ACTA SCIENTIARUM POLONORUM Acta Sci. Pol., Hortorum Cultus 7(4) 2008, 77-88

COMPARISION DYNAMICS OF N, P, K CONTENTS IN DIFFERENT ANTHURIUM CULTIVARS (*Anthurium cultorum* Birdsey) GROWN IN EXPANDED CLAY

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Abstract. Vegetation experiments were conducted in the years 2002–2004, in two specialist horticultural farms. The dynamics of nitrogen, phosphorus and potassium contents were analyzed in the index parts of selected anthurium cultivars (*Anthurium cultorum* Birdsey): 'Baron', 'Choco', 'Midori', 'Pistache', 'President' and 'Tropical'. Plants were grown in expanded clay using drip fertigation with standard nutrient solution. Fully expanded leaves after fresh-cut flowers as the index parts for chemical analyses were collected every 2 months over the period of 3 years. A varied dynamic of nutrient contents was found in the index parts of plants. During the 3 years of studies a downward trend was recorded for nitrogen content, while an upward trend was observed for contents of phosphorus and potassium. A cultivar differentiation was shown for contents of the above mentioned nutrients and quantitative proportions between them.

Key words: anthurium, dynamics, nitrogen, potassium, phosphorus, expanded clay

INTRODUCTION

Poland is one of the biggest producers of anthurium (*Anthurium cultorum* Birdsey) in Europe. In terms of the quantity of produced flowers only Holland ranks higher [Jablońska 2005]. An increase in the yields of flower growing was possible because of the application of inert media, mainly expanded clay and polyphenolic foam [Komosa and Kleiber 2003a]. Their physical properties make them suitable for growing epiphytic species, such as anthurium. Expanded clay is burnt clay, formed into pellets with a diameter of maximum 16 mm. It is a cheap medium, with very stable physical properties, with air properties dominating over water properties and a lack of exchange sorption. The most advantageous properties for anthurium growing are found for the fraction of Ø 8–16 mm. Another medium, found relatively often in plantations in Poland, and predominant in Dutch cultures, is polyphenolic foam. It is produced from furniture edgings,

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granulated into aggregates of Ø approximately 1.5 cm and steamed for 20 minutes at 120°C. It is pressure formed into mats and blocks. In the initial culture period it has physical properties similar to those of rockwool, in example total porosity of 93%, and density of 74 $kg \cdot m^{-3}$. Polyphenolic foam may be used for many seasons; however, its air-water properties deteriorate considerably: water capacity increases to 59% at pF = 1, and air capacity decreases to 32% [Chohura 2000, after Benoit and Ceustermans 1995].

At present fertigation nutrient solutions recommended for anthurium growing do not take into consideration the development phase of plants. However, nutritional requirements of plants and the dynamics of nutrient uptake change with ageing of plants. Incorporation of these factors in fertilization programs creates a real opportunity to significantly improve the quality and quantity of yields from anthurium growing. In the modifications of the chemical composition of media, an important indicator should be dynamic changes in nutrient contents in the index parts of anthurium with the ageing of culture. Studies conducted so far determined only the optimum ranges of nutrient contents in the index parts of plants, not taking into consideration the effect of plant age on the nutritional status of the plant [Anthura 1998, Mills and Scoggins 1998].

The main aim of these investigations was to determine in the index parts of anthurium contents of nitrogen, phosphorus and potassium, as well as determine the dynamics of these components during the 3 years of growth, for the most popular cultivars 'Baron', 'Choco', 'Midori', 'Pistache', 'President' and 'Tropical'.

MATERIALS AND METHODS

The vegetation experiments were conducted on two commercial farms specializing in anthurium growing (I and II), located in the vicinity of Poznań (the Wielkopolska region, western Poland). Venlo-type greenhouses were equipped with modern systems of fertigation, climate control and recording, humidity control, shading and energy-saving curtains. One culture bad measured of 1.2×46 m (55.2 m^2) and there were grown 14 plants per 1 m^2 (772 plants per bad). Agrotechnical practices were performed with the current recommendations for anthurium.

Experiments were conducted on the anthurium (*Anthurium cultorum* Birdsey) cultivars most frequently grown in Poland:. 'Baron', 'Choco', 'Midori', 'Pistache', 'President' and 'Tropical'. Cuttings purchased from "Anthura" (The Netherlands) growing in rockwool pots (75 cm^3) were planted in a greenhouse to beds filled with expanded clay (ø 8–16 mm) between 8 and 11.08.2000. Investigations were initiated on 14.01.2002 (on 2-year old plants) and completed on 14.11.2004 (5-year old plants). Yielding of tested plants was optimal in terms of both quantity and quality. In the experiment drip fertigation was applied in the closed system without recirculation. Medium was distributed by dripping lines, in which emitters were placed every 20 cm. The frequency and time of irrigation were dependent on the season of the year. In the summer fertigation was applied 6–8 times, supplying 4–5 dm^3 nutrient solution per 1 m^2, while in the winter it was 2–3 times, applying 2–3 dm^3 daily. Approximately 20% of nutrient solution flowed out from the root medium. In order to ensure appropriate humidity of air and good moisture of root medium the culture was sprinkled with rain water using microsprinklers.

