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INFLUENCE OF GROWING MEDIA AND VARIETIES ON GROWTH AND DEVELOPMENT OF MOKARA IN TAM KY, QUANG NAM PROVINCE

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Abstract: Mokara Orchid is a trigeneric hybrid between the Ascocentrum, Vanda and Arachnis Orchids and was created in Singapore in 1969. Mokara is now popularly grown in Vietnam; however, research on variety or growing medium for Mokara orchid in Quang Nam has not been reported yet. The objective of this study is to identify adapted Moraka varieties and suitable growing media for the cultivation of Mokara orchids under the local conditions. The experiment was conducted from June 2016 to December 2017 at Truong Xuan Ward, Tam Ky City, Quang Nam province using a subplot design, where the growing medium is the main plot and Mokara orchid varietyis the split-plot. The experiment includes three Mokara varieties belonging to genus Mokara with 3 colors: yellow, lime, and pink spotand four growing media with different ratios of peanut shell, charcoal, and coir. The results show that the growing media significantly affect the plant height and flower yield, but they do not affect the leaf number, leaf length, leaf width, root number, and flower quality of the Mokara varieties. The varieties affect the growth and development, flower quality, and yield of Mokara. Using the same media, the pink spot Mokara variety gains the best growth and development, and the yellow Mokara variety provides the highest yield. These Mokara varieties gain the best flower quality. The growing medium with 50% coir and 50% peanut shell can be used to plant yellow Mokara (or pink spot Mokara) under the local conditions.

Keywords: Mokara orchid varieties, growing medium, coir, peanut shell, yellow Mokara, pink spot Mokara

1 Introduction

Orchidaceae is thebiggest family in the plant kingdom with 20,000 to 30,000 species [1]. Orchids are considered as the most attractive clusters of ornamental plants based on theirmorphological characteristics, especially the size, shape, color, and beauty of flowers [2] [3]. In recent years, the orchid planting industry has developed significantly and penetratedto the agricultural sector strongly. Orchids have become a valuable commodity in business and exported worldwide. Mokara (*Mokaraspp.*), commonly known as "Smile Orchid", originated from Singapore, where it was first discovered and cultivated [4]. Mokara orchids are intergeneric hybrids of *Arachnis*×*Ascocentrum*×*Vanda.* This orchid is characterized by beautiful flowers and colors from

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Vanda andfast growth from *Ascocenda* (*Ascocentrum*×*Vanda*). In Vietnam, Mokara has recently been planted with a large scale in Ho Chi Minh City and other provinces, such as Dong Nai, Tien Giang, Khanh Hoa, and Da Nang. However, theresearch on planting techniques to optimize the growth, yield and adaptation of some main Mokara species was conducted only for the climate of Ho Chi Minh City.Recently, the farmers in Tamky haveinitiated growing Mokara because the income from Mokara is higher than that of rice or vegetables. However, there has been no research dealing with building an economic production model of Mokara to adapt the sub-climate conditions in Quang Nam province.Therefore, the purpose of this study is to evaluate the influence of the growing media and the varieties on the growth and development of Mokara in Tam Ky, Quang Nam province.

2 Materials and method

2.1. Materials

The study used three varieties of orchids belonging to the genus Mokara. The number of plants and morphological characteristics of the varieties are shown in Table 1. Four types of growing media with different ratios fof peanut shell, charcoal, and coir were applied to the growth and development of Mokara (Table 2). The thickness of each growing medium is 10 cm.

Table 1. List of Mokara varieties used and criteria for Mokara branch planted

Name of variety	Number of plants (piece)	Average height (cm)	Number of mature roots (piece)
1. Yellow	200	28	≥2
2. Lime	200	31	≥2
3. Pink spot	200	59	≥2

Table 2. Growing medium applied

Growing medium	Ratio (100%)
I	100% peanut shell
II	25% coir below + 75% peanut shell
III	50% coir below + 50% peanut shell
IV	25% coir below + 25% charcoal middle + 50% peanut shell

2.2 Cultivation condition

The orchids were cultured in beds using plastic pipes with a diameter of 42 mm and a height of 1.35 m to support the plants. The plastic pipes (pillars) were buried firmly with a 30 cm depth

into 3 rows with a spacing of 30 cm × 56 cm. Each pair of opposite orchids was fixed at the center of the pillar with a copper wire covered with plastic with a 0.5 mm diameter.

