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EFFECT OF HYDRO GEL AND SOIL COVER ON ROOT MASS PRODUCED BY THE LAWN MIXTURES IN THE YEARS 2007–2009

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Abstract

JANKOWSKI, K., J. JANKOWSKA, G. A. CIEPIELA, B. WISNIEWSKA – KADZAJAN, R. KOLCZAREK and J. SOSNOWSKI, 2014. Effect of hydro gel and soil cover on root mass produced by the lawn mixtures in the years 2007–2009. *Bulg. J. Agric. Sci.*, 20: 1295-1301

Research was carried out in years 2007–2009 on the basis of field experiment in split – plot design, in three repetitions. Mixture lawn was set up for the experiment. In mixture sowing, four species of lawn grass were studied: perennial ryegrass, red fescue, common meadow-grass and common bent. In the experiment, the following factors were applied: bedding type: a- no hydro gel ”0” control plot; b – with the addition of hydro gel at the depths of 5 cm, 10 cm, and 15 cm; soil cover: a – cultivated soil (P); b - horticultural peat (T). At the end of each growth period, turf samples with root systems were collected from the plots at the depth of 10 cm. On their basis, the assessment of root dry matter was carried out and the number of roots was calculated on each turf block. Developing of the root biomass by the tested lawn mixtures in subsequent years of the experiment varied in study years and depends on the depth of the hydro gel placement as well as the type of soil cover. Throughout research period the most root biomass produced a mixture dominated in 40% by Kentucky bluegrass. Type of soil cover only in 2007, significantly differentiated the size of the root biomass produced for the benefit of cultivated soil cover.

Key words: lawn, hydro gel, root biomass, soil cover

Abbreviations: M 1 - Perennial ryegrass 40%; M 2 - Red fescue 40%; M 3 - Kentucky bluegrass 40%;
M 4- Common bent 40%

Note: in this experiment, the following test factors were used:
- Subsoil type (GUH): a / without hydro gel - “0” – control; b / with the addition of the hydro gel placed on the depth: 5 cm, 10 cm, 15 cm;
- Soil cover: a / arable soil - (P); b / horticultural peat - (T)
- D.M

Introduction

The intensity of grass use, affects the changes in root biomass (mainly in the reduction) as well as the distribution of the roots in the soil profile (Fiala, 1997; Pielota and Smucker, 1995). Moreover, the root biomass has a large importance as the most essential element stabilizing sodded grounds. Grasses reduce a negative effect of erosion, since they create the strong root system; they form dense and compact turf (Domański, 1996; Kozłowski, et al., 2000; Frey and Miziany, 2006; Wolski, et al., 2006, Frey, 2007). In the sod process (which takes place under the influence of grass plants; it is characterized by the predominance of accumulating organic matter in the top layer over the process of mineralization), the proper development of the fibrous root system is the basic element stabilizing the substrate horizontally and vertically. Roots of grasses are usually placed horizontally, but they also form a strongly developed and deep, orthotropic ally own distributed root mass (plant growth, expressed by assuming the vertical position) (Wolski et al., 2006; Frey, 2007).

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Knowing the number of active, live roots and their distribution in the soil profile of different habitats and information about the number of reserve substances accumulated in underground plant organs provides important data to compare different habitats. This is important from the point of view of their persistence in terms of the various events taking place in the habitat (Domański, 1998).

In turn Domański (2002) argues that the most important criterion in assessing suitability of species and varieties of 1awngrasses is the coverage of the ground by shoots. He be1ieves that in the years of comp1ete cultivation the degree of coverage is a subject to variation and is dependent on the season and on the weather conditions. In addition, he draws attention to the dynamics of tillering, directly affecting the overall aspect of the turf.

Wolski et al. (2006) thinks that the most critical moment is the period of initial growth of p1ants forming turf and underlines the efficiency of acry1ic po1ymer (hydrogel), which contributes to the development of the root system and green mass, offsetting the impact of unsuitab1e weather conditions. According to Leciejewski (2008), the hydrogel addition significantly affected the increase of soil moisture and slowed the loss of water at all depths of the studied soi1 profile. These observations are confirmed by the results presented in another paper (Martyn and Onuch – Amborska, 1993) which show that the drying rate of greenhouse substrates depends on the proportion of the sorbent. Thus, the sorbent is characterized by high water sorption capacity, increasing water capacity of the soil. This effect may be associated with the interruption of vertical pores in the soi1, which reduces evaporation of water, whi1e maintaining soi1 porosity (Mellouti, et al., 1998). Moreover, according to Al- Hrabi (1999), hydro gel reduces the density of the soil substrate, which contributes to the increase of soil loosening. Soils with higher concentrations of hydro gel dry slower when their moisture content in the initial period is lower. After some time, they have higher moisture content than soil without hydrophilic polymers.

