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INFLUENCE OF GEOCOMPOSITE APPLICATION ON SELECTED BIOMETRIC FEATURES OF *ROSA* ,WHITE MEIDILAND' AND *BERBERIS THUNBERGII* ,GREEN CARPET' IN THE CONTAINER NURSERY PRODUCTION

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Abstract

An innovative technology of superabsorbent application in a form of agrotextile filled with polymer, called geocomposite, is a solution that allows preserving the beneficial effect of using superabsorbents with simultaneous reduction of their negative influence on soil environment. Research was carried out in 2012-2014 on one year old cuttings of *Rosa*, White Meidiland' and *Berberis thunbergii* ,Green Carpet' in unheated foil tunnel at the Research Station belonging to the Department of Horticulture at Wrocław University of Environmental and Life Sciences. First factor was the use of geocomposite, while the second was fertilization with full (3 g) and half (1.5 g) dose of Osmocote Plus 3-4M and 3 g of YaraMila Complex fertilizer. The aim of this study was to assess the influence of geocomposite application with the use of fertilizers on selected biometric features and fresh weight of plants. Geocomposite had the positive influence on tested shoots and roots biometric features of *Rosa* 'White Meidiland' and *Berberis thunbergii* ,Green Carpet', on the fresh weight of roots and total of both species, as well as on their root:shoot ratio. In both species there was a tendency to obtain the highest values with 1.5 g Osmocote fertilization.

Key words: geocomposite, *Rosa* ,White Meidiland', *Berberis thunbergii*, ,Green Carpet', nursery production, growth

INTRODUCTION

Geocomposite is an interesting geotechnical innovation, which may have a wide range of functionality in horticulture. It is made of superabsorbent strengthened with openwork disc called skeleton and covered with geotextile. The advantage of using geocomposite is the lack of negative correlation between superabsorbent and soil or substrate in the case of potted plants. Skeleton used in geocomposite minimizes swelling reduction burden and at the same time geotextile protects the soil or substrate against the negative influence of superabsorbent swelling on physical parameters of soil or substrate. The major advantage of geocomposite functionality is that it can be removed at any time of cultivation, what was not possible while mixing superabsorbent itself with soil or substrate (Orzeszyna *et al.* 2006). It is also essential, that in geocomposite the polymer is not exposed to UV radiation, which in hydrogels based on the poliacrylic acids may led to the reduction of absorbency (Kim *et al.* 2010). Geocomposites prevent or decrease the surface erosion of soil, which can have negative impact on slopes and areas with differentiated surface, especially on light soils, where plants cultivation is hard and needs large professional knowledge (Tohidi-Mokhadam *et al.* 2009). They are used as a biotechnical protection on slopes and embankments (www.geosap.up.wroc.pl).

Research studies on hydrogels in container cultivation were limited to mixing them with substrates and then growing plants. Innovation of using geocomposites involves placing them on the bottom of pot, placing the roots of plants directly on them and then covering with substrate. Root system can easily outgrow the agrotextile and the consequence of this is constant accessibility of water and mineral salts closed in the matrix of superabsorbent. Moreover, fertilizers are not drained off the substrate and are used increasingly by plants. Research studies on using geocomposite in ground cultivation of perennials proved its beneficial effect on the growth and development, what was apparent in analysis of selected biometric features of plants (Wróblewska *et al.* 2012). Geocomposites may also have wider use as plants protection during transportation and storage, such as garden centers, where plants are exposed to water shortages and watering is complicated. Moreover, geocomposites can elongate the plants survival during unfavorable weather conditions. Above mentioned result of studies and new possibilities of geocomposites application led authors to conduct a research with using geocomposite in container production of selected ornamental shrubs.

The aim of the study was to assess the influence of geocomposite and different fertilizers in different doses on the selected biometric features of *Rosa* ‚White Meidiland' and *Berberis thunbergii* ‚Green Carpet' in the container nursery production.

MATERIALS AND METHODS

In this research the influence of the geocomposite with the use of different fertilizers and their rates on selected biometric features of *Rosa* 'White Meidiland' and *Berberis thunbergii* ‚Green Carpet' in the nursery production in unheated foil tunnel was studied.

