Electronic Journal of Polish Agricultural Universities is the very first Polish scientific journal published exclusively on the Internet, founded on January 1, 1998 by the following agricultural universities and higher schools of agriculture: University of Technology and Agriculture of Bydgoszcz, Agricultural University of Cracow, Agricultural University of Lublin, Agricultural University of Poznan, Higher School of Agriculture and Teacher Training Siedlce, Agricultural University of Szczecin, and Agricultural University of Wroclaw.

ELECTRONIC JOURNAL OF POLISH AGRICULTURAL UNIVERSITIES

2003
Volume 6
Issue 2
Series HORTICULTURE

KORSZUN S., ZALEWSKA J. 2003. THE INFLUENCE OF TWO FERTILISERS WITH PROLONGED NUTRIENT RELEASE ANDTHEIR FOUR DIFFERENT DOSES ON THE GROWTH OF ROCKY MOUNTAIN JUNIPER (*Juniperus scopulorum*) 'BLUE ARROW' CULTIVAR IN CONTAINER CULTIVATION **Electronic Journal of Polish Agricultural Universities**, Horticulture, Volume 6, Issue 2.
Available Online http://www.ejpau.media.pl

THE INFLUENCE OF TWO FERTILISERS WITH PROLONGED NUTRIENT RELEASE ANDTHEIR FOUR DIFFERENT DOSES ON THE GROWTH OF ROCKY MOUNTAIN JUNIPER (*Juniperus scopulorum*) 'BLUE ARROW' CULTIVAR IN CONTAINER CULTIVATION

Stanisława Korszun, Joanna Zalewska
The Division of Dendrology and Nursery, Department of Seed Science and Horticulture Nursery, August Cieszkowski Agriculture University of Poznań, Poland

ABSTRACT
INTRODUCTION
MATERIALS AND METHODS
RESULTS
DISCUSSION
CONCLUSIONS
REFERENCES

ABSTRACT

The experiments on the influence of the two different fertilisers and their four different doses on the growth of Rocky Mountain juniper 'Blue Arrow' cultivar were conducted in an unheated glasshouse in the years 2001-2003. Rooted cuttings of Rocky Mountain juniper 'Blue Arrow' cultivar were set for cultivation on 15 May 2001 into a growing substrate composed of high moor peat and frittered and composted pine bark (v:v 1:1) with pH in H_2O 4.5. Two types fertilisers were used, namely Osmocote Exact Lo-Start and Osmocote Exact Standard, in four doses: 2.0, 2.5, 3.0 and 3.5 g·dm^{-3} of substrate. During vegetation season the measurements of plants height and length of lateral shoots [cm] were taken, and the number of lateral shoots was counted. When vegetation of Rocky Mountain juniper 'Blue Arrow' cultivar in 2001 ceased, the fresh weight of roots and above-ground part was measured.

Of the two prolonged nutrient release fertilisers used, in the first year of cultivation of Rocky Mountain juniper 'Blue Arrow' cultivar Osmocote Exact Standard acted more profitably on the growth of plants. By contrast, in the second year of cultivation Osmocote Exact Lo-Start appeared to be more profitable. Of the four different fertiliser doses used in 2001 the best parameters of researched features were obtained when 2.0 g of Osmocote Exact Standard · dm^{-3} and 3.5 g of Osmocote Exact Lo-Start · dm^{-3} were added to the mixture of high moor peat and pine bark (growing substrate). In the second year of container cultivation the most profitable dose of fertiliser used for plant growth was that of 3.0 g·dm^{-3}, independently of its kind (i.e. Osmocote Exact Standard and Osmocote Exact Lo-Start acted equally profitably).

Key words: Rocky Mountain juniper, *Juniperus scopulorum* Sarg., 'Blue Arrow', growing substrate pH, container cultivation.

INTRODUCTION

In recent years the interest in lesser-known species and new varieties of ornamental plants has been systematically growing. The highest popularity is gained by all-year-round decorative coniferous shrubs and trees. They are characterised by large diversity of shape and the colouring of needles and scales. Their ornamental values diversify many ornamental plant compositions in parks and gardens.

The Rocky Mountain juniper originates from the western part of the North America. In its original, natural environment the juniper grows on mugwort semi-deserts [3]. Krüssmann [4] states that the Rocky Mountain juniper has been grown since 1839 and its cultivars grow well even in areas with an annual rainfall of 150-200 mm. The cultivar of the Rocky Mountain juniper 'Blue Arrow' was introduced to Poland in the 1990s. It has gained high appreciation and popularity very quickly. It looks similar to the well known cultivar 'Skyrocket'. However, it differs from 'Skyrocket' cultivar in its narrower shape, intensive blue colour of scales and higher tolerance to fungal diseases [1].