On the other hand, Domański (2002) claims that the most important criterion in the assessment of the usefulness of particular lawn species and hybrids is bedding cover with straws. He states that in the years of full utilization, soil bedding cover undergoes diversification and depends on the season, and therefore on the weather conditions. Wolski et al. (2006) name the initial development of plants that form the lawn as the most critical moment.

According to Dąbrowski and Pawluśkiewicz (2011), a greatly significant element in lawn setting is the preparation of bedding with certain richness in basic nutrients, proper porosity, and permeability (Jeznach, 2002; Pawluśkiewicz, 2009). Whilst with house lawns it is possible to apply organic substance in order to enrich the bedding (peat, compost), with lawns of high charge it is not recommended. The most frequently used components for building the structural layer of lawn is sand with the addition of native soil or peat (Wysocki, 2002; Wolski et al., 2006).

Therefore, the aim of this work was to determine the effect of hydro per unit area of lawns and mixtures with varying proportions of red fescue.

Materials and Methods

The experiment was established in 2007 and it was conducted gel placed in the subsoi1 and of type soil cover on the root biomass in relation to a number of shoots until 2009 on the experimental field of the University of Natural Sciences and Humanities in Siedlce. The research was carried out on the basis of field experiment established in triplicate, conducted in a split-plot design. The experimental unit was a plot with an area of 1m^2. In the experiment four lawn mixtures were studied (Table 1). In each mixture sowing of one grass as a dominant species (40%) and the other three species were at 20% were used, and so on: M 1 - Perennial ryegrass 40%, M 2 - Red fescue 40%, M 3 - Kentucky bluegrass 40%, M 4- Common bent 40%.

In this experiment, the following test factors were used:

- Subsoil type (GUH): a / without hydro gel - “0” - control b / with the addition of the hydro gel placed on the depth: 5 cm, 10 cm, 15 cm;

- Soil cover: a / arable soil - (P) b / horticultural peat - (T)

After replacement of all the plots, hydro gel was used in the amount of 50 g·m^{-2} in the surface layer in a depth of: 5, 10 and 15 cm. At the end of April 2007 the seeds were sown. After sowing of grass seeds, the soil surface in a random design with a thin layer horticulture peat or arable soil (native) was covered. In the growing seasons in research years (2007 - 2009) an assessment of selected traits of lawn grasses was done (Prończuk, 1993; Domański, 1998), among others the weight of roots and shoots number. At the end of the vegetation period from the study plots the samples with the turf root system to a depth of 10 cm were taken. On their basis, the dry

Table 1
The grasses used in the experiment

Grass species	Cultivar	Seeds sowing, g /1 m^2
Lolium perenne	Inka	3.10
Red fescue	Nil	3.90
Kentucky bluegrass	Alicja	2.40
Common bent	Tolena	1.10

matter of the root systems by the method of Böhm (1985) and shoots number were evaluated.

Experiments were carried out on the soil classified as anthropogenic soils with hortisol type formed from poorly loamy sand.

As results from studies of the soil, it has an alkaline reaction, a high content of magnesium (8.4 mg Mg/100 g) and phosphorus (90 mg P_2O_5/100 g), a low content of potassium (19 mg K_2O/100 g).

In the study the variability of meteorological factors were used, which have impact on the growth and development of plants in the years 2007–2009. On this basis, the hydrothermal indexes of Sielianinow (Bac et al., 1993) were calculated (Table 2).

In the year of experiment foundation (2007) the values of Sielianinow hydrothermal coefficient indicate a strong drought during the months: from April to October. The growing season was very unfavorable for plants, because a strong drought has dominated. In 2008, in the months April, June, July, August and October were strong drought, and in 2009 there was a strong drought in April, July, August and September.

The results were statistically analyzed by performing analysis of variance. The major sources of variation (factors and interactions) were made a detailed comparison of averages by Tukey's test at a significance level $P \le 0.5$.