On farm I tap water was used, with the following chemical composition ($mg \cdot dm^{-3}$): NH_4 tr. (traces), N-NO_3 1.0, P 0.8, K 2.4, Ca 58.1, Mg 20.3, S-SO_4 7.9, Na 9.1, Cl 12.9, Fe 0.015, Mn 0.025, Zn 0.358, B 0.008, Cu tr., pH 6.69, EC 0.59 $mS \cdot cm^{-1}$. On farm II there were two independent sources of water: well and rain water. Well water contained ($mg \cdot dm^{-3}$): N-NH_4 tr., N-NO_3 2.2, P 1.2, K 1.3, Ca 141.4, Mg 8.1, S-SO_4 98.7, Na 20.5, Cl 24.8, Fe 0.678, Mn 0.322, Zn 0.034, B 0.020, Cu 0.002, pH 7.46, EC 0.934 $mS \cdot cm^{-1}$. Rain water was poor in nutrients ($mg \cdot dm^{-3}$): N-NH_4 and N-NO_3 tr., P 0.2, K 0.2, Ca 5.0, Mg 0.1, S-SO_4 0.4, Na 0.5, Cl 0.1, Fe 0.062, Mn 0.022, Zn 0.933, B 0.003, Cu 0.005, pH 6.46, EC 0.060 $mS \cdot cm^{-1}$. In the experiment a standard nutrient solution for anthurium drip fertigation was applied ($mg \cdot dm^{-3}$): N-NH_4<14.0, N-NO_3 105.0, P 31.0, K 176.0, Ca 60.0, Mg 24.0, S-SO_4 48.0, Fe 0.84, Mn 0.16, Zn 0.20, B 0.22, Cu 0.03, Mo 0.05, pH 5.5-5.7, EC 1.5-1.8 $mS \cdot cm^{-1}$ [Komosa 2000].

Samples of plant material were collected every 2 months, between the 14th and 16th day of a given month, in January, March, May, July, September and November in the years 2002–2004. The index parts were fully expanded leaves from plants after fresh-cut flowers [De Kreij et al. 1990]. They were selected at random from the entire area of beds from plants characteristic for a given cultivar, healthy, well-yielding and with no symptoms of damage. One average sample of a given cultivar from one farm consisted of 10 leaves. Leaves were dried at 45–50°C and ground. For the purpose of determination of total nitrogen the plant material was mineralized in a mixture of sulfuric and sulfosalicylic acids, while for the determination of total phosphorus and potassium – in concentrated sulfuric acid [IUNG 1972]. After mineralization of plant material the following assays were performed: N (total) using the distillation method according to Kjeldahl in a Parnas-Wagner apparatus, P by colorimetricaly with ammonium molybdate (according to Schillak), and K by atomic absorption spectroscopy (AAS).

Regression equations were determined for contents of nitrogen, phosphorus and potassium in the index parts of anthurium in the 3-year study. Quantitative relationships between the above mentioned nutrients were determined. Moreover, a two-way analysis of variance was performed. Conclusions were drawn at significance level $\alpha = 0.05$.

RESULTS AND DISCUSSION

Dynamics of nitrogen content in the index parts of plants in the course of the 3 years of the study exhibited considerable stability (tab. 1, fig. 1). In case of all analyzed cultivars they were similar for both farms. For most cultivars (except for 'Choco' and 'Baron'), higher contents of nitrogen were recorded for farm II than for farm I. In all cultivars a downward trend was found for nitrogen content in the index parts of plants as they were aging. Regression equations describing this phenomenon are given in table 1. For example, the equation describing the trend for nitrogen content for the mean of all cultivars from farm I in the 3 years of the study took the form: $y = -0.0004x^3 + 0.0127x^2 - 0.1049x + 1.771$ (where: y – expected content of a nutrient at a given date, x – date of sample collection – from 1 to 18, i.e. January 2002 – November 2004; 3 years × 6 dates = 18). For the 6th date of sample collection (i.e. November 2002) x = 6, and nitrogen content was: $y = (-0.0004 \cdot 6^3) + 0.0127 \cdot 6^2 - 0.1049 \cdot 6 + 1.771 = 1.685\%$ N ≈ 1.69% N.

