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Assessment of the Performance of Pot Phalaenopsis Orchids for Pre-Flowering Growth under Shade Net

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ABSTRACT: Phalaenopsis (*Phalaenopsis* sp.) is one of the most economically important genera of orchids, popularly grown as an ornamental potted plant and for cut flowers throughout the world. However, its vegetative growth is slow and largely influenced by different environmental conditions, which has a greater impact on flowering characteristics. Therefore, assessment of its suitability for a specific location is necessary. The present study was carried out in Botanical Garden, Department of Floriculture and Landscape Architecture, Tamil Nadu Agricultural University, Coimbatore. Eight varieties of Phalaenopsis orchid were assessed for growth under shade net house condition. The study revealed that among the eight different varieties assessed, Washington recorded the maximum plant height (22.20 cm), leaf length (20.34 cm), leaf breadth (6.58 cm) and number of roots per plant (20.66). The maximum number of leaves per plant (5.24) was observed in the variety Cali. However, this variety registered minimum values for the other vegetative parameters recorded. Physiological growth parameters *viz.* leaf area (94.92 cm^2), chlorophyll index (59.11 SPAD units), and photosynthetic rate (15.17 µ mol m^{-2} s^{-1}) were registered maximum in the variety Washington, while transpiration rate (0.86 m mol m^{-2} s^{-1}) and leaf temperature (42ºC) were registered maximum in the variety Durban. Assessment of vegetative and physiological growth parameters led to the inference that the variety Washington, Bilbao and Nottingham had better overall adaptability, while Cali had a compact growth habit owing to more number of leaves. Suitability of these varieties as pot plants for tropical conditions will be assessed further based on their flowering potentials.

Keywords: Orchids, Phalaenopsis, Environmental conditions, Shade net, Vegetative parameters.

INTRODUCTION

Floriculture and landscaping has been identified by the Indian government as a lucrative industry with 100% export focus (Vahoniya *et al.*, 2018). This sector has flourished as a blooming enterprise due to the constantly increasing need for floriculture products such as cut flowers, loose flowers, pot plants, foliage plants and dry flowers as well the increasing demand for establishment of outdoor and indoor gardens (Rajendran and Smitha 2016). Flowers are the most intriguing creations on the planet because of their many different colours, shapes, sizes and forms (Waser, 1983). Indoor gardening which is a rapidly growing area in recent years relies heavily on potted plants (Gabellini & Scaramuzzi 2022). Factors such as the recent Covid-19 pandemic and the increasing rates of outdoor and indoor pollution have laid greater emphasis on safe and healthier indoor environments (Agarwal *et al.*, 2021). Indoor flowering pot plants are the best choice for meeting these requirements and among the indoor flowering plants, orchids are the most highly valued plant group. Orchids are also considered as a symbol of royalty, with the most spectacular flowers and unique plant architecture. As a result, people in urbanized areas are evincing increasing interest in orchids, resulting in a large demand for these plants, which in turn has increased the scope of benefits to farmers to cultivate these plants and nursery men to

propagate these plants on large scale. Orchids are mostly used for two purposes; as cut flowers for various decorations, as well as potted plants for their aesthetic appearance in interior landscapes for homes, shopping malls, gardens, offices and educational institutions (Khuraijam *et al.*, 2017).

Orchids belongs to the most evolved and second largest family in Angiosperms, Orchidaceae with around 800 genera and 22,500 species (Mabberley, 2008; Singh *et al.*, 2019). More than one lakh hybrids have been identified and are being produced around the world. The eastern Himalayas, western and southern Indian hills, the north-eastern Himalayan region and Kerala's west coast are the main orchid-producing areas (Rajeevan & Sobhana 1993). Phalaenopsis is the most common monopodial epiphytic orchid found in warm temperate zones and it is highly appreciated as a cut flower and ornamental potted plant. It is commonly called as moth orchids. The genus Phalaenopsis was first formally described by Carl Ludwig Blume in 1825 and as 70 species native to India, Taiwan, China, Southeast Asia, and Australia with majority in Indonesia and Philippines. It has been constantly ranked among the best sellers in the world potted plant trade, owing to the easy growing and flowering under manmade infrastructure (De, 2020). Phalaenopsis is naturally grown in evergreen forests in tropical and sub-tropical Asia, characterized by constant shade, humid and warm conditions.

