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EFFECT OF TYPE OF OSMOCOTE FERTILIZERS ON THE GROWTH AND YIELDING OF *Clematis* FROM JACKMANII GROUP 'JOHN PAUL II' CULTIVAR

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Abstract: A vegetation experiment was carried out in the years 2006 and 2007, with *Clematis* from Jackmanii group, cultivar 'John Paul II'. Two types of multicomponent fertilizers with slowed down action from Osmocote Exact group were used: Osmocote Exact Hi-Start and Osmocote Exact Standard. Influence of these fertilizers was studied on growth and yielding of *Clematis* 'John Paul II'. The longest shoots of *Clematis* were obtained after the application to the substrate of Osmocote Exact Hi-Start and Osmocote Exact Standard fertilizers in the dose of 8 $g \cdot dm^{-3}$. Plants fetrilized with Osmocote Exact Hi-Start obtained the highest weight of their above ground plant parts at the dose of 8 $g \cdot dm^{-3}$ of substrate, while plants fertilized with Osmocote Exact Standard obtained the highest weight of their aboveground plant parts at the dose of 6 $g \cdot dm^{-3}$ of substrate. Plants in a 5-month period of growing with the application of the fertilizers Osmocote Exact Standard did not show any signs of mineral malnutrition. The greatest number of flowers and the greatest weight of flowers was found in plants grown in the substrate with an addition of the fertilizer Osmocote Exact Standard in the dose of 6 $g \cdot dm^{-3}$. The best fertilizer for the growing of *Clematis* 'John Paul II' cv. has shown to be Osmocote Exact Standard in the dose of 6 $g \cdot dm^{-3}$.

Key words: *Clematis*, fertilizers with a slowed down activity, Osmocote

INTRODUCTION

One of the basic agrotechnical factors deciding about the size and the quality of plants is fertilization. In the production of ornamental plants grown in containers, fertilizers with a slowed down action enjoy increasing application [Chohura 2004]. In Great Britain, about 100% of container cultivations use fertilizers with slowed down activity [Rainbow 1999]. In Poland, in the recent years, the use of these fertilizers keeps increasing in spite of their high prices. Therefore, studies have been undertaken to verify the

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usefulness of coated fertilizers Osmocote Exact (of two types and different doses) for the cultivation of *Clematis* 'John Paul II' in containers.

MATERIAL AND METHODS

Studies were carried out in the years 2006 and 2007 in a foil tunnel in the Department of Horticultural Plant Fertilization of the August Cieszkowski Agricultural University in Poznań. A vegetation experiment was carried out with *Clematis* from Jackmanii group, cultivar 'John Paul II'. Two types of multicomponent fertilizers with slowed down action from Osmocote Exact group were used: Osmocote Exact Hi-Start and Osmocote Exact Standard. The activity time of both fertilizers was 5–6 months. The fertilizers were applied in four increasing doses: 2, 4, 6 and 8 g·dm^{-3} substrate. The contents of mineral components in the particular fertilizer doses are shown in table 1.

Table 1. Content of components in grams in one dose of fertilizer
Tabela 1. Zawartość składników w gramach w dawce nawozu

	Osmocote Exact Hi-start				Osmocote Exact Standard			
	dose – dawka g·dm $^{-3}$							
	2	4	6	8	2	4	6	8
N	0.3	0.6	0.9	1.2	0.3	0.6	0.9	1.2
P_2O_5	**0.2**	**0.4**	**0.6**	**0.8**	**0.18**	**0.36**	**0.54**	**0.72**
K_2O	**0.2**	**0.4**	**0.6**	**0.8**	**0.18**	**0.36**	**0.54**	**0.72**
MgO	0.06	0.12	0.18	0.24	0.06	0.12	0.18	0.24
Fe	0.008	0.016	0.024	0.032	0.008	0.016	0.024	0.032
Zn	0.0003	0.0006	0.0009	0.0012	0.0003	0.0006	0.0009	0.0012
Mn	0.0012	0.0024	0.0036	0.0048	0.0012	0.0024	0.0036	0.0048
Cu	0.001	0.002	0.003	0.004	0.001	0.002	0.003	0.004
B	0.0004	0.0008	0.0012	0.0016	0.0004	0.0008	0.0012	0.0016
Mo	0.0004	0.0008	0.0012	0.0016	0.0004	0.0008	0.0012	0.0016