In the literature available, there is only scarce information about the Rocky Mountain juniper species and this researched 'Blue Arrow' cultivar to be found. There is no data on its container cultivation and fertiliser recommendations. There is also lack of information on use in cultivation of new generation prolonged nutrient release fertilisers like Osmocote Exact Standard for example. Sanftleben [5] researched the content of macronutrients in peat growing substrate and the content of macro and micronutrients in leaves and scales of three chosen taxons, among them *Juniperus chinensis* 'Pfitzeriana Aurea' cultivar. He conducted research with two fertilisation variants, i.e. 4 kg of Plantacote 8 M·m^{-3} of growing substrate and 2.5 kg Basacote 6 M + 1.5 kg Triabon · m^{-3} of growing substrate. Sanftleben among others proved the occurrence of differences of macro and micronutrients content in leaves of *Amelanchier lamarckii* and scales of *Chamaecyparis lawsoniana* 'Alumii'. However, he does not present fertiliser recommendations for taxons researched.

Therefore on the basis of this research it was intentional to design agro-technique and to test the two fertilisers with prolonged nutrient release and design the fertiliser recommendations and application programme to the Rocky Mountain juniper 'Blue Arrow' cultivar.

MATERIALS AND METHODS

Cultivation research was conducted in the years 2001-2003 in an unheated glasshouse. For the setting of the cultivation experiment, plants of the Rocky Mountain juniper of 'Blue Arrow' cultivar rooted in spring 2000 were used. They were planted into growing containers on 15 May 2001. The analysis of biometric features of cuttings (namely height, length and number of lateral roots) did not show significant differences among them. The plants were allocated to individual combinations at random.

The growing substrate for the Rocky Mountain juniper of 'Blue Arrow' cultivar plants was composed of 50% high moor peat and 50% frittered and composted pine bark. The pH of the mixture was very acid (pH in H_2O 4.5). The composition and pH of the growing substrate was acknowledged as the best on the basis of the results obtained from earlier designed experiments. The Rocky Mountain juniper of 'Blue Arrow' cultivar plants were planted into containers of 2.7 dm^3 volume.

The factor differentiating the experiment combinations was the type and the dose of fertilisers with prolonged nutrient release. Two different fertilisers of 5-6 months of nutrient release from the company Scotts were used, namely Osmocote Exact Lo-Start with delayed start of macro and micronutrients release, and Osmocote Exact Standard with linear release of feeding nutrients. Both were used in four different doses: 2.0, 2.5, 3.0 and 3.5 g·dm^{-3} substrate. The composition of the nutrients ingredients is given in table 1.

Table 1. The content of macro- and micronutriens (%) in 5-6 months fertilisers used for the experiment

Nutriens	Osmocote Exact Lo-Start with the delayed start of nutrient release	Osmocote Exact Standard with linear nutrient release
N	15.0	15.0
P_2O_5	8.0	10.0
K_2O	10.0	12.0
MgO	3.0	2.0
Fe	0.4	0.2
Mn	0.06	0.04
Cu	0.05	0.03
B	0.02	0.01
Mo	0.02	0.01
Zn	0.015	0.01

The fertilisers were weighed and added separately to each substrate placed in a container two days before planting of rooted cuttings.

During vegetation season in the years of running the experiment the biometric measurements took place: i.e. height of plants, length of lateral shoots [cm] as well as their number. Also the dynamic of growth of the Rocky Mountain juniper of 'Blue Arrow' cultivar was examined.

When the plants' growth ceased in 2001, 10 plants of each combination were chosen at random and their fresh weight of roots as well as above-ground part was measured.

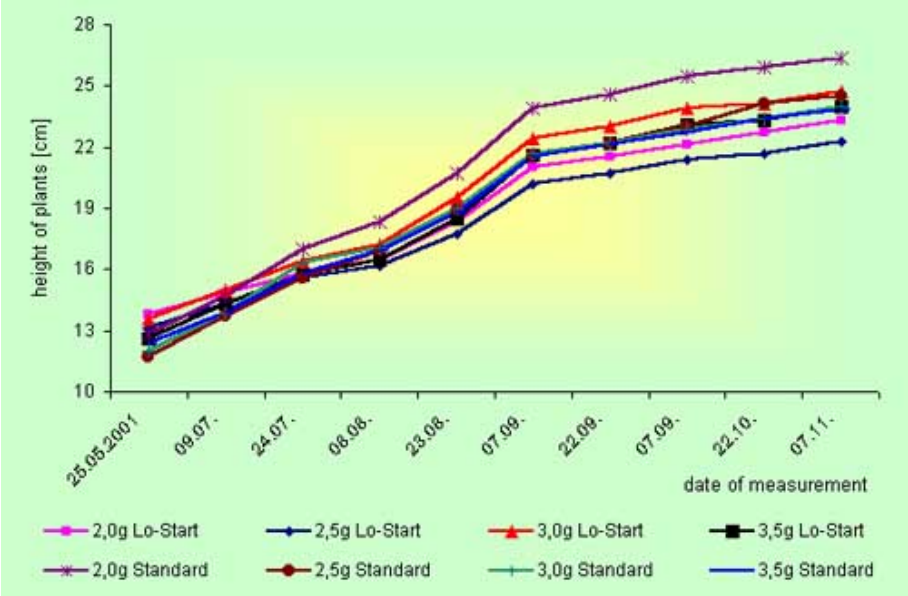
There were 10 plants in four replications (320 in total) in each combination in the first year of the container growth experiment, and in the second year 10 plants in each combination in three replications (240 in total).

