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Phalaenopsis CULTIVATION IN DIFFERENT MEDIA. PART I. GROWTH AND FLOWERING

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Abstract. The production costs force the orchids growers to look for media that could become an alternative for the basic ones. *Phalaenopsis* plants (*ex in vitro*) were planted into containers filled with different media: New Zealand sphagnum moss, mixture of expanded clay pellets and New Zealand sphagnum moss (v:v = 1:1) and expanded clay pellets. Originally, orchids were grown in translucent plastic pots of 7 cm diameter (8,5 months) and then, they were transferred to translucent plastic pots of 11 cm diameter and 0.5 dm^3 capacity. Effect of medium on the size of plant, hydratation of leaves tissue and flowering was evaluated. Orchids grown in New Zealand sphagnum moss create a significantly greater mass of the aboveground plant part and the roots. Also parameters characterizing the inflorescence and flowers indicate that the most favorable for the orchids is to grow them in sphagnum moss. The least favorable growth conditions were provided by the growing in expanded clay pellets without any additions. In this medium, only 25 to 35% of plants flowered.

Key words: orchids, medium, sphagnum moss, expanded clay pellets

INTRODUCTION

Thanks to the improvement of the in vitro propagation of orchids from Phalaenopsis genus, these plants have recently become very popular. The interest in this groups of plants has been significantly increased not only because of the unusual beauty, but also because of their long life span which exceeds that of all other flowering plants grown in containers.

Phalaenopsis developed from an exclusive specimen destined for cut flowers have become very popular and demanded pot orchids. Among ornamental plants, the cultivation of *Phalaenopsis* orchids is actually the most important and profitable cultivation in the world [Khin et al. 2001; Hwang et al. 2004].

However, increasing production costs force the growers to look for media that could become an alternative for the increasingly harder available bark of pine (*Pinus pinea*),

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bark of douglas fir (*Pseudetsuga taxifolia*), or sphagnum moss which represent the basic media or media components for the growing of the discussed orchids [Blanchard and Runkle 2008; Wang and Konow 2002; Amberger-Ochsenbauer 1997].

The objective of the presented studies was the verification of the usefulness of expanded clay pellets and New Zealand sphagnum moss for *Phalaenopsis* growing.

MATERIAL AND METHODS

In the years 2006–2008, an experimental growing of two *Phalaenopsis* orchid cultivars 'Zagreb®' and 'Springfield®' was carried out. The plants originated from Arthura BV – Netherlands. Plants (*ex in vitro*) were planted 26.07.2006 into containers filled with different media:

– New Zealand sphagnum moss,

– mixture of expanded clay pellets (8–16 mm granulation) and New Zealand sphagnum moss (v:v = 1:1),

– expanded clay pellets (8–16 mm granulation).

Plants with a diameter of 5–6 cm showed 2–4 leaves about 3 cm long. The mentioned sphagnum moss originated mainly from *Sphagnum cristatum* and *Sphagnum australe* [Maseyk and Green 1999]. However, according to the producer of the horticultural media, Moutere River Company Ltd., in the New Zealand sphagnum moss, there are also contained *Sphagnum falcatulum*, *Sphagnum subnitens, Sphagnum squarrosum* and *Sphagnum subsecundum*. Its basic properties include: pH = 4.8, electrical conductivity (EC) 0.02 $mS \cdot cm^{-1}$, air filled porosity approximately 55% in loose condition, and water holding capacity of 96%. Originally, orchids were grown in translucent plastic pots of 7 cm diameter. During cultivation plants were fertilized with nutrient solution (once a week 50 cm^3; chemical composition of solution is shown below). On the 15 March 2007 plants were transferred to translucent plastic pots of 11 cm diameter and 0.5 dm^3 capacity. During cultivation in the greenhouse, there was maintained a temperature of 22°C to 30°C and the relative air humidity was at the level of 70 –80%. Orchids were additionally nourished, once in 2 weeks, with 100 ml of nutrient per plant which consisted of: $N\text{-}NH_4$ – 10; $N\text{-}NO_3$ – 120; P – 40, K – 230; Ca – 30; Mg – 20; Na – 10; Cl – 20; $S\text{-}SO_4$ – 40; Fe – 0.8; Mn – 0.4; Zn – 0.2; Cu – 0.07; B – 0.2 $mg \cdot dm^3$; pH 6.6; EC – 1.8 $mS \cdot cm^{-1}$. In September 2008, for a period of 3 weeks, in order to induce flowering, the temperature was lowered to 17°C at night and to 22°C during the day.

