

**EVALUATION OF VANDA ORCHIDS FOR
COMMERCIAL TRAITS**

By
MINNU SEBASTIAN
(2012-12-108)

THESIS

Submitted in partial fulfilment of the requirement for the degree of

Master of Science in Horticulture

**Faculty of Agriculture
Kerala Agricultural University**

**DEPARTMENT OF POMOLOGY AND FLORICULTURE
COLLEGE OF HORTICULTURE
VELLANIKKARA, THRISSUR-680 656
KERALA, INDIA**

2015

DECLARATION

I hereby declare that the thesis entitled “**Evaluation of vanda orchids for commercial traits**” is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar title, of any other university or society.

Vellanikkara

Minnu Sebastian

(2012-12-108)

CERTIFICATE

Certified that the thesis entitled **“Evaluation of vanda orchids for commercial traits”** is a record of research work done independently by **Ms. Minnu Sebastian (2012-12-108)** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, associateship or fellowship to her.

Vellanikkara

Dr. C. K. Geetha
(Chairman, Advisory Committee)
Professor
Dept. of Pomology and Floriculture
College of Horticulture
Vellanikkara

CERTIFICATE

We, the undersigned members of the advisory committee of **Ms. Minnu Sebastian (2012-12-108)**, a candidate for the degree of **Master of Science in Horticulture**, with major field in Horticulture, agree that the thesis entitled **“Evaluation of vanda orchids for commercial traits”** may be submitted by **Ms. Minnu Sebastian (2012-12-108)**, in partial fulfilment of the requirement for the degree.

Dr. C. K. Geetha

(Chairman, Advisory Committee)

Professor

Department of Pomology and

Floriculture

College of Horticulture, Vellanikkara

Dr. T. Radha

(Member, Advisory Committee)

Professor and Head

Department of Pomology and Floriculture

College of Horticulture

Vellanikkara

Dr. P. K. Sudhadevi

(Member, Advisory Committee)

Professor

Department of Pomology and

Floriculture

College of Horticulture

Vellanikkara

Dr. S. Krishnan

(Member, Advisory Committee)

Associate Professor

Department of Agricultural Statistics

College of Horticulture

Vellanikkara

Dr. M. Kannan

Professor and Head

Department of Floriculture and

Landscaping

Horticultural College &

Research Institute

TNAU, Coimbatore

(EXTERNAL EXAMINER)

CONTENTS

Chapter	Title	Page No.
1	INTRODUCTION	1-4
2	REVIEW OF LITERATURE	5-22
3	MATERIALS AND METHODS	23-33
4	RESULTS	34-89
5	DISCUSSION	90-100
6	SUMMARY	101-108
7	REFERENCES	(i)-(x)
	ABSTRACT	
	APPENDIX	

LIST OF TABLES

Table No.	Title	Page No.
1	Vanda varieties/ hybrids selected for evaluation	24
2	Plant height in vanda varieties/ hybrids during the period of observation	35, 36
3	Plant spread of vanda varieties/ hybrids during the period of observation	37, 38
4	Shoot characters of vanda varieties/ hybrids	40
5	Leaf length of vanda varieties/ hybrids during the period of observation	42, 43
6	Leaf breadth of vanda varieties/ hybrids during the period of observation	45, 46
7	Leaf area of vanda varieties/ hybrids during the period of observation	47, 48
8	Number of leaves in vanda varieties/ hybrids during the period of observation	50, 51
9	Other leaf characters of vanda varieties/ hybrids	52, 53
10	Leaf sheath characters of vanda varieties/ hybrids	54
11	Aerial root characters of vanda varieties/ hybrids	56, 57
12	Root number in vanda varieties/ hybrids during the period of observation	59, 60
13	Flowering characters of vanda varieties/ hybrids	62, 63
14	Spike characters of vanda varieties/ hybrids	67, 68
15	Floral characters of vanda varieties/ hybrids	71, 72
16	Qualitative characters of flower/ petal of vanda varieties/ hybrids	74, 75
17	Qualitative characters of lip and column of flowers of vanda varieties/ hybrids	76
18	Post harvest characters of spikes of vanda varieties/ hybrids	79, 80
19	Visual scoring of spikes of thirty vanda varieties/ hybrids	87
20	Plant quality rating of thirty vanda varieties/ hybrids by visual scoring	89

LIST OF PLATES

Plate No.	Title
1	<i>Vanda</i> Dr. Anek
2	<i>Vanda</i> Rothchildiana
3	<i>Vanda</i> Thongchai
4	<i>Vanda</i> Katsuura x <i>Vanda</i> Fuchs Delight
5	<i>Vanda</i> Taweesuksa x <i>V.</i> Kultana Gold x <i>V.</i> Green Gold
6	<i>Vanda</i> Apec Blue
7	<i>Vanda</i> Pakchong Blue
8	<i>Vanda</i> Sirilak x <i>Vanda</i> Bitz's Heartthrob
9	<i>Vanda</i> Pachara Delight Pink
10	<i>Vanda</i> Pakchong New Land x <i>Vanda</i> Annette Jones
11	<i>Vanda</i> Red Gem
12	<i>Vanda</i> Anek Delight
13	<i>Vanda</i> Urbchitr x v. Bitz's Heartthrob
14	<i>Vanda</i> Kasem's Delight x <i>Vanda</i> Bitz's Heartthrob
15	<i>Vanda</i> Pranermprai x <i>Vanda tessellata</i>
16	<i>Vanda</i> Pathum Gold
17	<i>Vanda</i> Lumpini Red
18	<i>Vanda</i> Kultana Delight Red
19	<i>Vanda</i> Pompimol
20	<i>Vanda</i> Lumpini Red x <i>Vanda</i> Taweewan
21	<i>Vanda</i> Madame Rattana
22	<i>Vanda</i> Lanka Sri pink
23	<i>Vanda</i> Varuvathe Pink
24	<i>Vanda</i> Robert's Delight
25	<i>Vanda</i> Dr. Anek x <i>Vanda</i> Mimi Palmer
26	<i>Vanda</i> Fuchs Delight x <i>Vanda</i> Bitz's Heartthrob
27	<i>Vanda</i> Prapawan
28	<i>Vanda</i> Thailand Beauty
29	<i>Vanda</i> Dr. Anek x <i>Vanda</i> Bitz's Heartthrob
30	<i>Vanda</i> Fuchs Delight

LIST OF FIGURES

Figure No.	Title	Between pages
1	Shoot girth in different vanda varieties/hybrids	40 & 41
2	Days taken from spike emergence to opening of florets in different vanda varieties/ hybrids	64 & 65
3	Spike longevity of thirty different vanda varieties/ hybrids	64 & 65
4	Number of florets per spike in different vanda varieties/ hybrids	72 & 73
5	Flower size in different vanda varieties / hybrids	73 & 74

ACKNOWLEDGEMENT

*First of all, I bow my head before **Lord Almighty** whose blessings enabled me to undertake this venture successfully.*

*It is with great respect and devotion, I place on record my deep sense of gratitude and indebtedness to my chairperson **Dr. C. K. Geetha**, Professor, Department of Pomology and Floriculture for her sustained and valuable guidance, constructive suggestions, unfailing patience, friendly approach, constant support and encouragement during the conduct of this research work and preparation of the thesis. I gratefully remember her knowledge and wisdom which nurtured this research project in right direction without which fulfillment of this endeavor would not have been possible. If it was not her, I would not have completed this thesis. Thank you Mam for everything.*

*No words can truly represent my profound gratitude and indebtedness to **Dr. P. K. Rajeevan**, retired Professor and Head, Department of Pomology & Floriculture, moreover, my mentor, for his unstinted support and guidance and nourishing me with the inspiration to fulfill the goal. I also express my gratitude to **Dr. P. K. Valsalakumari**, retired Professor and Head, Department of Pomology & Floriculture for her support and guidance during my research work. I am also thankful to **Dr. T. Radha**, Professor and Head, Department of Pomology & Floriculture, for her positive attitude, valuable suggestions and boosting approach during the conduct of my thesis preparation.*

*I am deeply obliged to **Dr. P. K. Sudhadevi**, Professor, Department of Pomology & Floriculture and member of my Advisory Committee for the strength she provided me during the course of study.*

*I consider it is a privilege to express my sincere thanks to **Dr. N. K. Parameswaran**, **Dr. Laila Mathew**, **Dr. Ajithkumar**, **Dr. S. Sarada**, **Dr. Simi**, Department of Pomology & Floriculture for the valuable help and advice rendered during the course of my study.*

*I am extremely delighted to place on record my profound sense of gratitude to **Dr. S. Krishnan**, Associate Professor, Department of Agricultural Statistics, for his support, help and valuable advice during the preparation of this manuscript. I am deeply indebted to **Dr. C. George Thomas**, **Dr. Sara T. George** and **Dr. S. Beena** for their support and kindness which helped me to finish the defense on time.*

I wish to express my sincere gratitude to Mrs. Roshmi, Mrs. Pushpa, Mrs. Femina, Ms. Kamya, Sri. Unni, Sri. Pankajakshan, Smt. Rema, Smt. Santha and all the faculties of Department for their support and help during the entire period of research.

Words fall short as I place on record my indebtedness to my seniors, classmates, juniors and friends, Anu chechi, Chaitanya, Simmi, Sadhana, Rasiq, Aswini, Sameera, Reshma, Greeshma, Deepika, Anila, Rubi, Aparna, Mahsu, Teena, Shanthi, Sajeera and Manju for their love and cooperation during the entire period.

It is my fortune to gratefully acknowledge the support of my dearest friends Surya, Sandhya, Gopika, Maya, Sharon and Deepak who were always beside me during the happy and hard moments in my life to push and motivate me. Thank you all.

Special thanks to students' library, photostat service and Aravindettan, students computer club, COH, for rendering necessary help whenever needed. The award of junior research fellowship of the KAU is also thankfully acknowledged.

Family is the compass and inspiration to reach great heights, providing comfort when we occasionally falter. I would like to thank my Amma, Daddy, Dany Sebastian, Clint Sebastian and Maa for their boundless patience, prayers, love and care throughout the period of my course. I owe everything to them. Sobhanakumari Madem and Joy Sir of Canara Bank are also gratefully remembered for their kind and goodwill, which helped me to complete the post graduation.

It is a pleasant task to express my thanks to all those who contributed in many ways to the success of this study and made it an unforgettable experience for me.

Minnu Sebastian

INTRODUCTION

1. INTRODUCTION

Floriculture in India has gone a sea change during past ten years and the country is fast emerging as a global 'Flower Power'. Rose, carnation, orchids, gerbera, anthurium and chrysanthemum are important cut flowers that rank high in the global trade. Among them some are bewitchingly beautiful and have attracted people over hundreds of years. Protected cultivation and green house technology enabled us to go for commercial production of major cut flowers like orchids and anthurium. Orchids are unique with their versatility in form, flower colour, size, shape and longer life span of flower. Taxonomically, they represent the most highly evolved family among monocotyledons with 600-800 genera and 25,000-35,000 species. They are the most pampered plants and occupy top position among all the flowering plants valued for cut flower production and as potted plants. They are known for their long lasting and bewitchingly beautiful flowers which fetch a very high price in the international market. The orchid cut-flower industry is growing at an annual rate of 10-20 per cent (Sheela, 2008). They have always been considered as mysterious plants. Several orchids are used as food in different parts of the world. A few species of orchids induce sterility among women. The native habitants in some areas use seeds of *Cymbidium maladium* and pseudobulbs of *Dendrobium tokai* as oral contraceptives. Some species of orchids have religious influence like *Cymbidium finlaysonianum* and a few species of *Dendrobium* (Bose and Bhattacharjee, 1980).

Orchids can be divided into two groups - monopodial or sympodial depending upon their habit of growth. Monopodial orchids such as *Phalaenopsis*, *Renanthera* and *Vanda* have a main stem which continues to grow year after year whereas sympodials like *Cattleya*, *Cymbidium* have a main stem which terminates growth at the end of each season. A new shoot then grows from the base forming its own bulbous stem called pseudo-bulb which eventually flowers. Tropical orchids comprise both terrestrial and epiphytic types, but the latter constitutes the major share. Most of the temperate zone orchids are terrestrial and tropical orchids are

epiphytes. There are about 60 genera and 250 species of wild orchids in Kerala. The forests of Western Ghats constitute home of some 200 species of native orchids. Prominent among them is the *Paphiopedilum drurii* or Lady's slipper orchid, beautiful yellow flowered orchid now included in the list of endangered plants (Sheela, 2008).

Orchids are grown all over the world ranging from Equator to the arctic circle, especially in tropics and temperate regions. Most of the cultivated orchids are natives of tropical countries. Tropical forests of Amazon and Indo-Malayan region are the main centres of origin. Orchids are abundant in tropical countries in South East Asia, South and Central America and South Africa. India is blessed with a wealth of orchid flora, and about 200 genera including 1700 species are estimated to occur in this country. The major areas are the Eastern Himalayas, the Western and South Indian Hills. North-eastern Himalayan region and the west-coast of Kerala which are the main centres of orchid production (Rajeevan, 2003). India has a large variety of orchids and hilly regions have one or the other orchid flowering almost throughout the year. The diversity is so large that there are large-flowered, terrestrial, epiphytic and also saprophytic orchids. In general, terrestrial orchids are more common in North-Western India, epiphytic orchids in North-Eastern India and small flowered orchids in Western Ghats. Many orchids native to this country have already proved to be important parent plants and have contributed to the production of several outstanding hybrids of the world (Bose *et al.*, 1999). Commercial cultivation of orchids has gathered momentum in Kerala during early nineties. Though monopodial orchid genera like *Arachnis*, *Aranthera*, *Renanthera*, *Mokara*, *Aranda*, *Phalaenopsis* and *Vanda* are also cultivated, greater emphasis is given to hybrids of *Dendrobium*, a sympodial orchid, in view of its easiness in cultivation.

Monopodials have recently gained popularity due to the availability of large number of varieties and hybrids including intergeneric ones that show a wide range of variability in floral characters. Wide spread cultivation of such monopodials would

also create diversity in the dominance of monogeneric cultivation of *Dendrobium*. Moreover, import of flowers from Thailand has reduced the market value of *Dendrobium* in the recent past. Among the monopodial orchids, *Phalaenopsis*, *Aranda*, *Mokara* and *Vanda* are most popular in the world market. Vandas have become extremely popular and they are now amongst the foremost orchids cultivated outdoors or in greenhouse in the warmer regions of the world. It is a genus consisting of more than 70 species and are distributed in India, China, Sri Lanka, Philippines and throughout South East Asia. These orchids are grown commercially in Thailand, Singapore, Malaysia and Hawaii. The most striking character in *Vanda* is the remarkable range of colour in the flowers of different species and varieties. They are easy to grow and handsome in habit, which supersede the other genera of cultivated orchids. It is a parent in many popular intergeneric orchids like *Aranda*, *Ascocenda*, *Renantanda*, *Holttumara*, *Vascostylis* and *Mokara*. Vandas are vigorous in growth and are free flowering with the capacity to produce a flower spike from the axil of each leaf. They can be multiplied easily through cuttings and can be grown in full sun. They are diversified in vegetative and reproductive growth. Based on leaf characters they are grouped into three categories, strap shaped, terete and semi-terete. The tip of strap shaped leaves is very irregular while the terete leaves are of pencil thickness. The inflorescence is axillary, erect and simple. The flowers are small to large, few to many, fleshy, heavy textured, long lasting and yellow, brown, purple, magenta, blue or lavender in colour. The flower size varies from 2.5 to 10.0 cm. some popular *Vanda* hybrids are Miss Joaquim, (National flower of Singapore), John Club (widely cultivated in Kerala) and Popoe Diana (white flowered). *Vanda spathulata*, a native of Kerala, is a beautiful yellow flowered variety. *Vanda coerulea* is the famous blue *Vanda*. Some therapeutically important *Vanda* species like *V. roxburghii*, *V. testacea*, *V. cristata* and *V. parviflora* are commonly used in drugs of ayurvedic system.

The potential of epiphytic basket vanda is ever growing and it has not been systematically exploited so far in the country. Researches on *Vandaceous* orchids

have to be effectively conducted for the further advancement into this arena. Therefore there is an imperative need to evaluate performance of epiphytic slow growing basket vandas for commercial exploitation. A study was undertaken in the Department of Pomology and Floriculture, College of Horticulture, Kerala Agricultural University with the following objective

1. To evaluate the performance of *Vanda* orchids grown in hanging baskets (basket vandas)
2. To classify them based on economic and aesthetic parameters for commercial exploitation

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

Orchids are the most fascinating and beautiful of all flowers. They are highly priced in the international florist trade due to their intricately designed spectacular flowers, brilliant colours, delightful appearance, myriad sizes, shapes, forms and long lasting qualities. This manifold and perplexing range of floral structures arouse our highest admiration (Bose *et al.*, 1999). Orchids account for a large share of global floriculture trade and are estimated around 10 per cent of international fresh cut flower trade. They have taken a significant position in cut flower industry due to its attractiveness, diversity in forms, shape and colour, high productivity, right season of bloom, and easy packing and transportation (De *et al.*, 2014). Orchids constitute an order of royalty in the world of ornamental plants and they are of immense horticultural importance and play a very useful role to balance the forest ecosystem. Orchids with their bewildering range of flowers and beautiful colour combinations provide a source of profound aesthetic pleasure to both owners and visitors. Orchids, having flowers of wonderful beauty and very good keeping qualities, are of highest value as cut-flowers. Several orchids have been used as food in different parts of the world. Orchids are being used in the indigenous system of medicine for over 3000 years.

India is blessed with a huge wealth of orchid flora (Arora, 1983). In India, orchid comprises about 200 genera and 1700 species which grow up to an elevation of 5000 m. Indian terrestrials are located in humus rich moist earth under tree shades in North Western India. Western Ghats harbour the small flowered orchids. Epiphytic orchids are common in North Eastern India which grows up to an elevation of 2000 m from sea level (De *et al.*, 2014). There is tremendous scope for orchid improvement and development of industry based on these wonderful plants. Many orchids native to India have already proved to be important parent plants and contributed to the production of several outstanding hybrids in the world.

Grove (1995) has dealt with *Vandas* and *Ascocendas* and their combinations with other genera. Hybrids of certain Indian orchids like *Vanda coerulea* and species of *Cymbidium*, *Dendrobium* and *Paphiopedilum* are considered the monarchs in the orchid world (Behera *et al*, 2013). Due to the diversity of environmental condition in India, it is possible to grow all types of orchids in suitable places without the control of environment.

In the last three decades, *Vandas* have become extremely popular and they are now amongst the foremost orchids cultivated outdoors or in greenhouse in the warm regions of the world. They are attractive because of large dimension and unusual shaped flowers, which last longer and in some species the flower may remain fresh for a period of three months. *Vanda* consists of more than 70 species of monopodial epiphytic orchids distributed in India, China, The Himalayas, Sri Lanka, Philippines and throughout South East Asia. These commercial orchids are grown in Thailand, Singapore, Malaysia and Hawaii (De and Debnath, 2011). Although orchids are being cultivated and valued mainly for ornamental purposes, some of them are used from time immemorial in various traditional medicines.. According to Reddy *et al*. (2005), the different ethnic groups of Andhra Pradesh are known to use some 23 species of orchids for the treatment of ailments that are associated with different diseases. In one study conducted at a botanical research institute in India, scientists evaluated the species *Vanda tessellata* and discovered its role as a potent aphrodisiac and fertility booster. This species, grown in abundance locally, has had a long history of use by the native population for its anti-inflammatory properties (Kumar *et al.*, 2005). The Indian *Vanda* orchid does indeed express antiproliferative effects against various types of cancers, including those from choriocarcinoma (cancer of germ cells), lung cancers, and stomach cancers (Ho and Chen, 2003). Still other orchids have been used in the treatment of epilepsy, flatulence, rheumatism and spasms. They have also been used for sedatives and flavor enhancers (Kong *et al.*, 2003).

Distribution of orchids in India and Kerala

In India orchids are known since Vedic period. There are references to orchid in ancient Sanskrit literature like 'Nighantus' and 'Amarakosha'. The term 'Vanda', applied to one of the widely cultivated orchid genera of Asian countries, derives from the Sanskrit term 'Vandika'. Orchids form about nine per cent of our flora. Nearly 1300 species of orchids, spread over 140 genera, are reported from our country. Orchids form about nine per cent of our flora. Orchid species are distributed in different regions like North Western Himalayas (200 species), North Eastern India (800 species), Western Ghats (200 species) and other regions occupy about 100 species (Rajeevan *et al.*, 2002). More than 13 species of orchids of traditional medical importance are reported in Kerala forests.

There is immense scope for improving orchids in India, because large number of species is native to this country and many of them have already proved to be important parent plants and contributed in the production of several outstanding hybrids in the world. According to Rajeevan (1995), prevalence of salubrious climatic conditions greatly favour cultivation of a vast majority of orchids in Kerala. In India, *Vanda* are found scattered in the hilly districts of Assam, Meghalaya, Arunachal Pradesh, Darjeeling, Western Ghats, Garhwali and in the Andaman and Nicobar Islands (Bose and Bhattacharjee, 1980). The North East India due to its agro climatic diversity and high humidity and rainfall forms the richest orchid belt in the country. Of the estimated species of orchids known in India, around 750-800 species occur in this region. Maximum diversity of orchids is found in Arunachal Pradesh followed by Sikkim (Chowdhery, 2001). The Niyamgiri hills, is an important orchid-rich area of Orissa, next only to Similipal and Rebana and at par with the Koira (Sundargarh) forests. Mishra (2005), however, accounts for 31 species (19 epiphytic, 12 terrestrial) of orchids from Niyamgiri. Ethnobotanical studies on orchids of Niyamgiri Hill Ranges were carried out to find out the therapeutic potentials of some 20 species of orchids for the treatment of different diseases and ailments

(Dash *et al.*, 2008). The study concluded that the orchids are used as emetic, purgative, aphrodisiac, vermifuge, broncho-dilator and as anti-tumor agent. Further studies are in progress to explore the various medicinal uses of orchids, as well as the problems of their threatened ecosystems. Kumar *et al.* (2012) evaluated forty orchid species belonging to 16 genera for vegetative and flowering characters at sub-tropical mid-hills of Meghalaya and made significant findings. *Calanthe masuca*, *Cymbidium giganteum*, *Dendrobium nobile*, *Phaius tankervilleae*, *Renanthera imshootiana*, *Thunia marshalliana* and *Vanda coerulea* were found promising as cut flowers.

India is one of the primary/secondary centre of orchid biodiversity and the major regions of diversity are Northeastern Himalayas, Western Ghats, and Andaman and Nicobar Islands.

Biodiversity conservation of orchids

Orchids in their natural habitat are highly vulnerable to loss or erosion. Certain species like *Aphyllorchis gollaoii*, *Coelogyne truetleri*, *Anoectochilus rotandifolius*, *Paphiopedilum charlsworthii*, *Paphiopedilum wardii* and *Vanda wightiana* probably have vanished from Indian lands. India has an elaborate Protective Area Network (PAN) comprising 86 National Parks, 480 wildlife sanctuaries covering about 4.66 per cent of total geographical area of the country for in-situ conservation of the species. The Botanical Survey of India has established three National Orchidaria at Shillong, Yercaud, and Howrah for conservation and multiplication of orchids. The Tropical Botanical Garden Research Institute (TBGRI), Kerala, National Research Centre for Orchids, Sikkim, and several other organizations are also engaged in the mission. According to Ram *et al.* (2011), orchid seed banks and in-vitro conservation are other techniques for conservation of orchid biodiversity. In Nepal, 363 species of orchids are organized into 97 genera (Rajbhandari and Bhattarai, 2001). Habitat loss, forest destruction and degradation and over exploitation have threatened the conservation of orchids in Nepal. Accordingly orchid habitat hotspots and host plants were identified within the forests to conserve the orchid wealth of the Nation.

North eastern region of India is the traditional home of nearly 876 orchid species in 151 genera of which many species are economically important for their ornamental and medicinal values. The people of this region have a tradition of conservation of wild orchids in nature based on various religious beliefs and herbal healthcare (Medhi and Syamali, 2009). On a study conducted by Chun (1992) on the conservation and propagation of wild orchids in Hong Kong, it was found that orchid seeds with a moisture content between 6 per cent and 10 per cent stored more successfully than those at temperatures of 4°C, -18°C and -196°C.

Tissue culture and breeding

Over the past few decades, extensive breeding through interspecific and intergeneric hybridization has produced thousands of vandaceous hybrids worldwide (Chen *et al.*, 1999). Amplified fragment length polymorphism (AFLP) is used as a powerful technique to establish the taxonomic status of breeding material and to verify orchid hybrids with doubtful parentage. The genetic closeness of various species of *Vanda* was determined using random amplified polymorphic DNA (RAPD) in the study conducted by Lim *et al.* (1999). Strap-leaved *Vanda* species (like *Vanda sanderiana*) and *Ascocentrum miniatum* were more closely related to each other than to the terete-leaved *Vanda* species studied. RAPD analysis supports the suggestion that terete-leaved *Vanda teres* and *Vanda hookeriana* be classified in the separate genus *Papilionanthe* and that *Vanda sanderiana* should remain in the genus *Vanda*.

Commercial orchid production is now international in scope. Based upon today's breeding efforts, the cultivars of the future will have a compact growth habit, variegated foliage, fragrance, and be ever flowering (Griesbach, 2002). From the findings of Prakash *et al.* (1996) on the effect of different media on *in vitro* seed germination and protocorm formation of *Vanda tessellata*, it was concluded that MS medium is best for seed germination and protocorm formation of *Vanda tessellata* orchid in comparison to that of other media by immature seeds. It suggests that the nutritional requirement in *in-vitro* is species and/ or genera specific. Hence media plays a very important role for shortening the growth period and rapid propagation.

According to a study conducted by Luan *et al.* (2006) on *in vitro* germination capacity and plant recovery of some native and rare orchids, all seeds of the selected orchid species were germinated after three months of culture. All *in vitro* seed-derived plants were vigorous and well acclimatized in greenhouse conditions. This study was very important for the preservation of genetic resources and basic researches of plant breeding. Cytogenetic studies of *Vandaceous* orchids like *Aranda* and *Mokara* for commercial cut flowers provided information on the significance of ploidy levels and genomic constitution on the horticultural performance of cut flower cultivars and also on the strategy for effective breeding in *Vandaceous* orchids (Lee *et al.*, 1996).

Mass propagation of endangered species like *V. coerulea* was made easier through multiplication of PLBs from leaf tissue. Artificial seeds were produced from these encapsulated protocorm-like bodies. It was found that among the different concentrations tested, 3 per cent sodium alginate and exposure to 100 mM $\text{CaCl}_2 + 2\text{H}_2\text{O}$ solution for 30 min produced firm, clear, round and uniform optimal beads which were suitable for handling (Sarmah *et al.*, 2010). Occurrence of endopolyploidy in somatic tissues of the hybrid orchid *Vanda* Miss Joaquim (*Vanda hookeriana* $\times$ *Vanda teres*) was investigated with respect to tissue type and developmental stage. Effects of naphthaleneacetic acid (NAA) and gibberellic acid (GA_3) on endopolyploidy during embryo development were also studied (Lim and Loh, 2003). An efficient protocol for cryopreservation of protocorm like bodies (PLBs) of *Dendrobium nobile*, based on encapsulation–dehydration (ED) and encapsulation–vitrification (EV), was established. EV method proved to be most appropriate way to cryopreserve the PLBs of *D. nobile* (Mohanty *et al.*, 2011). A study was conducted by Johnson (2007) with the objective to compare the germination and development of three *Vanda* hybrids. Seeds of *Vanda* Motes Primrose $\times$ *Ascocenda* Tavivat showed higher germination (82.0–95.3%) than seeds of *V. Paki* $\times$ (*V. tessellata* $\times$ *V. cristata*) or (*V. Joan Warne* $\times$ *V. Paki*) $\times$ *V. Loke* when cultured on Knudson C and $\frac{1}{2}$ MS. Mass clonal propagation of *Vanda teres*

(roxb.) through *in vitro* culture of nodal segments has been studied by Alam *et al.* (2006). According to an experiment conducted to investigate the effect of potato extract (PE) on *Vanda roxburgii in vitro*, potato extracts was found to enhance seed germination and seedling growth (Islam *et al.*, 2011). *In vitro* multiplication and ecorehabilitation of the endangered Blue Vanda, *Vanda coerulea* was studied by Seeni and Latha (2000) at TBGRI, Palode and evolved at significant results on the medium suitable for the rapid multiplication of the same.

Performance of selected orchids, under varying light regimes, culture methods and nutrition was undertaken by Thekkayam (1996) at Vellayani to evolve agrotechniques for cut flower orchid production in Kerala. Two of the rare species of *Vanda* was described (*Vanda bidupensis* and *Vanda fuscoviridis*) by Averyanov and Christenson (1998) based on a study conducted on Vietnamese orchids and was labeled as new species from IndoChina. Based on a performance study conducted by Amin *et al* (2004) on six indigenous epiphytic monopodial orchids of Bangladesh, *Aeridis multiflorum* produced the longest inflorescence whereas *Vanda teres* had the biggest floret and was recommended as suitable for cut flower production. Kaveriamma (2007) evaluated forty monopodial orchids belonging to monogeneric, bigeneric and trigeneric origin based on their field performance for commercial exploitation. Morphological and molecular analysis of genetic variability was investigated by using SDS-PAGE and RAPD markers in *Vanda tessellata* by Khasim and Ramesh (2010). *V. tessellata* is an epiphytic orchid from the Eastern Ghats of Andhra Pradesh, India.

Growth parameters and evaluation of orchids

Vegetative characters

Orchids are divided into two groups as monopodial and sympodial depending on plant structure. Monopodials grow from a single vegetative apex. They do not have rhizomes and pseudobulbs. They are mostly climbers. Single stem is the main characteristic of monopodials. Roots are adventitious and photosynthetic, clinging and absorbing and generally very thick, round or flattened and produced from aerial

parts of the stem. Non climbers have short stems with no aerial roots. Important monopodials include *Arachnis*, *Vanda*, *Renanthera*, *Phalaenopsis*, *Aerides*, *Ascocentrum*, *Rhyncostylis* and *Vanilla* (Mercy and Dale, 1997). Sympodials are characterized by presence of rhizomes or modified bulbs. The pseudobulbs swell up with stored food and arise in succession from the base of pseudobulbs. *Dendrobium*, *Cattleya* and *Oncidium* are common examples. The stem in both monopodials and sympodials is usually thick and green storing food and water. According to their habitat, orchids can be divided into terrestrial, epiphytes, lithophytes, saprophytes and subterranean.

Leaves

Leaves are simple, arising directly from the stem and usually distichous. Leaves are generally green in colour, but sometimes have silvery or golden veins providing beautiful ornamentation as in species of *Anoectochilus* (Bose *et al.*, 1999).

There are three distinct groups of *Vandas* which are easily distinguished by the shape of their leaves: Strap-leaf *Vanda* has rather flat, broad leaves growing close together, alternating on the right and left sides to give a beautifully symmetrical plant. The flower stems also alternate sides, coming from the axils of the leaves on the upper part of the plant. Terete-leaf *Vanda* has cylindrical leaves, shaped like and about the thickness of a pencil on mature plants. The flower stems appear on the side of the stem opposite the leaf. They are sun-loving orchids. Semi-terete *Vanda* is a hybrid between the other two and the leaves are somewhat in between.

Roots

Aerial roots are commonly present in orchids. The term “aerial root” may be applied to any lateral root which develops and remains in free air. The root differs according to the orchid habit. Usually the roots of most orchids are cylindrical, often thread like, branched and frequently elongated. The role of velamen of aerial roots of orchids was studied by Dycus and Knudson (1957). They are effective in providing the plant with essential water and nutrients from the atmosphere. In the epiphytic

species, the aerial roots emerge from the rhizome, are grey in colour with a green apex and are covered by the velamen. These roots arise from an above-ground stem, become exposed and free hanging or more often appress to an adjacent surface. They arise at intervals near the nodal region along the stem axis. According to a study conducted in aerial root production in *Aranda* orchids, it was concluded that the pattern of root production is not controlled genetically but possibly by physiological and/or environmental factors (Goh, 1983). The roots of *Phalaenopsis* become flat and assist the plant to creep over the surface while those of *Aerides* and *Vanda* help the plants to climb on the tall trees (Bose *et al.*, 1999).

Floral characters

A detailed study of floral traits is important for understanding the diversity of monopodial orchid genotypes and selecting them as parents for a successful hybridization programme. Evaluation of 15 monopodial orchid genotype belonging to genera *Aranda*, *Aranthera*, *Kagawara*, *Mokara*, *Renanthera* and *Vanda* were carried out by Thomas and Rani (2008) and found that wide range of variability existed among the selected orchid genotypes, enabling them to be suitable as parents in hybridization. The orchid flowers show great range of variations in size, colour and form. Fifty four characters were included for conduct of DUS test on *Vanda* orchids (PPV & FRA, 2012).

Colour and fragrance

The colour of a flower or plant depends on heredity, environmental factors and colour perception. Colouring is mostly predetermined on a cellular level. A plant's potential genetic colour palette consists of only four pigments: Chlorophyll (green), flavones (pale yellow), carotenes (yellow, orange) and anthocyanidins (red, blue, purple). Several pigments may be present within the same plant, creating unique shades of colour. The flowers of the orchid *Vanda* vary in colour from white, yellow, red, red-purple to violet-blue. *Vanda coerulea* is one of the few botanical orchids which can produce varieties with blue flowers, which is much appreciated for producing interspecific and intergeneric hybrids. *Vanda dearei* is one of the chief

sources of yellow colour in *Vanda* hybrids. The bluing effect was dependent on the numbers of hydroxycinnamic acids (Lu *et al.*, 1991; Honda and Saito, 2002). The occurrence of delphinidin and cyanidin as anthocyanidins in the flowers of *Vanda coerulea* was first reported by Yokoi (1975) and, then Arditti (1992). More than 11 anthocyanins were observed in the violet-blue and red-purple flowers of *Vanda* hybrid cultivars, from which eight major acylated anthocyanins were isolated (Tatsuzawa *et al.*, 2004). According to Griesbach (2005), the blue colour in many orchid flowers is known to be associated with an alkaline floral pH. Research on some blue orchid forms has shown that blue colour increases as the floral pH becomes more alkaline. (<http://blueorchid.org/the-blueness-of-orchids.html>)

Longevity

Vase life or longevity of a cut flower was determined on the basis of attributes like diameter and length of florets, opening of flowers, changes in fresh weight, diameter or length of stem or pedicel, senescence pattern, colour of petals, total longevity and foliage burning (De *et al.*, 2014). Colouration of labellum and senescence is accelerated by emasculation whereas pre-treatment with Amino-oxyacetic acid had a retarding effect on the same. To delay colouration of the albellum induced by exogenous ethylene, a higher concentration of AOA is required (Harkema and Struijlaart, 1989). Flower colours and pigments in *Disa* hybrids (Orchidaceae) were analyzed by Tatsuzawa *et al.* (2004) and enlisted the pigments present as carotenoids, anthocyanins and cyanidin-based anthocyanins. Pollination causes considerable acceleration of senescence symptoms in the petals such as discolouration, wilting, anthocyanin synthesis and abscission. Pollination-induced senescence involves two signals, one of which is ACC (1-aminocyclopropane-1-carboxylic acid), which initially is transferred from pollen to stigma and latter is produced in the pistil by stimulation of ACC-synthase by the germinating pollen tubes (Halevy, 1986).

Production environment and climate

Orchid plants are hardy and can withstand quite a lot of adversities. However successful orchid growing to flowering includes critical factors like light, temperature, photoperiod, humidity, watering, pots and potting media, repotting, fertilizer application and plant protection (Sheela, 2008). Molecular phylogenetics of *Vanda* and related genera was worked out by Gardiner *et al.* (2013).

Growing media

Epiphytic orchids are best grown on some type of container or support like coconut husk, tree fern rafts, clay pots with large holes, plastic containers or wooden baskets. Climbing orchids like *Arachnis*, *Renanthera*, *Vanda* and hybrids like *Aranda*, *Aranthera* and *Mokara* can be planted on the ground and given staking (Sheela, 2008). When grown bare root, the epiphytic species require daily watering and weekly feeding and are very heavy feeders in cultivation.

Potting media

Vanda plants are easy to grow in wooden baskets, with most thriving in bright, humid, and warm to intermediate conditions. Use a coarse grade of pine bark as the potting medium. The thick roots will often venture outside the confines of the pot or basket, and this culture is to be encouraged as the roots require unimpeded air circulation and must dry out quickly after watering. Commercially prepared orchid potting mixes are typically a combination of coarse peat moss, fiber and charcoal. The most common potting mixture for orchids consists of charcoal, coconut husk pieces, dry fern roots, sphagnum moss, broken pieces of bricks and perlite pieces. Potting media should provide drainage, along with moisture retention. The potting material must be fresh, clean and suitably sized. Repotting is essential every two to three years when the media have decomposed and require replacement. The best time to repot is just after flowering or when the plants resume new growth (Sheela, 2008).

Many alternatives for suitable growing media are open to the orchid grower. Selection should be based on the availability of quality materials, and on the water needs of the orchids involved. These needs can be best met by choosing a medium which, when in use, approximates the drying cycle (length of time between watering) recommended for the type of orchid grown. Whatever the growing medium used, it must be well aerated for successful orchid culture.

Nutrition

Studies were conducted from very early times on the nutrition aspects of orchids. Effects of nutrition and potting media on growth and flowering of certain epiphytic orchids were studied by Sheehan (1960), mainly on *Cattleya* and *Phalaenopsis*. In the study, it was concluded that levels of phosphorus and potassium had no effect on flowering and growth. *Vandas*, according to Kono (1956), grow best in mixtures of tree fern chips and charcoal. Chitosan application have varying effects on the growth and development of orchid cultured *in vitro*. Significant increase in number of clumps, leaves, number of flowers/inflorescence, size of flowers and length of inflorescence was obtained with 17:17:17 NPK complex sprayed at seven days interval (Shobhana and Rajeevan, 1993) in *Dendrobium*. Spraying with chitosan has been shown to significantly reduce the severity of leaf spot disease in orchids. Also, it has been shown that application of chitosan to *Dendrobium* orchid plants tended to increase the size of open florets and length of the inflorescences, but did not affect the display-life of cut orchids (Uthairatanakij *et al.*, 2007).

Orchids, like any other plants, require nitrogen, phosphorus, potash and trace elements for healthy growth. Fertilizers are applied in liquid form as a very dilute solution for easy absorption by roots. Most of the orchids flower best with bi-weekly feedings of dilute, water-soluble fertilizer. Orchids were light feeders and they required nitrogen from beginning to two-third of their life cycle. During rest period, they did not need any fertilizers. During flower initiation and inflorescence development plants were fed with less nitrogen, more phosphorus and potassium. In

orchids, foliar feeding was found to be ideal. Frequent application of fertilizers in low concentrations was the best way of feeding orchids. A concentration of 0.2 to 0.3 per cent of 30:10:10 (N:P:K) at vegetative stage and 10:20:20 (N:P:K) at blooming stage were applied for quality flower production. Sometimes, fresh coconut water, diluted cow urine and fish meal emulsions were also useful as foliar spray (De *et al.*, 2014).

Aeration

The high humidity in tropical areas is often accompanied by gentle and constant air movement. Stagnant, humid air is as detrimental to orchids as are cold drafts. Air movement is essential as it evaporates moisture on leaves and stems and helps protect plants from the spread of disease. Constant air movement around orchids is a must for keeping plants in good health. Stagnant and still air promote fungal growth. Air circulation alone keeps many of the diseases away (Sheela, 2008).

Irrigation

Water requirements of epiphytes and terrestrials are different. Condensation of fog on the plant surface may provide adequate moisture to epiphytes. On the contrary, heavy rains followed by dry spell can be detrimental to epiphytes. The potting media should never dry up in any case. It is the best to water well once a day in morning and gives a sprinkling in the evening (Sheela, 2008). Water is an important factor that controls successful orchid cultivation. Most orchids preferred water of pH 5.0-6.5. Watering with lower or higher pH or with high levels of dissolved minerals could hamper nutrient uptake. Rain water was the best. Regular watering was essential under high sunlight and high temperature conditions. Sprinkling or misting might be practiced during hot summer. Watering should be reduced in late summer and keep the plants barely moist during winter. Watering the plants with thick leaved orchids having CAM activities such as *Aranda* and

Dendrobium in the late afternoon prior to harvesting season improved the keeping quality (De *et al.*, 2014).

Temperature and photoperiod

Temperature may not be so crucial for survival but for flowering. Generally, higher temperature resulted in higher level of respiration. Cooling was essential to reduce other metabolic changes such as enzymatic activity and to slow the maturation of flowers. Cooling prior to packaging and transport reduced ethylene production and improved longevity. Based on temperature requirements, orchids were classified into three groups as warm orchids (*Aerides*, *Vanda*, *Rhyncostylis* and *Dendrobium*) which require 32.2°C day temperature and 15.5°C night temperature, intermediate orchids (*Cattleya*, *Laelia*, *Oncidium*, *Miltonia*), requiring 26.6°C day temperature and 12.8°C night temperature and cool orchids (*Cymbidium*, *Odontoglossum*, *Cypripedium*) with 24°C day temperature and 10°C night temperature (De *et al.*, 2014).

