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INFLUENCE OF BETOKSON SUPER AND FERTILIZERS ON CHEMICAL COMPOSITION OF FRUITS AND LEAVES OF BLUE HONEYSUCKLE

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Abstract. The aim of the experiment was study the response of blue honeysuckle cv. 'Atut' and 'Duet' to application of Betokson Super and some fertilizers. The study was carried out in 2004–2007 on three years old plants growing in clay-loam soil. Bormax applied twice during blooming period and one after fruit harvest in concentration 0.2%. Calcium nitrate $Ca(NO_3)_2$ applied to the soil around plants in April at the rate of 50 kg·ha^{-1}. Betokson Super 050 SL applied twice during blooming period in concentration 0.1%. Finally combination of calcium nitrate + Bormax and calcium nitrate + Betokson were used. Untreated by chemicals plants served as a control. Boron fertilization enhanced significantly amount of anthocyanins and ascorbic acid in fruit. Blue honeysuckle fruits are plenty of anthocyanins and ascorbic acid and as a first ripening fruit in our climate could be a good its source for human consumption. Soil application of calcium nitrate resulted in significantly lower levels of phosphorus in leaves of blue honeysuckle. However plants did not showed the symptoms of P deficiency. According to results of present study, in order to reach high yield and high fruit quality, blue honeysuckle plants could be fertilized by calcium nitrate and Bormax, as well as treated by Betokson Super. Clear differences in yielding and leaf characteristic of both studied cultivars indicate that they are genetically distant.

Key words: *Lonicera caerulea* var. *kamtschatica,* quantity and quality of yield, chemical composition of leaves

INTRODUCTION

The blue honeysuckle are alternative berry plant in Poland, witch come from Russia and it has introduced to cultivation at second half of 19'th century [Antalikova and Matuskovic 2006]. In Poland, blue honeysuckle becomes more and more popular, especially in amateurish cultivation and small plantation. Plants on the plantation, in order to

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improve the quantity and quality of yield, require several treatments. Proper management of nutrition at proper time is particularly important to reach a commercial berry production. Adequate plant nutrition is important for good healthiness, high yielding and fruit quality. The are two main methods of fertilization: addition of fertilizer directly to the soil and foliar spraying. Both have been proved to be effective crops. Soil application are generally used for applying to field crops, but foliar sprays are more common on perennial crops such as fruit trees and bushes. Foliar application rates are usually about 50% lower than soil application rates [Abdollahi et al. 2010].

The positive effect of calcium treatments on berry firmness, rot resistance and storage quality in strawberry plantation has been reported [Cheour et al. 1991, Wójcik and Lewandowski 2003]. Calcium binds pectin in the middle lamella cell walls thereby reinforcing cell strength and improving quality. High concentration of calcium are required to ensure diffusion to the blossom end will occur.

Another nutrient which also has an important role in fruit quality is boron. Boron is an essential element for all vascular plants. It play a role in carbohydrate and RNA metabolism and prevents phenolic accumulation which inhibits auxin activity. It is estimated that approximately 70% of the agricultural land in Poland has low B status [Wójcik 2004].

The next management performed to improve plant productivity, as well as quality and nutritional value of fruits is the use of biostimulants. The typical preparation from group of synthetic biostimulants is Betokson Super 050 SL containing 2-naphtoxyacetic acid. It is applied in cultivation of strawberry and other fruit plant to improve field, fruit quality and to accelerate their ripening [Żurawicz et al. 2004].

The aim of this study was to examine the vegetative and the generative responses of blue honeysuckle to fertilization and application of Betokson Super.

MATERIAL AND METHODS

The study was carried out at University of Life Science, Lublin in 2004–2007. The plantation of two blue honeysuckle (*Lonicera caerulea* var. *kamtschatica*) cultivars 'Atut' and 'Duet' was established in the spring of 2001, near Lublin in Poland (NL: 51°, EL: 22°). Bushes were planted in a bed system with spacing 1 × 1 × 1.2 m.

