, pendulous or drooping with soft textured deciduous lanceolate leaves. Flowers are 5cm in diameter, scented, short lived, pale pink with yellow lip streaked with red and produced during March - April. This species is ideal for covering bare walls and hanging baskets.

11. *Dendrobium speciosum*: A robust species from Australia and New Guinea. Pseudobulbs are swollen, conical and terminated by 2 to 4 leaves. The leaves are apical, persistent, rigid and leathery. Flowers are many and arranged closely in pendent thyrses. Flowers are fragrant and produced during autumn and early winter.

12. *Dendrobium spectabilis*: Native to New Guinea and Solomon Islands. The pseudobulbs are club shaped. The flowers are 7.5cm across, cream to pale greenish in colour with mottled dull purple veins and yellow white lip.

13. *Dendrobium thyrsiflorum*: Native to Himalayas, Burma and Thailand. The pseudobulbs are club shaped with several ridges and cylindrical. The leaves are persistent and coriaceous. Inflorescence is pendulous

and densely flowered. The flowers are 5cm in diameter, white with orange yellow lip and produced during winter and spring.

Den. thyrsiflorum

14. *Dendrobium crepidatum*: Native to Bhutan, India and Nepal. A pendulous orchid with long, curved pseudobulbs and linear lanceolate leaves. Inflorescence is lateral, leafless at flowering and borne in fascicles of 2 to 4 flowers. Flowers are 2-3.5cm across, white, flushed with pink lilac ans white lip. Flowers are produced in April-May.

15. *Dendrobium denudans*: Native to Bhutan, India and Nepal. Paesudobulbs are slender, clustered with oblong, sessile leaves. Inflorescence is terminal and bearing about ten flowers. Flowers are grrenish or white and produced during September-October.

16. *Dendrobium heterocarpum*: Native to Bhutan, India and Nepal. Pseudobulbs are stout, erect or pendent, with many oblanceolate leaves. Inflorescence is lateral and bearing blooms in fascicles of 1-3 along the nodes. The flowers are 5cm across, ochraceous yellow to cream in colour and produced in March-April.

Den. heterocarpum

17. *Dendrobium jenkensii*: Native to India and Bhutan. Pseudobulbs are aggragated, oval, compressed, ridged

with solitary leaves borne at the apex. The flowers are 2 to 4cm indiameter, orange yellow with a heart shaped lip and produced during May.

Den. jenkensii

18. *Dendrobium bensoniae*: Native to Manipur and Mizoram. Pseudobulbs are fleshy, stout and pale yellow with deciduous linear leaves. The flowers arise in fascicles of 1-3 flowers from the upper nodes of leafless pseudobulbs. The flowers are long lasting, 4-6cm in diameter, scented and pure white in colour and yellow lip. The flowers are produced in May-June.

Den. bensoniae

19. *Dendrobium devonianum*: This species is native to Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram and Nagaland. Pseudostems are slender, cylindrical, pendent with linear –lanceolate leaves. Inflorescence is lateral, 1-3 flowered. Flowers are 2-5cm across, white with purple apex and produced in May-July.

20. *Dendrobium falconeri*: Native to Arunachal Pradesh, Manipur, Meghalaya, Mizoram and Nagaland. Pseudostems are pendent, branched with bead like nodes and linear leaves. Inflorescence is lateral, 1-2 flowered. Flowers are 3-5cm across, white-pale pink

with purple tips and are produced during May-June.

21. *Dendrobium farmeri*: Native to North East India. Pseudobulbs are 4 angled, club shaped with 2-3 lance shaped leaves near the apex. Inflorescences are borne on cylindric, pendulous raceme arises from the apices of the mature new growth.

Den. farmeri

22. *Dendrobium gibsonii*: Native to Arunachal Pradesh, Meghalaya, Nagaland and Sikkim. Pseudostems are tall, slender and bearing many ovate-lanceolate sessile leaves. Inflorescence is lateral, pendent, slender and 5-10 flowered. Flowers are fragrant, 2-3cm in diameter, yellow orange and produced in July-Agugust.

Den. gibsonii

23. *Dendrobium infundibulum*: Native to Manipur, Mizoram and Nagaland. Pseudostems are erect, cylindric with linear lanceolate leaves. Inflorescence is terminal or lateral, 2-3 flowered and borne in raceme. Flowers are 7.5 to 10cm across, pure white and long lasting with orange yellow lip disc. Flowers are produced during April-May.