The growth of Phalaenopsis can be divided into three stages. The vegetative phase is the longest, lasting on an average till 35 to 40 weeks from the time the plants are moved to polyhouse or shade net house after being propagated. Phalaenopsis requires relatively higher temperatures (28°C) during vegetative phase, which stimulates leaf initiation and expansion while inhibiting blooming (Runkle, 2018) and thrives best in the environment with low temperature and humidity levels of ≥50%. Plants grow vigorously and the leaves appear healthy when there is enough humidity. Humidity in polyhouse may be readily managed by foggers, watering the walkway, or using a humidifier. Companion plants such as ferns, bromeliads, and other leaf plants can be placed near the Phalaenopsis plant in the growing environment also boost the humidity level. The performance of any crop or variety greatly depends on genotypic environmental interaction. So change in environmental conditions changes performance of varieties. Therefore, it is necessary to assess the suitability of different varieties under location specific conditions.

Since there is limited previous research on this species in the climatic circumstances of Tamil Nadu and considering the long vegetative phase of Phalaenopsis orchid, the present study was taken up. Findings of this study will aid farmers and nurserymen venturing into cultivation of Phalaenopsis orchids, as well as landscape architects involved in indoor gardening and landscaping.

MATERIALS AND METHODS

The present study was carried out in the Botanical Garden, Department of Floriculture and Landscape Architecture, Tamil Nadu Agricultural University, Coimbatore in 2022 under 75% shade net condition to assess the comparative performance of eight different varieties of Pot Phalaenopsis. The varieties assessed were Andorra, Bilbao, Cali, Durban, Nottingham, Torino, Volterra and Washington. Planting materials were 6 months old tissue cultured plants, sourced from Florance Flora Pvt. Ltd, a popular public authorized ornamental plant supplier in Bengaluru. The plants were planted in 12 cm height and 13.5 cm width transparent polypropylene orchid pots. Broken brick and tile pieces, charcoal and coco peat were used to make the potting media. The experiment was carried out in CRD with eight treatments, three replications and ten plants in each replication. Overhead misting was used to irrigate the plants. Temperature, relative humidity (RH) and light intensity were measured at weekly intervals during the period of experiment. The weekly mean temperature, relative humidity and light intensity during the crop period ranged from 28 to 35°, RH 60 to 75 % and 3000 to 6000 foot candles (fc) respectively. The vegetative and physiological parameters were recorded and analyzed statistically.

Physiological parameters namely, net rate of photosynthesis (µmol CO_2 M^{-2} S^{-1}), transpiration rate (mol H_2O M^{-2} S^{-1}) and leaf temperature (ºC) were recorded using Portable Photosynthesis system (LI-6400 XT; LI-COR Inc. Lincoln, Nebraska, USA). Chlorophyll meter from Minolta (model 502 of Minolta, Japan) was used to measure SPAD values (Chlorophyll index). The most recently matured leaf was used to measure the recordings. Leaf area was measured using Leaf Area Meter (Licor Model 3100) and expressed as cm^2 $plant^{-1}$.

RESULTS AND DISCUSSION

Vegetative parameters. The statistically analyzed data pertaining vegetative parameters namely, plant height, number of leaves per plant, leaf length, leaf breadth, internodal length and number of roots per plant are presented in Table 1.

The results of the present study revealed significant variations among the eight Phalaenopsis varieties for the various vegetative parameters assessed (Table 1).

Table 1: Vegetative growth parameters of pot Phalaenopsis varieties under shade net condition at three months after transplanting.

Variety	Plant height (cm)	No. of leaves/ plant^{-1}	Leaf length (cm)	Leaf breath (cm)	Internodal length (cm)	No. of roots/plant
Andorra	19.10	4.67	16.31	5.10	1.03	11.53
Bilbao	22.01	4.68	19.77	6.29	1.23	17.77
Cali	14.40	5.24	13.19	3.60	0.60	10.10
Durban	17.50	4.08	16.00	5.40	1.04	10.21
Nottingham	21.8	4.15	18.76	6.02	1.18	14.80
Torino	21.56	3.69	17.12	5.95	1.02	10.11
Volterra	20.40	3.78	17.58	6.00	1.17	14.31
Washington	22.20	3.29	20.34	6.45	1.30	20.66
SEd	0.433	0.110	0.370	0.119	0.021	0.328
CD (0.05)	0.918	0.233	0.784	0.237	0.045	0.697
CV %	2.670	3.21	2.61	2.45	2.42	2.94