The soil and climatic conditions of experimental site were as follows: clay-loam, pH 6,5, many-year averages of temperature during vegetative period is 13.1°C, average rainfall 552 mm per year. The actual values of average rainfall and temperature in April–June 2004–2007 are given in Table 1. Thermal conditions were favorable for the growth and development of blue honeysuckle in 2004, 2005 and 2007. Despite the low temperatures of April in 2006, the term of individual phonological phases did not differ from other years of research. Basing on the results of Pokorná-Juríková and Matuškovič [2007], which were reached from the experiment established on *Lolicera edulis* and *Lonicera kamtchatica*, it can be assumed that humid conditions had no effect on the nutritional value of leaves and fruit quality.

The conventional agronomic treatments were adapted to low soil and water requirements of the species. No chemical plant protection was applied because of resistance to

Table 1. Climatic conditions. Mean air temperature and total precipitation in 2004 to 2007 with characterization versus a background of many-year averages

Tabela 1. Warunki klimatyczne. Średnia temperatura powietrza oraz sumy opadów w latach od 2004 do 2007 z charakterystyką w stosunku do średnich wieloletnich

Climatic condition Warunki klimatyczne	Month Miesiąc	2004	2005	2006	2007
Average temperature Średnia temperatura powietrza (˚C)	April – kwiecień	7.9	9.1	1.9	8.7
	characterization charakterystyka	normal norma	normal norma	very cold bardzo zimno	normal norma
	May – maj	12.3	13.1	13.6	14.9
	characterization charakterystyka	normal norma	normal norma	normal norma	normal norma
	June – czerwiec	15.9	16.1	16.9	16.2
	characterization charakterystyka	normal norma	normal norma	normal norma	normal norma
Amount of precipitation Suma opadów (mm)	April – kwiecień	38.1	18.6	30.3	17.4
	characterization charakterystyka	normal norma	dry susza	normal norma	dry susza
	May – maj	38.0	98.0	59.5	80.5
	characterization charakterystyka	normal norma	very humid bardzo mokro	normal norma	very humid bardzo mokro
	June – czerwiec	49.9	55.9	37.9	87.8
	characterization charakterystyka	normal norma	normal norma	dry susza	humid mokro

diseases and pests of *Lonicera* plants. Twelve bushes were planted for each treatment. To avoid the potential movement of fertilizers, around the plots the isolation belts were applied with successive two shrubs.

The fertilization was applied in the following combinations:

1. The control – untreated plants;

2. Bormax applied twice during blooming period and one after fruit harvest in concentration 0.2%;

3. Calcium nitrate $Ca(NO_3)_2$ applied to the soil around plants in April at the rate of 50 $kg{\cdot}ha^{-1}$;

4. Betokson Super 050 SL applied twice during blooming period in concentration 0.1%;

5. Calcium nitrate + Bormax: Calcium nitrate $Ca(NO_3)_2$ applied to the soil around plants in April at the rate of 50 $kg{\cdot}ha^{-1}$ and Bormax applied twice during blooming period and one after fruit harvest in concentration 0.2%;

6. Calcium nitrate + Betokson: Calcium nitrate $Ca(NO_3)_2$ applied to the soil around plants in April at the rate of 50 $kg{\cdot}ha^{-1}$ and Betokson Super 050 SL applied twice during blooming period in concentration 0.1%.

Bormax is liquid fertilizer for foliar application. It is containing 3.7% of nitrogen and 11% of boron, as boroetaloamin, which is easy absorbed by plant.

Calcium nitrate ($Ca(NO_3)_2$ is modern granular fertilizer for soil application. It is containing nitrogen (15.5%) mainly as nitrate nitrogen and calcium (26%) as CaO,

Betokson Super is containing 25 g 1^{-1} salt of 2 – naphtoxyacetic acid with triethanolamin.

