ACTA Acta Sci. Pol., Hortorum Cultus 11(2) 2012, 203-216

THE INFLUENCE OF WATER SORBING GEOCOMPOSITE AND PINE BARK MULCHING ON GROWTH AND FLOWERING OF SOME PERENNIAL SPECIES

Katarzyna Wróblewska, Regina Dębicz, Przemysław Bąbelewski
Wrocław University of Environmental and Life Sciences

Abstract. Previous research demonstrated positive influence of hydrophilic polymers on plant growth. Their utilization in agriculture is based mainly on mixing with the soil or medium. The aim of the experiment was to asses the influence of new form of supersorbent application in form of geocomposite consisted of polymer closed inside geotextile on development of *Erigeron hybridus* hort., *Eupatorium purpureum* L. and *Silene chalcedonica* (L.) E. Krause. The first factor of the experiment was utilization of geocomposite, the second one – pine bark mulching. After soaking in water geocomposite was placed in soil and plants were planted above. The growth and flowering of plants were assessed in the term of their most abundant flowering. The experiment documented positive influence of geocomposite on vegetative growth, it is: plant diameter and the number of shoots of all species as well as the height of *Eupatorium*. It also prompted *Eupatorium* and *Erigeron* flowering: plants developed more inflorescences of increased diameter. Pine bark positively determined the diameter of *Eupatorium*, whereas negatively influenced *Silene* diameter and number of shoots.

Key words: hydrophilic polymer, mulch, *Erigeron*, *Eupatorium*, *Silene*, plant development

INTRODUCTION

Water is one of the main factors limiting growth and survival of plants in urban areas. Although the problem of water deficit involves different ecological habitats and cultivations, the special issue is water deficit in urban areas because of their unusual hydrologic cycle. Small volume of growing medium, caused by considerable building of the ground and underground systems, together with physical and chemical degradation of the soil and decrease in its hydraulic conductivity, provide for the fact that water

Corresponding author – Adres do korespondencji: Katarzyna Wróblewska, Department of Horticulture, Wrocław University of Environmental and Life Sciences, pl. Grunwaldzki 24 A, 50-363 Wrocław, Poland, e-mail: katarzyna.wroblewska@up.wroc.pl

supply in city habitats is limited. On the other hand, increased water demand in urban sites can be observed. Higher air temperature in city areas, in comparison to an open countryside, as well as lower humidity lead to more intensive transpiration. The result of this negative balance of supply and demand is the necessity of irrigation. Nevertheless, many municipalities limit the amount of water applied to landscape plants because of technical difficulties connected with water supply, as well as its distribution, abundance and quality concerns [Montague et al. 2004]. Due to these reasons the choice of appropriate plants for green areas becomes considerably reduced to species and varieties which can best survive in the conditions of water deficit. Resulting monotony of urban green establishment is negatively reflected in its esthetic reception. In order to diminish irrigation costs, and often to replace irrigation, there are applied such agricultural measures as mulches, which, to some extend, apart from arresting water in the soil, decrease soil temperature fluctuations, reduce plant freezing and erosion caused by the wind, as well as make weed infestation more difficult [Greenly and Rakow 1995, Ramakrishna et al. 2006]. Their effect on elevating esthetic value of green establishments cannot be underrated as well [Skroch et al. 1992]. In landscape horticulture, there are used both types of mulches – organic and inorganic ones. Inorganic mulches include gravel, pebbles, polyethylene or polyvinyl chloride film and woven polypropylene. Organic mulches are even more numerous. They may be composed of bark, wood chops, leaves, needles or cones of different tree and shrub genus: *Pinus*, *Taxodium*, *Eucalyptus*, *Melaleuca*, *Prunus* [Skroch et al. 1992, Greenly and Rakow 1995, Duryea et al. 1999]. In Poland, most commonly used mulch is shredded bark of common pine *Pinus sylvestris* L. Yet, in the conditions of still growing demand, its price has been continuously increasing. Therefore, there can be observed a search for new solutions, favoring the establishment and development of plants through increased availability of water in the soil on green areas. One of the mentioned solutions is introduction of superabsorbents [Abedi-Koupai et al. 2008].

Superabsorbents (SAPs), another name supersorbents, hydrogels or agrogels are loosely cross – linked hydrophilic polymers, which, in relation to their weight, are able to absorb high quantities of water. In recent decades, these substances are commonly applied in medicine, hygienic materials industry, as well as in agriculture and forestry. As far as agriculture is concerned, these polymers are, first of all, applied to the soil or a growing medium from where water, absorbed by superabsorbents can be taken up due to suction force of roots. The type of synthetic polymers introduction into the soil depends on their kind and properties, as well as on the aim of their usage and the way the land is used. So far superabsorbent application into the soil was realized through the following methods: spraying in the form of solution directly onto field surface, mixing with growing medium or soil – into determined depth, polymer injection to determined depth, hydrosowing with diluted emulsion with seeds, conditioning plant root system prior to planting [Ingram and Burbage 1985, Hetman et al. 1996, Martyn and Szot 2001, Paluszek 2003, Ramakrishna et al. 2006]. The most common method of superabsorbent application in agriculture is their direct mixing with the soil. In this way they are used in the USA, yearly on 400 000 ha of cultivations. To this end, polymer dose can range 300 kg ha^{-1} [Yazdani et al. 2007]. Such a way of application is justified in agricultural cultivation at plants density amounting even 180 plants m^{-2}. In cultivation of trees, bushes and perennials, following not so dense planting pattern, to efficiently use polymers one should apply them as side dressing, directly into the region of a root system.

