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ORIGINAL PAPER

THE INFLUENCE OF GEOCOMPOSITES ON THE BIOMASS PRODUCTION, THE NUTRITIONAL STATUS OF PLANTS AND THE SUBSTRATE CHARACTERISTICS IN THE CONTAINER NURSERY PRODUCTION OF *ROSA* CV. WHITE MEIDILAND AND *BERBERIS THUNBERGII* CV. GREEN CARPET

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Abstract

Geocomposites are a new technology consisting in the application of a superabsorbent in the form of agrotextile filled with a polymer. Geocomposites can be placed directly in the root zone and removed at any time. Moreover, the agrotextile that covers the superabsorbent protects the soil structure against the negative impact of the polymer and reduces the influence of soil on the ability of the superabsorbent to swell. The research was carried out in the years 2012-2014 on one-year-old cuttings of *Rosa* cv. White Meidiland and *Berberis thunbergii* cv. Green Carpet in an unheated foil tunnel at the Research Station of the Department of Horticulture at Wrocław University of Environmental and Life Sciences. The first factor was the use of a geocomposite, while the second one was fertilisation with full (3 g) and half (1.5 g) doses of Osmocote Plus 3-4M and 3 g of YaraMila Complex fertiliser. The aim of the study was to assess the influence of applying a geocomposite in combination with fertilisers on the fresh and dry biomass production in both species, their nutritional status regarding selected macronutrients and the chemical characteristics of substrates in the nursery production of both species. The use of a geocomposite increased both the fresh and the dry weight of roots, their total weight and the root/shoot ratio in the tested species. Its application increased the N, P, K, Mg and Ca content in the leaves of *Berberis*, and the N, Mg and Ca content in *Rosa*. For both species, using a geocomposite decreased the salinity of the substrates and increased their content of nitrates, K and Mg.

Keywords: root weight, shoot weight, total weight, root/shoot ratio, nutrient level.

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INTRODUCTION

Geocomposites are created by the mechanical, thermal or chemical connection of different types of geosynthetics to other compounds. Geocomposites applied in practice are filled with a superabsorbent (SAP; syn. hydrogel, agrogel, superabsorbent). It has been proven that water quickly infiltrates light and sandy soils and a geocomposite can prevent this by rapidly absorbing the rainwater which accumulates in the hydrogel matrix. The roots of plants can easily grow through the agrotextile and thus use the water retained in it (Lejcuś et al. 2008).

Geocomposites prevent or significantly reduce the erosion of soil surface, which has a negative impact on slopes and other areas with uneven surface covered with plants. They can be used as biotech strengthening of slopes and embankments (http://www.geosap.up.wroc.pl). It has been proven that the application of superabsorbents extends the survival of plants in unfavourable weather conditions (Sarvas et al. 2003, Arbona et al. 2005, Chirino et al. 2011). Moreover, one of the most important functions of geocomposites might be the protection of plants during storage and transport, when life processes like respiration and transpiration proceed intensively and the plants cannot be watered all the time.

Undoubtedly, one of the most important benefits of using geocomposites is the possibility to place the material very precisely in position without mixing the superabsorbent with soil. This new technology of enclosing superabsorbents in agrotextile eliminates the negative interaction between the polymer and soil – due to the frames, the ability of the superabsorbent to swell is minimally reduced, whereas the geotextile prevents the negative effect of swelling on the physical parameters of soil. High functionality also lies in the possibility to remove the geocomposite from the soil environment at any time, which is not possible when pure superabsorbents are mixed with soil (Orzeszyna et al. 2006). Geotextile is highly frost-resistant, which is very important in the case of a long-term use of such material (Cholewa et al. 2008). Moreover, it also protects the superabsorbent from the UV radiation negatively affecting the absorbing capacity, especially in polyacrylamide-based hydrogels (Kim et al., 2010). The advantage of using geocomposites within the root zone is their positive influence on the development of the whole plants, grown not only in dry and poor soils but also in a soil rich in nutrients (Gudarowska, Szewczuk 2009, Dereń et al. 2010, Wróblewska et al. 2012). The above research results encouraged the authors to conduct an experiment with the use of geocomposites in the nursery production of potted ornamental shrubs.

The aim of the study was to assess the influence of applying a geocomposite and simultaneously different fertilisers at varied doses on the fresh and dry biomass of *Rosa* cv. White Meidiland and *Berberis thunbergii* cv. Green Carpet, their nutritional status and the chemical characteristics of substrates.