24. *Dendrobium parishii*: Native to Manipur and Mizoram. Pseudostems are cylindrical, archingto pendent with oblong lanceolate leaves. Inflorescence

is borne at nodes of leafless pseudostems and 2-3 flowered. The flowers are 3-5cm in diameter, fragrant, rosy purple and produced in June-July.

Den. parishii

25. *Dendrobium primulinum*: Native to North East States of India. Pseudostems are stout, cylindrical, prostrate or pendent with oblanceolate leaves. Inflorescence arises from nodes of past seasons growth and 1-2 flowered. The flowers are 4-8cm across, highly scented, rosy pastel pink with cream yellow lip. The flowers are produced during March-April.

Den. primulinum

26. *Dendrobium transparens*: Native to A.P., Meghalaya, Nagaland and Sikkim. Pseudostems are slender, erect or pendent, with linearlanceolate leaves. Inflorescence develops laterally and 2-3 flowered. Flowers are 3-5cm in diameter, fragrant, pale rosy mauve to white in colour and produced during May.

27. *Dendrobium williamsonii*: Native to Assam, Manipur and Meghalaya. Pseudostems are erect, spindle shaped with velvety lanceolate leaves.

Den. williamsonii

Inflorescence is 1 to 3 flowered. Flowers are 3-5cm across, fragrant, pale green ivory with brick red lip and produced during March-April.

28. *Dendrobium ochreatum*: Native to North east States. Pseudostems are stout, cylindrical, curved with ovate lanceolate leaves. Flowers are 5-7cm across, fragrant, fleshy, golden yellow with maroon purple disc. The flowers are produced during May-June.

Den. ochreatum

29. *Dendrobium aphyllum*: Native to Assam and Meghalaya. Flowers develop in fascicles od 2-4 at each node of long pendent stem. Flowers are soft mauve with a white lip and produced during April-May.

Den. aphyllum

30. *Dendrobium moschatum: Native to Meghalya, Assam and Nagaland.* Drooping racemes of 7-15 apricot yellow flowers appear on the upper part of the stem. Lip is slipper shaped, dark orange in colour and with two identical eye like maroon blotches. Flowers are produced during May-June.

Den. moschatum

Common Commercial hybrids

White: 'Snow White', 'Pagoda White', 'Emma White', 'White Surprise', 'Jacquelyn Concert x Walter Oumae', 'Kasem White', 'Big White 4N', 'Big White Jumbo', 'White 5N'

Den. Big Whjte Jumbo

Den. Bangkok Blue

Blue: 'Vorawit Blue', 'Lee Chong Blue', 'Kultana Blue', 'Kiyoshi Izumi', 'Blue Fairy', 'Lee Chong Blue', 'Bangkok Blue'

Pink: 'Chiengmai Pink', 'Ekapol Panda', 'Jisu's Star', 'Juree Red', 'Kiilani Stripe', 'Long Champ', 'Penang Sugar', 'Sagura Pink', 'Miss Singapore', 'Madam Pink', 'Sonia -16', 'Ear Sakul', 'Candy Stripe Pink', 'Sonia-17', 'Sonia -28', 'Dr. A. Abraham'

Den. A Abraham

Den. Thonchai Gold

Yellow: 'Sri Siam', 'Swan Lake', 'Thongchai Gold', 'Bonchoo Gold', 'Sarifa Fatima'.

Green: 'Daangsaard', 'Kanjana Green', 'Green Mist', 'Little Green Apples'

Den. Daang Saard

Den. Kating Dang

Red: 'Meike Beauty', 'Pathum Red x Sabin', 'Little Lolita', 'Cleopatra', 'Diamond Star', 'Fireball', 'Little Lolita', 'Kating Daang'

Interspecific hybrids: 'Australian Lemon Pepper', 'Jiali Paradise', 'Womad', 'Green Elf', 'Memoria Dipper Nishi', 'Falcan', 'First Star', 'Falcan', 'Mini Snowflake', 'Scotts Valentine', 'Dounan Spicy', 'Black Gold', 'Winter Frost', 'Peng Seng', 'Silver Wings', 'Aminah Khatum', 'Bruce Gorden', Green Mist', 'Aussies Queen', 'Sweet Phurichaya', Big Alex', 'Carly Hera', 'Pink Glow', 'Molly's Angel', 'Go Secret'

