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GROWTH AND FLOWERING OF LENTEN ROSE (*Helleborus orientalis* Lam.) DEPENDING ON THE DOSE OF CALCIUM CARBONATE AND TOP DRESSING WITH PETERS PROFESSIONAL SPECIAL

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Abstract. Seedlings and young plants of lenten rose (*Helleborus orientalis* Lam.) were grown for two years (2006–2007) in containers on peat substrate which was deacidified with calcium carbonate at doses ($g \cdot dm^{-3}$) of 2.5, 5.0, 7.5 and 10.0. Within each dose of $CaCO_3$ plants were divided into two groups, of which one was fertilized with a lower (0.1%) and the other with a higher (0.3%) concentration of Peters Professional PL Special (15:11:29). The $CaCO_3$ dose applied to deacidify high moor peat had a significant effect on plant height irrespective of their age. In the first and second year of pot cultivation the tallest plants were produced on a substrate to which calcium carbonate was added at 2.5 $g \cdot dm^{-3}$ $CaCO_3$, while the lowest at 10 $g \cdot dm^{-3}$ $CaCO_3$. The number of leaves and flowering of lenten rose did not depend on the amount of calcium carbonate introduced to the substrate. Fertilization of lenten rose cv. 'New Hybrids F1' with Peters Professional PL Special (15:11:29) at a higher concentration (0.3%) made it possible to produce taller plants, with a larger number of leaves, and earlier and more abundant flowering.

Key words: *Helleborus orientalis*, growth, flowering, dose $CaCO_3$, top dressing

INTRODUCTION

Due to the considerable variation of species and cultivars, their ornamental winter-hard leaves and an early flowering date which may additionally be forced, hellebores are ornamental plants commonly cultivated in western Europe and they are also becoming more and more popular in Poland [Pogroszewka 1996, Trier 2004]. They are often used to decorate interiors, balconies, terraces and gardens [Roggendorf 2003].

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Division of plants [Piskornik et al. 1999] is a method of low efficiency, but highly useful in case of species and cultivars, which vary considerably when propagated by seeds. The *in vitro* method is usually used to produce young plants of the most popular hellebore species, i.e. Christmas rose (*Helleborus niger* L.*)* [Seyring 2002]. Hellebores are most often propagated by seeds. It results from studies conducted by Piskornik et al. [1998] that seedlings of Christmas rose sprout unevenly after a period of several months to about a year, depending on the applied seed treatment, sowing date and growing conditions. Genslmeier and Henseler [1985] and Reimherr [1998] stressed high requirements of hellebore seedlings concerning the medium, including its acidity. The pH reported in literature as suitable for hellebore cultivation falls within a wide range from 5.7 to 7.0.

The aim of the study was to assess the effect of the applied dose of calcium carbonate used to deacidify high moor peat and the concentration of fertilizer solution in top dressing on the growth and flowering of lenten rose *(Helleborus orientalis* Lam.) in the first and second year of cultivation.

MATERIAL AND METHODS

Three experiments with new heterosis of lenten rose were conducted at the Marcelin Experimental Station of University of Life Sciences in Poznań. The were carried out on plants in different phases of growth: 1. on seedlings (1.03–10.05.2006), 2. on young plants grown in pots of 1.0 dm^3 (10.05.2006–27.03.2007) and 3. on plants in the second year of cultivation grown in pots of 2.1 dm^3 (27.03.2007–10.03.2008). Seedlings were supplied by Syngenta Seeds in pallets with 264 openings of 2 cm^3. For all experiment substrate was prepared at the same way. High moor peat Klasmann (pH 3.91) was enriched which 0.5 $g \cdot dm^{-3}$ Peters Professional PL Special fertilizer (15:11:29) and limed with calcium carbonate ($CaCO_3$) in different doses ($g \cdot dm^{-3}$): 2.5, 5.0, 7.5 and 10.0. After liming the substrate pH was 5.28, 6.80, 7.09 and 7.24, respectively.