MATERIALS AND METHODS

The researchers examined the influence of a geocomposite, used simultaneously with different fertilisers at varied doses, on *Rosa* cv. White Meidiland and *Berberis thunbergii* cv. Green Carpet in the nursery production in an unheated foil tunnel.

A two-factorial experiment was carried out in the middle of April of 2012, 2013 and 2014 at the Research Station of the Department of Horticulture at Wrocław University of Environmental and Life Sciences. In the research, one-year-old plants cultivated in P9-type pots were used. The first factor was a geocomposite (its presence or absence) and the second one was fertilisation (full dose of 3 g dm^{-3} Osmocote Plus 3-4M, half dose of 1.5 g dm^{-3} Osmocote Plus 3-4M and YaraMila Complex 3 x 1 g dm^{-3}). Each combination consisted of 3 replications with 8 plants in each replication. The shrubs were potted into 3-litre containers filled with peat substrate (pH 5.8), with a geocomposite placed at the bottom of each pot. The geocomposite used in this research had the form of an openwork plastic disc closed in black agrotextile and filled with superabsorbent (each disc contained 5 g of potassium salt of polyacrylic acid). The absorption capacity of this superabsorbent was 60 cm^3 per 1 g of polymer. Therefore, a single geocomposite placed in a pot had the absorption capacity of 300 cm^3 of distilled water. The pots were placed in an unheated foil tunnel, which had the following dimensions: width – 7 m, length – 30 m and height – 3.5 m. During the plant growing period the shrubs were watered twice a week with a dose of 200 cm^3 of water per plant and the weeds were removed. The containers were spaced as the plants were sprawling.

A multi-component, slow-release fertiliser with a 4-month activity period called Osmocote Plus 3-4M was used in the research. It contains N – 15%, P – 11%, K – 13%, Mg – 2%, B – 0.02%, Fe – 0.4 %, Mn – 0.06%, Zn – 0.015%, Cu – 0.05% and Mo – 0.02%. In the combinations, a full dose of 3 g dm^{-3} and half a dose of 1.5 g dm^{-3} were applied. The fertiliser was mixed with the peat substrate before planting the shrubs.

The second fertiliser was a multi-component, chloride-free fertiliser 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 fertiliser was used in 3 doses, each of 1 g dm^{-3}. The first dose was mixed with the peat substrate before planting the shrubs, the other two were used for top dressing every four weeks.

In the middle of October, when the growth of shrubs stopped, the plants were cleared of the substrate and then weighed. On the basis of the measurements, the fresh and dry weight of both shoots and roots were established, as well as the total fresh and dry weight and the root (fresh and dry)/shoot ratio. At the same time, samples of the leaves and the substrate were collected for chemical analyses. There were 3 replications for each combination.

The samples consisted of 20-25 leaves from the middle part of shoots or 500 ml of substrate. They were analysed with the use of various methods in order to determine the content of the following elements and compounds: N (the Kjeldahl method), P and Mg (the colorimetric method - Spectrophotometer S106 WPA), K and Ca (the flame photometry - Carl Zeiss Jena flame photometer), nitrates (the flow colorimetry). The soil salinity was measured by means of a conductivity meter Orion, model 142, and the pH of soil was analysed with an Elmetron CPI-501, at the 1:2 ratio of soil to distilled water.

The data were subjected to the analysis of variance (ANOVA). The *F*-test was used to identify the main effects of the treatment. It was followed by the Tukey's range test at a significance level of 0.05. As far as the tested features are concerned, no significant differences were observed in the particular years of the experiment. Therefore, the tables contain the mean values for the years 2012-2014.