Table 1. Regression equations and mean nitrogen contents (% N d. m.) in leaves analyzed anthurium cultivars in farms I and II (means from 3 years); $R^2_{(e)}$: for equation in the form $y = ax + b$; $R^2_{(f)}$ for $y = ax^2 + bx + c$; $R^2_{(g)}$ for $y = ax^3 + bx^2 + cx + d$

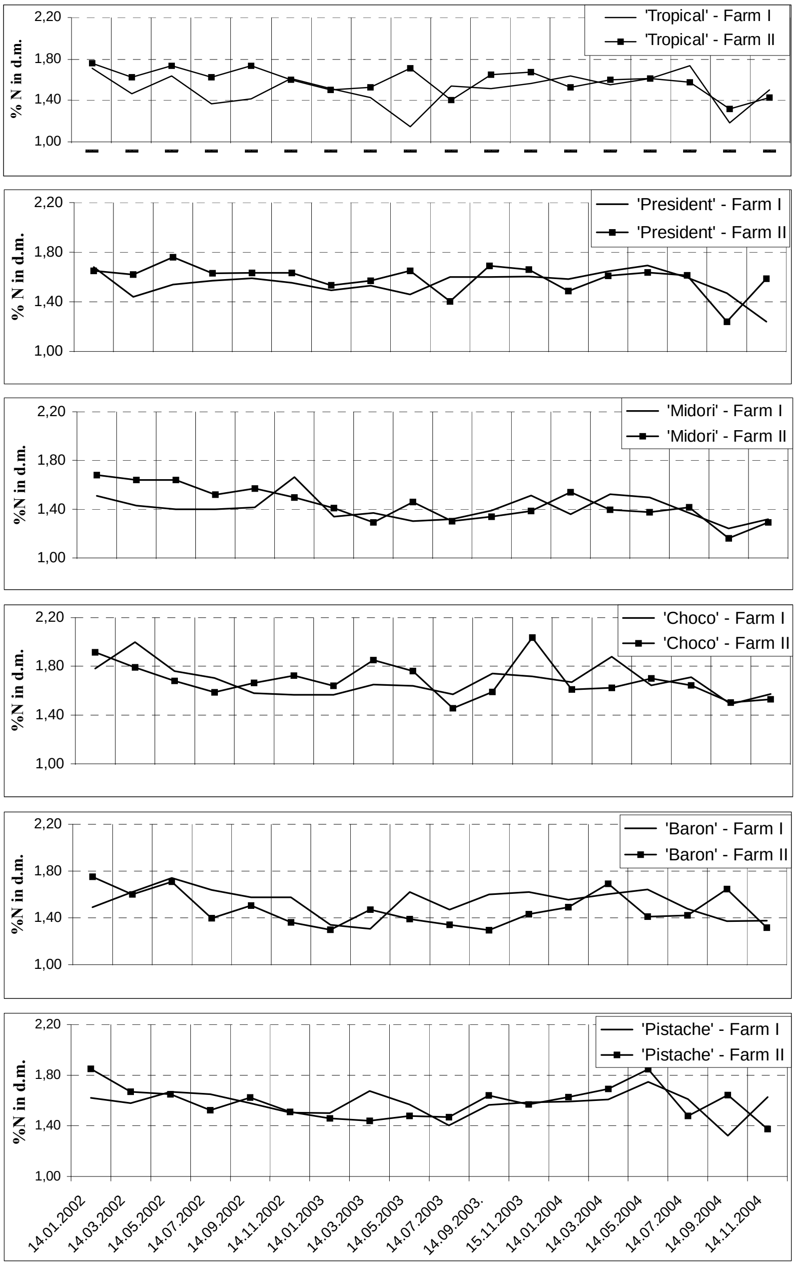
Tabela 1. Równania regresji i średnia zawartość azotu (% N s. m.) w liściach badanych odmian anturium w gospodarstwie I i II (średnia z 3 lat); $R^2_{(e)}$: dla równania w postaci $y = ax + b$; $R^2_{(f)}$ dla $y = ax^2 + bx + c$; $R^2_{(g)}$ dla $y = ax^3 + bx^2 + cx + d$

Cultivar Odmiana (A)	Regression equation Równanie regresji	R^2			$\bar{x}$
Farm – Gospodarstwo I (B)					
'Baron'	$y = -0.0004x^3 + 0.0099x^2 - 0.0792x + 1.718$	$0.09_{(e)}$	$0.10_{(f)}$	$0.21_{(g)}$	1.53
'Choco'	$y = -0.0006x^3 + 0.0196x^2 - 0.1735x + 2.087$	0.13	0.17	0.51	1.68
'Midori'	$y = -0.0003x^3 + 0.0071x^2 - 0.0589x + 1.553$	0.09	0.10	0.18	1.41
'Pistache'	$y = -0.0002x^3 + 0.0049x^2 - 0.0459x + 1.694$	0.02	0.03	0.06	1.58
'President'	$y = -0.0006x^3 + 0.0168x^2 - 0.1194x + 1.751$	0.03	0.13	0.58	1.55
'Tropical'	$y = -0.0006x^3 + 0.018x^2 - 0.1528x + 1.821$	0.01	0.21	0.25	1.51
$\bar{x}$ (B)	$y = -0.0004x^3 + 0.0127x^2 - 0.1049x + 1.771$	0.01	0.10	0.47	1.54
Farm – Gospodarstwo II (B)					
'Baron'	$y = -0.0006x^3 + 0.0189x^2 - 0.1886x + 1.960$	$0.01_{(e)}$	$0.34_{(f)}$	$0.51_{(g)}$	1.47
'Choco'	$y = -0.0005x^3 + 0.0137x^2 - 0.1144x + 1.963$	0.15	0.15	0.29	1.68
'Midori'	$y = -0.0003x^3 + 0.0102x^2 - 0.1139x + 1.837$	0.60	0.64	0.70	1.44
'Pistache'	$y = -0.0008x^3 + 0.0251x^2 - 0.2192x + 2.065$	0.04	0.13	0.61	1.59
'President'	$y = -0.0001x^3 + 0.0031x^2 - 0.0314x + 1.713$	0.18	0.19	0.20	1.59
'Tropical'	$y = -0.0003x^3 + 0.0096x^2 - 0.0852x + 1.839$	0.36	0.36	0.47	1.59
$\bar{x}$ (B)	$y = -0.0004x^3 + 0.0134x^2 - 0.1254x + 1.896$	0.37	0.42	0.68	1.56