The number of leaves was counted after 15 and 18 months of orchids growing. At the same time also maximal diameter of plants was measured. In December 2008, when the third flower opened in the inflorescence, the following measurements were carried out: number of leaves, length, width and area of leaf. For measurements, always the second well developed leaf was taken, counting from the top of the plant. Also the plant width and plant mass (of the aboveground part) were measured. Furthermore, all roots were weighed, the number of roots was counted (only of the main roots), and the length of roots was measured. On the same day, the weight of fresh matter and the leaf dry matter content were determined by the drying method, according to Bandurska et al. [2008].

Effect of the applied media on plant flowering was estimated on the basis of the measurements of the length of inflorescence, the inflorescence mass, number of flowers and buds, flower diameter. Also the percentage of flowering plants was calculated. Each combination was represented by 20 plants. Results of experiments were subjected to one-factorial analysis of variance using Duncan's test at the significance level of $\alpha = 0.05$.

RESULTS AND DISCUSSION

In the majority, orchids are epiphytes and the type of the media applied for the cultivation of these plants plays a key role in their proper growth and development. In Poland, experiments with medium used for orchids, and specifically with the components used for the growing medium preparation for *Cymbidium lowianum* Rchb., were conducted by Oszkinis [1981]. The author indicated that particularly useful for the cultivation of Cymbidium are such materials as fern roots, leaves of red beech, cow dung, or compost-and leaf litter-earth. Nowadays, the view concerning the growing of many orchids has been changed. There is a continuous search for cheaper and more easily available media, because only a healthy and correctly developed root system guaranties optimal uptake of nutrients and in consequence it ensures a quick growth and development of plants.

Table 1. Maximal diameter of *Phalaenopsis* and number of leaves measured after 15 and 18 months of growing
Tabela 1. Maksymalna średnica *Phalaenopsis* oraz liczba liści mierzone po 15 i 18 miesiącach uprawy

Date Data	Medium Podłoże	Max diameter of plant, cm Maksymalna średnica rośliny cm	Number of leaves Liczba liści	Max diameter of plant, cm Maksymalna średnica rośliny cm	Number of leaves Liczba liści
		'Springfield'		'Zagreb'	
16.10.2007	Sphagnum moss Mech torfowiec	12.60 b	2.73 a	12.47 b	2.73 a
	Expanded clay pellets + sphagnum moss Keramzyt + mech torfowiec	7.86 a	2.67 a	8.73 a	2.60 a
	Expanded clay pellets Keramzyt	7.26 a	2.60 a	6.40 a	2.67 a
25.01.2008	Sphagnum moss Mech torfowiec	13.93 b	2.87 a	15.13 b	3.20 b
	Expanded clay pellets + sphagnum moss Keramzyt + mech torfowiec	11.20 a	3.00 a	9.93 a	2.83 a
	Expanded clay pellets Keramzyt	10.00 a	2.80 a	10.00 a	3.06 a

Means followed by the same letters are not significantly different at $\alpha = 0.05$;
Średnie wartości oznaczone tymi samymi literami nie różnią się istotnie przy $\alpha = 0,05$