Effect of treatments on yield and fruit quality, as well as on mineral maters were evaluated on the basis of the following indices:

– Total yield from each bush which is the sum of individual harvests. In every year the yield was harvested tree times in period 07–28 of June;

– Mean mass of 100 fruits;

The 2 kg bulk samples of fruits from treated and non-treated bushes for each cultivar were collected at the second harvest. The samples of blue honeysuckle fruits were analyzed for:

– Dry matter content (%) with the oven-drying method);

– Soluble solids content (%) was determined with an Abbé refractometer;

– Total sugar content (%) was determined according to the Loof-Schoorl method [Krełkowska-Kułas 1993];

– Acidity (%) was determined potentiometrically by titration with 0.1 N NaOH solution and was converted to malic acid [Yermakov et al. 1987];

– Anthocyanins content %) – colorimetric method, converted to cyaniding chloride);

– Ascorbic acid content (%) was determined by colorimetric method of Roe and Kuether [1943].

The samples of leaves for chemical analyzes were taken in the second half of July. The indicator parts were whole leaf with petiole, which was 3^{rd}–5^{th} leaf from the tip of annual shoots. One sample contained about 100 leaves. After drying the material the following were determined: Nitrogen (N) content was determined after mineralization using Kjeldahl's method, phosphorus (P) content was determined by colorimetric method with ammonium molybdate; potassium (K), calcium (Ca) and magnesium (Mg) content was determined by ASA method.

A leaf portion from each sample was kept fresh for chlorophyll determination chlorophyll a and b (mg·g^{-1} of fresh matter) was determined colometrically according the methods of Arnon [1949].

Experimental data were statistically elaborated using analysis of variance for two-factorial experiments and Tukey's test at P = 0.05. Data were analyzed by 'STATISTICA' program.

RESULTS AND DISCUSSION

Yield and fruit quality. It can be seen that blue honeysuckle cultivars: 'Atut' and 'Duet' in general reacted positively to treatments with fertilizers and Betokson Super (tab. 2). Similar tendencies were obtained in study of Szot and Wieniarska [2012] after using calcium nitrate alone or followed by Goëmar®BM 86. Calcium nitrate + Betokson Super and Betokson Super alone significantly improved yield in 'Atut'. The yield of cv. 'Duet' increased after application calcium nitrate + Bormax, calcium nitrate + Betokson Super and calcium nitrate alone. The improvement in the weight of 100 fruits of both cultivars after treatments was stated, however only application calcium nitrate + Betokson Super on 'Duet' resulted in significant higher values of described feature, as compared to the control. The results showed, that yield of blue honeysuckle treated by calcium nitrate or Betokson Super was higher than those of control plots (tab. 4). This effect was due to improved fruit set because weight of 100 berries did not differ among treatments. However significant increasing in yield of bushes treated by calcium nitrate + Bormax and calcium nitrate + Betoxon Super did not result from fruit set, because of significant improving of weight of 100 berries in mentioned combinations. Beneficial influence of calcium nitrate fertilization on quantity of yield was noted by Domagała-Świątkiewicz [2006] on apple trees cv. 'Elise'.

Blue honeysuckle of cv. 'Atut' beneficial reacted in yield and fruit quality (dry matter, content of, sugar and acidity) after using Betokson Super alone (tab. 4). This results are in line with those reported by Masny et al [2002]. They stated that Betokson Super, particularly at 0.1 percent concentration, exerted a markedly positive effect on total yield and berry size of strawberry cv. 'Senga Sengana' and 'Ducat'. Thakur et al. [1991] for 'Teoga' strawberry stated that using α-naphthyloacetic acid applied at concentrations from 5 to 20 ppm increased fruit diameter and weight. However Marjańska--Cichoń and Sapieha-Waszkiewicz [2011] stated that Betokson Super during tree years of study influenced on slightly lower yield of strawberry cv. 'Salut' compared to the control.

