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Selection of Proper Medium and Amount of Applied Fertilizer for Exportable *Cymbidium* Young Plants Grown in Korea

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Abstract. Bark is a general medium for potted *Cymbidium* in Korea, but it is difficult to shake off or eliminate the medium from the roots before exporting the potted plants. This working process can injure the roots and then deteriorate plant marketability. This study was carried out to select the optimum medium easier to eliminate from the roots instead of bark and the optimum amount of applied fertilizer to improve the plant growth. *Cymbidium* young plants 'Honey Hot' and 'Desert Look' were planted in pots with bark, cocochip, and peatmoss. The plants were treated with 2, 4, and 6 g of slow release fertilizer. The plant growth characteristics were investigated in the first and second years during production period of three years. The medium characteristics and mineral nutrient content of the leaves were also examined in the second year. In the first year, the plant growth of 'Desert Look' was improved in all peatmoss treatments more than bark. 'Honey Hot' showed the highest plant growth values in the bark treatment. In the second year, the plant growth of the two cultivars was improved in peatmoss. Cocochip treatments showed the lower plant growth values than bark and peatmoss in the first and second year. There was no significant difference among fertilizer amounts in all the media. The higher CEC values of peatmoss medium resulted to higher capacity to hold more nutrients than bark, and the nutrient retention of the peatmoss improved the plant growth. The higher K and Ca contents in the leaves would contribute to improve the plant growth. Consequently, it would be possible to use peatmoss instead of bark for *Cymbidium* young plants, but there must be always attention to appropriately water the medium and manage the moisture.

Key words : bark, calcium, cation exchange capacity (CEC), cocochip, peatmoss

Introduction

Orchids are marketed globally as cut flowers for corsages, floral arrangements, and bouquets; as potted flowering plants; and as bedding or aerial plants in tropical regions (Lopez and Runkle, 2005). The world consumption of orchids (potted plants) was valued at more than $500 million in 2000 (Wang, 2004). Countries with large-scale potted orchid production include China, Germany, Japan, The Netherlands, Taiwan, Thailand, and the United States (Griesbach, 2000). Korea had 253ha for orchid production in 2009, which accounted for 20% of the total area of pot plant cultivation (Ministry for Food, Agriculture, Forestry and Fisheries, 2010). The total value of *Cymbidium* was US$ 33million in 2009, occupying 35% the total value of all orchid flowering plants in Korea. Commercial cultivation was started in 1980's when standard *Cymbidium* was introduced from Japan and it became one of strategic pot flowers for export to China from the beginning of 1997 (Lee et al., 2007).

Bark is a traditionally-used medium for potted *Cymbidium* in Korea, but it is difficult to shake off or eliminate the medium from the roots before exporting the plants. This working process can injure the roots and then deteriorate plant marketability. The procedure to remove the media is labor-intensive which increases production cost, because of the orchid's succulent roots and the bark chips. Because bark does not hold much water, frequent watering is needed and then plants recover slowly after being in transit for many days (Wang and Gregg, 1994). Additionally, bark decomposes quickly, resulting in nutrient deficiency, poor aeration, low pH, pest infestation, and frequent repotting. Therefore, media with smaller particle sizes need to be developed to provide better root contact and evaluated for mass production of this orchid.

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Cymbidium young plants are generally grown for two years and the flowering plants are trade on the market in the third year. Fertilizer requirements must also be determined during this period for various media.

This study was carried out to select the proper medium easier to eliminate from the *Cymbidium* young plants instead of bark and the amount of applied fertilizer to improve the plant growth.

Materials and Methods

Cymbidium young plants 'Honey Hot' and 'Desert Look' were planted in pots with bark, cocochip, and peatmoss on 25 October, 2007 (Table 1). The plants were treated with 2, 4, and 6 g of slow release fertilizer (OsmocotePlus 15+11+13+2MgO+TE, Scotts).