On the basis of our own studies, it was found that there is a significant influence exerted by the medium type on the vegetative growth of both studied *Phalaenopsis* cultivars. Already after 15 months of growing (October 2007) a differentiation of *Phalaenopsis* size was observed (tab. 1). On the other hand, the effect of medium on the number of leaves was documented as late as in January 2008 and only in 'Zagreb' cultivar. Results of measurements carried out in December 2008 were more univocal. Orchids grown in New Zealand sphagnum moss create a significantly greater mass of the aboveground plant part and the roots, in comparison with plants grown in the two remaining media. A favorable effect of sphagnum moss was shown by the measurements of the leaf number and the width and area of leaf. *Phalaenopsis* plants created also a greater size of the root system (tab. 2 and 3). Also the flowering of *Phalaenopsis* cultivars 'Zagreb' and 'Springfield' depended on the growing media (tab. 4 and 5). Parameters characterizing the inflorescence and flowers indicate that the most favorable for the generative development of orchids is to grow them in sphagnum moss. In this medium, the greatest number of orchids flowered (85–95%), the number of flowers in the inflo-

Table 2. Effect of medium on selected morphometrical parameters of leaves tissue of *Phalaenopsis* 'Springfield'
Tabela 2. Wpływ podłoża na wybrane parametry morfometryczne *Phalaenopsis* 'Springfield'

Medium Podłoże	Fresh weight of plants Świeża masa rośliny g	Width of plant Szerokość rośliny cm	Number of leaves Liczba liści	Length of second leaf Długość drugiego liścia cm	Width of second leaf Szerokość drugiego liścia cm	
Sphagnum moss Mech torfowiec	63.67 c	25.7 c	5.1 c	14.8 c	7.9 c	
Expanded clay pellets + sphagnum moss Keramzyt + mech torfowiec	36.35 b	20.9 b	4.1 b	12.5 b	6.8 b	
Expanded clay pellets Keramzyt	18.32 a	14.5 a	2.8 a	7.4 a	4.6 a	
	Leaf area Powierzchnia liścia cm^2	Fresh weight of roots Świeża masa korzeni g	Number of roots Liczba korzeni	Length of roots Długość korzeni cm	Weight of 1 cm^2 of leaf tissue Masa 1 cm^2 tkanki liścia	
					Fresh weight Swieża masa mg	Dry weight Sucha masa mg
Sphagnum moss Mech torfowiec	113.10 c	42.65 b	5.4 a	19.2 b	1.30a	0.05a
Expanded clay pellets + sphagnum moss Keramzyt + mech torfowiec	81.22 b	24.72 a	5.8 a	15.9 a	1.24a	0.05a
Expanded clay pellets Keramzyt	34.00 a	15.72 a	5.4 a	14.1 a	1.30a	0.05a

Means followed by the same letters are not significantly different at $\alpha = 0.05$;
Średnie wartości oznaczone tymi samymi literami nie różnią się istotnie przy $\alpha = 0,05$

Table 3. Effect of medium on selected morphometrical parameters of leaves tissue of *Phalaenopsis* 'Zagreb'
Tabela 3. Wpływ podłoża na wybrane parametry morfometryczne *Phalaenopsis* 'Zagreb'

Medium Podłoże	Fresh weight of plants Świeża masa rośliny g	Width of plant Szerokość rośliny cm	Number of leaves Liczba liści	Length of second leaf Długość drugiego liścia cm	Width of second leaf Szerokość drugiego liścia cm
Sphagnum moss Mech torfowiec	74.93 b	18.5 b	4.9 b	16.5 b	7.2 b
Expanded clay pellets + sphagnum moss Keramzyt + mech torfowiec	21.53 a	12.8 a	3.7 a	9.0 a	5.6 a
Expanded clay pellets Keramzyt	22.59 a	14.3 a	3.7 a	8.1 a	5.2 a

Medium Podłoże	Leaf area Powierzchnia liścia cm^2	Fresh weight of roots Świeża masa korzeni g	Number of roots Liczba korzeni	Length of roots Długość korzeni cm	Weight of 1 cm^2 of leaf tissue Masa 1 cm^2 tkanki liścia	
					Fresh weight Swieża masa mg	Dry weight Sucha masa mg
Sphagnum moss Mech torfowiec	117.06 b	41.77 b	5.2 b	18.5 b	1.20a	0.05a
Expanded clay pellets + sphagnum moss Keramzyt + mech torfowiec	47.18 a	11.63 a	3.9 a	12.8 a	1.12a	0.05a
Expanded clay pellets Keramzyt	45.77 a	15.72 a	4.4 a	14.3 a	1.08a	0.05a