The experiments consisted of eight combinations and each combination included 20 replications. One replication consisted of one plant grown in an outflowless container of 2 dm^3 capacity. Plants used in the experiment were produced in the horticultural farm of Mr. Antoni Żurek in Lower Silesia. Seedlings of an average height of 7 cm were planted on the 19th of April into containers filled with an earlier prepared substrate consisting of raised peat with an addition of $CaCO_3$ and an adequate amount and type of slowed down fertilizer. The content of nutritive components, pH (in H_2O) and EC (mS·cm^{-1}) in raised peat before and after liming was determined by universal method.

In order to obtain the pH value in the interval of 6.5–7.0, the raised peat was limed. The dose of $CaCO_3$ in the the amount of 7.5 g per 1 dm^3 was determined using the neutralization curve. After 14 days, macroelements and microelements in the form of

slowed down fertilizers Osmocote in the form of slowed down fertilizers Osmocote were added. In order to obtain a thorough mixture, raised peat was transferred to a bowl, an adequate amount of fertilizer was added and then, it was mixed. This substrate was used to fill the containers. In the experiment, fertilization was applied only a single time on the 11th of April, i.e. 8 days before the plantation of seedlings. Fertilizers were mixed with the substrate separately for each pot according to the experimental scheme. During plant growth, the following measurements were determined: plant height, number of flowers and flower diameter. Height measurements were made on the following days: 37, 71, 93, 127 and 164 days of growing. Plant material was harvested after five days of vegetation, i.e. on the 29th of September 2006. After plant cutting, the following measurements were done: plant length, yield of the fresh weight of leaves and stalks, the number of flowers and the weight of flowers. Statistical analyses referred to the analysis of variance for plant yield (weight of leaves, stalks and total weight). Statistical analyses were carried out in Staatobl program – singlevariate analysis of variance for factorial orthogonal experiments. Differences between mean values were determined at the significance level of $\alpha = 0.05$.

RESULTS AND DISCUSSION

In the experiment, differentiated effects of Osmocote Exact fertilizers and their doses on the growth of Clementis were found. The application in *Clematis* growing of Osmocote Exact Standard fertilizer in comparison with Osmocote Exact Hi-Start fertilizer exerted an influence on the plant size. Also the fresh weight of plants grown with the application of this fertilizer was greater.

The average total yield of fresh plant weight was 48.64 g. It depended on the type of fertilizer and on the applied dose. A higher mean weight was shown by the plants fertilized with Osmocote Exact Standard fertilizer and it amounted to 55.22 g, while plants fertilized with Osmocote Hi-Start had a mean weight of 42.06 g (tab. 2).

Table 2. Total yield of the aboveground plant part (g·plant^{-1} of fresh weight)
Tabela 2. Plon ogólny nadziemnej części roślin (g·roślina^{-1}, świeżej masy)

Fertilizer – Nawóz	Dose – Dawka, g·dm $^{-3}$				**A**
	2	4	6	8	
Osmocote Exact Hi-Start	16.33	38.74	48.99	64.18	**42.06**
Osmocote Exact Standard	33.21	48.95	86.97	51.75	**55.22**
B	**24.77**	**43.85**	**67.98**	**57.97**	

LSD $NIR_{\alpha = 0.05}$ Fertilizer – Nawóz (A) = 2.29
LSD $NIR_{\alpha = 0.05}$ Dose – Dawka (B) = 3.22
LSD $NIR_{\alpha = 0.05}$ A×B = 4.46

Analysing the effect of the applied doses on the mean total yield, it was found that a smaller weight (24.77 g) was reached by plants fertilized with a dose of 2 g·dm^{-3}. The greatest weight was found in plants fertilized with a dose of 6 g·dm^{-3}. The difference between the heighest and the lowest yield was 43.21 g. According to Mynett [2000] the dose of these fertilizers on the beginning of the plant growing, should make up 75–80% their application and the remaining shortages of components should be complete with dissolve fertilizers.