1. Measurements of the media

pH and EC values were measured by hydration of each dry sample (20 mL) for 1 h with 100 mL of distilled water and filtering. The cation exchange capacity (CEC) was measured by the Brown method (RDA, 2000). Each dry sample of 5 g was hydrated for 30 min with 1 N HOAc (pH 2.31) and pH values were measured. CEC was calculated by following formula:

Total exchangeable cation ($cmol^+/kg$)
$= (\text{measured pH}-2.31) \times 22$

2. Plant growth and mineral nutrient content of leaves

The plant characteristics like leaf length, leaf width, number of leaves, pseudobulb width, new shoot length, new shoot width, number of new shoots, and bulb width of new shoot were investigated in the first and second years (2 May, 2008 and 4 March, 2009). Dry weight was measured after drying the plants for 72 h at 70°C. Dry sample (500 mg) from leaves was ground in a stainless mill and hydrolyzed with 10 mL of 50% perchloric acid and 1 mL of conc. sulfuric acid at 300°C. Total nitrogen (T-N) was measured by the Indophenol-Blue method (RDA, 1988). Samples were analyzed for phosphate by the Vanadate method (Murphy and Riley, 1962). K, Ca, and Mg were measured by atomic absorption spectroscopy (Spectra AA 880, Varian).

Table 1. Sorts of media and amounts of slow release fertilizer for potted *Cymbidium* in this study.

Treatment	Media	Amount of fertilizer (g)
1	Cocochip	2
2		4
3		6
4	Bark	2
5	Peatmoss	2
6		4
7		6

3. Statistical analysis

The least significant difference (LSD) at 5% was analyzed for plant growth parameters using the SAS system (Version 9.1, SAS Institute Inc., Cary, NC, USA). SigmaPlot (Ver 9.01, Systat Software Inc., San Jose, CA, USA) was used.

Results and Discussion

1. Characteristics of the media

The pH range was from 3 to 4 in all the media (Fig. 1). The EC values were highest in the bark treatment than the other media. The EC values of cocochip were higher than that of peatmoss, and there was no significant difference among fertilizer amounts in the two media. The CEC values were higher in peatmoss and cocochip treatments than that of bark without significant difference among fertilizer amounts in the two media.

It could be supposed that the retained mineral nutrients leached from the media during the EC measurement and bark leached the most amount of nutrients compared with the other two media. These results were opposite to other studies. According to Wang and Konow (2002), leached samples taken from the bark-peat medium had higher EC than that from the bark, indicative of the former being able to retain higher amounts of nutrients. But the results of CEC values in this research corresponded to other studies. The CEC indicates the capacity of the medium to hold positively-charged nutrient ions. And the greater the CEC, the more nutrient ions the medium will hold (Dole and Wilkins, 1999). It was also well known that peat has a higher CEC than bark (Wang and Konow, 2002). As a result, peatmoss and cocochip media showed a higher capacity to hold nutrient ions than bark in this study.

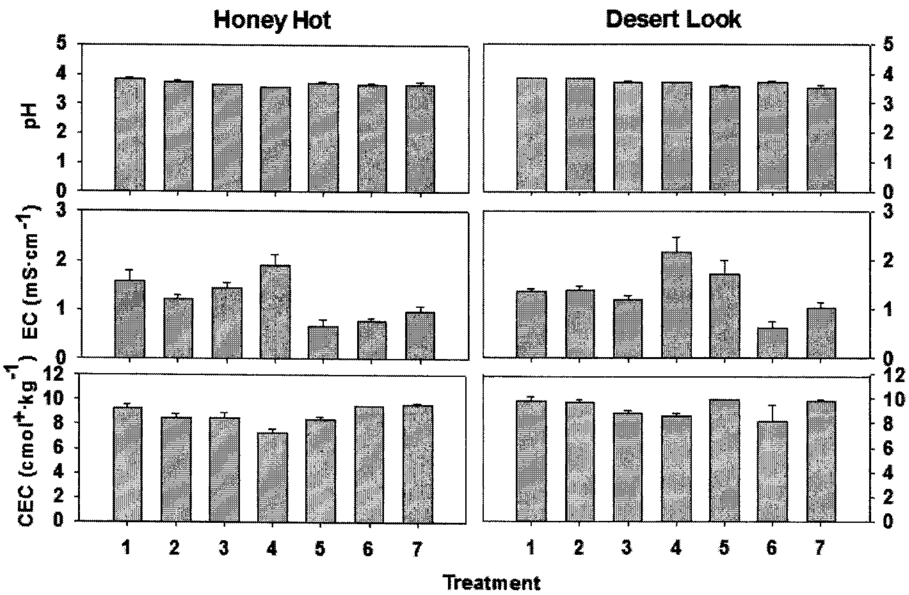

Fig. 1. Media characteristics of potted *Cymbidum* as affected by medium and amount of applied fertilizer at the end of the experiment. Contents of each treatment were shown in Table 1.