RESULTS AND DISCUSSION

The data presented in Table 1 show that the geocomposite increased the fresh weight of the shoots of *Rosa* but did not affect the same trait in *Berberis*. Dehgan et al. (1994) also noted different reactions to the application of a superabsorbent, depending on a species, i.e. the fresh weight of shoots of *Photinia freserii* was higher, but it remained unchanged in *Podocarpus macrophyllus*. In both *Rosa* and *Berberis*, the fresh weight of roots increased under the influence of the geocomposite, same as the total fresh weight and the ratio of fresh roots to shoots (Table 1). Identical relationships were observed by Dehgan et al. (1994), Orikiriza (2009) and Ghehsareh et al. (2010). On the other hand, Ghehsareh et al. (2010) obtained opposite results referring to the fresh root/shoot ratio in *Ficus*, where the highest values were noted in the control group with no polymer applied. The highest value of the fresh shoot weight in *Rosa* was achieved under the fertilisation with 3 g of Osmocote and with YaraMila, and in *Berberis* – when both doses of the Osmocote fertiliser were applied. For both species, the highest values of the fresh root weight and the total fresh weight were recorded for the plants fertilised with 1.5 g Osmocote (Table 1). Bosiacki et al. (2011) noticed that *Berberis thunbergii* cv. Erecta and *B.* x*ottawiensis* cv. Superba, treated with different doses (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 at 6 g dm^{-3}. In the present study, the ratio of fresh roots to shoots in *Rosa* was the highest in the 1.5 g Osmocote treatment, and in *Berberis* – when YaraMila was used. Taking into account the interactions between the tested factors, the application of a geocomposite together with half a dose of Osmocote (1.5 g) seems to result in the highest fresh and dry weight of shoots and roots in *Berberis*. The same holds true about the total weight. In *Rosa*, this tendency was

Table 1

Fresh and dry biomass (g) of *Rosa* cv. White Meidiland and *Berberis thunbergii* cv. Green Carpet cultivated with a 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	3 g O	1.5 g O	3x1 g YM	Mean	3 g O	1.5 g O	3x1 g YM	Mean
		shoots				roots				total				root: shoot ratio			
		Rosa ‚White Meidiland'															
Fresh weight	with	59.93	40.30	54.37	51.53	25.20	55.03	41.93	40.72	85.13	95.33	96.30	92.25	0.420	1.365	0.771	0.852
	without	57.03	56.77	57.17	56.99	22.13	41.60	29.53	31.09	79.16	98.37	86.70	88.08	0.389	0.733	0.517	0.546
	mean	58.48	48.54	55.77		23.67	48.32	35.73		82.15	96.85	91.50		0.405	1.049	0.644	
	$LSD_{\alpha=0.05}$ for: geocomposite (I) fertilization (II) interaction (IxII)	3.333 4.081 5.776				1.373 1.682 2.374				0.964 1.180 1.669				0.018 0.022 0.031			
Dry weight	with	25.62	18.76	28.18	24.19	15.30	23.34	20.83	19.82	40.92	42.10	49.01	44.01	0.597	1.244	0.739	0.860
	without	25.34	22.18	23.67	23.73	10.18	21.25	14.16	11.86	35.52	43.43	37.80	38.92	0.402	0.958	0.598	0.653
	mean	25.48	20.47	25.93		12.74	22.30	17.50		38.22	42.77	43.41		0.500	1.091	0.669	
	$LSD_{\alpha=0.05}$ for: geocomposite (I) fertilization (II) interaction (IxII)	n.s. 1.010 1.428				0.784 0.960 1.357				0.879 1.077 1.523				0.027 0.033 0.047			
		Berberis thunbergii ‚Green Carpet'															
Fresh weight	with	24.10	25.50	16.20	21.93	75.33	96.67	74.60	82.20	99.43	122.2	90.80	104.1	3.126	3.791	4.605	3.841
	without	26.57	21.50	15.20	21.09	65.90	64.07	56.60	62.19	92.00	85.57	71.80	83.12	2.480	2.980	3.724	3.061
	mean	25.34	23.50	15.70		70.62	80.37	65.50		95.72	103.9	81.30		2.803	3.386	5.857	
	$LSD_{\alpha=0.05}$ for: geocomposite (I) fertilization (II) interaction (IxII)	n.s. 2.826 3.995				5.593 6.852 9.684				1.909 2.338 3.307				0.228 0.279 0.395			
Dry weight	with	10.62	12.43	5.860	9.637	28.26	45.54	25.32	33.04	38.88	57.97	31.18	42.68	2.661	3.664	4.321	3.549
	without	11.43	9.840	5.070	8.780	19.34	22.32	15.06	18.91	30.77	32.16	20.13	27.69	1.692	2.263	2.970	2.308
	mean	11.03	11.14	5.465		23.80	33.93	20.19		34.83	45.07	25.66		2.177	2.964	3.646	
	$LSD_{\alpha=0.05}$ for: geocomposite (I) fertilization (II) interaction (IxII)	0.437 0.535 0.757				0.565 0.692 0.978				0.725 0.888 1.256				0.103 0.126 0.178			