Means followed by the same letters are not significantly different at $\alpha = 0.05$;
Średnie wartości oznaczone tymi samymi literami nie różnią się istotnie przy $\alpha = 0,05$

Table 4. Influence of medium on flowering of *Phalaenopsis* ' Springfield'
Tabela 4. Wpływ podłoża na kwitnienie *Phalaenopsis* ' Springfield'

Medium Podłoże	Length of inflorescence Długość kwiatostanu cm	Mass of inflorescence Masa kwiatostanu g	Number of flowers and buds Liczba kwiatów i pąków	Diameter of flower Średnica kwiatu cm	Flowered plants Rośliny kwitnące %
Sphagnum moss Mech torfowiec	29.83b	18.57b	7.93b	7.09a	90%
Expanded clay pellets + sphagnum moss Keramzyt + mech torfowiec	14.2a	12.5a	4.3a	7.03a	50%
Expanded clay pellets Keramzyt	13.0a	11.8a	3.6a	7.18a	25%

Means followed by the same letters are not significantly different at $\alpha = 0.05$;
Średnie wartości oznaczone tymi samymi literami nie różnią się istotnie przy $\alpha = 0,05$

Table 5. Influence of medium on flowering of *Phalaenopsis* ' Zagreb'
Tabela 5. Wpływ podłoża na kwitnienie *Phalaenopsis* ' Zagreb'

Medium Podłoże	Length of inflorescence Długość kwiatostanu cm	Mass of inflorescence Masa kwiatostanu g	Number of flowers and buds Liczba kwiatów i pąków	Diameter of flower Średnica kwiatu cm	Flowered plants Rośliny kwitnące %
Sphagnum moss Mech torfowiec	39.33b	17.33b	8.73b	7.26a	85%
Expanded clay pellets + sphagnum moss Keramzyt + mech torfowiec	15.62a	10.3a	3.75a	7.87a	40%
Expanded clay pellets Keramzyt	14.0a	10.8a	3.4a	7.40a	35%

Means followed by the same letters are not significantly different at α = 0.05;
Średnie wartości oznaczone tymi samymi literami nie różnią się istotnie przy α = 0,05

rescence was the greatest (7.9–8.7) and so was the length (29.8 to 39.3 cm) and the weight of inflorescence (17.3–18.6 g). The type of the applied medium did not affect significantly the flower diameter. In all treatments, the flower diameters showed about 7–8 cm. Both the vegetative growth and flowering of orchids grown in a mixture of expanded clay pellets + sphagnum moss, or only in expanded clay pellets was distinctly worse. However, definitely the least favorable growth conditions were provided by the growing in expanded clay pellets without any additions. In this medium, only 25 to 35% of plants flowered. Significant influence of medium exerted on *Phalaenopsis* is illustrated in table 5. The shoots : roots ratio (fresh mass) calculated for Springfield cultivar grown in sphagnum moss and in mixture of expanded clay pellets + sphagnum moss (1:1) was respectively 0.67–0.68, for Zagreb cultivar was respectively 0.55–0.56. The shoots : roots ratio calculated for above mentioned *Phalaenopsis* cultivars grown in expanded clay pellets was higher and reach 0.86 and 0.70, respectively. Sphagnum moss, thanks to its porosity ensured the most favourable growth conditions. However, the sphagnum moss did not improve leaf tissue hydration (tab. 2 and 3). Similar leaves hydration found in all orchids suggested that none of the applied media did disturb plant water relations.

Sphagnum moss as medium for orchids growing has been used already for many years. The favorable effect was verified by Wang and Konow [2002]. After 54 weeks of experiments, they recorded an increase of the leaf number by 1.8, and an increase of fresh leaf matter by 77% in orchids grown in a medium with an addition of 30% Canadian moss, in comparison with plants grown in *Pseudotsuga taxifolia* bark without any additives. In turn, Korean researchers [Cui et al. 2004] carried out experiments with *Doritaenopsis* 'Tinny Tender'. That hybrid is closely related with *Phalaenopsis* because it was developed in result of crossing orchids of *Doritis* and *Phalaenopsis* genera. The mentioned researchers, after six months of experiments, have found that the hybrid grown in pure sphagnum moss reached a mass of its aboveground part and of the leaf area by 60% higher, in comparison with plants grown in coconut chips or in bark. Slightly poorer effects were obtained in plants grown in peatmoss mixed with perlite.