The variety Washington recorded maximum plant height (22.20 cm) followed by Bilbao (22.01 cm), while the least plant height was recorded in the variety Cali (14.40 cm) (Fig. 1 A). The varieties varied significantly for plant height, this can be attributed to genetic makeup and level of impact of biotic and abiotic factors on plant varieties. This observation is in accordance with the report of Singh *et al.* (2014) who conducted evaluation study on ten different varieties of Phalaenopsis under West Bengal situation, Anand *et al.* (2013) in orchid species in Shevaroy hills of Eastern Ghats and Sahare *et al.* (2018) in anthurium under south Gujarat condition.

Leaves are the functional unit of photosynthesis, having a significant influence on growth and yield metrics. In the present study, the number of leaves varied significantly among the varieties tested. This is also attributable mostly to the plant's genetic makeup, environmental parameters including temperature range, light intensity and relative humidity. Among the different varieties assessed, Cali recorded the highest number of leaves per plant (5.24), followed by Bilbao (4.68) (Fig. 1 B). The variety Washington which had registered the highest plant height, leaf length and leaf breadth recorded the lowest number of leaves per plant (3.29). Similar observations were reported earlier in *Dendrobium* sp by Pachuau and Fatmi (2007); Fadelah (2007) in Dendrobium at Malaysia, Singh *et al*. (2014) in Phalaenopsis under controlled condition in West Bengal, Biswal *et al.* (2017) in Dendrobium at Odisha, Nataraj *et al.* (2019) in anthurium under hilly zone of Karnataka.