$LSD_{\alpha\,0.05}$ for A = 0.05; $LSD_{\alpha\,0.05}$ for B = n.d.; $LSD_{\alpha\,0.05}$ for A×B = 0.06; n.d. – no differences
$NIR_{\alpha\,0.05}$ dla A = 0,05; $NIR_{\alpha\,0.05}$ dla B = r.n..; $NIR_{\alpha\,0.05}$ dla A×B = 0,06; r.n. – różnice nieistotne

The downward trend of nitrogen content in the index parts of plants, determined for the 3-year study, may indicate decreasing nutritional requirements of plants in relation to this nutrient as they were aging. Results of analyses are similar to those in earlier studies by Kleiber and Komosa [2004, 2006]. It was shown that for anthurium grown in pots the application of excessive nitrogen fertilization, not adapted to the current development phase of the plant and culture conditions, resulted in decreased yield and deteriorated quality of yields [Henny et al. 2003].

There are significant differences between cultivars in nitrogen contents in the index parts of plants. The cultivar with the highest content of this nutrient was ‘Choco’ (1.68% N), followed by ‘Pistache’ (for farms I and II it was 1.58% N and 1.59% N, respectively). The cultivar with the lowest nitrogen content in the index parts was ‘Midori (1.41% and 1.44% N). The other cultivars from farm I contained between 1.51% N (‘Tropical) and 1.55% N in case of cv. ‘President’, while from farm II – between 1.47% N for cv. ‘Baron’ and 1.59% N (‘President’ and ‘Tropical’). Similar nitrogen contents to those assayed here were given by Komosa and Kleiber [2002]. The results are markedly lower than the contents given by Anthura (1998). They also differ from contents recommended by De Kreij et al. [1990], and Higaki et al. [1992]. Sonneveld and Voogt [1993] showed higher contents for the cultivation on polyphenolic foam. Assayed contents fell within the range reported by Mills and Scoggins [1998], amounting to 1.19–2.06% N in mature leaves of anthurium grown on volcanic slag.



The same descriptions for all the figures: % in d.m. – % w s.m.; Farm – Gospodarstwo

Fig. 1. Dynamics of nitrogen content (% N in d.m.of index parts) in different cultivars grown in farms I and II

Rys. 1. Dynamika zawartości azotu (% N w s.m. części wskaźnikowych) w różnych odmianach uprawianych w gospodarstwie I i II

Content of phosphorus in the index parts of plants changed considerably (tab. 2, fig. 2). A marked increase in the content of this nutrient in all analyzed cultivars was found in the first dates of 2003, after which it decreased. Until the end of the study a minimal upward trend was observed for phosphorus content in the index parts of plants. Anthurium cultivars grown on farm I contained more phosphorus than those on farm II. Regression equations describing the upward trend for phosphorus content in the index parts of plants, coming from both farms, are presented in Table 2. Studies conducted to date [Komosa and Kleiber 2002, Kleiber and Komosa 2004, 2006] confirm the investigations conducted by the authors of this study.

Table 2. Regression equations and mean phosphorus contents (% P d. m.) in leaves analyzed anthurium cultivars in farms I and II (means from 3 years); $R^2_{(e)}$: for equation in the form $y = ax + b$; $R^2_{(f)}$ for $y = ax^2 + bx + c$; $R^2_{(g)}$ for $y = ax^3 + bx^2 + cx + d$; $a = 10^{-1}(-4)x^3$

Tabela 2. Równania regresji i średnia zawartość fosforu (% P s. m.) w liściach badanych odmian anturium w gospodarstwie I i II (średnia z 3 lat); $R^2_{(e)}$: dla równania w postaci $y = ax + b$; $R^2_{(f)}$ dla $y = ax^2 + bx + c$; $R^2_{(g)}$ dla $y = ax^3 + bx^2 + cx + d$; $a = 10^{-1} \cdot (-4)x^3$