O – Osmocote Plus 3-4M; YM – YaraMila Complex observed only in the fresh and dry weight of roots and in the ratio of both fresh and dry roots to shoots (Table 1). As Islam et al. (2011) suggest, the use of a superabsorbent with half a dose of conventional fertiliser could be the most appropriate practice. The results presented herein seem to confirm it. In the experiment, the application of the geocomposite had no influence on the dry shoot weight of *Rosa* but it increased the dry root weight, the total dry weight and the dry root/shoot ratio. In *Berberis*, the geocomposite increased the dry weight of shoots and roots, the total dry weight and the dry root/shoot ratio. It can be observed that the differences between the two species concerned only the dry shoot weight, whereas the other traits showed the same tendency to obtaining the highest results with the use of the geocomposite (Table 1). Also Ghehsareh et al. (2010) in their study on *Ficus benjamina* cv. Starlight noticed a positive influence of superabsorbent on the dry root weight. Similar results were obtained by Tongo et al. (2014) in *Acacia victoriae* seedlings and by Ghasemi and Khoshkhai (2007) in *Chrysanthemum* species, where the application of polymers increased the ratio of dry roots to aerial organs, as compared to the control group with no polymer applied. Completely different results were shown in the experiment by Tripepi et al. (1991), where the application of hydrogel resulted in a decrease in the shoot and root dry weight of *Betula pendula* seedlings. As far as the fertilisation is concerned, the highest value of dry shoot weight in *Rosa* was achieved with the use of 3 g Osmocote and YaraMila, while the application of both doses of the Osmocote fertiliser caused this result in *Berberis* (Table 1). Agro and Zheng (2014) also recorded different reactions of species to varied doses of a fertiliser. In their experiment, the dry shoot weight in *Spiraea japonica* cv. Magic Carpet and in *Hibiscus syriacus* cv. Ardens was not correlated to the application of control release fertiliser (CRF), but in *Weigela florida* cv. Alexandra it was rising linearly with the increase of CRF and in *Cornus sericea* cv. Cardinal' and in *Hydrangea paniculata* cv. Bombshell it was increasing, but only up to a point. In the present research, the highest dry root weight in both species was observed in the shrubs fertilised with 1.5 g Osmocote. In *Rosa* the highest total dry weight was noted for the 1.5 g dose of Osmocote and for YaraMila, while in *Berberis* the same result was achieved by a 1.5 g dose of Osmocote. In *Rosa*, the highest value of the dry root/shoot ratio was observed when the 1.5 g Osmocote treatment was applied, while in *Berberis* – when the YaraMila fertiliser was used. In both species, the lowest ratio of roots (both fresh and dry) to shoots was recorded in response to the 3 g Osmocote application (Table 1). This is confirmed by Agro and Zheng (2014), who showed that the increasing supply of a fertiliser is accompanied by a decrease in the root/shoot ratio.

In *Rosa*, the highest content of N, Mg and Ca in leaves was obtained after applying the geocomposite, while the shrubs with no geocomposite had the highest content of P and K. In *Berberis* all the nutrients tested in the experiment reached their highest values when the geocomposite was used (Table 2). The highest content of Ca in the leaves of both species as a result

Table 2

The content of selected nutrients in the leaves (% of dry weight) of *Rosa* cv. White Meidiland and *Berberis thunbergii* cv. Green Carpet cultivated with a geocomposite (years 2012-2014)

Geocomposite	Fertilisation																			
	3 g O	1.5 g O	3x1 g YM	mean	3 g O	1.5 g O	3x1 g YM	mean	3 g O	1.5 g O	3x1 g YM	mean	3 g O	1.5 g O	3x1 g YM	mean	3 g O	1.5 g O	3x1 g YM	mean
	N				P				K				Mg				Ca			
	Rosa cv. White Meidiland																			
With	0.570	0.360	0.750	0.560	0.420	0.370	0.480	0.423	2.430	2.350	2.680	2.487	0.260	0.290	0.330	0.293	0.850	0.850	0.720	0.807
Without	0.440	0.210	0.580	0.410	0.400	0.560	0.550	0.503	2.300	2.760	3.030	2.697	0.130	0.210	0.140	0.240	0.700	0.800	0.700	0.733
Mean	0.505	0.285	0.665		0.410	0.465	0.515		2.365	2.555	2.855		0.195	0.250	0.235		0.775	0.825	0.710	
$LSD_{\alpha=0.05}$ for: geocomposite (I) fertilization (II) interaction (IxII)	0.029 0.036 0.051				0.047 0.057 0.081				0.069 0.084 0.119				0.044 0.054 0.076				0.045 0.056 0.079			
	Berberis thunbergii cv. Green Carpet																			
With	0.890	0.510	1.850	1.083	0.600	0.340	0.420	0.453	1.880	1.630	2.480	1.997	0.190	0.260	0.180	0.417	1.050	1.000	1.000	1.017
Without	0.620	0.400	1.690	0.903	0.490	0.300	0.390	0.393	1.680	1.530	1.930	1.713	0.180	0.210	0.140	0.177	1.000	0.750	0.800	0.850
Mean	0.755	0.455	1.770		0.545	0.320	0.405		1.780	1.580	2.205		0.185	0.235	0.110		1.025	0.875	0.900	
$LSD_{\alpha=0.05}$ for: geocomposite (I) fertilization (II) interaction (IxII)	0.083 0.101 0.143				0.054 0.067 0.094				0.095 0.119 0.165				0.021 0.026 0.037				0.163 n.s. 0.283			