Though not as critical as quality of light, length of light also influences growth and flowering in orchids. Bhattacharjee (1979) reported that short days accelerated flowering in many different genera of orchids. In some, short days increased spike length, flower number and longevity. Onset of flowering in many of the orchid species or hybrids can be advanced or delayed by manipulating photoperiod in combination with regulation of temperature and light (Sheela, 2008).

Light

Light is the most important single factor that controls healthy growth of plants and their ability to reach flowering. The light requirement varies according to species. Intensity of light falling on plants can be controlled by adopting shading methods. Rajeevan (1997) described a system for cultivation of *Dendrobium* orchids in Kerala, which involve double layer roofing, the lower layer being at a height of 2.5 m for the purpose of changing according to weather condition. Light was found to determine the carbohydrate levels before harvest which in turn influence the keeping quality. Plants having few leaves, or leather like leaves (like most *Cattleyas* and *Oncidiums*),

required a high-light environment. If the leaves are soft and limp (like some *Phalaenopsis* and most *Paphiopedilum*), the plants were probably very light-sensitive, and should not be placed in a sunny south-facing window. Most orchids preferred indirect or filtered light and 50 per cent shading. *Cymbidium* and *Vandaceous* groups are high light requiring orchids (De *et al.*, 2014).

Humidity

As a thumb rule, orchids required 80-85 per cent humidity for satisfactory growth. Monopodial orchids required higher humidity than sympodial ones. If temperature is high, orchids require higher humidity. Frequent overhead misting is employed for achieving this. Water droplets produced from a centrifugal fogger are so fine that plants virtually do not become wet at all. Fluctuation in humidity level is however desirable as it gives the plants chance to dry up (Sheela, 2008).

Post harvest handling

Time of harvest: Flowers should be harvested in mild temperature because high temperature causes rapid respiration rates and excessive water loss. Flowers should be harvested in the early morning or in the evening. In the early morning, flowers remained turgid due to transpiration at night and higher sugar levels. Similarly, flowering stems retain a higher amount of stored carbohydrates if cut in the afternoon and retained more vase life.

Method of harvest: Sharp tools or secateurs were always used to detach the stem of flowers from the mother plant. The angle of the cut was given in slanting position and the stem was not crushed during harvesting, especially hard wood stems. The spikes were dipped in a bucket containing water immediately after harvest.

Stage of harvest: The optimum harvesting stage of the commercial orchids varies and in *Vanda*, fully opened flowers are harvested.

Factors influencing post-harvest life

Post harvest life is influenced by the following factors (De *et al.*, 2014):

Temperature: Opening of flower buds and rate of senescence accelerated at higher temperatures. At lower temperature, the respiration came down and the flowers

produced a lesser amount of ethylene. Temperature played an important role for flowers harvested at the immature stage for full expansion of buds and the flower buds were kept at temperatures as low as 0.5 to 4.0°C in *Cymbidium* and *Paphiopedilum*, 5-7°C in *Dendrobium* and 7-10°C in *Cattleya*.

Light: Light was essential for long distance transport or prolonged storage of cut flowers. Similarly, high light intensity was essential for opening of tight bud cut flowers. Florists had to maintain a light intensity of 2000-3000 lux for 12-24 hours in their shops for illuminations for most of cut flowers.

Humidity: Cut flowers were kept at 90-95 per cent relative humidity for maintaining turgidity. Flowers started showing wilting symptoms when they had lost 10-15 per cent of their fresh weight. The rate of transpiration from leaves was reduced with the increase of high relative humidity.

Water quality, ethylene concentration and incidence of pests and diseases are the other post harvest factors.

Optimum post harvest handling is essential for the maintenance of quality and vase life. At harvest, the flowers' source of water, ions, and sugars is violently broken off. This loss of supply is modified in the postharvest handling of flowers by the ability to supply water and some of the nutrients in the vase solution. In general, the rate of water uptake declines after harvest, which is caused primarily due to microbial contamination that blocks the xylem vessels. Factors controlling quality and post harvest life are pre harvest factors, ethylene sources, storage temperature and relative humidity (Paull, 1991). The expression of early wilting in tropical cut flowers depends on the degree of vascular blockage on the one hand, and the rate of transpiration on the other (Doorn, 1999).

Latha and Jayasree (2002) have done vase life studies on *Vanda* 'John Clubb' inflorescence in which freshly harvested cut inflorescences of the orchid hybrid, 'John Clubb' (*Vanda cooperi* × *V. tessellata* var. *rufescens*), were subjected to conditioning treatment. The study resulted in the conclusion that solutions containing silver nitrate significantly increased vase life. According to De *et al.* (2014), postharvest life of

orchid cut flowers is influenced by pre-harvest factors like varietal or species differences light intensity, sugar level of flowers, temperature and water loss. Flowers containing relatively higher amounts of carbohydrates especially mobile sugars lasted longer in the vase. It is also affected by harvest factors such as time and stage of harvest and postharvest factors viz. ethylene production, precooling, pulsing, use of preservatives, packaging and storage.

The hybrids of *Dendrobium*, *Vanda* and *Mokara* remain perfect from 7 days to 30 days. Higher sugar levels of flowers improve longevity of cut flowers. The optimum harvesting stage of commercial orchids is fully open and mature flowers. In tropical orchids like *Dendrobium* and *Oncidium*, AgNO_3 (10-30 ppm) and HQS (50-100 ppm) extends vase life and bud opening of cut flowers (De *et al.*, 2014). The effects of harvesting stages and preservative solutions on vase life of *Mokara* Madame Panne were worked out by Sharma (2008). Four harvesting stages and five preservative solutions were tested to identify their effects on extending the vase life and improving the bud opening of *Mokara* and found that there was no significant difference in the vase life and bud opening among the four harvesting stages. Results revealed that the preservative solution containing 150 ppm 8 HQS + 50 ppm $\text{Al}_2(\text{SO}_4)_3$ can extend the vase life significantly for 26 days. Sharma *et al* (2008) also studied the postharvest physiological changes among the different maturity stages of *Mokara* Madame Panne to investigate their effects on vase-life and concluded that different maturity stages of *Mokara* inflorescences had no effect on vase life. The postharvest physiology of harvested *Mokara* inflorescences was investigated by Sartpetch *et al.* (2010) and the results indicate that the vase life and physiological changes of cut *Mokara* inflorescences depend on the cultivar.

Storage

Low temperature treatment during storage or shipment period reduced the entire metabolism in the tissues, slowed down the respiration, transpiration and ethylene action and retarded the multiplication of bacteria and fungi. In general, temperate orchids were stored at lower temperature even at 5°C in cold chambers

whereas tropical orchids were stored at 7-10°C. A 90-95 per cent relative humidity was necessary during storage to minimize moisture loss and to prevent wilting (De *et al.*, 2014).

Packaging

Cut flowers were inserted in tube containing water or water with preservatives or simply wrapped in wet cotton swab and the same was covered with a piece of plastic and tied with rubber band to keep in its place. Flower spikes were bunched into bunch of 5 or 10 or so. Bunches or individual spikes were placed inside the box in alternate fashion. Ethylene scrubbers with KMnO₄ or Purafil could also be kept level of CO₂ and lower level of O₂ to reduce the respiration rate and production and action of ethylene. Generally, the concentration of CO₂ was maintained higher than 4 per cent and not below 0.4 per cent in CA storage (De *et al.*, 2014).

Marketing

Global demand for flowers and plants will maintain the past trends and will show a continuous growth over the next years. Prompt delivery date and design are more important than price. Quantity: quality: price relationship is the most important criterion to spend money in flowers (Kras, 1999). Market preferences are different according to importing countries. *Cymbidiums* are leaders among all orchids in global cut flower trade presently ranking seventh in top 10 cut flowers. *Cattleya*, *Phalaenopsis*, *Oncidium*, *Dendrobium*, *Vanda*, *Mokara*, *Aranda* and *Arachnis* are also popular, worldwide (Sheela, 2008). According to Gajanana (2006), there are two main channels for marketing orchids – local marketing and distant marketing. About 69 per cent of the growers marketed orchids to local buyers and remaining 31 per cent to distant markets. A strong research support in the form of development of internationally acceptable varieties/hybrids, standardization of production technologies, availability of quality planting material in large-scale and post harvest management, marketing support in the form of proper market subsidy in transport and reduced freight charges will go a long way in establishing orchid industry in the country (Upadhyay and Das, 2003).

MATERIALS AND
METHODS

3. MATERIALS AND METHODS

The present study entitled “Evaluation of vanda orchids for commercial traits” was carried out in the Department of Pomology and Floriculture, College of Horticulture, Vellanikkara, from February 2013 to February 2014. The materials used and methodology adopted for the investigation is dealt with in this chapter.

1. LOCATION

Vellanikkara is situated at latitude of 10°31' N and longitude of 76°13' E. The area lies 22.25m above MSL.

2. CLIMATE

The site enjoyed a humid tropical climate with maximum temperature varying from 28.4°C to 35.4°C and the minimum temperature from 22.2°C to 25.2°C during the period of investigation. The mean relative humidity varied from 51 per cent to 91 per cent. The total rainfall recorded during the period of investigation was 2336.5 mm. Weather data during the period of study is given in Appendix.

3. FIELD EVALUATION

3.1. Materials

Thirty vanda varieties/hybrids were grown in an open ventillated polyhouse to evaluate their field performance. List of selected varieties/hybrids is given in Table 1.

3.2. Shade

Vanda orchids were grown in an open ventillated polyhouse (21m x 6m) providing 25 per cent shade, which was found to be the best for their growth.

Table.1. Vanda varieties/ hybrids selected for evaluation

Sl. No.	Variety/ hybrid
1	V. Dr. Anek
2	V. Rothchildiana
3	V. Thongchai
4	V. Katsuura x V. Fuchs Delight
5	V. Taweesuksa x V. Kultana Gold x V. Green Gold
6	V. Apec Blue
7	V. Pakchong Blue
8	V. Sirilak x V. Bitz's Heartthrob
9	V. Pachara Delight Pink
10	V. Pakchong New Land x V. Annette Jones
11	V. Fuchs Delight
12	V. Red Gem
13	V. Anek Delight
14	V. Urbchitr x V. Bitz's Heartthrob
15	V. Kasem's Delight x V. Bitz's Heartthrob
16	V. Pranermprai x V. <i>tessellata</i>
17	V. Pathum Gold
18	V. Lumpini Red
19	V. Kultana Delight Red
20	V. Pompimol
21	V. Lumpini Red x V. Taweewan
22	V. Madame Rattana
23	V. Lanka Sri pink
24	V. Varuvathe Pink
25	V. Robert's Delight
26	V. Dr. Anek x V. Mimi Palmer
27	V. Fuchs Delight x V. Bitz's Heartthrob
28	V. Prapawan
29	V. Thailand Beauty
30	V. Dr. Anek x V. Bitz's Heartthrob

3.3. Media

The plants were grown in hanging pots with slots with little (coconut husk, broken tiles and brick pieces) or no media.

3.4. General management

The plants were watered twice a day to provide good moisture, but with good drainage and aeration for the roots. The hanging pots with slots ensured good aeration and free downward growth of the roots.

Foliar application of N:P:K 13:27:27 at 0.3 per cent (3 g/l) concentration was given at weekly interval. Need based application of plant protection chemicals was also carried out.

3.5. Design of the experiment

A completely randomized design with three replications was laid out.

3.6. Observations

In each variety/hybrid, three plants per replication were used for recording the following observations.

3.6.1. Quantitative characters

A. PLANT CHARACTERS

1. Plant height

The height of the plant was measured from the base to the growing apex at monthly intervals and expressed in centimeter.

2. Plant spread

The plant spread was measured at monthly intervals and expressed in centimeter.

3. Shoot girth

Girth of shoot was measured at 10.0 cm above the base and expressed in centimeter.

4. Internodal length

The internodal length was measured at 20.0 cm below the growing tip of the shoot and expressed in centimeter.

5. Number of leaves

The total number of leaves present on the plant was counted and recorded monthly.

6. Leaf length

Length of the leaf was measured from base to the tip and expressed in centimeter at monthly intervals.

7. Leaf breadth

The maximum width of the expanded leaf was measured and recorded at monthly intervals.

8. Leaf area

Dot method (Bleasdale, 1973) was used to measure the leaf area and the same was expressed in square centimeter.

9. Interval of leaf production

The interval between the production of two successive leaves was taken and expressed in days.

10. Number of roots

Number of roots produced by the plant was counted and recorded.

11. Length of roots

Length of the roots was measured from the base to the tip and expressed in centimeter.

12. Girth of roots

Girth of root at 5.0 cm from the base was measured and expressed in centimeter.

B. FLORAL CHARACTERS

1. Days from spike emergence to opening of first floret

Time taken for the opening of first floret after spike emergence was recorded in days

2. Days from spike emergence to harvest

Time taken for opening of fifty per cent of the flowers after spike emergence was recorded in days

3. Days from spike emergence to complete opening of florets

Time taken for complete (100%) opening of all the florets on the spike was recorded in days

4. Longevity of spike on the plant

Longevity was measured from the day the spike becomes suitable for use as cut flower to wilting of one floret

13. Interval of spike production

The interval between the production of two consecutive spikes was recorded in days

14. Number of spikes produced per year

Number of spikes produced on each plant was noted and number of spikes per plant per year in each variety/hybrid was estimated.

15. Blooming period/ season

Spike emergence in each variety/hybrid was observed throughout the year and recorded as the blooming period for that particular variety/hybrid.

16. Length of spike

The total length of the spike from base of the spike to tip in each plant was recorded in centimeter.

17. Length of rachis

The length of flowering area (rachis) per spike in each plant was recorded in centimeter.

18. Length of flower stalk

The length of flower stalk in each plant was recorded in centimeter.

19. Girth of spike at base

The circumference of the spike at 5.0 cm from the point of attachment to the stem was recorded as the spike girth.

20. Number of florets per spike

The number of florets per spike in each plant was recorded.

21. Internodal length (between florets at the base)

Length between the nodes of the base florets was recorded and expressed in centimeter.

22. Flower size

Size of individual floret was recorded as the product of length (vertically) and width (across) of flower and expressed in centimeter.

23. Length of labellum

Length of the labellum (lip) was observed and expressed in centimeter.

24. Width of labellum

Width of the labellum (lip) was observed and expressed in centimeter.

25. Length of column

Length of column was measured from base to the tip and expressed in centimeter.

26. Life of individual floret on the spike

Life of individual floret on the spike was measured for four florets per spike from the day the floret opens to the day it wilts and the mean values were expressed.

C. POST HARVEST CHARACTERS

The following characters were observed during the vase study

1. Fresh weight

Fresh weight of the freshly cut spike was taken immediately after harvest and recorded.

2. Spike longevity

Time taken from the harvest of the spike till it remain fresh without wilting, shriveling or drooping and expressed in days.

3. Buds opening

Number of buds opening in vase was counted and recorded.

4. Wilting of first floret

Days taken for wilting of first floret from the day of harvest were noted.

5. Physiological loss in weight (PLW)

The loss in weight of the spike in vase life was recorded by deducting the weight at the end of experiment from the initial fresh weight of the spike and expressed in grams.

6. Water uptake

The quantity of vase solution remaining at the end of the experiment was recorded and by finding the difference between the initial and final volumes of the vase solution, total uptake was worked out and expressed in milliliters.

7. Life span of floret

Life of individual floret in vase was measured for four florets per spike from the day of harvest till the day it wilts in vase and mean values were expressed in days.

3.6.2 Qualitative characters

A. PLANT CHARACTERS

1. Nature of growth—erect, hanging, prostrate

2. Nature of shoot – stout, covered by persistent leaf sheath

3. **Shoot colour** – green, brown
4. **Branching of shoot** – present, absent
5. **Root location** – basal, along the stem
6. **Nature of roots** – cylindrical, thread like, thick/ shrivelled/ creeping/ robust and flattened
7. **Branching of roots** – present/absent
8. **Colour of roots** – grey, green, white

B. LEAF CHARACTERS

1. **Shape** – terete, semi-terete, strap, channelled
2. **Texture** – smooth, verrucose, rigid, leathery, glabrous, pubescent, fleshy
3. **Margin** – entire, wavy, serrate, coriaceous
4. **Apex** – bilobed, retuse, tridentate, praemorse, truncate, emarginate
5. **Leaf colour** – green, dark green, dark green with reddish purple underneath
6. **Markings** – present/ absent
7. **Pigmentation** – colour changes during maturity
8. **Arrangement** – distichous, spiral, alternate, clustered at base
9. **Orientation** – straight, arching, deflexed, horizontal
10. **Nature of sheath** – membranous, nerved or not
11. **Colour of sheath** – green, dark green
12. **Other characters** – deeply channelled, channelled at apex, channelled at the base, channel not prominent,

C. FLORAL CHARACTERS

1. **Spike orientation** – erect, horizontal, drooping
2. **Inflorescence** – dense, lax
3. **Arrangement of florets on spike** – facing in one direction, facing in two directions, facing in all directions
4. **Petal shape** – linear, oblong, elliptic, lanceolate, obovate

5. **Petal curvature** – incurved with deflexed apex, incurved with straight apex, straight, deflexed, deflexed with incurved apex
6. **Petal apex** – acute, obtuse, truncate, bilobed
7. **Petal margin** – entire, undulate, erose
8. **Petal colour pattern** – uniform, spotted, blotched, streaked/ striped, tessellated
9. **Lip mid-lobe shape** – ovate, lanceolate, orbicular
10. **Lip lateral-lobe shape** – ovate, lanceolate, orbicular
11. **Lip curvature** – straight, deflexed with straight apex, deflexed with incurved apex
12. **Lip apex** – acute, obtuse, bilobed
13. **Lip surface** – glabrous, pubescent
14. **Lip colour** – single, double, triple or more
15. **Lip colour pattern** – uniform, spotted, blotch, streaked/ striped, tessellated
16. **Column colour pattern** – uniform, spotted, blotched, streaked/ striped
17. **Pigmentation** – present/ absent
18. **Spur type** – saccate, conical, cylindrical, tubular
19. **Spur length** – short (<0.5 cm), medium (0.5-1.0 cm), long (>1.0 cm)
20. **Fragrance** – present/absent

Floral characters both quantitative and qualitative contributed towards their use as cut flower/ potted plant. Other general characters of the plant such as branching habit, incidence of pests, diseases and disorders were also recorded.

3.6.3. Visual evaluation

The spikes of the vanda varieties/hybrids were visually scored for use as cut flower and their general acceptability was observed. Scoring was done based on flower colour and pigmentation, shape, size, arrangement of florets on spike and texture.

Plant quality rating was done based on fullness, growth and visual appearance viz. flower colour and pigmentation, spike longevity, shape and arrangement of

foliage during the growth period. The grades ranged from 1-10 for each character and its totalling to each variety/ hybrid.

Selected persons were briefed with required information about the plants and allowed to observe for a period of two weeks before rating.

3.7. Statistical analysis

The data from the study was subjected to analysis of variance suggested by Panse and Sukhatme (1985). Treatment means were compared using DMRT wherever necessary. SPSS software was made use (SP SS16, 2007).

RESULTS

4. RESULTS

Studies were conducted at the Department of Pomology and Floriculture, College of Horticulture, Vellanikkara, during 2013-2014, to evaluate the performance of thirty vanda varieties/ hybrids.

4.1. QUANTITATIVE CHARACTERS

4.1.1. Plant characters

Data pertaining to the plant characters of vanda varieties/ hybrids are presented in Tables 2-4 and Fig. 1.

Plant height

Plant height observed at monthly intervals for the period of study (February 2013 to January 2014) is presented in Table 2. V. Pompimol recorded the maximum plant height (54.40 cm), and was on par with V. Lumpini Red x V. Taweewan (52.47 cm) and V. Madame Rattana (50.00 cm). During the initial years, V. Pakchong Blue had the minimum plant height, but by the end of the study, plant height was the minimum for V. Thailand Beauty (15.33 cm), which was on par with V. Pakchong Blue (15.97 cm).

Plant spread

Appreciable differences were observed with regard to plant spread in different vanda varieties/ hybrids (Table 3). Maximum plant spread was observed in V. Kasem's Delight x V. Bitz's Heartthrob (64.77 cm) initially which was on par with V. Pranermprai x V. *tessellata* (63.00 cm), V. Dr. Anek x V. Mimi Palmer (62.50 cm), V. Fuchs Delight x V. Bitz's Heartthrob (60.47 cm) and V. Urbchitr x V. Bitz's Heartthrob (58.17 cm), followed by V. Kultana Delight Red (54.50 cm). The minimum plant spread was for V. Pachara Delight Pink (25.33 cm) followed by V. Anek Delight (29.33 cm). During April, V. Dr. Anek x V. Mimi Palmer recorded

Table.2. Plant height in vanda varieties/ hybrids during the period of observation

Sl. No.	Varieties/hybrids	Plant height (cm)											
		Feb '13	Mar '13	Apr '13	May '13	Jun '13	Jul '13	Aug'13	Sep '13	Oct '13	Nov'13	Dec '13	Jan '14
1	V. Dr. Anek	34.30 ^{ef}	34.50 ^{de}	35.30 ^{cde}	36.13 ^{def}	36.53 ^{de}	37.13 ^{cd}	37.83 ^{de}	38.30 ^{de}	38.43 ^{abcdefgh}	38.50 ^{de}	38.57 ^{def}	38.67 ^c
2	V. Rothchildiana	27.70 ^{efg}	27.80 ^{fg}	28.33 ^{fg}	29.23 ^{fgh}	29.40 ^{fg}	29.73 ^{ef}	30.40 ^f	31.23 ^{efgh}	31.37 ^{bcdefghi}	31.40 ^{efg}	31.7 ^{fgh}	31.70 ^{cde}
3	V. Thongchai	22.87 ^g	23.10 ^{ghi}	23.97 ^{fghi}	24.77 ^{ghij}	24.87 ^{fghi}	25.13 ^{efgh}	25.70 ^{fgh}	26.27 ^{ghi}	26.27 ^{defghi}	26.33 ^{fgh}	27.00 ^{hijk}	27.90 ^{cde}
4	V. Katsuura x V. Fuchs Delight	13.77 ^{ij}	14.40 ^{klm}	14.50 ^{kl}	14.73 ^{lm}	14.73 ^{kl}	14.87 ^j	15.53 ^j	16.07 ^j	16.10 ^{hi}	16.13 ⁱ	16.23 ^{lm}	16.20 ^f
5	V. Taweesuksa x V. Kultana Gold x V. Green Gold	17.13 ^{hij}	17.60 ^{ijklm}	17.60 ^{ijkl}	18.10 ^{iklm}	18.27 ^{ijkl}	18.40 ^{hij}	19.67 ^{hij}	20.23 ^{ij}	20.27 ^{hi}	20.30 ^{hi}	20.67 ^{klm}	20.60 ^{def}
6	V. Apec Blue	15.90 ^{hij}	15.97 ^{ijklm}	16.03 ^{kl}	16.33 ^{klm}	16.40 ^{kl}	16.43 ^{ij}	16.93 ^{ij}	17.07 ^j	17.13 ^{hi}	17.13 ⁱ	17.27 ^{lm}	17.87 ^{ef}
7	V. Pakchong Blue	12.67 ^{ij}	12.93 ^m	13.00 ^l	13.30 ^m	13.40 ^l	13.50 ^j	15.23 ^j	15.27 ^j	15.23 ⁱ	15.37 ⁱ	15.87 ^m	15.97 ^f
8	V. Sirilak x V. Bitz's Heartthrob	19.63 ^h	20.57 ^{hijkl}	20.67 ^{hijk}	21.03 ^{ijkl}	21.17 ^{hijk}	21.20 ^{ghij}	21.97 ^{ghij}	22.07 ^{ij}	22.47 ^{fghi}	22.50 ^{hi}	23.47 ^{ijkl}	25.00 ^{de}
9	V. Pachara Delight Pink	14.00 ⁱ	14.50 ^{klm}	14.53 ^{kl}	14.77 ^{lm}	14.83 ^{kl}	14.90 ^j	15.80 ^j	16.53 ^j	16.63 ^{hi}	16.63 ⁱ	16.87 ^{lm}	17.17 ^{ef}
10	V. Pakchong New Land x V. Annette Jones	21.30 ^{ghi}	22.33 ^{ghij}	22.53 ^{ghij}	22.53 ^{hijk}	22.57 ^{ghij}	22.87 ^{fghi}	24.10 ^{fghi}	24.40 ^{hi}	24.50 ^{efghi}	24.80 ^{gh}	25.40 ^{hijk}	25.73 ^{de}
11	V. Fuchs Delight	27.93 ^{efg}	28.50 ^{efg}	28.57 ^{efg}	28.83 ^{gh}	28.90 ^{fg}	29.27 ^{ef}	30.60 ^f	31.03 ^{fgh}	31.37 ^{bcdefghi}	31.40 ^{efg}	31.43 ^{gh}	31.87 ^{cde}
12	V. Red Gem	16.07 ^{hi}	19.80 ^{hijklm}	20.20 ^{hijkl}	20.43 ^{ijklm}	20.57 ^{hijkl}	20.63 ^{ghij}	21.37 ^{ghij}	21.73 ^{ij}	21.87 ^{ghi}	21.87 ^{hi}	22.10 ^{ijklm}	22.13 ^{def}
13	V. Anek Delight	27.10 ^{efg}	29.00 ^{efg}	29.27 ^{efg}	29.40 ^{fgh}	29.50 ^{fg}	29.53 ^{ef}	29.80 ^f	30.03 ^{gh}	30.07 ^{bcdefghi}	30.07 ^{fg}	30.73 ^{ghi}	31.23 ^{cde}
14	V. Urbchitr x V. Bitz's Heartthrob	40.43 ^{bcd}	41.57 ^{bc}	42.23 ^{bc}	42.57 ^{bcd}	42.90 ^{bcd}	43.03 ^{bc}	43.50 ^{cd}	44.40 ^{cd}	44.47 ^{abcdef}	44.53 ^{cd}	45.00 ^{cd}	45.30 ^{bc}
15	V. Kasem's Delight x V. Bitz's Heartthrob	27.50 ^{efg}	30.07 ^{ef}	30.17 ^{def}	30.37 ^{efg}	30.50 ^{ef}	30.57 ^{de}	31.47 ^{ef}	33.30 ^{efgh}	33.30 ^{abcdefghi}	33.30 ^{ef}	34.90 ^{efg}	34.90 ^{cd}
16	V. Pranermprai x V. tessellata	38.33 ^{bcde}	38.47 ^{bcd}	38.73 ^{bc}	39.10 ^{cd}	39.13 ^{cd}	39.27 ^c	40.87 ^d	42.97 ^{cd}	43.03 ^{abcdefg}	43.07 ^{cd}	44.00 ^{cd}	44.10 ^{bc}
17	V. Pathum Gold	36.20 ^e	37.97 ^{bcd}	38.47 ^{bc}	38.90 ^{cd}	39.00 ^{cd}	39.10 ^c	43.07 ^{cd}	46.30 ^{bc}	46.30 ^{abcde}	46.40 ^{bc}	47.57 ^{bc}	48.57 ^b
18	V. Lumpini Red	26.27 ^{efg}	26.47 ^{fgh}	26.63 ^{fgh}	27.00 ^{ghi}	27.20 ^{fgh}	27.20 ^{efg}	27.33 ^{fg}	27.50 ^{ghi}	27.50 ^{cdefghi}	27.50 ^{fgh}	28.33 ^{ghij}	28.33 ^{de}

Plant height in vanda varieties/ hybrids during the period of observation contd...

Sl. No.	Varieties/hybrids	Feb '13	Mar '13	Apr '13	May '13	Jun '13	Jul '13	Aug'13	Sep '13	Oct '13	Nov'13	Dec '13	Jan '14
19	V. Kultana Delight Red	33.20 ^{ef}	36.87 ^{cd}	36.87 ^{cd}	37.27 ^{cde}	37.40 ^{cde}	37.50 ^{cd}	37.50 ^{de}	37.57 ^{def}	37.57 ^{abcdefghi}	37.57 ^{de}	38.80 ^{de}	37.60 ^{cd}
20	V. Pompimol	49.80 ^a	50.10 ^a	50.50 ^a	50.50 ^a	50.50 ^a	50.70 ^a	52.20 ^a	54.00 ^a	54.00 ^a	54.00 ^a	54.50 ^a	54.40 ^a
21	V. Lumpini Red x V. Taweewan	46.50 ^{ab}	48.67 ^a	49.40 ^a	49.40 ^{ab}	49.47 ^{ab}	49.60 ^{ab}	51.17 ^{ab}	51.77 ^{ab}	52.00 ^{ab}	52.00 ^{ab}	52.47 ^{ab}	52.47 ^{ab}
22	V. Madame Rattana	44.00 ^{ab}	49.00 ^a	49.10 ^a	49.10 ^{ab}	49.40 ^{ab}	49.43 ^{ab}	49.43 ^{abc}	49.70 ^{abc}	49.70 ^{abc}	49.70 ^{abc}	50.00 ^{abc}	50.00 ^{ab}
23	V. Lanka Sri pink	25.33 ^{gh}	26.57 ^{fgh}	26.67 ^{fgh}	26.73 ^{ghi}	26.80 ^{fgh}	26.87 ^{efg}	27.13 ^{fgh}	27.13 ^{ghi}	27.13 ^{defghi}	27.13 ^{fgh}	27.83 ^{ghijk}	28.30 ^{de}
24	V. Varuvathe Pink	13.53 ⁱ	13.73 ^{lm}	14.37 ^{kl}	14.57 ^{lm}	14.63 ^{kl}	14.67 ^j	15.53 ^j	15.87 ^j	15.90 ^{hi}	15.90 ⁱ	17.10 ^{lm}	17.20 ^{ef}
25	V. Robert's Delight	35.00 ^e	36.70 ^{cd}	36.80 ^{cd}	37.00 ^{cde}	37.10 ^{cde}	37.20 ^{cd}	37.80 ^{de}	38.20 ^{de}	38.50 ^{abcdefgh}	38.50 ^{de}	38.50 ^{def}	38.50 ^c
26	V. Dr. Anek x V. Mimi Palmer	23.03 ^{gh}	23.37 ^{fghi}	24.07 ^{fghi}	24.77 ^{ghij}	25.00 ^{fghi}	25.17 ^{efgh}	25.30 ^{fgh}	25.33 ^{hi}	25.33 ^{efghi}	25.43 ^{gh}	25.43 ^{hijk}	25.53 ^d
27	V. Fuchs Delight x V. Bitz's Heartthrob	19.40 ^h	19.47 ^{ijklm}	19.57 ^{hijkl}	19.80 ^{ijklm}	20.23 ^{hijkl}	20.37 ^{ghij}	20.83 ^{ghij}	20.97 ^{ij}	21.13 ^{ghi}	21.17 ^{hi}	21.17 ^{ijklm}	21.23 ^e
28	V. Prapawan	41.20 ^{bc}	43.90 ^{ab}	43.90 ^{ab}	44.30 ^{abc}	44.30 ^{abc}	44.5 ^{0abc}	44.50 ^{bcd}	44.50 ^{cd}	44.50 ^{abcdef}	44.50 ^{cd}	44.50 ^{cd}	45.00 ^{bc}
29	V. Thailand Beauty	14.03 ⁱ	14.17 ^{klm}	14.53 ^{kl}	14.53 ^{lm}	14.60 ^{kl}	14.83 ^j	14.93 ^j	15.03 ^j	15.20 ⁱ	15.23 ⁱ	15.27 ^m	15.33 ^{efg}
30	V. Dr. Anek x V. Bitz's Heartthrob	21.80 ^{ghi}	20.77 ^{hijk}	20.30 ^{hijkl}	20.57 ^{ijklm}	20.90 ^{hijkl}	21.00 ^{ghij}	21.13 ^{ghij}	21.27 ^{ij}	21.37 ^{ghi}	21.40 ^{hi}	21.50 ^{ijklm}	21.57 ^{de}

Table.3. Plant spread of vanda varieties/ hybrids during the period of observation

Sl. No.	Varieties/hybrids	Plant spread (cm)											
		Feb '13	Mar '13	Apr '13	May '13	Jun '13	Jul '13	Aug '13	Sep '13	Oct '13	Nov '13	Dec '13	Jan '14
1	V. Dr. Anek	48.23 ^{efghi}	48.23 ^{defg}	48.33 ^{defg}	48.40 ^{defgh}	48.57 ^{defg}	48.67 ^{defg}	49.80 ^{cde}	50.40 ^{cdef}	50.47 ^{cdef}	50.50 ^{cde}	50.57 ^{cde}	50.63 ^{cde}
2	V. Rothchildiana	37.00 ^{ijklmn}	39.00 ^{ghijk}	39.00 ^{ghijk}	39.30 ^{ghijkl}	39.40 ^{ghijk}	39.40 ^{ghijkl}	39.47 ^{ghijk}	39.57 ^{ghijk}	39.57 ^{ghijk}	39.57 ^{ghijk}	39.80 ^{fghijk}	39.87 ^{fghijk}
3	V. Thongchai	37.40 ^{ijklmn}	37.60 ^{hijkl}	37.73 ^{hijkl}	38.10 ^{ijkl}	38.13 ^{hijk}	38.40 ^{hijkl}	38.57 ^{hijkl}	38.80 ^{ghijk}	38.83 ^{ghijk}	38.90 ^{ghijk}	38.90 ^{ghijk}	39.00 ^{ghijk}
4	V. Katsuura x V. Fuchs Delight	48.93 ^{efgh}	49.00 ^{def}	49.23 ^{def}	49.30 ^{def}	49.60 ^{def}	49.80 ^{def}	51.53 ^{cde}	52.13 ^{cdef}	52.23 ^{cdef}	52.73 ^{cde}	53.00 ^{cde}	53.13 ^{cde}
5	V. Taweesuksa x V. Kultana Gold x V. Green Gold	47.90 ^{efghi}	48.73 ^{def}	48.77 ^{def}	49.10 ^{def}	49.10 ^{def}	49.40 ^{def}	50.36 ^{cdef}	50.40 ^{cdef}	50.40 ^{cdef}	50.40 ^{cdef}	50.43 ^{cde}	50.47 ^{cde}
6	V. Apec Blue	38.87 ^{ijklm}	39.03 ^{ghijk}	39.03 ^{ghijk}	38.77 ^{hijkl}	38.80 ^{hijk}	39.07 ^{hijkl}	39.70 ^{ghijk}	39.73 ^{ghijk}	39.73 ^{ghijk}	39.73 ^{ghijk}	39.77 ^{fghijk}	39.83 ^{fghijk}
7	V. Pakchong Blue	32.83 ^{lmno}	32.83 ^{klm}	34.03 ^{klm}	33.97 ^{klm}	34.17 ^{kl}	34.17 ^{klm}	34.23 ^{kl}	34.27 ^{kl}	34.27 ^{kl}	34.27 ^{kl}	34.30 ^{kl}	34.33 ^{kl}
8	V. Sirilak x V. Bitz's Heartthrob	47.90 ^{efghi}	48.00 ^{defg}	48.37 ^{defg}	48.33 ^{defgh}	48.97 ^{def}	49.07 ^{def}	49.33 ^{cdef}	49.37 ^{cdef}	49.40 ^{cdef}	49.40 ^{cdef}	49.43 ^{cdef}	49.57 ^{cdef}
9	V. Pachara Delight Pink	25.33 ^o	25.53 ^m	25.77 ^m	25.77 ^m	25.90 ^l	26.07 ^m	26.16 ^m	26.33 ^l	26.33 ^l	26.33 ^l	27.17 ^l	27.23 ^l
10	V. Pakchong New Land x V. Annette Jones	54.33 ^{bcdef}	54.53 ^{bcd}	54.63 ^{bcd}	55.00 ^{bcd}	55.07 ^{bcd}	55.23 ^{bcd}	57.57 ^{bcd}	57.73 ^{bc}	57.87 ^{bc}	57.90 ^{bc}	57.90 ^{bc}	57.90 ^{bc}
11	V. Fuchs Delight	43.17 ^{ghijk}	43.17 ^{fghij}	43.37 ^{efghijk}	43.50 ^{efghijk}	43.53 ^{efghij}	43.77 ^{efghijk}	44.17 ^{efg}	44.20 ^{efghi}	44.23 ^{efghi}	44.23 ^{efgh}	44.30 ^{efghi}	44.37 ^{efghi}
12	V. Red Gem	45.00 ^{fghij}	48.53 ^{def}	48.53 ^{def}	48.97 ^{defg}	49.33 ^{def}	49.33 ^{def}	49.60 ^{cde}	49.73 ^{cdef}	49.73 ^{cdef}	49.73 ^{cdef}	51.33 ^{cde}	52.00 ^{cde}
13	V. Anek Delight	29.33 ^{no}	29.33 ^{lm}	29.53 ^{lm}	29.63 ^{lm}	29.87 ^{kl}	29.97 ^{lm}	31.20 ^{kl}	31.27 ^{kl}	31.27 ^{kl}	31.27 ^{kl}	31.33 ^{kl}	31.40 ^{kl}
14	V. Urbchitr x V. Bitz's Heartthrob	58.17 ^{abcd}	58.33 ^{abc}	59.20 ^{abc}	59.60 ^{abc}	60.00 ^{abc}	60.23 ^{abc}	62.90 ^{ab}	63.77 ^{ab}	64.17 ^{ab}	64.17 ^{ab}	64.67 ^{ab}	64.77 ^{ab}
15	V. Kasem's Delight x V. Bitz's Heartthrob	64.77 ^a	65.00 ^a	65.10 ^a	65.20 ^a	65.20 ^a	65.30 ^a	66.90 ^a	69.60 ^a	69.70 ^a	69.77 ^a	69.77 ^a	70.60 ^a
16	V. Pranermprai x V. tessellata	63.00 ^{ab}	63.87 ^a	65.00 ^a	66.43 ^a	66.43 ^a	66.53 ^a	69.03 ^a	70.10 ^a	70.43 ^a	70.43 ^a	70.43 ^a	70.53 ^a

Plant spread of vanda varieties/ hybrids during the period of observation contd...