Cultivar Odmiana (A)	Regression equation Równanie regresji	R^2			$\bar{x}$
Farm – Gospodarstwo I (B)					
'Tropical'	$y = -0.0004x^3 + 0.0106x^2 - 0.0525x + 0.377$	0.24	0.35	0.50	0.42
'President'	$y = (-1E\text{-}04x^3)^a + 0.0024x^2 - 0.0078x+0.370$	0.16	0.17	0.18	0.42
'Midori'	$y = -0.0003x^3 + 0.0058x^2 - 0.0063x + 0.178$	0.32	0.53	0.59	0.34
'Choco'	$y = -0.0003x^3 + 0.006x^2 - 0.0191x + 0.347$	0.39	0.55	0.64	0.44
'Baron'	$y = 0.0003x^3 - 0.0085x^2 + 0.0803x + 0.175$	0.39	0.40	0.54	0.41
'Pistache'	$y = -0.0003x^3 + 0.0058x^2 - 0.0172x + 0.268$	0.44	0.56	0.63	0.38
$\bar{x}$ (B)	$y = -0.0002x^3 + 0.0037x^2 - 0.0038x + 0.286$	0.50	0.65	0.71	0.40
Farm – Gospodarstwo II (B)					
'Tropical'	$y = 0.0001x^3 - 0.0047x^2 + 0.0651x + 0.114$	0.31	0.43	0.45	0.36
'President'	$y = -0.0001x^3 + 0.0021x^2 + 0.0069x + 0.235$	0.31	0.39	0.41	0.36
'Midori'	$y = -0.0005x^3 + 0.0137x^2 - 0.0737x + 0.283$	0.41	0.47	0.62	0.33
'Choco'	$y = -0.0006x^3 + 0.0135x^2 - 0.0639x + 0.278$	0.30	0.43	0.58	0.36
'Baron'	$y = -0.0003x^3 + 0.0067x^2 - 0.0213x + 0.235$	0.50	0.62	0.71	0.35
'Pistache'	$y = -0.0003x^3 + 0.0069x^2 - 0.0114x + 0.199$	0.23	0.53	0.62	0.35
$\bar{x}$ (B)	$y = -0.0003x^3 + 0.0064x^2 - 0.0164x + 0.224$	0.42	0.58	0.66	0.35

$LSD_{\alpha\,0.05}$ for A = 0.03; $LSD_{\alpha\,0.05}$ for B = 0.02; $LSD_{\alpha\,0.05}$ for A×B = 0.03
$NIR_{\alpha\,0.05}$ dla A = 0,03; $NIR_{\alpha\,0.05}$ dla B = 0,02; $NIR_{\alpha\,0.05}$ dla A×B = 0,03

Statistically significant differences were shown in the content of phosphorus between the analyzed cultivars. The lowest content of this nutrient in the index parts of anthurium was found for cv. 'Midori' (0.33–0.34% P). Assayed contents of phosphorus in case of the other cultivars from farm II were similar and amounted to 0.35–0.36% P. Small differences were also found in cultivars from farm I: from 0.38% P ('Pistache') to 0.44% P ('Choco'). Assayed contents of phosphorus in the index parts of anthurium are similar to those given by Mills and Scoggins [1998] and Komosa and Kleiber [2003b].