Seedlings on average one-leaf stage, were transplanted to multipots, with openings of 110 cm^3 and they were grown in a greenhouse approx. Cultivation in multipots lasted approx. 2 months (to 10.05.2006). For each liming level there were 48 replications, each consisting of one seedling. Their growth was assessed taking into consideration the height of plants and the number of leaves. Based on the difference in the number of leaves (10 May vs. 1 March) their growth increment was established. Results were analyzed statistically by one-way analysis of variance with the Newman-Keuls test at the significance level $\alpha = 0.05$.

On 10 May, 2006 and and 27 March, 2007 plants were transplanted to pots of 1.0 dm^{-3} and 2.1 dm^{-3}, respectively. They were grown in a hotbed frame equipped with a hothouse mat and a mulching mat. During winter, from November to April 2006/2007 and 2007/2008, plant were grown in an unheated plastic tunnel. These plants, within each calcium carbonate dose, were divided into 2 groups, of which one was fertilized with a solution at a lower (0.1%) and the other – a higher (0.3%) concentration of Peters Professional PL Special fertilizer (15:11:29) at 100 ml per pot. Fertilization was started a month after transplantation and it was repeated every 15 days, until the end of August.

Towards the end of vegetation substrate pH was determined. In 2006 for increasing $CaCO_3$ doses at the fertilization with a 0.1% solution pH was 5.40, 6.58, 7.30 and 7.54, while in 2007 it was 5.87, 7.04, 7.17 and 7.64, whereas at fertilization with a 0.3% solution in 2006 pH was 4.86, 6.71, 7.32 and 7.52, and in 2007 it was 5.85, 7.08, 7.32 and 7.55, respectively.

Measurements of the number of the leaves and hight of plants were taken every 2 months, starting from August 2006 and June 2007. Flowering was assessed only in 2008, as in 2007 very few plants flowered. The dates of the onset of flowering (the first developed flower) and anthesis (10 flowering plants in a combination) were recorded. At the beginning of flowering the diameter of flowers and the length of peduncles were measured. During anthesis flowers, buds and inflorescences were counted. Data recorded on the basis of these measurement were analyzed using two-way analysis of variance applying the Newman-Keuls test at the significance level $\alpha = 0.05$. Within one combination (the dose of $CaCO_3$ used on the substrate x the concentration of fertilizer solution applied in top dressing) there were 24 replications. Analysis of flowering was conducted on these 10 plants within a combination, which were the first to begin flowering. Dates of the onset of flowering and anthesis were calculated using the weighted means method, while the other dates were calculated using the two-way analysis of variance with the use of the Duncan test (due to the small number of replications) at the significance level $\alpha = 0.05$.

RESULTS AND DISCUSSION

The level of calcium carbonate in the substrate and the related soil pH have a considerable effect of growth of plants. The substrates containing too little calcium are acid and have poor structure. The substrate pH affects availability of important nutrients to plants. At an acid reaction K, P, Ca and Mg are less available, while at an alkaline reaction inadequate availability is recorded in case of Fe, Cu and Zn [Cregan 1981]. Plants exhibit different tolerance to substrate acidity; those growing on an acid substrate are tolerant to the toxic action of aluminum and manganese, and to calcium and magnesium deficiencies [Scott 1981].

In case of hellebores recommendations are found in literature for the most commonly grown species, i.e. Christmas rose (*Helleborus niger)*. According to Genslmeier and Henseler [1985] in the cultivation of Christmas rose seedlings the substrate should be slightly acid with pH of 5.7–6.2, while for older plants it should be pH of 6.0–6.5. Piskornik [2003] successfully applied substrate with pH 6.8–7.0 when growing seedlings and young plants of this species. In the cultivation of both young and older plants Belke [1996] recommended inoculation of the substrate with mycorrhiza. Lenten rose grows in the wild in north-eastern Greece, northern and north-eastern Turkey and in the Caucasus, on calcareous, fertile, humous and permeable soils [Ikinci and Güner 2007]. As it was stressed by Rice and Strangman [2001], it is surprising that it grows equally well on acid soils.