Analysis of the increasing doses of each of the applied fertilizers indicated that in plants to which Osmocote Exact Hi-Start was applied, together with the increasing dose, there increased the aboveground part of the plants. After the application of Osmocote Exact Standard, the highest yield (86.97 g) was found in the substrate with the dose of 6 g·dm^{-3}. The yield obtained in the substrate with the dose of 8 g·dm^{-3} was decreased by 35.22 g in relation to the yield of plants in the substrate with the addition of 6 g·dm^{-3} and it amounted to 51.75 g.

The height of plants, the weight of leaves and stalks, and the aboveground plant parts are shown in figure 1. It presents the results of the last harvest and at the same time of the end of the experiment. As reported by Sękowski [1987], *Clematis*, 'John Paul II' cv. reaches the height of 300 cm. In our own studies, the mean height of all plants was 219 cm, however, it depended on the type of the applied fertilizer. The mean height of plants fertilized with Osmocote Exact Standard amounted to 242 cm and it was by 46 cm higher than plants grown in the substrate with an addition of Osmocote Exact Hi-Start fertilizer.

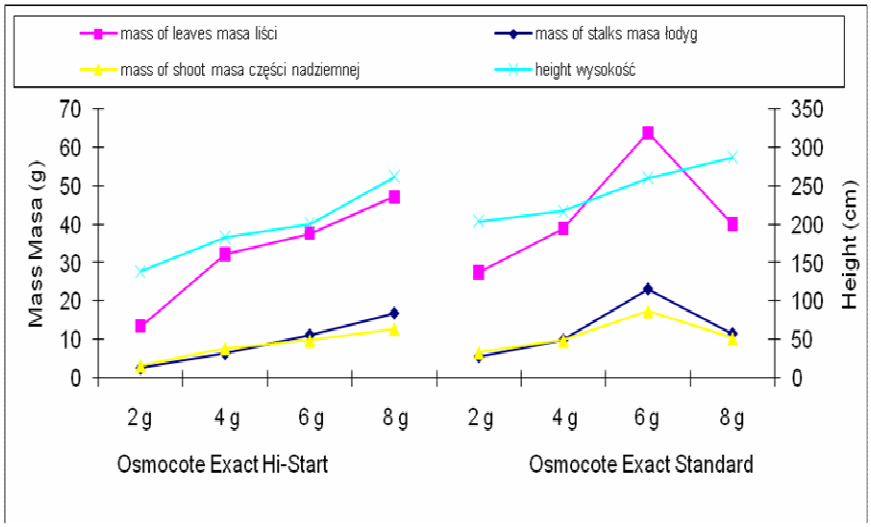

Fig. 1. The influence of type and doses of Osmocote fertilizers on the height of plants, mass of leaves, stalks and mass of shoot

Rys. 1. Wpływ typu i dawek nawozów Osmocote na wysokość roślin, masę liści, łodyg i części nadziemnej

In both applied fertilizers, it was found that increasing doses of these fertilizers added to the substrate caused an increased height of plants. In substrates where Osmocote Exact Hi-Start was used, the plant growth was accompanied by an increase of the weights of leaves, stalks and the total weight of the studied plant. In substrates fertilized with the Standard type fertilizers, the growth of plant height increased with the increase of the fertilizer dose. On the other hand, the greatest weight of leaves, stalks and the greatest total yield were obtained in the substrate where this fertilizer was added in the amount of 6 g·dm^{-3}. Kolasiński [2006] did not find any significant differences in the height of plants.

The dose for these two types of fertilizers recommended by the producer is 4.5 g·dm^{-3} of substrate [Scotts 2006]. Our own studies have shown that Clematis 'John Paul II' cultivar grown in a substrate with an addition of Hi-Start fertilizer in the dose of 4 g·dm^{-3} reached the average height of 183 cm, but, when grown in a substrate with an addition of Osmocote Exact Standard in the dose of 4 g·dm^{-3}, it reached 217 cm height.

Fresh weight of *Clematis* plant in combination with Osmocote Exact Standard fertilizer was higher than in the combination with Osmocote Exact Hi-Start. The increments of *Clematis* height were calculated on the basis of data obtained from biometric measurements made in six terms, i.e. on the 19th of April, 26th of May, 28th of June, 20th of July, 23rd of August and 29th of September. Since the planted seedlings were 7 cm high during plantation, therefore the increment in the first measurement term was measured in relation to 7 cm original height. The total height of plant included the height of the transplant (7 cm) and the height increments in the particular terms of measurement.