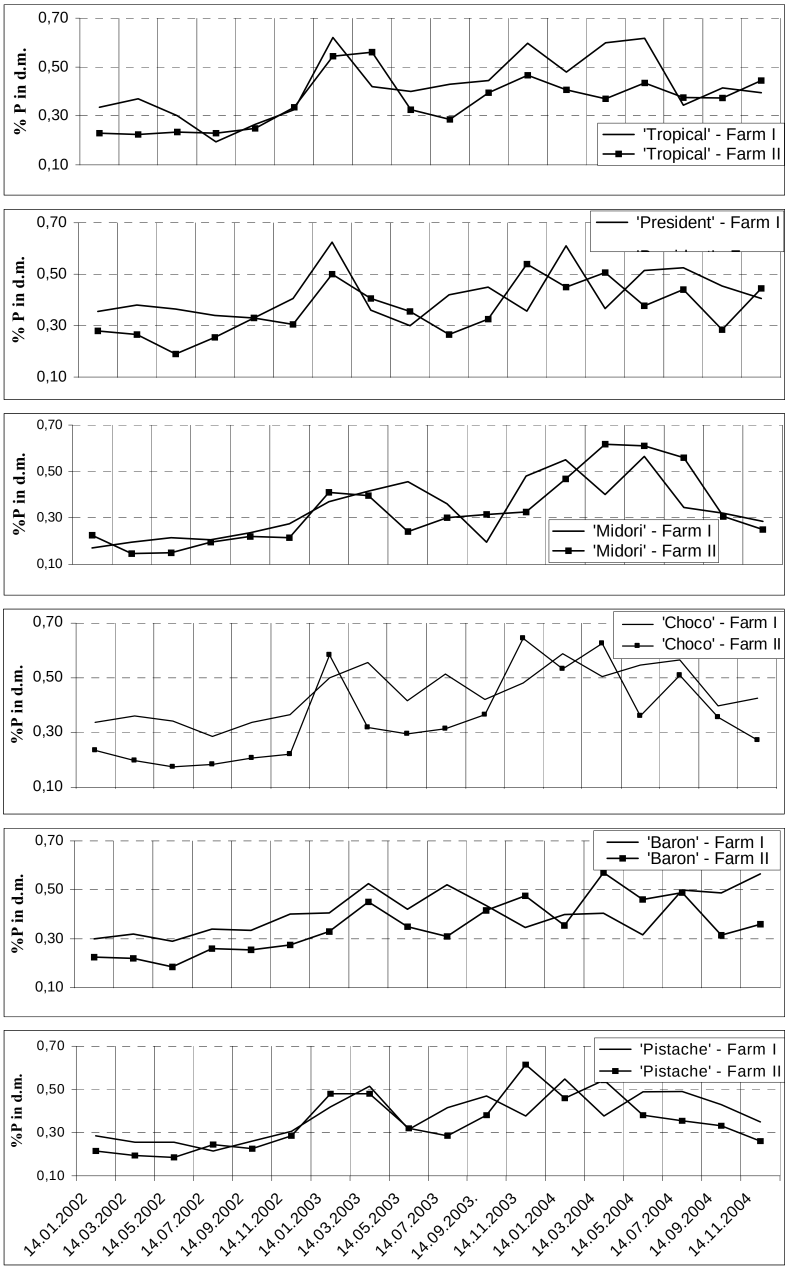


Fig. 2. Dynamics of phosphorus content (% P in d.m.of index parts) in different cultivars grown in farms I and II

Rys. 2. Dynamika zawartości fosforu (% P w s.m. części wskaźnikowych) w różnych odmianach uprawianych w gospodarstwie I i II

However, they exceed contents reported by De Kreij et al. [1990], as well as Higaki et al. [1992] for traditional cultivation of anthurium and Sonneveld and Vogt [1993] for cultivation in polyphenolic foam.

An increase was shown in the content of potassium in the index parts of plants during the 3 years of the study (tab. 3, fig. 3). It was most marked in the years 2002–2003. In case of cv. 'Tropical', 'President', 'Midori' and 'Pistache' potassium contents in the index parts of plants were higher for farm II than for farm I. The dynamics of potassium content for the same anthurium cultivars were similar in both farms. Results of investigations conducted by the authors of this study confirm earlier studies by Kleiber and Komosa [2004, 2006] and Komosa and Kleiber [2002]. Dufour and Guérin [2005] reported that for plants grown in a medium composed of volcanic slag and wood chips (2 : 1 v/v), increased potassium requirement is observed in the generative growth phase. It is a typical phenomenon, observed also in many other plant species. Increased potassium requirement is connected, among other things, with the transfer of considerable amounts of this element inside the plant – from older leaves to younger leaves and to flowers.

Table 3. Regression equations and mean potassium contents (% K d. m.) in leaves analyzed anthurium cultivars in farms I and II (means from 3 years); $R^2_{(e)}$: for equation in the form y =ax + b; $R^2_{(f)}$ for $y = ax^2 + bx + c$; $R^2_{(g)}$ for $y = ax^3 + bx^2 + cx + d$

Tabela 3. Równania regresji i średnia zawartość potasu (% K s. m.) w liściach badanych odmian anturium w gospodarstwie I i II (średnia z 3 lat); $R^2_{(e)}$: dla równania w postaci y =ax + b; $R^2_{(f)}$ dla $y = ax^2 + bx + c$; $R^2_{(g)}$ dla $y = ax^3 + bx^2 + cx + d$

Cultivar Odmiana (A)	Regression equation Równanie regresji	R^2			$\bar{x}$
	Farm Gospodarstwo I (B)				
'Baron'	$y = 0.0016x^3 - 0.0452x^2 + 0.4205x + 2.478$	0.55	0.55	0.71	3.72
'Choco'	$y = -0.0002x^3 + 0.0011x^2 + 0.0557x + 3.911$	0.01	0.22	0.23	4.19
'Midori'	$y = 0.0013x^3 - 0.0333x^2 + 0.2619x + 3.243$	0.42	0.48	0.64	3.94
'Pistache'	$y = 0.0004x^3 - 0.0175x^2 + 0.2724x + 2.810$	0.53	0.59	0.60	4.04
'President'	$y = 0.0006x^3 - 0.0238x^2 + 0.2925x + 3.217$	0.08	0.41	0.44	4.01
'Tropical'	$y = 0.0004x^3 - 0.0181x^2 + 0.2345x + 3.405$	0.09	0.28	0.30	4.18
$\bar{x}$ (B)	$y = 0.0007x^3 - 0.0228x^2 + 0.2563x + 3.177$	0.45	0.54	0.61	4.01
	Farm Gospodarstwo II (B)				
'Baron'	$y = -0.0002x^3 - 0.0017x^2 + 0.1329x + 2.828$	0.28	0.60	0.60	3.55
'Choco'	$y = 0.0004x^3 - 0.0234x^2 + 0.3276x + 3.087$	0.00	0.50	0.51	4.08
'Midori'	$y = 0.0006x^3 - 0.0184x^2 + 0.1865x + 3.457$	0.21	0.23	0.29	4.02
'Pistache'	$y = 0.0005x^3 - 0.0217x^2 + 0.2834x + 3.141$	0.22	0.54	0.57	4.09
'President'	$y = 0.0015x^3 - 0.0491x^2 + 0.4734x + 2.864$	0.10	0.29	0.51	4.06
'Tropical'	$y = 0.001x^3 - 0.0349x^2 + 0.3947x + 3.044$	0.24	0.48	0.55	4.26
$\bar{x}$ (B)	$y = 0.0006x^3 - 0.0249x^2 + 0.2997x + 3.070$	0.22	0.61	0.68	4.01