The application of different doses of calcium carbonate used in our experiment to deacidify high moor peat applied as a substrate in the cultivation of lenten rose seed-

lings had an effect on growth of only young plants (tab. 1). At calcium carbonate doses of 2.5–7.5 g·dm^{-3} young plants reached the height of 7.2–7.8 cm and they were significantly higher than plants grown on a substrate with 10 g·dm^{-3}. During 70-day cultivation of seedlings the number of leaves increased on average by 1.8–2.1.

Table 1. Seedling growth of lenten rose depending on $CaCO_3$ dose introduced to substrate
Tabela 1. Wzrost siewek ciemiernika wschodniego w zależności od dawki $CaCO_3$ wprowadzonej do podłoża

Dose of Dawka $CaCO_3$·dm^{-3}	Increment of leaf number Przyrost liczby liści	Height of plant Wysokość roślin cm
2.5	1.92 a*	7.35 b*
5.0	2.06 a	7.76 b
7.5	2.00 a	7.22 b
10.0	1.81 a	6.63 a

*The means followed by the same letters do not differ at α = 0.05.
Średnie oznaczone tymi samymi literami nie różnią się istotnie przy α = 0,05.

Table 2. Height of lenten rose in the first year of pot cultivation depending on $CaCO_3$ dose introduced to substrate and fertilizer solution concentration applied in top dressing, cm
Tabela 2. Wysokość ciemiernika wschodniego w pierwszym roku uprawy w doniczkach w zależności od dawki $CaCO_3$ wprowadzonej do podłoża i stężenia roztworu nawozu stosowanego pogłównie, cm

Dose of Dawka $CaCO_3$ · dm^{-3}	Date of measurement – Termin pomiaru					
	10.08.2006			10.10.2006		
	concetration of fertilizer stężenie nawozu %		mean średnia	concetration of fertilizer stężenie nawozu %		mean średnia
	0.1	0.3		0.1	0.3	
2.5	8.0 a*	8.2 a	8.1 A	13.6 b*	16.8 c	15.2 C
5.0	8.5 a	8.6 a	8.6 A	12.7 b	14.8 b	13.7 B
7.5	8.9 a	8.3 a	8.6 A	12.6 b	14.0 b	13.3 AB
10.0	7.2 a	7.7 a	7.4 A	10.6 a	13.6 b	12.1 A
Mean Średnia	8.1 *a*	8.2 *a*		12.4 *a*	14.8 *b*	

*Explanations as in Table 1 – Objaśnienia jak w tabeli 1.

In the first year of pot culture the height of lenten rose depended significantly on the dose of $CaCO_3$ and the concentration of fertilizer solution applied in top dressing, which for measurements taken in October was confirmed by statistical analysis (tab. 2). The tallest plants were recorded only in growing on high moor peat deacidified with 2.5 g·dm^{-3} $CaCO_3$ and at top dressing with 0.3% solutions, while the lowest plants were observed at the application of 10 g·dm^{-3} $CaCO_3$ to the substrate. In October the difference in height between the tallest and the lowest plants, depending on the applied $CaCO_3$ dose, was on average 3.1 cm, while depending on the concentration of fertilizer

solution used in top dressing it was 2.4 cm. Plants did not differ in terms of the number of leaves, although on average there were by 1.4 more when 7.5 g·dm^{-3} $CaCO_3$ was added to the substrate in comparison to the dose of 10 g·dm^{-3} $CaCO_3$, and by 1.2 more at an increased fertilizer concentration used in top dressing (tab. 3).

Table 3. The number of leaves in lenten rose in the first year of pot cultivation depending on $CaCO_3$ dose introduced to substrate and fertilizer solution concentration applied in top dressing

Tabela 3. Liczba liści u ciemiernika wschodniego w pierwszym roku uprawy w doniczkach w zależności od dawki $CaCO_3$ wprowadzonej do podłoża i stężenia roztworu nawozu stosowanego pogłównie