Sl. No.	Varieties/hybrids	Feb '13	Mar '13	Apr '13	May '13	Jun '13	Jul '13	Aug '13	Sep '13	Oct '13	Nov '13	Dec '13	Jan '14
17	V. Pathum Gold	53.10 ^{cdef}	53.20 ^{cde}	54.67 ^{bcd}	54.87 ^{bcd}	55.10 ^{bcd}	55.10 ^{bcd}	55.17 ^{bcd}	55.30 ^{bcd}	55.30 ^{bcd}	55.50 ^{bcd}	56.07 ^{bcd}	56.20 ^{bcd}
18	V. Lumpini Red	36.47 ^{klmn}	36.67 ^{ijkl}	36.67 ^{ijkl}	36.97 ^{ijkl}	37.00 ^{ijk}	37.03 ^{ijkl}	37.30 ^{ghij}	37.50 ^{ghijk}	37.50 ^{ghijk}	37.87 ^{ghijk}	37.97 ^{ghijk}	38.03 ^{ghijk}
19	V. Kultana Delight Red	54.50 ^{bcde}	54.57 ^{bcd}	54.77 ^{bcd}	54.80 ^{bcd}	54.90 ^{bcd}	55.00 ^{bcd}	56.90 ^{bc}	57.67 ^{bc}	57.67 ^{bc}	57.67 ^{bc}	57.67 ^{bc}	57.77 ^{bc}
20	V. Pompimol	61.00 ^{abc}	64.00 ^a	66.10 ^a	66.50 ^a	66.60 ^a	66.70 ^a	67.50 ^a	67.50 ^a	67.50 ^a	67.50 ^a	67.50 ^a	68.47 ^a
21	V. Lumpini Red x V. Taweewan	50.27 ^{defg}	51.30 ^{cdef}	52.57 ^{cde}	52.87 ^{cde}	53.00 ^{cde}	53.00 ^{cde}	53.20 ^{cde}	53.60 ^{cde}	53.87 ^{cde}	54.50 ^{bcde}	55.50 ^{bcd}	56.50 ^{bcd}
22	V. Madame Rattana	40.70 ^{hijkl}	41.70 ^{fg hij k}	42.00 ^{fg hij k}	42.00 ^{fg hij k}	42.30 ^{fg hij}	42.50 ^{fg hijk}	43.50 ^{fg hij}	43.50 ^{fg hij}	43.50 ^{fg hij}	43.50 ^{fg hij}	43.50 ^{efghij}	43.50 ^{efghij}
23	V. Lanka Sri pink	42.53 ^{ghijk}	44.03 ^{efghi}	44.27 ^{efghi}	44.63 ^{efghij}	44.70 ^{efghi}	44.73 ^{efghi}	45.23 ^{efgh}	45.23 ^{efgh}	45.30 ^{efgh}	45.33 ^{efgh}	45.67 ^{efgh}	45.77 ^{efgh}
24	V. Varuvathe Pink	30.17 ^{mno}	33.43 ^{klm}	33.93 ^{klm}	34.33 ^{klm}	34.33 ^{ijkl}	34.40 ^{klm}	34.97 ^{ijk}	35.17 ^{ijkl}	35.17 ^{ijkl}	35.30 ^{ijkl}	35.50 ^{ijkl}	35.60 ^{ijkl}
25	V. Robert's Delight	42.10 ^{ghijkl}	44.00 ^{efghi}	44.00 ^{efghij}	44.20 ^{efghij}	44.20 ^{efghi}	44.50 ^{efghij}	44.50 ^{efgh}	44.50 ^{efghi}	44.50 ^{efghi}	44.50 ^{efgh}	44.50 ^{efghi}	44.70 ^{efghi}
26	V. Dr. Anek x V. Mimi Palmer	62.50 ^{ab}	64.30 ^a	66.40 ^a	67.50 ^a	67.53 ^a	67.60 ^a	67.70 ^a	67.83 ^a	67.90 ^a	67.97 ^a	67.97 ^a	68.03 ^a
27	V. Fuchs Delight x V. Bitz's Heartthrob	60.47 ^{abc}	62.27 ^{ab}	63.27 ^{ab}	63.57 ^{ab}	63.70 ^{ab}	63.83 ^{ab}	63.93 ^a	64.03 ^a	64.13 ^{ab}	64.13 ^{ab}	64.17 ^{ab}	64.20 ^{ab}
28	V. Prapawan	34.00 ^{klmno}	34.17 ^{ijklm}	34.60 ^{ijklm}	35.00 ^{ijkl}	35.00 ^{ijkl}	35.00 ^{ijklm}	35.10 ^{ijklm}	35.60 ^{hijkl}	35.60 ^{hijkl}	35.60 ^{hijkl}	35.87 ^{hijkl}	37.10 ^{hijk}
29	V. Thailand Beauty	36.33 ^{ijklmn}	36.67 ^{ijkl}	37.27 ^{hijkl}	37.53 ^{ijkl}	37.80 ^{hijk}	38.43 ^{hijkl}	38.93 ^{hijk}	39.27 ^{ghijk}	39.53 ^{ghijk}	39.83 ^{ghij}	40.23 ^{fghijk}	40.33 ^{fghijk}
30	V. Dr. Anek x V. Bitz's Heartthrob	45.57 ^{efghij}	46.30 ^{defgh}	46.33 ^{defgh}	46.37 ^{defghi}	46.77 ^{defgh}	46.77 ^{defgh}	46.93 ^{defg}	47.03 ^{defg}	47.17 ^{defg}	47.20 ^{defg}	47.23 ^{defg}	47.33 ^{defg}

the maximum plant spread, on par with *V. Pompimol*, *V. Kasem's Delight* x *V. Bitz's Heartthrob*, *V. Pranermprai* x *V. tessellata* and *V. Fuchs Delight* x *V. Bitz's Heartthrob* followed by *V. Kultana Delight Red* and *V. Pathum Gold*. Plant spread was minimum for *V. Pachara Delight Pink* itself, followed by *V. Anek Delight*.

Almost similar situation continued for the rest of the months and by the end of the study period, *V. Kasem's Delight* x *V. Bitz's Heartthrob* had the maximum plant spread (70.60 cm) which was on par with *V. Pranermprai* x *V. tessellata* (70.53 cm), *V. Pompimol* (68.47 cm), *V. Dr. Anek* x *V. Mimi Palmer* (68.03 cm), *V. Urbchitr* x *V. Bitz's Heartthrob* (64.47 cm) and *V. Fuchs Delight* x *V. Bitz's Heartthrob* (64.20 cm) followed by *V. Pakchong New Land* x *V. Annette Jones* (57.90 cm). The minimum plant spread was observed in *V. Pachara Delight Pink* (27.23 cm) followed by *V. Anek Delight* (31.40 cm).

Shoot girth

The data pertaining to shoot characters of the various vanda varieties are presented in Table 4 and Fig.1.

Significant differences were observed in shoot girth of different vanda varieties/ hybrids evaluated. *V. Taweesuksa* x *V. Kultana Gold* x *V. Green Gold* recorded the maximum (4.33 cm) and statistically on par with *V. Sirilak* x *V. Bitz's Heartthrob* (4.17 cm), *V. Apec Blue* (4.07 cm), *V. Katsuura* x *V. Fuchs Delight*, *V. Robert's Delight*, *V. Pakchong New Land* x *V. Annette Jones* (4.00 cm), *V. Lumpini Red* x *V. Taweewan* (3.73 cm), *V. Landa Sri pink* (3.67 cm). Minimum shoot girth was recorded in *V. Varuvathe Pink* (2.67 cm), followed by *V. Prapawan* (2.80 cm).

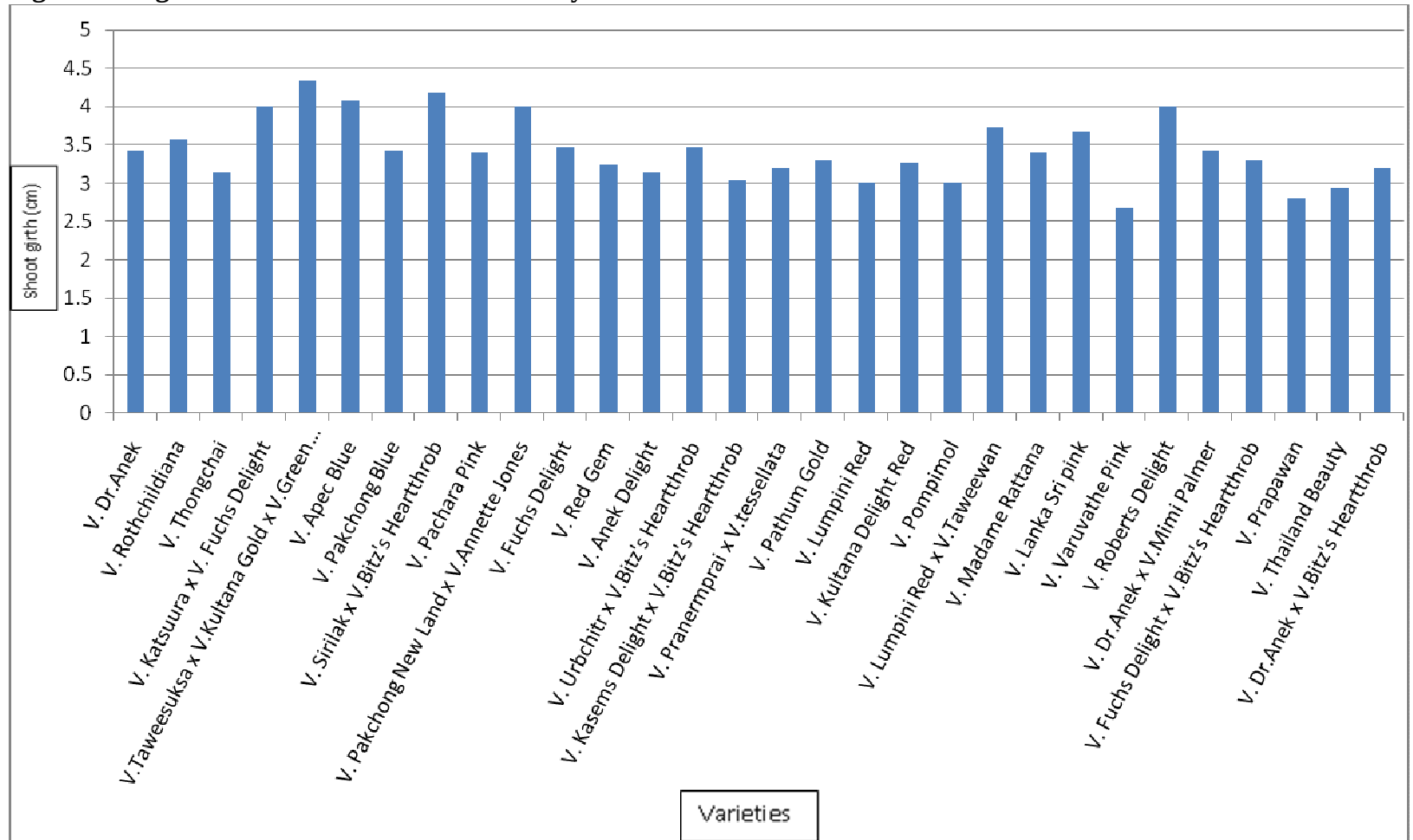
Internodal length

Detectable differences were observed in the internodal lengths of the selected varieties. It was maximum in *V. Pakchong New Land* x *V. Annette Jones* (2.30 cm), which was on par with *V. Dr. Anek* (2.27 cm) and *V. Taweesuksa* x *V. Kultana Gold*

Table 4. Shoot characters of vanda varieties/ hybrids

Sl. No.	Varieties/hybrids	Shoot characters				
		Shoot girth(cm)	Internodal length(cm)	Nature of shoot	Shoot colour	Branching
1	V. Dr. Anek	3.43 ^{bcdefg}	2.27 ^a	Medium sized	brown	absent
2	V. Rothchildiana	3.57 ^{abcdef}	1.07 ^{efgh}	Medium sized	brown	absent
3	V. Thongchai	3.13 ^{defg}	1.37 ^{cde}	Medium sized	brown	absent
4	V. Katsuura x V. Fuchs Delight	4.00 ^{abcd}	1.53 ^{cd}	Medium sized	brown	absent
5	V. Taweesuksa x V. Kultana Gold x V. Green Gold	4.33 ^a	1.97 ^{ab}	Medium sized	brown	Absent
6	V. Apec Blue	4.07 ^{abc}	1.67 ^{bc}	Medium sized	brown	Absent
7	V. Pakchong Blue	3.43 ^{bcdefg}	1.17 ^{defgh}	Medium sized	brown	Absent
8	V. Sirilak x V. Bitz's Heartthrob	4.17 ^{ab}	1.37 ^{cde}	Medium sized	brown	Absent
9	V. Pachara Delight Pink	3.40 ^{bcdefg}	0.80 ⁿ	Medium sized	brown	Absent
10	V. Pakchong New Land x V. Annette Jones	4.00 ^{abcd}	2.30 ^a	Medium sized	brown	Absent
11	V. Fuchs Delight	3.47 ^{bcdefg}	1.27 ^{cdef}	slender	brown	Absent
12	V. Red Gem	3.23 ^{cdefg}	1.13 ^{defgh}	Medium sized	brown	Absent
13	V. Anek Delight	3.13 ^{defg}	1.23 ^{defg}	Medium sized	brown	Absent
14	V. Urbchitr x V. Bitz's Heartthrob	3.47 ^{bcdefg}	1.23 ^{defg}	Sturdy	brown	Absent
15	V. Kasem's Delight x V. Bitz's Heartthrob	3.03 ^{efg}	1.20 ^{defgh}	Medium sized	brown	Absent
16	V. Pranermprai x V. <i>tessellata</i>	3.20 ^{defg}	1.23 ^{defg}	Medium sized	brown	Absent
17	V. Pathum Gold	3.30 ^{cdefg}	0.93 ^{fgh}	Medium sized	brown	Absent
18	V. Lumpini Red	3.00 ^{efg}	0.93 ^{fgh}	Medium sized	brown	Absent
19	V. Kultana Delight Red	3.27 ^{cdefg}	1.43 ^{cde}	Medium sized	brown	Absent
20	V. Pompimol	3.00 ^{efg}	1.20 ^{defgh}	Sturdy	brown	Absent
21	V. Lumpini Red x V. Taweewan	3.73 ^{abcde}	1.30 ^{cdef}	Sturdy	brown	Absent
22	V. Madame Rattana	3.40 ^{bcdefg}	1.10 ^{efgh}	Sturdy	brown	Absent
23	V. Lanka Sri pink	3.67 ^{abcdef}	1.27 ^{cdef}	Medium sized	brown	Absent
24	V. Varuvathe Pink	2.67 ^g	1.27 ^{cdef}	Slender	brown	Absent
25	V. Robert's Delight	4.00 ^{abcd}	1.47 ^{cde}	Medium sized	brown	Absent
26	V. Dr. Anek x V. Mimi Palmer	3.43 ^{bcdefg}	1.37 ^{cde}	Medium sized	brown	Absent
27	V. Fuchs Delight x V. Bitz's Heartthrob	3.30 ^{cdefg}	1.27 ^{cdef}	Medium sized	brown	Absent
28	V. Prapawan	2.80 ^{fg}	1.13 ^{defgh}	Medium sized	brown	Absent
29	V. Thailand Beauty	2.93 ^{efg}	0.83 ^{gh}	Short	brown	Absent
30	V. Dr. Anek x V. Bitz's Heartthrob	3.20 ^{defg}	1.47 ^{cde}	Medium sized	brown	Absent

Fig.1. Shoot girth in different vanda varieties/ hybrids



x V. Green Gold (1.97 cm) and were significantly superior to all others but closely followed by V. Apec Blue (1.67 cm). Minimum intermodal length was recorded in V. Thailand Beauty (0.83 cm), followed by V. Pathum Gold and V. Lumpini Red (0.93 cm).

4.1.1.2. Leaf characters

The data regarding leaf characters of different vanda varieties/ hybrids are presented in Tables 5-10.

Leaf length

The vanda varieties/ hybrids showed detectable differences in leaf length (Table 5). During February and March 2013, V. Dr. Anek x V. Mimi Palmer had the maximum leaf length (35.67 cm) and was on par with V. Urbchitr x V. Bitz's Heartthrob (34.83 cm), V. Fuchs Delight x V. Bitz's Heartthrob (34.07 cm), V. Pompimol (34.00 cm), and V. Kasem's Delight x V. Bitz's Heartthrob (32.47 cm). Minimum leaf length was observed in V. Prapawan (13.10 cm), followed by V. Anek Delight (15.67 cm). The difference remained almost the same during the rest of the months.

V. Pompimol had the maximum (37.00 cm) leaf length at the end of the period of study and was on par with V. Urbchitr x V. Bitz's Heartthrob (36.13 cm), V. Dr. Anek x V. Mimi Palmer (36.00 cm), V. Fuchs Delight x V. Bitz's Heartthrob (34.53 cm), V. Kasem's Delight x V. Bitz's Heartthrob (34.33 cm) and V. Dr. Anek x V. Bitz's Heartthrob (31.30 cm) followed by V. Kultana Delight Red (29.30 cm). Minimum leaf length was recorded in V. Prapawan (14.50 cm) followed by V. Anek Delight (15.83 cm) which were on par with V. Pachara Delight Pink (16.53 cm), V. Thailand Beauty (17.10 cm) and V. Pakchong Blue (17.47 cm).

Table.5. Leaf length of vanda varieties/ hybrids during the period of observation

Sl. No.	Varieties/hybrids	Leaf length (cm)											
		Feb '13	Mar '13	Apr '13	May '13	June '13	July '13	Aug '13	Sept '13	Oct '13	Nov '13	Dec '13	Jan '14
1	V. Dr. Anek	24.63 ^{bcd}	24.63 ^{defgh}	25.00 ^{defg}	25.03 ^{defghi}	25.03 ^{defgh}	25.07 ^{defghi}	25.07 ^{defghi}	25.07 ^{defghi}	25.07 ^{defghi}	25.07 ^{defghi}	25.07 ^{defghi}	25.07 ^{defghi}
2	V. Rothchildiana	24.20 ^{bcd}	24.20 ^{defgh}	24.53 ^{defg}	24.67 ^{efghi}	24.67 ^{efgh}	24.67 ^{efghi}	24.67 ^{efghi}	24.67 ^{efghi}	24.70 ^{efghi}	24.70 ^{efghi}	24.70 ^{efghi}	24.70 ^{efghi}
3	V. Thongchai	21.87 ^{def}	21.50 ^{hi}	21.53 ^{gh}	21.80 ^{ij}	21.97 ^{hi}	22.00 ^{hij}	22.00 ^{hij}	22.00 ^{hij}	22.03 ^{hij}	22.03 ^{hij}	22.03 ^{hij}	22.03 ^{hij}
4	V. Katsuura x V. Fuchs Delight	22.53 ^{de}	23.57 ^{efgh}	25.60 ^{defg}	26.50 ^{defgh}	26.50 ^{defg}	26.5 ^{defgh}	26.5 ^{defgh}	26.50 ^{defgh}	26.50 ^{dfgh}	26.50 ^{dfgh}	26.50 ^{defgh}	26.50 ^{defgh}
5	V. Taweesuksa x V. Kultana Gold x V. Green Gold	27.47 ^{bc}	27.70 ^{cde}	27.97 ^{cde}	28.43 ^{cdef}	28.53 ^{cdef}	28.53 ^{cdef}	28.57 ^{cdef}	28.57 ^{cdef}	28.57 ^{cdef}	28.57 ^{cdef}	28.57 ^{cdef}	28.57 ^{cdef}
6	V. Apec Blue	22.77 ^{de}	22.77 ^{gh}	23.37 ^{efgh}	23.50 ^{ghi}	23.50 ^{ghi}	23.50 ^{ghij}	23.50 ^{ghij}	23.50 ^{ghij}	23.50 ^{ghij}	23.50 ^{ghij}	23.50 ^{ghij}	23.50 ^{ghij}
7	V. Pakchong Blue	17.10 ^{gh}	17.33 ^l	17.40 ^{ijk}	17.40 ^{kl}	17.47 ^{jk}	17.47 ^{kl}	17.47 ^{kl}	17.47 ^{kl}	17.47 ^{kl}	17.47 ^{kl}	17.47 ^{kl}	17.47 ^{kl}
8	V. Sirilak x V. Bitz's Heartthrob	25.37 ^{bcd}	25.47 ^{cdefgh}	25.57 ^{defg}	25.63 ^{defghi}	25.63 ^{defgh}	25.63 ^{defghi}	25.63 ^{defghi}	25.63 ^{defghi}	25.70 ^{defghi}	25.70 ^{defghi}	25.70 ^{defghi}	25.70 ^{defghi}
9	V. Pachara Delight Pink	14.83 ^{gh}	16.13 ^{kj}	16.27 ^{jk}	16.50 ^{kl}	16.53 ^{jk}	16.53 ^{kl}	16.53 ^{kl}	16.53 ^{kl}	16.53 ^{kl}	16.53 ^{kl}	16.53 ^{kl}	16.53 ^{kl}
10	V. Pakchong New Land x V. Annette Jones	26.30 ^{bcd}	27.37 ^{cdef}	27.83 ^{cdef}	28.07 ^{cdef}	28.07 ^{cdef}	28.07 ^{cdef}	28.07 ^{cdef}	28.07 ^{cdef}	28.07 ^{cdef}	28.07 ^{cdef}	28.07 ^{cdef}	28.07 ^{cdf}
11	V. Fuchs Delight	22.90 ^{cde}	23.00 ^{gh}	23.07 ^{fgh}	23.07 ^{hij}	23.10 ^{ghi}	23.10 ^{ghij}	23.10 ^{ghij}	23.10 ^{ghij}	23.10 ^{ghij}	23.10 ^{ghij}	23.10 ^{hij}	23.10 ^{ghij}
12	V. Red Gem	23.47 ^{bcd}	25.33 ^{defgh}	25.70 ^{defg}	25.70 ^{defghi}	25.70 ^{defgh}	25.70 ^{defghi}	25.70 ^{defghi}	25.70 ^{defghi}	25.70 ^{defghi}	25.70 ^{defghi}	25.70 ^{defghi}	25.70 ^{defghi}
13	V. Anek Delight	15.50 ^{gh}	15.67 ^{jk}	15.73 ^{jk}	15.77 ^{kl}	15.80 ^{jk}	15.80 ^{kl}	15.80 ^{kl}	15.80 ^{kl}	15.80 ^{kl}	15.80 ^{kl}	15.80 ^{kl}	15.83 ^{kl}
14	V. Urbchitr x V. Bitz's Heartthrob	32.63 ^a	34.83 ^a	35.97 ^a	36.10 ^a	36.13 ^a	36.13 ^a	36.13 ^a	36.13 ^a	36.13 ^a	36.13 ^a	36.13 ^a	36.13 ^a
15	V. Kasem's Delight x V. Bitz's Heartthrob	32.27 ^a	32.47 ^{ab}	33.10 ^{ab}	33.30 ^{ab}	34.30 ^{ab}	34.30 ^{ab}	34.30 ^{ab}	34.33 ^{ab}	34.33 ^{ab}	34.33 ^{ab}	34.33 ^{ab}	34.33 ^{ab}
16	V. Pranermprai x V. tessellata	25.70 ^{bcd}	26.73 ^{cdefg}	27.53 ^{cdf}	27.53 ^{cdefg}	27.53 ^{cdefg}	27.53 ^{cdefg}	27.57 ^{cdefg}	27.57 ^{cdefg}	27.57 ^{cdefg}	27.57 ^{cdefg}	27/60 ^{cdefg}	27.60 ^{cdefg}
17	V. Pathum Gold	25.27 ^{bcd}	25.30 ^{defgh}	25.57 ^{defg}	25.63 ^{defghi}	25.63 ^{defgh}	25.63 ^{defghi}	25.63 ^{defghi}	25.63 ^{defghi}	25.63 ^{defghi}	25.63 ^{defghi}	25.67 ^{defghi}	25.67 ^{defghi}

Leaf length of vanda varieties/ hybrids during the period of observation contd...

[illegible]

Leaf breadth

Distinguishable differences in leaf breadth was recorded in vanda varieties/hybrids (Table 6). At the beginning of the period of study (February and March), V. Lumpini Red x V. Taweewan recorded the maximum leaf breadth (3.67 cm) and was on par with V. Pompimol (3.50 cm), V. Madame Rattana (3.40 cm) and V. Pakchong New Land x V. Annette Jones (3.27 cm), which was followed by V. Kasem's Delight x V. Bitz's Heartthrob (3.17 cm). Minimum was observed in V. Fuchs Delight (1.93 cm), followed by V. Varuvathe Pink (2.10 cm). From April onwards, the leaf breadth of V. Pakchong New Land x V. Annette Jones was significantly different from V. Lumpini Red x V. Taweewan and V. Pompimol. Similar situation continued for the rest of the months.

By the end of study period, V. Lumpini Red x V. Taweewan recorded the maximum leaf breadth (3.70 cm), and was statistically on par with V. Pompimol (3.50 cm) and V. Madame Rattana (3.40 cm) and were significantly superior to others. Minimum leaf breadth was observed in V. Fuchs Delight (2.03 cm), which was on par with V. Varuvathe Pink (2.20 cm).

Leaf area

Significant differences were observed in the leaf area in different varieties/hybrids of vanda (Table 7). V. Pompimol recorded maximum leaf area throughout the period of study and was distinctly superior to others. It was on par with V. Urbchitr x V. Bitz's Heartthrob, V. Kasem's Delight x V. Bitz's Heartthrob and V. Lumpini Red x V. Taweewan during the initial months. Minimum leaf area was recorded in V. Varuvathe Pink and V. Anek Delight.

By the end of the study period, the leaf area was significantly high in V. Pompimol (90.63 cm²), which was superior to other varieties/ hybrids and was on par with V. Urbchitr x V. Bitz's Heartthrob (88.88 cm²), V. Lumpini Red x

Table.6. Leaf breadth of vanda varieties/ hybrids during the period of observation

[illegible]

Leaf breadth of vanda varieties/ hybrids during the period of observation contd...

[illegible]

Table. 7. Leaf area of vanda varieties/ hybrids during the period of observation

Sl. No.	Varieties/hybrids	Leaf area (cm ²)											
		Feb '13	Mar '13	Apr '13	May'13	Jun '13	Jul '13	Aug '13	Sep '13	Oct '13	Nov '13	Dec '13	Jan '14
1	V. Dr. Anek	36.40 ^{klm}	38.86 ^{klm}	41.65 ^{klm}	41.73 ^{klm}	41.73 ^{klm}	41.85 ^{klm}	41.85 ^{klm}	41.85 ^{klm}	41.85 ^{klm}	41.85 ^{klm}	41.85 ^{klm}	41.85 ^{klm}
2	V. Rothchildiana	43.53 ^k	44.78 ^k	46.82 ^k	46.85 ^k	47.10 ^k	47.19 ^k	47.19 ^k	47.23 ^k	47.23 ^k	47.27 ^k	47.27 ^k	47.27 ^k
3	V. Thongchai	33.07 ^{lmn}	34.62 ^{mn}	34.89 ^{mn}	35.35 ^{mn}	35.39 ^{mn}	35.56 ^{mn}	35.56 ^{mn}	35.56 ^{mn}	35.58 ^{mn}	35.62 ^{mn}	35.62 ^{mn}	35.62 ^{mn}
4	V. Katsuura x V. Fuchs Delight	47.59 ^{ijk}	49.23 ^{ij}	52.35 ^{ij}	55.05 ^{ij}	55.80 ^{ij}	58.31 ^{ij}	58.31 ^{ij}	58.31 ^{ij}	58.31 ^{ij}	58.31 ^{ij}	58.31 ^{ij}	58.31 ^{ij}
5	V. Taweesuksa x V. Kultana Gold x V. Green Gold	63.58 ^{ghi}	64.78 ^{ghi}	66.07 ^{ghi}	67.10 ^{ghi}	67.27 ^{ghi}	67.27 ^{ghi}	67.31 ^{ghi}	67.35 ^{ghi}	67.38 ^{ghi}	67.38 ^{ghi}	67.38 ^{ghi}	67.38 ^{ghi}
6	V. Apec Blue	44.81 ^k	46.10 ^k	46.80 ^k	47.75 ^k	48.00 ^k	48.43 ^k	48.43 ^k	48.43 ^k	48.43 ^k	48.43 ^k	48.43 ^k	48.43 ^k
7	V. Pakchong Blue	31.90 ^{mn}	33.20 ^{mn}	33.75 ^{mn}	35.00 ^{mn}	35.24 ^{mn}	35.57 ^{mn}	35.57 ^{mn}	35.58 ^{mn}	35.58 ^{mn}	35.58 ^{mn}	35.58 ^{mn}	35.58 ^{mn}
8	V. Sirilak x V. Bitz's Heartthrob	66.47 ^{ghi}	66.79 ^{ghi}	67.35 ^{ghi}	67.68 ^{ghi}	67.98 ^{ghi}	67.98 ^{ghi}	67.98 ^{ghi}	68.19 ^{ghi}	68.19 ^{ghi}	68.19 ^{ghi}	68.19 ^{ghi}	68.19 ^{ghi}
9	V. Pachara Delight Pink	27.09 ^{mn}	29.30 ^{mn}	29.75 ^{mn}	32.84 ^{mn}	33.19 ^{mn}	33.62 ^{mn}	33.62 ^{mn}	33.62 ^{mn}	33.62 ^{mn}	33.62 ^{mn}	33.62 ^{mn}	33.62 ^{mn}
10	V. Pakchong New Land x V. Annette Jones	72.34 ^{cdef}	74.57 ^{cdef}	76.30 ^{cdef}	76.93 ^{cdef}	77.15 ^{cdef}	77.91 ^{cdef}	78.00 ^{cdef}	78.12 ^{cdef}	78.12 ^{cdef}	78.12 ^{cdef}	78.12 ^{cdef}	78.12 ^{cdef}
11	V. Fuchs Delight	36.89 ^{klm}	39.10 ^{klm}	39.56 ^{klm}	41.07 ^{klm}	41.15 ^{klm}	41.15 ^{klm}	41.80 ^{klm}	41.88 ^{klm}	41.88 ^{klm}	41.88 ^{klm}	41.88 ^{klm}	41.88 ^{klm}
12	V. Red Gem	28.56 ^{lmn}	29.98 ^{lmn}	32.20 ^{lmn}	34.01 ^{lmn}	34.25 ^{lmn}	34.27 ^{lmn}	36.00 ^{lmn}	36.80 ^{lmn}	36.81 ^{lmn}	36.81 ^{lmn}	36.81 ^{lmn}	36.81 ^{lmn}
13	V. Anek Delight	25.65 ^{mn}	25.98 ^{mn}	26.50 ⁿ	27.06 ⁿ	27.10 ⁿ	27.10 ⁿ	28.56 ⁿ	29.13 ⁿ	29.13 ⁿ	29.13 ⁿ	29.13 ⁿ	29.13 ⁿ
14	V. Urbchitr x V. Bitz's Heartthrob	75.01 ^{ab}	77.57 ^{ab}	79.95 ^{ab}	83.27 ^{ab}	86.00 ^{ab}	86.05 ^{ab}	87.98 ^{ab}	88.88 ^{ab}	88.88 ^{ab}	88.88 ^{ab}	88.88 ^{ab}	88.88 ^{ab}
15	V. Kasem's Delight x V. Bitz's Heartthrob	73.42 ^{ab}	75.59 ^{ab}	78.87 ^{abc}	80.25 ^{abcd}	81.00 ^{abcd}	81.20 ^{abcd}	82.10 ^{abcd}	82.23 ^{abcd}	82.38 ^{abcd}	82.38 ^{abcd}	82.38 ^{abcd}	82.38 ^{abcd}
16	V. Pranempchai x V. tessellata	56.23 ^{ghi}	58.56 ^{ghi}	61.23 ^{ghi}	63.79 ^{ghi}	64.11 ^{ghi}	64.26 ^{ghi}	65.05 ^{ghi}	65.24 ^{ghi}	65.24 ^{ghi}	65.24 ^{ghi}	65.24 ^{ghi}	65.24 ^{ghi}

Leaf area of vanda varieties/ hybrids during the period of observation contd...

Sl. No.	Varieties/hybrids	Feb '13	Mar '13	Apr '13	May'13	Jun '13	Jul '13	Aug '13	Sep '13	Oct '13	Nov '13	Dec '13	Jan '14
17	V. Pathum Gold	70.10 ^{defg}	71.29 ^{defg}	72.75 ^{defg}	73.10 ^{defg}	73.16 ^{defg}	73.19 ^{defg}	73.46 ^{defg}	73.50 ^{defg}	73.50 ^{defg}	73.50 ^{defg}	73.50 ^{defg}	73.50 ^{defg}
18	V. Lumpini Red	39.12 ^k	41.27 ^k	45.23 ^k	46.10 ^k	46.75 ^k	47.00 ^k	47.08 ^k	47.08 ^k	47.08 ^k	47.08 ^k	47.08 ^k	47.08 ^k
19	V. Kultana Delight Red	67.35 ^{bcde}	69.34 ^{bcde}	72.04 ^{bcde}	77.38 ^{bcde}	77.97 ^{bcde}	78.67 ^{bcde}	80.01 ^{bcde}	80.81 ^{bcde}	80.81 ^{bcde}	80.81 ^{bcde}	80.81 ^{bcde}	80.81 ^{bcde}
20	V. Pompimol	78.69 ^a	79.93 ^a	84.23 ^a	88.67 ^a	89.21 ^a	89.35 ^a	90.04 ^a	90.63 ^a	90.63 ^a	90.63 ^a	90.63 ^a	90.63 ^a
21	V. Lumpini Red x V. Taweewan	73.40 ^{abc}	75.02 ^{abc}	79.89 ^{abc}	83.24 ^{abc}	86.07 ^{abc}	86.13 ^{abc}	87.06 ^{abc}	87.13 ^{abc}	87.13 ^{abc}	87.13 ^{abc}	87.13 ^{abc}	87.13 ^{abc}
22	V. Madame Rattana	42.91 ^{jk}	44.37 ^{jk}	47.78 ^{jk}	50.09 ^{jk}	50.22 ^{jk}	50.22 ^{jk}	50.51 ^{jk}	50.75 ^{jk}	50.75 ^{jk}	50.75 ^{jk}	50.75 ^{jk}	50.75 ^{jk}
23	V. Lanka Sri pink	54.26 ^{hi}	56.78 ^{hi}	59.21 ^{hi}	59.66 ^{hi}	59.77 ^{hi}	59.77 ^{hi}	60.23 ^{hi}	60.88 ^{hi}	60.88 ^{hi}	60.88 ^{hi}	60.88 ^{hi}	60.88 ^{hi}
24	V. Varuvathe Pink	21.20 ⁿ	24.69 ⁿ	27.50 ^{mn}	30.01 ^{mn}	31.05 ^{mn}	31.89 ^{mn}	32.21 ^{mn}	32.25 ^{mn}	32.25 ^{mn}	32.25 ^{mn}	32.25 ^{mn}	32.25 ^{mn}
25	V. Robert's Delight	41.35 ^{kl}	43.49 ^{kl}	44.98 ^{kl}	45.21 ^{kl}	45.28 ^{kl}	46.00 ^{kl}	46.00 ^{kl}	46.00 ^{kl}	46.00 ^{kl}	46.00 ^{kl}	46.00 ^{kl}	46.00 ^{kl}
26	V. Dr. Anek x V. Mimi Palmer	59.80 ^{efg}	61.26 ^{efg}	65.72 ^{efg}	68.06 ^{efg}	70.22 ^{efg}	71.78 ^{efg}	72.19 ^{efg}	72.24 ^{efg}	72.25 ^{efg}	72.25 ^{efg}	72.25 ^{efg}	72.25 ^{efg}
27	V. Fuchs Delight x V. Bitz's Heartthrob	56.37 ^{fgh}	57.98 ^{fgh}	63.47 ^{fgh}	66.99 ^{fgh}	68.17 ^{fgh}	68.23 ^{fgh}	69.71 ^{fgh}	70.43 ^{fgh}	70.63 ^{fgh}	70.63 ^{fgh}	70.63 ^{fgh}	70.63 ^{fgh}
28	V. Prapawan	30.29 ^{klm}	34.20 ^{klm}	40.78 ^{klm}	41.27 ^{klm}	41.55 ^{klm}	41.58 ^{klm}	41.63 ^{klm}	41.63 ^{klm}	41.63 ^{klm}	41.63 ^{klm}	41.63 ^{klm}	41.63 ^{klm}
29	V. Thailand Beauty	51.82 ^{ghi}	54.72 ^{ghi}	57.98 ^{ghi}	60.09 ^{ghi}	61.68 ^{ghi}	62.49 ^{ghi}	63.98 ^{ghi}	64.50 ^{ghi}	64.63 ^{ghi}	64.63 ^{ghi}	64.63 ^{ghi}	64.63 ^{ghi}
30	V. Dr. Anek x V. Bitz's Heartthrob	51.93 ^{ij}	52.98 ^{ij}	56.21 ^{ij}	56.35 ^{ij}	57.11 ^{ij}	57.21 ^{ij}	58.05 ^{ij}	58.25 ^{ij}	58.25 ^{ij}	58.25 ^{ij}	58.25 ^{ij}	58.25 ^{ij}

V. Taweewan (87.13 cm²) and V. Kasem's Delight x V. Bitz's Heartthrob (82.38 cm²). Minimum leaf area (29.13 cm²) was observed in V. Anek Delight, followed by V. Varuvathe Pink (32.25 cm²), V. Pachara Delight Pink (33.62 cm²), V. Pakchong Blue (35.58 cm²) and V. Thongchai (35.62 cm²).

Number of leaves

Significant differences were observed in the number of leaves in selected varieties/hybrids of vanda during the entire study period (Table 8). During February 2013, V. Pachara Delight Pink had the maximum number of leaves (19.33), which was on par with V. Urbchitr x V. Bitz's Heartthrob (18.67), V. Pakchong New Land x V. Annette Jones (18.33), V. Pranermprai x V. *tessellata* (18.00), V. Dr. Anek x V. Mimi Palmer (18.00), V. Madame Rattana (17.00), V. Lumpini Red x V. Taweewan (16.67), V. Pathum Gold (16.00), V. Kasem's Delight x V. Bitz's Heartthrob (16.00) and V. Kultana Delight Red (15.67). Minimum leaf number was observed in V. Varuvathe Pink (8.67) followed by V. Apec Blue (9.33). During May, June and July also leaf number recorded the highest in V. Pachara Delight Pink and minimum leaf number was observed in V. Apec Blue.

Gradually by the end of study period, V. Prapawan (21.00) had the maximum number of leaves and was significantly superior to all others and was on par with V. Pachara Delight Pink (20.67), V. Pranermprai x V. *tessellata* (18.67), V. Anek x V. Bitz's Heartthrob (17.67), V. Lumpini Red x V. Taweewan (17.67) and V. Madame Rattana (16.33). Minimum leaf number (7.67) was recorded in V. Apec Blue and was on par with V. Lanka Sri pink (8.67).

Interval of leaf production

Wide variation was recorded in the interval of leaf production among the varieties (Table 9). It varied from 54.00 days (V. Lumpini Red x V. Taweewan) to 349.33 days (V. Katsuura x V. Fuchs Delight). Leaf production interval was

Table.8. Number of leaves in vanda varieties/ hybrids during the period of observation

Sl. No	Varieties/hybrids	Number of leaves											
		Feb '13	Mar '13	Apr '13	May '13	Jun'13	Jul '13	Aug '13	Sep'13	Oct '13	Nov '13	Dec '13	Jan '14
1	V. Dr. Anek	12.00 ^{defg}	12.00 ^{fghij}	12.00 ^{efgh}	11.67 ^{ghij}	12.33 ^{ghijk}	12.33 ^{fgh}	10.67 ^{hi}	11.00 ^{ghij}	11.00 ^{hijk}	11.00 ^{hijk}	9.33 ^{ijk}	9.33 ^{ikl}
2	V. Rothchildiana	12.00 ^{defg}	12.00 ^{fghij}	12.33 ^{defgh}	12.67 ^{fghij}	13.33 ^{fghij} _k	13.33 ^{efgh}	11.67 ^{efghi}	12.33 ^{defgh} _i	12.33 ^{defghij} _k	12.33 ^{efghijk}	11.00 ^{efghijk}	11.00 ^{fghijkl}
3	V. Thongchai	11.67 ^{defg}	10.33 ^{ij}	11.00 ^{fgh}	11.33 ^{hij}	11.67 ^{ghijk}	11.67 ^{gh}	11.67 ^{efghi}	12.00 ^{efghij}	12.00 ^{efghijk}	12.00 ^{fghijk}	10.00 ^{hijk}	10.00 ^{ijkl}
4	V. Katsuura x V. Fuchs Delight	12.67 ^{cdefg} _h	11.33 ^{ghij}	11.33 ^{efgh}	11.67 ^{ghij}	12.00 ^{ghijk}	12.33 ^{fgh}	9.67 ⁱ	9.67 ^{ij}	9.67 ^{jk}	9.67 ^{jk}	10.33 ^{ghijk}	10.33 ^{hijkl}
5	V. Taweesuksa x V. Kultana Gold x V. Green Gold	10.67 ^{fg}	10.33 ^{ij}	10.33 ^{gh}	10.33 ^{ij}	11.33 ^{hijk}	11.33 ^{gh}	11.00 ^{ghi}	10.00 ^{ij}	10.33 ^{ijk}	10.33 ^k	10.33 ^{ghijk}	10.33 ^{hijkl}
6	V. Apec Blue	9.33 ^{fg}	9.00 ^j	8.67 ^h	9.00 ^j	9.33 ^k	9.33 ^h	9.33 ⁱ	7.33 ^j	8.00 ^k	8.00 ^k	7.67 ^k	7.67 ^l
7	V. Pakchong Blue	11.00 ^{fg}	11.00 ^{ghij}	10.67 ^{gh}	11.00 ^{hij}	11.67 ^{ghijk}	11.67 ^{gh}	12.33 ^{defgh} _i	12.33 ^{defgh} _i	12.67 ^{defghij} _k	12.67 ^{efghijk}	10.33 ^{ghijk}	10.33 ^{hijkl}
8	V. Sirilak x V. Bitz's Heartthrob	11.33 ^{efg}	11.00 ^{ghij}	9.67 ^{gh}	10.33 ^{ij}	10.33 ^{ijk}	10.67 ^{gh}	12.00 ^{efghi}	12.00 ^{efghij}	12.00 ^{efghijk}	12.00 ^{fghijk}	10.00 ^{hijk}	10.00 ^{ijkl}
9	V. Pachara Delight Pink	19.33 ^a	19.33 ^a	21.00 ^a	21.00 ^{ab}	21.33 ^{ab}	22.00 ^a	20.00 ^{ab}	20.67 ^a	20.33 ^{ab}	12.67 ^{ab}	20.67 ^{ab}	20.67 ^{ab}
10	V. Pakchong New Land x V. Annette Jones	18.33 ^a	17.67 ^{abc}	18.00 ^{abc}	18.00 ^{abcd}	18.67 ^{abcd}	18.67 ^{abc}	16.33 ^{abcde}	16.67 ^{abcde}	16.67 ^{abcde}	12.67 ^{abcdef}	16.33 ^{bcd}	16.33 ^{bcd}
11	V. Fuchs Delight	12.00 ^{defg}	12.00 ^{fghij}	12.00 ^{efgh}	12.00 ^{fghij}	13.00 ^{fghij} _k	13.00 ^{fgh}	11.33 ^{fghi}	11.33 ^{fghij}	11.33 ^{ghijk}	11.33 ^{ghijk}	11.33 ^{efghijk}	11.33 ^{efghijkl}
12	V. Red Gem	13.00 ^{cdefg}	12.67 ^{efghij}	12.67 ^{defgh}	13.67 ^{efghi}	13.67 ^{efghij} _k	13.67 ^{defgh}	11.67 ^{efghi}	11.67 ^{fghij}	11.67 ^{fghijk}	11.67 ^{ghijk}	11.33 ^{efghijk}	11.33 ^{efghijkl}
13	V. Anek Delight	12.67 ^{cdefg}	12.33 ^{fghij}	12.33 ^{defgh}	13.00 ^{fghij}	13.33 ^{fghij} _k	13.33 ^{efgh}	11.67 ^{efghi}	12.00 ^{efghij}	12.00 ^{efghijk}	12.00 ^{fghijk}	11.33 ^{efghijk}	11.33 ^{efghijkl}
14	V. Urbchitr x V. Bitz's Heartthrob	18.67 ^a	18.33 ^{ab}	18.67 ^{ab}	19.67 ^{abc}	19.67 ^{abc}	19.67 ^{ab}	18.00 ^{abc}	18.33 ^{abc}	18.33 ^{abc}	18.33 ^{abcd}	15.33 ^{cdef}	15.33 ^{cdefg}
15	V. Kasem's Delight x V. Bitz's Heartthrob	16.00 ^{abcd}	15.67 ^{abcde} _f	15.67 ^{bcdef}	15.67 ^{cdefg}	16.67 ^{cdef}	16.67 ^{bcdef}	16.00 ^{abcde} _f	16.67 ^{abcde}	16.67 ^{abcde}	16.67 ^{abcdef}	15.67 ^{cde}	15.67 ^{cdef}

Number of leaves in vanda varieties/ hybrids during the period of observation contd...

