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NUTRITION OF LACY TREE PHILODENDRON (*Philodendron bipinnatifidum* Schott et Endl.). PART II. NUTRIENT CONTENTS IN LEAVES

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Abstract. The main aim of the study conducted in the years 2007–2008 was to evaluate the effect of increasing levels of N, P, K and Mg nutrition on contents of nutrients in leaves of lacy tree philodendron (*Philodendron bipinnatifidum* Schott et Endl.). Analyses were conducted for five levels of macroelement content in the substrate, while maintaining a constant quantitative ratio of N : P : K : Mg = 1.0 : 0.75 : 1.25 : 0.75. Levels of nutrients in the substrate were as follows (in $mg \cdot dm^{-3}$): L-1: N 100, P 75, K 125, Mg 75; L-2: N 150, P 112, K 187 Mg 112; L-3: N 200, P 150, K 250, Mg 150; L-4: N 250, P 187, K 312, Mg 187 and L-5: N 300, P 225, K 375, Mg 225, at the constant content of microelements (in $mg \cdot dm^{-3}$): Fe 75.0, Mn 25.0, Zn 20.0, Cu 10.0, B 1.5 and Mo 2.0. The third fully developed leaf, counting from the youngest leaf on a plant, was adopted as the index part for the evaluation of the nutrient status of plants. A significant effect of the substrate fertilization level was found on the contents of N, P, K, Fe, Mn, Zn and Cu in leaves. The date of sample collection in the vegetation period was also found to have an effect on the contents of N, P and K in leaves. It was shown that the age of plants had a significant effect on Ca content in leaves of lacy tree philodendron. Optimal yield of fresh and dry mass of aboveground parts of plants, as well as the number and length of leaves, width of leaf blades, length of petioles and leaf colour intensity was on the level of L-4, in which in the index part (the 3^{rd} leaf) of lacy tree philodendron was: (% in d.m.): N 2.99–3.55, P 0.33–0.58, K 2.99–4.72, Ca 1.44–2.08, Mg 0.33–0.39; ($mg \cdot kg^{-1}$ d.m.): Fe 50.2–59.3, Mn 60.1–68.2, Zn 49.4–57.4, Cu 28.5–32.4.

Key words: plant nutrition, plant analysis, philodendron

INTRODUCTION

Growing of plants for floral green is becoming an increasing popular branch of horticulture. *Philodendron bipinnatifidum* Schott et Endl., syn. *Philodendron selloum* K.

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Koch. – common name "lacy tree philodendron" – is a species highly suitable for this purpose. In literature there is a limited data on the optimization of nutrition and growing of these plants. Domingos and Almeida [2003] characterized conditions for Philodendron growing. Poole et al. [1976] reported the optimal ranges of nutrient for *Philodendron oxycardium* – moreover McConnell et al. [2007] for different *Philodendron* species. Uchida [2000] showed the ranges of nutrient in leaves for optimal growing of *Philodendron hastatum.* Others authors [Nowak et al. 1995, Chmiel and Wojtania 1996] studied the influence of the different fertilize schedule on the biometrical parameters of *Philodendron.* Conover and Poole [1982] tested the influence of N-source treatment on the growth and tissue nutrient content in *Philodendron selloum*. There are no threshold or standard values for the content of nutrients in the substrate or respective guide values in leaves.

Lacy tree philodendron is a strongly growing epiphyte. It may reach up to 2 meters in height. It originates from southern Brazil. When evaluating the effect of substrate fertilization on the nutrient status of philodendron, as an exceptionally vegetatively developed epiphyte, we need to consider such factor as light conditions [Kleiber et al. 2009a, 2009b] In case of anthurium (the same family like Philodendron) mentioned factor modified the status of phosphorus and potassium. Very important factor influence on the plant nutrient status is fertilization [Dufour and Guérin 2005, Kleiber et al. 2009c], availability of water [Huang 2001, Kolb and McCormick 1993], temperature [Huang and Grunes 1992] and soil reaction [Marler 1998, Melakeberhan et al. 2000].