Fertilizers did not effect on concentration of soluble solids, sugar and acidity (tab. 4). Whereas application of Betokson Super influenced on significantly higher content of dry matter, sugar and ascorbic acid in fruits as compared to the control. Żmuda et al. [2001] studying the effect of differ concentration of Betokson Super stated significant increasing in amount of ascorbic acid in strawberry fruit after application in concentration 0.1 and 0.2%. Using of Bormax resulted in significantly higher content of

Table 2. Influence of differ chemicals and cultivar on chosen features of yield and fruit of blue honeysuckle (mean from four years)
Tabela 2. Wpływ różnych substancji chemicznych i odmiany na wybrane cechy plonu i owoców jagody kamczackiej (średnia z czterech lat)

Cultivar Odmiana	Treatment Kombinacja	Yield (kg/bush) Plon (kg/krzew)	Weight of 100 fruits Masa 100 owoców (g)	Dry matter Sucha masa (%)	Soluble solids content Ekstrakt (%)	Sugar Cukry (%)	Acidity Kwasowość (%)	Anthocyjanins Antocyjany (%)	Ascorbic acid Witamina C (%)
Atut	control kontrola	0.82 a	83.78 a	14.82 ab	10.80 a	4.59 a	2.40 c-e	0.46 ab	63.44 ef
	Bormax	0.85 a	95.22 ab	14.99 bc	10.91 a	4.94 ab	2.36 c-e	0.66 b	64.84 f
	calcium nitrate saletra wapniowa	1.02 ab	100.44 a-c	15.00 bc	10.39 a	5.04 a-c	2.67 de	0.49 ab	52.63 c
	Betokson Super	1.29 b-d	85.89 ab	16.10 c	10.95 a	5.40 a-d	2.74 e	0.52 ab	62.55 e
	calcium nitrate + Bormax saletra wapniowa + Bormax	0.95 a	95.11 ab	15.02 bc	10.65 a	4.20 a	2.13 b-d	0.60 ab	68.56 g
	calcium nitrate + Betokson Super saletra wapniowa + Betokson Super	1.30 cd	97.22 ab	14.91 ab	11.09 a	4.85 ab	2.50 de	0.48 ab	84.42 h
Duet	control kontrola	1.08 a-c	116.89 b-d	13.95 ab	10.35 a	5.42 a-d	1.42 a	0.45 a	43.25 a
	Bormax	1.28 b-d	130.00 c-e	14.33 ab	10.43 a	6.06 b-d	1.83 a-c	0.58 ab	55.50 d
	calcium nitrate saletra wapniowa	1.65 e	136.67 de	13.75 a	10.57 a	6.26 b-d	1.88 a-c	0.42 a	51.03 c
	Betokson Super	1.33 cd	142.22 de	14.59 ab	10.53 a	6.38 cd	1.56 ab	0.51 ab	47.88 b
	calcium nitrate + Bormax saletra wapniowa + Bormax	1.52 de	147.33 de	14.11 ab	10.44 a	6.50 d	1.71 ab	0.56 ab	51.20 c
	calcium nitrate + Betokson Super saletra wapniowa + Betokson Super	1.45 de	156.00 e	14.05 ab	10.95 a	6.40 cd	1.61 ab	0.49 ab	41.54 a

*Means within column with the same letter are not significantly differ by Thukey's Multiple Range Test at $P \leq 0.05$.
*Średnie w kolumnie oznaczone tą samą literą nie różnią się istotnie według testu t-Tukeya przy poziomie istotności $P \leq 0,05$.

Table 3. Influence of cultivar on chosen features of yield and fruit of blue honeysuckle (mean from four years)
Tabela 3. Wpływ odmiany na wybrane cechy plonu i owoców jagody kamczackiej (średnia z czterech lat)

Cultivar Odmiana	Yield (kg/bush) Plon (kg/krzew)	Weight of 100 fruits Masa 100 owoców (g)	Dry matter Sucha masa (%)	Soluble solids content Ekstrakt (%)	Sugar Cukry (%)	Acidity Kwasowość (%)	Anthocyjanins Antocyjany (%)	Ascorbic acid Witamina C (%)
Atut	1.04 a*	92.94 a	15.14 b	10.80 a	4.84 a	2.47 b	0.53 a	66.09 b
Duet	1.38 b	138.19 b	14.13 a	10.54 a	6.17 b	1.67 a	0.50 a	48.40 a

*Means within column with the same letter are not significantly differ by Thukey's Multiple Range Test at $P \leq 0.05$.
*Średnie w kolumnie oznaczone tą samą literą nie różnią się istotnie według testu t-Tukeya przy poziomie istotności $P \leq 0,05$.