2. Plant growth

Cymbidium young plants are generally grown for two years in greenhouses and the flowering plants are come on to the market in the third year. Therefore, the plant characteristics were investigated in the first and second year. In the first year, 'Honey Hot' showed the highest plant growth values of leaf length, leaf width, leaf number, and bulb width in the bark treatment (Table 2). Treatment 6 had also good effects in leaf length, leaf width, leaf number, and bulb width on the plants. Cocochip treatments showed the lowest plant growth values. The plant growth characteristics of leaf length, leaf number, and bulb width in 'Desert Look' were improved in all peatmoss treatments more than bark. Cocochip treatments also showed the lowest plant growth values.

Table 2. Growth of potted *Cymbidium* as affected by medium and amount of applied fertilizer in the first year.

Treatment[z]	Leaf length (cm)	Leaf width (cm)	Number of leaves	Bulb width (cm)
		'Honey Hot'		
1	15.85bc[y]	9.96ab	7.14a	9.78ab
2	14.43cd	9.26bc	6.92a	8.98bc
3	12.40d	8.20d	5.59b	8.26c
4	17.86ab	10.47a	6.96a	10.77a
5	17.23ab	9.28bc	6.33a	8.86bc
6	18.80a	10.03ab	6.86a	10.43a
7	12.94d	8.77cd	6.71a	9.84ab
		'Desert Look'		
1	15.80b	7.28a	9.05bc	9.69bc
2	15.25b	6.73abc	8.69bc	8.66d
3	15.03b	6.43bc	8.47c	9.25cd
4	15.93b	7.04ab	9.27b	9.81bc
5	18.21a	6.56bc	10.38a	10.88a
6	17.17a	6.31c	10.66a	10.69a
7	16.03b	5.12d	10.32a	10.12ab

[z]Contents of each treatment were shown in Table 1.
[y]Mean separation within columns by LSD at $P = 0.05$.

In the second year, 'Honey Hot' showed the highest plant growth values of leaf length, leaf width, new shoot length, leaf number of new shoot, and bulb width of new shoot in Treatment 6 (Fig. 2, Table 3). Bark treatments had also good effects on the plants. Cocochip treatments showed lower plant growth values than bark and peatmoss. There was no significant difference among fertilizer amounts in peatmoss and cocochip treatments. The plant growth of 'Desert Look' were improved in all peatmoss treatments more than bark in leaf length, leaf width, number of new shoots, new shoot length, leaf number of new shoot, and bulb width of new shoot, as the amount of applied fertilizer increased. Cocochip treatments showed lower plant growth values than bark and peat-

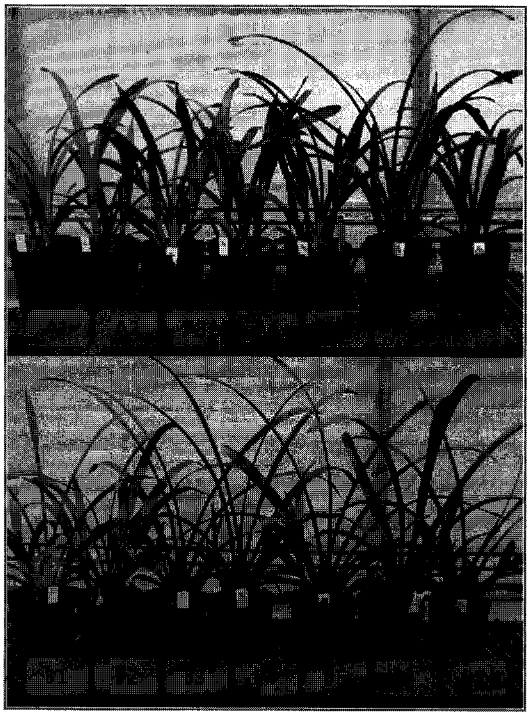

Fig. 2. Growth of potted *Cymbidium* as affected by medium and amount of applied fertilizer (A, 'Honey Hot'; B, 'Desert Look'). Contents of each treatment were shown in Table 1.

moss. There was no significant difference among fertilizer amounts in all media.