Sl. No	Varieties/hybrids	Feb '13	Mar '13	Apr '13	May '13	Jun'13	Jul '13	Aug '13	Sep'13	Oct '13	Nov '13	Dec '13	Jan '14
16	V. Pranemprai x V. tessellata	18.00 ^{ab}	18.33 ^{ab}	21.00 ^a	21.67 ^a	22.00 ^a	16.00 ^a	20.33 ^a	20.67 ^a	20.67 ^a	20.67 ^{ab}	18.67 ^{abc}	18.67 ^{abc}
17	V. Pathum Gold	16.00 ^{abcd}	14.67 ^{bcdefgh}	15.67 ^{bcdef}	16.00 ^{cdef}	16.67 ^{cdef}	16.67 ^{bcdef}	15.00 ^{cdefgh}	15.67 ^{bcdefg}	15.67 ^{bcdefgh}	15.67 ^{cdefgh}	13.67 ^{defghi}	13.67 ^{defghij}
18	V. Lumpini Red	10.67 ^{fg}	10.67 ^{hij}	11.00 ^{fgh}	11.67 ^{ghij}	11.67 ^{ghijk}	11.67 ^{gh}	12.00 ^{efghi}	12.00 ^{efghij}	12.00 ^{efghijk}	12.00 ^{fghijk}	10.67 ^{fghijk}	10.67 ^{ghijkl}
19	V. Kultana Delight Red	15.67 ^{abcde}	15.00 ^{bcdefg}	16.00 ^{bcde}	16.00 ^{cdef}	16.00 ^{cdefg}	16.67 ^{bcdef}	15.67 ^{abcdefg}	15.67 ^{bcdefg}	15.67 ^{bcdefgh}	15.67 ^{cdefghij}	15.00 ^{cdefg}	15.00 ^{cdefgh}
20	V. Pompimol	13.00 ^{cdefg}	14.00 ^{cdefghi}	14.00 ^{bcdefg}	15.00 ^{defg}	15.00 ^{defgh}	15.00 ^{cdefg}	16.00 ^{abcdef}	16.00 ^{abcdef}	16.00 ^{abcdefg}	16.00 ^{bcdefg}	15.00 ^{cdefg}	15.00 ^{cdefgh}
21	V. Lumpini Red x V. Taweewan	16.67 ^{abc}	16.67 ^{abcde}	13.33 ^{cdefgh}	17.67 ^{bcde}	17.67 ^{bcde}	17.67 ^{bcde}	17.00 ^{abcd}	17.00 ^{abcd}	17.00 ^{abcd}	17.00 ^{abcde}	17.00 ^{bcd}	17.67 ^{abcd}
22	V. Madame Rattana	17.00 ^{abc}	17.00 ^{abcd}	17.00 ^{abcd}	18.00 ^{abcd}	17.00 ^{cdef}	18.00 ^{abcd}	19.00 ^{abc}	20.00 ^{ab}	20.00 ^{ab}	20.00 ^{abc}	17.00 ^{bcd}	17.00 ^{abcd}
23	V. Lanka Sri pink	12.00 ^{defg}	11.33 ^{ghij}	11.33 ^{efgh}	12.00 ^{fghij}	12.33 ^{ghijk}	12.33 ^{fgh}	11.67 ^{efghi}	11.67 ^{fghij}	11.67 ^{fghijk}	11.67 ^{ghijk}	8.67 ^{jk}	8.67 ^{kl}
24	V. Varuvathe Pink	8.67 ^g	9.00 ^j	9.67 ^{gh}	9.33 ^j	9.67 ^{jk}	9.67 ^h	10.67 ^{hi}	10.67 ^{hij}	10.67 ^{ijk}	10.67 ^{ijk}	10.67 ^{fghijk}	10.67 ^{ghijkl}
25	V. Robert's Delight	10.00 ^{fg}	10.00 ^{ij}	10.00 ^{gh}	11.00 ^{hij}	11.00 ^{hijk}	11.00 ^{gh}	12.00 ^{efghi}	12.00 ^{efghij}	12.00 ^{efghijk}	12.00 ^{fghijk}	13.00 ^{defghij}	13.00 ^{defghijk}
26	V. Dr. Anek x V. Mimi Palmer	18.00 ^{ab}	15.67 ^{abcdf}	14.00 ^{bcdefg}	14.00 ^{defghi}	14.00 ^{efghij}	11.33 ^{gh}	11.87 ^{efghi}	12.33 ^{defghi}	13.00 ^{defghij}	13.33 ^{efghijk}	13.67 ^{defghi}	14.33 ^{cdefghi}
27	V. Fuchs Delight x V. Bitz's Heartthrob	9.00 ^g	9.00 ^j	9.00 ^{gh}	9.00 ^j	9.33 ^k	14.33 ^{cdefg}	14.67 ^{cdefgh}	15.00 ^{cdefgh}	15.00 ^{cdefghi}	15.33 ^{cdefghi}	15.33 ^{cdef}	16.00 ^{cde}
28	V. Prapawan	13.00 ^{cdefg}	13.00 ^{defghij}	14.00 ^{bcdefg}	15.00 ^{defgh}	15.00 ^{defgh}	15.00 ^{cdefg}	17.00 ^{abcd}	18.00 ^{abc}	19.00 ^{abc}	21.00 ^a	22.00 ^a	21.00 ^a
29	V. Thailand Beauty	10.67 ^{fg}	11.33 ^{ghij}	11.33 ^{efgh}	11.33 ^{hij}	11.67 ^{ghijk}	11.67 ^{gh}	12.33 ^{defghi}	13.00 ^{defghi}	13.33 ^{defghij}	14.33 ^{defghij}	14.33 ^{cdefgh}	14.33 ^{cdefghi}
30	V. Dr. Anek x V. Bitz's Heartthrob	13.67 ^{bcdef}	13.67 ^{cdefghi}	14.00 ^{bcdefg}	14.00 ^{defghi}	14.33 ^{efghi}	14.67 ^{cdefg}	15.33 ^{bcdefgh}	16.00 ^{abcdef}	16.33 ^{abcdf}	17.00 ^{abcde}	17.33 ^{bcd}	17.67 ^{abcd}

Table.9. **Other leaf characters of vanda varieties/ hybrids**

Sl. No.	Varieties/hybrids	Leaf orientation	Interval of production (days)	Leaf texture	Leaf apex	Leaf base	Leaf margin	Leaf colour	Leaf pigmentation	Other characters
1	V. Dr. Anek	Straight with arching tendency	137.33 ^{cdef}	Smooth, rigid	Tridentate	sheathed	entire	green	absent	Channelled
2	V. Rothchildiana	Straight with arching tendency	177.33 ^{bcd}	Smooth, rigid	Tridentate	sheathed	entire	green	absent	Channelled
3	V. Thongchai	Horizontal	245.00 ^b	Smooth, rigid	tridentate	sheathed	entire	green	absent	Deeply channelled
4	V. Katsuura x V. Fuchs Delight	Horizontal, with arching tendency	349.33 ^a	Smooth, rigid	tridentate	sheathed	entire	green	absent	Channelled
5	V. Taweesuksa x V. Kultana Gold x V. Green Gold	Horizontal, with arching tendency	146.33 ^{cde}	Smooth, rigid	praemorse	sheathed	entire	green	absent	Channelled
6	V. Apec Blue	straight, with arching tendency	189.33 ^{bc}	Smooth, rigid	tridentate	sheathed	entire	green	absent	Channelled, but strap like towards tip
7	V. Pakchong Blue	Arching	138.33 ^{cde}	Smooth, rigid	praemorse	sheathed	entire	green	absent	Channelled
8	V. Sirilak x V. Bitz's Heartthrob	Horizontal, with arching tendency	101.67 ^{def}	Smooth, rigid	tridentate	sheathed	entire	green	absent	Channelled
9	V. Pachara Delight Pink	Straight, with slight arching	126.67 ^{cdef}	Smooth, rigid	tridentate	sheathed	entire	green	absent	Widely channelled, strap-like
10	V. Pakchong New Land x V. Annette Jones	Horizontal, with arching tendency	132.33 ^{cdef}	Smooth, rigid	tridentate	sheathed	entire	green	absent	Channelled
11	V. Fuchs Delight	Horizontal, with arching tendency	98.00 ^{def}	Smooth, rigid	tridentate	sheathed	entire	green	absent	Channelled
12	V. Red Gem	Arching	89.67 ^{ef}	Smooth, rigid	tridentate	sheathed	entire	green	absent	Channelled
13	V. Anek Delight	Horizontal, with arching tendency	109.00 ^{cdef}	Smooth, rigid	tridentate	sheathed	entire	green	absent	Channelled
14	V. Urbchitr x V. Bitz's Heartthrob	Arching	127.67 ^{cdef}	Smooth, rigid	tridentate	sheathed	entire	green	absent	Channelled
15	V. Kasem's Delight x V. Bitz's Heartthrob	Horizontal, with arching tendency	110.67 ^{cdef}	Smooth, rigid	tridentate	sheathed	entire	green	absent	Channelled
16	V. Pranermprai x V. tessellata	Arching	118.33 ^{cdef}	Smooth, rigid	tridentate	sheathed	entire	green	absent	Channelled

Other leaf characters of vanda varieties/ hybrids contd...

Sl. No.	Varieties/hybrids	Leaf orientation	Interval of production (days)	Leaf texture	Leaf apex	Leaf base	Leaf margin	Leaf colour	Leaf pigmentation	Other characters
17	V. Pathum Gold	Arching	128.00 ^{cdef}	Smooth, rigid	tridentate	Sheathed	entire	green	absent	Channelled
18	V. Lumpini Red	Straight, with slight arching	124.00 ^{cdef}	Smooth, rigid	tridentate	Sheathed	entire	green	absent	Channelled
19	V. Kultana Delight Red	Horizontal, with arching tendency	92.33 ^{ef}	Smooth, rigid	tridentate	Sheathed	entire	green	absent	Channelled
20	V. Pompimol	Straight, with arching	82.50 ^{ef}	Smooth, rigid	tridentate	Sheathed	entire	green	absent	Deeply channelled
21	V. Lumpini Red x V. Taweewan	Horizontal, with arching tendency	54.00 ^f	Smooth, rigid	tridentate	Sheathed	entire	green	absent	Channelled
22	V. Madame Rattana	Horizontal, with arching tendency	115.00 ^{cdef}	Smooth, rigid	tridentate	Sheathed	entire	green	absent	Channelled
23	V. Lanka Sri pink	Horizontal, with arching tendency	86.67 ^{ef}	Smooth, rigid	tridentate	Sheathed	entire	green	absent	Channelled
24	V. Varuvathe Pink	Straight	77.00 ^{ef}	Smooth, rigid	emarginate	Sheathed	entire	green	absent	Widely channelled; old leaves are strap-like
25	V. Robert's Delight	Arching	157.50 ^{cde}	Smooth, rigid	praemorse	Sheathed	entire	green	absent	Channelled
26	V. Dr. Anek x V. Mimi Palmer	Arching	105.33 ^{def}	Smooth, rigid	tridentate	Sheathed	entire	green	absent	Channelled
27	V. Fuchs Delight x V. Bitz's Heartthrob	Horizontal, with arching tendency	131.33 ^{cdef}	Smooth, rigid	tridentate	Sheathed	entire	green	absent	Channelled
28	V. Prapawan	Straight, with slight arching	156.00 ^{cde}	Smooth, rigid	tridentate	Sheathed	entire	green	absent	Deeply channelled
29	V. Thailand Beauty	Arching	88.67 ^{ef}	Smooth, rigid	tridentate	Sheathed	entire	green	absent	Channelled
30	V. Dr. Anek x V. Bitz's Heartthrob	Horizontal & arching	96.67 ^{def}	Smooth, rigid	tridentate	Sheathed	entire	green	absent	Channelled

Table 10. Leaf sheath characters of vanda varieties/ hybrids

Sl. No.	Varieties/hybrids	Leaf sheath characters	
		Nature of leaf sheath	Sheath colour
1	V. Dr. Anek	Membranous, thick	Green
2	V. Rothchildiana	Membranous, thick	Green
3	V. Thongchai	Membranous, thick	Green
4	V. Katsuura x V. Fuchs Delight	Membranous, thick	Green
5	V. Taweesuksa x V. Kultana Gold x V. Green Gold	Membranous, thick	Green
6	V. Apec Blue	Membranous, thick	Green
7	V. Pakchong Blue	Membranous, thick	Green
8	V. Sirilak x V. Bitz's Heartthrob	Membranous, thick	Green
9	V. Pachara Delight Pink	Membranous, thick	Green
10	V. Pakchong New Land x V. Annette Jones	Membranous, thick	Green
11	V. Fuchs Delight	Membranous, thick	Green
12	V. Red Gem	Membranous, thick	Green
13	V. Anek Delight	Membranous, thick	Green
14	V. Urbchitr x V. Bitz's Heartthrob	Membranous, thick	Green
15	V. Kasem's Delight x V. Bitz's Heartthrob	Membranous, thick	Green
16	V. Pranermprai x V. <i>tessellata</i>	Membranous, thick	Green
17	V. Pathum Gold	Membranous, thick	Green
18	V. Lumpini Red	Membranous, thick	Green
19	V. Kultana Delight Red	Membranous, thick	Green
20	V. Pompimol	Membranous, thick	Green
21	V. Lumpini Red x V. Taweewan	Membranous, thick	Green
22	V. Madame Rattana	Membranous, thick	Green
23	V. Lanka Sri pink	Membranous, thick	Green
24	V. Varuvathe Pink	Membranous, thick	Green
25	V. Robert's Delight	Membranous, thick	Green
26	V. Dr. Anek x V. Mimi Palmer	Membranous, thick	Green
27	V. Fuchs Delight x V. Bitz's Heartthrob	Membranous, thick	Green
28	V. Prapawan	Membranous, thick	Green
29	V. Thailand Beauty	Membranous, thick	Green
30	V. Dr. Anek x V. Bitz's Heartthrob	Membranous, thick	Green

maximum in *V. Katsuura* x *V. Fuchs Delight*. It was followed by *V. Thongchai* (245.00 days) which was on par with *V. Apec Blue* (189.33 days) and *V. Rothchildiana* (177.33 days). *V. Lumpini Red* x *V. Taweewan* had the minimum interval of leaf production (54.00 days), followed by *V. Varuvathe Pink* (77.00 days) and was on par with *V. Pompimol* (82.50 days), *V. Lanka Sri pink* (86.67 days), *V. Thailand Beauty* (88.67 days), *V. Red Gem* (89.67 days) and *V. Kultana Delight Red* (92.33 days).

4.1.1.3. Aerial root characters

Data pertaining to aerial root characters of vanda orchid varieties/ hybrids are presented in Tables 11 and 12.

Root length

Marked variation was recorded in the root lengths of the selected varieties (Table 11). Maximum root length was recorded in *V. Anek Delight* (130.63 cm), while *V. Urbchitr* x *V. Bitz's Heartthrob* recorded the minimum (32.63 cm), followed by *V. Kasem's Delight* x *V. Bitz's Heartthrob* (50.80 cm) and *V. Pachara Delight Pink* (47.17 cm).

Root girth

Significant differences were also noticed in the girth of aerial roots (Table 11). Maximum root girth was observed in *V. Lumpini Red* x *V. Taweewan* (2.27 cm), which was on par with *Dr. Anek* (2.20 cm), *V. Urbchitr* x *V. Bitz's Heartthrob* (2.20 cm), *V. Pakchong New Land* x *V. Annette Jones* (2.07 cm), *V. Rothchildiana* (2.03 cm), *V. Thongchai* (2.00 cm), *V. Sirilak* x *V. Bitz's Heartthrob* (1.97 cm), *V. Fuchs Delight* (1.97 cm), *V. Lanka Sri pink* (1.93 cm), *V. Pathum Gold* (1.87 cm), *V. Pompimol* (1.83 cm), *V. Anek Delight* (1.80 cm) and *V. Kasem's Delight* x *V. Bitz's Heartthrob* (1.80 cm), followed by *V. Katsuura* x *V. Fuchs Delight* (1.70 cm).

Table.11. Aerial root characters of vanda varieties/ hybrids

Sl. No.	Varieties/hybrids	Aerial root characters					
		Root length (cm)	Root girth (cm)	Location	Branching	Nature of roots	Root colour
1	V. Dr. Anek	90.73 ^{abcd}	2.20 ^{ab}	basal	present	Cylindrical	Grey-brown
2	V. Rothchildiana	90.47 ^{abcd}	2.03 ^{abcd}	basal	present	Cylindrical	Green
3	V. Thongchai	58.30 ^{cde}	2.00 ^{abcde}	basal	present	Cylindrical	Green
4	V. Katsuura x V. Fuchs Delight	83.67 ^{bcd}	1.70 ^{bcdefg}	basal	present	Cylindrical	Green
5	V. Taweesuksa x V. Kultana Gold x V. Green Gold	105.23 ^{abc}	1.37 ^{ghi}	basal	present	Cylindrical	Green
6	V. Apec Blue	69.60 ^{bcde}	1.67 ^{cdefg}	basal	present	Cylindrical	Green
7	V. Pakchong Blue	69.83 ^{bcde}	1.50 ^{efgh}	basal	present	Cylindrical	Green
8	V. Sirilak x V. Bitz's Heartthrob	73.60 ^{bcde}	1.97 ^{abcde}	basal	present	Cylindrical	Green
9	V. Pachara Delight Pink	47.17 ^{de}	1.40 ^{ghi}	basal	present	Cylindrical	Green
10	V. Pakchong New Land x V. Annette Jones	92.43 ^{abcd}	2.07 ^{abc}	basal	present	Cylindrical	Green
11	V. Fuchs Delight	60.00 ^{cde}	1.97 ^{abcde}	basal	Lesser branching	Cylindrical	Brown
12	V. Red Gem	78.43 ^{bcde}	1.53 ^{defgh}	basal	present	Cylindrical	Green
13	V. Anek Delight	130.63 ^a	1.80 ^{abcdefg}	basal	present	Cylindrical	Greenish brown
14	V. Urbchitr x V. Bitz's Heartthrob	32.63 ^e	2.20 ^{ab}	basal	present	Cylindrical	Green
15	V. Kasem's Delight x V. Bitz's Heartthrob	50.80 ^{de}	1.80 ^{abcdefg}	basal	present	Cylindrical	Green
16	V. Pranermprai x V. tessellata	88.07 ^{abcd}	1.63 ^{cdefg}	Along the stem	present	Cylindrical	Green

Aerial root characters of vanda varieties/ hybrids contd...

Sl. No.	Varieties/hybrids	Root length(cm)	Root girth (cm)	Location	Branching	Nature of roots	Root colour
17	V. Pathum Gold	76.27 ^{bcde}	1.87 ^{abcdefg}	From middle of stem	present	Cylindrical	Green
18	V. Lumpini Red	87.75 ^{abcd}	1.50 ^{efgh}	basal	present	Cylindrical	Green
19	V. Kultana Delight Red	73.57 ^{bcde}	1.73 ^{bcdefg}	basal	present	Cylindrical	Green
20	V. Pompimol	90.00 ^{abcd}	1.83 ^{abcdefg}	basal	present	Cylindrical	Greenish brown
21	V. Lumpini Red x V. Taweewan	62.30 ^{bcde}	2.27 ^a	basal	present	Cylindrical	Green
22	V. Madame Rattana	87.00 ^{abcd}	1.70 ^{bcdefg}	basal	present	Cylindrical	Green
23	V. Lanka Sri pink	105.93 ^{abc}	1.93 ^{abcdef}	basal	Thickly branched at base	Cylindrical	Green
24	V. Varuvathe Pink	103.83 ^{abc}	1.43 ^{gh}	basal	Meagre branching	Cylindrical	Dark green
25	V. Robert's Delight	110.03 ^{ab}	1.70 ^{bcdefg}	basal	Present	Cylindrical	Green
26	V. Dr. Anek x V. Mimi Palmer	61.67 ^{cde}	1.40 ^{ghi}	basal	Thickly branched at base	Cylindrical	Old roots- pale green, young roots-dark green
27	V. Fuchs Delight x V. Bitz's Heartthrob	61.70 ^{cde}	1.10 ^{hi}	basal	Present	Cylindrical	Green
28	V. Prapawan	74.00 ^{bcde}	1.40 ^{ghi}	From middle of stem	Present	Cylindrical	Green
29	V. Thailand Beauty	72.70 ^{bcde}	1.07 ^{hi}	basal	Present	Cylindrical	Green
30	V. Dr. Anek x V. Bitz's Heartthrob	75.17 ^{bcde}	0.93 ⁱ	basal	Present	Cylindrical	Green

Root girth was minimum in V. Dr. Anek x V. Bitz's Heartthrob (0.93 cm), followed by V. Fuchs Delight x V. Bitz's Heartthrob (1.10 cm) and V. Thailand Beauty (1.07 cm).

Number of roots

The number of aerial roots produced showed noticeable difference in vanda varieties/ hybrids (Table 12). The varieties with maximum and minimum number of roots remained unchanged during the entire period of study. However, there were differences in the other varieties/hybrids.

Throughout the study period, V. Apec Blue had the maximum number of roots and V. Varuvathe Pink the minimum.

In February 2013, V. Apec Blue had maximum number of roots (18.00) and was on par with V. Rothchildiana (15.33), V. Pakchong Blue (15.00), V. Pachara Delight Pink (14.67), V. Pakchong New Land x V. Annette Jones (14.67), V. Pranermprai x V. *tessellata* (13.67), V. Sirilak x V. Bitz's Heartthrob (13.33), V. Thongchai (13.00), V. Taweesuksa x V. Kultana Gold x V. Green Gold (12.67), V. Pathum Gold (12.33), V. Pompimol (12.00) and V. Prapawan (12.00). Number of roots was minimum in V. Varuvathe Pink (5.67), followed by V. Lanka Sri pink (6.00). The same situation continued throughout the period of study.

At the end of the period of study, V. Apec Blue had the maximum number of roots (20.00) and was on par with V. Pakchong Blue (18.00), V. Rothchildiana (17.67), V. Pachara Delight Pink (17.67), V. Sirilak x Bitz's Heartthrob (17.00), V. Pakchong New Land x V. Annette Jones (16.67) and V. Pranermprai x V. *tessellata* (15.67). Whereas V. Varuvathe Pink (6.67) recorded the minimum number of roots, followed by V. Lanka Sri pink (7.33).

Table.12. Root number in vanda varieties/ hybrids during the period of observation

Sl. No	Varieties/hybrids	Number of roots											
		Feb '13	Mar '13	Apr '13	May '13	Jun '13	Jul '13	Aug '13	Sep '13	Oct '13	Nov '13	Dec '13	Jan '14
1	V. Dr. Anek	8.67 ^{defghij}	10.00 ^{bcdefgh}	10.00 ^{bcdef}	10.00 ^{cdefg}	10.33 ^{defg}	10.67 ^{cdefghi}	11.33 ^{cdefghi} _j	11.33 ^{cdefghi} _j	11.33 ^{defghi}	11.33 ^{defgh} _{ij}	11.67 ^{efghi}	11.67 ^{efghi}
2	V. Rothchildiana	15.33 ^{ab}	16.00 ^{ab}	16.00 ^{ab}	16.00 ^{ab}	16.33 ^{abc}	16.67 ^{ab}	16.67 ^{abc}	17.00 ^{ab}	17.00 ^{abc}	17.33 ^{ab}	17.67 ^{ab}	17.67 ^{abc}
3	V. Thongchai	13.00 ^{abcde} _{fg}	13.33 ^{abcde}	13.33 ^{abcde}	13.67 ^{abcde}	13.67 ^{abcdef}	13.67 ^{abcdef}	13.67 ^{abcdefg}	14.33 ^{abcdef}	14.67 ^{abcde}	14.67 ^{abcde} _f	14.67 ^{bcdef} _g	14.67 ^{bcdefg}
4	V. Katsuura x V. Fuchs Delight	10.33 ^{bcdef} _{ghij}	10.33 ^{bcdefgh}	10.67 ^{bcdef}	11.00 ^{bcdef} _g	11.33 ^{bcdefg}	12.00 ^{bcdefgh} _i	12.00 ^{bcdefgh} _{ij}	12.00 ^{bcdefgh} _i	12.67 ^{bcdefg}	12.67 ^{bcdef} _{gh}	12.67 ^{bcdef} _{gh}	12.67 ^{cdefgh}
5	V. Taweesuksa x V. Kultana Gold x V. Green Gold	12.67 ^{abcde} _{fg}	13.00 ^{abcdef}	13.33 ^{abcde}	13.33 ^{abcde} _f	13.33 ^{bcdef}	13.67 ^{abcdef}	14.00 ^{abcdefg}	14.00 ^{abcdefg}	14.00 ^{abcde}	14.00 ^{bcdef}	14.33 ^{bcdef} _g	14.33 ^{bcdefg}
6	V. Apec Blue	18.00 ^a	18.67 ^a	18.67 ^a	19.00 ^a	19.00 ^a	19.00 ^a	19.00 ^a	19.00 ^a	19.00 ^a	19.67 ^a	19.67 ^a	20.00 ^a
7	V. Pakchong Blue	15.00 ^{abc}	15.67 ^{abc}	15.67 ^{ab}	15.67 ^{abc}	16.67 ^{ab}	16.67 ^{ab}	17.33 ^{ab}	17.33 ^{ab}	17.33 ^{ab}	17.67 ^{ab}	17.67 ^{ab}	18.00 ^{ab}
8	V. Sirilak x V. Bitz's Heartthrob	13.33 ^{abcde} _f	13.33 ^{abcde}	13.67 ^{abcd}	13.67 ^{abcde}	15.33 ^{abcd}	15.33 ^{abcd}	15.33 ^{abcde}	15.33 ^{abcde}	15.67 ^{abcd}	16.33 ^{abcd}	17.00 ^{abcd}	17.00 ^{abcd}
9	V. Pachara Delight Pink	14.67 ^{abcd}	15.67 ^{abc}	16.00 ^{ab}	16.33 ^{ab}	16.67 ^{ab}	16.67 ^{ab}	16.67 ^{abc}	17.00 ^{ab}	17.00 ^{abc}	17.00 ^{abc}	17.33 ^{abc}	17.67 ^{abc}
10	V. Pakchong New Land x V. Annette Jones	14.67 ^{abcd}	14.67 ^{abcd}	15.33 ^{ab}	16.00 ^{ab}	16.33 ^{abc}	16.33 ^{ab}	16.33 ^{abc}	16.33 ^{abc}	16.67 ^{abc}	16.67 ^{abc}	16.67 ^{abcde}	16.67 ^{abcde}
11	V. Fuchs Delight	11.33 ^{bcdef} _{ghij}	11.67 ^{bcdefgh}	11.67 ^{bcdef}	11.67 ^{bcdef} _g	11.67 ^{bcdefg}	12.33 ^{bcdefgh}	13.00 ^{bcdefgh}	13.33 ^{bcdefgh}	13.33 ^{bcdef}	13.33 ^{bcdef} _g	13.33 ^{bcdef} _g	13.33 ^{bcdefg}
12	V. Red Gem	10.00 ^{bcdef} _{ghij}	11.00 ^{bcdefgh}	11.00 ^{bcdef}	11.00 ^{bcdef} _g	12.00 ^{bcdefg}	12.00 ^{bcdefgh} _i	12.33 ^{bcdefgh} _i	12.33 ^{bcdefgh}	12.30 ^{bcdefg}	12.67 ^{bcdef} _{gh}	13.00 ^{bcdef} _g	13.00 ^{bcdefgh}
13	V. Anek Delight	6.33 ^{hij}	6.67 ^{gh}	7.33 ^{ef}	7.67 ^{fg}	8.33 ^{fg}	8.33 ^{fghi}	8.67 ^{ghij}	8.67 ^{ghij}	8.67 ^{fghi}	8.67 ^{ghij}	9.67 ^{ghij}	9.67 ^{ghij}
14	V. Urbchitr x V. Bitz's Heartthrob	7.67 ^{efghij}	8.00 ^{efgh}	8.00 ^{def}	8.00 ^{efg}	9.67 ^{efg}	10.33 ^{cdefghi}	10.67 ^{defghij}	10.67 ^{defghij}	10.67 ^{defghi}	10.67 ^{efghij}	10.67 ^{fghij}	10.67 ^{fghij}
15	V. Kasem's Delight x V. Bitz's Heartthrob	7.33 ^{fghij}	8.33 ^{efgh}	8.67 ^{def}	9.00 ^{defg}	13.33 ^{bcdef}	13.67 ^{abcdef}	13.67 ^{abcdefg}	13.67 ^{bcdefg}	14.33 ^{abcde}	14.33 ^{bcdef}	14.33 ^{bcdef} _g	14.33 ^{bcdefg}

Root number in vanda varieties/ hybrids during the period of observation contd...

Sl. No	Varieties/hybrids	Feb '13	Mar '13	Apr '13	May '13	Jun '13	Jul '13	Aug '13	Sep '13	Oct '13	Nov '13	Dec '13	Jan '14
16	V. Pranemprai x V. tessellata	13.67 ^{abcde}	14.67 ^{abcd}	15.00 ^{abc}	15.33 ^{ab_c}	15.33 ^{abcd}	15.67 ^{abc}	15.67 ^{abcd}	15.67 ^{abcd}	15.67 ^{abcd}	15.67 ^{abcde}	15.67 ^{abcde} _f	15.67 ^{abcdef}
17	V. Pathum Gold	12.33 ^{abcde} _{fgh}	12.33 ^{bcdefg}	13.00 ^{abcde}	14.00 ^{abcd}	14.33 ^{abcde}	14.33 ^{abcde}	14.33 ^{abcdef}	14.33 ^{abcdef}	14.33 ^{abcde}	14.33 ^{bcdef}	14.67 ^{bcdef} _g	14.67 ^{bcdefg}
18	V. Lumpini Red	9.67 ^{bcdefg} _{hij}	9.67 ^{cdefgh}	10.00 ^{bcdef}	10.67 ^{bcdef} _g	11.33 ^{bcdefg}	11.67 ^{bcdefgh} _i	11.67 ^{cdefghi} _j	12.00 ^{bcdefgh} _i	12.00 ^{cdefg} _h	12.00 ^{cdefg} _{hi}	12.33 ^{cdefg} _h	12.33 ^{defgh}
19	V. Kultana Delight Red	9.33 ^{bcdefg} _{hij}	9.33 ^{defgh}	10.00 ^{bcdef}	10.00 ^{cdefg}	10.00 ^{defg}	10.00 ^{defghi}	10.00 ^{efghij}	10.00 ^{efghij}	10.33 ^{efghi}	10.33 ^{fghij}	10.33 ^{ghij}	10.33 ^{ghij}
20	V. Pompimol	12.00 ^{abcde} _{fghi}	14.00 ^{abcde}	14.00 ^{abcd}	14.00 ^{abcd}	14.00 ^{abcde}	14.00 ^{abcde}	14.00 ^{abcdefg}	14.00 ^{abcdefg} _j	14.00 ^{abcde}	14.00 ^{bcdef}	14.33 ^{bcdef} _g	14.33 ^{bcdefg}
21	V. Lumpini Red x V. Taweewan	8.33 ^{efghij}	8.67 ^{defgh}	9.00 ^{cdef}	9.00 ^{defg}	9.00 ^{efg}	9.00 ^{efghi}	9.00 ^{fghij}	9.67 ^{fghij}	9.67 ^{efghi}	9.67 ^{fghij}	9.67 ^{ghij}	9.67 ^{ghij}
22	V. Madame Rattana	22.00 ^{efghij}	8.00 ^{efgh}	9.00 ^{cdef}	9.00 ^{defg}	9.00 ^{efg}	10.00 ^{defghi}	10.00 ^{efghij}	10.00 ^{efghij}	10.00 ^{efghi}	10.00 ^{fghij}	10.00 ^{ghij}	10.00 ^{ghij}
23	V. Lanka Sri pink	6.00 ^{ij}	6.67 ^{gh}	6.67 ^f	6.67 ^g	6.67 ^g	7.00 ^{hi}	7.00 ^{ij}	7.00 ^{ij}	7.00 ^{hi}	7.00 ^{ij}	7.00 ^{ij}	7.33 ^{ij}
24	V. Varuvathe Pink	5.67 ^j	5.67 ^h	6.00 ^f	6.33 ^g	6.67 ^g	6.67 ⁱ	6.67 ^j	6.67 ^j	6.67 ⁱ	6.67 ^j	6.67 ^j	6.67 ^j
25	V. Robert's Delight	7.00 ^{ghij}	25 ^{fgh}	7.00 ^f	7.00 ^g	7.00 ^g	8.00 ^{ghi}	8.00 ^{hij}	8.00 ^{hij}	8.00 ^{ghi}	8.00 ^{hij}	8.00 ^{hij}	8.00 ^{hij}
26	V. Dr. Anek x V. Mimi Palmer	11.00 ^{bcdef} _{ghij}	11.67 ^{bcdefgh}	11.67 ^{bcdef}	12.00 ^{bcdef} _g	13.00 ^{bcdef}	13.00 ^{bcdefg}	13.00 ^{bcdefgh}	13.00 ^{bcdefgh}	13.00 ^{bcdef} _g	13.33 ^{bcdef} _g	13.33 ^{bcdef} _g	13.33 ^{bcdefg}
27	V. Fuchs Delight x V. Bitz's Heartthrob	9.00 ^{cdefghi} _j	10.00 ^{bcdefgh}	10.00 ^{bcdef}	10.00 ^{cdefg}	11.00 ^{cdefg}	12.00 ^{bcdefgh} _i	12.00 ^{bcdefgh} _{ij}	12.00 ^{bcdefgh}	12.00 ^{cdefg} _h	12.00 ^{cdefg} _{hi}	12.00 ^{defgh}	12.00 ^{defghi}
28	V. Prapawan	12.00 ^{abcde} _{fghi}	12.00 ^{bcdefg}	12.00 ^{bcdef}	12.00 ^{bcdef} _g	12.00 ^{bcdefg}	14.00 ^{abcde}	14.00 ^{abcdefg}	14.00 ^{abcdefg}	14.00 ^{abcde}	14.00 ^{bcdef}	14.00 ^{bcdef} _g	14.00 ^{bcdefg}
29	V. Thailand Beauty	7.67 ^{efghij}	8.67 ^{defgh}	9.00 ^{cdef}	9.00 ^{defg}	10.00 ^{defg}	10.00 ^{defghi}	10.00 ^{efghij}	10.00 ^{efghij}	10.00 ^{efghi}	10.00 ^{fghij}	10.33 ^{ghij}	10.33 ^{ghij}
30	V. Dr. Anek x V. Bitz's Heartthrob	10.33 ^{bcdef} _{ghij}	11.00 ^{bcdefgh}	11.33 ^{bcdef}	11.67 ^{bcdef} _g	11.67 ^{bcdefg}	12.00 ^{bcdefgh} _i	12.00 ^{bcdefgh} _{ij}	12.00 ^{bcdefgh} _i	12.00 ^{cdefg} _h	12.00 ^{cdefg} _{hi}	12.00 ^{defgh}	12.33 ^{defgh}

4.1.2. Floral characters

4.1.2.1. Flowering characters

Data pertaining to the flowering characteristics of the thirty varieties/hybrids such as days from spike emergence to opening of first floret, 50 per cent florets, opening of 100 per cent florets, spike longevity, interval of spike production, number of spikes/ plant/ year and blooming period are presented in Tables 13 and Figures 2 and 3.

Spike emergence to opening of first floret

Duration from spike emergence to opening of first floret differed significantly (Table 13 and Fig.2). The duration was maximum in V. Urbchitr x V. Bitz's Heartthrob (31.00 days) and was significantly superior to all others. V. Apec Blue recorded the minimum duration (17.67 days), followed by V. Varuvathe Pink, V. Anek Delight and V. Thongchai (18.67 days).

Spike emergence to opening of 50 per cent florets

Marked differences were also noticed with regard to the duration for spike emergence to 50 per cent florets open (Table 13 and Fig. 2). V. Urbchitr x V. Bitz's Heartthrob took maximum number of days for opening of 50 percent florets (37.33 days), followed by V. Madame Rattana (30.67 days) which was on par with V. Pranermprai x V. *tessellata* (30.00 days), V. Lumpini Red x V. Taweewan (28.67 days), V. Taweesuksa x V. Kultana Gold x V. Green Gold (28.67 days), V. Sirilak x V. Bitz's Heartthrob (28.33 days), V. Pathum Gold (28.00 days), V. Lanka Sri pink (28.00 days), V. Red Gem (27.67 days) and V. Robert's Delight (27.67 days). V. Anek Delight recorded the minimum (20.33 days) followed by V. Varuvathe Pink (21.00 days) and V. Apec Blue (21.33 days) and were on par.

Table.13. Flowering characters of vanda varieties/ hybrids

Sl. No	Varieties/hybrids	Flowering characters						
		Days from spike emergence to			Spike longevity (days)	Interval of spike production (days)	No. of spikes produce d/year	Blooming period
		1 st floret open	50% florets open	100% florets open				
1	V. Dr. Anek	21.33 ^{ghi}	25.33 ^{defgh}	28.33 ^{defg}	27.67 ^{bcdef}	349.67 ^{abc}	1.7 ^{cde}	Feb-June
2	V. Rothchildiana	19.67 ^{ijk}	23.33 ^{ghij}	25.67 ^{fghi}	29.33 ^{bcde}	282.33 ^{abcde}	1.7 ^{cde}	Feb-Mar, July-Sept
3	V. Thongchai	18.67 ^{jk}	23.00 ^{hij}	25.67 ^{fghi}	23.00 ^{hijkl}	254.00 ^{abcdef}	1.7 ^{cde}	Mar-Apr, July-Aug, Nov-Dec
4	V. Katsuura x V. Fuchs Delight	22.00 ^{efghi}	26.00 ^{defgh}	28.67 ^{defg}	24.00 ^{ghij}	202.00 ^{cdef}	1.7 ^{cde}	Feb-May, July-Sept, Nov-Dec
5	V. Taweesuksa x V. Kultana Gold x V. Green Gold	24.67 ^{cde}	28.67 ^{bcd}	32.00 ^{bcde}	31.00 ^b	374.00 ^{ab}	1.0 ^e	Mar-Apr
6	V. Apec Blue	17.67 ^k	21.33 ^{ij}	23.67 ^{hi}	30.00 ^{bc}	224.00 ^{abcdef}	1.7 ^{cde}	Feb-Mar, July-Aug
7	V. Pakchong Blue	23.67 ^{cdefg}	26.67 ^{cdefg}	28.67 ^{dfg}	20.67 ^{klmn}	375.33 ^{ab}	1.0 ^e	July-Aug
8	V. Sirilak x V. Bitz's Heartthrob	25.33 ^c	28.33 ^{bcd}	31.00 ^{bcde}	22.33 ^{ijklm}	332.00 ^{abcd}	1.3 ^{de}	Mar-June, Sept-Nov
9	V. Pachara Delight Pink	20.67 ^{hij}	25.33 ^{defgh}	28.33 ^{defg}	26.33 ^{defgh}	241.67 ^{abcdef}	1.7 ^{cde}	Feb-Mar, June-Nov
10	V. Pakchong New Land x V. Annette Jones	21.67 ^{fghi}	27.00 ^{cdef}	31.67 ^{bcde}	27.33 ^{cdefg}	263.33 ^{abcdef}	1.7 ^{cde}	Feb-Apr, July-Nov
11	V. Fuchs Delight	21.67 ^{fghi}	25.33 ^{defgh}	28.33 ^{defg}	19.00 ^{mno}	240.00 ^{abcdef}	2.0 ^{cde}	Feb-Apr, July-Nov
12	V. Red Gem	23.33 ^{cdefg} _h	27.67 ^{bcde}	31.00 ^{bcde}	27.33 ^{cdefg}	237.00 ^{abcdef}	2.0 ^{cde}	Mar-May, Aug-Oct
13	V. Anek Delight	18.67 ^{jk}	20.33 ^j	21.67 ⁱ	15.00 ^q	373.67 ^{ab}	1.0 ^e	June-Aug
14	V. Urbchitr x V. Bitz's Heartthrob	31.00 ^a	37.33 ^a	44.00 ^a	29.67 ^{bcd}	230.33 ^{abcdef}	2.7 ^{bc}	Feb-May, July-Dec
15	V. Kasem's Delight x V. Bitz's Heartthrob	22.00 ^{efghi}	24.00 ^{fghi}	25.33 ^{ghi}	18.33 ^{nop}	113.33 ^{ef}	2.3 ^{bcd}	Apr-Aug, Dec-Jan

Flowering characters of vanda varieties/ hybrids contd...