The analysis of shoot increments of *Clematis* for each of the applied fertilizers and its doses gave the following results. After the application of Osmocote Exact Hi-Start in different doses, it was found that on the 37th day of growing, the mean increment of shoots was 50 cm. The greatest increments (74 cm) were reached by plants grown in a substrate with an addition of 8 g·dm^{-3}. On the other hand, the lowest shoot increment was found in the substrate with an addition of a dose of 2 g·dm^{-3} and it was smaller by 46 cm (fig. 2).

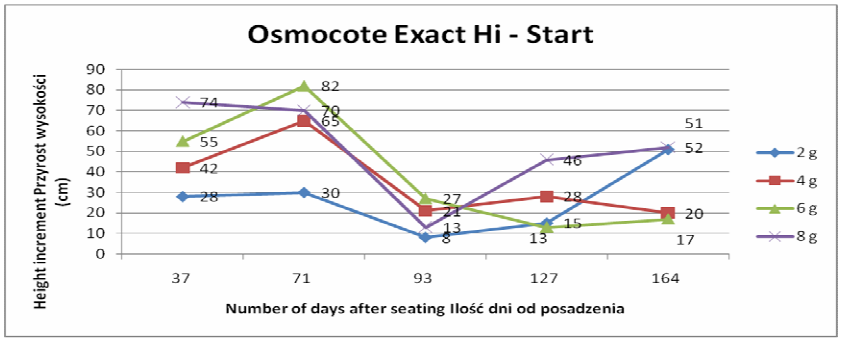

Fig. 2. The comparison of shoot increments of *Clematis* in next days after seating (Osmocote Exact Hi-Start)

Rys. 2. Porównanie przyrostów długości pędów *Clematis* w kolejnych dniach od posadzenia (Osmocote Exact Hi-Start)

On the 71st day, the mean increment of plants was 61 cm and it was by 11 cm longer than the mean shoot increment on the 31st day of growing. The greatest shoot increment of 82 cm was shown by plants fertilized with the dose of 6 g·dm^{-3}, while the smallest increment, 30 cm, was found in plants fertilized by the dose of 2 g·dm^{-3}.

On the 93rd day of growing, there followed a violent decrease of *Clematis* increments. The mean shoot increment of *Clematis* was 17 cm and it was smaller by 44 cm when compared with the mean increment obtained on the 71st day of growing. Similarly as on the 71st day of growing, the highest increments (27 cm) were shown by plants grown in the substrate with a dose of 6 g·dm^{-3}, and the lowest increment (8 cm) was reached by the plants grown in the substrate with an addition of 2 g·dm^{-3}.

In the successive term of measurement, i.e. on the 127th day of growing, the mean shoot increment was 26 cm. The lowest shoot increment (13 cm) was reached by plants grown in the substrate with the dose of 6 g·dm^{-3} which earlier achieved the highest shoot increments. Plants grown in the remaining substrates were characterized by a higher shoot increment in comparison with that shown on the 93rd day of growing. The highest shoot increment was found in plants fertilized with the dose of 8 g·dm^{-3}, it amounted to 46 cm and it was higher by 33 cm than the increment in the previous term of measurement.

On the last, i.e. the 164th day of measurement, higher increments were found in relation to the previous term. The mean increment for this term was 35 cm and it was higher than the previous increment by 9 cm. The highest increment (52 cm) was achieved by plants grown in the substrate with the dose of 8 g·dm^{-3}. while the lowest increment (17 cm) was shown by plants grown in the substrate with an addition of 4 g·dm^{-3}.