Inter-varietal hybrids: 'Candy Smile', 'Angel Moon', 'Million Gold', 'Liberty Girl', 'Asian Smile', 'Happy Holiday', 'Happy Smile', 'Pop Eye', 'Sunny Bird', 'Wonder Rabbit', 'Sunny Bird', 'Peach Blossom', 'Long river Giant', 'Sally Fiesta', 'Rudkin', 'Ice Storm', 'Genting Melody', 'Hawaiian Twinkle', 'Sea Sky', 'Singa Beauty', 'Arthur Reserve', 'Green Wonder', 'Open Heart Leaf', 'Rising Star', 'Fairy Star', 'Nice Boy Wanda', 'Burbank Candy', ' Burnt Orange', 'Justine'

Variety-species hybrid: 'Bright Angel', 'Blue Rain', 'Samson Toy', 'Margaret Thompson', 'Third Eyes Vision', 'Rods Eagle', 'Spider Lily', 'Sylvester', 'Paradise Fortune', 'Sky Mirror', 'Butter Fly Dawn', 'Island Snow', 'Australian Idol', 'Fine Ford', 'Half Moon Bay', 'Special Bride', 'Two Kings', 'Juliette Copper', 'Genting Lipstick', 'Singa Kagoshima', Jairuk Spin'

Medicinal Dendrobiums: The dried stems of *Dendrobium nobile* are used for making herbal medicines. *Dendrobium* enhances salivation and used for the treatment of dry mouth, dry coughs and severe thirst. Flowers could be used to cure eye ailments. The tonic made from *Dendrobium* nourishes stomach, lungs and kidneys. The plant is effective in treating pulmonary tuberculosis, impotence and anorexia. The pulp of pseudobulb is applied to boils and pimples. Juice of the plant is used to relieve fever.

Edible Dendrobiums: Dendrobiums blossoms are the most common species used in cooking. In Thailand, these edible flowers are dipped in butter and deep fried while many European cooks garnish desserts and cakes with them. The starchy stems of *Den. speciosum* are roasted and eaten.

Dendrobium for social function: Dendrobium orchids are one of the most famous orchids for use in weddings. Purple Dendrobium orchids containing 5 to 15 blossoms are used for this purpose. In some cases, individual blossoms are removed from the stem, wire

wrapped and used beautifically in corsages and boutonniers as well as wired bridal bouquets and bridesmaid bouquets. Dendrobium orchids are ideal for the tip of a cascading bridal bouquet. The orchid spikes are exquisite in floral arrangements for buffets or centerpieces.

Growth and physiology : Like other flowering plants, orchid plants also have to attain certain stage of growth and fulfill the energetic demand to initiate flowering. It may vary from 3 years to 7 years depending upon the type of species and hybrids. Orchid pseudobulbs are engaged in the control of physiological processes that are important for growth and survival. The ability to store water, mineral and carbohydrates in the pseudobulb has greater impact for survival in the harsh and nutrient limited epiphytic biotope. Pseudobulb photosynthesis recycles respiratory carbon that would contributing positively to whole plant carbon economy.

Out of sixteen hybrids of Dendrobium evaluated, fourteen hybrids came into flowering. Maximum length of flowering pseudobulb (55cm) and number of internodes (17) was recorded in 'Big White Jumbo', whereas longest internode (6cm) in 'Lervia' (Table 2).

Table 2. Vegetative growth in Dendrobium orchids

Name of hybrids	Length of flowering pseudobulb (cm)	Number of internodes	Length of longest internode (cm)	Diameter of longest internode (cm)	Number of leaves/cane	Maximum Leaf length (cm)	Leaf width (cm)
Big White 4N	41	10.5	5.2	1.2	6.43	11.80	4.5
Bangkok Blue	21	11	2.76	1.1	6.3	8.8	3.0
Big White Jumbo	55	17	4.5	2.0	13	13.5	4.25
Madam Pink	31.5	9.5	5.25	1.15	5.5	10.5	4.00
DaangSaard	34.5	11	5.5	2.6	4.5	14.5	6.5
Erika	25.5	9	4.75	2.0	4.0	13.25	5.75
Julie	22	9.5	3.75	2.25	8.0	13.5	2.0
KatingDang	34.5	12	5.5	1.75	6.5	13.75	6.25
Lervia	35	10	6	1	5.5	12.5	4.00
Madam Pompadour	34.5	10.5	5.5	1.75	4	13.5	4.75
Triple Pink	26.5	9	4.5	1.75	5	13	4
Emma White	42	16	4.5	1.75	6.5	11	3.75
Ear Sakul	26	8	4.75	1.5	3.5	9	3.75
Thongchai Gold	25.5	8	4.5	1.5	5.5	10	4.75
SE m	1.66	1.06	0.31	0.23	0.48	1.10	0.41
CD 5%	2.73	1.76	0.52	0.37	0.80	1.83	0.68