The main aim of the study was to evaluate the effect of increasing levels of substrate fertilization with N, P, K and Mg on contents of macro and microelements in leaves of lacy tree philodendron (*Philodendron bipinnatifidum* Schott et Endl.) and to establish guide values for the growing of this species in peat moss substrate. In an earlier study by these authors [Komosa et al. 2011] increasing levels of plant nutrition were found to influence on growth of lacy tree philodendron.

MATERIALS AND METHODS

The experiments were conducted in the years 2007–2008 in an unheated greenhouse of the Marcelin Experimental Station, the Poznań University of Life Sciences. The effect of increasing levels of substrate fertilization with N, P, K and Mg on nutrient status for macro and microelements was investigated in lacy tree philodendron (*Philodendron bipinnatifidum* Schott et Endl.*, syn. P. selloum*) grown in a peat moss substrate.

Plants were grown in peat moss substrate deacidified to pH 6.0. Increasing levels of macroelements in the substrate (denoted as L-1, L-2, L-3, L-4, L-5) were analyzed at the maintenance of a constant quantitative ratio of N : P : K : Mg = 1.0 : 0.75 : 1.25 : 0.75. Contents of nutrients in the analyzed fertilization levels were as follows (in $mg \cdot dm^{-3}$): L-1: N 100, P 75, K 125, Mg 75; L-2: N 150, P 112, K 187 Mg 112; L-3: N 200, P 150, K 250, Mg 150; L-4: N 250, P 187, K 312, Mg 187 and L-5: N 300, P 225, K 375, Mg 225. At all the fertilization levels standard contents of microelements were provided in the peat moss substrate amounting to (in $mg \cdot dm^{-3}$): Fe 75.0, Mn 25.0, Zn 20.0, Cu 10.0, B 1.5 and Mo 2.0. The adopted levels were maintained in the vegetation period based on chemical analyses of the substrate. The methodology of the study was presented in detail in part I of this paper [Komosa et al. 2011].

The pot experiment was performed in 10 replications. One pot with 1 plant constituted one replication. Plants were planted on 27.04.2007 to plastic containers filled with 5 dm^3 peat moss substrate with the assumed fertility level (L-1 – L-5). The experiment lasted from 27.04.2007 to 29.09.2008.

The index plant part, it was the third leaf counting from the youngest leaf, were collected for chemical analyses. Samples were taken on the following dates: 25.07, 30.08, 08.10 (2007) and 29.07, 28.08, 29.09 (2008). A representative sample, comprising 10 leaves of a given combination (1 from each plant), was collected at each date. Collected leaves were first analyzed in terms of their biometric parameters, next dried at 45–50ºC and then ground. For assays of total nitrogen, phosphorus, potassium, calcium and magnesium the plant material was mineralized in concentrated sulfuric acid [IUNG 1972]. After mineralization of the plant samples, chemical analyses were performed using the following methods: N-total according to Kjeldahl in a Parnas-Wagner distillation apparatus, P – by colorimetry with ammonium molybdate, and K, Ca, Mg by atomic absorption spectrometry (in a Carl Zeiss Jena apparatus). In the determinations of total iron, manganese, zinc and copper the plant material was mineralized in a mixture of dioxonitric and tetraoxochloric acids (3:1 v/v) [IUNG 1972]. After mineralization Fe, Mn, Zn and Cu were determined according to ASA. Results of chemical analyses of plants for their contents of macro- and microelements were analyzed statistically using the Duncan test, with inference at the significance level $\alpha = 0.05$.

RESULTS AND DISCUSSIONS

Results of chemical analyses of index parts of lacy tree philodendron concerning contents of nitrogen, phosphorus, potassium, calcium and magnesium are presented in tables 1–3.

Nitrogen. Substrate fertilization levels were found to have a significant effect on nitrogen content in leaves of lacy tree philodendron (tab. 1). It was significantly smallest – in case of both years of the study – in combination L-1 (2.29 and 2.33% N in d.m., respectively), while it was significantly highest in substrates intensively fertilized with macroelements, i.e. L-3 – L-5, which was statistically significant for means from the years of the study.