O – Osmocote Plus 3-4M; YM – YaraMila Complex of using geocomposite is confirmed by CHEN et al. (2004), studying the same relationship in the case of *Populus euphratica*. On the other hand, the content of K in the leaves of *Populus euphratica* remained on the same level, regardless of the use of hydrogel, whereas in the present research the geocomposite significantly affected the content of K in the tested species, and the values obtained were varied. For both species, the highest content of N and K in the leaves was achieved under the influence of YaraMila fertiliser and the highest content of Mg occurred after applying 1.5 g of Osmocote. In *Rosa*, the best nourishment with P was the result of using YaraMila, and in *Berberis* the same effect was achieved by using 3 g of Osmocote. The highest content of Ca in *Rosa* was observed after the treatment with 1.5 g Osmocote, while in *Berberis* the fertilisation had no effect on the content of Ca in the leaves (Table 2). As KOZERA and MAJCHERCZAK (2011) suggest, mineral fertilisation significantly increases the total content of nitrogen, phosphorus and potassium in the leaves of *Digitalis lanata*. As *Berberis* and *Rosa* have different nutritional demands, the uptake of particular nutrients is also different in each case. Taking into account the interaction of the experimental factors, in *Berberis* the highest content of all the nutrients could be observed after applying a geocomposite and fertilisation simultaneously. In *Rose* a similar tendency was noticed in the case of N, Mg and partially P (Table 2). As KHADEM et al. (2010) report, the use of a superabsorbent together with a fertiliser increases the uptake of nutrients by plant tissues.

In both *Rosa* and *Berberis* the highest level of salinity was determined in the substrate without the geocomposite (Table 3). Also CHEN et al. (2004) and

Table 3

Characteristics of the substrate under *Rosa* cv. White Meidiland and *Berberis thunbergii* cv. Green Carpet cultivated with a 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 cv. White Meidiland				*Berberis thunbergii* cv. Green Carpet			
	salinity (μS dm^{-3})							
1	2	3	4	5	6	7	8	9
With	641.0	336.0	1105	694.0	955.0	598.0	311.0	621.3
Without	903.0	366.0	1421	896.7	1184	599.0	274.0	685.7
Mean	772.0	351.0	1263		1.070	598.5	292.5	
$LSD_{\alpha=0.05}$ for: geocomposite (I) fertilization (II) interaction (IxII)	17.11 20.96 29.64				29.68 36.35 51.40			
	pH							
With	5.890	6.410	5.330	6.877	5.710	6.520	5.190	5.807
Without	5.390	6.210	4.920	5.507	5.490	6.470	4.920	5.627
Mean	5.640	6.310	5.125		5.600	6.495	5.055	
$LSD_{\alpha=0.05}$ for: geocomposite (I) fertilization (II) interaction (IxII)	0.283 0.347 0.490				n.s. 0.315 0.440			