The irrigation was performed twice a day during hot months and once a day during cool months. The plants were not watered in the rainy days. From 1 to 2 months after planting, the foliar fertilizers containing vitamin B1 and NPK growmore 30-10-10 were sprayed to promote the root system to develop and ensure the orchid to grow. A solution of vitamin B1 with a concentration of 1 mL/L was applied to the plants periodically every 5 to 8 days; a diluted solution of NPK growmore 30-10-10 of 10g in 8 liters of water was sprayed periodically every 5 to 7 days. In the next periods, a solution of NPK growmore combined with vitamin B1 and growmore Alaska at a concentration of 30 mL/8L was alternately sprayed periodically every 10 to 15 days.

2.3 Experimental design

The field experiment was conducted from June 2016 to June 2017 in an open field at Truong Xuan Ward, Tam Ky City, Quang Nam province. The experiment was laid out in a split-plot design with the growing media as the main plot and Mokara orchid varieties as the subplot treatment with three replications. A total of 12 treatments were prepared with the above mentioned media and Mokara varieties (Table 3). Each plot contains 10 plants.

Table 3. Experimental treatments

No.	Treatment	No.	Treatment
1	I.1	7	III.1
2	I.2	8	III.2
3	I.3	9	III.3
4	II.1	10	IV.1
5	II.2	11	IV.2
6	II.3	12	IV.3

1, 2, 3 corresponds to yellow, lime, pink spot flower of Mokara; I, II, III, IV are growing medium.

2.4 Agronomy characteristic observed

The development periods were recorded from transplanting to 50% of the plants to get new roots, to flowering and harvesting. The plant height, number of leaves, and number of roots were recorded. The plant height was measured once a month when a new root comes out. The leaf parameter was determined when 50% of the plants have new leaf appearance; the number of leaves in the stem was counted. The number of roots was counted when 50% of the plants showed the root and recorded once a month until the end of the experiment. The plant height, number of leaves, leaf length, leaf width and the number of roots were measured at the

harvesting time. The leaf width is the widest leaf; the leaf length was measured from the top of the leaf to the petiole. The flower indicators were assessed with the flower yield including the number of flower branches/plant, the number of buds/branch, and the total of flower branches in the plot. The flower quality was determined on the basis of the branch length of 20 cm, number of flowers/branch of at least 10 flowers, petal length (cm), and the largest flower diameter. The shelflife of flowers was recorded at 10 days after harvesting until wilting.

2.5 Weather conditions during the experiments

The weather condition during the experiments is presented in Table 4. In January and February 2017, the plants were affected by low average temperature with 22.5°C and 21.9°C, respectively; the temperature in other months ranged from 24.5°C to 30.7°C, whichis favorable for the growth and development of Mokara orchids. The lowest humidity was recorded in August 2016 (80%), and the highest was in December 2016 (96%). The last month of 2016 also had the highest rainfall (804.9 mm) and the longest number of rainy days (30 days). The highest total sunny hour was in July 2016 (259.6h).

Table 4. Meteorological conditions recorded from June 2016 to June 2017

Year	Month	Temperature (°C)			Humidity (%)	Rainfall		Total sunny hour (h)
		T_{mean}	T_{max}	T_{min}		R_{mean} (mm)	NRD (d)	
2016	June	29.9	38.2	22.9	82	47.7	12	236.5
	July	30.0	36.5	23.7	82	62.6	7	259.6
	August	30.7	39.0	23.8	80	183.4	14	220.1
	September	29.8	36.7	23.6	88	192.4	13	169.6
	October	28.1	33.6	22.8	90	385.9	18	136.9
	November	26.5	30.6	20.8	92	762.8	25	100.0
	December	25.0	28.0	17.5	96	804.9	30	30.6
2017	January	22.5	28.0	17.2	93	153.1	24	75.3
	February	21.9	31.0	26.6	92	124.8	16	85.3
	March	24.5	32.5	16.6	88	8	6	182.5
	April	26.9	37.4	20.6	84	31.9	8	194.9
	May	28.5	36.4	23.0	83	40.1	13	209
	June	29.6	39.6	24.3	78	113.8	6	156.8

T: temperature; R: rain; NRD: number of rainy days.