The aim of the experiment was determination of the effect of a new form of SAP application, closed inside geotextile and mulching with pine bark on growth and development of three species of decorative perennials.

MATERIAL AND METHODS

The experiment was established in Psary (5 km from Wrocław city), Poland, in September 2007. Plants of three taxa of ornamental perennials: *Erigeron hybridus* hort., *Eupatorium purpureum* L. and *Silene chalcedonica* (L.) E.Krause were planted in degraded black earth, formed from light clay. Humus content amounted 1.8%, pH (determined in distilled water, in water to medium ratio 2:1, V:V) equaled 8.26 and soil salinity amounted 155 μS cm^{-1}. Two-factorial experiment was established according to the method of randomized blocks, in three replications, each of them involving 8 plants. The first factor was application of geocomposite (with or without geocomposite), the second factor was the presence of pine bark mulch.

Hydrophilic polymer (potassium salt of cross-linked poliacrylic acid), placed between two geotextile layers measuring 10 cm in width, sewn on their sides, served as geocomposite. Geocomposite element of 1.0 m length absorbed 5.0 dm^3 of water. Plant roots could overgrow goetextile, obtaining access to water absorbed by SAP [Orzeszyna et al. 2004]. The film was placed in the soil at the depth of 35 cm, directly under plant rows, at a distance of 100 cm from one another. Plants, bought in perennial plant nursery, where they had been grown in 12 cm pots, were planted over the geocomposite, at the same depth that they were grown in pots. Mulch layer amounted 8 cm. Plants were planted in 0.5 × 1 m spacing, which resulted from geocomposite location. The plants were fertilized with multi-compound fertilizer Yara Mila Complex, in the dose of 30 g m^{-2} and annually trimmed after blooming. Weed control was done manually.

Table 1. Characteristics of climate conditions of spring and summer 2008–2010 in Psary against long term average (1970–2000)

Tabela 1. Charakterystyka warunków pogodowych wiosną i latem 2008–2010 w Psarach na tle średnich wieloletnich (1970–2000)

Year Rok	Total rainfall in month, mm Miesięczna suma opadów, mm					The mean air temperature, °C Średnia miesięczna temperatura powietrza, °C				
	IV	V	VI	VII	VIII	IV	V	VI	VII	VIII
2008	71.2	1.4	23.5	85.7	96,6	10.2	16.0	20.7	21.7	20.3
2009	4.2	54.2	79.39	115.9	94.0	13.9	15.8	17.0	21.0	21.3
2010	26.4	134.5	24.8	79.1	74.0	10.8	13.3	17.5	21.0	18.8
Long term average Średnie z wielolecia 1970–2000	31.9	49.9	64.9	75.4	63.5	8.1	13.9	16.7	18.5	17.7

Climate of Wrocław characterizes features of transitional climate of moderate latitudes. Mean year temperature (from years 1981–2000) equals 9°C. The warmest month is July, with average month temperature of 18.8°C, while the coldest is January (-0.4°C). Average total rainfall in year equals 567 mm, with the most intensive one in July (79.5 mm). Vegetative period lasts 234 days [Dubicki et al. 2002]. Characteristics of climate conditions of spring and summer 2008–2010 in Psary shows table 1.

Measurements and analyses. Plant growth and flowering was assessed in the years 2008–2010 on the basis of the following measurements: the height and diameter of plants, number of flowering shoots, number of inflorescences and inflorescence diameter. The measurements of plants took place in within the period of the most intensive blooming: *Erigeron* and *Silene* in June whereas *Eupatorium* in August. The chlorophyll content of the leaves was determined after extraction in 80% acetone [Arnon 1949] in July 2010. Absorption was measured using a spectrophotometer (WPA, S106), at 645 and 663 nm and chlorophyll content (in mg g^{-1} f.w.) was calculated according the equation: chlorophyll a + b = 8.02 (A_{663}) + 20.21 (A_{645}). Experimental results were statistically elaborated according to the method of analysis of variance for two-factorial experiment, at significance level α = 0.05. To estimate significance of differences t-Duncan test was used.