Sl. No	Varieties/hybrids	Days from spike emergence to			Spike longevity (days)	Interval of spike production (days)	No. of spikes produced/year	Blooming period
		1 st floret open	50% florets open	100% florets open				
16	V. Pranermprai x <i>V. tessellata</i>	24.33 ^{cdef}	30.00 ^{bc}	33.33 ^{bc}	25.00 ^{fghi}	94.67 ^f	3.3 ^{ab}	Mar-May, July-Jan
17	V. Pathum Gold	22.33 ^{defgh}	28.00 ^{bcde}	32.33 ^{bcd}	28.67 ^{bcde}	108.33 ^f	3.7 ^a	Mar-Dec,
18	V. Lumpini Red	23.00 ^{cdefg} _h	26.33 ^{defgh}	29.00 ^{cdefg}	26.00 ^{efgh}	238.00 ^{abcdef}	1.7 ^{cde}	Apr-June, Sept-Nov
19	V. Kultana Delight Red	20.67 ^{hij}	26.33 ^{defgh}	31.67 ^{bcde}	24.33 ^{fghi}	228.67 ^{abcdef}	1.7 ^{cde}	Mar-May, Sept-Nov
20	V. Pompimol	25.00 ^{cd}	27.00 ^{cdef}	29.00 ^{cdefg}	24.00 ^{ghijk}	380.67 ^a	1.0 ^e	June-July
21	V. Lumpini Red x V. Taweewan	24.67 ^{cde}	28.67 ^{bcd}	34.33 ^b	29.00 ^{bcde}	306.00 ^{abcd}	1.3 ^{de}	Mar-May, Sept-Oct
22	V. Madame Rattana	28.00 ^b	30.67 ^b	32.33 ^{bc}	36.00 ^a	338.33 ^{abc}	1.3 ^{de}	Apr-June, Nov-Dec
23	V. Lanka Sri pink	24.33 ^{cdef}	28.00 ^{bcde}	31.33 ^{bcde}	22.00 ^{ijklm}	264.00 ^{abcdef}	1.7 ^{cde}	Mar-May
24	V. Varuvathe Pink	18.67 ^{jk}	21.00 ^{ij}	23.33 ^{hi}	17.33 ^{opq}	211.00 ^{abcdf}	2.0 ^{cde}	Mar-June, Nov
25	V. Robert's Delight	25.67 ^c	27.67 ^{bcde}	29.00 ^{cdefg}	16.00 ^{pq}	196.00 ^{cdef}	2.3 ^{bcd}	Mar-Apr, July, Sep-Nov-Dec
26	V. Dr. Anek x V. Mimi Palmer	23.67 ^{cdefg}	26.67 ^{cdefg}	31.67 ^{bcde}	20.33 ^{lmno}	234.00 ^{abcdef}	1.7 ^{cde}	Mar-Apr, Sept-Oct
27	V. Fuchs Delight x V. Bitz's Heartthrob	23.67 ^{cdefg}	26.33 ^{defgh}	29.00 ^{cdefg}	21.00 ^{klmn}	162.33 ^{def}	2.0 ^{ce}	Mar-Apr, Oct-Nov
28	V. Prapawan	25.00 ^{cd}	27.00 ^{cdef}	29.33 ^{cdefg}	35.00 ^a	205.00 ^{bcdef}	2.0 ^{cde}	May-June, Oct-Nov
29	V. Thailand Beauty	21.00 ^{ghij}	24.67 ^{efgh}	27.33 ^{efgh}	20.67 ^{klmn}	130.33 ^{ef}	2.0 ^{cde}	Mar-May, July-Sept, Nov-Dec
30	V. Dr. Anek x V. Bitz's Heartthrob	23.67 ^{cdefg}	27.00 ^{cdf}	30.00 ^{bcdef}	21.67 ^{ijklmn}	315.67 ^{abcd}	1.3 ^{de}	Oct-Nov

Spike emergence to opening of all florets

Significant differences were also noticed among the varieties with respect to the duration from spike emergence to opening of all florets (Table 13 and Fig. 2). V. Urbchitr x V. Bitz's Heartthrob recorded the maximum duration (44.00 days) for opening of all florets, followed by V. Lumpini Red x V. Taweewan (34.33 days), which was on par with V. Pranernprai x V. *tessellata* (33.33 days), V. Madame Rattana (32.33 days), V. Pathum Gold (32.33 days), V. Taweeksu x V. Kultana Gold x V. Green Gold (32.00 days), V. Dr. Anek x V. Mimi Palmer (31.67 days), V. Kultana Delight Red (31.67 days), V. Pakchong New Land x V. Annette Jones (31.67 days), V. Lanka Sri pink (31.33 days), V. Red Gem (31.00 days), V. Sirilak x V. Bitz's Heartthrob (31.00 days) and V. Dr. Anek x V. Bitz's Heartthrob (30.00 days). V. Anek Delight recorded the minimum duration for all florets to open (21.67 days), followed by V. Varuvathe Pink (23.33 days) and V. Apec Blue (23.67 days), which were on par.

Spike longevity

Distinguishable differences were noticed with respect to the longevity of the spike on the plant in vanda varieties/ hybrids (Table 13 and Fig. 3). Among the varieties, V. Madame Rattana recorded maximum spike longevity (36.00 days) and was on par with V. Prapawan (35.00 days) and were significantly superior to all others. It was followed by V. Taweeksu x V. Kultana Gold x V. Green Gold (31.00 days), V. Apec Blue (30.00 days), V. Urbchitr x V. Bitz's Heartthrob (29.67 days), V. Rothchildiana (29.33 days), V. Lumpini Red x V. Taweewan (29.00 days), V. Pathum Gold (28.67 days) and V. Dr. Anek (27.67 days). The minimum spike longevity was recorded in V. Anek Delight (15.00 days), followed by V. Robert's Delight (16.00 days).

Fig.2. Days taken from spike emergence to opening of florets in different vanda varieties/ hybrids

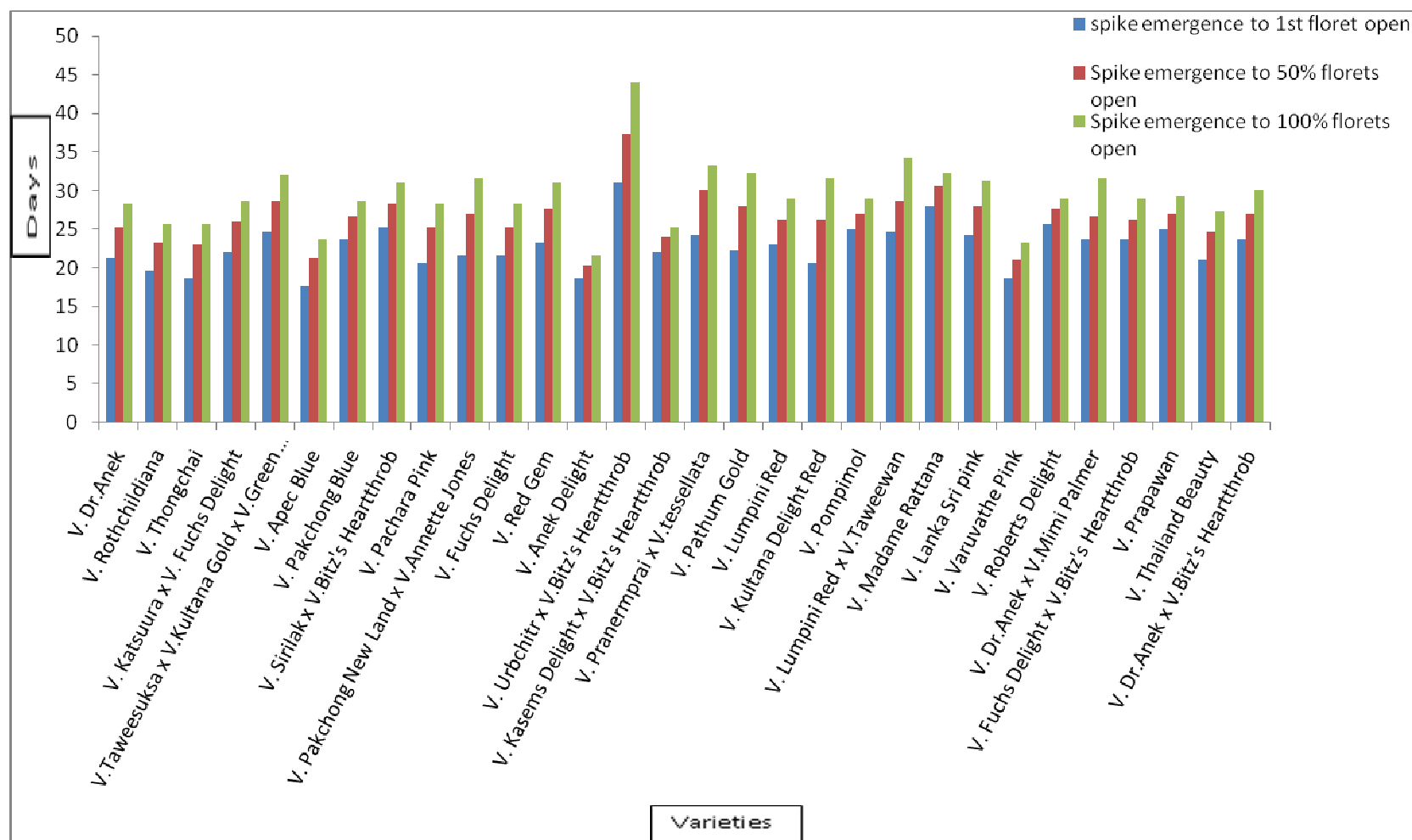
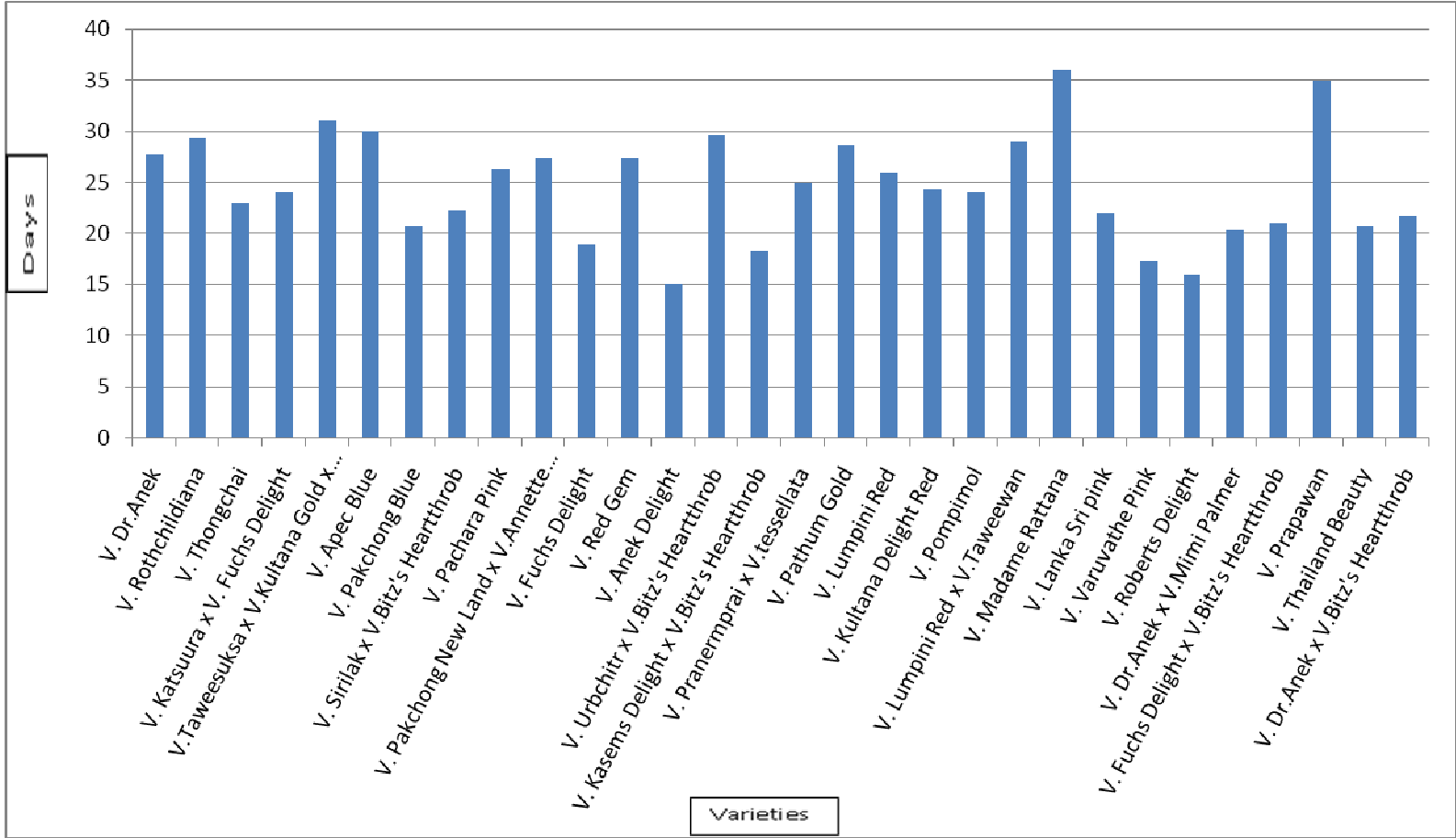


Fig.3. Spike longevity of thirty different vanda varieties/ hybrids



Interval of spike production

Significant differences were recorded in vanda orchids with respect to the interval of production of spikes (Table 13). The interval of spike production was maximum in *V. Pompimol* (380.67 days), and was statistically on par with *V. Pakchong Blue* (375.33 days), *V. Taweesuksa* x *V. Kultana Gold* x *V. Green Gold* (374.00 days), *V. Anek Delight* (373.67 days), *V. Dr. Anek* (349.67 days), *V. Madame Rattana* (338.33 days), *V. Sirilak* x *V. Bitz's Heartthrob* (332.00 days), *V. Dr. Anek* x *V. Bitz's Heartthrob* (315.67 days), and *V. Lumpini Red* x *V. Taweewan* (306.00 days). Spike production interval was observed minimum in *V. Pranermprai* x *V. tessellata* (94.67 days) on par with *V. Pathum Gold* (108.33 days) followed by *V. Kasem's Delight* x *V. Bitz's Heartthrob* (113.33 days) and *V. Thailand Beauty* (130.33 days).

Number of spikes produced per year

Considerable variation was observed with respect to the number of spikes produced per year (Table 13). *V. Pathum Gold* produced maximum number of spikes (3.7) and was on par with *V. Pranermprai* x *V. tessellata* (3.3) and significantly superior to all others. It was followed by *V. Urbchitr* x *V. Bitz's Heartthrob* (2.7), *V. Kasem's Delight* x *V. Bitz's Heartthrob* (2.3) and *V. Robert's Delight* (2.3). The number of spikes produced per year was minimum in *V. Pompimol*, *V. Anek Delight*, *V. Pakchong Blue* and *V. Taweesuksa* x *Kultana Gold* x *Green Gold* (1.0 each).

Blooming period/ season

The vanda varieties/ hybrids exhibited considerable variation with regard to the blooming season. Most of the varieties were seasonal, except *V. Pathum Gold*. In this variety short dearth period was observed in Jan-Feb.

Among the vanda varieties/ hybrids evaluated, single flowering season was observed in *V. Dr. Anek* (Feb-June), *V. Taweesuksa* x *V. Kultana Gold* x *V. Green Gold* (Mar-Apr), *V. Pakchong Blue* (July-Aug), *V. Anek Delight* (June-Aug), *V. Pompimol* (June-July), *V. Lanka Sri pink* (Mar-May) and *V. Dr. Anek* x *V. Bitz's Heartthrob* (Oct-Nov).

Three flowering seasons were noticed in *V. Thailand Beauty* (Mar-May, July-Sep, Nov-Dec), *V. Thongchai* (Mar-Apr, July-Aug, Nov-Dec), *V. Katsuura* x *V. Fuchs Delight* (Feb-May, July-Sep, Nov-Dec) and *V. Robert's Delight* (Mar-May, July-Sep, Nov-Dec). All the others flowered twice a year. Majority had peak flowering during Feb-June, i.e., during dry season and early rainy season.

4.1.2.2. Spike characters

Data pertaining to the spike characters of different vanda varieties/ hybrids are presented in Table 14.

Spike length

Vanda varieties/ hybrids differed significantly with respect to spike length (Table 14). *V. Dr. Anek* x *V. Mimi Palmer* recorded the maximum (35.67 cm), followed by *V. Kultana Delight Red* (33.87 cm) and *V. Lumpini Red* x *V. Taweewan* (33.77 cm) and were significantly superior to all others and statistically on par with *V. Dr. Anek* x *V. Bitz's Heartthrob* (32.10 cm), *V. Urbchitr* x *V. Bitz's Heartthrob* (31.87 cm), *V. Fuchs Delight* x *V. Bitz's Heartthrob* (31.40 cm), *V. Anek Delight* (31.20 cm), *V. Thailand Beauty* (31.0 cm) and *V. Kasem's Delight* x *V. Bitz's Heartthrob* (30.23 cm). *V. Pachara Delight Pink* recorded minimum spike length (8.23 cm), followed by *V. Varuvathe Pink* (12.67 cm).

Rachis length

The vanda varieties/ hybrids showed distinct variation with regard to rachis length (Table 14). Among the varieties, *V. Thailand Beauty* recorded the maximum rachis length (21.83 cm) and was significantly superior to all others. It was followed

Table 14. Spike characters of vanda varieties/ hybrids

Sl. No	Varieties/hybrids	Spike characters							
		Spike length	Rachis length	Stalk length/ peduncle length (cm)	Girth of spike (cm)	No. of spikes/ plant at a time	Spike orientation	Spike colour	Nature of spike
1	V. Dr. Anek	18.27 ^{ijkl}	8.50 ^{ijk}	9.77 ^{efgh}	1.87 ^{efghi}	1	Erect	green	Lax
2	V. Rothchildiana	26.60 ^{bcde}	14.50 ^{bcd}	12.10 ^{cdef}	2.07 ^{def}	1	erect	green	Lax
3	V. Thongchai	18.73 ^{hijkl}	11.50 ^{defghi}	7.23 ^{gh}	1.70 ^{hij}	1	erect	green	Lax
4	V. Katsuura x V. Fuchs Delight	13.50 ^{klm}	6.10 ^k	7.40 ^{gh}	1.87 ^{efghi}	1	erect	green	Lax
5	V. Taweesuksa x V. Kultana Gold x V. Green Gold	18.57 ^{ijkl}	8.77 ^{hijk}	9.80 ^{efgh}	2.00 ^{defg}	1	erect	green	Lax
6	V. Apec Blue	21.57 ^{ghij}	7.17 ^{jk}	14.40 ^{cd}	1.90 ^{efgh}	1	erect	green	Lax
7	V. Pakchong Blue	14.47 ^{kl}	8.00 ^{ijk}	6.47 ^h	2.00 ^{defg}	1	erect	green	Lax
8	V. Sirilak x V. Bitz's Heartthrob	22.17 ^{ghij}	10.50 ^{efghij}	11.67 ^{def}	1.90 ^{efgh}	1	erect	green	Lax
9	V. Pachara Delight Pink	8.23 ^m	6.77 ^k	1.46 ^l	1.50 ^{ijkl}	1	erect	green	Lax
10	V. Pakchong New Land x V. Annette Jones	24.77 ^{defgh} _{ij}	14.60 ^{bcd}	10.17 ^{defg}	2.43 ^{ab}	1	erect	green	Lax
11	V. Fuchs Delight	19.60 ^{ghijk}	7.43 ^{jk}	12.17 ^{cdef}	2.10 ^{cde}	1	erect	green	Lax
12	V. Red Gem	25.37 ^{bcdef} _{ghi}	15.00 ^{bc}	10.37 ^{defg}	1.37 ^{kl}	1	erect	green	Lax
13	V. Anek Delight	31.20 ^{abcd}	13.10 ^{cde}	18.10 ^b	1.83 ^{efghi}	1	erect	green	Lax
14	V. Urbchitr x V. Bitz's Heartthrob	31.87 ^{abc}	15.33 ^{bc}	16.54 ^{bcd}	2.50 ^a	1	horizontall y arched	green	Lax
15	V. Kasem's Delight x V. Bitz's Heartthrob	30.23 ^{abcd} _e	12.50 ^{cdef}	17.73 ^{bc}	1.93 ^{efgh}	1	erect	green	Lax
16	V. Pranermprai x V. tessellata	22.77 ^{ghij}	8.33 ^{ijk}	14.44 ^{cd}	1.97 ^{defgh}	2	erect	green	Lax

Spike characters of vanda varieties/ hybrids contd...

Sl. No	Varieties/hybrids	Spike length	Rachis length	Stalk length/ peduncle length (cm)	Girth of spike (cm)	No. of spikes/ plant at a time	Spike orientation	Spike colour	Nature of spike
17	V. Pathum Gold	25.87 ^{bcdefg}	12.17 ^{cdefgh}	13.70 ^{cde}	1.73 ^{ghij}	1	erect	green	Lax
18	V. Lumpini Red	24.33 ^{efghij}	9.03 ^{ghijk}	15.30 ^{bcde}	2.23 ^{bcd}	1	erect	green	lax
19	V. Kultana Delight Red	33.87 ^a	16.67 ^b	17.20 ^{bc}	1.87 ^{efghi}	1	erect	green	Lax
20	V. Pompimol	26.00 ^{bcdefg}	7.83 ^{jk}	18.17 ^b	1.97 ^{defgh}	1	erect	green	Lax
21	V. Lumpini Red x V. Taweewan	33.77 ^a	17.00 ^b	16.77 ^{bcd}	2.23 ^{abc}	1	erect	green	Lax
22	V. Madame Rattana	25.50 ^{bcdefgh}	17.00 ^b	8.50 ^{fghi}	1.60 ^{ijk}	1	erect	green	Lax
23	V. Lanka Sri pink	19.73 ^{ghijk}	6.17 ^k	13.56 ^{cde}	1.97 ^{defgh}	1	erect	green	Lax
24	V. Varuvathe Pink	12.67 ^{lm}	1.63 ^l	11.04 ^{def}	1.30 ^l	1	erect	green	Lax
25	V. Robert's Delight	22.33 ^{fghij}	8.00 ^{ijk}	14.33 ^{cd}	2.03 ^{def}	1	erect	green	Lax
26	V. Dr. Anek x V. Mimi Palmer	35.67 ^a	12.40 ^{cdefg}	23.27 ^a	1.60 ^{ijk}	1	erect	green	Lax
27	V. Fuchs Delight x V. Bitz's Heartthrob	31.40 ^{abcd}	10.50 ^{efghi} j	20.90 ^{ab}	1.83 ^{efghi}	1	erect	green	Lax
28	V. Prapawan	25.17 ^{cdefghi}	13.97 ^{bcd}	11.20 ^{def}	2.03 ^{def}	1	erect	green	Lax
29	V. Thailand Beauty	31.00 ^{abcde}	21.83 ^a	9.17 ^{efgh}	2.00 ^{defg}	1	erect	green	Lax
30	V. Dr. Anek x V. Bitz's Heartthrob	32.10 ^{ab}	9.43 ^{fghijk}	22.67 ^a	1.80 ^{fghi}	1	erect	green	Lax

by V. Lumpini Red x V. Taweewan (17.00 cm), V. Madame Rattana (17.00 cm), V. Kultana Delight Red (16.67 cm), V. Urbchitr x V. Bitz's Heartthrob (15.33 cm), V. Red Gem (15.00 cm), V. Pakchong New Land x V. Annette Jones (14.60 cm), V. Rothchildiana (14.50 cm) and V. Prapawan (13.97 cm). Rachis length was minimum in V. Varuvathe Pink (1.63 cm) followed by V. Katsuura x V. Fuchs Delight (6.10 cm), V. Lanka Sri pink (6.17 cm), and V. Pachara Delight Pink (6.77 cm).

Stalk length/ peduncle length

Considerable variation was observed in stalk length of the selected vanda varieties/ hybrids (Table 14). The stalk length was maximum in V. Dr. Anek x V. Mimi Palmer (23.27 cm), which was on par with V. Dr. Anek x V. Bitz's Heartthrob (22.67 cm) and V. Fuchs Delight x V. Bitz's Heartthrob (20.90 cm). Whereas the minimum stalk length was recorded in V. Pachara Delight Pink (1.46 cm), followed by V. Pakchong Blue (6.47 cm).

Girth of spike at base

There were detectable variation in girth of spikes among the varieties/ hybrids (Table 14). V. Urbchitr x V. Bitz's Heartthrob had the maximum spike girth (2.50 cm) and was on par with V. Pakchong New Land x V. Annette Jones (2.43 cm), V. Lumpini Red x V. Taweewan and V. Lumpini Red (2.23 cm each). The minimum spike girth (1.30 cm) was observed in V. Varuvathe Pink, followed by V. Red Gem (1.37 cm).

4.1.2.3. Flower characters

Data pertaining to different floral characters of vanda varieties/ hybrids like number of florets/ spike, internodal length of spike, pedicel length, flower size, individual floret life, lip length and width, column length, spur type and length are presented in Table 15 and Fig. 4 and 5.

Number of florets per spike

Significant differences could be noticed with regard to the number of florets per spike in vanda varieties/ hybrids (Table 15 and Fig. 4). Maximum number of florets was noticed in V. Thailand Beauty (23.33) and was significantly superior to all others. It was followed by V. Red Gem (17.00) followed by V. Lumpini Red x V. Taweewan and V. Pathum Gold (10.67 each) which were on par with V. Kultana Delight Red and V. Madame Rattana (10.00 each). Minimum number of florets (3.00) was recorded in V. Varuvathe Pink followed by V. Fuchs Delight (4.33) and V. Pachara Delight Pink (5.00).

Internodal length (between florets at the base)

Internodal length between florets differed significantly (Table 15) and was maximum in V. Prapawan (2.40 cm) and was on par with V. Anek Delight (2.07 cm) and V. Taweeksa x V. Kultana Gold x V. Green Gold (1.17 cm) followed by V. Lumpini Red (1.97 cm), V. Pompimol (1.90 cm), V. Urbchitr x V. Bitz's Heartthrob (1.70 cm) and V. Rothchildiana (1.70 cm). The minimum internodal length (0.63 cm) was observed in V. Red Gem followed by V. Lanka Sri pink (0.77 cm).

Pedicle length/ Length of flower stalk

Flower stalk length showed considerable differences among the varieties/ hybrids of vanda (Table 15). V. Dr. Anek x V. Bitz's Heartthrob had the maximum (7.03 cm) pedicle length and was on par with V. Pompimol (7.00 cm), V. Kultana Delight Red (6.60 cm), V. Pakchong New Land x V. Annette Jones (6.57 cm), V. Pakchong New Land x V. Annette Jones (6.57 cm), V. Madame Rattana (6.53 cm), V. Pranermprai x V. *tessellata* (6.50 cm) and V. Prapawan (6.47 cm). V. Red Gem and V. Thailand Beauty recorded the minimum pedicle length (3.57 cm), followed by V. Apec Blue (4.30 cm).

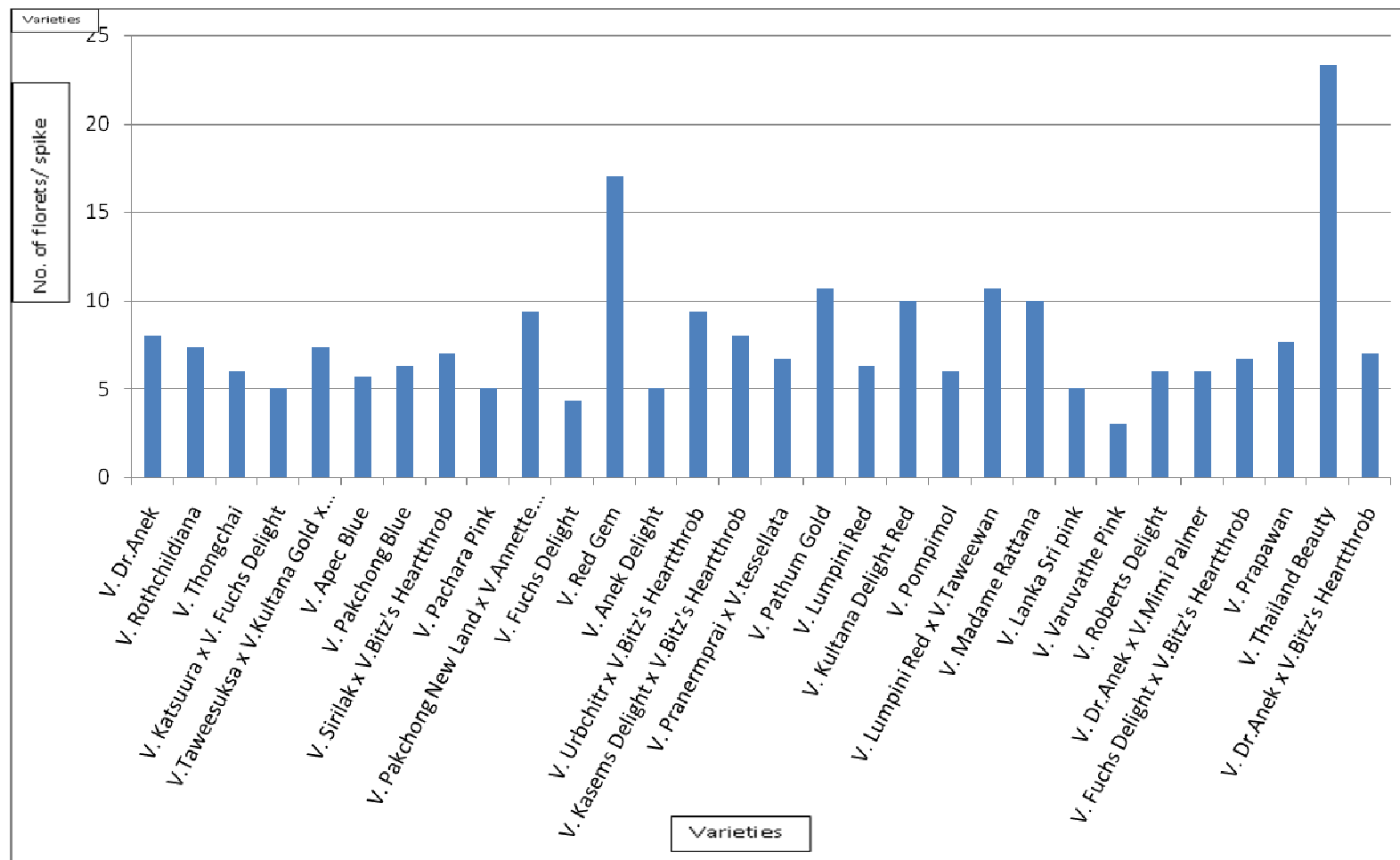
Table.15. Floral characters of vanda varieties/ hybrids

Sl. No.	Varieties/hybrids	Florets/s pike (no.)	Internodal length (cm)	Flower stalk length (cm)	Flower size		Floret life (days)	Lip length (cm)	Lip width (cm)	Column length (cm)	Spur type	Spur length
					L x W (cmxcm)	Area (cm ²)						
1	V. Dr. Anek	8.00 ^{cdef}	0.97 ^{fgh}	6.17 ^{cdef}	9.10 x 8.60	78.26 ^{cde}	6.00 ^{hi}	2.00 ^{bcd}	1.73 ^{cde}	0.73 ^{abc}	conical	Long
2	V. Rothchildiana	7.33 ^{cdef}	1.70 ^{bcd}	6.27 ^{cdef}	9.00 x 9.50	85.50 ^{cde}	8.00 ^{defghi}	1.97 ^{bcde}	2.07 ^b	0.40 ^{fg}	conical	Long
3	V. Thongchai	6.00 ^{efg}	1.13 ^{efg}	5.93 ^{defg}	8.60x 9.10	78.26 ^{cde}	6.67 ^{ghi}	1.83 ^{defgh}	2.03 ^b	0.43 ^{fg}	Conical	Short
4	V. Katsuura x V. Fuchs Delight	5.00 ^{fg}	1.00 ^{fgh}	5.07 ^{ij}	8.20 x 8.60	70.52 ^{cde}	18.33 ^a	1.57 ^{fghi}	0.87 ^{klmn}	0.60 ^{cde}	Saccate	Medium
5	V. Taweesuksa x V. Kultana Gold x V. Green Gold	7.33 ^{cdef}	1.17 ^{efg}	5.93 ^{defg}	8.30 x 7.90	65.57 ^{dfe}	6.33 ^{hi}	1.53 ^{ghi}	0.93 ^{klm}	0.60 ^{cde}	conical	Very short
6	V. Apec Blue	5.67 ^{efg}	0.97 ^{fgh}	4.30 ^k	7.40 x 7.90	58.46 ^{dfe}	9.67 ^{def}	2.20 ^{abcd}	0.83 ^{klmno}	0.40 ^{fg}	Conical	Medium
7	V. Pakchong Blue	6.33 ^{defg}	1.07 ^{efgh}	6.13 ^{cdef}	7.40 x 7.00	51.80 ^{efg}	7.33 ^{efghi}	1.97 ^{bcde}	0.90 ^{klm}	0.60 ^{cde}	Conical	Medium
8	V. Sirilak x V. Bitz's Heartthrob	7.00 ^{cdef}	1.20 ^{efg}	6.43 ^{bcd}	10.50 x 10.30	108.15 ^c	8.33 ^{defgh}	1.93 ^{cdef}	1.27 ^{gh}	0.67 ^{bcd}	Conical	Short
9	V. Pachara Delight Pink	5.00 ^{fg}	1.37 ^{def}	4.60 ^{jk}	6.50 x 7.10	46.15 ^{fgh}	10.33 ^{cd}	1.60 ^{efghi}	1.17 ^{ghij}	0.43 ^{fg}	Conical	Medium
10	V. Pakchong New Land x V. Annette Jones	9.33 ^{cde}	1.43 ^{def}	6.57 ^{abc}	11.00 x 10.30	113.30 ^c	5.00 ⁱ	2.00 ^{bcd}	1.70 ^{de}	0.63 ^{bcde}	Conical	Medium
11	V. Fuchs Delight	4.33 ^{fg}	1.30 ^{def}	5.20 ^{hi}	8.40 x 8.70	73.08 ^{cde}	6.67 ^{ghi}	1.93 ^{cdef}	1.40 ^{fg}	0.63 ^{bcde}	Conical	Medium
12	V. Red Gem	17.00 ^b	0.63 ^h	3.57 ⁱ	4.20 x 4.00	16.80 ^k	6.00 ^{hi}	1.03 ^j	0.60 ^o	0.37 ^g	Conical	Medium
13	V. Anek Delight	5.00 ^{fg}	2.07 ^{ab}	5.07 ^{ij}	10.90 x 10.20	111.18 ^c	6.67 ^{ghi}	1.83 ^{defgh}	1.07 ^{hijk}	0.50 ^{efg}	Conical	Medium
14	V. Urbchitr x V. Bitz's Heartthrob	9.33 ^{cde}	1.70 ^{bcd}	6.37 ^{cde}	11.20 x 10.80	120.96 ^b	12.67 ^{bc}	1.83 ^{defgh}	1.97 ^{bc}	0.73 ^{abc}	Conical	Short
15	V. Kasem's Delight x V. Bitz's Heartthrob	8.00 ^{cdef}	2.00 ^{ab}	6.17 ^{cdef}	12.00 x 10.90	130.80 ^a	9.33 ^{defg}	2.03 ^{bcd}	2.07 ^b	0.67 ^{bcd}	Conical	Medium
16	V. Pranermprai x V. tessellata	6.67 ^{defg}	1.30 ^{def}	6.50 ^{abcd}	7.60 x 7.30	55.48 ^{efg}	10.00 ^{cde}	1.60 ^{efghi}	1.00 ^{ijkl}	0.73 ^{abc}	Conical	Medium
17	V. Pathum Gold	10.67 ^c	1.20 ^{efg}	5.93 ^{defg}	7.40 x 7.60	56.24 ^{def}	7.67 ^{defghi}	1.40 ⁱ	1.40 ^{fg}	0.77 ^{ab}	Conical	Medium
18	V. Lumpini Red	6.33 ^{defg}	1.97 ^b	5.80 ^{efg}	8.00 x 8.40	67.20 ^{cdef}	7.67 ^{defghi}	1.83 ^{defgh}	1.40 ^{fg}	0.60 ^{cde}	Conical	Medium
19	V. Kultana Delight Red	10.00 ^{cd}	0.20 ^j	6.60 ^{abc}	3.90 x 9.20	35.88 ^{ghi}	6.00 ^{hi}	1.57 ^{fghi}	1.43 ^{fg}	0.77 ^{ab}	Conical	Medium

Floral characters of vanda varieties/ hybrids contd...

Sl. No.	Varieties/hybrids	Florets /spike (no.)	Internodal length (cm)	Flower stalk length (cm)	Flower size		Floret life (days)	Lip length (cm)	Lip width (cm)	Column length (cm)	Spur type	Spur length
					L x W (cmxcm)	Area (cm ²)						
20	V. Pompimol	6.00 ^{efg}	1.90 ^{bc}	7.00 ^{ab}	11.70 x 11.80	138.06 ^a	6.00 ^{hi}	2.40 ^a	1.87 ^{bcd}	0.50 ^{efg}	Conical	Medium
21	V. Lumpini Red x V. Taweewan	10.67 ^c	1.53 ^{cde}	6.40 ^{cd}	7.30 x 7.10	51.83 ^{efg}	7.00 ^{fghi}	1.53 ^{ghi}	0.80 ^{lmno}	0.53 ^{def}	Conical	Medium
22	V. Madame Rattana	10.00 ^{cd}	1.50 ^{cde}	6.53 ^{abcd}	9.20 x 8.90	81.88 ^{cde}	6.00 ^{hi}	1.90 ^{cdefg}	1.37 ^{fg}	0.70 ^{bc}	Conical	Medium
23	V. Lanka Sri pink	5.00 ^{fg}	0.77 ^{gh}	5.47 ^{ghi}	9.80 x 9.60	94.08 ^{cd}	8.00 ^{defghi}	1.97 ^{bcde}	1.27 ^{gh}	0.63 ^{bcde}	Conical	Medium
24	V. Varuvathe Pink	3.00 ^g	1.00 ^{fgh}	5.07 ^{ij}	7.20 x 6.90	49.68 ^{fgh}	13.67 ^b	1.47 ^{hi}	0.63 ^{no}	0.50 ^{efg}	conical	Medium
25	V. Robert's Delight	6.00 ^{efg}	1.30 ^{def}	5.50 ^{ghi}	8.20 x 8.20	67.24 ^{def}	5.33 ^{hi}	2.00 ^{bcd}	1.20 ^{ghi}	0.60 ^{cde}	Cylindrical	Medium
26	V.Dr. Anek x V. Mimi Palmer	6.00 ^{efg}	1.20 ^{efg}	5.93 ^{defg}	7.60 x 7.60	57.76 ^{efg}	6.00 ^{hi}	2.20 ^{abcd}	1.17 ^{ghij}	0.87 ^a	Conical	Medium
27	V. Fuchs Delight x V. Bitz's Heartthrob	6.67 ^{defg}	1.23 ^{ef}	5.70 ^{fgh}	8.80 x 8.60	75.68 ^{def}	7.00 ^{fghi}	2.33 ^{ab}	2.10 ^b	0.67 ^{bcd}	Conical	Medium
28	V. Prapawan	7.67 ^{cdef}	2.40 ^a	6.47 ^{abcd}	9.00 x 8.60	77.40 ^{def}	6.67 ^{ghi}	1.97 ^{bcde}	0.73 ^{mno}	0.53 ^{def}	Conical	Long
29	V. Thailand Beauty	23.33 ^a	1.33 ^{def}	3.57 ^l	4.40 x 4.70	20.68 ^{hij}	12.67 ^{bc}	2.13 ^{abcd}	1.57 ^{ef}	0.43 ^{fg}	Conical	Medium
30	V. Dr. Anek x V. Bitz's Heartthrob	7.00 ^{cdef}	1.43 ^{def}	7.03 ^a	9.90 x 9.80	97.02 ^{cd}	6.33 ^{hi}	2.23 ^{abc}	2.40 ^a	0.77 ^{ab}	conical	Medium

Fig.4. Number of florets per spike in different vanda varieties/ hybrids



Flower size

Distinguishable differences were noticed in vanda varieties/ hybrids with regard to the flower size (Table 15 and Fig. 5). The maximum flower size was recorded in *V. Pompimol* (138.06 cm²), followed by *V. Kasem's Delight* x *V. Bitz's Heartthrob* (130.80 cm²) and were significantly superior to all others. This was followed by *V. Urbchitr* x *V. Bitz's Heartthrob* (120.96 cm²), *V. Pakchong New Land* x *V. Annette Jones* (113.30 cm²), *V. Anek Delight* and *V. Sirilak* x *V. Bitz's Heartthrob* (108.15 cm²). Size of the flower was minimum in *V. Red Gem* (16.80 cm²) and was on par with *V. Thailand Beauty* (20.68 cm²), followed by *V. Kultana Delight Red* (35.88 cm²).