cont. Table 3

1	2	3	4	5	6	7	8	9
	NO_3 (mg dm^{-3})							
With	95.00	35.00	191.0	107.0	215.0	47.0	475.0	245.7
Without	63.00	24.00	142.0	76.33	129.0	44.0	436.0	203.0
Mean	79.00	29.50	166.5		172.0	45.50	455.5	
LSD$_{a=0.05}$ for: geocomposite (I) fertilization (II) interaction (IxII)	 6.912 8.465 11.97				 6.698 8.203 11.60			
	P (mg dm^{-3})							
With	48.00	39.00	112.0	66.33	70.00	55.00	309.0	144.7
Without	44.00	40.00	120.0	68.00	75.00	46.00	214.0	111.7
Mean	46.00	39.50	116.0		72.50	50.50	261.5	
LSD$_{a=0.05}$ for: geocomposite (I) fertilization (II) interaction (IxII)	 n.s. 9.415 13.32				 7.688 9.415 13.32			
	K (mg dm^{-3})							
With	180.0	108.0	370.0	219.3	244.0	202.0	840.0	428.7
Without	138.0	100.0	336.0	191.3	230.0	154.0	608.0	330.7
Mean	159.0	104.0	353.0		237.0	178.0	724.0	
LSD$_{a=0.05}$ for: geocomposite (I) fertilization (II) interaction (IxII)	 10.01 12.26 17.34				 11.92 14.59 20.65			
	Mg (mg dm^{-3})							
With	184.0	106.0	162.0	150.7	140.0	162.0	260.0	187.3
Without	150.0	122.0	134.0	135.3	144.0	150.0	244.0	179.3
Mean	167.0	114.0	148.0		142.0	156.0	252.0	
LSD$_{a=0.05}$ for: geocomposite (I) fertilization (II) interaction (IxII)	 4.832 5.918 8.369				 7.152 8.759 12.39			
	Ca (mg dm^{-3})							
With	800.0	700.0	800.0	766.7	800.0	1000	1160	986.7
Without	660.0	710.0	740.0	703.3	900.0	860.0	1140	966.7
Mean	730.0	705.0	770.0		850.0	930.0	1150	
LSD$_{a=0.05}$ for: geocomposite (I) fertilization (II) interaction (IxII)	 31.45 38.52 54.48				 n.s. 61.56 87.06			

O – Osmocote Plus 3-4M; YM – YaraMila Complex

SHI et al. (2010) noticed that the level of soil salinity was lower in trees cultivated with the use of hydrogel than in the control group. In our research, the substrates with the geocomposite had the highest content of nitrates, K and Mg in both species. In *Rosa*, the highest pH and the highest content of Ca was observed in the substrate with the geocomposite, although the presence of the geocomposite did not affect the content of P in the substrate. In *Berberis*, the highest content of P was observed in the substrate with the geocomposite but pH and the content of Ca remained on the same level (Table 3). Our results are similar to those obtained by Chen et al. (2004), who showed that the application of hydrogel increased the soil fertility but had no significant influence on soil pH. Moreover, also Bhat et al. (2009) observed a higher level of Mg and K in the soil treated with Agrihope and an increased content of Mg and Ca after applying hydrogel. In our experiment, the highest pH of substrates was noted in the 1.5 g Osmocote treatment, while the highest content of nitrates, P, K and Ca was the result of using YaraMila. These tendencies appeared for both species. In *Rosa*, the highest salinity was recorded in the YaraMila treatment, while in *Berberis* – when 3 g of Osmocote had been applied. In *Rosa,* the highest content of Mg in the substrate was noted after the 3 g Osmocote fertilisation, while in *Berberis* – when YaraMila fertiliser had been applied (Table 3). It is worth noticing that the application of YaraMila generated the best results, i.e. the highest values of the nutrient content as well as the highest substrate salinity. This fertiliser is easily soluble and provides substrates with greater amounts of nutrients than the control release fertiliser Osmocote.

CONCLUSIONS

1. In both *Rosa* and *Berberis*, the geocomposite resulted in higher fresh and dry weight of roots, fresh and dry total weight of plants and fresh and dry root/shoot ratio. A dose of 1.5 g Osmocote Plus 3-4M also increased the fresh and the dry weight of the plant parts tested in the experiment.

2. In the leaves of *Berberis*, the content of all the nutrients was higher in the shrubs cultivated with the geocomposite. The geocomposite increased the content of N, Mg and Ca in the leaves of *Rosa* but decreased their content of P and K. No significant influence of the fertilisers on the nutritional status of the tested species was observed.

3. In both species, the geocomposite decreased the salinity of the substrates and increased their content of nitrates, K and Mg. Using the geocomposite in the cultivation of *Rosa* resulted in a higher Ca content, while in the case of *Berberis* it increased the content of P. In both species, the highest content of nitrates, P and K was recorded after fertilising the substrates with YaraMila Complex. Moreover, the best variant in the cultivation of *Berberis,* that is the one which resulted in the highest levels of all the necessary nutrients, consisted of the geocomposite applied together with the fertiliser YaraMila Complex.

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