RESULTS AND DISCUSSION

Research conducted so far has confirmed advantageous effect of hydrophilic polymers on growth and yielding of numerous plant species. Most of investigation referred to light soils or growing media of insufficient moisture and concentrated on improving plant development in the conditions of water stress. The mentioned examination confirmed the fact that application of supersorbents prevents water loss from the soil, both as a result of seepage to the aquifer and evaporation. According to Akhter et al. [2004] and Abedi-Koupai et al. [2008] water holding capacity and retention of plant available water increase proportionally to doze of polymer (in range 1–8 g per 1 kg of soil). It does significantly affect plant development. In the conditions of water stress positive response of plants to hydrogel is expressed by, among others, higher percentage of plant establishment, better survival of plants resulting from delay of permanent wilting point as well as more intensive growth and biomass production [Davies et al. 1987, Hütterman et al. 1999, Akhter et al. 2004]. Water use efficiency is also increased [Woodhouse and Johnson 1991]. Positive polymer contribution to plant growth was confirmed in many species of herbaceous plants, such as maize, soybean, sunflower and petunia as well as woody species, including *Ligustrum*, *Eucalyptus* and *Pinus,* [Boatright et al. 1997, Hütterman et al. 1999, Akhter 2004, Abedi-Kopai et al. 2008, Orikiriza et al. 2009]. Better performance of plants can also result from positive influence of polymers on plants metabolism, including reduction in transpiration, increased leaf and xylem water potential as well as nitrogen uptake efficiency, elevated values of total soluble protein content in leaves and diminished oxidation stress through increased activity of antioxidant enzymes [Davies et al. 1987, Henderson et al. 1991, Islam et al. 2011]. It also prevents stress in the conditions of high salinity [Hütterman et al. 2009, Dorrayi et al. 2010, Shi et al. 2010].

For plants cultivated in heavy soils, usually under no limited water conditions the advantage of hydrogel application is not so specific, as increase in plant available water in loam and clay is lower than in sand and sandy loam soil [Abedi-Koupai et al. 2008, Agaba et al. 2010]. Positive effect of hydrogel amendment on biomass of nine tree species growing in different soil types, including clay was reported by Orikiriza et al. [2009]. As the authors suggest, this effect may result from enhanced efficiency of water uptake and utilization of photosynthates. It can be also caused by positive effect of polymers on soil structure, including its loosening and aeration resulting from numerous changes in its volume and increase in aggregate stability [Owczarzak et al. 2006, Abedi-Kopai 2008]. According to Boathright et al. [1997] advantageous effect of supersorbents application under not limited water conditions can be less pronounced comparing to dry conditions.

However, citing a contrary opinion, addition of hydrogels can, in some cases, remain with no response [Swietlik 1989], or even bring about a negative effect on plants [Ingram and Burbage 1985, Keever et al. 1989, Austin and Bondari 1992], especially under adequate or excessive water supply [Islam et al. 2011]. Under drought-stress conditions

Table 2. The influence of geocomposite and pine bark mulch on growth of *Erigeron hybridus*
Tabela 2. Wpływ geokompozytu i ściółki z kory sosnowej na wzrost przymiotna ogrodowego *Erigeron hybridus*

Geocomposite Geokompozyt	Year Rok	Plant feature – Cecha rośliny								
		height of plants, cm wysokość roślin, cm			diameter of plants, cm średnica roślin, cm			shoot number liczba pędów		
		mulch – ściółka			mulch – ściółka			mulch – ściółka		
		-	+	mean średnia	-	+	mean średnia	-	+	mean średnia
Without geocomposite Bez geokompozytu	2008	68.9	75.6	72.3	46.0	49.9	48.0	19.6	21.6	20.6
	2009	72.6	79.2	75.9	81.1	79.4	80.3	43.0	45.2	44.1
	2010	71.2	66.3	68.8	57.9	64.7	61.3	54.2	63.8	59.0
	mean średnia	70.9	73.7	72.3	61.7	64.7	63.2	39.0	43.5	41.2
With geocomposite Z geokompozytem	2008	81.4	76.1	78.8	72.2	51.5	61.9	34.4	24.0	29.2
	2009	81.6	79.3	80.5	80.0	79.2	79.6	52.6	56.8	54.7
	2010	69.7	71.4	70.6	78.9	73.7	76.3	87.6	70.8	79.2
	mean średnia	77.6	75.6	76.6	77.0	68.1	72.6	58.2	50.6	54.4
Mean – Średnia		74.3	74.7		69.4	66.4		48.6	47.1	
$LSD_{0.05}$ – $NIR_{0.05}$:										
For geocomposite Dla geokompozytu		n.s. – r.n.			4.8			12.4		
For mulch dla ściółki		n.s. – r.n.			n.s. – r.n.			n.s. – r.n.		
For geocomposite × mulch Dla geokompozytu × ściółka		n.s. – r.n.			n.s. – r.n.			n.s. – r.n.		

Table 3. The influence of geocomposite and pine bark mulch on growth of *Eupatorium purpureum*

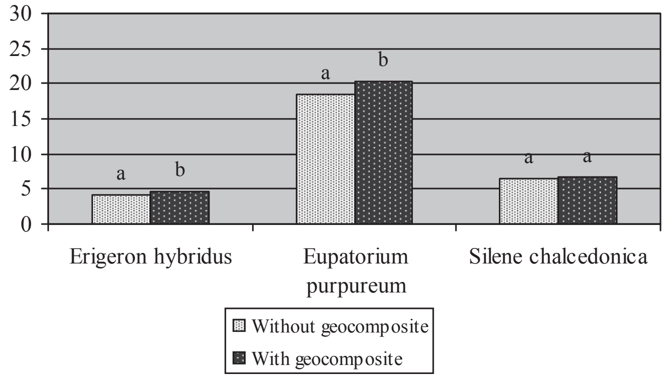
Tabela 3. Wpływ geokompozytu i ściółki z kory sosnowej na wzrost sadźca purpurowego *Eupatorium purpureum*