Individual flower life

Appreciable differences were noticed with respect to flower life within varieties (Table 15). *V. Katsuura* x *V. Fuchs Delight* recorded the maximum floret life (18.33 days) and was significantly superior to all others. This was followed by *V. Varuvathe Pink* (13.67 days) and was on par with *V. Thailand Beauty* (12.67 days) and *V. Urbchitr* x *V. Bitz's Heartthrob* (12.67 days), followed by *V. Pranermprai* x *V. tessellata* (10.00 days). Floret life was the minimum in *V. Pakchong New Land* x *V. Annette Jones* (5.00 days) followed by *V. Robert's Delight* (5.33 days) and *Dr. Anek* (6.00 days).

Length of labellum (lip)

Appreciable differences were found in the length of labellum of the vanda varieties (Table 15). Lip length was maximum in *V. Pompimol* (2.40 cm) and was on par with *V. Fuchs Delight* x *V. Bitz's Heartthrob* (2.33 cm), *V. Dr. Anek* x *V. Bitz's Heartthrob* (2.23 cm), *V. Apec Blue* (2.20 cm), *V. Dr. Anek* x *V. Mimi Palmer* (2.20 cm) and *V. Thailand Beauty* (2.13 cm). *V. Red Gem* recorded the minimum lip length (1.03 cm), followed by *V. Pathum Gold* (1.40 cm).

Fig.5. Flower size in different vanda varieties/ hybrids

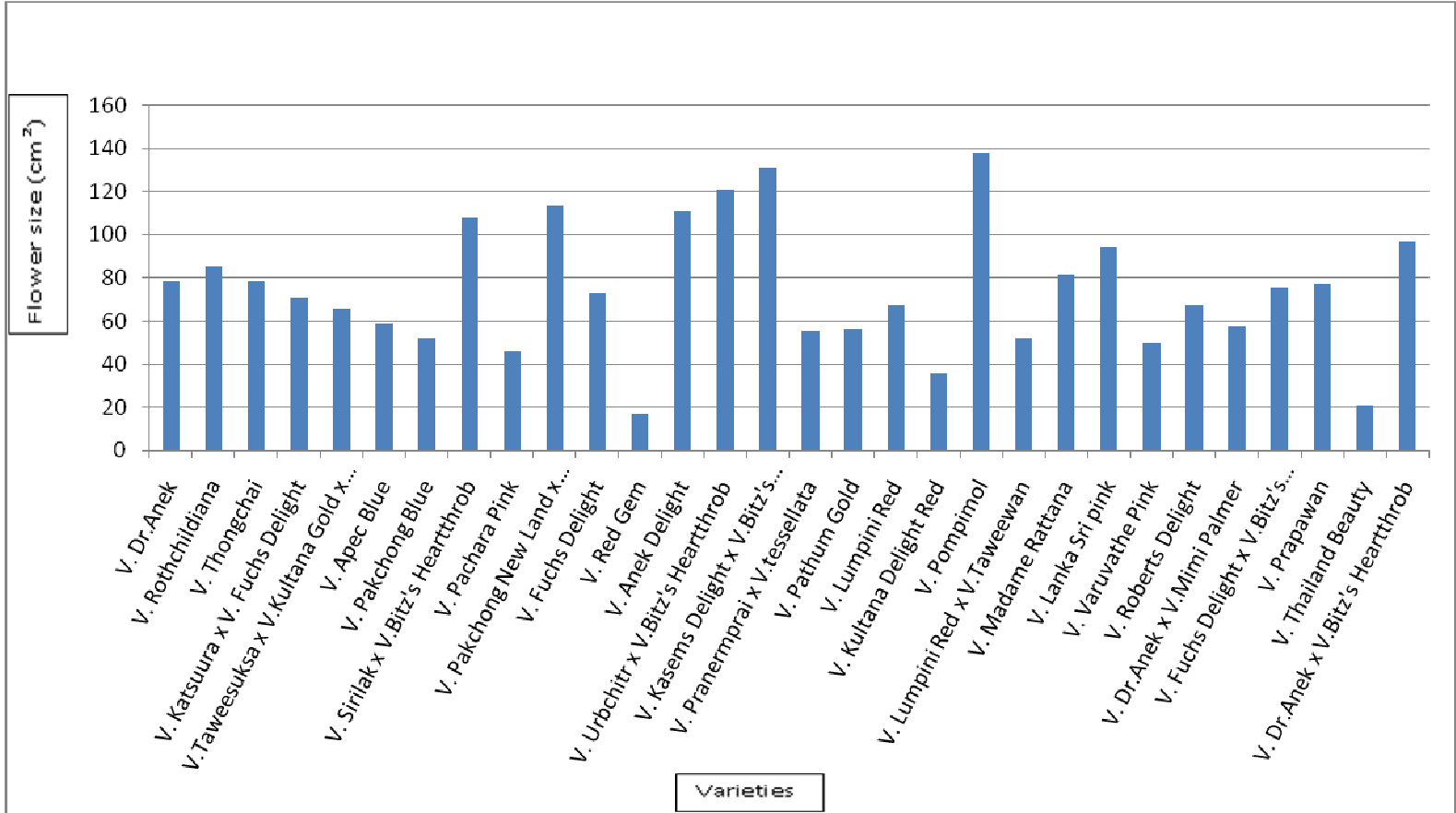


Table.16. Qualitative characters of flower/ petal of vanda varieties/ hybrids

Sl. No.	Varieties/hybrids	Orientation of flowers	Petal shape	Petal curvature	Petal apex	Petal margin	Petal colour	Petal colour pattern	Flower predominant colour	Flower fragrance
1	V. Dr. Anek	Facing in all directions	obovate	Deflexed with incurved apex	truncate	undulate	double	blotched	pinkish purple	Absent
2	V. Rothchildiana	Facing in all directions	obovate	Deflexed with incurved apex	truncate	undulate	double	blotched	violet	Absent
3	V. Thongchai	Facing in all directions	oblong	Incurved with deflexed apex	obtuse	undulate	double	spotted	purple	Absent
4	V. Katsuura x V. Fuchs Delight	Facing in all directions	obovate	Deflexed with incurved apex	obtuse	undulate	single	slightly tessellated	violet	Absent
5	V. Taweesuksa x V. Kultana Gold x V. Green Gold	Facing in all directions	elliptic	Incurved with deflexed apex	obtuse	undulate	triple	tessellated	pink	Absent
6	V. Apec Blue	Facing in all directions	obovate	straight	obtuse	entire	single	uniform	violet	Absent
7	V. Pakchong Blue	Facing in all directions	obovate	Deflexed with incurved apex	obtuse	undulate	single	uniform	purple	Absent
8	V. Sirilak x V. Bitz's Heartthrob	Facing in all directions	oblong	Incurved with deflexed apex	obtuse	entire	double	spotted	purple	Absent
9	V. Pachara Delight Pink	Facing in all directions	obovate	straight	obtuse	entire	double	tessellated	pink-purple	absent
10	V. Pakchong New Land x V. Annette Jones	Facing in all directions	obovate	Deflexed with incurved apex	truncate	undulate	double	tessellated, spotted	lilac-violet	Absent
11	V. Fuchs Delight	Facing in all directions	obovate	Incurved with incurved apex	truncate	undulate	double	spotted	purple	Absent
12	V. Red Gem	Facing in all directions	obovate	Incurved with deflexed apex	obtuse	entire	single	spotted	purple	Absent
13	V. Anek Delight	Facing in all directions	obovate	Incurved with deflexed apex	obtuse	entire	double	tessellated	violet	Absent
14	V. Urbchitr x V. Bitz's Heartthrob	Facing in all directions	oblong	Incurved with deflexed apex	obtuse	undulate	double	spotted	wine red	Absent
15	V. Kasem's Delight x V. Bitz's Heartthrob	Facing in all directions	obovate	Incurved with deflexed apex	obtuse	undulate	triple	spotted, tessellated	violet	Absent
16	V. Pranermprai x V. tessellata	Facing in all directions	obovate	straight	obtuse	entire	single	tessellated	yellow	Present

Qualitative characters of flower/ petal of vanda varieties/ hybrids contd...

Sl. No.	Varieties/hybrids	Orientation of flowers	Petal shape	Petal curvature	Petal apex	Petal margin	Petal colour	Petal colour pattern	Flower predominant colour	Flower fragrance
17	V. Pathum Gold	Facing in all directions	obovate	Incurved with deflexed apex	obtuse	entire	double	spotted	yellow	Absent
18	V. Lumpini Red	Facing in all directions	obovate	Incurved with deflexed apex	obtuse	undulate	double	spotted	purple	Absent
19	V. Kultana Delight Red	Facing in all directions	obovate	Incurved with deflexed apex	obtuse	undulate	double	spotted	purple	Absent
20	V. Pompimol	Facing in all directions	obovate	Incurved with deflexed apex	obtuse	undulate	double	spotted, tessellated	violet	Absent
21	V. Lumpini Red x V. Taweewan	Facing in all directions	oblong	Deflexed with incurved apex	obtuse	undulate	double	spotted	violet	Absent
22	V. Madame Rattana	Facing in all directions	obovate	Incurved with deflexed apex	obtuse	undulate	double	spotted, tessellated	violet	Absent
23	V. Lanka Sri pink	Facing in all directions	obovate	Incurved with deflexed apex	obtuse	undulate	single	uniform	purple	Absent
24	V. Varuvathe Pink	Facing in all directions	obovate	straight	Obtuse	entire	double	spotted	orange	Absent
25	V. Robert's Delight	Facing in all directions	obovate	Incurved with deflexed apex	obtuse	undulate	single	uniform	purple	Absent
26	V. Dr. Anek x V. Mimi Palmer	Facing in all directions	obovate	straight	obtuse	Undulate	Double	spotted	Violet	Absent
27	V. Fuchs Delight x V. Bitz's Heartthrob	Facing in all directions	obovate	straight	obtuse	undulate	double	spotted	purple	Absent
28	V. Prapawan	Facing in all directions	obovate	straight	obtuse	Slightly undulate	Single	tessellated	violet	Absent
29	V. Thailand Beauty	Facing in all directions	obovate	Incurved with deflexed apex	obtuse	undulate	double	tessellated	Lilac-violet	Absent
30	V. Dr. Anek x V. Bitz's Heartthrob	Facing in all directions	obovate	Incurved with deflexed apex	obtuse	undulate	single	blotched	purple	Absent

Table.17. Qualitative characters of lip and column of flowers of vanda varieties/ hybrids

Sl. No	Varieties/hybrids	Lip mid-lobe shape	Lip lateral-lobe	Lip curvature	Lip apex	Lip surface	Lip colour	Lip colour pattern	Column colour pattern
1	V. Dr. Anek	lanceolate	orbicular	Incurved with incurved apex	bilobed	glabrous	double	streaked	streaked
2	V. Rothchildiana	orbicular	ovate	Deflexed with incurved apex	bilobed	glabrous	double	uniform	blotched
3	V. Thongchai	lanceolate	ovate	Deflexed with deflexed apex	bilobed	glabrous	single	uniform	blotched
4	V. Katsuura x V. Fuchs Delight	lanceolate	orbicular	Deflexed with straight apex	bilobed	glabrous	double	uniform	blotched
5	V. Taweesuksa x V. Kultana Gold x V. Green Gold	lanceolate	orbicular	straight	bilobed	glabrous	double	uniform	streaked
6	V. Apec Blue	lanceolate	lanceolate	Deflexed with incurved apex	bilobed	glabrous	double	streaked	Blotched
7	V. Pakchong Blue	lanceolate	orbicular	straight	bilobed	glabrous	double	uniform	Blotched
8	V. Sirilak x V. Bitz's Heartthrob	lanceolate	orbicular	Deflexed with incurved apex	acute	glabrous	single	uniform	Uniform
9	V. Pachara Delight Pink	lanceolate	orbicular	straight	obtuse	glabrous	double	streaked	Blotched
10	V. Pakchong New Land x V. Annette Jones	orbicular	ovate	Deflexed with incurved apex	bilobed	glabrous	double	uniform	Blotched
11	V. Fuchs Delight	lanceolate	orbicular	Deflexed with incurved apex	bilobed	glabrous	double	uniform	Spotted
12	V. Red Gem	lanceolate	lanceolate	Deflexed with straight apex	truncate	glabrous	single	uniform	Spotted
13	V. Anek Delight	lanceolate	orbicular	straight	bilobed	glabrous	double	uniform	Uniform
14	V. Urbchitr x V. Bitz's Heartthrob	orbicular	orbicular	Deflexed with incurved apex	Slightly bilobed	glabrous	double	uniform	Uniform
15	V. Kasem's Delight x V. Bitz's Heartthrob	orbicular	orbicular	Deflexed with incurved apex	bilobed	glabrous	double	uniform	Streaked
16	V. Pranermprai x V. <i>tessellata</i>	lanceolate	ovate	straight	bilobed	glabrous	Double	uniform	Spotted
17	V. Pathum Gold	orbicular	ovate	Deflexed with incurved apex	bilobed	glabrous	triple	spotted	Uniform
18	V. Lumpini Red	lanceolate	orbicular	Deflexed with incurved apex	bilobed	glabrous	double	uniform	Blotched
19	V. Kultana Delight Red	lanceolate	orbicular	Deflexed with straight apex	bilobed	glabrous	single	uniform	Blotched
20	V. Pompimol	ovate	ovate	Incurved with incurved apex	bilobed	glabrous	single	uniform	Spotted
21	V. Lumpini Red x V. Taweewan	lanceolate	orbicular	Deflexed with straight apex	bilobed	glabrous	double	uniform	Blotched
22	V. Madame Rattana	lanceolate	orbicular	Deflexed with straight apex	truncate	glabrous	single	uniform	Streaked
23	V. Lanka Sri pink	lanceolate	orbicular	Deflexed with incurved apex	bilobed	glabrous	single	uniform	Streaked
24	V. Varuvathe Pink	lanceolate	ovate	straight	bilobed	glabrous	double	spotted	Uniform
25	V. Robert's Delight	lanceolate	ovate	Deflexed with straight apex	bilobed	glabrous	triple	uniform	Spotted
26	V. Dr. Anek x V. Mimi Palmer	lanceolate	orbicular	Deflexed with straight apex	Bilobed	glabrous	Single	Uniform	Blotched
27	V. Fuchs Delight x V. Bitz's Heartthrob	lanceolate	lanceolate	straight	bilobed	glabrous	double	spotted	Uniform
28	V. Prapawan	lanceolate	lanceolate	Deflexed with incurved apex	bilobed	glabrous	single	uniform	Spotted
29	V. Thailand Beauty	lanceolate	lanceolate	Deflexed with incurved apex	bilobed	glabrous	single	uniform	Uniform
30	V. Dr. Anek x V. Bitz's Heartthrob	lanceolate	orbicular	Deflexed with straight apex	bilobed	glabrous	double	spotted	Uniform

Width of labellum (lip)

Among the vanda varieties/ hybrids, lip width was maximum in V. Dr. Anek x V. Bitz's Heartthrob (2.40 cm) and was significantly superior to all others (Table 15). It was followed by V. Rothchildiana (2.07 cm), and was on par with V. Fuchs Delight x V. Bitz's Heartthrob (2.10 cm), V. Kasem's Delight x V. Bitz's Heartthrob (2.07 cm), V. Thongchai (2.03 cm), V. Urbchitr x V. Bitz's Heartthrob (1.97 cm) and V. Pompimol (1.87 cm). The minimum lip width (0.60 cm) was observed in V. Red Gem followed by V. Varuvathe Pink (0.63 cm).

Length of column

Marked differences in column length were also noticed in vanda varieties/ hybrids (Table 15). Column length was maximum in V. Dr. Anek x V. Mimi Palmer (0.87 cm) and was on par with V. Pathum Gold, V. Kultana Delight Red, V. Dr. Anek x V. Bitz's Heartthrob (0.77 cm each), V. Urbchitr x V. Bitz's Heartthrob, V. Pranermprai x V. *tessellata* and V. Dr. Anek (0.73 cm each). The lowest column length was observed in V. Red Gem (0.37 cm), followed by V. Apec Blue and V. Rothchildiana (0.40 cm).

4.1.3. Post harvest characters

The data on the post harvest characters, namely, fresh weight of spike, floret life span, spike longevity, number of buds opening in vase, days taken for wilting of first floret, water uptake and physiological loss in weight are presented in Table 18.

Fresh weight of the spike

Significant differences were observed in fresh weight of spike among vanda varieties/ hybrids (Table 18). Fresh weight of spike was maximum in V. Pakchong New Land x V. Annette Jones (65.47 g) and followed by V. Lumpini Red x V. Taweewan (64.37 g) and were significantly superior to other varieties.

V. Varuvathe Pink recorded the minimum (11.90 g), followed by V. Red Gem (13.27 g), V. Apec Blue (21.10 g) and V. Thailand Beauty (21.80 g).

Wilting of first floret

Significant differences were noticed among the vanda varieties/ hybrids in the time taken for wilting of the first floret (Table 18). The duration taken for wilting of first floret was maximum in V. Katsuura x V. Fuchs Delight (20.0 days) and was significantly superior to all others. This was followed by V. Urbchitr x V. Bitz's Heartthrob (17.7 days), V. Pranermprai x V. *tessellata* (14.0 days) and V. Thailand Beauty (14.0 days). Minimum days taken for wilting of first floret was in V. Robert's Delight (3.3 days), followed by V. Lumpini Red x V. Taweewan and V. Apec Blue (4.0 days).

Floret span

The life span of each floret in vase also differed significantly among varieties/ hybrids of vanda (Table 18). It was maximum in V. Katsuura x V. Fuchs Delight (18.3 days) and this was significantly superior to all others. This was followed by V. Varuvathe Pink (13.7 days), and V. Urbchitr x V. Bitz's Heartthrob and V. Thailand Beauty (12.7 days) and were on par. Minimum floret span was in V. Pakchong New Land x V. Annette Jones (5.0 days), followed by V. Robert's Delight (5.3 days) and were on par with V. Red Gem, V. Dr. Anek, V. Madame Rattana, V. Kultana Delight Red, V. Pompimol, V. Dr. Anek x V. Mimi Palmer (6.0 days each), V. Taweesuksa x V. Kultana Gold x V. Green Gold and V. Dr. Anek x V. Bitz's Heartthrob (6.3 days each).

Number of buds opening in vase

Among the varieties, maximum number of buds opening in vase was observed in V. Red Gem (4.0) and was significantly superior to all other varieties (Table 18). It was followed by V. Thailand Beauty (2.5) which was on par with V. Lanka Sri pink,

Table.18. Post harvest characters of spikes of vanda varieties/ hybrids

Sl. No.	Varieties/hybrids	Post harvest characters						
		Fresh wt of spike (g)	Wilting of first floret (days)	Floret life span (days)	Buds opening in vase (no.)	Spike longevity (days)	Water uptake (ml)	Physiological loss in wt (g)
1	V. Dr. Anek	22.10 ^{lm}	4.3 ^{lgh}	6.0 ^{hi}	0.3 ^d	9.3 ^f	8.83 ^{ijkl}	7.20 ^{fghi}
2	V. Rothchildiana	24.03 ^{klm}	5.7 ^{efgh}	8.0 ^{defghi}	0.7 ^d	12.0 ^{def}	13.83 ^{bcdef}	8.73 ^{defgh}
3	V. Thongchai	24.33 ^{klm}	8.0 ^{de}	6.7 ^{ghi}	0.2 ^d	9.0 ^f	9.50 ^{hijkl}	0.10 ^k
4	V. Katsuura x V. Fuchs Delight	22.43 ^{lm}	20.0 ^a	18.3 ^a	1.0 ^{cd}	19.0 ^a	10.00 ^{ghijkl}	8.70 ^{defgh}
5	V. Taweesuksa x V. Kultana Gold x V. Green Gold	24.20 ^{klm}	5.3 ^{lgh}	6.3 ^{hi}	1.0 ^{cd}	8.0 ^f	10.17 ^{ghijk}	8.77 ^{defgh}
6	V. Apec Blue	21.10 ^m	4.0 ^{gh}	9.7 ^{def}	0.7 ^d	16.0 ^{ab}	15.00 ^{bcd}	7.0 ^{efgh}
7	V. Pakchong Blue	26.73 ^{hijk}	5.7 ^{efgh}	7.3 ^{efghi}	0.3 ^d	11.3 ^{ef}	10.67 ^{efghij}	10.90 ^{defg}
8	V. Sirilak x V. Bitz's Heartthrob	27.90 ^{efghi}	5.7 ^{efgh}	8.3 ^{defgh}	0.3 ^d	12.0 ^{def}	14.83 ^{bcd}	12.0 ^{cd}
9	V. Pachara Delight Pink	23.43 ^{klm}	6.3 ^{defg}	10.3 ^{cd}	0.7 ^d	14.0 ^{de}	8.33 ^{ijklm}	7.40 ^{fghi}
10	V. Pakchong New Land x V. Annette Jones	65.47 ^a	5.7 ^{efgh}	5.0 ⁱ	0.0 ^d	9.0 ^f	16.00 ^b	16.70 ^{bc}
11	V. Fuchs Delight	25.47 ^{ijkl}	5.0 ^{fgh}	6.7 ^{ghi}	0.3 ^d	9.7 ^{ef}	8.83 ^{ijkl}	9.03 ^{defgh}
12	V. Red Gem	13.27 ⁿ	6.0 ^{defg}	6.0 ^{hi}	4.0 ^a	10.0 ^{ef}	6.67 ^{lmn}	3.20 ^{ijk}
13	V. Anek Delight	26.77 ^{hijk}	5.7 ^{efgh}	6.7 ^{ghi}	0.3 ^d	11.7 ^{ef}	11.67 ^{defghi}	6.30 ^{ghij}
14	V. Urbchitr x V. Bitz's Heartthrob	46.90 ^b	17.7 ^b	12.7 ^{bc}	2.0 ^{bc}	16.0 ^{ab}	12.33 ^{cdefgh}	20.60 ^b
15	V. Kasem's Delight x V. Bitz's Heartthrob	27.53 ^{fghij}	8.3 ^d	9.3 ^{defg}	0.3 ^d	14.0 ^{cd}	14.00 ^{bcde}	12.40 ^{cde}
16	V. Pranermprai x V. tessellata	30.57 ^{defg}	14.0 ^c	10.0 ^{cde}	1.0 ^{cd}	15.0 ^{bc}	9.33 ^{hijkl}	9.53 ^{defg}
17	V. Pathum Gold	31.33 ^{de}	4.7 ^{lgh}	7.7 ^{defghi}	0.0 ^d	12.7 ^{ef}	4.00 ⁿ	12.70 ^{cd}
18	V. Lumpini Red	28.03 ^{eh}	6.3 ^{defg}	7.7 ^{defghi}	0.3 ^d	11.7 ^{ef}	15.00 ^{bcd}	13.03 ^{cd}

Post harvest characters of spikes of vanda varieties/ hybrids contd...

Sl. No.	Varieties/hybrids	Fresh wt of spike (g)	Wilting of first floret (days)	Floret life span (days)	Buds opening in vase (no.)	Spike longevity (days)	Water uptake (ml)	Physiological loss in wt (g)
19	V. Kultana Delight Red	41.17 ^c	6.0 ^{defg}	6.0 ^{hi}	1.0 ^{cd}	9.0 ^f	7.17 ^{klm}	4.40 ^{hijk}
20	V. Pompimol	32.70 ^d	5.3 ^{lgh}	6.0 ^{hi}	0.2 ^d	9.3 ^f	14.00 ^{bcde}	9.87 ^{defg}
21	V. Lumpini Red x V. Taweewan	64.37 ^a	4.0 ^{gh}	7.0 ^{lghi}	0.0 ^d	12.0 ^{ef}	25.00 ^a	25.90 ^a
22	V. Madame Rattana	32.27 ^d	6.0 ^{defg}	6.0 ^{hi}	0.3 ^d	9.3 ^f	13.33 ^{bcdefg}	11.77 ^{def}
23	V. Lanka Sri pink	29.73 ^{defgh}	5.0 ^{lgh}	8.0 ^{defghi}	2.0 ^{bc}	11.0 ^{ef}	15.00 ^{bcd}	9.80 ^{defg}
24	V. Varuvathe Pink	11.90 ⁿ	12.0 ^c	13.7 ^b	2.0 ^{bc}	16.0 ^{ab}	15.00 ^{bcd}	0.90 ^k
25	V. Robert's Delight	24.57 ^{ijklm}	3.3 ^h	5.3 ^{hi}	0.0 ^d	3.0 ^g	5.50 ^{mn}	2.10 ^{jk}
26	V. Anek x V. Palmer	30.87 ^{def}	6.7 ^{def}	6.0 ^{hi}	0.5 ^d	12.0 ^{def}	8.00 ^{ijklm}	10.50 ^{defg}
27	V. Fuchs Delight x V. Bitz's Heartthrob	30.13 ^{defgh}	4.7 ^{lgh}	7.0 ^{lghi}	0.5 ^d	11.3 ^{ef}	10.50 ^{lghijk}	9.03 ^{defgh}
28	V. Prapawan	27.13 ^{ghij}	5.3 ^{lgh}	6.7 ^{ghi}	0.5 ^d	12.0 ^{ef}	13.17 ^{bcdefg}	8.70 ^{defgh}
29	V. Thailand Beauty	21.80 ^m	14.0 ^c	12.7 ^{bc}	2.5 ^b	19.0 ^a	15.17 ^{bc}	11.53 ^{def}
30	V. Anek x V. Bitz's Heartthrob	29.90 ^{defgh}	6.0 ^{defg}	6.3 ^{hi}	0.7 ^d	9.3 ^f	12.50 ^{cdefgh}	7.13 ^{lghi}

. Varuvathe Pink and V. Urbchitr x V. Bitz's Heartthrob (2.0 each). Bud opening was not observed in vase in V. Pakchong New Land x V. Annette Jones, V. Lumpini Red x V. Taweewan and V. Robert's Delight.

Spike longevity

Marked differences were noticed with respect to spike longevity in vanda varieties/ hybrids (Table 18). V. Katsuura x V. Fuchs Delight and V. Thailand Beauty recorded significantly maximum spike longevity (19.0 days) among all the selected varieties/hybrids, followed by V. Apec Blue, V. Urbchitr x V. Bitz's Heartthrob, V. Varuvathe Pink (16.0 days each) and V. Pranermprai x V. *tessellata* (15.0 days). The minimum spike longevity was recorded in V. Robert's Delight (3.0 days), followed by Taweesuksa x V. Kultana Gold x V. Green Gold (8.0 days), V. Thongchai, V. Kultana Delight Re and V. Pakchong New Land x V. Annette Jones (9.0 days each).

Water uptake

The varieties/ hybrids exhibited significant variation in water uptake (Table 18). The uptake of water was maximum in V. Lumpini Red x V. Taweewan (25.00 ml), followed by V. Pakchong New Land x V. Annette Jones (16.00 ml). The water uptake was minimum for V. Pathum Gold (4.00 ml), followed by V. Robert's Delight (5.50 ml).

Physiological loss in weight

Physiological loss in weight also varied among varieties (Table 18) and was maximum (25.90 g) in V. Lumpini Red x V. Taweewan, followed by V. Urbchitr x V. Bitz's Heartthrob (20.60 g). Minimum was recorded in V. Thongchai (0.10 g) and was on par with V. Varuvathe Pink (0.90 g), followed by V. Robert's Delight (2.10 g).

4.2. QUALITATIVE CHARACTERS

The qualitative characters of the varieties differed in all aspects and wide range of variation could be observed (Paltes 1 to 30). Data on qualitative stem and root characters are presented in Tables 4 and 12, respectively and floral characters in Tables 14-17.

4.2.1. Plant characters

All the *Vanda* varieties/ hybrids were hanging type; having medium sized, brown coloured shoots, with little or no branching (Table 4).

The roots were cylindrical and root branching was present in all the varieties/ hybrids, although variation was seen in the intensity of branching, *V. Fuchs Delight* and *V. Varuvathe Pink* had very few aerial root branches, whereas varieties like *V. Lanka Sri pink* and *V. Dr. Anek x V. Mimi Palmer* were thickly branched at the base. The colour of the roots was green in almost all the varieties. *V. Pompimol* had greenish brown roots, whereas *V. Varuvathe Pink* had dark green roots. The older roots were pale green and younger roots were dark green in some of the varieties like *V. Dr. Anek x V. Mimi Palmer* (Table 12).

4.2.2. Leaf characters

Data regarding the qualitative characters of leaf and leaf sheath are presented in Tables 9 and 10, respectively.

Most of the varieties/ hybrids had channelled leaf, although some were deeply channelled like *V. Thongchai*, *V. Pompimol* and *V. Prapawan*. In *V. Pachara Delight Pink* and *V. Varuvathe Pink*, the leaves were widely channelled and the older leaves were somewhat strap like in shape. Regarding the leaf texture, it was smooth and rigid in all the varieties. The leaves were green coloured with no pigmentation or markings, where leaf margin was entire (Table 9).

The selected *Vanda* varieties/ hybrids showed three types of leaf apex. Majority of them had tridentate leaf apex except *V. Taweesuksa* x *V. Kultana Gold* x *V. Green Gold*, *V. Robert's Delight* and *V. Pakchong Blue* had praemorse leaf apex and *V. Varuvathe Pink* with emarginate apex (Table 9).

The leaves were arranged alternately and were oriented as straight or horizontal with an arching tendency. Leaf orientation was horizontal in *V. Thongchai* whereas *V. Pakchong Blue*, *Red Gem*, *V. Urbchitr* x *V. Bitz's Heartthrob*, *V. Pranermprai* x *V. tessellata*, *V. Pathum Gold*, *V. Robert's Delight* and *V. Dr. Anek* x *V. Mimi Palmer* had arching orientation. *V. Varuvathe Pink* had straight orientation of leaves, whereas *V. Pompimol*, *V. Prapawan*, *V. Dr. Anek*, *V. Apec Blue*, *V. Pachara Delight Pink* had straight with slightly arching orientation. All others exhibited horizontal orientation with an arching tendency (Table 9).

All the varieties/ hybrids had green, membranous and thick leaf sheaths (Table 10).

4.2.3. Floral characters

Data pertaining to the floral characters are presented in Tables 14-17 and Plates 1-30.

The inflorescence was lax in all the varieties/ hybrids, with erect or arching spikes in most of the cases (Table 14). In all the plants inflorescence arise from lateral position and the florets on the spike were oriented such that they were facing in all the directions (Table 15).

Petal shape was obovate in all the varieties/ hybrids of vanda evaluated except *V. Sirilak* x *V. Bitz's Heartthrob*, *V. Thongchai* and *V. Urbchitr* x *V. Bitz's Heartthrob*, the petal shape was oblong whereas it was elliptic in *V. Taweesuksa* x *V. Kultana Gold* x *V. Green Gold* (Table 16).

Petal curvature was observed as deflexed with incurved apex (*V. Dr. Anek*, *V. Rothchildiana*, *V. Katsuura* x *V. Fuchs Delight*, *V. Pakchong Blue*, *V. Pakchong*

PLATES (1-30)



1. *Vanda Dr. Anek*

Plant intermediate climbing epiphyte; shoot medium thick; leaves channelled, rigid, smooth, fleshy, green, apex tridentate, leaf sheath membranous, dark green; roots grey-brown, thick, fleshy, branched. Spike erect, 8-10 soft pink-purple blotched florets, petals obovate, deflexed with incurved truncated apex; labellum bilobed, midlobe prominent, with bright purple, lightens towards base; laterals orbicular, white coloured with pink spots.

Flowering branch: 1.0

Average yield/year: 1.7 spikes

3. *Vanda Rothchildiana*

Plant intermediate climbing epiphyte; shoot medium thick; leaves channelled, smooth, rigid, green, apex tridentate,; leaf sheath membranous, green; stipules prominent green coloured with violet shade at margin and apex; roots green, thick, fleshy, branched. Stipules prominent, Spike erect, 7-8 soft violet blotched florets spreading, petals obovate, deflexed with incurved truncated apex; labellum bilobed, midlobe orbicular, prominent, deep violet at apex, base violet with white stripes; laterals ovate, white towards margin and white with violet spots at apex.

Flowering branch: 1.0

Average yield/year: 1.7 spikes





2. *Vanda Thongchai*

Plant intermediate climbing epiphyte; shoot medium thick; leaves deeply channeled, fleshy, smooth, rigid, green, apex tridentate, leaf sheath membranous, green; roots green, thick, fleshy, branched. Spike erect, 6-7 soft purple spotted florets and the colour lightens towards margin and apex; petals oblong, incurved with deflexed obtuse apex; labellum bilobed, midlobe lanceolate, prominent, purple coloured; laterals ovate, yellow with violet stripes.

Flowering branch: 1.0

Average yield/year: 1.7 spikes

4. *Vanda Katsuura* x *V. Fuchs Delight*

Plant intermediate climbing epiphyte; shoot medium thick; leaves channelled, smooth, rigid, fleshy, green, apex tridentate; leaf sheath membranous, green; roots green, thick, fleshy, branched. Spike erect, 6-7 soft violet florets with gentle tessellations; petals obovate, deflexed with incurved obtuse apex; labellum bilobed, midlobe lanceolate, prominent, deep purple which lightens towards base and margin; laterals orbicular, white with violet spots and yellow colour at base.

Flowering branch: 1.0

Average yield/year: 1.7 spikes





6. *Vanda* Taweessuksa x *V. Kultana Gold* x *V. Green Gold*

Plant intermediate climbing epiphyte; shoot medium thick; leaves green channelled, smooth, rigid, fleshy; apex praemorse, leaf sheath membranous, green; roots green, thick, fleshy, branched. Spike erect, 7-8 soft pink florets with yellow and purple tinged tessellations; petals elliptic, incurved with deflexed obtuse apex; labellum bilobed, midlobe lanceolate, prominent, deep purple at margin and apex, yellow at base; laterals orbicular, yellow with purple striations.

Flowering branch: 1.0

Average yield/year: 1.0 spike

5. *Vanda* Apec Blue

Plant intermediate climbing epiphyte; shoot medium thick; leaves channeled but, strap-like towards tip, smooth, rigid fleshy green; apex tridentate; leaf sheath membranous, green; roots green, thick, fleshy, branched. Spike erect, 5-6 soft uniformly violet coloured florets, petals obovate, straight with obtuse apex; labellum bilobed, midlobe lanceolate, prominent, deep violet at margin and apex, violet with white stripes at base; laterals lanceolate, violet spotted and base yellow.

Flowering branch: 1.0

Average yield/year: 1.17 spikes





8. *Vanda Sirilak* x *V. Bitz's Heartthrob*

Plant intermediate climbing epiphyte; shoot medium thick; leaves channelled, green smooth, rigid, green apex tridentate; leaf sheath membranous, green; roots green, thick, fleshy, branched; Spike erect, 7-8 soft purple florets with spots, petals oblong, incurved with deflexed obtuse apex; labellum bilobed, midlobe lanceolate, prominent, wine red in colour which lightens towards lower margin, white lined at base; laterals orbicular, yellow with wine red spots and striations.

Flowering branch: 1.0

Average yield/year: 1.3 spikes

7. *Vanda Pakchong Blue*

Plant intermediate climbing epiphyte; shoot medium thick; leaves channelled, fleshy green smooth, rigid, apex praemorse; leaf sheath membranous, green; roots green, thick, fleshy, branched; Spike erect, 6-7 soft uniformly purple coloured florets, petals obovate, deflexed with incurved obtuse apex; labellum bilobed, midlobe lanceolate, prominent, purple coloured; laterals orbicular, white with purple spots.

Flowering branch: 1.0

Average yield/year: 1.0 spike





9. *Vanda Pachara Delight* **Pink**

Plant intermediate climbing epiphyte; shoot medium thick; leaves channelled, smooth, rigid fleshy, green, apex tridentate, leaf sheath membranous, green; roots green, thick, fleshy, branched. Spike erect, 5-6 soft pink-purple florets, tessellated; petals obovate, straight with obtuse apex; labellum bilobed, midlobe lanceolate, prominent, bright purple and streaked at base, laterals orbicular, purple shaded.

Flowering branch: 1.0

Average yield/year: 1.7 spikes

10. *Vanda Pakchong New* **Land x V. Annette Jones**

Plant intermediate climbing epiphyte; shoot medium thick; leaves channelled, smooth, rigid green, apex tridentate; leaf sheath membranous, green; roots green, thick, fleshy, branched; stipules clasping to flower stalk; Spike erect, 9-10 soft lilac-violet florets with tessellations and spots; petals obovate, deflexed with incurved truncated apex; labellum bilobed, midlobe orbicular, prominent, reddish purple, subtending towards base; laterals ovate, yellow with purple stripes.

Flowering branch: 1.0

Average yield/year: 1.7 spikes





11. *Vanda Red Gem*

Plant intermediate climbing epiphyte; shoot medium thick; leaves channelled, smooth, rigid, green, apex tridentate; leaf sheath membranous, green; roots green, thick, fleshy, branched. Spike erect, 17-20 small sized purple florets with spots; petals obovate, incurved with deflexed obtuse apex; labellum bilobed, midlobe lanceolate, prominent, purple coloured, laterals lanceolate, yellow with purple spots.

Flowering branch: 1.0

Average yield/year: 2.0 spikes

12. *Vanda Anek Delight*

Plant intermediate climbing epiphyte; shoot medium thick; leaves channelled, smooth, rigid, green, apex tridentate, leaf sheath membranous; roots greenish brown, thick, fleshy, branched. Spike erect, 5-6 soft violet tessellated florets, petals obovate, incurved with deflexed obtuse apex; labellum bilobed, midlobe lanceolate, prominent, violet in colour; laterals orbicular, white with violet stripes.

Flowering branch: 1.0

Average yield/year: 1.0 spike





13. *Vanda Urbchitr* x *V. Bitz's Heartthrob*

Plant intermediate climbing epiphyte; shoot medium thick; leaves channelled, smooth, rigid, green, apex tridentate; leaf sheath membranous, green; roots green, thick, fleshy, branched. Spike erect, 9-10 soft wine-red florets with spots and gentle tessellations; slightly pubescent towards central base and are shiny; petals oblong, incurved with deflexed obtuse apex; labellum bilobed, midlobe orbicular, prominent, wine-red which lightens towards margin; laterals orbicular, white with vine red spots.

Flowering branch: 1.0

Average yield/year: 2.7 spikes

14. *Vanda Kasem's Delight* x *Vanda Bitz's Heartthrob*

Plant intermediate climbing epiphyte; leaves channelled, smooth, rigid, green apex tridentate; leaf sheath membranous, green; roots green, thick, fleshy, branched. Spike erect, 8-9 soft violet and purple florets with spots and tessellations; petals obovate, incurved with deflexed obtuse apex; labellum bilobed, midlobe orbicular, prominent, violet coloured which lightens towards margin; laterals orbicular, yellow coloured with violet spots and stripes.

Flowering branch: 1.0

Average yield/year: 2.3 spikes



15. *Vanda Pranermprai* x *Vanda tessellate*



Plant intermediate climbing epiphyte; shoot medium thick; leaves channelled, smooth, rigid, green, apex tridentate; leaf sheath membranous, green; roots green, thick, fleshy, branched. Spike erect, 6-7 soft yellow tessellate florets, petals obovate, straight with obtuse apex; labellum bilobed, midlobe lanceolate, prominent, yellow coloured with purple spots; laterals ovate, white with purple spots, base yellow.

Flowering branch: 1.0

Average yield/year: 3.3 spikes

16. *Vanda Pathum Gold*

Plant intermediate climbing epiphyte; shoot medium thick; leaves channelled, smooth, rigid, green, apex tridentate; leaf sheath membranous, green; roots green, thick, fleshy, branched. Spike erect, 10-11 soft yellow with purple spotted florets, petals obovate, incurved with deflexed obtuse apex; labellum bilobed, midlobe orbicular, prominent, yellow with green and purple tinge, laterals ovate, uniform pale yellow with shades of orange.