Source: Center for Hydrometeorology Forecast of Quang Nam province

2.6 Statistics analysis

All data were analyzed with Statistix 10.0. The data sets were analyzed as a split-plot design with a medium as the main factor and variety as the sub-factor. Two-way ANOVA was conducted to analyze the effects of the media, Mokara varieties and their interactions on the growth and development, flower yield and quality. Duncan's multiple range tests were performed to examine whether the differences between the mean values were statistically significant at a significance level of 0.05.

3 Results and discussion

3.1 Period of growth and development

The growth and development periods of Mokara varieties indifferent media are presented in Table 5. From planting to first rooting, the varieties affect rooting, but the media do not have any effects. However, both the media and varieties have an influence on the development at first flowering and harvesting.

With different media, pink spot Mokara has the longest time for first rooting, whereas yellow and lime Mokara varieties have earlier rooting. As for flowering and harvesting, the yellow Mokara variety comes first, especially with medium IV (Treatment IV.1) and medium III (Treatment III.1);the lime Mokara variety comes last with different media; however, with medium IV (Treatment IV.2), this Mokara varietyis flowering and harvesting latest (Table 5).

Table 5. Influence of growing medium on the duration of growth and development of Mokara varieties

Treatment	From plant to (day)		
	First rooting	First flowering	First harvesting
I.1	20	150	165
I.2	21	187	202
I.3	23	165	180
II.1	21	150	165
II.2	21	185	200
II.3	23	165	180
III.1	21	145	160
III.2	20	170	185
III.3	24	155	170
IV.1	20	140	155
IV.2	20	180	195
IV.3	23	152	167

1, 2, 3 corresponds to yellow, lime, pink spot color of Mokara flower; I, II, III, IV are growing medium.

3.2 Growth and development ability

The influence of growing medium on growth ability of Mokara varieties was recorded and the data are presented in Table 6. While the plant height of Mokara in treatments I.3, II.3, III.3, and IV.3 is about 60.0 cm, that of the remaining treatments is under 40.0 cm. The plant height of the varieties in this study is larger than that reported by Shah et al. [5] with Marigold and Pham et al. [6] with *Torenia fournieri* Linden. The number of leaves at harvest ranges from 9.9 leaves (III.2) to 15.3 leaves (III.3). The leaf length and leaf width show the growth ability of a variety and the photosynthesis capacity of plants. The leaf length of Mokara in treatment I.3 is longest (33.8 cm), followed by that in treatment II.3 (33.6 cm) and treatment IV.1 (33.3 cm). The leaf length of Mokara in this study is larger than that published by Sugapriya et al. [7] who study nine dendrobium orchid varieties under the partial environment of the controlled greenhouse; their leaf length ranges from 2.8 to 16.5 cm. The widest leaf is observed in treatment I.2 (4.2 cm), and the narrowest is in treatments I.3 and IV.3 (3.8 cm). There is no significant difference in the leaf length and leaf width among treatments. The number of roots ranges from 5.7 roots (I.1) to 7.3 roots (III.3). The difference in the number of roots between treatment III.3 and other treatments has a statistical significance at the 95% confidence level.

Thus, the pink spot Mokara variety grows well under the local conditions; the media significantly affect the plant height but not the leaf number, leaf length, leaf width, and the root number of the variety.