Wang and Gregg [1994] also cultivated *Phalaenopsis* in several multicomponent media (including perlite, Metro Mix 250 and charcoal mixture, or perlite rockwool mixture). The effect of above mentioned media on the growth and flowering of plants was not great, neither in the first nor in the second flowering season. Trials were also undertaken to grow orchids in recirculating ebb and flow hydroponic system (EBB). Growth and flowering of *Phalaenopsis* were greater when commercial medium was mixed with 20% sphagnum moss [Hwang et al. 2004]. For the cultivation of the discussed species in rockwool and perlite mixture, Lee and Dong [2004] utilized six hydroponic systems. The number of flower stems, the number of flowers, flower height and flower width were the highest in the EBB system. Besides the mentioned media, the usefulness of expanded polystyrene flax – Styromul [Amberger-Ochsenbauer 1997] and cryptomeria bark [Kohara et al. 2004] were tested as well.

Table 6. Effect of medium on shoot : roots ratio (fresh mass)
Tabela 6. Wpływ podłoża na stosunek masy części nadziemne do korzeni (świeża masa)

Cultivar Odmiana	Medium Podłoże	Shoot : roots Część nadziemna: korzenie
Springfield	Sphagnum moss Mech torfowiec	0.67
	Expanded clay pellets + sphagnum moss Keramzyt + mech torfowiec	0.68
	Expanded clay pellets Keramzyt	0.86
Zagreb	Sphagnum moss Mech torfowiec	0.56
	Expanded clay pellets + sphagnum moss Keramzyt + mech torfowiec	0.55
	Expanded clay pellets Keramzyt	0.70

Aformentioned Oszkinis [1981] did not record any significant differences in the growth and yielding of Cymbidium, in spite of having tested as many as seven different mixtures in its growing. Bik and Van den Berg [1983] arrived to similar conclusions when they compared the growth of *Cymbidium* 'Pendragon Sikkin' grown in mineral wool and peat. The researchers did not find any effect of the medium on the vegetative growth and yielding of the earlier mentioned hybrid. Other media for the growing of *Dendrobium nobile* (tree fern fiber, blocks of pressed coconut bark, bark of *Eucalyptus grandis*, mixtures with coconut bark blocks and *Eucalyptus* bark and mixtures of the last mentioned materials with charcoal) were tested by Demattê and Graziano [2000]. With the exception of eucalyptus bark, all studied media were suitable for plant growth. It can be supposed that a abudant plant growth and flowering in a medium with an addition of sphagnum moss is caused by its higher water capacity and sorption. Thanks to these properties, there occur smaller fluctuation of medium moisture. Similar opinions were expressed by Wang and Konow [2002], Droll [2005], Blanchard and Runkle [2008]. However, not every organic substrate can be used for the growing of orchids. It refers, for example, to black peat (highly decomposed raised bog peat). Peat with such