The obtained results were statistically analysed by the two-factor analysis of variance. The averages were compared with the aid of Duncan's test with the significance level $\alpha = 0.05$.

RESULTS

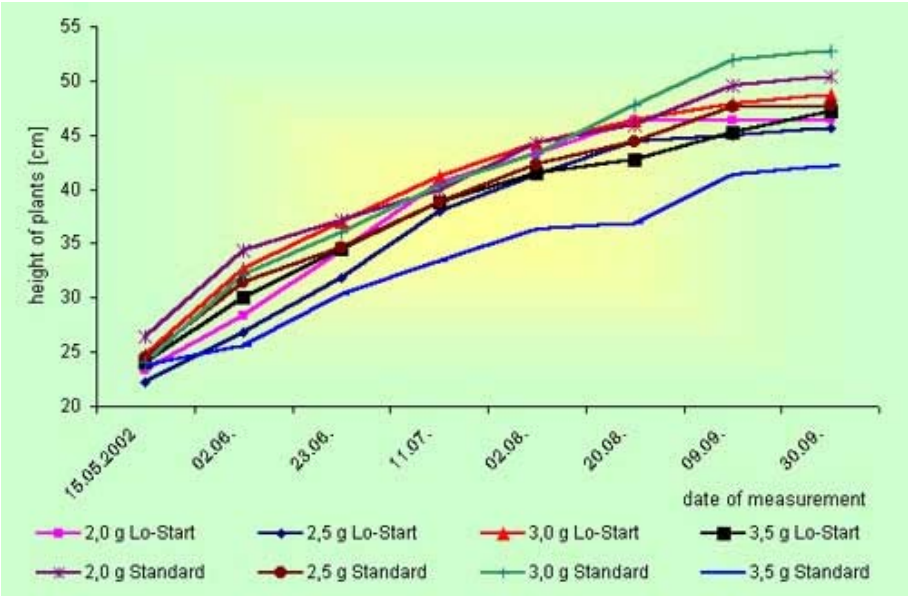
In the year 2001 the description of the dynamic of growth of the Rocky Mountain juniper of 'Blue Arrow' cultivar plants began after their planting to the substrates placed in containers in the third decade of May. The most intensive growth of plants was observed from 25 May until 7 September. Junipers showed similar growth during the entire vegetation season independently of the type and the dose of fertiliser used (fig. 1). In the first year of container cultivation the most intensive growth was observed among plants when a single dose of 2.0 g of Osmocote Exact Standard · dm^{-3} growing substrate was applied. The lowest values of growth rate were observed when a dose of 2.5 g of Osmocote Exact Lo-Start · dm^{-3} of the mixture of high moor peat and pine bark was applied.

Fig. 1. The dynamics of growth of plants Rocky Mountain juniper 'Blue Arrow' variety in the first year of container cultivation