The two-factorial research was established in the middle of April in 2012, 2013 and 2014 at the Research Station of the Department of Horticulture of the Wrocław University of Environmental and Life Sciences. In research were used one year old plants cultivated in P9-type pots. The first factor used in the study was geocomposite (its presence or absence) and the second was fertilization (dose of 3 $g \cdot dm^{-3}$ Osmocote Plus 3-4M, half dose of 1.5 $g \cdot dm^{-3}$ Osmocote Plus 3-4M and YaraMila Complex at dose of 3 x 1 $g \cdot dm^{-3}$). Each combination consisted of 3 replications of 8 plants in each replication. Shrubs were replanted to 3 dm^3 containers filled with peat substrate (pH 5.8) mixed with fertilizers, with geocomposite placed previously on the bottom of pots in combination with the use of this material. Geocomposite had a form of superabsorbent closed in openwork plastic disc and covered with black agrotextile (each disc contained 5 g of potassium salt of poliacrylic acid). Absorption capacity of superabsorbent was 60 cm^3 per 1 g of polymer, so therefore single geocomposite in pot had absorption capacity of 300 cm^3 of distilled water. Afterward pots were placed in unheated foil tunnel: width 7 m, length 30 m and height 3.5 m. Shrubs were watered 2 times a week during vegetation period at a dose of 200 cm^3 water per plant and the weeds were removed. Containers were spaced as plants sprawled.

In research was used slow-released encapsulated multicomponent fertilizer Osmocote Plus 3-4M with 4 months activity period composed of N – 15%, P – 11%, K – 13%, Mg – 2%, B – 0.02%, Fe – 0.4 %, Mn – 0.06%, Zn – 0.015%, Cu – 0.05%, Mo – 0.02%. In the combinations were used full dose of 3 g dm^{-3} and half dose of 1.5 g dm^{-3}. Fertilizer was mixed with peat substrate before planting.

The second fertilizer was chloride-free multicomponent easy soluble fertilizer YaraMila Complex composed of N – 12% ($N\text{-}NO_3$ – 5%, $N\text{-}NH_4$ – 7%), $P\text{-}P_2O_5$ – 11%, $K\text{-}K_2O$ – 18%, Mg-MgO – 2.7%, S – 8%, B – 0.015%, Fe – 0.2%, Mn – 0.02% and Zn – 0.02%. This fertilizer was used in 3 doses, each per 1 $g \cdot dm^{-3}$. The first dose was mixed with peat substrate before planting, the other two was used for top dressing with four week frequency.

After the shrubs stopped their vegetation (middle of October), plants were measured (shoots number and length, roots number and length) and then cleared from substrate to assess their fresh weight (shoot, root, total) and on this basis the root:shoot ratio was calculated.

The data were subjected to the analysis of variance (ANOVA). The *F*-test was used to identify the main effects of treatments and factors interactions followed by Tukey's range test at the 0.05 significance level. Interactions between years of experiment within tested features was not significant, thus results in tables are means of 2012-2014.

RESULTS AND DISCUSSION

The highest main shoots number both *Rosa* and *Berberis* obtained while cultivated with geocomposite use (Table 1). Also Falińska-Król and Hetman (2002) had observed the positive influence of superabsorbent application on shoots number in rose ‚Samantha' and, moreover, increase in their number with the increase of polymer rate. *Rosa* had the highest main shoots number with YaraMila fertilization and the lowest number with 3 g Osmocote. In *Berberis* the highest number of main shoots was noted in fertilization with 1.5 g Osmocote, while lowest with full dose of 3 g Osmocote and YaraMila fertilization. Adversely effect of Osmocote fertilization was noted by Korszun *et al.* (2005), where *Berberis* ‚Profesor Sękowski' had the highest number of shoots when fertilized with higher dose of Osmocote (2.5 g) and the lowest in lower dose (2 g). Taking into account the factors interaction, *Rosa* produced the highest number of main shoots with using geocomposite with simultaneous fertilization with YaraMila and the lowest number in fertilization with 3 g Osmocote without use of geocomposite. *Berberis* had the highest main shoots number with use of geocomposite with fertilization of 1.5 g Osmocote.

Both species had the longest main shoots with the use of geocomposite (Table 1). Similar results were noted by Sloup and Salas (2010), where tree shoots were longer with the superabsorbent amendment. Conversely, Apostol *et al.* (2009) observed, that *Quercus rubra* seedlings did not respond to superabsorbent application in shoots length. *Rosa* had the longest main shoots while fertilized with YaraMila and the shortest with the use of 3 g Osmocote. *Berberis* produced the longest main shoots with the use of 1.5 g Osmocote, while the shortest in YaraMila fertilization. In contrast, Bosiacki *et al.* (2011) observed, that *Berberis thunbergii* 'Erecta' and 'Superba' did not differed significantly in shoots length in treatments with different doses of Osmocote fertilizer. The longest main shoots of both species were noted in simultaneous use of geocomposite with 1.5 g Osmocote fertilization. *Rosa* had the shortest main shoots with 3 g Osmocote without geocomposite, while *Berberis* with YaraMila fertilization, also without use of geocomposite.