Table 4. Influence of differ chemicals on chosen features of yield and fruit of blue honeysuckle (mean from four years)
Tabela 4. Wpływ różnych substancji chemicznych na wybrane cechy plonu i owoców jagody kamczackiej (średnia z czterech lat)

	Yield (kg/bush) Plon (kg/krzew)	Weight of 100 fruits Masa 100 owoców (g)	Dry matter Sucha masa (%)	Soluble solids content Ekstrakt (%)	Sugar Cukry (%)	Acidity Kwasowość (%)	Anthocyjanins Antocyjany (%)	Ascorbic acid Witamina C (%)
Control Kontrola	0.95 a	100.33 a	14.39 a	10.58 a	5.00 a	1.91 a	0.46 a	53.35 b
Bormax	1.06 ab	112.61 ab	14.66 ab	10.67 a	5.50 ab	2.10 a	0.62 b	60.22 d
Calcium nitrate Saletra wapniowa	1.33 c	118.56 ab	14.38 a	10.48 a	5.65 ab	2.28 a	0.46 a	51.83 a
Betokson Super	1.31 c	114.06 ab	15.35 b	10.74 a	5.89 b	2.15 a	0.52 ab	55.22 c
Calcium nitrate + Bormax Saletra wapniowa + Bormax	1.24 bc	121.22 b	14.57 a	10.54 a	5.35 ab	1.92 a	0.58 ab	59.88 d
Calcium nitrate + Betokson Super Saletra wapniowa+ Betokson Super	1.38 c	126.61 b	14.48 a	11.02 a	5.62 ab	2.06 a	0.48 a	62.98 e

*Means within column with the same letter are not significantly differ by Thukey's Multiple Range Test at $P \leq 0.05$.
*Średnie w kolumnie oznaczone tą samą literą nie różnią się istotnie według testu t-Tukeya przy poziomie istotności $P \leq 0,05$.

Table 5. Influence of differ chemicals and cultivar on content of chlorophyll, nitrogen, potassium, phosphorus, calcium and magnesium in leaves of blue honeysuckle (mean from four years)

Tabela 5. Wpływ różnych substancji chemicznych i odmiany na zawartość chlorofilu, azotu, potasu, fosforu, wapnia i magnezu w liściach jagody kamczackiej (średnia z czterech lat)

Cultivar Odmiana	Treatment Kombinacja	Chlorofil a Chlorophyll a $mg \cdot g^{-1}$ of fresh matter	Chlorofil b Chlorophyll b $mg \cdot g^{-1}$ of fresh matter	Nitrogen Azot (%)	Potassium Potas (%)	Phosphorus Fosfor (%)	Calcium Wapń (%)	Magnesium Magnez (%)
Atut	control – kontrola	52.63 c	29.39 cd	2.06 a	1.25 a-d	0.255 c	1.48 a-c	0.103 cd
	Bormax	64.94 f	33.28 d	2.07 a	0.95 a	0.205 a-c	1.56 a-d	0.118 de
	calcium nitrate saletra wapniowa	63.44 ef	32.76 d	2.27 a	1.07 ab	0.170 a	1.04 a	0.109 d
	Betokson Super	62.55 e	34.10 e	2.17 a	1.16 a-c	0.220 a-c	1.38 ab	0.151 f
	calcium nitrate + Bormax saletra wapniowa + Bormax	68.56 g	38.76 f	2.24 a	0.99 a	0.180 a	1.49 a-c	0.125 e
	calcium nitrate + Betokson Super saletra wapniowa + Betokson Super	84.42 h	43.50 g	2.16 a	1.02 ab	0.185 a	1.52 a-d	0.130 e
Duet	control – kontrola	43.25 a	22.79 a	2.32 a	1.24 a-d	0.245 bc	2.02 c-e	0.061 a
	Bormax	55.50 d	28.60 c	2.21 a	1.38 cd	0.225 a-c	1.76 b-e	0.082 b
	calcium nitrate saletra wapniowa	51.03 c	26.52 b	2.21 a	1.31 b-d	0.205 a-c	2.14 e	0.085 b
	Betokson Super	47.88 b	25.38 b	2.23 a	1.50 d	0.220 a-c	1.79 b-e	0.088 bc
	calcium nitrate + Bormax saletra wapniowa + Bormax	51.20 c	28.36 c	2.15 a	1.43 cd	0.190 ab	1.74 b-e	0.077 b
	calcium nitrate + Betokson Super saletra wapniowa + Betokson Super	41.54 a	21.91 a	2.39 a	1.21 a-d	0.205 a-c	2.07 de	0.087 b