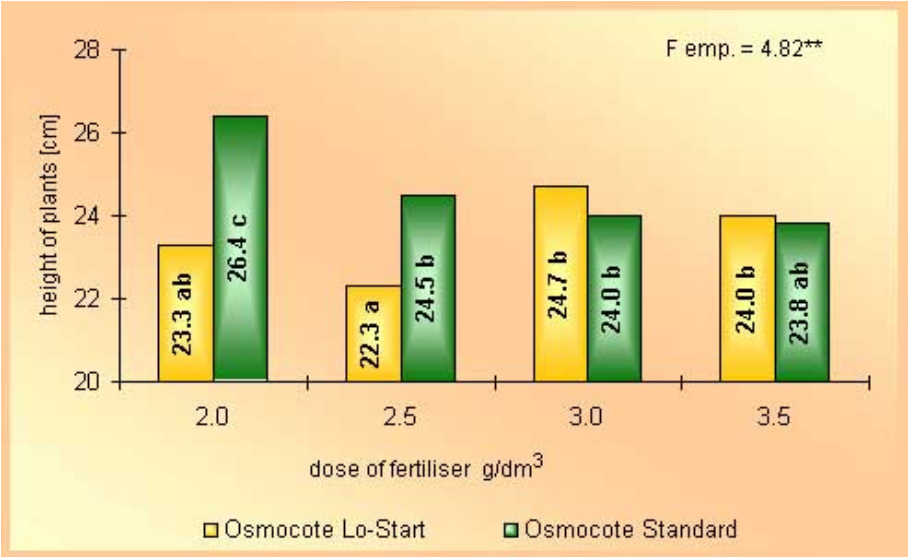
In the second year of cultivation the Rocky Mountain juniper of 'Blue Arrow' cultivar began vegetation on 15 May and grew intensively till 20 August 2002, with the exception of the plants grown with the addition of Osmocote Exact Standard in doses of 3.0 and 2.0 g · dm^{-3} the growing substrate. The junipers in those combinations grew until 9 September (fig. 2). Of the four doses of fertilisers used, the least profitable for growth of the juniper plants appeared to be the dose of 3.5 g·dm^{-3} substrate, mainly when Osmocote Exact Standard was applied.

Fig. 2. The dynamics of growth of plants Rocky Mountain juniper 'Blue Arrow' variety in the second year of container cultivation



The height of the plants depended on the type of fertiliser used as well as on its dose. Of the two fertilisers used in the experiment, the better appeared to be Osmocote Exact Standard. However, with an increase in the dose the height of plants was lower. The highest juniper plants (i.e. 26.4 cm) were obtained when a dose of 2.0 g of Osmocote Exact Standard · dm^{-3} substrate was applied. The lowest profitable dose was 2.5 g of Osmocote Exact Lo-Start · dm^{-3} substrate. In that case the juniper plants reached a height of only 22.3 cm. The fertiliser with the delayed release of feeding ingredients most influenced the researched feature (plants' height) most positively when the Rocky Mountain juniper cultivar 'Blue Arrow' was grown in the substrates where 3.0 and 3.5 g·dm^{-3} substrate of the fertiliser was applied (fig. 3).

Fig. 3. Average height of plants 'Blue Arrow' variety dependant on the type and dose of fertiliser in the first year of container cultivation. Average values marked with the same letter do not differ statistically; $\alpha = 0.05$



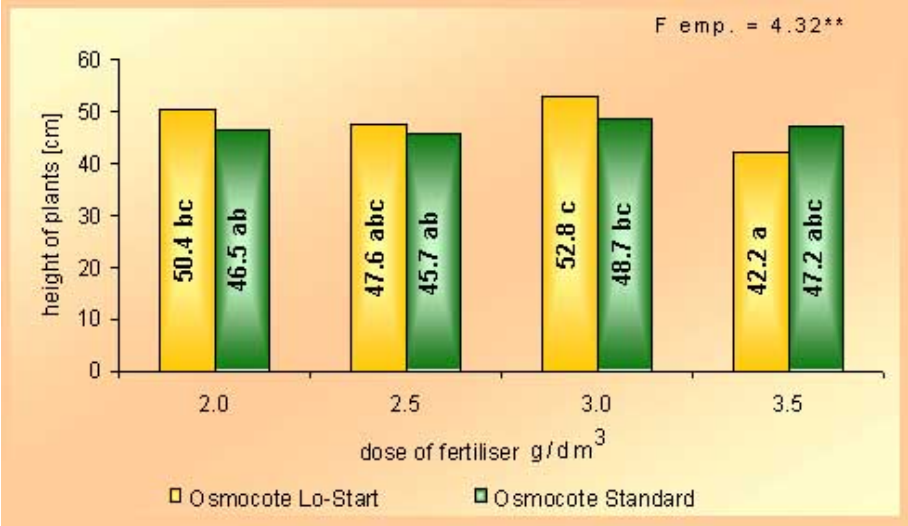
In the second year of container cultivation the researched cultivar was higher when it was fed with the fertiliser with delayed start of release of macro and micronutrients (with the exception of the largest applied dose). The cultivar of the Rocky Mountain juniper 'Blue Arrow' plants were the highest i.e. 52.8 cm, when 3.0 g·dm^{-3} substrate of Osmocote Exact Lo-Start fertiliser or 48.7 cm when 3.0 g·dm^{-3} substrate of Osmocote Exact Standard fertiliser were added. The least profitable appeared to be application to the mixture of high moor peat and pine bark (v:v 1:1) of Osmocote Exact Lo-Start in the dose 3.5 g. These plants reached a height of 42.2 cm. In the same statistical group the values for the examined feature i.e. when the dose of 2.5 g of Osmocote Exact Lo-Start as well as 2.0, 2.5 and 3.5 g·dm^{-3} substrate of Osmocote Exact Standard were applied also fell (fig. 4).