Dose of Dawka $CaCO_3$ · dm^{-3}	Date of measurement – Termin pomiaru					
	10.08.2006			10.10.2006		
	concetration of fertilizer stężenie nawozu %		mean średnia	concetration of fertilizer stężenie nawozu %		mean średnia
	0,1	0,3		0,1	0,3	
2.5	4.1 a*	4.7 a	4.4 A	7.6 a*	9.3 a	8.4 A
5.0	4.8 a	4.2 a	4.6 A	8.1 a	8.6 a	8.3 A
7.5	4.8 a	4.7 a	4.7 A	8.0 a	9.3 a	8.7 A
10.0	4.3 a	4.2 a	4.3 A	6.6 a	7.9 a	7.3 A
Mean Średnia	4.5 *a*	4.4 *a*		7.6 *a*	8.8 *b*	

*Explanations as in Table 1 – Objaśnienia jak w tabeli 1.

Table 4. Height of lenten rose in the second year of pot cultivation depending on $CaCO_3$ dose introduced to substrate and fertilizer solution concentration applied in top dressing, cm

Tabela 4. Wysokość ciemiernika wschodniego w drugim roku uprawy w doniczkach w zależności od dawki $CaCO_3$ wprowadzonej do podłoża i stężenia roztworu nawozu stosowanego pogłównie, cm

Dose of Dawka $CaCO_3$·dm^{-3}	Date of measurement – Termin pomiaru								
	21.06.2007			13.08.2007			16.10.2007		
	concetration of fertilizer stężenie nawozu %		mean średnia	concetration of fertilizer stężenie nawozu %		mean średnia	concetration of fertilizer stężenie nawozu %		mean średnia
	0.1	0.3		0.1	0.3		0.1	0.3	
2.5	21.4 a*	26.1 c	23.7 C	23.5 d*	22.5 d	23.0 D	20.1 b*	22.4 c	21.3 D
5.0	21.7 ab	24.3 bc	23.0 BC	21.6 cd	21.1 cd	21.4 C	19.3 b	19.6 b	19.4 C
7.5	21.7 ab	22.2 ab	22.0 B	18.7 b	21.0 cd	19.9 B	16.1 a	18.3 b	17.2 B
10.0	19.4 a	20.6 a	20.0 A	16.7 a	19.9 bc	18.3 A	14.4 a	16.0 a	15.2 A
Mean Średnia	21.0 *a*	23.3 *b*		20.2 *a*	21.1 *b*		17.5 *a*	19.1 *b*	

*Explanations as in Table 1 – Objaśnienia jak w tabeli 1.

In the second year of cultivation a significant effect of the $CaCO_3$ dose and the concentration of fertilizer solution used in top dressing on the height of plants was observed at all measurement dates (tab. 4). In contrast, the number of leaves depended only on the concentration of fertilizer solution used in top dressing (tab. 5). Plants which were top-dressed with fertilizer at a concentration of 0.3% were on average by 0.9–2.3 cm taller and had by 2.8–3.7 more leaves in comparison to plants top-dressed with fertilizer at a concentration of 0.1%. Although plant height was reduced as a result of a change in habit towards the end of vegetation, in October a bigger difference was recorded (6.1 cm) in comparison to June (3.7 cm) between the tallest plants growing in the substrate at a dose of 2.5 $g \cdot dm^{-3}$ $CaCO_3$ and the lowest at a dose of 10 $g \cdot dm^{-3}$ $CaCO_3$. In August and in October significant differences were observed between plants at the application of each of the calcium carbonate doses.

A significant effect of liming and top dressing on growth of one-year old plants of a hybrid *Helleborus* × *hybridus* grown in containers on a pine bark substrate was also shown by Kraus and Warren [2002]. Hellebores grew best when the lowest dolomite lime dose was added to the substrate at the highest fertilizer concentration applied in top dressing.