*Means within column with the same letter are not significantly differ by Thukey's Multiple Range Test at $P \le 0.05$.

*Średnie w kolumnie oznaczone tą samą literą nie różnią się istotnie według testu t-Tukeya przy poziomie istotności $P \le 0,05$.

Table 6. Influence of cultivar on content of chlorophyll, nitrogen, potassium, phosphorus, calcium and magnesium in leaves of blue honeysuckle (mean from four years)

Tabela 6. Wpływ odmiany na zawartość chlorofilu, azotu, potasu, fosforu, wapnia i magnezu w liściach jagody kamczackiej (średnia z czterech lat)

Cultivar Odmiana	Chlorofil a Chlorophyll a $mg \cdot g^{-1}$ of fresh matter	Chlorofil b Chlorophyll b $mg \cdot g^{-1}$ of fresh matter	Nitrogen Azot (%)	Potassium Potas (%)	Phosphorus Fosfor (%)	Calcium Wapń (%)	Magnesium Magnez (%)
Atut	66.09 b	35.30 b	2.16 a	1.07 a	0.203 a	1.41 a	0.123 b
Duet	48.40 a	25.59 a	2.25 a	1.34 b	0.215 a	1.92 b	0.080 a

*Means within column with the same letter are not significantly differ by Thukey's Multiple Range Test at $P \leq 0.05$.
*Średnie w kolumnie oznaczone tą samą literą nie różnią się istotnie według testu t-Tukeya przy poziomie istotności $P \leq 0,05$.

Table 7. Influence of differ chemicals on content of chlorophyll, nitrogen, potassium, phosphorus, calcium and magnesium in leaves of blue honeysuckle (mean from four years)

Tabela 7. Wpływ różnych substancji chemicznych na zawartość chlorofilu, azotu, potasu, fosforu, wapnia i magnezu w liściach jagody kamczackiej (średnia z czterech lat)

Treatment Kombinacja	Chlorofil a Chlorophyll a $mg \cdot g^{-1}$ of fresh matter	Chlorofil b Chlorophyll b $mg \cdot g^{-1}$ of fresh matter	Nitrogen Azot (%)	Potassium Potas (%)	Phosphorus Fosfor (%)	Calcium Wapń (%)	Magnesium Magnez (%)
Control – Kontrola	47.94 a	26.09 a	2.19 a	1.24 ab	0.250 b	1.75 a	0.082 a
Bormax	60.22 d	30.94 bc	2.14 a	1.16 ab	0.215 ab	1.66 a	0.100 bc
Calcium nitrate Saletra wapniowa	57.24 c	29.64 b	2.24 a	1.19 ab	0.188 a	1.59 a	0.097 b
Betokson Super	55.22 b	29.74 b	2.20 a	1.33 b	0.220 ab	1.58 a	0.120 d
Calcium nitrate + Bormax Saletra wapniowa + Bormax	59.88 d	33.56 c	2.19 a	1.21 ab	0.185 a	1.61 a	0.101 bc
Calcium nitrate + Betokson Super Saletra wapniowa + Betokson Super	62.98 e	32.71 c	2.27 a	1.11 a	0.195 a	1.79 a	0.109 c

*Means within column with the same letter are not significantly differ by Thukey's Multiple Range Test at $P \leq 0.05$.
*Średnie w kolumnie oznaczone tą samą literą nie różnią się istotnie według testu t-Tukeya przy poziomie istotności $P \leq 0,05$.

anthocyjanins and ascorbic acid (tab.4). Wang and Lin [2003] speculated that conditions for optimum plant growth increased nutrient availability and antioxidant production. Wójcik [2005] working on raspberry cv. 'Polana' stated that fertilization increased soluble solids content in fruit as explained by improved transport of sugars in the phloem via the formation of B-sugar complex. He supposed that it could be resulted from increased leaf photosynthesis rate.