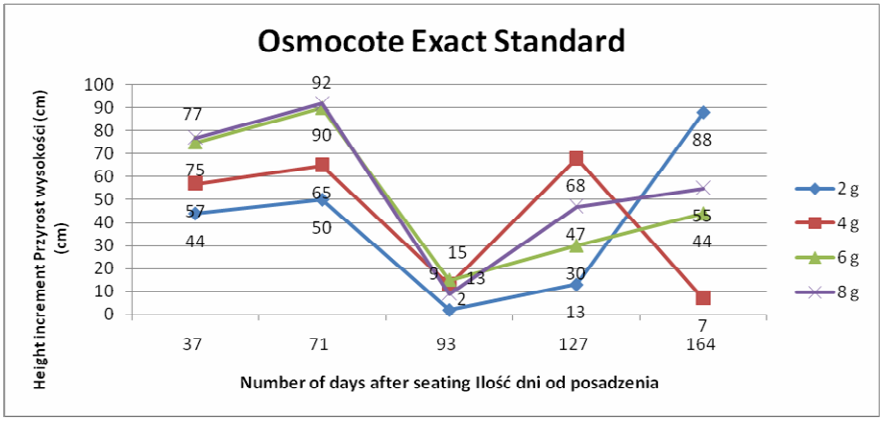

Fig. 3. The comparison of shoot increments of *Clematis* in next days after seating (Osmocote Exact Standard)

Rys. 3. Porównanie przyrostów długości pędów *Clematis* w kolejnych dniach od posadzenia (Osmocote Exact Standard)

The average increment of *Clematis* on the 37th day of growing in the substrate with the addition of Osmocote Exact Standard fertilizer was 63 cm. The highest increments were found in plants with the dose of 6 g·dm^{-3} and 8 g·dm^{-3} and it was 75 cm and 77 cm, respectively. The smallest increment characterized the plants grown in the substrate with a dose of 2 g·dm^{-3} and this tendency was maintained until the 127th day of growing (fig. 3).

In the successive measurement term, i.e. on the 71st day of growing, the mean plant increment increased by 17% and it was 74 cm. Similarly as in the previous term of measurement, the greatest increments were shown by plants fertilized with the doses of 6 and 8 g·dm^{-3} and they were 90 cm and 92 cm, respectively.

On the 93rd day of plant cultivation, smaller increments were found in comparison with the previous measurement term. The mean increment was 10 cm and it was by 86.5% smaller than that from the previous measurement term. The highest increment (19 cm) was found in plants grown in the substrate with an addition of 6 g·dm^{-3} of this fertilizer, The smallest mean increment was obtained in the substrate with a dose of 2 g·dm^{-3}. In the next term of measurement, i.e. on the 127th day, the mean shoot increment was 40 cm.

The smallest increment (13 cm) was still shown by plants grown in the substrate with a dose of 2 g of fertilizer per 1 liter of substrate. On the other hand, the highest increment in that term was shown by plants fertilized with the dose of 4 g·dm^{-3} and it was 68 cm. This dependence changed on the 164th day (the last term of measurement) when the highest shoot increment (88 cm) was found in the substrate with a dose of 2 g·dm^{-3}. The smallest shoot increment (7 cm) was obtained in the substrate with 4 g·dm^{-3}. After the calculation of the mean shoot increment for that term, it was found that it was higher by 9 cm than the mean increment obtained on the 127th day of growing and it was 49 cm.

Table 3. Effect of Osmocote fertilizer type and doses on the number of flowers, the mean weight of one flower, the mean yield of all flowers, flower diameter and the number of petals

Tabela 3. Wpływ typu oraz dawek nawozu Osmocote na liczbę kwiatów, średnią masę jednego kwiatu, średni plon wszystkich kwiatów, średnicę kwiatu i ilość płatków

Fertilizer Nawóz	Dose Dawka g·dm^{-3}	Number of flowers Liczba kwiatów szt.	The mean weight of one flower, g Średnia masa jednego kwiatu, g	The mean yield of all flowers, g·plant^{-1} Średni plon wszystkich kwiatów, g·roślina^{-1}	Diameter of flower Średnica kwiatu, cm	Amount of petals Ilość płatków szt.
Osmocote Exact Hi-Start	2	-	-	-	-	-
	4	3	0,93	2,88	7,5	6
	6	4	1,38	5,52	9,0	6
	8	3	1,18	3,54	8,0	6
Osmocote Exact Standard	2	-	-	-	-	-
	4	3	1,63	4,89	12,5	6
	6	5	2,21	11,05	15,0	6
	8	3	1,95	5,85	13,5	6