Fig. 4. The height of plants of the 'Blue Arrow' variety after a year of container cultivation: 1 – 2.0 g, 2 – 2.5 g, 3 – 3.0 g, 4 – 3.5 g Osmocote Exact Lo-Start, 5 – 2.0 g, 6 – 2.5 g, 7 – 3.0 g, 8 – 3.5 g Osmocote Exact Standard·dm^{-3} substrate

The average length of lateral shoots on the juniper plant in the first year of container cultivation, independently of the dose of the fertiliser used always had higher values, and this was statistically confirmed when Osmocote Exact Standard fertiliser was applied. The juniper plants grown in substrate when 2.0 and 2.5 g·dm^{-3} substrate was applied produced the longest shoots i.e. 3.2 cm and 3.1 cm respectively. The values obtained for plants

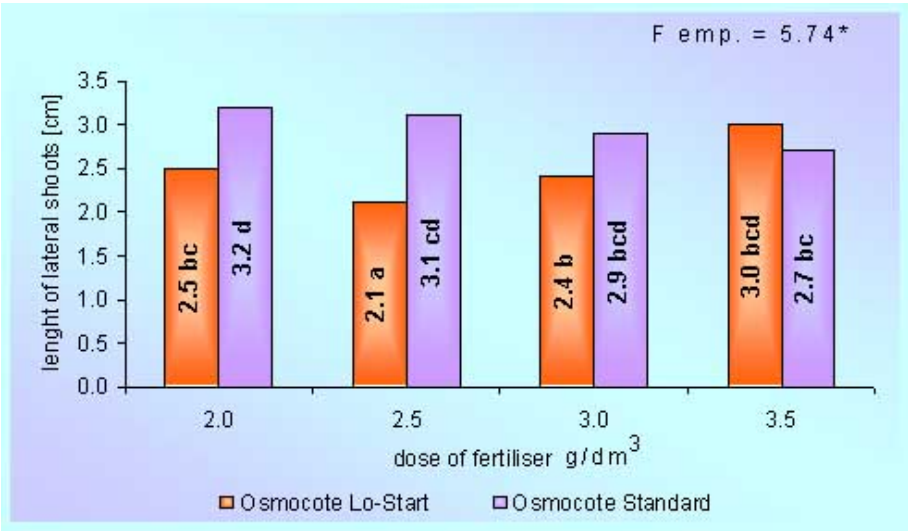
height i.e. 3 cm when 3.5 g of Osmocote Exact Lo-Start and 2.9 cm when 3.0 g Osmocote Exact Standard were applied also fell into the same statistical group. The shortest lateral shoots (i.e. 2.1cm) were measured for plants grown in the mixture of high moor peat and pine bark when 2.5 g of Osmocote Exact Lo-Start · dm^{-3} substrate was applied (fig. 5).

Fig. 5. Average height of plants 'Blue Arrow' variety dependant on the type and dose of fertiliser in the second year of container cultivation. Average values marked with the same letter do not differ statistically; $\alpha = 0.05$



After two years of container cultivation the average length of the lateral shoots possessed values more than twice as high. For the examined feature, the fertiliser Osmocote Exact Lo-Start in the dose of 3.0 g·dm^{-3} cultivation substrate had the most profitable influence. The juniper plants produced lateral shoots with an average length of 8.2 cm. The shortest lateral shoots of the Rocky Mountain juniper 'Blue Arrow' cultivar i.e. 7.0 and 7.1 cm were produced when Osmocote Exact Standard fertiliser was applied in the dose of 2.0 and 2.5 g·dm^{-3} cultivation substrate respectively. Other than the values mentioned, the values obtained for plants when 3.5 g of Osmocote Exact Lo-Start and 3.0 or 3.5 g of Osmocote Exact Standard · dm^{-3} cultivation substrate were applied fell into the same statistical group (fig. 6).