Table 5. The number of leaves in lenten rose in the second year of pot cultivation depending on $CaCO_3$ dose introduced to substrate and fertilizer solution concentration applied in top dressing

Tabela 5. Liczba liści u ciemiernika wschodniego w drugim roku uprawy w doniczkach w zależności od dawki $CaCO_3$ wprowadzonej do podłoża i stężenia roztworu nawozu stosowanego pogłównie

Dose of Dawka $CaCO_3 \cdot dm^{-3}$	Date of measurement – Termin pomiaru								
	21.06.2007			13.08.2007			16.10.2007		
	concetration of fertilizer stężenie nawozu %		mean średnia	concetration of fertilizer stężenie nawozu %		mean średnia	concetration of fertilizer stężenie nawozu %		mean średnia
	0.1	0.3		0.1	0.3		0.1	0.3	
2.5	8.7 a*	14.1 b	11.4 A	11.3 a*	14.0 a	12.7 A	9.1 a*	10.7 a	9.9 A
5.0	10.5 ab	14.3 b	12.4 A	12.4 a	13.8 a	13.1 A	10.3 a	12.0 a	11.2 A
7.5	10.5 ab	13.9 b	12.2 A	10.8 a	14.8 a	12.8 A	8.4 a	12.4 a	10.4 A
10.0	9.9 ab	12.2 ab	11.1 A	9.7 a	13.0 a	11.4 A	7.9 a	11.6 a	9.7 A
Mean Średnia	9.9 *a*	13.6 *b*		11.1 *a*	13.9 *b*		8.9 *a*	11.7 *b*	

*Explanations as in Table 1 – Objaśnienia jak w tabeli 1.

In our experiment it was shown that at the end of cultivation at a dose of 2.5 $g \cdot dm^{-3}$ $CaCO_3$ the substrate pH was 4.86–5.87, which Cregan [1981] defined as strongly acid and medium acid reaction. This substrate had an advantageous effect on plant growth, although under natural site conditions for this species soil usually has a neutral reaction. A similar dependence was found by Kolasiński [2004] when growing dawn redwoods in containers. In this experiment it was shown that plants grew best at pH of 5.0–5.5, whereas under natural conditions the soil pH of 7.0–7.6 is the most favourable.

Table 6. Evaluation of flowering of lenten rose in the second year of pot cultivation depending on $CaCO_3$ dose introduced to substrate and fertilizer solution concentration applied in top dressing

Tabela 6. Ocena kwitnienia ciemiernika wschodniego w drugim roku uprawy w doniczkach w zależności od dawki $CaCO_3$ wprowadzonej do podłoża i stężenia roztworu nawozu stosowanego pogłównie

Dose of Dawka $CaCO_3 \cdot dm^{-3}$	Number of florescences Liczba kwiatostanów			Length on peduncle Długość szypuły kwiatostanowej, (cm)			Number of flowers and buds Liczba kwiatów i pąków			Flower diameter Średnica kwiatu (cm)		
	concetration of fertilizer stężenie nawozu %		mean średnia	concetration of fertilizer stężenie nawozu %		mean średnia	concetration of fertilizer stężenie nawozu %		mean średnia	concetration of fertilizer stężenie nawozu %		mean średnia
	0.1	0.3		0.1	0.3		0.1	0.3		0.1	0.3	
2.5	1.3 a*	1.7 a	1.5 A	19.1 a*	16.9 a	18.0 A	3.5 a*	5.8 b	4.6 A	6.1 abc*	6.0 abc	6.0 A
5.0	1.2 a	2.2 ab	1.7 A	18.0 a	19.4 a	18.7 A	3.2 a	6.5 b	4.8 A	5.7 ab	6.4 bc	6.1 A
7.5	1.2 a	3.0 b	2.1 A	18.2 a	17.7 a	18.0 A	2.7 a	6.0 b	4.3 A	5.3 a	6.8 c	6.0 A
10.0	1.3 a	1.3 a	1.3 A	18.3 a	17.6 a	17.9 A	3.6 a	3.8 a	3.7 A	6.4 bc	6.8 c	6.6 A
Mean Średnia	1.3 *a*	2.1 *b*		18.4 *a*	17.9 *a*		3.2 *a*	5.5 *b*		5.9 *a*	6.5 *b*	

*Explanations as in Table 1 – Objaśnienia jak w tabeli 1.