Both in the first and the second year of the study the content of nitrogen in the index parts of plants showed a downward trend with the passing vegetation period. Mean nitrogen content in leaves in case of younger plants (2007), as well as older ones (2008) was similar (2.91 and 2.98% N in d.m., respectively). The content of nitrogen, recorded in this study, fell within the range of 2.0–3.0% N in d.m., recommended for *Philodendron oxycardium* [Poole et al. 1976]. McConnel et al. [2007] reported the following ranges of nitrogen content in leaves of plants from genus *Philodendron*: low (< 2.5% N), medium (2.6–4.5% N) and high content (> 4.5% N in d.m.). In this study the content of nitrogen fell within the range of mean contents reported by McConnel et

Table 1. Contents of nitrogen and phosphorus in the index parts of lacy tree philodendron (*Philodendron bipinnatifidum* Schott et Endl.) (the 3rd leaf; % d.m.)

Tabela 1. Zawartości azotu i fosforu w częściach wskaźnikowych filodendrona podwójnie pierzastego (*Philodendron bipinnatifidum* Schott et Endl.) (3. liść; % s.m.)

	Year Rok	2007 (C)						2008 (C)						Mean Średnia (B)
		Nutrient level – Poziom żywienia (A)												
	term termin (B)	L-1	L-2	L-3	L-4	L-5	mean średnia (A×B)	L-1	L-2	L-3	L-4	L-5	mean średnia (A×B)	
N	I	2.80	3.26	3.46	3.49	3.60	3.32b	2.61	3.20	3.40	3.55	3.68	3.29b	3.30b
	II	1.80	2.28	2.84	2.99	3.14	2.61a	2.22	2.78	3.12	3.18	3.24	2.91a	2.76a
	III	2.27	2.42	2.76	3.23	3.29	2.79a	2.17	2.34	2.92	3.02	3.18	2.73a	2.76a
	mean średnia (A×C)	2.29a	2.65ab	3.02bc	3.24c	3.34c		2.33a	2.77ab	3.15bc	3.25bc	3.37d		
	mean średnia (A)	L-1 (2007 + 2008) 2.31a			L-2 (2007 + 2008) 2.71ab			L-3 (2007 + 2008) 3.09bc			L-4 (2007 + 2008) 3.25c		L-5 (2007 + 2008) 3.36d	
	mean średnia (C)	2.91a						2.98a						
P	I	0.41	0.44	0.43	0.47	0.49	0.45c	0.46	0.50	0.53	0.58	0.61	0.54a	0.49b
	II	0.24	0.29	0.29	0.33	0.38	0.30a	0.30	0.33	0.32	0.42	0.52	0.38a	0.34a
	III	0.46	0.40	0.36	0.41	0.47	0.42b	0.43	0.39	0.40	0.44	0.50	0.43a	0.42ab
	mean średnia (A×C)	0.37a	0.38a	0.36a	0.40a	0.45a		0.40a	0.41a	0.42a	0.48ab	0.54b		
	mean średnia (A)	L-1 (2007 + 2008) 0.38a			L-2 (2007 + 2008) 0.39a			L-3 (2007 + 2008) 0.39a			L-4 (2007 + 2008) 0.44b		L-5 (2007 + 2008) 0.49b	
	mean średnia (C)	0.39a						0.45a						

Values described with identical letters do not differ significantly at α = 0.05;
Wartości opisane tymi samymi literami nie różnią się od siebie istotnie przy α = 0,05

Table 2. Contents of potassium and calcium in the index parts of lacy tree philodendron (*Philodendron bipinnatifidum* Schott et Endl.) (the 3[rd] leaf; % d.m.)

Tabela 2. Zawartości potasu i wapnia w częściach wskaźnikowych filodendrona podwójnie pierzastego (*Philodendron bipinnatifidum* Schott et Endl.) (3. liść; % s.m.)