The highest main roots number both *Rosa* and *Berberis* obtained with the use of geocomposite. Similarly, Oraeel and Moghadam (2013) observed, that *Prunus cerasifera* had higher root number with superabsorbent in compare to non-treated plants and, moreover, their number increased with the increase of polymer rate. *Rosa* had the highest number of main roots while fertilized with 1.5 g Osmocote, while the lowest with fertilization of 3 g Osmocote. In *Berberis* the highest numbers of main roots was noted in YaraMila fertilization and the lowest with using half dose of 1.5 g Osmocote. Factors interaction affected the highest main roots number in *Rosa* was using geocomposite with 1.5 g Osmocote, while lowest number was observed in 3 g Osmocote fertilization, irrespectively of geocomposite use, and in YaraMila fertilization without geocomposite. *Berberis* produced the highest number of main roots with the use of geocomposite with fertilization 3 g Osmocote and the lowest with YaraMila without geocomposite use.

Table 1. Biometric features (cm) of *Rosa* ‚White Meidiland' and *Berberis thunbergii* ‚Green Carpet' cultivated with geocomposite (years 2012-2014)

Geocomposite	Fertilization							
	3 g O	1,5 g O	3x1 g YM	Mean	3 g O	1,5 g O	3x1 g YM	Mean
	Rosa ‚White Meidiland'				*Berberis thunbergii* ‚Green Carpet'			
	Main shoots number							
With	14.1 B	14.0 B	15.6 A	14.6 a	11.8 B	13.1 A	11.7 B	12.2 a
Without	11.0 D	12.3 C	12.6 C	12.0 b	10.1 C	10.5 C	10.2 C	10.3 b
Mean	12.6 c	13.2 b	14.1 a		11.0 b	11.8 a	11.0 b	
	Main shoots length							
With	29.6 B	30.5 A	29.5 B	29.9 a	25.6 B	29.3 A	25.6 B	26.8 a
Without	23.1 E	24.8 D	26.5 C	24.8 b	24.9 C	25.8 B	22.5 D	24.4 b
Mean	26.4 c	27.7 b	33.0 a		25.3 b	27.6 a	24.1 c	
	Main roots number							
With	9.3 D	14.0 A	13.0 B	12.1 a	18.7 A	15.8 C	17.2 B	17.2 a
Without	9.2 D	11.4 C	9.2 D	9.9 b	12.8 D	11.1 E	17.1 B	13.7 b
Mean	9.3 c	12.7 a	11.1 b		15.8 b	13.5 c	17.2 a	
	Main roots length							
With	38.4 B	39.6 A	36.0 C	38.0 a	26.0 A	25.8 B	23.1 C	25.0 a
Without	34.9 D	37.5 B	31.6 E	34.7 b	22.0 D	21.1 E	19.7 F	20.9 b
Mean	36.7 b	38.6 a	33.8 c		24.0 a	23.5 a	21.4 b	

O – Osmocote Plus 3-4M; YM – YaraMila

Means with different letters are statistically different within parameter at the 0.05 significance level: a,b in column for fertilization, in rows for methods of cultivation; A,B for factors interaction

The longest main roots of both species were produced by shrubs growing with the use of geocomposite. Also Tongo *et al.* (2014) and Rad *et al.* (2010) observed that superabsorbent application increased the root length. Moreover, Ghehsareh *et al.* (2010) noted, that plants treated with hydrogel had up to 3.5-fold longer shoots than non-treated. *Rosa* had the longest main roots while fertilized with 1.5 g Osmocote, while *Berberis* in both rates of 3 g and 1.5 g Osmocote. The shortest main roots of both species were noted with YaraMila fertilization. On the other hand, Bosiacki *et al.* (2011) noted, that response of roots length of *Berberis* thunbergii 'Erecta' and *B.* x*ottawiensis* 'Superba' on different rates of Osmocote fertilizer was not significant. Taking into account factors interaction, the longest main roots of *Rosa* were observed in geocomposite use with 1.5 g Osmocote, while in *Berberis* with simultaneous use of geocomposite with 3 g Osmocote. Both species produced the shortest main roots in cultivation without the use of geocomposite fertilized with YaraMila.

Higher shoots fresh weight of *Rosa* was observed without the use of geocomposite, while in *Berberis* there was no reaction on geocomposite application (Table 2). As was noted by Dehgan *et al.* (1994), species may react in diverse way on superabsorbent use. They have observed, that shoots fresh weight of *Photinia freserii* increased while cultivated with superabsorbent, while in *Podocarpus macrophyllus* there was no reaction of this feature under hydrogel treatment. In both *Rosa* and *Berberis* roots and total fresh weight, as well as fresh root:shoot ratio was higher with the use of geocomposite. Increase in fresh roots weight of plants with the superabsorbent amendment was also obtained by Dehgan *et al.* (1994), Orikiriza (2009) and Ghehsareh *et al.* (2010). On the other hand, Ghehsareh *et al.* (2010) have noted diverse result in compare to this study, where the highest values of fresh root:shoot ratio of *Ficus* were noted in control without the use of polymer.