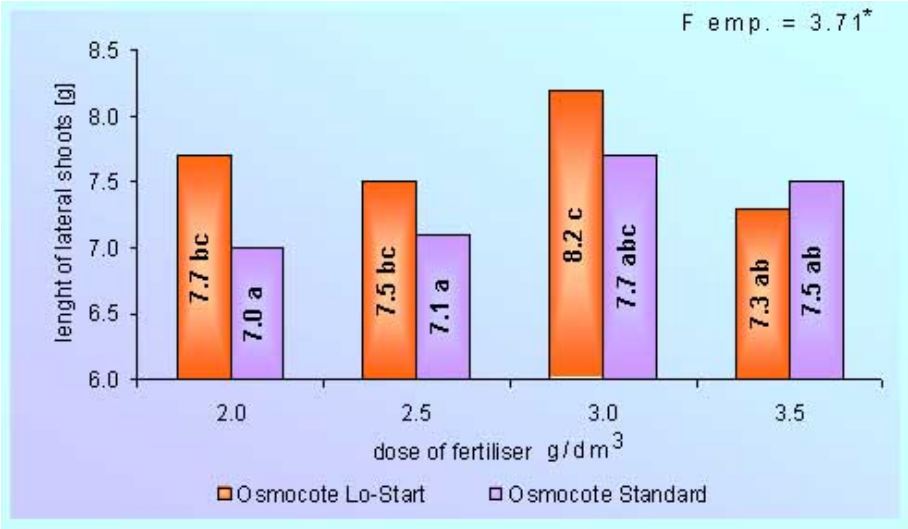
Fig. 6. Average lenght of growth of lateral shoots of the plants of 'Blue Arrow' variety dependant on the type and dose of fertiliser in the first year of container cultivation. Average values marked with the same letter do not differ statistically; $\alpha = 0.05$



Larger number of lateral shoots was produced by juniper plants when they were fed with the fertiliser possessing linear feeding nutrients release (fig. 7). After one year of container cultivation the Rocky Mountain juniper 'Blue

Arrow' cultivar possessed an average of between 3.3 (2.5 g Osmocote Exact Lo-Start) and 4.9 (2.0 g Osmocote Exact Standard) lateral shoots per plant. The most profitable influence for this examined feature was the application of 2.0 g of Osmocote Exact Standard fertiliser · dm^{-3} cultivation substrate.

Fig. 7. Average lenght of growth of lateral shoots of the plants of 'Blue Arrow' variety dependant on the type and dose of fertiliser in the second year of container cultivation. Average values marked with the same letter do not differ statistically; $\alpha = 0.05$



In 2002, a more profitable influence of Osmocote Exact Lo-Start fertiliser on average number of lateral shoots per plant was observed. In the cultivation substrate with the addition of that fertiliser in doses of 2.0 and 3.0 g·dm^{-3} mixture of high moor peat and pine bark the junipers produced respectively 59.3 and 58.3 of lateral shoots. Of the applied doses of Osmocote Exact Standard fertiliser, the best was the lowest, i.e. 2.0 g·dm^{-3} cultivation substrate. The junipers' plants in that combination produced on average 52.4 lateral shoots. The lowest number of lateral shoots was counted on the plants of the Rocky Mountain juniper 'Blue Arrow' cultivar when 3.6 g of Osmocote Exact Lo-Start or 2.5 g Osmocote Exact Standard · dm^{-3} fertilisers were applied, i.e. 47.6 and 47.4 respectively (fig. 8).

Fig. 8. Average number of growth of lateral shoots of the plants of 'Blue Arrow' variety dependant on the type and dose of fertiliser in the first year of container cultivation. Average values marked with the same letter do not differ statistically; $\alpha = 0.05$