	Year – Rok	2007 (C)						2008 (C)						Mean Średnia (B)
	term termin (B)	Nutrient level – Poziom żywienia (A)												
		L-1	L-2	L-3	L-4	L-5	mean średnia (A×B)	L-1	L-2	L-3	L-4	L-5	mean średnia (A×B)	
K	I	3.77	4.18	4.56	4.62	4.77	4.38b	3.80	4.41	4.67	4.72	4.95	4.51b	4.44b
	II	1.82	2.54	1.88	3.40	3.96	2.72a	2.40	3.65	3.77	3.99	4.11	3.58a	3.15a
	III	2.03	2.93	2.84	2.99	3.23	2.80a	2.27	3.58	3.86	3.87	3.39	3.39a	3.09a
	mean średnia (A×C)	2.54a	3.22ab	3.09ab	3.67b	3.98b		2.82a	3.88ab	4.10b	4.19b	4.15b		
	mean średnia (A)	L-1 (2007 + 2008) 2.68a			L-2 (2007 + 2008) 3.55b			L-3 (2007 + 2008) 3.59b			L-4 (2007 + 2008) 3.93bc		L-5 (2007 + 2008) 4.06c	
	mean średnia (C)				3.30a						3.83b			
Ca	I	2.06	2.01	2.02	1.50	1.51	1.82b	2.13	2.15	2.12	2.00	2.10	2.10a	1.96a
	II	1.45	1.36	1.62	1.63	1.36	1.48a	1.99	2.00	2.06	2.08	1.99	2.02a	1.75a
	III	1.92	1.83	1.63	1.44	1.39	1.64a	2.33	2.34	2.39	2.03	2.23	2.26a	1.95a
	mean średnia (A×C)	1.81c	1.73bc	1.76bc	1.52ab	1.42a		2.15a	2.16a	2.19a	2.04a	2.11a		
	mean średnia (A)	L-1 (2007 + 2008) 1.98a			L-2 (2007 + 2008) 1.94a			L-3 (2007 + 2008) 1.97a			L-4 (2007 + 2008) 1.78a		L-5 (2007 + 2008) 1.76a	
	mean średnia (C)				1.65b						2.13a			

Values described with identical letters do not differ significantly at $\alpha = 0.05$;
Wartości opisane tymi samymi literami nie różnią się od siebie istotnie przy $\alpha = 0,05$

Table 3. Contents of magnesium in the index parts of lacy tree philodendron (*Philodendron bipinnatifidum* Schott et Endl.) (the 3rd leaf; % d.m.)
Tabela 3. Zawartości magnezu w częściach wskaźnikowych filodendrona podwójnie pierzastego (*Philodendron bipinnatifidum* Schott et Endl.) (3. liść; % s.m.)

	Year Rok	2007 (C)						2008 (C)						Mean Średnia (B)
		Nutrient level – Poziom żywienia (A)												
	term termin (B)	L-1	L-2	L-3	L-4	L-5	mean średnia (A×B)	L-1	L-2	L-3	L-4	L-5	mean średnia (A×B)	
Mg	I	0.39	0.36	0.35	0.37	0.33	0.36b	0.41	0.38	0.40	0.39	0.34	0.38ab	0.37a
	II	0.35	0.34	0.36	0.33	0.31	0.34a	0.35	0.33	0.41	0.36	0.32	0.35a	0.34a
	III	0.38	0.40	0.37	0.34	0.32	0.36b	0.40	0.46	0.43	0.35	0.35	0.40b	0.38a
	mean średnia (A×C)	0.37a	0.37a	0.36a	0.35a	0.32a		0.39a	0.39a	0.41a	0.37a	0.34a		
	mean średnia (A)	L-1 (2007 + 2008) 0.38a		L-2 (2007 + 2008) 0.38a			L-3 (2007 + 2008) 0.38a			L-4 (2007 + 2008) 0.36a			L-5 (2007 + 2008) 0.33a	
	mean średnia (C)	0.35a						0.38a						

Values described with identical letters do not differ significantly at α = 0.05;
Wartości opisane tymi samymi literami nie różnią się od siebie istotnie przy α = 0,05

al. [2007]. Similar ranges of nitrogen contents in leaves (2.5–4.0% N in d.m.) were given by Uchida [2000] in case of Philodendron hastatum.