Geocomposite Geokompozyt	Year Rok	Plant feature – Cecha rośliny								
		height of plants, cm wysokość roślin, cm			diameter of plants, cm średnica roślin, cm			shoot number liczba pędów		
		mulch – ściółka			mulch – ściółka			mulch – ściółka		
		-	+	mean średnia	-	+	mean średnia	-	+	mean średnia
Without geocomposite Bez geokompozytu	2008	92.8	98.3	95.6	63.8	71.9	67.9	10.6	13.4	12.0
	2009	146.6	145.7	146.2	91.0	108.6	99.8	15.0	14.2	14.6
	2010	143.8	147.5	145.7	88.2	93.1	90.7	24.7	24.1	24.4
	mean średnia	127.7	130.5	129.1	81.0	91.2	86.1	16.8	17.2	17.0
With geocomposite; Z geokompozytem	2008	100.1	113.2	106.7	76.6	91.7	84.1	17.2	17.2	17.2
	2009	150.2	163.0	156.6	105.9	115.8	110.9	19.1	22.4	20.8
	2010	149.8	163.5	156.7	107.7	104.3	106.0	39.7	37.5	38.6
	mean średnia	133.4	146.6	140.0	96.7	103.9	100.3	25.3	25.7	25.5
Mean – Średnia		130.6	138.6		88.9	97.6		21.1	21.5	
$LSD_{0.05}$ – $NIR_{0.05}$: For geocomposite dla geokompozytu			7.2.			3.8			1.8	
For mulch dla ściółki			7.9			7.5			n.s, – r.n.	
For geocomposite × mulch Dla geokompozytu × ściółka			n.s. – r.n.			n.s. – r.n.			n.s. – r.n.	

hydrogel can compete with roots for available water [Syvertsen and Dunlop 2004], whereas too high dosage of agrogel introduced in the conditions of water abundance can provide for worsening of physical properties of growing medium. There is no such a danger in the case of introduction of the examined geocomposite, which arrests superсorbent inside geotextile, at the same time, enabling root system using it as water reservoir. This experiment confirms favorable effect of geocomposite, applied to heavy soil, on vegetative growth of all the examined species of perennial plants. In combinations with geocomposite, plants obtained higher value of a diameter and they formed more shoots (tab. 2–4) regardless the year and precipitation distribution, especially during the most intensive development, i.e. both in the conditions of rainfall deficit, which happened in May 2008 and twice higher than average values of precipitation, which occurred in May 2010 (tab. 1). Particularly advantageous effect of geocomposite was recorded in *Eupatorium purpureum*. Plants of that species featured not only increased diameter and higher number of shoots, but they also reached more considerable height (tab. 3). Stronger response of *Eupatorium* probably resulted from high water requirements of that species. Similar conclusions were drawn by Boatright et al. [1997], who claimed that drought-sensitive plants, such as petunia, benefit most from application of polymers. Those observation involved not only plant growth, but also focused on positive effect of geocomposite on plant flowering. It increased the number and diameter of fluorescence of *Erigeron* and *Eupatorium*, while it did not affect on *Silene* blooming (fig. 1, 2). Among species selected for experiments this species is most sensitive to excess amount of water in the soil [Aniśko 2008]. Beneficial effect on flowering of some annual landscape bed species was also reported by Boatright et al. [1997], although it referred only to plants cultivated in the conditions of drought, whereas under not limited water conditions hydrogel amendment did not influence flowering of plants. Under drought stress conditions supersorbent also increased head diameter of *Helianthus annuus* L. [Nazarli and Zardashti 2010]. One of the factors stimulating flowering is potassium availability. Sita et al. [2005], on the example of *Dendranthema grandiflorum* hort., confirmed that the use of supersorbent does positively influence potassium availability in the soil, diminishing, at the same time, calcium and magnesium uptake. That resulted in the increase in K/Ca and K/Mg ratio in plant tissues. Similar observations were made in case of K/Na ratio [Shi et al. 2010].

Table 4. The influence of geocomposite and pine bark mulch on growth of *Silene chalcedonica*
Tabela 4. Wpływ geokompozytu i ściółki z kory sosnowej na wzrost firletki chalcedońskiej *Silene chalcedonica*