The hybrid 'Daang Saard' had highest diameter of longest internode (2.6cm), maximum leaf length (14.5cm) and leaf width (6.5cm). Number of leaves per cane (13) was found maximum in case of 'Big White Jumbo' and minimum in Ear Sakul (3.5). These variations may be due to varied genetic make up of different hybrids along with prevailing environmental conditions.

Significant variations were also observed with reproductive parameters. It is evident from Table 3 that the spike length varies from 21.9cm in 'Triple Pink' to 47.7 cm in case of 'Madam Pink'. Rachis length was maximum in 'Madam Pink'(32.7cm) and minimum in 'Lervia'(11.8cm).

Table 3. Flowering behaviour in Dendrobium orchids

Name of hybrids	Spike length (cm)	Rachis length (cm)	Number of spikes/cane	No of florets/spike	Diameter of floret (cm)	Longevity on plants (days)	Vase life (days)
Big White 4N	36.7	25.2	2	9	7.3	54	20.6
Bangkok Blue	34	17.4	2	11	5.4	48	21
Big White Jumbo	31	17.4	3	7	6.8	41	29.5
Madam Pink	47.7	32.7	2	15	6.8	44	15.3
DaangSaard	25.5	16.5	2	10	6	33	27.5
Erika	41.9	27.5	2	6.2	15	50	34.8
Julie	29.25	15	4	12	3.5	38	25
Kating Dang	28.7	16.3	2	6.7	12	45	28
Lervia	22.8	11.8	2	7.8	5.25	41	28.2
Madam Pompadour	32	17.95	1	9.6	6.25	50	37
Triple Pink	21.9	16.9	1	6.4	6	70	40
Emma White	26.9	16.4	2	5.4	6	50	37
Ear Sakul	30	17	1	9	7.5	71	33.5
Thongchai Gold	25.4	14.2	3	7.6	10.5	69	30.4
SE m	1.56	0.70	0.34	0.82	0.74	1.98	5.36
CD 5%	2.58	1.16	0.56	1.36	1.23	3.27	8.85

Highest number of spikes/cane was recorded in 'Julie' (4.0) followed by 'Thongchai Gold' (3.0) and 'Big White Jumbo'(3). 'Madam Pink' had highest number of florets/spike (15) while 'Emma White' had minimum(5.4). Flower diameter was recorded maximum in 'Erika'(15) followed by 'Kating Dang'(12cm). Longevity on plants was recorded highest in 'Ear Sakul' (71 days) and lowest in 'Daang Saard' (33 days). The hybrid 'Triple Pink' had the highest vase life (40 days) and lowest in 'Madam Pink' (15.3 days).

Table 4. Changes in carbohydrates in pseudobulbs and flowers and chlorophyll content in leaf in Dendrobium orchids

Name of hybrid	Carbohydrate content in Flower (mg/g)	Carbohydrate content in pseudobulb (mg/g)	Chlorophyll content in leaf (mg/100g)
Big White 4N	227	240	34.5
Bangkok Blue	192	203	43.9
Fatima	----	46	32.9
Big White Jumbo	112	136	36.4
Madam Pink	218	259	46.5
Channel	----	65	32.6
Daang Saard	125	71	33.28
Erika	259	279	44.6
Julie	192	197	36.3
Kating Dang	260	248	27.5
Lervia	112	147	41.3
Madam Pompadour	177	185	43.4
Triple Pink	185	144	37.6
Emma White	199	134	31.4
Ear Sakul	209	127	47.8
Thongchai Gold	172	163	34.6
SE m	1.87	1.67	1.24
CD 5%	3.08	2.75	2.05

It is clear from Table 4 that there were significant variations in the content of carbohydrates in pseudobulbs and flowers and chlorophyll content in leaves. Out of 16 hybrids evaluated, two hybrids viz. 'Fatima' and 'Channel' did not bloom and they had lower levels of carbohydrates and chlorophyll content. 'Fatima' had shown 46 mg/g carbohydrates in pseudobulbs and 32.9 mg/100g chlorophyll content in leaf whereas 'Channel had 65 mg/g carbohydrates in pseudobulbs and 32.6 mg/100g chlorophyll in leaves. In flower, maximum amount of carbohydrate was estimated in 'Kating Dang'(260 mg/g) and minimum in Lervia (112mg) and 'Big White Jumbo'(112 mg/g).