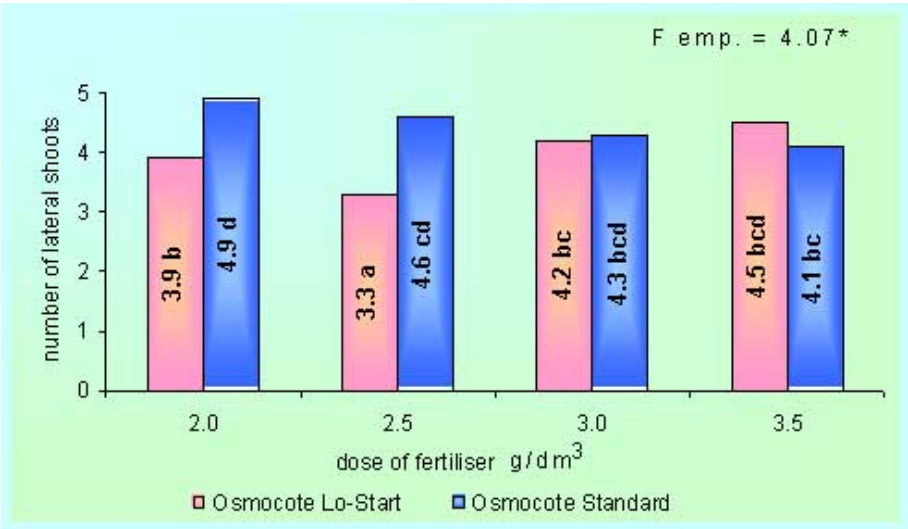
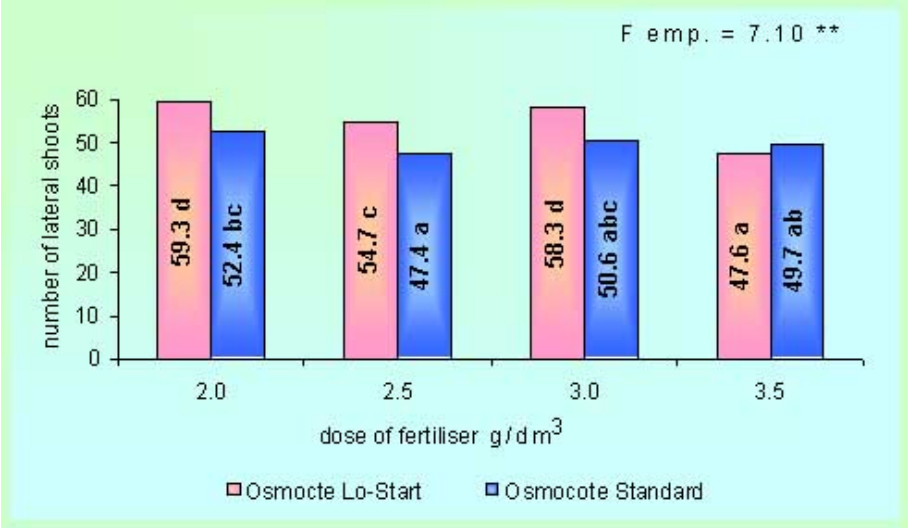


Fig. 9. Average number of growth of lateral shoots of the plants of 'Blue Arrow' variety dependant on the type and dose of fertiliser in the second year of container cultivation. Average values marked with the same letter do not differ statistically; $\alpha = 0.05$



When the vegetation ceased in 2001 the largest fresh weight of roots (i.e. 3.6 g and above-ground part 6.5 g) were produced by juniper plants cultivated with Osmocote Exact Standard fertiliser in the dose of 3.5 g·dm^{-3} cultivation substrate. The lowest fresh root weight (only 1.5 g) and above-ground part (3.6 g) were produced by juniper plants cultivated with the application of Osmocote Exact Lo-Start fertiliser of a dose 2.0 g·dm^{-3} cultivation substrate – table 2.

Table 2. The weights of fresh root and above-ground part of the Rocky Mountain juniper 'Blue Arrow' variety after vegetation ceased in 2001

Dose of fertiliser Osmocote Exact g·dm^{-3} substrate	Average fresh weight	
	roots [g]	above ground part [g]
Lo-Start 2.0	1.5 a[1)]	3.6 a
Lo-Start 2.5	1.9 ab	4.3 ab
Lo-Start 3.0	2.3 ab	5.0 abc
Lo-Start 3.5	2.8 b	5.8 bc
Standard 2.0	2.6 b	5.7 bc
Standard 2.5	2.1 ab	4.2 ab
Standard 3.0	2.0 ab	4.5 ab
Standard 3.5	3.6 c	6.5 c
F. emp.	4.20**	3.01*

[1)] average values in column marked with the same letter do not differ statistically; $\alpha = 0.05$

Table 3. The interaction among the type of the fertiliser and the examined features in the second year of container cultivation

Feature Fertiliser	Height of plants cm	Average lenght of lateral shoots, cm	Average number of lateral shoots
Osmocote Exact Standard	47.0 a[1)]	7.3 a	50.0 a
Osmocote Exact Lo-Start	48.3 a	7.7 b	55.0 b
F emp.	1.41	12.11**	31.25**

[1)]see table 2

Table 4. The interaction among the dose of the fertiliser and the examined features in the second year of container cultivation

Feature Dose of fertiliser	Height of plants [cm]	Average lenght of lateral shoots [cm]	Average number of lateral shoots
2.0 g·dm^{-3}	48.4 bc[1)]	7.4 a	55.8 b
2.5 g·dm^{-3}	46.6 ab	7.4 a	51.0 a
3.0 g·dm^{-3}	50.8 c	7.9 b	54.5 b
3.5 g·dm^{-3}	44.7 a	7.4 a	48.6 a
F emp.	6.26**	5.34**	13.77**

[1)]see table 2

In table 3, the relationship between the type of fertiliser and the examined features in the second year of container cultivation was compared. No statistically significant differences were found among the values of the height of juniper plants. Although a more positive influence on average length and the number of lateral shoots created by Osmocote Exact Lo-Start fertiliser was observed.