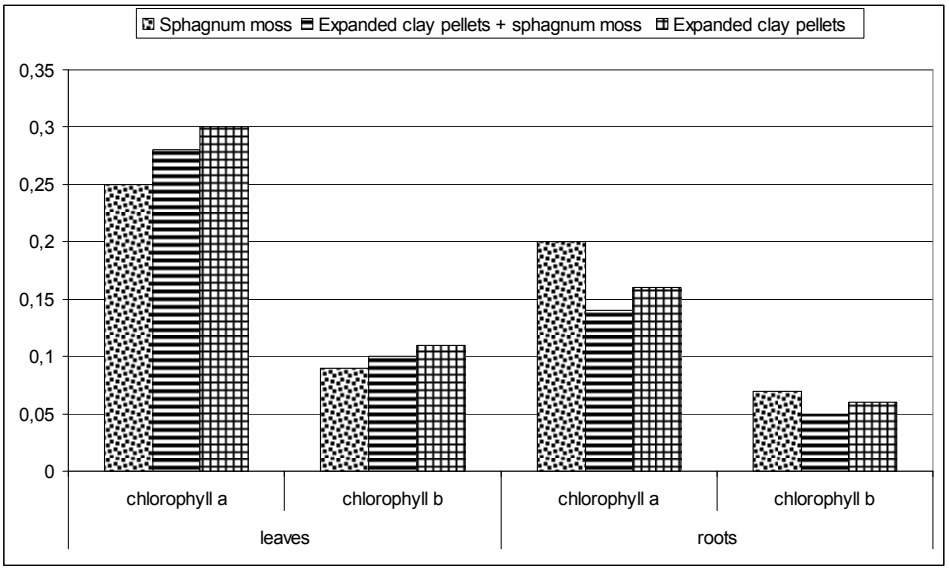

Fig. 1. Chlorophyll concentration in leaves and roots of *Phalaneopsis* 'Sprigfield' grown in different media (mg·g^{-1} f.m.)

Rys. 1. Zawartość chlorofilu w liściach i korzeniach *Phalaneopsis* 'Sprigfield' uprawianego w różnych podłożach (mg·g^{-1} ś.m.)

quality is totally unusable for the cultivation of orchids because its structure is too fine and its air capacity is too low [Schmilewski 2008]. Kohara et al. [2004] believe that the effects of growing do not depend only on water retention by medium, but also on the finding of an optimal irrigation frequency for each potted plant material.

CONCLUSIONS

1. The New Zealand sphagnum moss is the best substrate for the cultivation of *Phalaenopsis* orchids. Size (leaves and roots) and decorative value of the plants grown in this medium are significantly better in comparison to other plants.

2. *Phalaenopsis* cultivated in the mixture of New Zealand sphagnum moss and expanded clay pellets demonstrated low vegetative growth and lesser flowering.

3. Expanded clay pellets alone is not suitable for growing Phalaenopsis. Plants which were cultivated in this substrate flowered only in 25–35% of cases.

4. The medium did not affect on leaf tissue hydration.

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UPRAWA *Phalaenopsis* W RÓŻNYCH PODŁOŻACH. CZĘŚĆ I. WZROST I KWITNIENIE

Streszczenie. Koszty produkcji zmuszają producentów storczyków do poszukiwania podłoży, będących alternatywą dla podstawowych podłoży lub komponentów podłoży. W latach 2006–2008 przeprowadzono doświadczenie z uprawą 2 odmian storczyka *Phalaenopsis*: 'Zagreb®' i 'Springfield®'. Sadzonki (*ex in-vitro*) posadzono do pojemników wypełnionych nowozelandzkim mchem torfowcem, mieszaniną mchu i keramzytu (1:1) lub keramzytem. Początkowo (8,5 miesiąca) storczyki uprawiano w przezroczystych po-

jemnikach o średnicy 7 cm, a następnie o średnicy 11 cm i objętości 0,5 dm^3. Oceny wpływu podłoży dokonano na podstawie pomiarów wykonanych gdy otwarł się 3 kwiat w kwiatostanie. Storczyki uprawiane w nowozelandzkim mchu torfowcu wytworzyły istotnie większą masę zarówno części nadziemnej, jak i podziemnej w porównaniu do roślin uprawianych w dwóch pozostałych podłożach. Korzystny wpływ mchu wykazały pomiary ilości, długości, szerokości liści i powierzchni liści. Rośliny wytworzyły także większych rozmiarów system korzeniowy. Wyżej oceniono także ich wartość ozdobną. *Phalaenopsis* uprawiane w mieszaninie złożonej z mchu torfowca i keramzytu charakteryzowały się słabym wzrostem wegetatywnym i słabszym kwitnieniem. Keramzyt jako samodzielne podłożem nie nadaje się do uprawy storczyka. Spośród storczyków rosnących w tym podłożu zakwitło tylko 25–35% roślin.

Słowa kluczowe: storczyki, podłoże, mech torfowiec, keramzyt

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