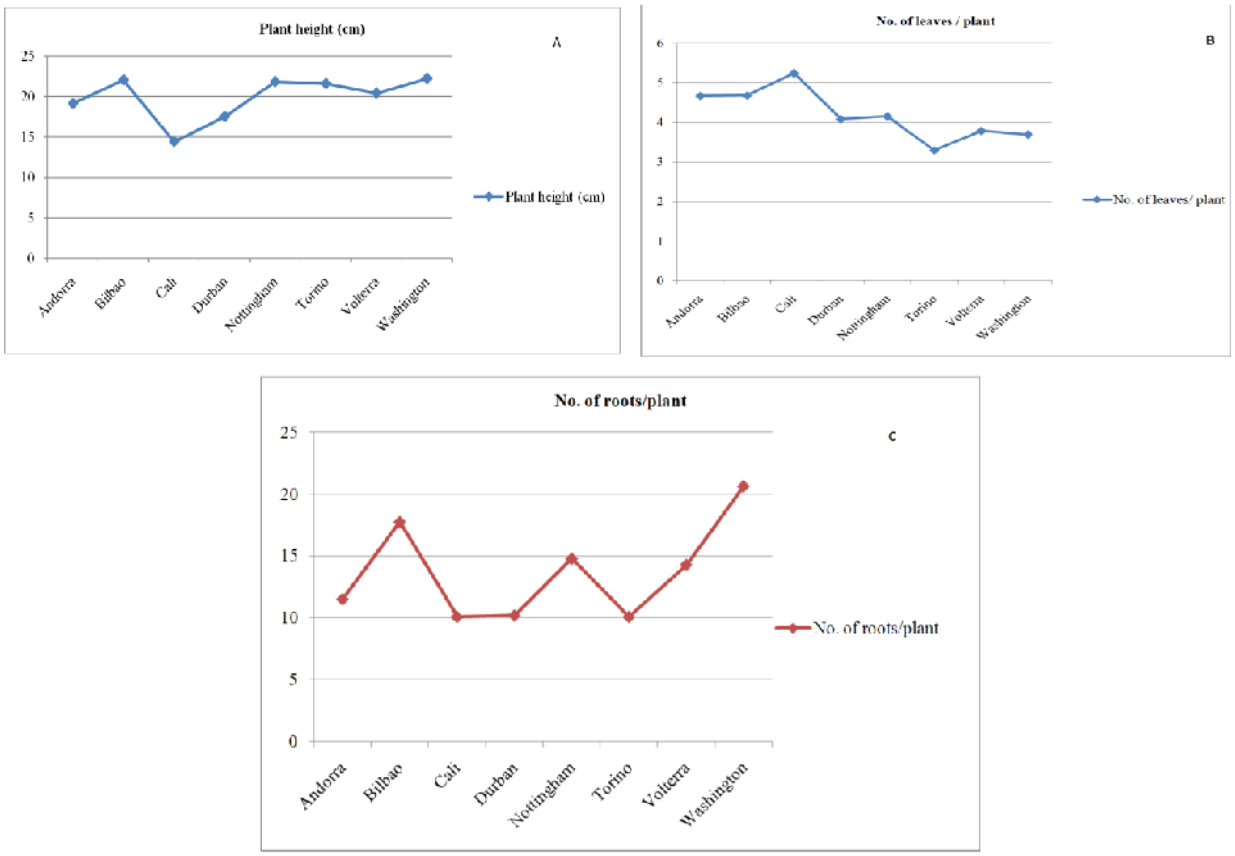
The leaf length and leaf breadth of the Phalaenopsis varieties differed greatly from variety to variety and had a stronger impact on other plant characteristics and these factors are heavily influenced by the genetic makeup and environmental parameters. As the leaf length increased, the leaf drooped and limited the surface area exposed to appropriate sunlight, lowering the efficiency of plant photosynthesis. Hence, the size of leaf length and leaf breadth should be adequate, so that it is appropriately exposed to proper sunlight for optimal growth. The presence of leaves that are longer and narrower than the older ones suggests that the light level is lower than the optimal level (Dewi *et al*., 2014). The variety Washington had the maximum leaf length (20.34 cm) and leaf breadth (6.58 cm), facilitating outstanding growth in comparison to the other varieties. This might be due favorable environmental conditions of shade net house providing optimal temperature, humidity, ventilation and light intensity, which aid in efficient metabolic processes of the plants. Leaf length and breadth play a major role influencing photosynthetic efficiency and plant spread. The leaves with more breadth and less length exposed more surface for photosynthesis whereas, leaves with more length and less breadth drooped down which ultimately reduced its surface area for photosynthesis which might affect the growth of plant. Similar results were noticed earlier in Phalaenopsis variety by Singh *et al.* (2014). In the present study, the variety Cali recorded the shortest leaf length (13.19 cm) and leaf breadth (3.74 cm), thereby reducing the leaf area exposed to sunlight and plant's ability to grow and develop rapidly. These results corresponded with the findings of Barman and Naik (2017) in Cymbidium and Roychowdhury *et al*. (2004) in Dendrobium orchid hybrids respectively and Singh *et al.* (2014) in Phalaenopsis at West Bengal.

The variation in internodal length was found significant among the varieties studied, variety the highest and lowest internodal length was registered in the varities Washington (1.30 cm) and Cali (0.60cm) respectively. The length of the internode determines the position and orientation of the leaves, which is a crucial aspect in exposing the plant's surface spread. Higher the length of internode, more the exposure of the leaf to the sunlight and aeration. These results confirmed with the observations of Thomas and Lekharani (2008) in monopodial orchids, Singh *et al*. (2014) in Phalaenopsis under West Bengal condition, Sugapriya *et al.* (2012) in Dendrobiuum in zones of Karanataka.

In orchid plants, roots are one of the most impressive structures because they are highly modified to aid in the absorption of moisture and minerals from the medium,

which is essential for proper plant growth and development. For a successful plant establishment, good root growth is the most crucial aspect. Root growth is mostly influenced by the plant's genetic makeup, media used (Hwang & Jeong 2007) and environmental condition. Among the varieties assessed in the present study, Washington had recorded the maximum number of roots per plant (20.66) which had shown better performance among the varieties assessed and the variety Cali had recorded the lowest (10.10) (Fig. 1 C). This indicates that the plant growth is largely influenced by root growth. Similar results has been noticed in Dendrobium by Thirugnanavel *et al.* (2019).

Physiological parameters. The statistically analyzed data pertaining to leaf area, photosynthetic rate, transpiration rate, chlorophyll index and leaf temperature are presented in Table 2.



(A) Plant height (B) Number of leaves/plant (C) No. of roots/plant

Fig. 1. Graphical representation of vegetative growth parameters of pot Phalaenopsis varieties.