In pseudobulb, carbohydrate content ranges from 46 mg/g in 'Fatima' to 279 mg/g in case of 'Erika' and other hybrids with higher levels of carbohydrate were 'Madam Pink' (259 mg/g), 'Kating Dang'(248 mg/g) and 'Big White 4N (240 mg/g).

In variable response to chlorophyll content in leaves, 'Ear Sakul' had maximum(47.8 mg/100 g) followed by 'Madam Pink' (46.5 mg/100g), 'Erika' (44.6 mg/100g) and minimum in 'Kating Dang'(27.5 mg/100g).

Reducing sugar analysis was carried out in Dendrobium hybrid 'Thanchai Gold'. Three stages of flowers like opened flowers, half opened flowers and bud has taken for analysis. It was found out that opened flower contains 29.00 %, half opened flower contains 28.25 % and buds contain 16.17 % of reducing sugars

CULTIVATION

A flowering potted Dendrobium orchid should have the following characteristics:

- Attractive upright to arching sprays
- Long lasting flowers
- A minimum of two inflorescences per plant per flowering period
- More than one flowering period per year
- Upright psedobulbs upto 50-60 cm
- Multiple pseudobulbs

Temperature: The cool growing Dendrobium orchid group thrives well temperatures ranging between 10 and 24°C. The intermediate Dendrobium orchid prefers a temperature range of 14-26°C whereas the warm growing Dendrobium orchids prefer 16 to 30°C. The warmer group species like *Dendrobium phalaenopsis*, *Den. gouldii*, *Den. biggibum*, *Den. antennatum* and *Den. discolor* bloom at night temperatures above 16°C and the cool growing species such as *Den. lindleyi*, *Den. aggregatum*, *Den. parishii*, *Den. pierardii*, *Den. densiflorum*, *Den. chrysotoxum* and *Den. anosmum* perform well at night temperature of 10°C. Low day temperature causes leaf yellowing, defoliation and reduces vegetative growth and higher temperatures delay flower bud development. Low temperature and short days could change the concentration of endogenous growth regulators leading to the induction of flowering in sympodial orchids.

Light: Most orchids generally prefer indirect or filtered light.

Although it varies species to species, growth habit and habitat, as the rule of the thumb, 50% shading is always advised for most of the commercial orchids. Under enough light, orchid plants have short, plump stems with bright green leathery leaves and yellowing, stunting and scorching of plants under too much of light and under too much shade plants have darker green , soft and succulent leaves with thin and spiny stems. All types of Dendrobium orchids require warm bright light (2500-3000 foot candles). They should get at least 12-14 hours of light each day year round.

Propagation: Conventionally, Dendrobiums are easy to propagate through keikis that produces along old canes or by division of pseudobulbs. 10-12 cm long cuttings also can be taken from a healthy, older and leafless cane keeping three nodes on each cuttings and placed in moist sphagnum moss for rootings. Commercially, Dendrobium hybrids are usually either seed-propagated or clonally propagated through tissue culture of apical and lateral buds that proliferate as protocorm like bodies. For seed propagation, green capsules are surface sterilized and seeds are dropped on a basal salt medium containing 15% coconut water and 2% sucrose at pH 4.8 to 5.0 for germination. Three months after sowing seedlings are transflasked with 75 to 100 plants per 500 ml flask on a salt medium containing 15% coconut

Divisions of pseudo

water, 2% banana powder, and 1% sucrose at pH 4.8-5.0.

Keikis in Dendrobium

Atmosphere : Fresh air and good circulation are essential for orchid production. Full of continual light breezes make a good source carbon dioxide for photosynthesis.