Flowering branch: 1.0

Average yield/year: 3.7 spikes





17. *Vanda Lumpini Red*

Plant intermediate climbing epiphyte; shoot medium thick; leaves channelled, smooth, rigid, green apex tridentate; leaf sheath membranous, green; roots green, thick, fleshy, branched. Spike erect, 6-7 soft purple florets with spots, petals obovate, Incurved with deflexed obtuse apex; labellum bilobed, midlobe lanceolate, prominent, deep purple towards apex, lightens at base and margins; laterals orbicular, violet with white stripes.

Flowering branch: 1.0

Average yield/year: 1.7 spikes

18. *Vanda Kultana Delight Red*

Plant intermediate climbing epiphyte; shoot medium thick; leaves channelled, smooth, rigid, green, apex tridentate; leaf sheath membranous, green; roots green, thick, fleshy, branched. Spike erect, 10-11 soft purple, spotted florets; petals obovate, Incurved with deflexed obtuse apex; labellum bilobed, midlobe lanceolate, prominent, purple coloured; laterals orbicular, white with purple gentle stripes.

Flowering branch: 1.0

Average yield/year: 1.7 spikes





19. *Vanda Pompimol*

Plant intermediate climbing epiphyte; shoot medium thick; leaves deeply channelled, fleshy, smooth, rigid, green apex tridentate; leaf sheath membranous, green; roots greenish brown, thick, fleshy, branched. Spike erect, 6-7 soft violet purple florets with wine red spots and tessellations; petals obovate, incurved with deflexed obtuse apex; labellum bilobed, midlobe ovate, prominent, purple in colour with white tinge at margin and base; laterals ovate, white with purple spots and streaks.

Flowering branch: 1.0

Average yield/year: 1.0 spike

20. *Vanda Lumpini Red* x *Vanda Taweewan*

Plant intermediate climbing epiphyte; shoot medium thick; leaves channelled, smooth, rigid, fleshy, green, apex tridentate; leaf sheath membranous, green; roots green, thick, fleshy, branched. Spike erect, 10-11 soft violet florets with spots; petals oblong, deflexed with incurved obtuse apex; labellum bilobed, midlobe lanceolate, prominent, deep purple towards tip, white striped towards base; laterals orbicular, creamish yellow with violet spots.

Flowering branch: 1.0

Average yield/year: 1.3 spikes





21. *Vanda* Madame Rattana

Plant intermediate climbing epiphyte; shoot medium thick; leaves channelled, smooth, rigid, green apex tridentate; leaf sheath membranous, green; roots green, thick, fleshy, branched. Spike erect, 10-11 soft violet florets with spots and tessellations; petals obovate, incurved with deflexed obtuse apex; labellum bilobed, midlobe lanceolate, prominent, deep violet; laterals orbicular, white with violet striations.

Flowering branch: 1.0

Average yield/year: 1.3 spikes

22. *Vanda* Lanka Sri pink

Plant intermediate climbing epiphyte; shoot medium thick; leaves channelled, smooth, rigid, fleshy, green, apex tridentate; leaf sheath membranous, green; roots green, thick, fleshy, branched; keel present; spike erect, 5-6 soft purple florets, uniform in colour; petals obovate, incurved with deflexed obtuse apex; labellum bilobed, midlobe lanceolate, prominent, purple coloured; laterals orbicular, white with purple striations.

Flowering branch: 1.0

Average yield/year: 1.7 spikes





23. *Vanda* Varuvathe Pink

Plant intermediate climbing epiphyte; shoot medium thick; leaves widely channelled, smooth, rigid, green apex emarginate,; leaf sheath membranous, green; roots dark green, thick, fleshy, branched. Spike erect, 3-4 soft orange florets, spotted; petals obovate, straight with obtuse apex; labellum bilobed, midlobe lanceolate, prominent, red coloured, towards base yellow coloured with red markings; laterals ovate, yellow with red spots.

Flowering branch: 1.0

Average yield/year: 2.0 spikes

24. *Vanda* Robert's Delight

Plant intermediate climbing epiphyte; shoot medium thick; leaves channelled, smooth, rigid, green apex praemorse; leaf sheath membranous, green; roots green, thick, fleshy, branched. Spike erect, 6-7 soft uniformly purple coloured florets, petals obovate, incurved with deflexed obtuse apex; labellum bilobed, midlobe lanceolate, prominent, deep violet, which lightens towards base and margin; laterals ovate, purple coloured with white stripes.

Flowering branch: 1.0

Average yield/year: 2.3 spikes





27. *Vanda Fuchs Delight* x *V. Bitz's Heartthrob*

Plant intermediate climbing epiphyte; shoot medium thick; leaves channelled, smooth, rigid, fleshy, green, apex tridentate; leaf sheath membranous, green; roots green, thick, fleshy, branched. Spike erect, 6-7 soft purple, spotted florets; petals obovate, straight with obtuse apex; labellum bilobed, midlobe lanceolate, prominent, purple in colour; laterals orbicular, white with purple striations.

Flowering branch: 1.0

Average yield/year: 2.0 spikes

25. *Vanda Dr. Anek* x *Vanda Mimi Palmer*

Plant intermediate climbing epiphyte; shoot medium thick; leaves channelled, smooth, rigid, fleshy, green, apex tridentate; leaf sheath membranous, green; roots dark green to pale green according to maturity, thick, fleshy, branched. Spike erect, 5-6 soft violet florets, spotted; petals obovate, straight with obtuse apex; labellum bilobed, midlobe lanceolate, prominent, violet coloured; laterals orbicular, white with violet spots.

Flowering branch: 1.0

Average yield/year: 1.7 spikes





27. *Vanda Prapawan*

Plant intermediate climbing epiphyte; shoot medium thick; leaves deeply channelled, smooth, rigid, green, apex tridentate, leaf sheath membranous, green; roots green, thick, fleshy, branched. Spike erect, 7-8 soft violet uniformly tessellated florets, petals obovate, straight with obtuse apex; labellum bilobed, midlobe lanceolate, prominent, violet in colour and white stripes at base; laterals lanceolate, violet with white tinge in colour and yellow at base.

Flowering branch: 1.0

Average yield/year: 2.0 spikes

28. *Vanda Thailand Beauty*

Plant intermediate climbing epiphyte; shoot medium thick; leaves channelled, smooth, rigid, green, apex tridentate; leaf sheath membranous, green; roots green, thick, fleshy, branched. Spike erect, 20-24 small sized lilac-violet tessellated florets, petals obovate, incurved with deflexed obtuse apex; labellum bilobed, midlobe lanceolate, prominent, violet coloured; laterals lanceolate, violet coloured.

Flowering branch: 1.0

Average yield/year: 2.0 spikes





29. *Vanda Dr. Anek x V. Bitz's Heartthrob*

Plant intermediate climbing epiphyte; shoot medium thick; leaves channelled, smooth, rigid, fleshy, green, apex tridentate; leaf sheath membranous, green; roots green, thick, fleshy, branched. Spike erect, 7-8 soft purple, blotched florets; petals obovate, incurved with deflexed obtuse apex; labellum bilobed, midlobe lanceolate, prominent, purple coloured; laterals orbicular, white with purple shades.

Flowering branch: 1.0

Average yield/year: 2.0 spikes

30. *Vanda Fuchs delight*

Plant intermediate climbing epiphyte; shoot medium thick; leaves channelled, smooth, rigid, green, apex tridentate, leaf sheath membranous; roots brown, thick, fleshy, branched. Spike erect, 4-5 soft purple, spotted florets, petals obovate, incurved with incurved truncated apex; labellum bilobed, midlobe lanceolate, prominent, deep purple towards apex, white striped towards base; laterals orbicular, white with pink spots and base yellow.

Flowering branch: 1.0

Average yield/year: 2.0 spikes



New Land x V. Annette Jones, V. Lumpini Red x V. Taweewan) as well as incurved with deflexed apex (V. Dr. Anek x V. Bitz's Heartthrob, V. Thailand Beauty, V. Robert's Delight, V. Lanka Sri pink, V. Pompimol, V. Kultana Delight Red, V. Madame Rattana, V. Lumpini Red, V. Pathum Gold, V. Kasem's Delight x V. Bitz's Heartthrob, V. Pathum Gold, V. Urbchitr x V. Bitz's Heartthrob, V. Anek Delight, V. Red Gem, V. Fuchs Delight, V. Sirilak x V. Bitz's Heartthrob, V. Taweeksu x V. Kultana Gold x V. Green Gold and V. Thongchai) in the varieties. In V. Pranermprai x V. *tessellata*, V. Varuvathe Pink, V. Dr. Anek x V. Mimi Palmer, V. Fuchs Delight x V. Bitz's Heartthrob and V. Prapawan, the petal curvature was straight (Table 16).

Majority of the varieties had undulated petal margin (V. Dr. Anek, V. Rothchildiana, V. Katsuura x V. Fuchs Delight, V. Thongchai, V. Taweeksu x V. Kultana Gold x V. Green Gold, V. Pakchong Blue) whereas V. Apec Blue, V. Sirilak x V. Bitz's Heartthrob, V. Pachara Delight Pink, V. Red Gem, V. Anek Delight, V. Pranermprai x V. *tessellata*, V. Pathum Gold and V. Varuvathe Pink had entire margin. In V. Prapawan, petal margin was slightly undulate (Table 16).

The petal colour pattern varied in the different varieties/ hybrids (Table 16). The varieties had uniform colour pattern in V. Apec Blue, V. Pakchong Blue, V. Robert's Delight and V. Lanka Sri pink. Spotted colour pattern was found in V. Thongchai, V. Sirilak x V. Bitz's Heartthrob, V. Fuchs Delight, V. Red Gem and tessellated in V. Taweeksu x V. Kultana Gold x V. Green Gold, V. Pachara Delight Pink, V. Anek Delight. Blotched colour pattern was also found in V. Dr. Anek, V. Rothchildiana and V. Dr. Anek x V. Bitz's Heartthrob.

Lip mid-lobe shape was lanceolate in majority of the varieties evaluated, but it was orbicular in V. Dr. Anek, V. Katsuura x V. Fuchs Delight, V. Taweeksu x V. Kultana Gold x V. Green Gold, V. Pakchong Blue etc. Lip mid-lobe shape was ovate in V. Pakchong New Land x V. Annette Jones (Table 17).

Lip lateral-lobe shapes also varied considerably in vanda varieties/ hybrids evaluated (Table 17). They were found to be orbicular (V. Dr. Anek, V. Katsuura x V. Fuchs Delight, V. Taweesuksa x V. Kultana Gold x V. Green Gold, V. Pakchong Blue, V. Sirilak x V. Bitz's Heartthrob, V. Pachara Delight Pink), ovate (V. Rothchildiana, V. Thongchai, V. Pakchong New Land x V. Annette Jones, V. Pranermprai x V. *tessellata*, V. Pathum Gold, V. Pompimol, V. Varuvathe Pink and V. Robert's Delight) and lanceolate (V. Thailand Beauty, V. Prapawan, V. Fuchs Delight x V. Bitz's Heartthrob, V. Red Gem and V. Apec Blue).

Wide variation was found in the lip curvatures of the different varieties/ hybrids of vanda (Table 17). It was straight in V. Anek Delight, V. Pachara Delight Pink, V. Pakchong Blue, V. Taweesuksa x V. Kultana Gold x V. Green Gold, V. Varuvathe Pink, V. Pranermprai x V. *tessellata* and V. Fuchs Delight x V. Bitz's Heartthrob; deflexed with incurved apex (V. Rothchildiana, V. Apec Blue, V. Sirilak x V. Bitz's Heartthrob, V. Pakchong New Land x V. Annette Jones, V. Fuchs Delight, V. Kasem's x V. Bitz's Heartthrob, V. Urbchitr x V. Bitz's Heartthrob etc); deflexed with deflexed apex (V. Thongchai); deflexed with straight apex (V. Kultana Delight Red, V. Lumpini Red x V. Taweewan, V. Madame Rattana, V. Anek x V. Palmer, V. Robert's Delight, V. Anek x V. Bitz's Heartthrob, V. Red Gem and V. Katsuura x V. Fuchs Delight) and incurved with incurved apex (V. Fuchs Delight).

Marked differences were noticed in the lip apex in all the vanda varieties/ hybrids evaluated (Table 17). Lip apex was observed to be bilobed in all the varieties, except in V. Sirilak x V. Bitz's Heartthrob (acute), V. Pachara Delight Pink (obtuse), V. Red Gem and V. Madame Rattana (truncate).

The lip surface was glabrous in all the *Vanda* varieties/ hybrids selected for the study (Table 17). The lips were single coloured as in V. Thongchai, V. Sirilak x V. Bitz's Heartthrob, V. Kultana Delight Red, V. Pompimol, V. Madame Rattana, or double coloured (V. Dr. Anek, V. Rothchildiana, V. Katsuura x V. Fuchs Delight,

V. Taweesuksa x V. Kultana Gold x V. Green Gold) or triple coloured (Pathum Gold and V. Robert's Delight).

Lip colour pattern was uniform as in V. Rothchildiana, V. Thongchai, V. Katsuura x V. Fuchs Delight; streaked as in V. Dr. Anek, V. Apec Blue, V. Pachara Delight Pink; spotted as in V. Pathum Gold, V. Varuvathe Pink, V. Fuchs Delight x V. Bitz's Heartthrob and V. Dr. Anek x V. Bitz's Heartthrob (Table 17).

The column colour pattern also varied considerably among the varieties (Table 17). It was streaked (V. Dr. Anek, V. Kasem's Delight x V. Bitz's Heartthrob); blotched (V. Rothchildiana, V. Thongchai, V. Katsuura x V. Fuchs Delight); spotted (V. Fuchs Delight, V. Red Gem, V. Pranermprai x V. *tessellata*) or uniform as in V. Sirilak x V. Bitz's Heartthrob, V. Anek Delight, V. Urbchitr x V. Bitz's Heartthrob).

Spur type was conical in most of the varieties evaluated, except in V. Robert's Delight (cylindrical) and V. Katsuura x V. Fuchs Delight (saccate). Spur length also varied considerably. Most of the varieties had medium spur length, but some had long spur as in V. Dr. Anek, V. Rothschildiana; short as in V. Thongchai, V. Sirilak x V. Bitz's Heartthrob and very short as in V. Taweesuksa x V. Kultana Gold x V. Green Gold (Table 15).

Among the varieties/ hybrids of vanda evaluated, good fragrance was present only in V. Pranermprai x V. *tessellata* (Table 15).

4.2.4. Visual scoring/ evaluation

Data pertaining to the scores obtained for the spikes of thirty *Vanda* varieties/ hybrids are presented in Table 19. The highest mean total score was obtained for V. Pathum Gold and V. Lumpini Red x V. Taweewan (45.6 each), followed by V. Anek Delight (45.5), V. Pachara Delight Pink (45.2) and V. Kultana Delight Red (45.1). The lowest score was for V. Sirilak x V. Bitz's Heartthrob (41.7), followed by V. Katsuura x V. Fuchs Delight (43.0) and V. Rothchildiana (43.3). The highest score

Table 19. Visual scoring of spikes of thirty vanda varieties/ hybrids

Sl. No	Varieties/ hybrids	Scoring					
		Colour & pigmentat ion (out of 10)	Texture (out of 10)	Shape & pattern (out of 10)	Size of florets (out of 10)	Arrangement of florets on spike (out of 10)	Total
1	V. Dr. Anek	8.8	9.0	8.8	9.0	8.5	44.1
2	V. Rothchildiana	8.7	8.8	9.0	8.8	8.0	43.3
3	V. Thongchai	9.0	9.0	8.9	9.0	8.4	44.3
4	V. Katsuura x Fuchs Delight	8.4	8.6	8.8	8.8	8.4	43
5	V. Taweesuksa x V. Kultana Gold x V. Green Gold	9.2	8.9	8.8	9.0	8.7	44.6
6	V. Apec Blue	8.6	8.8	9.0	8.8	8.7	43.9
7	V. Pakchong Blue	9.0	8.8	8.9	8.9	9.0	44.6
8	V. Sirilak x V. Bitz's Heartthrob	8.0	8.5	8.2	9.0	8.0	41.7
9	V. Pachara Pink	9.2	9.0	9.1	9.0	8.9	45.2
10	V. Pakchong New Land x V. Annette Jones	9.2	8.9	8.6	8.6	8.7	44
11	V. Fuchs Delight	8.8	9.0	9.0	9.0	8.8	44.6
12	V. Red Gem	8.9	8.8	9.0	8.8	9.0	44.5
13	V. Anek Delight	9.3	9.0	9.1	9.1	9.0	45.5
14	V. Urbchitr x V. Bitz's Heartthrob	9.0	9.1	8.9	9.0	8.9	44.8
15	V. Kasems Delight x Bitz's Heartthrob	8.8	8.8	9.0	9.0	9.0	44.6
16	V. Pranermprai x V. tessellata	8.9	8.8	8.8	9.0	9.0	44.5
17	V. Pathum Gold	9.2	9.0	9.0	9.2	9.2	45.6
18	V. Lumpini Red	8.8	8.8	9.0	8.9	8.9	44.4
19	V. Kultana Delight Red	9.0	9.0	9.0	9.0	9.1	45.1
20	V. Pompimol	8.9	8.9	8.8	8.8	8.5	43.9
21	V. Lumpini Red x V. Taweewan	9.2	9.1	9.2	9.3	8.8	45.6
22	V. Madame Rattana	8.8	8.8	8.6	8.7	8.5	43.4
23	V. Lanka Sri pink	8.7	9.0	8.8	8.9	8.7	44.1
24	V. Varuvathe Pink	9.0	8.7	8.9	8.8	8.8	44.2
25	V. Roberts Delight	8.9	8.9	9.0	9.0	8.8	44.6
26	V. Dr. Anek x V. Mimi Palmer	8.9	8.9	8.9	8.9	8.8	44.4
27	V. Fuchs Delight x Bitz's Heartthrob	8.7	8.8	8.7	8.7	8.5	43.4
28	V. Prapawan	9.0	8.8	9.0	9.1	9.0	44.9
29	V. Thailand Beauty	9.1	9.0	8.9	8.9	9.0	44.8
30	V. Dr. Anek x Bitz's Heartthrob	8.8	8.8	8.7	8.7	8.9	43.9

or four characters viz., colour and pigmentation (9.2), texture (9.1), shape and pattern (9.2) and size of florets (9.3) was recorded in V. Lumpini Red x V. Taweewan, whereas the highest score (9.2) for arrangement of florets on the spike was for V. Pathum Gold.

Plant quality rating was done based on fullness, growth and visual appearance viz., flower colour and pigmentation, spike longevity, shape and arrangement of foliage during the growth period (Table 20). V. Pachara Delight Pink and V. Prapawan recorded the highest mean total score (45.1), followed by V. Pathum Gold (45.0), whereas Dr. Anek recorded lowest mean score (39.7).

The results generated from the present study indicate that there were consistent differences in the growth performance of different vanda varieties/ hybrids.

Considering the overall quantitative and qualitative parameters, V. Pathum Gold, V. Lumpini Red x V. Taweewan, V. Pachara Delight Pink, V. Apec Blue, V. Prapawan, V. Urbchitr x V. Bitz's Heartthrob and V. Thailand Beauty were excellent, both for cut flower production and as pot plants. V. Pranermprai x V. *tessellata* and V. Katsuura x V. Fuchs Delight have more potential for use as cut flower whereas V. Red Gem and V. Anek Delight were excellent as pot plants.

Table 20. Plant quality rating of thirty vanda varieties/ hybrids by visual scoring

Sl. No.	Varieties/ hybrids	Scores (each out of 10)					
		Growth & fullness	Shape & arrangement (leaves)	Flower colour & pigmentation	Spike longevity on plant	Visual appeal/ general appearance	Total (out of 50)
1	V. Dr. Anek	7.0	8.0	8.1	8.6	8.0	39.7
2	V. Rothchildiana	8.3	8.5	8.6	8.8	8.6	42.8
3	V. Thongchai	8.5	8.9	8.9	8.2	8.8	43.3
4	V. Katsuura x Fuchs Delight	8.5	8.6	8.6	8.3	8.6	42.6
5	V. Taweesuksa x V. Kultana Gold x V. Green Gold	8.6	9.0	8.9	9.0	8.8	44.3
6	V. Apec Blue	8.7	8.8	8.7	8.9	8.7	43.7
7	V. Pakchong Blue	8.8	9.2	9.2	8.1	9.0	44.3
8	V. Sirilak x V. Bitz's Heartthrob	8.5	8.7	8.8	8.1	8.8	42.9
9	V. Pachara Pink	9.0	9.2	9.2	8.5	9.2	45.1
10	V. Pakchong New Land x V. Annette Jones	8.4	9.0	9.0	8.6	8.9	43.9
11	V. Fuchs Delight	8.4	8.5	8.5	8.0	8.7	42.1
12	V. Red Gem	8.3	8.9	8.7	8.6	8.8	43.3
13	V. Anek Delight	8.5	9.2	9.2	7.8	9.0	43.7
14	V. Urbchitr x V. Bitz's Heartthrob	8.9	9.0	8.9	8.8	9.0	44.6
15	V. Kasems Delight x Bitz's Heartthrob	8.6	8.7	8.7	7.9	8.8	42.7
16	V. Pranermprai x V. tessellata	8.4	8.5	8.7	8.4	8.8	42.8
17	V. Pathum Gold	8.8	9.2	9.2	8.7	9.1	45.0
18	V. Lumpini Red	8.4	8.6	8.6	8.5	8.7	42.8
19	V. Kultana Delight Red	8.8	8.8	8.7	8.3	8.7	43.3
20	V. Pompimol	8.5	8.8	8.8	8.3	8.9	43.3
21	V. Lumpini Red x V. Taweewan	8.7	9.0	9.0	8.8	9.0	44.5
22	V. Madame Rattana	8.6	8.8	8.8	9.3	8.8	44.3
23	V. Lanka Sri pink	8.7	8.7	8.6	8.1	8.7	42.8
24	V. Varuvathe Pink	8.4	8.8	8.8	7.9	8.7	42.6
25	V. Roberts Delight	8.9	8.9	8.8	7.8	8.9	43.3
26	V. Dr. Anek x V. Mimi Palmer	8.6	8.8	8.9	8.0	8.8	43.1
27	V. Fuchs Delight x Bitz's Heartthrob	8.8	8.7	8.7	8.1	8.8	43.1
28	V. Prapawan	9.1	9.0	8.9	9.2	8.9	45.1
29	V. Thailand Beauty	8.6	8.7	8.8	8.0	8.7	42.8
30	V. Dr. Anek x Bitz's Heartthrob	8.6	8.7	8.7	8.1	8.7	42.8

DISCUSSION

5. DISCUSSION

The results on evaluation of vanda orchids for commercial traits are discussed in this chapter.

Orchids are distinctive plants and are valuable for their intricately designed spectacular flowers with brilliant colours, brightful appearance and long lasting qualities. Orchid cut flowers have occupied the most prominent place in international flower trade and have contributed immensely to the economy of several countries. They remain the only cut flower crop grown as pot plant due to the epiphytic nature of the commercially cultivated orchids. Orchids are important primarily for their horticultural and floricultural appeal.

Monopodials have recently gained popularity due to the availability of large number of varieties and hybrids including intergeneric ones that show a wide range of variability in floral characters. Among the monopodial orchids, *Phalaenopsis*, *Aranda*, *Mokara* and *Vanda* are the most popular in the world market. Vandas have become extremely popular and they are now amongst the foremost orchids cultivated commercially. The handsome growth habit and remarkable range of colours in the different vanda orchids/varieties made it important in parental crosses also. The leaves may be terete, semi-terete, strap or channelled. The inflorescence is produced at the leaf axils, piercing the leaf sheaths as they emerge.

The performance of any plant depends upon its inherent genetic characters as influenced by the growing environment. Each plant has its own inherent characters which makes it suitable for commercial exploitation. However, the environment under which it is grown largely determines the realization of its genetic potential. Thus, it becomes a prime requisite to evaluate the plant types based on their growth and other characters.

In the present study, thirty epiphytic *Vanda* varieties/hybrids were evaluated for commercial exploitation.

5.1. QUANTITATIVE CHARACTERS

The quantitative characters under study were plant characters like height, shoot girth, plant spread, internodal length; leaf characters like length, breadth, leaf area, number of leaves and interval of leaf production together with root characters like length, girth and number were recorded. Floral characters, like days taken from spike emergence to opening of first floret, 50 per cent florets and complete opening of all florets; longevity of spike on plant, interval and annual spike production, blooming period; spike length, girth, rachis length, number of florets/spike, flower size, flower stalk length, length and width of labellum and column, internodal length, as well as life of individual floret on the spike were also observed to compare the varieties. Post harvest characters like wilting of first floret in vase, spike longevity, buds opening, physiological loss in weight and water uptake by the spike and floret span in vase were also counted.

In general, tropical orchids enjoy humid, warm atmosphere and burst into activity during rainy season. During the period of study, majority of the varieties performed during June to October (rainy season) both in terms of vegetative and flower production. Vegetative growth is a pre-requisite for better flower production. Growth, development and productivity depend on the interaction between environmental factors and genetic constitution of the plants. Orchid is one such crop which expresses a high magnitude of diversity and responds very well to the environment (Abraham and Vatsala, 1981).

5.1.1. Plant characters

Height is an inherent genetic character of plants which can be influenced by growing conditions. The height differences are mainly due to differences in internodal length. The maximum plant height recorded was in V. Pompimol and V. Lumpini Red x V. Taweewan, which were having a comparatively good internodal length. Whereas the minimum plant height was in V. Thailand Beauty, which had the least internodal length.

Plant spread indicates the area occupied by the plant under growing environmental conditions and thus it determines the plant density in the given area. Since vanda is non branching, the plant spread is largely determined by leaf characteristics such as length, orientation and arrangement. Maximum plant spread was observed in V. Kasem's Delight x V. Bitz's Heartthrob while V. Pachara Delight Pink recorded the minimum spread. The more the spread, the spacing between plants should also be more. It may be further noted that the long and arching nature of the spikes has better role in deciding the spacing.

The girth of shoot gives an indication about the strength of the stem. The shoot girth recorded in different varieties varied considerably. Maximum shoot girth was found in V. Taweeksa x V. Kultana Gold x V. Green Gold and the minimum in V. Varuvathe Pink.

Leaf characters, both quantitative and qualitative, contribute to the selection of plants for commercial exploitation. Quantitative characters, include leaf length and width which are indicative of the leaf size; leaf number, interval of leaf production, together with leaf sheath characters which directly contribute to the photosynthetic efficiency of the plant.

Leaf length was maximum in V. Pompimol followed by x V. Bitz's Heartthrob. As leaf length contributes largely to the area of leaf, leaf area was also maximum in V. Pompimol followed by x V. Urbchitr x V. Bitz's Heartthrob. It was minimum in V. Prapawan followed by V. Anek Delight. The width was maximum in V. Lumpini Red x V. Taweewan and V. Fuchs Delight recorded the minimum. Such wide differences were also indicated in the descriptions of Bose *et. al.* (1999); Bhattacharjee *et. al.* (2002) and Kaveriamma (2007) of different cultivars of orchids.

Interval of leaf production is an indicative of leaf yield. Leaf production interval was maximum in V. Katsuura x V. Fuchs Delight. Hence the leaf count was also minimum in this. However the leaf count was maximum in V. Prapawan which recorded the minimum interval of leaf production.

Angle of orientation of leaves benefit the plants by proper interception of light. Appreciable differences were recorded with respect to angle of orientation of leaves, such as straight and arching was noticed in the varieties evaluated.

In vanda orchids; roots are lengthier and hung freely thus indicating the need to cling to a support (Bose *et. al.* 1999). The aerial roots which arise from the basal portion of shoot or slightly above base help the plant in absorption of moisture and nutrients from atmosphere. Based on a study conducted in aerial root production in *Aranda* orchids, Goh (1983) reported that the pattern of root production is not controlled genetically but possibly by physiological and/or environmental factors. The varieties/hybrids exhibited wide variation in root characters viz., number, length and girth of roots. **The number of roots** was maximum in V. Apec Blue, followed by V. Pakchong Blue, while V. Varuvathe Pink recorded the minimum. **The longest roots were observed** in V. Anek Delight followed by V. Robert's Delight whereas, the length was minimum in V. Urbchitr x V. Bitz's Heartthrob. Besides, the roots have velamen tissues which help in easy absorption of moisture and nutrients through entire length.

5.1.2. Floral characters

Different flowering patterns were observed in orchids. Few flowered year-round whereas a few were seasonal. Soon (1980) opined that most hybrid orchids, which grow in the tropical lowlands, appear to be uninfluenced by day length and thus probably are day neutral plants. While Dressler (1981) stated that within the tropics, seasonality is primarily due to variation in rainfall. Majority of the orchid hybrids were prolific. Drastic differences were observed with regard to floral characters between varieties. Yong and Hew (2004) stated that juvenility, vernalisation and photoperiodism are the three important factors that determine when the plants will flower with respect to ontogeny and season. Plants often respond to changes in photoperiod and temperature so that they naturally flower when environmental conditions are favourable for reproduction (Lopez and Runkle, 2004).

Different genera of orchids differ in the growth requirements. Many species of *Arachnis*, *Ascocentrum*, *Renanthera* and *Vanda* require full sun for free flowering and any shading delays or suppresses the flowering process. Many of their hybrids, such as *Aranda* and *Aranthera* are known to behave in the same manner whereas *Phalaenopsis*, *Dendrobium* etc. require shading for flower production. (Soon, 1980).

According to Lee and Lin (1984), flower bud initiation occurred after the spike had reached a certain length under the required environmental conditions. Lopez and Runkle (2005) stated that once the flower buds have initiated, flower development time is dependent upon genotype and temperature. The duration from spike emergence to opening of first floret was minimum in *V. Apec Blue* followed by *V. Varuvathe Pink* and *V. Anek Delight* while *V. Urbchitr* x *V. Bitz's Heartthrob* took the maximum time, followed by *V. Madame Rattana*. It was observed that the vanda varieties/ hybrids open florets acropetally. Goh (1977) stated that flowers in the inflorescence of *Vanda-Arachnis* tribe open acropetally at one-day interval.

In monopodials, the stage of harvest is calculated based on the opening of 50 per cent of the florets. Of the varieties, *V. Anek Delight* could be harvested first, followed by *V. Varuvathe Pink*. *V. Urbchitr* x *V. Bitz's Heartthrob* and *V. Madame Rattana* attained harvestable stage late. The duration between spike emergence to opening of all florets also showed significant difference. *V. Urbchitr* x *V. Bitz's Heartthrob* recorded significantly longer periods for all the florets to open. *V. Anek Delight* recorded minimum number of days followed by *V. Varuvathe Pink* and *V. Apec Blue*.

Orchids with good spike length find a place in the cut flower trade while this is not a criterion for pot plants. Significant differences were observed in the length of spikes of the different varieties. Spike length was significantly higher in *V. Kultana Delight Red* followed by *V. Lumpini Red* x *V. Taweewan*, *V. Dr. Anek* x *V. Mimi Palmer* and *V. Dr. Anek* x *V. Bitz's Heartthrob*, whereas in *V. Pachara Delight Pink* recorded the minimum, followed by *V. Varuvathe Pink*. According to Robinson (2002), temperature has little or no effect on spike length.

Rachis area is given prime importance as it is the flower bearing area. V. Thailand Beauty recorded the maximum rachis (flowering area) length, followed by V. Lumpini Red x V. Taweewan, while V. Varuvathe Pink recorded the shortest rachis length, followed by V. Lanka Sri. pink, V. Katsuura x V. Fuchs Delight and V. Pachara Delight Pink. From the commercial point of view, rachis length has to be seen together with number and size of florets.

Spikes with good girth would be sturdier, hence it is more preferred. There was detectable variation in girth of spikes for most of the selected varieties. However, V. Urbchitr x V. Bitz's Heartthrob had the maximum spike girth, which was on par with V. Pakchong New Land x V. Annette Jones and V. Lumpini Red x V. Taweewan. Spike girth decides the space a spike occupies in arrangement and thus the probability of inclusion of different types in arrangement.

During the period of study, V. Pranermprai x V. *tessellata* and V. Pathum Gold produced maximum number of spikes/plant/year. The interval of spike production was less.

Significant differences were observed with respect to the number of florets produced per spike. Number of florets per spike was maximum in V. Thailand Beauty and was significantly superior to all others. It was followed by V. Red Gem and V. Lumpini Red x V. Taweewan and were on par with V. Pathum Gold. The number of florets was minimum in V. Varuvathe Pink, followed by V. Fuchs Delight and V. Pachara Delight Pink. The internodal length between florets at the base was maximum for V. Prapawan followed by V. Anek Delight, while it was minimum for V. Red Gem. This character gives a compact appearance in the rachis.

Spike longevity on the plant is generally an indicative of the longevity after harvest, a major criterion for increasing the commercial value of orchids. It depends on environmental conditions, genetic factors and incidence of pests and diseases. Under normal conditions of growth among the varieties evaluated, spikes of V. Madame Rattana were found to have maximum longevity and was followed by V.

Prapawan. Longevity of spike on the plant is also an important factor for choosing as pot plants.

Large showy flowers always attract attention and good floret size would be an added advantage. Lokesha and Vasudeva (1994) analyzed 746 Indian orchids and reported that those with large showy flowers were the most vulnerable for commercial exploitation and the most likely to be endangered species. Floret size is determined by the length and width of petals, which is a major attraction in most of the flowers. Among the varieties *V. Pompimol* had larger flowers and was on par with *V. Kasem's Delight* x *V. Bitz's Heartthrob*, followed by *V. Urbchitr* x *V. Bitz's Heartthrob*. *V. Red Gem* had small but very attractive florets, while *V. Thailand Beauty* and *V. Kultana Delight Red* also had smaller floret size.

Considerable variations were observed in vanda varieties/hybrids with respect to pedicel/flower stalk length. Flowers with good pedicel length are useful as corsages. Maximum pedicel length was recorded in *V. Dr. Anek* x *V. Bitz's Heartthrob*, followed by *V. Pompimol* and in *V. Red Gem*.

Labellum is an attractive floral part in most of the orchid flowers due to its varied shapes and colour tinges. Marked differences were noticed in quantitative characters like, length and width of labellum and column length.

Post harvest behaviour and lasting quality of flower species and cultivars vary considerably. In general, longevity is determined by senescence and wilting of petals. Spikes of *V. Katsuura* x *V. Fuchs Delight* recorded significantly longest vase life. It was minimum for *V. Robert's Delight*, followed by *V. Lumpini Red* x *V. Taweewan*. The opening of buds in vase indicates active growth of the inner tissues and hormonal functions in plant. Hence, it also contributes largely to the vase life. Maximum opening was recorded in *V. Red Gem* and the minimum in *V. Pakchong New Land* x *V. Annette Jones*.

The physiological loss in weight of the spike under vase conditions was maximum in *V. Lumpini Red* x *V. Taweewan* and this is related to water absorption and retention in the tissues.

5.2. QUALITATIVE CHARACTERS

Plant, leaf and floral characters were observed in all the vanda varieties and hybrids. These characters mainly help in identifying the varieties and have economic relevance.

All the vanda varieties/ hybrids were intermediate, climbing epiphytes. The shoot type observed were medium thick, sturdy, brown, with little or no branching. Root branching was present in all the varieties/ hybrids, although variation was shown in the intensity of branching. Primary roots and secondary roots were very prominent in some of the varieties. V. Fuchs Delight and V. Varuvathe Pink had very few aerial root branches, whereas varieties like V. Lanka Sri. pink and V. Dr. Anek x V. Mimi Palmer were thickly branched at the base. Root branching was seen to have influence on the health of the plant, as more absorption of water and minerals would be possible in such cases. The colour of roots was predominantly green in almost all the varieties. V. Pompimol had greenish brown roots, whereas V. Varuvathe Pink had dark green roots. The older roots were pale green and younger roots were dark green in some of the varieties like V. Dr. Anek x V. Mimi Palmer. According to Goh and Sung (1978), epiphytic species have aerial roots emerged from rhizome, grey coloured with a green apex and are covered by velamen. These roots arise from an above-ground stem, become exposed and free hanging or more often appress to an adjacent surface.

Leaves green coloured, most had channelled leaf, although some were deeply channelled like V. Thongchai, V. Pompimol and V. Prapawan. Some were widely channelled, whereas the older leaves were somewhat strap. Leaf texture was smooth and rigid, with no pigmentation or markings. Leaf margin entire; apex being tridentate, praemorse and emarginate. Orientation of leaves was found to be horizontal, straight, arching or horizontal with an arching tendency. All recorded sheathed leaf base. Sheath was green and membranous.

Flowering habit of different vanda orchids recorded a considerable variation. Some **had** peak flowering in February – June, **with** two blooming periods while the others were with three or single blooming period during a year. V. Thongchai, V. Robert's Delight and V. Thailand Beauty flowered thrice a year viz., Mar-Apr, July-Sep and Oct-Nov. The varieties, V. Katsuura x V. Fuchs Delight, V. Apec Blue, V. Fuchs Delight, V. Pachara Pink, V. Urbchitr x V. Bitz's Heartthrob, V. Lumpini Red, V. Madame Rattana, V. Prapawan and V. Dr. Anek x V. Mimi Palmer with two blooming periods. Whereas V. Dr. Anek, V. Pachong Blue, V. Pranernprai x V. *tessellata*, V. Pompimol, V. Lanka Sri. pink and V. Dr. Anek x V. Bitz's Heartthrob flowered only once a year. In V. Pathum Gold, short dearth period was observed only in Jan – Feb.

Sanford (1971), based on observations of West African orchids indicated that the blooming time response of some orchids is genetically controlled. The flowering season of orchids and its duration are both determined genetically (Goh and Arditti, 1985). During the period of study plants performed considerably well throughout. Goh (1984) recorded that several tropical lowland species were free flowering and produced flowers throughout the year and this freedom of flowering is said to be a genetic character. During the period of study, it was observed that flowering peaked from June-October and also during February-March. May and November received maximum rainfall and flowering showed a steep decline. Gordinez (1996) stated that flowering among epiphytic orchids peaked during the dry season and early rainy season and decreased with increase in rainfall. Decline in flowering from November-January could be attributed to shorter day lengths. Yong and Hew (2004) stated that the occurrence of flowering gradient in monopodial orchids appeared to be widespread. However, flowering gradient in monopodial orchids was not unique, as the same has been reported in other plants as well.

In all the varieties, inflorescence arise from lateral position, was oriented erect or, arching and the florets were displayed facing all the directions. Erect, straight spike may be an advantage as cut flower, but arching spike may as well be graceful.

Goh (1977) stated that orchid inflorescence is normally raceme or indeterminate. The flowering nature often indicates how plants are best grown; those with single and upright stems are usually grown in pots, whereas those with cascading and arching stems are ideal for planting towards the edge of a **shelf** (Squire, 2005).

Florets displayed a wide range of shape (obovate, oblong, elliptic), curvature (deflexed with incurved apex, incurved with deflexed apex or straight), petal margin (undulate, slightly undulate, entire), colour pattern (uniform, spotted, tessellated or blotched) and shades (white, yellow, red, **purple**, violet, blue, pink, magenta, brown, lavender and rose) and apex (bilobed, acute, obtuse or truncate) also differed. Griesbach (2005) opined that blue flower colour is rare in plants, including orchids, and a few orchids are naturally sky blue as in *Vanda coerulea*. Meanwhile orchids which attract moths at night are usually white in colour. Because of the **rarity** of this colour, blue flowered orchids are highly sought after.

Some had very attractive labellum. It is usually glabrous and attractively coloured. Some had even two or three colours on the labellum, with uniform, spotted or streaked colour patterns. The labellum colour and shape is an identifying character in many of the species. Column colour pattern also differed as uniform, streaked, blotched or spotted. Spur type was conical in most of the cases, except in *V. Robert's Delight* which had cylindrical spur and *V. Katsuura* x *V. Fuchs Delight* with saccate spur. Spur length also showed variation such as long, short or very short.

As far as flowers are concerned, fragrance is a remarkable character for general acceptability. Among the varieties/. hybrids of vanda evaluated, sweet fragrance was present only in *V. Pranermprai* x *V. tessellata*. Kaveriamma, (2007) evaluated forty monopodial orchids belonging to monogeneric, bigeneric and trigeneric origin and reported very sweet fragrance only in *Vanda Prolific* and *Aranda Deborah*. While the strongest fragrance persists in the species, a number of primary hybrids retain some degree of scent, but most often in the complex hybrids all traces of scent are usually lost. *Miltonopsis* and *Cattleya* are exceptional where hybrids are still sweeter (Rittershausen and Rittershausan, 1999).

A vital tool for evaluating a plant in terms of its economic feasibility, more importantly as cut flower and at times as pot plant (single spike stays for a very long time) is by the number of spikes produced by the plant per annum. The qualitative characters are also important for selection of varieties for commercial exploitation. These characters give visual effect for use as cut flowers and pot plants.