Table 6. Influence of growing medium on growth ability of Mokara varieties

Treatment	Plant height (cm)	Number of leaves (piece)	Leaf length (cm)	Leaf width (cm)	Number of roots (piece)
I.1	33.2^{cd}	10.0^{c}	32.1^{a}	4.0^{a}	5.7^{e}
I.2	36.6^{cd}	10.6^{c}	30.2^{a}	4.2^{a}	6.5^{bcd}
I.3	66.1^{b}	15.0^{a}	33.8^{a}	3.8^{a}	7.1^{ab}
II.1	33.0^{d}	12.0^{bc}	33.0^{a}	4.1^{a}	5.9^{de}
II.2	37.2^{c}	11.9^{bc}	31.9^{a}	4.1^{a}	6.9^{ab}
II.3	63.0^{b}	14.0^{ab}	33.6^{a}	3.9^{a}	6.7^{abc}
III.1	36.2^{cd}	11.0^{c}	33.0^{a}	4.1^{a}	6.1^{cde}
III.2	36.4^{cd}	9.9^{c}	31.6^{a}	4.1^{a}	6.3^{bcde}
III.3	71.1^{a}	15.3^{a}	31.3^{a}	4.0^{a}	7.3^{a}
IV.1	34.1^{cd}	11.4^{bc}	33.3^{a}	3.9^{a}	5.8^{de}
IV.2	37.0^{cd}	11.5^{bc}	29.7^{a}	4.0^{a}	5.9^{de}
IV.3	64.4^{b}	14.0^{ab}	33.1^{a}	3.8^{a}	7.0^{ab}
$LSD_{0.05}$	4.0	2.9	5.0	0.7	0.8

1, 2, 3 corresponds to yellow, lime, pink spot color of Mokara flower; I, II, III, IV are growing medium; Symbols *a–e*means that different letters in each column indicate a significant difference at α= 0.05.

3.3 Flower indicators

Flower yield

The influence of growing media on the flower yield is presented in Table 7. The Mokara in treatment II.2 has the lowest number of flower branches/plant (3.5) and the highest in treatment III.1 (7.3). The number of flower branches in other treatments ranges from 3.0 branches/plant (IV.2) to 7.2 branches/plant (I.1). The number of buds is an important characteristic to evaluate flower quality. Treatment II.1 shows the largest influence on the number of buds (21.1 buds/branch), followed by treatment IV.1 (20.7 buds/branch), I.1 (17.4 buds/branch), II.3 (17.3 buds/branch), and III.1 (17.2 buds/branch). The lowest number of buds is observed in treatment I.2 with 13.3 buds/branch. The total of flower branches in each plot is highest in treatments IV.1, III.1, and II.1 with 62.3, 62.0 and 61.5 flower branches, respectively and lowest in treatment I.2 (40.1 flower branches). This difference is significantly different. Thus, both medium and variety affect the flower yield of Mokara. Therefore, the medium with 50% coir below + 50% peanut shell (treatment III.3) and the yellow Mokara variety can be used under the local conditions.

Table 7. Influence of growing medium on flower yield of Mokara varieties

Treatment	Number of flower branches/plant (piece)	Number of buds/branch(piece)	Total of flower branches/plot(piece)
I.1	7.2^{a}	17.4^{b}	59.3^{a}
I.2	4.8^{cd}	13.3^{d}	40.1^{c}
I.3	5.7^{bc}	16.8^{bc}	52.9^{b}
II.1	6.3^{ab}	21.1^{a}	61.5^{a}
II.2	3.5^{e}	14.2^{cd}	40.1^{c}
II.3	5.3^{bc}	17.3^{b}	50.3^{b}
III.1	7.3^{a}	17.2^{b}	62.0^{a}
III.2	4.1^{de}	15.1^{bcd}	40.3^{c}
III.3	5.6^{bc}	16.7^{bc}	49.2^{b}
IV.1	6.4^{ab}	20.7^{a}	62.3^{a}
IV.2	3.0^{e}	15.5^{bcd}	43.7^{c}
IV.3	6.0^{b}	16.6^{bc}	48.8^{b}
$LSD_{0.05}$	1.1	2.6	5.1

1, 2, 3 corresponds to yellow, lime, pink spot color of Mokara flower;I, II, III, IV are growing medium; Symbols *a–e* means that different letters in each column indicate significant difference at α= 0.05.