Phosphorus. A significant effect of substrate fertilization level – for the mean of the years of the study – was found on the nutrient status of plants in case of phosphorus (tab. 1). The lowest phosphorus content was recorded in leaves of plants grown in substrates containing nutrients at levels L-1 to L-3 (0.38–0.39% P), while it was highest for L-4 and L-5 (0.44 and 0.49% P in d.m., respectively). Significant differences in phosphorus contents were observed during the vegetation period. Similarly as in case of nitrogen, no significant differences were recorded in terms of phosphorus content in leaves of younger (2007) and older plants (2008). Contents of this nutrient being markedly smaller than those found in this study (0.15–0.25% P) were reported in leaves of plants from genus *Philodendron* by Poole et al. (1976). In turn, phosphorus contents shown in this study were similar to those given by Uchida [2000], and McConnell et al. [2007].

Potassium. Similarly as in case of nitrogen and phosphorus, the level of substrate fertilization significantly modified nutrient status of plants in case of potassium (tab. 2). The lowest potassium content in leaves was recorded in plants growing at the lowest levels of macroelements: L-1 (on average 2.68% K), while the highest – in combinations L-4 and L-5 (3.93 and 4.06% K in d.m., respectively). The age of plants significantly modified the nutrient status in case of potassium (3.30% in 2007 and 3.83% K in d.m. in 2008). A downward trend, confirmed in the two years of the study, was found for the content of potassium in leaves with the passing vegetation period. The contents of potassium shown in this study for combination L-1 were smaller than those reported by Poole et al. [1976], although they fell within the recommended range, just as it was the case for the other analyzed levels. McConnell et al. [2007] defined the ranges of nutrition with this nutrient at: < 2.0% K (low content), 2.0–3.5% K (medium) and > 3.5% K in d.m. (high content). Contents of potassium recorded in this study ranged from 2.50 to 4.50% K in d.m., which had also been reported by Uchida [2000].

Calcium. No significant effect of the analyzed levels of substrate fertility on calcium content in leaves of philodendron was found here (tab. 2). It was similar in all the combinations, ranging from 1.76% Ca (L-5) to 1.98% Ca in d.m. leaves (L-1). The content of this nutrient in leaves was found to increase significantly with the age of plants. Calcium contents in leaves recorded in this study were markedly higher than those reported by Poole et al. [1976], falling within a range of medium values of 1.0–2.5% Ca in d.m. presented by McConnell et al. [2007]. Similar contents of calcium in philodendron leaves were also found by Uchida [2000].

Magnesium. Similarly as in case of calcium, substrate fertilization level did not have a significant effect on the content of magnesium in leaves of lacy tree philodendron (tab. 3). Contents of this nutrient ranged from 0.33% Mg (in case of L-5) to 0.38% Mg in d.m. (for L-1 – L-3). Magnesium content in leaves – for means from the analyzed combinations – did not change significantly in the course of vegetation. Young and older plants had similar contents of this nutrient (on average 0.35–0.38% Mg in d.m.). In this study the contents of this nutrient were similar to those reported by Uchida [2000] and Poole et al. [1976]. They also fell within the range of medium contents (0.25–0.50% Mg in d.m.) recommended by McConnell et al. [2007].

Table 4. Contents of iron and manganese in the index parts of lacy tree philodendron (*Philodendron bipinnatifidum* Schott et Endl.) (the 3rd leaf; $mg \cdot kg^{-1}$ d.m.)

Tabela 4. Zawartości żelaza i manganu w częściach wskaźnikowych filodendrona podwójnie pierzastego (*Philodendron bipinnatifidum* Schott et Endl.) (3. liść; $mg \cdot kg^{-1}$ s.m.)