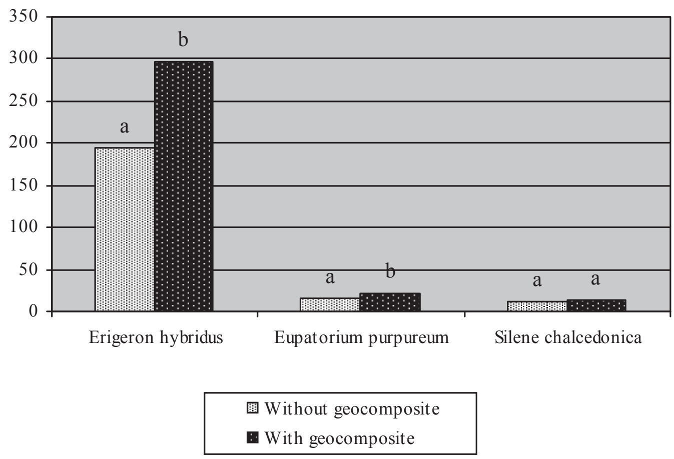
Geocomposite Geokompozyt	Year Rok	Plant feature – Cecha rośliny								
		height of plants, cm wysokość roślin, cm			diameter of plants, cm średnica roślin, cm			shoot number liczba pędów		
		mulch – ściółka			mulch – ściółka			mulch – ściółka		
		-	+	mean średnia	-	+	mean średnia	-	+	mean średnia
Without geocomposite Bez geokompozytu	2008	82.8	84.3	83.6	23.3	16.0	19.7	8.4	4.4	6.4
	2009	86.6	95.8	91.2	47.5	44.6	46.1	12.6	9.1	10.9
	2010	88.5	99.6	94.1	57.4	52.4	54.9	20.8	17.4	19.1
	mean średnia	86.0	93.2	89.6	42.7	37.7	40.2	13.9	10.3	12.1
With geocomposite Z geokompozytem	2008	87.7	85.9	86.8	31.2	23.2	27.2	6.3	5.5	5.9
	2009	101.8	96.4	99.1	48.3	50.0	49.2	14.1	10.5	12.3
	2010	86.7	86.2	86.5	71.8	56.0	63.9	29.2	17.0	23.1
	mean średnia	92.1	89.5	90.8	50.4	43.1	46.8	16.5	11.0	13.8
Mean – Średnia		89.1	91.4		46.6	40.4		15.2	10.7	
$LSD_{0.05}$ – $NIR_{0.05}$: For geocomposite dla geokompozytu		n.s. – r.n.			6.4			1.5		
For mulch dla ściółki		n.s. – r.n.			4.9			2.2		
For geocomposite × mulch Dla geokompozytu × ściółka		7.0			n.s. – r.n.			n.s. – r.n.		



Means followed by the same letter do not differ significantly
Średnie oznaczone tą samą literą nie różnią się istotnie

Fig. 1. The influence of geocomposite on the diameter of inflorescences of *Erigeron hybridus, Eupatorium purpureum* and *Silene chalcedonica* (means of three years), cm

Rys. 1. Wpływ geokompozytu na średnicę kwiatostanów przymiotna ogrodowego *Erigeron hybridus,* sadźca purpurowego *Eupatorium purpureum* i firletki chalcedońskiej *Silene chalcedonica* (średnie z trzech lat), cm



Means followed by the same letter do not differ significantly
Średnie oznaczone tą samą literą nie różnią się istotnie

Fig. 2. Influence of geocomposite on the number of inflorescences of *Erigeron hybridus, Eupatorium purpureum* and *Silene chalcedonica* (means of three years)

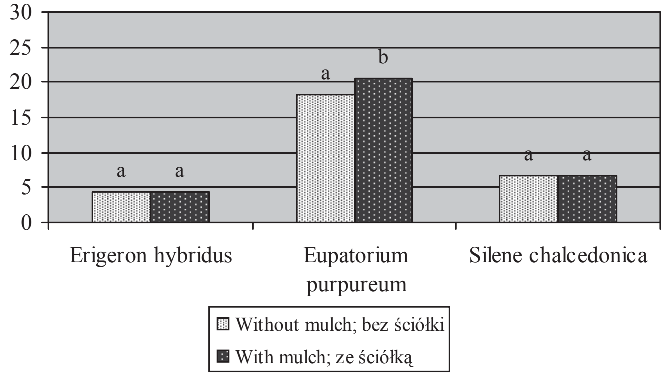
Rys. 2. Wpływ geokompozytu na liczbę kwiatostanów przymiotna ogrodowego *Erigeron hybridus,* sadźca purpurowego *Eupatorium purpureu* i firletki chalcedońskiej *Silene chalcedonica* (średnie z trzech lat)

Increased diameter of plants and inflorescences, as well as higher number of shoots is directly translated into higher esthetic value. It is also affected by other plant responses to hydrophilic polymers, such as number of leaves, leaf area index and elevated value of chlorophyll content in leaves, which was observed in the conditions of water stress [Yazdani et al. 2007, Nazarli and Zardashti 2010]. In this experiment higher content of chlorophyll in combinations with geocomposite was determined in leaves of all the examined species of perennial plants (tab. 5).

Table 5. Chlorofil content in leaves of *Erigeron hybridus*, *Eupatorium purpureum* and *Silene chalcedonica* depending on geocomposite and pine bark mulch application (in mg g^{-1} f.w.)
Tabela 5. Zawartośc chlorofilu w liściach przymiotna ogrodowego *Erigeron hybridus*, sadźca purpurowego *Eupatorium purpureum*. i firletki chalcedońskiej *Silene chalcedonica* w zależności od zastosowania geokompozytu i ściółki z kory sosnowej (w mg g^{-1} św.m.)

Geocomposite Geokompozyt	Species – Gatunek								
	Erigeron hybridus			*Eupatorium purpureum*			*Silene chalcedonica*		
	mulch – ściółka			mulch – ściółka			mulch – ściółka		
	-	+	mean średnia	-	+	mean średnia	-	+	mean średnia
Without geocomposite Bez geokompozytu	0.37	0.46	0.42	0.43	0.26	0.35	0.34	0.32	0.33
With geocomposite Z geokompozytem	0.48	0.49	0.49	0.35	0.43	0.39	0.31	0.47	0.39
Mean – Średnia	0.43	0.48		0.39	0.35		0.33	0.39	
$LSD_{0.05}$ – $NIR_{0.05}$:									
For geocomposite dla geokompozytu	0.06			0.03			0.05		
For mulch dla ściółki	n.s. – r.n.			0.03			0.05		
For geocomposite × mulch Dla geokompozytu × ściółka	n.s. – r.n.			0.11			n.s. – r.n.		