The foregoing discussion on the present study suggests that there were consistent differences in the growth performance of the selected vanda varieties/hybrids. Considering the overall quantitative and qualitative parameters, *V. Pathum Gold*, *V. Lumpini Red* x *V. Taweewan*, *V. Pachara Delight Pink*, *V. Apec Blue*, *V. Prapawan*, *V. Urbchitr* x *V. Bitz's Heartthrob* and *V. Thailand Beauty* were excellent, both for cut flower production and as pot plants. *V. Pranermprai* x *V. tessellata* and *V. Katsuura* x *V. Fuchs Delight* have more potential for use as cut flower whereas *V. Red Gem* and *V. Anek Delight* were excellent as pot plants.

The present study on evaluation of thirty vanda varieties for commercial exploitation was conducted under uniform growing conditions. Useful information has been obtained on growth differences and behaviour. It is necessary to conduct further studies to improve the yield and quality of cut flower and pot plants by critically studying the requirements of essential inputs in order to fully exploit the commercial feasibility. Post harvest handling techniques should also be standardized to maintain keeping quality for commercial exploitation as cut flower.

SUMMARY

6. SUMMARY

Evaluation of vanda orchids for commercial traits was conducted at the Department of Pomology and Floriculture, College of Horticulture, Vellanikkara, during 2013-2014. The main objective was to evaluate their field performance for commercial exploitation.

Thirty intermediate climbing vanda varieties/ hybrids were used for the study. The salient findings of the study are summarized here. They exhibited wide variation in both vegetative and floral characters.

- Maximum plant height was recorded in *V. Pompimol* (54.40 cm), followed by *V. Lumpini Red* x *V. Taweewan* (52.47 cm) while it was minimum in *V. Thailand Beauty* (15.33 cm).
- Appreciable differences were observed with regard to the plant spread. Maximum plant spread was observed in *V. Kasem's Delight* x *V. Bitz's Heartthrob* (70.60 cm) which was on par with *V. Pranernprai* x *V. tessellata* (70.53 cm) and minimum (27.23 cm) in *V. Pachara Delight Pink* followed by *V. Anek Delight* (31.40 cm).
- The vanda varieties/ hybrids were hanging type having medium sized, brown coloured shoots, with little or no branching.
- Shoot girth recorded maximum (4.33 cm) in *V. Taweesuksa* x *V. Kultana Gold* x *V. Green Gold* on par with *V. Sirilak* x *V. Bitz's Heartthrob* (4.17 cm), while it was minimum in *V. Varuvathe Pink* (2.67 cm), followed by *V. Prapawan* (2.80 cm).
- Internodal length among the selected plants was maximum (2.30 cm) in *V. Pakchong New Land* x *V. Annette Jones* and *V. Thailand Beauty* the minimum (0.83 cm).
- Initially, *V. Pachara Delight Pink* had the maximum number of leaves (19.33), followed by *V. Urbchitr* x *V. Bitz's Heartthrob* (18.67) and *V. Pakchong New*

Land x V. Annette Jones (18.33). But, by the end of study period, V. Prapawan recorded the maximum (21.00) and V. Apec Blue the minimum (7.67).

- Leaf length was maximum (37.00 cm) in V. Pompimol, leaf breadth in V. Lumpini Red x V. Taweewan (3.70 cm). V. Pompimol recorded the maximum leaf area (90.63 cm²).
- The interval of leaf production was minimum (54.00 days) in V. Lumpini Red x V. Taweewan, while V. Katsuura x V. Fuchs Delight recorded the maximum interval (349.30 days), which was followed by V. Thongchai (245.00 days).
- Most of the hybrids had channelled leaf, although some were deeply channelled like in V. Thongchai, V. Pompimol and V. Prapawan. In V. Pachara Delight Pink and V. Varuvathe Pink, the leaves were widely channelled and the older leaves were somewhat strap like in shape. Regarding the leaf texture, it was smooth and rigid in all the varieties/ hybrids. The leaves were green coloured with no pigmentation or markings, where leaf margin was entire.
- Three types of leaf apex were observed. Most were tridentate (V. Dr. Anek, V. Rothchildiana, V. Thongchai, V. Katsuura x V. Fuchs Delight, V. Apec Blue, V. Sirilak x V. Bitz's Heartthrob, V. Pachara Delight Pink, V. Pakchong New Land x V. Annette Jones) except in V. Taweeksu x V. Kultana Gold x V. Green Gold, V. Robert's Delight and V. Pakchong Blue, which were having praemorse leaf apex and V. Varuvathe Pink (emarginate apex).
- The leaves were oriented as straight or horizontal with an arching tendency. V. Thongchai was oriented horizontally whereas V. Pakchong Blue, V. Red Gem, V. Urbchitr x V. Bitz's Heartthrob, V. Pranermprai x V. *tessellata*, V. Pathom Gold, V. Robert's Delight and V. Dr. Anek x V. Mimi Palmer had arching orientation. V. Varuvathe Pink had straight orientation of leaves, whereas V. Pompimol, V. Prapawan, V. Dr. Anek, V. Apec Blue, V. Pachara

Delight Pink had straight with slightly arching orientation. All others were having horizontal orientation with an arching tendency.

- Root branching was present in all the varieties/ hybrids, although variation was shown in the intensity of branching, V. Fuchs Delight and V. Varuvathe Pink had very few aerial root branches, whereas varieties like V. Lanka Sri pink and V. Dr. Anek x V. Mimi Palmer were thickly branched at the base. The colour of the roots was more or less green in almost all the varieties.
- Vanda varieties differed in their length, girth and number of aerial roots. V. Anek Delight recorded the maximum (130.63 cm) root length, V. Lumpini Red x V. Taweewan the maximum root girth (2.27 cm). Number of aerial roots was maximum (20.00) in V. Apec Blue.
- Duration from spike emergence to opening of first floret and for 50 per cent florets was maximum by V. Urbchitr x V. Bitz's Heartthrob (31.00 and 37.33 days, respectively) and minimum in V. Apec Blue and V. Anek Delight (17.67 and 20.33 days, respectively). For all florets to open, V. Urbchitr x V. Bitz's Heartthrob recorded maximum duration (44.00 days) and V. Anek Delight, the minimum (21.67 days).
- Distinguishable differences were noticed with respect to the longevity of spike on the plant. Among the varieties, V. Madame Rattana recorded the maximum spike longevity (36.00 days) on the plant while V. Anek Delight had the minimum (15.00 days).
- The interval of spike production was maximum (380.67 days) in V. Pompimol while V. Pranermprai x V. *tessellata* produced spikes at minimum intervals (94.67 days).
- Maximum number of spikes was produced by V. Pathum Gold (3.7) followed by V. Pranermprai x V. *tessellata* (3.3). Annual spike production was minimum (1.0) in V. Pompimol, V. Anek Delight, V. Pakchong Blue and V. Taweesusksa x V. Kultana Gold x V. Green Gold.

- There was significant difference in the spike length among the different varieties/ hybrids. V. Kultana Delight Red recorded the maximum spike length (33.87 cm) and V. Pachara Delight Pink the minimum (8.23 cm).
- Among the varieties, V. Thailand Beauty had the maximum rachis length (21.83 cm), followed by V. Lumpini Red x V. Taweewan and V. Madame Rattana (17.00 cm, each) while V. Varuvathe Pink, the minimum (1.63 cm).
- Considerable variation was observed in the stalk length of the selected vanda varieties/ hybrids. Maximum stalk length (23.27 cm) was in V. Dr. Anek x V. Mimi Palmer, which was on par with V. Dr. Anek x V. Bitz's Heartthrob (22.67 cm) and V. Fuchs Delight x V. Bitz's Heartthrob (20.90 cm). While the minimum stalk length (1.46 cm) was in V. Pachara Delight Pink.
- Spike girth was maximum (2.50 cm) in V. Urbchitr x V. Bitz's Heartthrob and minimum (1.30 cm) in V. Varuvathe Pink.
- V. Thailand Beauty recorded maximum number of florets (23.33) and was significantly superior to all others. It was followed by V. Red Gem (17.00). V. Varuvathe Pink recorded the minimum (3.00).
- The internodal length between florets was maximum in V. Prapawan (2.40 cm) and was on par with V. Anek Delight (2.07 cm) whereas it was the minimum in V. Red Gem (0.63 cm).
- V. Pompimol recorded maximum flower size (138.06 cm²), followed by V. Kasem's Delight x V. Bitz's Heartthrob (130.80 cm²) and were significantly superior to all others. Size of the flower was minimum (16.80 cm²) in V. Red Gem and was on par with V. Thailand Beauty (20.68 cm²).
- Among the lip characters of flower, V. Pompimol recorded maximum lip length and V. Red Gem, the minimum. Whereas lip width was maximum in V. Dr. Anek x V. Bitz's Heartthrob and minimum in V. Red Gem.

- Flowers of vanda varieties/ hybrids showed considerable variation in column length also. Column length was maximum in V. Dr. Anek x V. Mimi Palmer while it was minimum in V. Red Gem.
- Individual floret life recorded varied significantly among vanda varieties/ hybrids. It was maximum in V. Katsuura x V. Fuchs Delight (18.33 days) followed by V. Varuvathe Pink (13.67 days). While V. Pakchong New Land x V. Annette Jones recorded the minimum (5.00 days).
- In all varieties, inflorescences were from lateral position and florets displayed in a manner facing all directions. Florets displayed a wide range of size, pattern and shades. Fragrance was observed only in V. Pranermprai x V. *tessellata*.
- Among the post harvest characters studied, V. Katsuura x V. Fuchs Delight and V. Thailand Beauty recorded the maximum (19.0 days) spike longevity (vase life) whereas V. Robert's Delight recorded the minimum (3.0 days).
- V. Red Gem recorded the maximum number of buds opening in vase and was significantly superior to all other varieties while, bud opening in vase was not observed in V. Pakchong New Land x V. Annette Jones, V. Lumpini Red x V. Taweewan and V. Robert's Delight.
- V. Lumpini Red x V. Taweewan recorded the maximum physiological loss in weight under vase conditions, followed by V. Urbchitr x V. Bitz's Heartthrob and it was minimum for V. Thongchai.
- The vanda varieties/ hybrids varied with regard to flowering or blooming period. The peak flowering period was from Feb-June. Most of the varieties were seasonal except V. Pathum Gold. In this variety short dearth period was observed only in Jan – Feb. V. Dr. Anek, V. Taweeksu x V. Kultana Gold x V. Green Gold, V. Pakchong Blue, V. Anek Delight, V. Pompimol, V. Lanka Sri pink and V. Dr. Anek x V. Bitz's Heartthrob bloomed once a year. Three flowering seasons were noticed in V. Thailand Beauty, V. Thongchai,

V. Katsuura x V. Fuchs Delight and V. Robert's Delight. All the others flowered twice a year.

- Significant variation could be observed in the floral parts (petal, lip, column, spur etc) of selected vanda varieties/ hybrids.
- Petal shape was obovate in majority of the varieties. In V. Lumpini Red x V. Taweewan, V. Sirilak x V. Bitz's Heartthrob, V. Thongchai and V. Urbchitr x V. Bitz's Heartthrob, the petal shape was found to be oblong. Whereas it was elliptic in V. Taweesuksa x V. Kultana Gold x V. Green Gold.
- Petal curvature was observed as deflexed with incurved apex (V. Dr. Anek, V. Rothchildiana, V. Katsuura x V. Fuchs Delight, V. Pakchong Blue, V. Pakchong New Land x V. Annette Jones, V. Lumpini Red x V. Taweewan), whereas majority had incurved with deflexed apex such as in V. Dr. Anek x V. Bitz's Heartthrob, V. Thailand Beauty, V. Robert's Delight, V. Lanka Sri pink, V. Pompimol. In V. Pranermprai x V. *tessellata*, V. Varuvathe Pink, V. Dr. Anek x V. Mimi Palmer, V. Fuchs Delight x V. Bitz's Heartthrob and V. Prapawan, the petal curvature was straight.
- Majority of the varieties had undulate petal margin whereas others had entire margin. In V. Prapawan, petal margin was slightly undulate.
- The petal colour pattern varied in the different varieties/ hybrids. The varieties had uniform colour pattern as in V. Apec Blue, V. Pakchong Blue, V. Robert's Delight or spotted colour pattern as in V. Thongchai, V. Sirilak x V. Bitz's Heartthrob. Tessellated pattern was seen in V. Taweesuksa x V. Kultana Gold x V. Green Gold, V. Pachara Delight Pink, V. Anek Delight. Blotched colour pattern was also found in some of the varieties.
- Lip mid-lobe shape was lanceolate in majority of the cases, but it was orbicular in V. Dr. Anek, V. Katsuura x V. Fuchs Delight, V. Taweesuksa x V. Kultana Gold x V. Green Gold, V. Pakchong Blue etc. Lip mid-lobe shape was ovate in V. Pakchong New Land x V. Annette Jones.

- Lip lateral-lobe shapes were found to be orbicular (V. Dr. Anek, V. Katsuura x V. Fuchs Delight, V. Taweesuksa x V. Kultana Gold x V. Green Gold, V. Pakchong Blue, V. Sirilak x V. Bitz's Heartthrob, V. Pachara Delight Pink), ovate (V. Rothchildiana, V. Thongchai, V. Pakchong New Land x V. Annette Jones, V. Pranermprai x V. *tessellata*, V. Pathum Gold, V. Pompimol, V. Varuvathe Pink and V. Robert's Delight) and lanceolate (V. Thailand Beauty, V. Prapawan, V. Fuchs Delight x V. Bitz's Heartthrob, V. Red Gem and V. Apec Blue).
- Wide variation was found in the lip curvatures of the different varieties/ hybrids. The lip curvature was found to be either straight or deflexed with incurved apex, deflexed with deflexed apex, deflexed with straight apex or incurved with incurved apex.
- Lip apex was observed to be biolobed in most of the cases, except in V. Sirilak x V. Bitz's Heartthrob (acute), V. Pachara Delight Pink (obtuse), V. Red Gem and V. Madame Rattana (truncate).
- The lip surface was glabrous in all the *Vanda* varieties/ hybrids selected for the study. And the lips were either single coloured or double coloured and in some of the cases triple coloured as in V. Pathum Gold and V. Robert's Delight.
- Lip colour pattern was uniform or streaked or spotted. Whereas the column colour pattern was streaked, blotched, spotted or uniform.
- Spur type was conical in most of the cases, while it was cylindrical (V. Robert's Delight) or saccate (V. Katsuura x V. Fuchs Delight). Most of the varieties had medium spur length, but some had long spur (V. Dr. Anek, V. Rothschildiana) whereas some had short spur (V. Thongchai, V. Sirilak x V. Bitz's Heartthrob), very short in V. Taweesuksa x V. Kultana Gold x V. Green Gold.

- The highest visual score for the characters for use as cut flower viz., colour and pigmentation, texture, shape and pattern as well as size of florets and arrangement of florets on spike was obtained in V. Pathum Gold and V. Lumpini Red x V. Taweewan (45.6, each), followed by V. Anek Delight (45.5), while V. Sirilak x V. Bitz's Heartthrob recorded the minimum (41.7).

Based on plant quality rating carried out with the characters like, fullness, growth and visual appearance viz., flower colour and pigmentation, spike longevity, shape and arrangement of foliage during the growth period, V. Pachara Delight Pink and V. Prapawan recorded the highest mean total score (45.1, each), whereas V. Dr. Anek had the lowest (39.7).

Considering the overall quantitative and qualitative parameters, V. Pathum Gold, V. Lumpini Red x V. Taweewan, V. Pachara Delight Pink, V. Apec Blue, V. Prapawan, V. Urbchitr x V. Bitz's Heartthrob and V. Thailand Beauty were excellent, both for cut flower production and as pot plants. V. Pranermprai x V. *tessellata* and V. Katsuura x V. Fuchs Delight have more potential for use as cut flower whereas V. Red Gem and V. Anek Delight were excellent as pot plants.

REFERENCES

REFERENCES

- Abraham, A. and Vatsala, P. 1981. *Introduction to Orchids*. Tropical Botanical Garden and Research Institute, Trivandrum. 533p.
- Alam, M. F., Sinha, P., and Hakim, M. L. 2006. Mass clonal propagation of *Vanda Teres* (Roxb.) Lindl through in-vitro culture of nodal segments. *Propagation of Ornamental Plants*. 6(3): 140-144.
- Amin, M. M. U., Mollah, M. S., Tania, S. A., Ahmad, M. R., and Khan, F. N. 2004. Performance study of six indigenous epiphytic monopodial orchids of Bangladesh. *J. Biol. Sciences*. 4(2): 87-89.
- Arditti, J. 1992. *Fundamentals of Orchid Biology*. John Wiley and Sons. Inc., New York, 691p.
- Arditti, J. 1993. *Micropropagation of orchids*. John Wiley and Sons, Inc., New York, 723p.
- Arora, R. K. 1983. Plant Diversity in the Indian Gene Centre. In: Paroda, R. S. and Arora, R. K. (eds), *Plant Genetic Resources Conservation and Management Concepts and Approaches*. International Board for Plant Genetic Resources Regional Office for South and Southeast Asia, New Delhi.
- Averyanov, L. V. and Christenson, E. A. 1998. A new *Vanda* species from IndoChina. *Orchid Digest*. (23): 27-29.

Behera, D., Chandi, C. R., and Mohapatra, U. 2013. *Medicinal Orchids in India and their Conservation: A Review*. In: Floriculture and Ornamental Biotechnology 7(1): 53-59.

Bhattacharjee, S. K. 1979. Photoperiodism effects on growth and flowering in some species of orchids. *Sci. Cult.* 45(7): 293-295.

Bhattacharjee, S. K., Pushkar, S., and Kumar, P. N. 2002. *Passport Data of Flower Crops Germplasm*. AICRP on Floriculture Technical Bulletin No. 23, Indian council of Agricultural Research, New Delhi. 210p.

Bleasdale, J. K. A. 1973. *Plant Physiology in Relation to Horticulture*. English language book Society and Mac Millan Press Ltd, London. 139p.

Bose, T. K. and Bhattacharjee, S. K. 1980. *Orchids in India*. Naya Prakash Publishers, Calcutta, West Bengal, India, 538p.

Bose, T. K., Bhattacharjee, S. K., Das, P. and Basak, U. C. 1999. *Orchids of India*. Naya Prokash, Kolkatta, 487p.

Chen, X., Lim, S. H., Wong, S. M., Lee, Y. H., Kuo, J., Yam, T. W., and Lin, J. J. 1999. Amplified fragment length polymorphism analysis of vandaceous orchids. *Plant Sci.* 141: 183-189.

Chowdhery, H. J. 2001. Orchid diversity in North-East India. *J. Orchid Soc. India* 15: 1-17.

Chun, T. Y. 1992. Conservation and propagation of wild orchids in Hong Kong. M.Sc. thesis, The University of Hong Kong, 255p.

Dai, J. and Paull, R. E. 1991. Effect of Water Status on *Dendrobium* Flower Spray Postharvest Life. *J. Am. Soc. Hort. Sci.* 116(3): 491-196.

Dash, P. K., Sahoo, S. and Subhasisa, B. 2008. Ethnobotanical Studies on Orchids of Niyamgiri Hill Ranges. *Ethnobotanical Leaflets* 12: 70-78.

De, L. C. and Debnath, N. G. 2011. *Vision 2030*. NRC for Orchids, Pakyong, Sikkim, 43p.

\

De, L. C., Vij, S. P., and Medhi, R. P. 2014. Postharvest Physiology and Technology in Orchids. *J. Hortic.* 1:1.

Doorn, W. G. 1999. Water relations of cut flowers; Some species of tropical provenance. Institute for Agrotechnological Research, The Netherlands. Proc. of the Int. Symp. on Cut Flowers in the Tropics. eds. Fischer, G. and Angarita, A. *Acta Horticulturae*, 482, ISHS 1999.

Dressler, R. L. 1981. *The Orchids, Natural History and Classification*. Harvard University Press, Cambridge, USA, 171p.

Dressler, R. L. 1993. *Phylogeny and classification of the orchid family*. Cambridge University Press, Melbourne, Australia, 223p.

Dycus, A. M. and Knudson, L. 1957. The role of the velamen of the aerial roots of orchids. *Botanical Gazette*. 119(2): 78-87.

Gajanana, T. M. 2006. Marketing of traditional and modern cut flowers. In: Rajeevan, P. K., Valsalakumari, P. K., Geetha, C. K., and Sudhadevi, P. K. (eds.), *Reflection on Indian Floribusiness*. Kerala Agricultural University, Thrissur, pp. 69-87.

Gardiner, L. M., Kocyan, A., Motes, M., Roberts, D. L., and Emerson, B. C. 2013. Molecular phylogenetics of *Vanda* and related genera (Orchidaceae). *Bot. J. Linnean Soc.* 173: 549–572.

Goh, C. J. 1977. Regulation of floral initiation and development in orchid hybrid *Aranda Deborah*. *Ann. Bot.* 41: 763-769.

Goh, C. J. 1983. Aerial root production in *Aranda* orchids. National University of Singapore. *Ann. Bot.* 51: 145-147 pp.

Goh, C. J. 1984. Physiology of flowering in orchids. In: Tan, K. N. (ed.), *Proceedings of the Eleventh World Orchid Conference*, Florida, pp.166-173.

Goh, C. J. and Arditti, J. 1985. Orchidaceae, In: A.H. Halevy (ed.), *Handb. of flowering: Vol. 1*. CRC Press, pp. 309-336.

Gordinez, E. S. 1996. Trends in the phenology of flowering in the Orchidaceae of Western Mexico. *Biotropica* 28(1): 130-136.

Griesbach, R. J. 2002. Development of Phalaenopsis Orchids for the Mass Market. In: Janick, J. and Whipkey, A. (eds.), *Trends in new crops and new uses*. ASHS Press, Alexandria, VA, pp. 147.

Griesbach, R. J. 2005. A Scientific approach to breeding blue orchids: exploring new frontiers in search of elusive flower colours. *Orchids*. 74(5): 378-379.

Grove, D. L. 1995. *Vandas and Ascocendas and their combinations with other genera*. Timber Press, Portland, 241p.

Halevy, A. H. 1986. Pollination induced corolla senescence. *Acta Hort.* 181: 21-32.

Harkema, H. and Struijlaart, P. F. 1989. Effect of aminooxyacetic acid on coloration of the labellum and longevity of cut cymbidium flowers. *Acta Horticulturae* 261: 293-304.

Ho, C. K. and Chen, C. C. 2003. Moscatillin from the orchid *Dendrobium loddigesii* is a potential anticancer agent. *Cancer Invest.* 21: 729–736.

Honda, T. and Saito, N. 2002. Recent progress in the chemistry of polyacylated anthocyanins as flower color pigments. *Heterocycles* 56: 633–692.

Islam, M. O., Akter, M., and Prodhan, A. K. M. A. 2011. Effect of potato extract on *in vitro* seed germination and seedling growth of local *Vanda roxburgii* orchid. *J. Bangladesh Agric. Univ.* 9(2): 211–215.

Johnson, T. R. 2007. Asymbiotic seed germination of *Vanda*: *in vitro* germination and development of three hybrids. Plant Cell, Tissue and Organ Culture. University of Florida, Gainesville, USA. *An Int. J. Biotech. Higher Plants*. MSc. Thesis. University of Florida.153p.

Kano, K. 1965. Studies on the media for orchid seed germination. *Mem. Fac. Agric.* Kagawa University, Japan, 20: 30-74.

Kaveriamma, M. M. 2007. Evaluation of monopodial orchids for cut flower. MSC. thesis. Kerala Agricultural University, Thrissur. 120 p.

Khasim, S. M. and Ramesh, G. 2010. Molecular and Morphological Studies in *Vanda tessellata*, an Epiphytic Orchid from the Eastern Ghats of India. In: M.G. Blanchard et al (eds.), *Proceedings of the First Int. Orchid Symposium* Department of Botany and Microbiology. Acharya Nagarjuna University, Guntur, Andhra Pradesh, India.. *Acta Hort.* 878p.

Kong, J. M., Goh, N. K., Chia, L. S., and Chia, T. F. 2003. Recent advances in traditional plant drugs and Orchids. *Acta Pharmacol.* 24: 7–21.

Kras, J. 1999. Marketing of cut flowers in the future. *Acta Hort.*, 482: 401-405.

Kumar, P., Pandey, A. K., Rawat, G. S., and Jalal, J. S. 2005. Diversity and conservation of orchids in state of Jharkhand, *Plant taxonomy: Advances and relevance*, CBS Publication, New Delhi, pp. 345-353.

Kumar, R., Deka, B. C., and Roy, A. R. 2012. Evaluation of Orchid species under Sub-tropical Mid-hills of Meghalaya. *Hort Flora Res. Spectrum* 1(1): 24-28.

Latha, P. G. and Jayasree, M. 2002. Vase life studies on *Vanda* 'John Clubb' inflorescences. *J. Phytological Res.* 15(2): 213-214.

Lee, N. and Lin, G. M. 1984. Effect of temperature on growth and flowering of *Phalaenopsis* white hybrid. *J. Chinese Soc. Hort. Sci.* 30: 223-231.

Lee, Y. H., Wong, S. M., Tan, W. K., and Goh, C. J. 1996. Breeding Vandaceous orchids for commercial cut-flowers in Singapore: An Overview. *Euphytica.* 89: 235-241.

Lim, S. H., Teng, P. C. P., Lee, Y. H., and Goh, C. J. 1999. RAPD Analysis of some species in the Genus *Vanda* (Orchidaceae). Department of Biological Sciences, National University of Singapore, *Ann. of Bot.* 83: 193-196.

Lim, W. L. and Loh, C. S. 2003. Endopolyploidy in *Vanda* Miss Joaquim (Orchidaceae). Department of Biological Sciences, National University of Singapore, *New Phytologist*. 159: 279–287pp.

Lokesha, R. and Vasudeva, R. 1994. Do floral features determine the endangered status of Indian Orchids. *J. Orchid Soc. India*. 8(1): 53-54.

Lopez, R. G. and Runkle, E. S. 2004. *The flowering of orchids* [on-line]. Available: <http://www.hrt.msu.edu/faculty/Runkle/Orchid/Articles/AOS%20Lopez%20and%20Runkle.pdf>. [26 Mar. 2007].

Lopez, R. G. and Runkle, E. S. 2005. Environmental physiology of growth and flowering of orchids. *Hort. Sci.* 40(7): 1969-1973.

Lu, C., Nugent, G., Terese, W., Chaudler, S. F., Young, R., and Dalling, M. J. 1991. Agrobacterium-mediated transformation of carnation (*Dianthus caryophyllus* L.). *Biotechnol.* 9: 864–868.

Luan, V. Q., Thien, N. Q., Khiem, D. V., and Nhut, D. T. 2006. In vitro germination capacity and plant recovery of some native and rare orchids. *Proceedings of International Workshop on Biotechnology in Agriculture*. Nong Lam University, Ho Chi Minh City, pp. 111.

Medhi, R. P. and Syamali C. 2009. Traditional knowledge of North Eastern people on conservation of wild orchids. *Indian J. Traditional Knowledge*. 8(1): 11-16.

Mercy, S. T. and Dale, B. 1997. *Orchids*. St. Josephs Press, Thiruvananthapuram, Kerala, India, 132p.

Mishra, S. 2005. Brief Report on the Orchids of Niyamgiri *Ethnobotanical Leaflets* 12: 70-78, 2008.

Mohanty, P., Das, M. C., Kumaria, S., and Tandon, P. 2011. High-efficiency cryopreservation of the medicinal orchid *Dendrobium nobile* Lindl. Plant Biotechnology Laboratory, Centre for Advanced Studies in Botany, North Eastern Hill University, Shillong, Meghalaya, India. Plant Cell, Tissue and Organ Culture (PCTOC). *J. Plant Biotech.* 109: 297-305.

Paul, R. E. 1991. Season and fertilization affects the post harvest flower life of anthurium. *Scientia Hort.*(in press).

Prakash, L., Lee, C. L., Loh, C. S., and Goh, C. J. 1996. *In vitro* propagation of commercial orchids: An assessment of current methodologies and development of a novel approach – thin cross-section culture. In: Islam, A. S. (ed.), Oxford and IBH Publishing Company, New Delhi. pp. 42-49.

Prakash, B., Khan, S. and Bais, R. T. 2013. Effect of different media on *In vitro* Seed Germination and Protocorm Formation of *Vanda tessellata* (Roxb.) Hook. Ex. G an endangered medicinal orchid. *Researcher* 5(4): 293p.

Rajbhandari, K. R. and Bhattarai, S. 2001. *Beautiful Orchids of Nepal*. Kishor Offset Press (P.) Ltd, Kathmandu, Nepal.

Rajeevan, P. K. 1995. The scenario of orchid industry in Kerala: Retrospective of a decade. *J. Orchid Soc. India.* 9(1): 1-5.

Rajeevan, P. K. 1997. Towards developing a sustainable orchid industry in India In: *Abstracts Cum Souvenir*, March 8-9, 2013, NRC for Orchids (Indian Council of Agricultural Research), Pakyong, Sikkim, 37p.

Rajeevan, P. K., Sobhana, A., Bhaskar, J., Swapna, S. and Bhattacharjee, S. K. 2002. *Orchids*. All India Co-ordinated Research Project on Floriculture, Indian Agricultural Research Institute, New Delhi, 62p.

Rajeevan, P. K. 2003. Orchids. In: Chadha, K. L. (ed.), *Handb. Of Hort.* Indian Council of Agriculture Research, New Delhi, pp. 573-577.

Ram, R. B., Lata, R., and Meena, M. L. 2011. Conservation of Floral Biodiversity of Himalayan Mountain Regions with Special Reference to Orchids. *Int. J. of Asian agric. Hist.* 15(3): 231-241.

Reddy, K.N., Subba G. V., Reddy, C. S., and Raju, V. S. 2005. Ethnobotany of certain orchids of Eastern Ghats, Andhra Pradesh, *ENVIS News Lett.* 3: 5-9.

Ritterhausen, W. and Ritterhausan, B. 1999. *Orchids*. Quadrille Publishing Ltd, Great Britain, 224p.

Robinson, K. A. 2002. Effects of temperature on the flower development rate and morphology of *Phalaenopsis* orchid. MSc(Ag) thesis, Mich. State University, East Lansing, 120p.

Sanford, W. W. 1971. The flowering time of West African orchids. *Bot. J. Linnear Soc.* 64: 163-181.

Sarmah, D. K., Borthakur, M., and Borua, P. K. 2010. Artificial seed production from encapsulated PLBs regenerated from leaf base of *Vanda coerulea* Griffth. ex. Lindl. – an endangered orchid. *Curr. Sci.* 98(5): 126-132.

Sartpetch, J., Jitareerat, P., Uthairatanakij, A., and Obsuwan, K. 2010. Postharvest Physiology of Harvested *Mokara* Inflorescences. Proc. of the First Int. Orchid Symp. eds.: Blanchard *et al.* *Acta Horticulturae*. 878, ISHS.

Seeni, S. and Latha, P. G. 2000. *In vitro* multiplication and ecorehabilitation of the endangered Blue Vanda. Plant Biotechnology Division, Tropical Botanic Garden and Research Institute, Pacha Palode, Thiruvananthapuram. *Plant Cell, Tissue and Organ Culture* 61: 1–8.

Sharma, K. P. 2008. Effects of harvesting stages and preservative solutions of vase life of *Mokara* Madame Panne cut orchid. M.Sc. thesis, Maejo University, Thailand, 94p.

Sharma, K. P., Jaroenkit, T., Usahatanonta, S., and Khamsee, Y. 2008. Postharvest Physiological Changes in Different Maturity Stages of ‘*Mokara* Madame Panne’ Cut Orchid. *Agric. Sci. J.* 39(3): 124-127.

Sheehan, T. 1960. Effects of nutrition and potting media on growth and flowering of certain epiphytic orchids. Florida State Horticultural Society. *J. Fla Agric. Experiment.* 1177: 563- 584.

Sheehan, T.J. 1961. Effects of nutrition and potting media on growth and flowering of certain epiphytic orchids. *American Orchid Society Bulletin* 30: 289-292.

Sheela, V. L. 2008. *Flowers for Trade. Vol. 10. Horticulture Science Series*. New India Publishing Agency, New Delhi, 369p.

Shobhana, A. and Rajeevan, P. K. (1993). In vitro multiple shoot production in *Dendrobium* as influenced by cytokinins. *J. Ornamental Hortic.* 1: 1-5.

Soon, T. E. 1980. *Asian Orchids*. Times Books International, Singapore, 287p.

Squire, D. 2005. *The Orchid Specialist*. New Holland Publishers, 80p.

Tatsuzawa, F., Saito, N., Seki, H., Yokoi, M., Yukawa, T., Shinoda, K., and Honda, T. 2004. Acylated anthocyanins in the flowers of *Vanda* (Orchidaceae). *Biochemical Systematics and Ecol.* 32: 651–664.

Thekkayan, S. G. 1996. Performance of selected orchids under varying light regimes, culture methods and nutrition. Ph.D. Thesis. Kerala Agricultural University. Thrissur. 346 p.

Thomas, B. and Rani, C. L. 2008. Assessment of floral characters in commercial varieties of monopodial orchids. Dept. of Plant Breeding and Genetics, College of Agriculture, Vellayani, Thiruvananthapuram. *J. Ornamental. Hort.* 11(1): 15-20.

Upadhyay, R. C. and Das, S. P. 2003. Prospects and potential of orchid export from India. *Indian Hortic.* 48(3): 22–23.

Uthairatanakij, A ., Jaime, A., Silva, T., and Obsuwan, K. 2007. Chitosan for Improving Orchid Production and Quality. *Orchid Sci. and Biotech.* 1(1): 1-5.

Yokoi, M. 1975. Colour and pigment distribution in the cultivars of selected ornamental plants, with special reference to their contribution to the ornamental value of plants. Transactions of Faculty of Horticulture, Chiba University 14, 20-28.

Yong, J. W. H. and Hew, C. S. 2004. *The Physiology of Tropical Orchids in Relation to the Industry*. World scientific. 370p [book on-line]. Available: <http://www.google.com/books?vid=ISBN981238801X>.

EVALUATION OF VANDA ORCHIDS FOR COMMERCIAL TRAITS

By
MINNU SEBASTIAN
(2012-12-108)

ABSTRACT

**DEPARTMENT OF POMOLOGY AND FLORICULTURE
COLLEGE OF HORTICULTURE
VELLANIKKARA, THRISSUR-680 656
KERALA, INDIA**

2015

ABSTRACT

The investigation on the evaluation of *Vanda* orchids was conducted at the Department of Pomology and Floriculture, College of Horticulture, Vellanikkara, during 2013-'14 with the objective of evaluating the field performance for commercial exploitation.

Thirty *Vanda* varieties/ hybrids were selected for the study. They were evaluated for their height, spread, shoot characters (nature, girth, internodal length), leaf characters (length, breadth, area, number, interval of leaf production, leaf sheath characters), root characters (length, girth, number), floral characters (days from spike emergence to opening, longevity of spike, interval of spike production, annual production of spike, blooming period, number of florets per spike, individual flower life, flower size, features of petal, lip and column) under field conditions, as well as post harvest parameters (spike longevity, number of buds opening in vase, physiological loss in weight, water uptake and floret span).

The varieties exhibited wide variation in both vegetative and floral characters. Maximum plant height was observed in *V. Pompimol* and the minimum in *V. Thailand Beauty*. *V. Kasem's Delight* x *V. Bitz's Heartthrob* recorded the maximum plant spread and *V. Pachara Delight Pink* the minimum. Shoot girth and internodal length were the maximum in *V. Taweesuksa* x *V. Kultana Gold* x *V. Green Gold* and *V. Pakchong New Land* x *V. Annette Jones*, respectively while the minimum was recorded by *V. Varuvathe Pink* and *V. Thailand Beauty*, respectively. Leaf number was maximum in *V. Prapawan* and the minimum in *V. Apec Blue*. Leaf length as well as leaf area were the maximum in *V. Pompimol*, whereas the least values for these characters were for *V. Prapawan* and *V. Anek Delight*, respectively. *V. Lumpini Red* x *V. Taweewan* recorded the maximum leaf breadth and *V. Fuchs Delight*, the minimum. Interval of leaf production was the maximum in *V. Katsuura* x *V. Fuchs Delight* and the least in *V. Lumpini Red* x *V. Taweewan*.

Among the vanda varieties, *V. Apec Blue* recorded, the maximum number of roots whereas *V. Anek Delight* and *V. Lumpini Red* x *V. Taweewan* had maximum root length and girth, respectively and the minimum was in *V. Varuvathe Pink*, *V. Urbchitr* x *V. Bitz's Heartthrob* and *V. Dr Anek* x *V. Bitz's Heartthrob*, respectively.

The duration from spike emergence to opening of florets was the maximum in *V. Urbchitr* x *V. Bitz's Heartthrob*. Time required for opening florets (first and 50%) was the least for *V. Apec Blue* and *V. Anek Delight*, respectively. Spike longevity was the maximum for *V. Madame Rattana* and the minimum for *V. Anek Delight*. Interval of spike production was the maximum in *V. Pompimol* and the minimum in *V. Pranermprai* x *V. tessellata*. Accordingly, annual spike production was the minimum in *V. Pompimol* and it was the highest in *V. Pathum Gold*.

Spike characters, like length was maximum in *V. Kultana Delight Red*, while girth in *V. Urbchitr* x *V. Bitz's Heartthrob*. The rachis length and number of florets were the maximum in *V. Thailand Beauty* and the minimum in *V. Varuvathe Pink*. The internodal length between florets was the maximum in *V. Prapawan* and the minimum in *V. Red Gem*. Lip length and flower size recorded the highest values in *V. Pompimol* whereas column length was the highest in *V. Dr Anek* x *V. Mimi Palmer*. All these characters were the lowest in *V. Red Gem*. The life of individual floret on the spike was the maximum for *V. Katsuura* x *V. Fuchs Delight* and the minimum in *V. Pakchong New Land* x *V. Annette Jones*.

Among the post harvest characters, spike longevity (vase life) was the maximum in *V. Katsuura* x *V. Fuchs Delight* followed by *V. Thailand Beauty* and the minimum in *V. Lumpini Red* x *V. Taweewan*. The life span of each floret was also high in *V. Katsuura* x *V. Fuchs Delight*.

The qualitative characters of vanda varieties/hybrids differed in all aspects. The leaves were channelled, smooth, rigid and green coloured, with no pigmentation. Three types of leaf apex, viz., tridentate, praemorse and emarginate were observed. The leaves were arranged alternately and were oriented as straight or horizontal with

an arching tendency. Varying petal shapes and curvatures were observed. The petal margin was undulated in most of the cases and rarely entire. Uniform, spotted as well as blotched colour patterns were seen in the petals. Lip-lobe shapes and lip curvature were varying in the varieties. Lip apex was bilobed in most cases; acute or truncate apices were also noticed. Lip surface was glabrous, usually single or double coloured whereas it was triple coloured in *V. Pathum Gold* and *V. Robert's Delight*. Lip colour pattern was uniform or streaked or spotted. The column colour pattern was uniform, streaked, blotched or spotted. Spur type was found to be cylindrical in most varieties and saccate in some. The variety *V. Pranermprai* x *V. tessellata* possessed good fragrance.

Considering the overall quantitative and qualitative parameters, *V. Pathum Gold*, *V. Lumpini Red* x *V. Taweewan*, *V. Pachara Delight Pink*, *V. Apec Blue*, *V. Prapawan*, *V. Urbchitr* x *V. Bitz's Heartthrob* and *V. Thailand Beauty* were excellent, both for cut flower production and as pot plants. *V. Pranermprai* x *V. tessellata* and *V. Katsuura* x *V. Fuchs Delight* have more potential for use as cut flower whereas *V. Red Gem* and *V. Anek Delight* were excellent as pot plants.

APPENDIX

APPENDIX

Monthly distribution of weather parameters during the experiment February 2013 – January 2014

Parameters	Feb '13	Mar '13	Apr '13	May '13	Jun '13	July '13	Aug '13	Sep '13	Oct '13	Nov '13	Dec '13	Jan '14
Mean maximum (°C)	34.7	35.4	34.9	33.6	28.5	28.4	29.9	30.0	30.8	32.6	31.9	32.1
Mean minimum (°C)	23.3	24.4	25.1	25.2	22.7	22.7	22.9	22.2	22.6	23.9	22.3	23.3
Mean RH (%)	57.0	64.0	71.0	77.0	90.0	91.0	84.0	85.0	83.0	73.0	61.0	74.0
Rainfall	84.4	14.6	0.0	99.1	103.8	932.3	305.9	344.1	369.8	82.0	0.5	0.0
No. of rainy days	2.0	2.0	0.0	5.0	28.0	30.0	16.0	17.0	16.0	5.0	0.0	0.0
Mean sunshine hours	8.6	7.1	6.5	4.0	1.0	0.8	4.3	3.7	5.3	6.2	7.2	9.0