Table 7. Phenology of flowering of lenten rose in the second year of pot cultivation (2008) depending on $CaCO_3$ dose introduced to substrate and fertilizer solution concentration applied in top dressing

Tabela 7. Fenologia kwitnienia ciemiernika wschodniego w drugim roku uprawy (2008) w doniczkach w zależności od dawki $CaCO_3$ wprowadzonej do podłoża i stężenia roztworu nawozu stosowanego pogłównie

Dose of Dawka $CaCO_3 \cdot dm^{-3}$	Date – Data					
	onset of flowering początku kwitnienia			anthesis pełni kwitnienia		
	concetration of fertilizer stężenie nawozu %		mean średnia	concetration of fertilizer stężenie nawozu %		mean średnia
	0.1	0.3		0.1	0.3	
2.5	29.02	25.02	27.02	9.03	3.03	6.03
5.0	1.03	18.02	24.02	9.03	26.02	3.03
7.5	7.03	20.02	28.02	11.03	3.03	7.03
10.0	21.02	22.02	22.02	10.03	3.03	7.03
Mean Średnia	29.02	21.02		10.03	2.03	

Flowering of lenten rose was not significantly affected by the dose of calcium carbonate used to deacidify high moor peat. Certain trends were only observed in comparison to plants grown using the other calcium carbonate doses. Plants grown in a substrate to which 5.0 $g \cdot dm^{-3}$ $CaCO_3$ were added reached anthesis the fastest (tab. 7) and had the longest peduncles with the biggest number of flowers and buds (tab. 6). In turn, the biggest number of peduncles was recorded in plants grown at 7.5 $g \cdot dm^{-3}$ $CaCO_3$, while plants grown at 10 $g \cdot dm^{-3}$ $CaCO_3$ began flowering the earliest and their flowers had the biggest diameter. A significant effect on flowering of lenten rose was recorded for the concentration of fertilizer used in top dressing (tables 6 and 7). Plants fertilized at a higher concentration of 0.3% flowered a week earlier, had more peduncles, flowers and buds, while their flowers had bigger diameter in comparison to plants fertilized with a 0.1% solution. Fertilizer concentration had no effect on the length of the peduncle.

CONCLUSIONS

1. The dose of $CaCO_3$ used to deacidify high moor peat had a significant effect on the height of lenten rose irrespective of the age of plants. In the first and second year of pot cultivation the tallest plants were produced on a substrate, to which calcium carbonate was applicated at a dose of 2.5 $g \cdot dm^{-3}$ $CaCO_3$, while the lowest plants at a dose of 10 $g \cdot dm^{-3}$ $CaCO_3$.

2. The number of leaves and flowering of lenten rose did not depend on the amount of calcium carbonate applied in a substrate.

3. Fertilization of lenten rose with Peters Professional PL Special (15:11:29) at a concentration of 0.3% made it possible to produce taller plants, with a larger number of flowers, and exhibiting earlier and more abundant flowering in comparison to plants fertilized with a 0.1% solution.

REFERENCES

Belke H. J., 1996. Helleborus. Eine Kultur mit sieben Siegeln? Zierpflanzenbau 2, 59–60.

Cregan P., 1981. The acid soil problem defined. Riverina Outlook Conference: www.regional.org.au/au/roc/1981/roc198109.htm

Genslmeier H., Henseler K., 1985. Schnittstauden. Eugen Ulmer GmbH & Co, Stuttgart, 278–290.

Ikinci N., Güner A., 2007. Flora of the Gölcük area (Bolu Turkey). Turk J. Bot. 31, 87–100, journals.tubitak.gov.tr/botany/issues/bot-07-31-2/bot-31-2-2-0604-7.pdf

Kolasiński M., 2004. Wpływ odczynu podłoża na wzrost roślin metasekwoi chińskiej (*Metasequoia glyptostroboides* Hu Et Cheng) uprawianych w pojemnikach [The effect of substrate reaction on growth of container-grown dawn redwood (*Metasequoia glyptostroboides* Hu Et Cheng)]. Folia Univ. Agric. Stein., Agricultura 236(94), 65–70.

Kraus H.T., Warren S.L., 2002. Nutrient and pH Management Programs for Nursery Production of *Helleborus* × *hybridus.* SNA Research Conference "Container–Grown Plant Production", 47, 18–22.