Some researchers proved the beneficial influence of calcium application on anthocyanins content in fruit. Vitrac et al. [2000] suggested the involvement of Ca^{2+} in the induction of anthocyanin biosynthesis in grape cells. Li et al. [2004] also observed the positive effect of calcium on anthocyanin accumulation in intact apple fruit and therefore suggested that calcium may affect anthocyanin synthesis via the increase in the activity of chalcone isomerase. Data reported herein do not indicate the beneficial influence of calcium nitrate on anthocyanins content (tab. 4). It could be explained by the fact that the main constituent of calcium nitrate, beside of calcium is nitrogen. The effect of nitrogen on anthocyanin accumulation remains unclear. Lekhova [1971] observed that a low level of nitrogen fertilization increased the amount of anhocyanin pigments. Sato et al. [1996] reported that in suspended cell cultures of strawberry, anthocyanin accumulation was enhanced by treatment with to 14.6 mM total nitrogen, but decreased at higher doses.

Cultivars 'Atut' and 'Duet' differed significantly in quantity and quality of the yield (tab. 3). Blue Honeysuckle cv. 'Duet' gave higher yield with bigger fruit, which characterized significantly higher concentration of sugar and much lower content of dry matter, ascorbic acid and acidity. It corresponds with findings of Szot and Wieniarska [2012].

Leaf chemical composition. There is a lack of sufficiency ranges of blue honeysuckle leaf nutrients, however basing on such indication for strawberry leaves [Almaliotis et al. 2002] it could be conclude that N (2.07–3.04%) and P (0.20–0.38%) were in proper concentration, while K (1.84–2.21%) and Mg (0.25–0.70%) concentration was much lower and Ca (0.77–1.48%) higher above recommended level (tab. 5 and 7). Relying on the leaf analysis standards for the apple and pear tree [Hoying et al. 2004] all minerals were in sufficient amount, besides of lower Mg concentration. Leaf analysis integrates all factors contributing to plant's nutritional status including soil nutrient content, plant and root nutrient and conductive tissue to transport minerals to where they are need. No visible signs of deficiency in present study (for example small fruit, poor soluble solids content, premature fruit drop and weak bushes growth) indicates that the plants of blue honeysuckle were well-revitalized. Fertilization with calcium nitrate alone or followed by Bormax and Betokson Super decreased the phosphorus content in blue honeysuckle leaves (tab. 7), and especially in cv. 'Atut' (tab. 5). Similar results were obtained in study on sour cherries cv. 'Łutówka' [Pacholak et al. 2011]. Nitrogen fertilization exerted a significant effect in leaves on the decrease of phosphorus. Rumas-Rudnicka et al. [2009] also showed that nitrogen fertilization resulted in decreasing of leaves phosphorus content in raspberry cv. 'Norna'. Švagždys and Viškelis [2002] stated that phosphorus and potassium levels in leaves of young apple trees were higher after nitrogen application in dose 50 $kg \cdot ha^{-1}$. However higher doses (100 $kg \cdot ha^{-1}$) contributed to decreasing in amount of mentioned nutrients in leaves, as compared to the control. Regardless of nitrogen fertilization leaves and fruits from older apple trees always had lower concentration of phosphorus and potassium. Effect of fertilization by calcium nitrate on decrease in phosphorus concentration in leaves could be explained by pseudo antagonism. Excessive nitrogen supply of plant may result in slower uptake and transportation of phosphorus, which in such conditions left behind the plant growth.