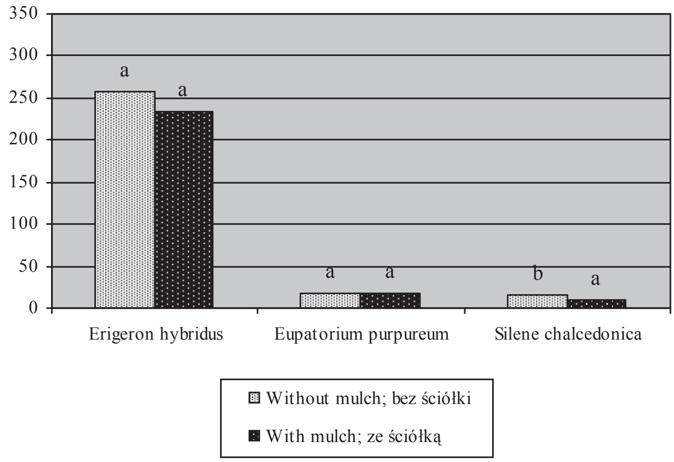
The effect of mulching with pine bark on vegetative growth and flowering depended on perennial species. Pine bark advantageously influenced diameter and height, regarding *Eupatorium* (tab. 3), while its disadvantageous effect could be observed in the case of plant diameter and number of shoots of *Silene* (tab. 4). As far as *Erigeron* was concerned, there was not recorded any effect of mulching on its vegetative growth (tab. 2). Similar relation was observed when flowering was taken into account. Mulching significantly affected the increase in fluorescence diameter of *Eupatorium* (fig. 3) and decrease inflorescence number of *Silene* (fig. 4). Composted pine bark, in spite of the fact that it is commonly used for mulching perennial beds, affects plants in not always beneficial way. Advantageous influence of mulch on perennials was proved by Krzymińska and Lisiecka [2004], as well as by Czuchaj and Szczepaniak [2008]. Yet, according to Dębicz [2008, 2009], pine bark mulching negatively affects on growth dynamics of most of covering perennials subjected to her research. Disadvantageous effect on inflorescence of *Liatris spicata* was also reported by Hetman and Po-



Means followed by the same letter do not differ significantly
Średnie oznaczone tą samą literą nie różnią się istotnie

Fig. 3. The influence of mulch on the diameter of inflorescences of *Erigeron hybridus, Eupatorium purpureum* and *Silene chalcedonica* (means of three years), cm

Rys. 3. Wpływ ściółki na średnicę kwiatostanów przymiotna ogrodowego *Erigeron hybridus,* sadźca purpurowego *Eupatorium purpureum* i firletki chalcedońskiej *Silene chalcedonica* (średnie z trzech lat), cm



Means followed by the same letter do not differ significantly
Średnie oznaczone tą samą literą nie różnią się istotnie

Fig. 4. The influence of mulch on the number of inflorescences of *Erigeron hybridus, Eupatorium purpureum* and *Silene chalcedonica* (means of three years)

Rys. 4. Wpływ ściółki na liczbę kwiatostanów przymiotna ogrodowego *Erigeron hybridus,* sadźca purpurowego *Eupatorium purpureum* i firletki chalcedońskiej *Silene chalcedonica* (średnie z trzech lat) groszewska [1997]. Unfavourable effect in relation to *Silene* can be explained by decrease in soil pH value [Duryea et al. 1999], since plants of that species require alkaline soil reaction [Jelitto et al. 2002]. This situation can also result from pine bark allelopathic properties. Inhabiting effect of hydroxylated aromatic compounds, contained in pine bark, was observed in case of lettuce seeds germination [Duryea et al. 1999].

Positive influence of geocomposite on growth and flowering of *Eupatorium*, *Erigeron* and, slightly lesser expressed in the case of *Silene*, in different years characterizing various course of precipitation, confirms the possibility of geocomposite use for perennials cultivation in urban green areas. Positive response of *Eupatorium* suggests that the use of geocomposite will enable widening the range of plants choice by including taxa of high water requirements.

CONCLUSIONS

1. The results of the experiment proved advantageous effect of geocomposite on vegetative growth of all the examined species of perennial plants. The plants reached increased diameter and number of shoots as well as height in case of *Eupatorium purpureum*.

2. As the result of geocomposite application *Erigeron hybridus* and *Eupatorium purpureum* species featured abundant flowering and produced bigger inflorescences. No such effect was recorded for *Silene chalcedonica*.

3. The influence of mulching with pine bark on growth and flowering depended on perennial species. Pine bark proved to be advantageous for height and diameter of *Eupatorium purpureum*, while negative influence of that mulch on growth of *Silene chalcedonica* was observed. Mulching did not affect vegetative growth of *Erigeon hybridus*.

REFERENCES

Abedi-Koupai J.A., Eslamian S.S., Kaziem J.A., 2008. Enhancing the available water content in unsaturated soil zone using hydrogel, to improve plant growth indices. Ecohydrol. Hydrobiol. 8 (1), 67–75.