In the second year, the plants growth of the two cultivars was in better condition in peatmoss treatments compared to bark and cocochip. Orchid's roots usually do not have tight contact with the loose porous medium particles like bark, making them unable to explore a large volume of the medium (Wang and Gregg, 1994). Such porous media probably did not retain a sufficient amount of nutrients for optimum plant growth (Poole and Seeley, 1977). According to Wang (1995), bark initially does not retain much moisture after irrigation and adding a small fraction of peatmoss to increase moisture and nutrient retention of the bark improves plant performance. McDowell (1992) also suggested peat-lite medium for potting orchids. Moreover, the plants of the two cultivars showed especially higher values of leaf length, leaf width, leaf number of new shoot in peatmoss treatments compared to bark and cocochip. It was revealed that the assimilates from a single leaf never meet the demand of an inflorescence, but many leaves contributes to the flower spike and flower formation (Lin, 1994). In *Phalaenopsis*, plants with more leaves and larger total leaf areas produce a higher number of inflorescences and florets than those with fewer leaves (Wang and Gregg, 1999). There must be also studies about the correlation between the increased leaf area and flowering characteristics in *Cymbidium*.

Table 3. Growth of potted *Cymbidium* as affected by medium and amount of applied fertilizer in the second year.

Treatment[z]	Leaf length (cm)	Leaf width (cm)	Number of new shoots	New shoot length (cm)	Leaf number of new shoot	Bulb width of new shoot (cm)
			'Honey Hot'			
1	33.21bc[y]	1.65b	1.57a	25.28b	5.00a	13.83bc
2	30.92c	1.73ab	1.79a	27.90ab	5.63a	15.01abc
3	30.98c	1.64b	1.48a	23.21b	4.40a	12.12c
4	33.40bc	1.81ab	1.81a	32.27a	5.85a	17.26ab
5	36.63ab	1.66b	1.78a	28.66ab	4.83a	15.04abc
6	39.96a	1.87a	1.57a	34.30a	5.71a	17.87a
7	35.31b	1.76ab	1.43a	33.11a	5.00a	16.40ab
			'Desert Look'			
1	39.03b	1.40c	1.65ab	16.39ab	4.40ab	11.89bc
2	34.97b	1.46bc	1.27b	17.89a	4.40ab	11.22bc
3	39.07b	1.45bc	1.36ab	10.26b	3.00b	8.90c
4	38.95b	1.41c	1.54ab	16.80ab	4.38ab	13.72ab
5	49.74a	1.66a	1.90a	22.83a	4.90a	16.65a
6	49.95a	1.62a	1.62ab	20.80a	4.69a	15.69a
7	47.55a	1.57ab	1.75ab	20.22a	4.42ab	15.26a

[z]Contents of each treatment were shown in Table 1.
[y]Mean separation within columns by LSD at $P = 0.05$.

3. Mineral nutrient content of leaves

The mineral nutrient contents (T-N, P, K, Ca, Mg) of the leaves were also examined in the second year. There was no significant difference in the mineral nutrient contents of leaves except the cations (Fig. 3). The K and Ca contents were higher in the leaves of plants grown in peatmoss, whereas the Mg content was higher in the leaves of plants grown in cocochip.

According to Wang and Konow (2002), there was no difference in P and K concentration between extracts from bark and bark-peat media used in their study, and higher N in the bark-peat medium may be more important than P and K in contributing to increased plant growth in moth orchids. However, the plant growth of *Cymbidium* was improved by the cations like K and Ca in this study. It could be supposed that the higher contents of K and Ca in peatmoss medium increased the plant growth more than the other two media. In addition, it is well known that Ca and Mg antagonize the absorption of each other, and so the high Mg contents would inhibit the absorption of Ca in cocochip medium. Cocochip treatments should be applied with lower Mg fertilizers for better plant growth.

The higher CEC values of peatmoss medium resulted in higher capacity to hold more nutrients than bark, and the nutrient retention of the peatmoss improved the plant growth. Especially, leaf length, leaf width, leaf number of new shoot from plants grown in peatmoss were higher than those of the other media, and there must be studies about the correlation between the increased leaf area and flowering characteristics. The higher leaf contents of K and Ca would also contribute to improve the plant growth in peatmoss medium. However, there was no significant difference among fertilizer amounts. Consequently, it would be possible to use the peatmoss medium instead of bark for *Cymbidium* young plants, but there