$LSD_{\alpha\,0.05}$ for A = 0.16; $LSD_{\alpha\,0.05}$ for B = n.d.; $LSD_{\alpha\,0.05}$ for A×B = 0.20; n.d. – no differences
$NIR_{\alpha\,0.05}$ dla A = 0,16; $NIR_{\alpha\,0.05}$ dla B = n.d.; $NIR_{\alpha\,0.05}$ dla A×B = 0,20; r.n. – różnice nieistotne

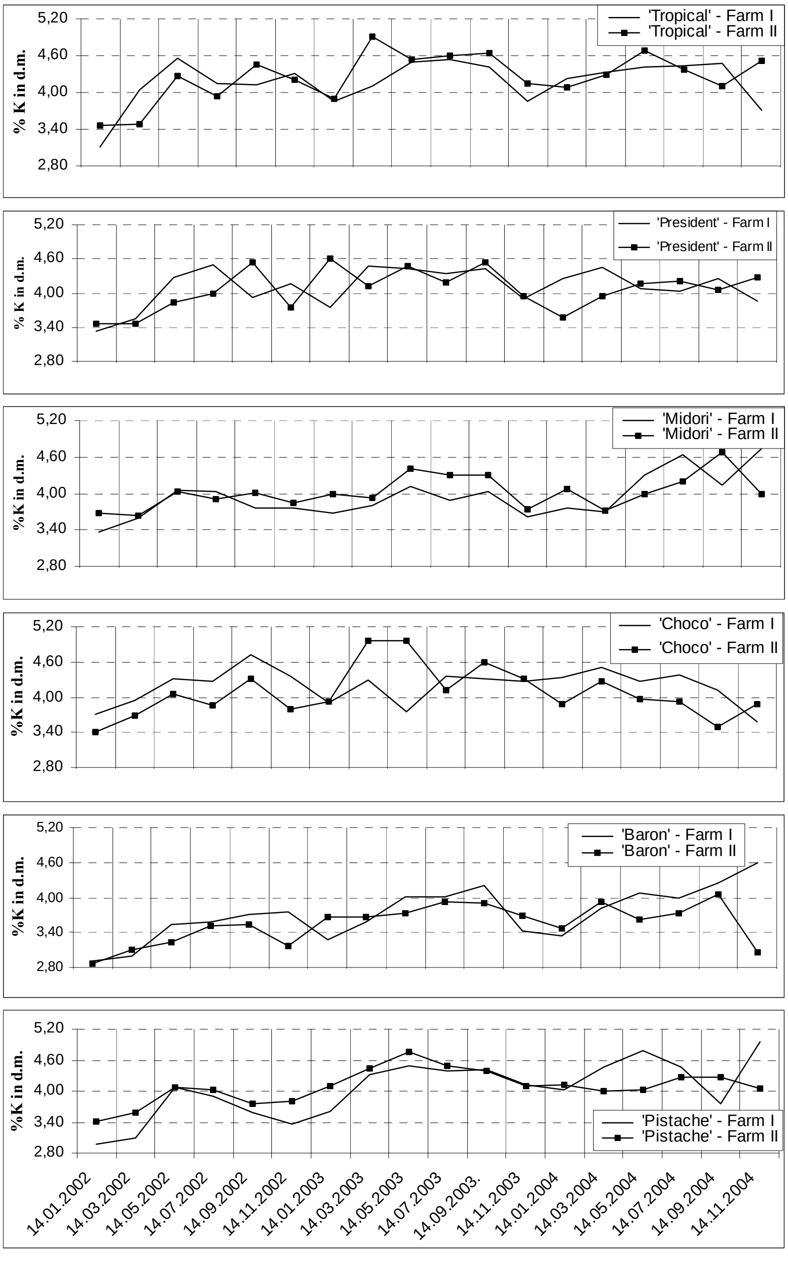


Fig. 3. Dynamics of potassium content (% K in d.m. of index parts) in different cultivars grown in farms I and II

Rys. 3. Dynamika zawartości potasu (% K w s.m. części wskaźnikowych) w różnych odmianach uprawianych w gospodarstwie I i II

Significant differences were shown in potassium content between analyzed cultivars. The highest potassium content was recorded for 'Tropical' (4.18 and 4.26% K, respectively farm I and II), while the lowest in cv. 'Baron' (3.74% and 3.55% K). The other cultivars from farm I contained between 3.94% K ('Midori') and 4.04% K ('Pistache'), while from farm II it was between 4.02% ('Midori') and 4.09% K ('Pistache'). Assayed contents of potassium in the index parts of anthurium fell within the range given by De Kreij et al. [1990] and Anthura [1998]. Other authors [Higaki et al. 1992, Sonneveld and Vogt 1993] showed much lower contents of this element (2.07% K and 3.52% K, respectively).