Flower quality

The flower quality is an important factor to increase the flower value. It includes the branch length, number of flowers/branch, petal length, flower diameter, and the flowershelf life. The

flower quality depends on many factors, such as weather conditions, culture techniques, and plant variety.The branch length in treatment III.3, II.3, I.3, and IV.3 is larger than that in the remainingtreatments with 53.0, 49.8, 48.5, and 47.9 cm, respectively (Table 8). The number of flowers/branch ranges from 13.8 flowers (treatment IV.2) to 20.7 flowers(treatment II.1). Treatments III.3 and III.1 havea high number of flowers/branch with 20.2 and 20.0 flowers, respectively. The longest petal length is observed in treatment I.3 (3.7 cm), and the shortest is in treatment II.1 (3.0 cm). The Mokara in treatment II.1 also has the smallest flower diameter (6.5 cm), while the flower diameter in the other treatments ranges from 6.6 cm (I.1, III.1, and IV.1) to 7.8 cm (I.3, and IV.3). The flower diameter in this study issmaller than that reported by Newton and Runkle [8]; they found that benzyladenine affects the vegetative growth and flowering of potted *Miltoniopsis* orchids, and the flower diameter ranges from 6.4 to 8.9 cm. The shelf life of flowers is also an important indicator to assess flower quality. It depends on different factors, such as growing medium and weather conditions. The flowershelf life of of Mokara varieties ranges from 20 to 22 days. The shelf life of flowers in this study is longer than that reported by Nguyen et al. [9] who apply Dau Trau MK 30-10-5, Gibberellin 25-10-10, and Abscisic acid (ABA) to *Petunia hybrida* plants and found that it ranges from 3.78 to 7.03 days. Thus, the flower quality is influenced by the variety with pink spot Mokara being the best; the medium does not have any effect.

Table 8. Influence of growing medium on flower quality of Mokara varieties

Treatment	Branch length (cm)	Number of flowers/branch (piece)	Petal length (cm)	Flower diameter (cm)	Shelf life of flowers (day)
I.1	43.7^{cd}	19.3^{a}	3.2^{def}	6.6	22
I.2	36.3^{e}	14.6^{b}	3.5^{bc}	7.4	20
I.3	48.5^{abc}	19.1^{a}	3.7^{a}	7.8	20
II.1	40.8^{de}	20.7^{a}	3.0^{f}	6.5	22
II.2	40.4^{de}	14.0^{b}	3.4^{cdf}	7.3	20
II.3	49.8^{ab}	19.0^{a}	3.4^{cdf}	7.3	20
III.1	43.5^{cd}	20.0^{a}	3.1^{f}	6.6	22
III.2	36.9^{e}	14.9^{b}	3.4^{bcd}	7.4	20
III.3	53.0^{a}	20.2^{a}	3.6^{abc}	7.6	20
IV.1	45.3^{bcd}	18.8^{a}	3.1^{ef}	6.6	22
IV.2	36.2^{e}	13.8^{b}	3.4^{cde}	7.3	20
IV.3	47.9^{abc}	19.1^{a}	3.7^{ab}	7.8	20
$LSD_{0.05}$	5.4	2.1	0.3		

1, 2, 3 corresponds to yellow, lime, pink spot color of Mokara flower; I, II, III, IV are growing medium; Symbols *a–f* means that different letters in each column indicate a significant difference at $\alpha = 0.05$.

4 Conclusions

Three Mokara varieties can grow under the local conditions with four growing media in the study. However, the pink spot Mokara variety exhibits the best growth and development; the yellow Mokara variety has the highest yield with one of the four media. These Mokara varieties have the best flower quality.

The growing media significantly affect the plant height and flower yield; they do not have a significant influence on the leaf number, leaf length, leaf width, root number, and flower quality of the Mokara varieties. The varieties affect the growth and development, flower quality, and yield of Mokara.

The medium with 50% coir below + 50% peanut shell can be used to cultivate yellow Mokara or pink spot Mokara under the local conditions.

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