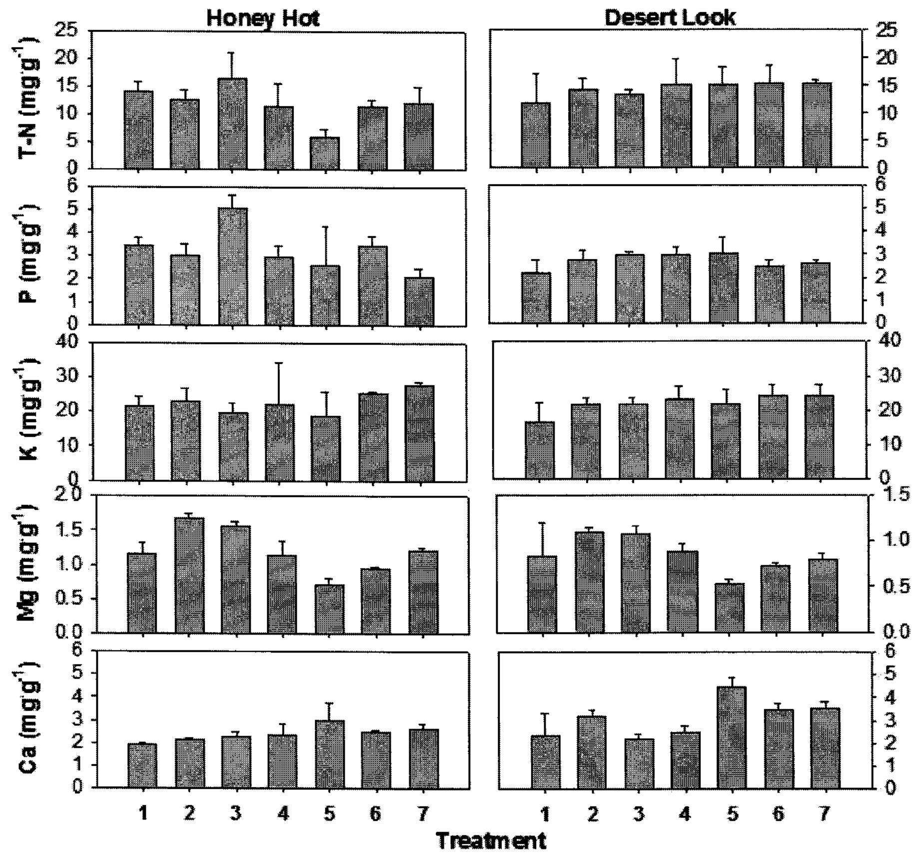

Fig. 3. Mineral nutrient contents in the leaves of potted *Cymbidium* as affected by medium and amount of applied fertilizer at the end of the experiment. Contents of each treatment were shown in Table 1.

must be always attention to appropriately water the medium and manage the moisture in the pots.

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수출용 심비디움 묘 생산에 적합한 배지 선발 및 시비량 구명

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적 요. 바크는 심비디움 분화의 배지로서 국내에서 가장 많이 이용되는 배지지만, 분화 수출 시 제거 과정 중에서 쉽게 떨어지지 않아 뿌리가 손상되어 상품성이 낮아지게 된다. 본 연구에서는 식물체로부터 쉽게 제거되며 바크를 대체할 수 있는 배지를 선발하고, 이때 식물의 생장에 필요한 시비량을 알아보고자 하였다. 심비디움 'Honey Hot'와 'Desert Look'의 묘를 바크, 코코칩, 그리고 피트모스 배지에 식재하였고, 완효성 비료 2, 4, 6g을 처리하였다. 심비디움 묘들은 일반적으로 2년 동안 재배하고 3년째 되는 해에 개화시켜 상품으로 출하하게 되므로, 1년차와 2년차에 식물의 생장 특성들을 조사하였으며, 배지의 특성과 잎의 무기이온 함량을 최종적으로 조사하였다. 1년차에는, 'Desert Look'의 생육이 피트모스 처리구에서 바크보다 더 향상되었다. 'Honey Hot'의 생육 측정값들은 바크 처리구에서 가장 높은 값을 보였다. 2년차에는, 두 품종 모두 피트모스 처리구에서 생육이 향상되었다. 코코칩 처리구들은 바크와 피트모스에 비해 생육이 안 좋았다. 모든 배지 처리구에서 시비량에 따른 유의성은 보이지 않았다. 피트모스는 바크에 비해 CEC가 높아 더 많은 양분들을 보유하므로 식물의 생육을 향상시켰다. 특히, 엽내의 높은 K과 Ca 함량은 식물 생육에 좋은 것으로 판단되었다. 결과적으로, 심비디움 묘 생산에서 피트모스가 바크를 대체할 수 있는 것으로 판단되었으며, 이때 배지가 너무 과습하지 않도록 주의가 요구된다.

주제어 : 바크, 양이온 치환용량(CEC), 칼슘, 코코칩, 피트모스