	Year – Rok	2007 (C)						2008 (C)						Mean Średnia (B)
		Nutrient level – Poziom żywienia (A)												
	term termin (B)	L-1	L-2	L-3	L-4	L-5	mean średnia (A×B)	L-1	L-2	L-3	L-4	L-5	mean średnia (A×B)	
Fe	I	41.1	48.6	53.3	54.8	64.3	52.4a	44.4	45.1	52.4	56.7	72.5	54.2a	53.3a
	II	39.3	40.4	53.0	59.4	66.1	51.6a	45.2	44.9	49.6	59.3	73.1	54.4a	53.0a
	III	42.7	44.6	50.8	50.2	61.9	50.0a	43.5	48.3	50.1	53.2	68.2	52.7a	51.3a
	mean średnia (A×C)	41.0a	44.5a	52.4b	54.8b	64.1c		44.4a	46.1a	50.7b	56.4c	71.3d		
	mean średnia (A)	L-1 (2007 + 2008) 42.7a			L-2 (2007 + 2008) 45.3a			L-3 (2007 + 2008) 51.5b			L-4 (2007 + 2008) 55.6b		L-5 (2007 + 2008) 67.7c	
	mean średnia (C)			51.4a						53.8a				
Mn	I	44.0	52.7	58.5	68.2	70.8	58.8a	41.9	50.0	60.6	66.3	66.5	57.1a	57.9a
	II	42.3	46.6	59.2	63.6	71.0	56.5a	37.1	38.9	59.5	64.9	69.2	53.9a	55.2a
	III	39.2	45.2	58.7	60.1	64.3	53.5a	40.3	39.3	48.9	59.7	68.1	51.3a	52.4a
	mean średnia (A×C)	41.8a	48.2b	58.8c	64.0cd	68.7d		39.8a	42.7a	56.3b	63.6c	67.9d		
	mean średnia (A)	L-1 (2007 + 2008) 40.8a			L-2 (2007 + 2008) 45.4a			L-3 (2007 + 2008) 57.5b			L-4 (2007 + 2008) 63.8bc		L-5 (2007 + 2008) 68.3c	
	mean średnia (C)			56.3a						54.1a				

Values described with identical letters do not differ significantly at $\alpha = 0.05$;

Wartości opisane tymi samymi literami nie różnią się od siebie istotnie przy $\alpha = 0,05$

Table 5. Contents of zinc and copper in the index parts of lacy tree philodendron (*Philodendron bipinnatifidum* Schott et Endl.) (the 3rd leaf; $mg \cdot kg^{-1}$ d.m.)

Tabela 5. Zawartości cynku i miedzi w częściach wskaźnikowych filodendrona podwójnie pierzastego (*Philodendron bipinnatifidum* Schott et Endl.) (3. liść; $mg \cdot kg^{-1}$ s.m.)

	Year – Rok	2007 (C)						2008 (C)						Mean Średnia (B)
		Nutrient level – Poziom żywienia (A)												
	term termin (B)	L-1	L-2	L-3	L-4	L-5	mean średnia (A×B)	L-1	L-2	L-3	L-4	L-5	mean średnia (A×B)	
Zn	I	38.8	41.6	47.7	54.5	61.9	48.9a	37.9	43.1	49.0	53.9	59.8	48.7a	48.8a
	II	41.4	40.2	45.3	52.1	58.7	47.5a	40.8	41.0	44.3	57.4	57.2	48.1a	47.8a
	III	43.5	44.4	48.9	49.4	59.7	49.2a	42.1	43.9	43.8	52.3	54.9	47.4a	48.3a
	mean średnia (A×C)	41.2 a	42.1 b	47.3 c	52.0cd	60.1d		40.3a	42.7ab	45.7b	54.5c	57.3c		
	mean średnia (A)	L-1 (2007 + 2008) 40.7a		L-2 (2007 + 2008) 42.4a			L-3 (2007 + 2008) 46.5b			L-4 (2007 + 2008) 53.2c			L-5 (2007 + 2008) 58.7d	
	mean średnia (C)	48.5a						48.1a						
Cu	I	22.3	23.5	26.3	31.8	33.9	27.6a	23.3	26.8	27.1	32.4	38.4	29.6a	28.6a
	II	27.1	26.8	25.3	30.6	32.8	28.5a	25.3	27.2	26.9	31.2	34.3	29.0a	28.7a
	III	25.9	27.5	26.9	28.5	35.3	28.8a	25.7	26.3	28.3	30.0	31.8	28.4a	28.6a
	mean średnia (A×C)	25.1a	25.9a	26.2a	30.3b	34.0c		24.8a	26.8a	27.4a	31.2b	34.8c		
	mean średnia (A)	L-1 (2007 + 2008) 24.9a		L-2 (2007 + 2008) 26.3a			L-3 (2007 + 2008) 26.8a			L-4 (2007 + 2008) 30.7b			L-5 (2007 + 2008) 34.4c	
	mean średnia (C)	28.3a						29.0a						