Regarding leaf chlorophyll content data presented in Table 7. show that chlorophyll a and b content showed significant increase due to all studied treatments compared with the control. The significant higher content of chlorophyll a and b stated after application Bormax alone, as well as calcium nitrate + Bormax and calcium nitrate + Betokson Super. That results are in agreement with study of Shahin et al. [2010], who worked on apple cv. 'Anna' treated by foliar fertilizer and gibberellic acid. The observe increase in the concentration of magnesium in the leaves in blue honeysuckle might help in interpretation the obtained results (tab. 7). The participation of magnesium in the structure and the integrity of the chlorophyll molecules together play indispensable role with iron in chlorophyll synthesis [Bidwell 1979]. Faust [1989] reported that over 10–20% of leaf magnesium are located in the chlorophyll. Thurzó et al. [2010], basing on three years of study on sweet cherries stated that foliar application of B during flowering increased content of chlorophyll a and b in leaves. Previously not found that B is the component of any enzyme or is effecting their activity. Application of B or lack of this microelement influence on the process of some reaction. Boron is of key importance in many physiological processes [Marschner 1995].

Studied cultivars of blue honeysuckle differed in leaf characteristics (tab. 6). Leaves of 'Atut' had significantly higher level of chlorophyll a, b and magnesium, but much lower concentration of potassium and calcium.

CONCLUSIONS

1. Boron fertilization enhanced significantly amount of anthocyanins and ascorbic acid in fruit. Blue honeysuckle fruits are plenty of anthocyanins and ascorbic acid and as a first ripening fruit in our climate could be a good its source for human consumption.

2. Soil application of calcium nitrate resulted in significantly lower levels of phosphorus in leaves of blue honeysuckle. However plants did not showed the symptoms of P deficiency.

3. According to results of present study, in order to reach high yield and high fruit quality, blue honeysuckle plants could be fertilized by calcium nitrate and Bormax, as well as treated by Betokson Super.

4. Clear differences in yielding and leaf characteristic of both studied cultivars indicate that they are genetically distant.

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WPŁYW BETOKSONU SUPER I NAWOZÓW NA SKŁAD CHEMICZNY OWOCÓW I LIŚCI JAGODY KAMCZACKIEJ

Streszczenie: Celem doświadczenia było zbadanie reakcji jagody kamczackiej odmian: 'Atut' i 'Duet' na działanie Betoksonu Super i nawozów. Doświadczenie przeprowadzono w latach 2004–2007 na trzyletnich roślinach rosnących na glebie gliniastej. Bormax zastosowano dwukrotnie w czasie kwitnienia i jeden raz po zbiorze w stężeniu 0,2%. Saletrą wapniową nawożono doglebowo w kwietniu w dawce 50 kg · ha $^{-1}$. Betokson Super 050 SL aplikowano dolistnie dwukrotnie w czasie kwitnienia, w stężeniu 0,1%. Kombinacje 5 i 6 stanowiły połączenie zastosowania saletry wapniowej i Bormaxu oraz saletry wapniowej i Betoksonu Super. Rośliny nietraktowane preparatami chemicznymi stanowiły kontrolę. Nawożenie borem istotnie zwiększyło w owocach zawartość antocyjanów i kwasu askorbinowego. Owoce jagody kamczackiej są bogate w antocyjany i kwas askorbinowy, przez co jako najwcześniej dojrzewające w naszych warunkach klimatycznych, mogą stanowić cenne źródło tych substancji w żywieniu człowieka. Doglebowe nawożenie saletrą wapniową spowodowało istotne obniżenie poziomu fosforu w liściach, jednakże rośliny nie wykazywały objawów jego niedoboru. Opierając się na wynikach doświadczenia dotyczących wysokiego plonu i jakości owoców można polecać nawożenie roślin jagody kamczackiej saletrą wapniową, Bormaxem jak również traktowanie Betoksonem Super. Wyraźne różnice w plonowaniu i cechach liści wskazują, że obie badane odmiany są genetycznie odległe.

Słowa kluczowe: *Lonicera caerulea* var. *kamtschatica,* wielkość i jakość plonu, skład chemiczny liści

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