Taking into account fertilization, the highest shoots fresh weight of *Rosa* was noted in 3 g Osmocote fertilization and fertilization with YaraMila, while *Berberis* in both Osmocote treatments. The highest roots fresh weight and total fresh weight for both species was noted in plants fertilized with 1.5 g Osmocote (Table 1). In research conducted by Bosiacki *et al.* (2011) *Berberis* thunbergii 'Erecta' and *B.* x*ottawiensis* 'Superba' with the use of different rates (2 g·dm^{-3}, 4 g·dm^{-3}, 6 g·dm^{-3}and 8 g·dm^{-3}) of Osmocote Exact Standard (5-6M) reached the highest total fresh weight with 6 g·dm^{-3} treatment. That suggests that in some cases lower doses of fertilizers are more efficient for plants development. In own study fresh root:shoot ratio of *Rosa* was the highest in 1.5 g Osmocote treatment, while in *Berberis* in YaraMila treatment. In both species the lowest root:shoot ratio was noted with the use of 3 g Osmocote (Table 2). These results are confirmed by Agro and Zheng (2014), where increasing fertilizer dose affected reduction of root:shoot ratio.

Taking into account factors interaction, *Berberis* has shown a tendency to obtain the highest fresh weight of shoots, roots, as well as total weight, with the use of geocomposite with half dose of Osmocote (1.5 g). In *Rosa* this tendency was observed only in roots fresh weight and root:shoot ratio (Table 2). As mentioned by Islam *et al.* (2011), using of such polymers with a half of conventional fertilizer rate could be the more beneficial practice, what confirms most of the results obtained in own study.

Table 2. Fresh and dry biomass [g] of *Rosa* 'White Meidiland' and *Berberis thunbergii* 'Green Carpet' cultivated with geocomposite (years 2012-2014).

Geocomposite	Fertilization							
	3 g O	1,5 g O	3x1 g YM	Mean	3 g O	1,5 g O	3x1 g YM	Mean
	Rosa ,White Meidiland'				*Berberis thunbergii* ,Green Carpet'			
	Shoots							
With	59.9 A	40.3 B	54.4 A	51.5 b	24.1 A	25.5 A	16.2 B	21.9 a
Without	57.0 A	56.8 A	57.2 A	57.0 a	26.6 A	21.5 A	15.2 B	21.1 a
Mean	58.5 a	48.6 b	55.8 a		25.4 a	23.5 a	15.7 b	
	Roots							
With	25.2 D	55.0 A	41.9 B	40.7 a	75.3 B	96.7 A	74.6 B	82.2 a
Without	22.1 E	41.6 B	29.5 C	31.1 b	65.9 BC	64.1 C	56.6 C	62.2 b
Mean	23.7 c	48.3 a	35.7 b		70.6 b	80.4 a	65.6 c	
	Total							
With	85.1 C	95.3 B	96.3 B	92.2 a	99.4 B	122.2 A	90.8 C	104.1 a
Without	79.2 D	98.4 A	86.7 C	88.1 b	92.0 C	85.6 D	71.8 E	83.1 b
Mean	82.2 c	96.9 a	91.5 b		95.7 b	103.9 a	81.3 c	
	Root:shoot ratio							
With	0.42 CD	1.37 A	0.77 B	0.85 a	3.13 C	3.79 B	4.61 A	3.84 a
Without	0.39 D	0.73 BC	0.52BCD	0.55 b	2.48 D	2.98 CD	3.72 B	3.06 b
Mean	0.41 c	1.1 a	0.65 b		2.81 c	3.39 b	4.17 a	

O – Osmocote Plus 3-4M; YM – YaraMila

Means with different letters are statistically different within parameter at the 0.05 significance level: a,b in column for fertilization, in rows for methods of cultivation; A,B for factors interaction

CONCLUSIONS

1. Geocomposite had the positive influence on tested biometric features of both shoots an roots of *Rosa* 'White Meidiland' and *Berberis thunbergii* 'Green Carpet' and on the roots and total fresh weight of both species, as well as on their root:shoot ratio.
2. Taking into account fertilization, in both species there was a tendency to obtain the highest values with 1.5 g Osmocote fertilization.
3. The effect of factors interaction was different in *Rosa* and *Berberis* and, moreover, was various among tested features.

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