Values described with identical letters do not differ significantly at $\alpha = 0.05$;
Wartości opisane tymi samymi literami nie różnią się od siebie istotnie przy $\alpha = 0,05$

Iron. Fertilization level in the peat moss substrate significantly influenced the content of iron in leaves of philodendron (tab. 4). It was lowest in combinations L-1 and L-2 (42.7 and 45.3 mg·kg^{-1}, respectively), while it was highest in case of L-5 (67.7 mg·kg^{-1} d.m. leaves). For a mean from the analyzed combinations the content of iron did not change significantly in the years of the study and it was stable during the vegetation period. Similar ranges of iron content (50–200 mg·kg^{-1} d.m.) in leaves of *Philodendron hastatum* were reported by Uchida [2000]. A similar range of mean contents of this nutrient, amounting to 60–200 mg·kg^{-1}, was also recommended by McConnell et al. [2007].

Manganese. Similarly as in case of iron, substrate fertilization level significantly modified the content of manganese in leaves of lacy tree philodendron (tab. 4). Significantly the lowest content was found in leaves in combinations L-1 and L-2 (40.8 and 45.4 mg·kg^{-1}, respectively), while it was highest in L-4 and L-5 (63.8 and 68.3 mg·kg^{-1} d.m., respectively). Contents of manganese in leaves in the two years of the study were similar (56.4–54.1 mg·kg^{-1}). No significant changes were observed in manganese contents in the index parts of lacy tree philodendron in the course of the vegetation period. Contents of manganese in leaves fell within the ranges of contents reported by Uchida [2000] and McConnell et al. [2007].

Zinc. The content of this nutrient, similarly as those of the other metallic microelements: iron, manganese and copper, was dependent on the level of substrate fertilization (tab. 5). The lowest zinc content was recorded in leaves of plants grown at L-1 and L-2 (40.7 and 42.4 mg·kg^{-1}, respectively), while it was highest in combination L-5: 58.7 mg·kg^{-1} d.m. Zinc content in leaves was similar throughout the entire vegetation period. The contents of zinc recorded in leaves in this study fell within the medium range for plants from genus *Philodendron* (25–100 mg·kg^{-1}) given by McConnell et al. [2007].

Copper. Increasing contents of macroelements in the substrate had a significant effect on the content of copper in leaves of lacy tree philodendron (tab. 5). Similarly as in case of the other microelements, the lowest content was found in leaves of plants grown in combinations L-1 and L-2 (24.9 and 26.3 mg·kg^{-1}, respectively), while it was highest for L-5 (34.4 mg·kg^{-1} d.m.). No significant changes were found in copper content in leaves in the vegetation period. Also the year of the study had no significant effect on the nutrient status of plants in case of copper. Copper contents recorded in this study in philodendron leaves fell within the medium range of its content (10–100 mg·kg^{-1}) reported by McConnell et al. [2007].

Results of analyses concerning the effect of peat substrate fertilization on the yield of fresh and dry mass of plants, length and width of leaf blades, number of leaves, number and weight of cuttings as well as the intensity of green colour of leaves, presented in part I of this study [Komosa et al. 2011], were optimal at L-4 level. Contents of macro and microelements in the index part (the 3rd leaf counting from the youngest leaf) in lacy tree philodendron, corresponding to this level in the two years study was (in % in d.m.): N 2.99–3.55, P 0.33–0.58, K 2.99–4.72, Ca 1.44–2.08, Mg 0.33–0.39; (in mg·kg^{-1} d.m.): Fe 50.2–59.3, Mn 60.1–68.2, Zn 49.4–57.4 and Cu 28.5–32.4. Maintaining this levels in the index plant parts allows to obtain the satisfactory growth of lacy tree philodendron (*Philodendron bipinnatifidum* Schott et Endl.).