Fertilization: Orchids are light feeders and they require nitrogen from beginning to two-third of their life cycle. During rest period, they do not need any fertilizers. During flower initiation and inflorescence development plant are fed with less nitrogen, more phosphorus and potassium. During the blooming time, a small level of nitrogen and phosphorus and high levels of potassium are maintained. In orchids, foliar feeding is found to be ideal. Frequent application of fertilizers in low concentrations is the best way of feeding orchids. A concentration of 0.2 to 0.3 % of 30:10:10 (N:P: K) at vegetative stage and 10:20:20 (N:P:K) at blooming stage are applied for quality flower production. Sometimes, fresh coconut water, diluted cow urine are also useful as foliar sprays.

Potting mixture: The potting medium of Dendrobium orchid should be loose, friable as well as well drained. A potting

medium consisting of charcoal, brick pieces and coconut fibre in equal proportions is ideal for vegetative growth and flowering of epiphytic orchids like Aerides, Dendrobium etc. Under low humid conditions (30%), plastic pots with a mixture of bark/perlite/sphagnum moss or osmunda are used. Under average humidity (35-50%), it is advisable to use plastic pots with a mixture of bark and sphagnum moss. Under high humidity (55% and above), clay pots are used with bark, stone culture, charcoal or tree fern. In Dendrobium, among potting maixtures, cocochips + cocopeat + leaf mould + brick pieces (4: 1: 2: 3) showed longevity on plants in Den. 'Ear Sakul'(71 days) followed by Den. 'Triple Pink' (70 days) and Den. 'Thongchai Gold' (69 days).

Watering and humidity: Most orchids are damaged by overwater rather than under watering. Over watering leads to root rot and many other diseases. Most orchids prefer water of pH 5.0-6.5. Watering with lower or higher pH or with high levels of dissolved minerals can hamper nutrient uptake. Frequent watering is essential under high sunlight and high temperature conditions. Plants in small containers dry out more quickly than in large containers. Plants in earthen pots require more watering than plants in plastic pots. A hanging plant, with better aeration than one in a pot needs more frequent watering. More frequent watering is necessary for fresh potting materials. Watering should be practiced either in the morning or in afternoon time. Potting materials like coconut husk, tree fern etc having more moisture retention capacity needs less water and less frequently and vice versa. The single dominant factor which affects the cultivation of orchid is humidity which should be as high as 50-75%. It varies species to species depending

upon habit of growth, light, temperature and ecotypes. As rule of thumb, in high temperature, humidity should be kept high. Provisions of misting units or foggers or even humidifiers will ensure adequate humidity. Standing water beneath the benches may be kept to improve humidity.

Repotting: Orchid plants require repotting if there is no space left in the pots for new growths and if the substrate has decomposed or roots are rotting. Timing is the most important part of good repotting. The best time for repotting of an orchid is when new growth and new roots are just beginning to form, before those new roots reach even 1cm long. In most of the orchids, it occurs right after flowering. It shows that repotting should be done between February and June.

Application of growth regulators: Experimental evidences have shown that photoperiod and low temperature modify concentration of endogenous growth regulators. Combined application of GA_3 and BA improves inflorescence length and reduces percentage of abnormal flowers. In ***Dendrobium*** hybrid 'Thongchai Gold' maximum flower spikes were found in drenching followed by morning and evening spray. Spike length was found maximum in morning spray with GA_3 200 ppm (46cm) while in evening spray with GA_3 100 ppm spike length was 43.6cm and in morning spray with GA_3 100 ppm spike length was minimum (42cm). In ***Dendrobium*** hybrid, 'Emma White', treatment with NPK 20:20:20 with Ca, Mg and Mn along with BA 10 ppm and GA_3 100 ppm increased number of leaves (20.06), pseudobulbs (2.73) and pseudo bulb girth (1.94 cm). Plant height was highest (59.79 cm) in treatment with NPK 30:30:30 with Ca, Mg and Mn along with BA 25 ppm

and GA_3 50 ppm. Treatment with NPK 20:20:20 with Ca, Mg and Mn along with BA 50 ppm and GA_3 100 ppm gave maximum number of spikes / plant (2).

POST HARVEST MANAGEMENT

Harvest: *Dendrobium* orchid spikes possess the vase life of 2 to 3 weeks. Usually, 40-60 cm long floral spikes with 10-15 flowers are harvested at a stage when all flowers are open except top bud. Harvested sprays should be immediately placed in clean bucket of water with the cut ends submerged about 2-3 inches. Then the sprays are taken in the cool shaded packing area. In Dendrobium, it has been reported that flowers harvested early in the morning, generally lasts longer than those harvested in the late morning.