Clematis 'John Paul II' starts blooming on older shoots in June. In our experiment, there was no June blooming. Blooming started on the 23rd of July in 2006, and on the 18th of July in 2007 and it lasted until the termination of the experiment. Flowers were obtained on plants fertilized with both types of fertilizers in the doses of 4, 6, and 8 $g \cdot dm^{-3}$ (tab. 3). However, the best flowering was found in plants grown in substrates with the addition of Osmocote Exact Standard in the dose of 6 $g \cdot dm^{-3}$. Plants grown in substrates which received two types of fertilizers in the dose of 2 $g \cdot dm^{-3}$ did not develop flowers throughout the whole period of experiment duration. The highest yield of flowers expressed in grams per plant fresh weight was found in plants grown in substrates fertilized with Osmocote Exact Standard in the dose of 6 $g \cdot dm^{-3}$. The mean yield of all flowers obtained from plants grown in the substrate was 11.05 $g \cdot plant^{-1}$. This yield consisted of five flowers with a mean weight of 2.21 g.

As reported by Sękowski [1987], the diameter of *Clematis* flowers, 'John Paul II' cv. is 14 cm. In our own studies, the flower diameter oscillated between 7.5 and 15.0 cm, whereby a smaller diameter was shown by flowers of plants fertilized with Osmocote Exact Hi-Start, while bigger flowers (from 12.5 to 15.0 cm) were obtained on plants grown with an addition of Osmocote Exact Standard fertilizer.

CONCLUSIONS

1. The longest shoots of *Clematis* were obtained after the application to the substrate of Osmocote Exact Hi-Start and Osmocote Exact Standard fertilizers in the dose of 8 $g \cdot dm^{-3}$.

2. Plants fetrilized with Osmocote Exact Hi-Start obtained the highest weight of their above ground plant parts at the dose of 8 $g \cdot dm^{-3}$ of substrate, while plants fertilized with Osmocote Exact Standard obtained the highest weight of their aboveground plant parts at the dose of 6 $g \cdot dm^{-3}$ of substrate.

3. Plants in a 5-month period of growing with the application of the fertilizers Osmocote Exact Standard did not show any signs of mineral malnutrition.

4. The greatest number of flowers and the greatest weight of flowers was found in plants grown in the substrate with an addition of the fertilizer Osmocote Exact Standard in the dose of 6 $g \cdot dm^{-3}$.

5. The best fertilizer for the growing of *Clematis* 'John Paul II' cv. has shown to be Osmocote Exact Standard in the dose of 6 $g \cdot dm^{-3}$.

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WPŁYW NAWOZÓW TYPU OSMOCOTE NA WZROST I PLONOWANIE *Clematis* Z GRUPY JACKMANII, 'JAN PAWEŁ II'

Streszczenie. W latach 2006 i 2007 przeprowadzono badania, których celem było stwierdzenie przydatności dwóch typów nawozu Osmocote Exact o spowolnionym działaniu, do uprawy pojemnikowej *Clematis* z grupy Jackmanii, 'Jan Paweł II'. Badano wpływ tych nawozów na wzrost i plonowanie *Clematis* 'Jan Paweł II'. Najdłuższe pędy powojnika uzyskano po zastosowaniu dawki 8 g·dm^{-3}, nawozów Osmocote Exact Hi-Start i Osmocote Exact Standard. Rośliny nawożone nawozem Osmocote Exact Hi-Start największa masę części nadziemnej uzyskały przy dawce nawozu 8 g·dm^{-3}, natomiast rośliny nawożone nawozem Osmocote Exact Standard największą masę części nadziemnej uzyskały przy dawce 6 g·dm^{-3}. Rośliny w pięciomiesięcznym okresie uprawy przy zastosowaniu nawozów Osmocote Exact Hi-Start i Standard nie wykazywały objawów niedożywienia mineralnego. Największą liczbę kwiatów oraz masę kwiatów stwierdzono u roślin rosnących w podłożu, do którego wprowadzono Osmocote Exact Standard w ilości 6 g·dm^{-3}. Za najlepszy do uprawy *Clematis* 'Jan Paweł II' należy uznać nawóz Osmocote Exact Standard w dawce 6 g·dm^{-3}.

Słowa kluczowe: *Clematis*, nawozy o spowolnionym działaniu, Osmocote

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