SUMMARY

Among the several factors influencing the yield of plants, both in the quantitative and qualitative aspects, there is also the adaptation of nutrition to species-specific requirements. This may be provided by the determination of guide values of nutrients, at which yield of plants is optimal. Guide values are a valuable diagnostic tool in controlled nutrition of plants. Their determination is particularly significant for species of an increasing economic importance in commercial growing, the group which includes lacy tree philodendron (*Philodendron bipinnatifidum* Schott et Endl.), used more commonly by florists for floral green. The aim of the conducted investigations on the optimization of nutrition in this species was to determine the effect of different levels of peat moss substrate fertilization with N, P, K and Mg on the content of nutrients in leaves, in order to establish their guide values for the cultivation of lacy tree philodendron in peat moss substrate. The third leaf, counting from the youngest leaf growing on a plant, constituted the index part, recording changes in the applied fertilization levels.

The conducted analyses showed a significant effect of substrate fertilization levels on contents of nitrogen, phosphorus, potassium, iron, manganese, zinc and copper in leaves. The date of sample collection in the vegetation period had a significant effect on the contents of nitrogen, phosphorus and potassium, while age of plants influenced calcium content in leaves of lacy tree philodendron. The most advantageous biometric parameters of plants (mass of leaves, width, length and colour intensity of leaf blades, length of petioles) were recorded on the L-4 level of nutrient contents in substrate (I part of this study – Komosa et al. 2011). Contents of macro and microelements in the index part (3-rd leaf) of lacy tree philodendron corresponding with this level were the following (in % in d.m.): N 2.99–3.55, P 0.33–0.58, K 2.99–4.72, Ca 1.44–2.08, Mg 0.33–0.39 and (in mg·kg^{-1} d.m.): Fe 50.2–59.3, Mn 60.1–68.2, Zn 49.4–57.4 and Cu 28.5–32.4.

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ODŻYWIANIE FILODENDRONA PODWÓJNIE PIERZASTEGO (*Philodendron bipinnatifidum* Schott et Endl.). CZ. II. ZAWARTOŚĆ SKŁADNIKÓW W LIŚCIACH

Streszczenie. Głównym celem przeprowadzonych w latach 2007–2008 badań była ocena wpływu wzrastających poziomów żywienia N, P, K i Mg na zawartość składników pokarmowych w liściach filodendrona podwójnie pierzastego (*Philodendron bipinnatifidum* Schott et Endl.). Badano 5 poziomów zawartości makroelementów w podłożu, przy zachowaniu stałej relacji ilościowej między N : P : K : Mg = 1,0 : 0,75 : 1,25 : 0,75. Poziomy składników pokarmowych w podłożu były następujące (w mg·dm^{-3}): L-1: N 100, P 75, K 125, Mg 75; L-2: N 150, P 112, K 187 Mg 112; L-3: N 200, P 150, K 250, Mg 150; L-4: N 250, P 187, K 312, Mg 187; L-5: N 300, P 225, K 375, Mg 225 przy stałej zawartości mikroelementów (w mg·dm^{-3}) Fe 75,0, Mn 25,0, Zn 20,0, Cu 10,0, B 1,5, Mo 2,0. Jako część wskaźnikową do oceny stanu odżywienia roślin przyjęto trzeci w pełni wyrośnięty liść, licząc od najmłodszego na danej roślinie. Wykazano istotny wpływ poziomu nawożenia podłoża na zawartość N, P, K, Fe, Mn, Zn i Cu w liściach. Stwierdzono również wpływ terminu pobierania prób w okresie wegetacji na zawartość N, P i K w liściach. Wykazano, że wiek roślin miał istotny wpływ na zawartość Ca w liściach filodendrona podwójnie pierzastego. Najkorzystniejsze parametry biometryczne roślin (plon części nadziemnej roślin, długość liści, szerokość blaszki liściowej i intensywność jej zabarwienia, długość ogonka liściowego) uzyskano w kombinacji L-4 (I część pracy – Komosa et al. 2011). Zawartości składników pokarmowych w części wskaźnikowej filodendrona podwójnie pierzastego (3. liść od najmłodszego) odpowiadające tej kombinacji, w dwóch latach badań, wynosiły (w % w s.m.): N 2.99–3.55, P 0.33–0.58, K 2.99–4.72, Ca 1.44–2.08, Mg 0.33–0.39; (w mg·kg^{-1} s.m.): Fe 50.2–59.3, Mn 60.1–68.2, Zn 49.4–57.4, Cu 28.5–32.4.

Słowa kluczowe: odżywianie roślin, analiza roślin, filodendron

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