Table 2: Physiological parameters of Pot Phalaenopsis varieties under shade net condition at three months after transplanting.

Variety	Leaf area (cm^2)	Photosynthetic rate (µ mol $m^{-2}s^{-1}$)	Transpiration rate (m mol $m^{-2}s^{-1}$)	Chlorophyll index (SPAD units)	Leaf temperature (ºC)
Andorra	75.87	10.86	0.66	50.42	39.24
Bilbao	92.74	13.89	0.53	53.67	39.55
Cali	35.27	6.51	0.09	48.23	37.15
Durban	83.48	11.10	0.86	47.92	42.15
Nottingham	91.99	13.63	0.21	52.71	40.15
Torino	64.50	9.68	0.85	51.41	39.51
Volterra	59.30	12.98	0.66	52.43	40.21
Washington	94.92	15.17	0.20	58.78	38.92
SEd	1.728	0.433	0.009	1.073	0.648
CD (0.05)	3.663	0.918	0.019	2.274	1.375
CV %	2.830	2.670	2.24	2.53	2.01

The results showed significant differences among the varieties. Increased leaf area will cause the net assimilation rate increase so that the rate of growth also gets increased (Pollet *et al.*, 2010). In the present study, the variety Washington had registered highest leaf area (94.92 cm^2) and Cali recorded the lowest leaf area (35.27 cm^2) the results are in agreement with the findings of Nair and Shiva (2003); Bhattacharjee (1981). Leaf chlorophyll index of any plant is greatly impacted by its leaf size and area. The maximum chlorophyll concentration was found in plants with larger leaf area, which may have enhanced photosynthetic processes and influenced better plant growth and development (Ling & Subramaniam 2007). The same variety Washington has recorded maximum chlorophyll index (58.78 SPAD units) and Cali has recorded minimum chlorophyll index (47.92 SPAD units). Identical difference in leaf chlorophyll index between varieties was also reported by Shiragur *et al.* (2004). Photosynthetic capacity is an important indicator that explains the physiological activity and potentiality for vegetative development of the plants (Chen *et al.*, 2008). The variety Washington had recorded high photosynthetic rate (15.17 µ mol m^{-2} s^{-1}) and Cali recorded least photosynthetic rate (6.51 µ mol m^{-2} s^{-1}). The enhanced photosynthesis was accompanied by an increase in the ability to consume CO_2, which was influenced greatly by growing environment and genotypes (Pollet *et al.*, 2010). The size of leaves of the plants are key factor in determining its ability to capture solar energy for photosynthesis, which has a significant impact on plant growth and development. The variety Durban has shown maximum transpiration rate (0.86 m mol m^{-2} s^{-1}) and leaf temperature (42.15ºC), while Cali has shown least transpiration rate (0.09 m mol m^{-2} s^{-1}) and leaf temperature (37.15ºC). This may be due to leaf size parameters and plant adaption capacity.

CONCLUSION

In the present study, it could be observed that the variety Washington outperformed the other varieties in terms of both vegetative and physiological parameters *viz*. plant height, leaf length, leaf breadth, leaf area, internodal length, root growth, leaf area, chlorophyll index, photosynthetic rate, transpiration rate and leaf temperature under shade net conditions. The variety Cali with more number of leaves was found to have a compact growth form compared to the other varieties. Thus, assessment of vegetative growth parameters in the present study led to the inference that the variety Washington had better adaptability followed by the varieties Bilbao and Nottingham. On the other hand, the variety Cali had a compact growth habit owing to more number of leaves. Suitability of these varieties as pot plants for tropical conditions will be assessed further based on their flowering potentials.

FUTURE SCOPE

As cut flowers and flowering plants for pots, Phalaenopsis orchids are considered as one among the best choices in world. Japan, China, Germany, The Netherlands, Taiwan, Malaysia and India have extensive cut-orchid or potted orchid production since recent past few years. Corsages, boutonnieres, flower arrangements, cornucopias and bouquets made by them are the prettiest around. Growing Phalaenopsis orchids is now a successful business since the ornamental crop sector is quickly becoming a cutting-edge industry with trade in cut flowers, cut foliage, potted plants, bulbous plants, and value-added items.

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Conflict of Interest. None.

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