Pre-cooling: It is the fast removal of field heat and is an important operation in post harvest handling and transport of cut flowers, wherever flowers are held dry pack. All flowers should be pre-cooled immediately after harvest by placing them in cold storage without packing or in open boxes until they reach the desired temperature. It varies with the species and cultivars: *Cattleya* (7-10°C), *Cymbidium* and *Paphiopedilum* (0.5 to 4°C), *Dendrobium* (5-7°C). Precooling lowers respiration rate and decreases the break down of nutritional and other stored materials in the stems, leaves and petals; delays bud opening and flower senescence. It also prevents rapid water loss and decreases flower sensitivity to ethylene. Several pre-cooling techniques such as room cooling, forced air cooling, hyder-cooling, vacuum cooling and ice bar cooling etc. are available.

Pulsing: The absorption of chemical solutions containing sugars and germicides through the lower cut bases of flower stems is known as pulsing. Pulsing may be used by growers, wholesalers or retail florists in order to enhance the cut flowers subsequent vase life in water. Pulsing is employed with higher concentrations of sugar, mainly sucrose, the percentage of which varies with species and cultivars. Other chemicals used in the pulsing treatments are STS, $AgNO_3$, HQ, MH, AOA, $CaCl_2$, $CoCl_2$, nickel sulphate, aluminium sulphate and benzyladenine. Pulsing is found to be of great value in prolonging life, promoting opening and improving the colour and petal size of petals through osmo-regulation. In *Dendrobium* hybrid 'Pompadour' with 25ppm $AgNO_3$ + 135 $Na_2S_2O_3$, $5H_20$ for 30 minutes increases vase life of cut flowers. In *Dendrobium* cv. 'Sonia' pulsing with 4% sucrose + 400 ppm HQ recorded the highest vase life of 21.33 days.

Bud opening: It is a procedure of harvesting flowers at a stage earlier than normally considered as the cutting stage and then opening the buds off the plant. Such types of post harvest handling may be applied by growers or wholesalers. Bud opening of flowers increases longevity of cut flowers by reducing the sensitivity of flowers to extreme temperatures, low humidity and ethylene, saving space during shipment and extending the useful storage life. The sugar concentration used is lower than the concentration of pulsing and the optimum temperature is kept lower. In *Dendrobium* hybrid, 'Thongchai Gold' opened flowers had 29%, half opened flowers had 28.25 % and buds had 16.17% reducing sugars. In *Dendrobium* hybrids, HQS or $AgNO_3$ (50ppm) is effective for opening of

tight bud cut flowers. It has been reported that a preservative solution containing 225ppm HQS, 30ppm $AgNO_3$ and 4% glucose increased bud opening and the time to wilting of the open florets of *Dendrobium* Cv. 'Ceasar'. In *Dendrobium* hybrid 'Thongchai Gold', per cent of fully opened buds (66%) was recorded maximum with sucrose(4%) + $Ca(NO_3)_2$ (1%) followed by sucrose (4%) + acetyl acetic acid (100 ppm) (60%). Longest vase life (36 days) was found with sucrose (4%) + $Al_2(SO_4)_3$ (100 ppm) followed by sucrose (4%) + acetyl acetic acid (100 ppm) (33 days).

Preservatives: Preservatives are used in the holding solutions in the form of tablets containing a mixture of chemicals such as sugars, germicides, salts, growth regulators etc. Besides, the chemicals are employed during conditioning, pulsing and for making bud opening solutions to improve flower shape, size and opening and colour of the flowers.

Sugar, biocide, anti-ethylene compounds and hydrated compounds are used for conditioning. The sugar and biocide solutions are effective for opening of bud cut flowers

The vase solution should contain sugars, acidifying agent and a biocide. Citric acids are mainly used for acidifying agent and hydroxy quinoline as biocide. Metallic salts like silver nitrate, cobalt chloride, aluminium sulphate, zinc sulphate, calcium nitrate and nickel chloride have been found for prolonging post-harvest life of various cut flowers. A combination of biocide, sugar and hormone (8-HQC 100 ppm + sucrose 2 % + BA 25 ppm) remarkably enhances the post harvest life of the *Dendrobium* cut flowers. New chemicals that have been found promising as floral preservatives are ethylene inhibitors like

amino- oxyacetic acid, 1-amino cyclopropane, aminotriazole, aminoethoxy vinyl glycine, alpha aminoisobutyric acid, diazocyclopentadiene and phenidone. Holding solutions for increased longevity of Dendrobium as reported by various workers are 8-HQC (200 ppm) + sucrose (2%), 0.5 mM AOA + 4% sucrose, AgNO3 (30 ppm) + 4% sucrose, 400ppm HQ + 30ppm AgNO3 + 2 % sucrose, 200 ppm 8-HQS + 50ppm AgNO3 + 8% sucrose.