Agaba H., Orikiriza L.J.B., Esegu J.F.O., Obua J., Kabasa J.D., Hüttermann A., 2010. Effects of hydrogel amendment to different soils on plant available water and survival of trees under drought conditions. Clean – Soil, Air, Water 38 (4), 328–335.

Akhter J., Mahmood K., Malik K.A., Mardan A., Ahmad M., Iqbal M.M., 2004. Effects of hydrogel amendment on water storage of sandy loam and loam soils and seedling growth of barley, wheat and chickpea. Plant Soil Environ. 50, (10), 463–469.

Aniśko T., 2008. When perennials bloom. Timber Press, Portland – London.

Arnon D., 1949. Copper enzymes in isolated chloroplasts. Poly-phenoloxidase in *Beta vulgaris*. Plant Physiol. 24, 1–15.

Austin M.E., Bondari K., 1992. Hydrogel as a field medium amendment for blueberry plants. *HortScience,* 27, 973–974.

Boatright J.L., Balint D.E., Mackay W.A., Zajicek J.M., 1997. Incorporation of a hydrophilic polymer into annual landscape beds. J. Environ. Hort. 15(1), 37–40.

Czuchaj P., Szczepaniak S., 2008. Wpływ ściółkowania gleby na wzrost i kwitnienie kilku odmian żurawki drżączkowatej (*Heuchera* × *brizoides* hort. Ex Lemoine)**.** Zesz. Probl. Post. Nauk Roln. 525, 63–71.
Davies F.T., Castro-Jimenez JR., Duray S.A.Y., 1987. Mycorrhizae, soil amendments, water relations and growth of *Rosa multiflora* under reduced irrigation regimes. Sci. Hort. 33, 261–267.
Dębicz R., 2008. Dynamika rozrastania się wybranych gatunków bylin na glebie ściółkowanej i nieściółkowanej korą sosnową. Zesz. Probl. Post. Nauk Roln. 525, 73–79.
Dębicz R., 2009. Dynamika rozrastania się wybranych gatunków bylin na glebie ściółkowanej i nieściółkowanej korą sosnową. Zesz. Probl. Post. Nauk Roln. 539: 127–133.
Dorraji S.S., Golchin A., Ahmadi S., 2010. The effects of hydrophilic polymer and soil salinity on corn growth in sandy and loamy soils. Clean – Soil, Air, Water 38 (7), 584–591.
Dubicki A., Dubicka M., Szymanowski M., 2002. *Klimat Wrocławia.* [in:] Środowisko Wrocławia – Informator 2002, Dolnośląska Fundacja Ekorozwoju, Wrocław, 9–25.
Duryea M.L., English R.J., Hermansen L.A., 1999. A comparison of landscape mulches: chemical, allelopathic, and decomposition properties. J. Arboric. 25 (2), 88–97.
Greenly K.M., Rakow D.A., 1995. The effect of wood mulch type and depth on weed and tree growth and certain soil parameters. J. Arboric. 21(5), 225–232.
Henderson J.C., Davies, F.T., Jr., Pemberton H.B., 1991. Landscape rose response to low moisture levels and a hydrophilic gel. Sci. Hort. 46, 129–135.
Hetman J., Martyn W., Misztal M., Ligęza S., 1996. Wpływ hydrożeli na właściwości sorpcyjne podłoży szklarniowych. Prob. Post. Nauk Roln. 429, 137–141.
Hetman J., Pogroszewska E., 1997. Kwitnienie liatry kłosowej (*Liatris spicata*) uprawianej w nieogrzewanym tunelu foliowym i na polu, z zastosowaniem ściółkowania. Zesz. Probl. Post. Nauk Rol. 449, 61–74.
Hüttermann A., Zommorodi M., Reise K.K., 1999. Addition of hydrogels to soil for prolonging the survival of *Pinus halepensis* seedlings subjected to drought. Soil Tillage Res. 50, 295–304.
Hüttermann A., Orikiriza L.J.B., Agaba H., 2009. Application of superabsorbent polymers for improving the ecological chemistry of degraded or polluted lands. Clean 37 (7), 517–526.
Ingram D.L., Burbage W., 1985. Effects of irrigation regime, antitranspirants, and a water absorbing polymer on the survival and establishment of transplanted live oaks. Proc. Fla. State Hort. Soc. 95, 85–87.
Islam M.R., Hu Y., Mao S., Mao J., Enejid A.E., Xuea X., 2011. Effectiveness of a water-saving super-absorbent polymer in soil water conservation for corn (*Zea mays* L.) based on ecophysiological parameters. J. Sci. Food Agric. 91 (11): 1998–2005.
Jelitto L., Schacht W., Simon H., 2002. Die Freiland – Schmuckstauden. Verlag Eugen Ulmer & Co. Stuttgart.
Keever G.J., Cobb G.S., Stephenson J.C., Foster W.J., 1989. Effect of hydrophilic polymer amendment on growth of container grown landscape plants. J. Environ. Hort. 7(2), 52–56.
Krzymińska A., Lisiecka A. 2004. Wpływ ściółkowania gleby na wzrost i kwitnienie wybranych gatunków bylin. Folia Univ. Agric. Stetin., Agricultura 236 (94), 93–96.
Martyn W.P., Szot P., 2001. Influence of superabsorbents on the physical properties of horticultural substrates. Int. Agrophysics, 15, 87–94.
Montague T., Kjelgren R., Allen R., Wester D., 2004. Water Loss Estimates for Five Recently Transplanted Landscape Tree Species in a Semi-Arid Climate. J. Environ. Hort. 22(4), 189–196.
Nazarli H., Zardashti M.R., 2010. The effect of drought stress and super absorbent polymer (A200) on agronomical traits of sunflower (*Helianthus annuus* L.) under field condition. Cercetări Agronomice în Moldova, XLIII, 3 (143), 152–161.