Of the four different doses of fertilisers the optimal one for all of the examined features appeared to be the dose of 3.0 g·dm^{-3} cultivation substrate. The dose of 4.0 g·dm^{-3} cultivation substrate, which has been suggested for application by the fertilisers' producer, the company Scotts, was found to be too large, since only after the application of 3.5 g were the obtained values of the examined features lower, which was statistically confirmed (table 4).

DISCUSSION

The cultivation of arborescent ornamental plants in containers originated in California in the 1930s, and in Poland in the 1970s. At present around 60% of ornamental plants are produced that way [2]. Bugała [1] states that during potting and planting of junipers the root lump may be broken up, the effect of which being that the roots may be damaged, and so it is much more profitable to cultivate them in containers.

In the literature available, there is general information concerning the original, natural environment of the Rocky Mountain juniper as well as short descriptions of its cultivars. However, there is no information on their cultivation requirements and especially on ornamental plant nursery container production.

In this experiment the new generation of fertilisers with prolonged activity was used. They were introduced to Poland in 2000 by the producer company Scotts. One of the fertilisers, Osmocote Exact Lo-Start, is intended for coniferous plants. It is characterised by a delayed start to the release of feeding nutrients. Gymnospermous plants began growth later than angiosperms plants, which is why the rate of macro and micronutrients release from the aforementioned fertiliser should have a positive influence on them. In the experiment described here, the influence of four different doses (2.0, 2.5, 3.0 and 3.5 g·dm^{-3} cultivation substrate) of fertilisers Osmocote Exact Standard and Osmocote Exact Lo-Start on the growth of the Rocky Mountain juniper 'Blue Arrow' cultivar in container cultivation was compared. In the first year of cultivation, it was observed that the application to thecultivation substrate of the fertiliser with linear release of nutrients (Osmocote Exact Standard) was more profitable for the plants. And in the second year, better parameters of the examined juniper plants features were obtained in plants cultivated in the growing substrate with the application of Osmocote Exact Lo-Start. The dose of 4.0 g·dm^{-3} cultivation substrate suggested by the fertilisers' producer seems to be too large, in the light of the

results obtained from that experiment. In the first year of container cultivation the juniper plants grew better in the cultivation substrate when 2.0 g of Osmocote Exact Standard and 3.5 g of Osmocote Exact Lo-Start · dm^{-3} mixture of high moor peat and pine bark were applied, and in the second when the dose of 3.0 g of fertiliser was applied, independently of its type.

CONCLUSIONS

1. For the cultivation of the Rocky Mountain juniper 'Blue Arrow' cultivar in containers in the first year of growth, 5-6 months Osmocote Exact Standard with linear macro and micronutrients release was more profitable for plants than Osmocote Exact Lo-Start with delayed start of feeding nutrient release. In the second year Osmocote Exact Lo-Start appeared to be more profitable.
2. Of the four different doses (2.0, 2.5, 3.0 and 3.5 g·dm^{-3} cultivation substrate) of fertilisers in container cultivation better junipers' plant growth was obtained in the first year when 2.0 g of Osmocote Exact Standard and 3.5 g of Osmocote Exact Lo-Start were applied to the growing substrate.
3. In the second year of container cultivation, of the four different doses, the optimal one for the plants' growth, the length of lateral shoots and their number appeared to be the dose of 3.0 g·dm^{-3} cultivation substrate, independently of the type of the fertiliser used.

REFERENCES

1. Bugała W., 2001. Drzewa i krzewy iglaste [Evergreen trees and bushes]. PWRiL. Warszawa, 112-116 [in Polish].
2. Górka W., 2001. Ekologiczne pojemniki szkółkarskie [Ecological nursery containers]. Szkółkarstwo 1, 38-39 [in Polish].
3. Hrynkiewicz-Sudnik J, Sękowski B., Wilczkiewicz M., 1999. Rozmnażanie drzew i krzewów nagozalążkowych [Reproduction of gymnocarpous trees and bushes]. PWN. Warszawa, 394-406 [in Polish].
4. Krüssmann G., 1979. Die Nadelgehölze. Paul und Parey. Berlin und Hamburg, 132-168.
5. Sanftleben H., 1989. Depot-Düngesysteme bei Containerkulturen im Praxisvergleich. Deutsche Baumschule 10, 502-505.

Stanisława Korszun, Joanna Zalewska
Division of Dendrology and Nursery
Department of Seed Science and Horticulture Nursery
August Cieszkowski Agriculture University of Poznań
28 Szamotulska Street, 62-081 Przeźmierowo, Poland
e-mail: kolamarc@owl.au.poznan.pl