Grading: The export quality orchids are graded to maintain high standards of excellence. Sprays are graded according to length, colour, flower size etc. The grading is done in four standard sizes, based on the quality of the stalk and spike length for each grade.

Name of the grade	**Length of the spike**	**No. of opened flowers**
SMALL-S	30 cm	4-5
MEDIUM-M	40 cm	6-8
LARGE-L	45 cm	8-10
EXTRA LARGE-XL	50 cm	>10

Packaging: The flower spikes of *Dendrobiums* are first sleeved in polyethylene sleeves of standard thickness. The standard is to bunch around 5 spikes of the same grade and variety in a pack box. Each stem in the box should be placed in the tube containing water or preservative solution. During shipment loss of water could be supplemented by employing flowers tube or vials, which could be filled with water or preservative solution. Instead of small tube cotton wrapping can also be used, in this

case cotton pieces should be dipped in water or preservative solution. Then the piece of polythene can be used to cover the cotton and it should be tied with rubber band. And cushioning materials should be provided in the back side of the sleeve to avoid the damage during transportation.

Then these graded flowers are packed in suitable size of boxes. In order to check movement of spikes within the boxes during transit the base of the spikes should be tied to the base of the carton by adhesive tapes. *Dendrobium* flower spikes are normally packed in carton of different sizes. The length of the carton varies mainly based on the length of the flower spikes. The carton should be provided with sufficient numbers of holes or vents for aeration. The carton is exclusively designed to ensure better care of the flowers and help reach their destination in pristine conditions. In *Dendrobium* hybrid 'Sonia-17' a low gauge polyfilm of 100 gauge thickness the cotton dipped in 8-HQS (25ppm) covering the base of the spike had maximum vase life and flower quality.

Storage: Storage of cut flower is an essential part of floriculture industry. Tropical orchids like *Dendrobium*, can be stored at 7-10^{0}C and 90-95 % RH. The longest vase life of 19 days has been observed in *Dendrobium* hybrid Sonia 28 followed by 15 days in Sonia 17 when stored at 10^{0}C. The orchids stored below optimum temperature cause chilling injury characterized by darkening of labellum. In extreme cases, the sepals and petal also get affected. Orchids are sensitive to ethylene and the storage environment should be free from ethylene which can be effectively accomplished by proper ventilation and placing

Ethylene scrubber or absorbent containing potassium permanganate.

Value addition: Value addition in flower crops can directly or indirectly influence floral market to a great extent. Value addition in flower crops by employing techniques like colouring in white flowers, flower dehydration, flower processing, advances in flower arrangements etc can add value upto 5 to 10 times

Tinting: It is one of the important value addition technique for imparting desired shades of colour to the flowers. It is very useful technique in flower crops where pigments are absent or light and dull. Aesthetic beauty of the cut flowers and dry flowers were enhanced through tinting. Translocation, immersion and spraying are methods followed in tinting. Stopping irrigation two days before the harvest of flower improves the flower colour. It can be combined with pulsing solution. Edible dyes of 0.25 to 1% can be used along with pulsing solutions for 30 minutes to 3 hours. Different dyes and strains such as food colours, feulgen stain, bromocresol blue, bromocresol green, eosin yellow, ammonium purpurate and phenol red at varying concentrations can be used to get flowers with different shades of colours. Artificial colouring can be done by using edible dyes like Apple green, Kalakhatta, rose pink etc. Employing this technique, the white flowers can be obtained in all shades of red, blue, green and yellow.

Bouquet is prepared with different colours of *Dendrobium* cut flowers were selected and combined according to colour and arranged with some foliage plants and packed in boxes. Loose flowers are treated and packed in numbers in poly pack for the

preparation of garlands, corsages and garnishing of foods etc. Pendants, earrings, brooches or pins made from orchid flower by casting a metal mould on it and then by gold or silver planting the same is common in Singapore and U.S.A. These ornaments usually contain a real orchid flower inside. However, in some cases mould prepared from an orchid flower is also used for casting the Jewellery.

Dendrobium in floral arrangement