Orikiriza L., J., B., Agaba H., Tweheyo M., Eilu G., Kabasa J.,D., Hüttermann A., 2009. Amending soils with hydrogels increases the biomass of nine tree species under non-water stress conditions. Clean 37 (8), 615–620
Orzeszyna H., Garlikowski D., Pawłowski A., 2004**.** Geokompozyt z superabsorbentem w zabezpieczeniach biotechnicznych. Materiały Budowlane 8, 40–44.
Owczarzak W., Karczmarek Z., Szukała J., 2006. The influence of Stockosorb hydrogel on selected structure forming properties of gray-brown podzolic soil and black earth. J. Res. Appl. Agric. Eng. 51(3), 55–61.
Paluszek J., 2003. Kształtowanie syntetycznymi polimerami właściwości gleb erodowanych terenów lessowych. Rozpr. Nauk. AR w Lublinie 277.
Ramakrishna A., Tam H.M., Wani S.P., Long T.D., 2006. Effect of mulch on soil temperature, moisture, weed infestation and yield of groundnut in northern Vietnam. Field Crops Res. 95, 115–125.
Shi Y., Li J., Shao J., Deng S., Wang R., Li N., Sun J., Zhang H., Zhu H., Zhang Y., Zheng X., Zhou D., Hüttermann A., Chen S., 2010. Effects of Stockosorb and Luquasorb polymers on salt and drought tolerance of *Populus popularis*. Sci. Hort. 124, 268–273.
Sita R.C.M., Reissmann C.B., Marques R., de Oliveira E., Taffarel A.D., 2005. Effect of polymers associated with N and K fertilizer sources on *Dendrathema grandiflorum* growth and K, Ca and Mg relations. Brazil. Arch. Biol. Technol. 48(3), 335–342.
Skroch W.A., Powell M.A., Bilderback T.E., Henry P.H. 1992. Mulches: durability, aesthetic value, weed control, and temperature. J. Environ. Hort. 10(1), 43–45.
Syvertsen J.P., Dunlop J.M., 2004. Hydrophilic gel amendments to sand soil can increase growth and nitrogen uptake efficiency of citrus seedlings. Sci. Hort. 39(2), 267–271.
Swietlik D., 1989. Effect of soil amendment with Viterra hydrogel on establishment of newly-planted grapefruit trees cv. Ruby Red. Commun. Soil Sci. Plant Anal. 20(15–16), 1697–1705.
Woodhouse J., Johnson M.J., 1991. Effect of superabsorbent polymers on survival and growth of crop seedlings. Agric. Water Manamegent 20, 63–70.
Yazdani F., Allahdadi I., Akbari G.A., 2007. Impact of superabsorbent polimer on yield and growth analysis of soybean (*Glycine max* L.) under drought stress condition. Pakistan J. Biol. Sci. 10 (23), 4190–4196.

WPŁYW SORBUJĄCEGO WODĘ GEOKOMPOZYTU I ŚCIÓŁKOWANIA KORĄ SOSNOWĄ NA WZROST I KWITNIENIE WYBRANYCH GATUNKÓW BYLIN

Streszczenie. W dotychczasowych badaniach potwierdzono korzystne działanie polimerów hydrofilowych na wzrost roślin. Ich wykorzystanie w rolnictwie polega głównie na mieszaniu z glebą lub podłożem. Celem doświadczenia było określenie wpływu nowej formy aplikacji supersorbentu w postaci geokompozytu na rozwój przymiotna ogrodowego, sadźca purpurowego i firletki chalcedońskiej. Pierwszy czynnik stanowiło zastosowanie geokompozytu, drugi – ściółkowanie korą sosnową. Geokompozyt składał się z polimeru zamkniętego w geowłókninie. Po namoczeniu w wodzie umieszczano go w glebie i sadzono nad nim rośliny. Oceniano wzrost i kwitnienie roślin w terminie ich najobfitszego kwitnienia. Wykazano korzystny wpływ geokompozytu na wzrost wegetatywny wszystkich badanych bylin. Rośliny osiągnęły większą średnicę i liczbę pędów oraz (u sadźca) wysokość. Geokompozyt wpływał także pozytywnie na kwitnienie przymiotna i sadźca. Niezależnie od zastosowania ściółki w kombinacjach z geokompozytem rośliny kwitły obficiej i miały większe kwiatostany. Kora sosnowa korzystnie wpływała na wysokość i średnicę sadźca, a niekorzystnie na średnicę roślin i liczbę pędów firletki.

Słowa kluczowe: polimer hydrofilowy, ściółka, przymiotno, sadziec, firletka, rozwój roślin

Accepted for print – Zaakceptowano do druku: 21.12.2011