Table 4. Quantitative relationships between nitrogen, phosphorus and potassium (N:P:K) in analyzed cultivars, in farms I and II (nitrogen content for each cultivar was assumed as 1.0)

Tabela 4. Relacje ilościowe między azotem, fosforem i potasem (N:P:K) w badanych odmianach, w gospodarstwie I I II (dla każdej odmiany zawartość azotu przyjęto za 1,0)

Cultivar	Farm I	Farm II	$\bar{x}$
'Baron'	1.0 : 0.27 : 2.43	1.0 : 0.24 : 2.41	1.0 : 0.26 : 2.42
'Choco'	1.0 : 0.26 : 2.49	1.0 : 0.21 : 2.43	1.0 : 0.24 : 2.46
'Midori'	1.0 : 0.24 : 2.79	1.0 : 0.23 : 2.79	1.0 : 0.24 : 2.79
'Pistache'	1.0 : 0.24 : 2.56	1.0 : 0.22 : 2.57	1.0 : 0.23 : 2.57
'President'	1.0 : 0.27 : 2.58	1.0 : 0.23 : 2.55	1.0 : 0.25 : 2.57
'Tropical'	1.0 : 0.28 : 2.76	1.0 : 0.22 : 2.67	1.0 : 0.25 : 2.72
$\bar{x}$	1.0 : 0.26 : 2.60	1.0 : 0.22 : 2.57	1.0 : 0.24 : 2.59

Analyzed anthurium cultivars differed in terms of the quantitative proportions of nitrogen, phosphorus and potassium (tab. 4). Cultivars with the narrowest quantitative ratios between nitrogen and potassium were 'Choco' (1.0 : 2.46) and 'Baron' (1.0 : 2.42). The widest ratio between these nutrients was found for 'Tropical' (1.0 : 2.72) and 'Midori' (1.0 : 2.79). For all analyzed cultivars relations between nitrogen and phosphorus were similar, ranging from 1.0 : 0.23 ('Pistache') to 1.0 : 0.26 ('Baron').

CONCLUSIONS

1. It was found a decreasing tendency for nitrogen and increasing one for phosphorus and potassium anthurium leaves contents.

2. Anthurium cultivars differed in terms of the quantitative proportions of nitrogen, phosphorus and potassium. Cultivars with the narrowest quantitative ratios N : K were 'Choco' (1.0 : 2.46) and 'Baron' (1.0 : 2.42). The widest ratios were found for: 'Tropical' (1.0 : 2.72) and 'Midori' (1.0 : 2.79).

3. Anthurium cultivars had similar N : P ratios in leaves, which were ranging from 1.0 : 0.23 for 'Pistache' to 1.0 : 0.26 for 'Baron'.

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PORÓWNANIE DYNAMIKI ZAWARTOŚCI N, P, K W RÓŻNYCH ODMIANACH ANTURIUM (*Anthurium cultorum* Birdsey) UPRAWIANEGO W KERAMZYCIE

Streszczenie: Doświadczenia wegetacyjne przeprowadzono w latach 2002–2004 w dwóch specjalistycznych gospodarstwach ogrodniczych. Badano dynamikę zawartości azotu, fosforu i potasu w częściach wskaźnikowych wybranych odmian anturium *(Anthurium cultorum* Birdsey): 'Baron', 'Choco', 'Midori', 'Pistache', 'President' i 'Tropical'. Rośliny uprawiano w keramzycie, z zastosowaniem fertygacji kroplowej pożywką standardową. Części wskaźnikowe roślin, którymi były w pełni rozwinięte liście po świeżo ściętym kwiecie pobierano co 2 miesiące w trakcie 3 lat badań celem ich analiz chemicznych. Stwierdzono zróżnicowaną dynamikę zawartości składników w częściach wskaźnikowych roślin. W trakcie 3 lat badań zarejestrowano trend malejący zawartości azotu, podczas gdy trend wzrastający stwierdzono dla zawartości fosforu i potasu. Udowodniono różnice odmianowe dla zawartości wspomnianych składników oraz relacji ilościowych między nimi.

Słowa kluczowe: anturium, dynamika, azot, potas, fosfor, keramzyt

The research was supported by the State Committee for Scientific Research (KBN), grant No. 0381/P06/2004/26

Accepted for print – Zaakceptowano do druku: 5.12.2008