Piskornik M., Kowalik M., Saltarska J., 1998. Stratyfikacja nasion ciemiernika białego (*Helleborus niger* L.) w warunkach laboratoryjnych [Seed stratification of Christmas rose (*Helleborus niger* L.) under laboratory conditions]. Proceedings from the National Conference "Growing of Ornamental Plants at the Turn of Centuries". Kraków 14–15 May, 78.

Piskornik M., Piskornik Z., Klimek A., Mrugacz M., 1999. Rozmnażanie ciemiernika białego (*Helleborus niger*) 'Praecox' [Propagation of Christmas rose (*Helleborus niger*) 'Praecox'. The 12th National Scientific Convention of Florists. Skierniewice 9–10 December, 72–73.

Piskornik M., 2003. Production of Christmas Rose young plants from seedlings during one vegetation season. EJPAU, Horticulture, 6, 1, www.ejpau.media.pl

Pogroszewska E., 1996. Przyspieszona uprawa ciemiernika ogrodowego (*Helleborus* × *hybridus* hort.) w szklarni [Forced greenhouse cultivation of bear's foot (*Helleborus* × *hybridus* hort.)]. "New plants and technologies in horticulture". The 2nd National Symposium at the 40th anniversary of the Faculty of Horticulture, the Agricultural University of Poznań. 17–19 September, 397–400.

Reimherr P. (ed.), 1998. *Helleborus niger* (Ranunculaceae). Vetshöchheimer Kultur-Informationen zur Christrose. Gärtnerbörse 9, 27–29.

Rice G., Strangman E., 2001. Hellebores. Timber Press, Portland, Oregon. Paperback edition first publ., 3–4, 59–60.

Roggendorf U., 2003. Breites *Helleborus* – Sortiment erfüllt Verbraucherwünsche. Zierpflanzenbau 9, 44–45.

Scott B., 1981. Species and varieties for acid soils. www.regional.org.au/au/roc/1981/roc198161.htm.

Seyring M., 2002. *In vitro* cloning of *Helleborus niger*. Plant Cell Rep. 20, 895–900.

Trier H., 2004. *Helleborus.* Fleur Kreativ 4, 23–25.

WZROST I KWITNIENIE CIEMIERNIKA WSCHODNIEGO (*Helleborus orientalis* Lam.) W ZALEŻNOŚCI OD DAWKI WĘGLANU WAPNIA I NAWOŻENIA POGŁÓWNEGO PETERS PROFESSIONAL SPECIAL

Streszczenie. Rozsadę i młode rośliny ciemiernika wschodniego (*Helleborus orientalis* Lam.) uprawiano przez dwa lata (2006–2007) w pojemnikach, w podłożu torfowym, które odkwaszono węglanem wapnia w dawkach ($g \cdot dm^{-3}$): 2,5; 5,0; 7,5; 10,0. W obrębie każdej dawki $CaCO_3$ podzielono rośliny na 2 grupy, jedną nawożono roztworem o niższym (0,1%), a drugą o wyższym (0,3%) stężeniu nawozu Peters Professional PL Special (15:11:29). Dawka $CaCO_3$ zastosowana do odkwaszania torfu wysokiego miała istotny wpływ na wysokość roślin niezależnie od ich wieku. W pierwszym i w drugim roku uprawy w doniczkach uzyskano najwyższe rośliny w podłożu, do którego dodano węglan wapnia w dawce 2,5 $g \cdot dm^{-3}$ $CaCO_3$, a najniższe przy dawce 10 $g \cdot dm^{-3}$ $CaCO_3$. Liczba liści i kwitnienie ciemiernika wschodniego nie zależały od ilości węglanu wapnia zastosowanego do podłoża. Nawożenie ciemiernika wschodniego nawozem Peters Professional PL Special (15:11:29) o wyższym stężeniu (0,3%) pozwoliło uzyskać wyższe rośliny, z większą liczbą liści oraz z wcześniejszym i obfitszym kwitnieniem

Słowa kluczowe: *Helleborus orientalis*, wzrost, kwitnienie, dawka $CaCO_3$, nawożenie pogłówne

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