Results and Discussion

Lawn grasses differs drought resistance, the ability to run the nutrients from the soil, and in response to fertilization (Falkowski et al., 1994), what indicates that roots play an important role in the adaptation of plants to stress conditions. The root system is one of the most important factors determining the survival of plants under drought conditions (Böhm, 1985). In addition, root biomass has great importance as a key stabilizing element of compact areas (Table 3).

Analyzing the results of the root mass produced by the lawns mixture in different years of the study (Table 3), it

Table 2
Hydrothermical Sielianinow indexes (K) in individual months of vegetation seasons in 2007-2009

Lata Years	IV	V	VI	VII	VIII	IX	X
2007	0.24	0.40	0.32	0.37	0.16	0.51	0.20
2008	0.30	0.67	0.28	0.37	0.40	0.51	0.01
2009	0.07	0.53	0.92	0.13	0.45	0.17	1.45

Note: 0.5 – *strong drougth*; 0.51 – 0.69 - *drougth*; 0.70-0.99 – *poor drougth*; *over* 1 – *no drought*

Table 3
The root dry mass (g/m²) of lawn mixtures depending on the type of subsoil and type of soil cover (From the years 2007-2009)

		2007					2008					2009				
		Type of substrate														
		M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean
Hydrogel, cm (GUH)	„0"	201.4	195.1	200.5	259.0	214.0	193.4	17.3	196.2	251.8	203.2	261.5	263.8	291.7	214.5	257.9
	5	250.7	178.9	247.5	214.0	222.8	216.4	193.8	260.9	243.9	228.8	237.4	207.7	274.1	273.1	248.0
	10	234.7	278,5	226.4	212.2	237.9	229.3	177.2	301.0	199.7	226.8	219.1	237.5	245.8	270.0	243.1
	15	196.3	247.0	236.9	264.4	236.2	216.1	234.5	238.3	250.0	234.7	252.8	298.9	237.5	228.8	254.5
Type of soil cover																
Type of soil cover	P	223.4	240.7	240.1	268.4	243.2	222.7	174.7	248.6	223.9	217.4	256.0	262.4	268.6	247.5	258.6
	T	218.0	209.1	215.6	206.3	212.3	205.0	213.8	249.6	248.8	229.3	229.4	241.6	255.9	245.8	243.2
Mean		220.7	224.9	227.8	237.4		213.8	194.2	249.1	236.3		242.7	251.9	262.3	246.6	
$LSD_{\le 0,05}$ for Mixture (A) - n.i. GUH – (B) - n.i. Type of soil cover (C) - 30.9 interaction : (AxB) - 80.1 (CxA) - 59.4							$LSD_{\le 0,05}$ for Mixture (A) -54.8 GUH – (B) -n.i. Type of soil cover (C) -n.i. interaction : (BxA) - 61.1 (CxA) - 73.8					$LSD_{\le 0,05}$ for Mixture (A)- n.i. GUH – (B) - n.i. Type of soil cover –(C) -n.i. ineraction: (BxA) - 62.2 (CxA) - 39.1				

was found that generally the most of the root mass, the tested mixtures produced in the third (2009) year of the study, and the least in the second year (2008). Root mass produced by each lawn mixtures in the successive three years of the study was different.

And so in the first year (2007) the most root mass produced mixtures M4 with domination of Common bent (237.4 g/m^2), and in the second and third year mixture M3 with domination of Kentucky bluegrass (249.1 and 262.3 g/m^2 respectively). In the studies of Jankowski, et al. (2011a, b, c) it is shown that in the case of lawn mixtures, higher percentage of red fescue guarantee a higher level of root's biomass. Also in Wolski et al. (2006) studies, in the stabilization of tailings embankments the best rooting system had the turf with red fescue.

In regard to type of the soil surface has been shown the different reaction on root mass produced by lawn mixtures in subsequent study years. Well, in the first study year, the largest root mass produced mixture grown on a subsoil with 10 cm depth of hydro gel placing (237.9 g/m^2), and in the second year at 15 cm depth of hydro gel placing (234.7 g/m^2). In the third year of the study the most of the root mass tested lawn mixtures on control object (257.9 g/m^2). It is worth noting, that in all the research years the difference in the root mass of studied lawns was not significant between different types of subsoil.

Considering the type of soil cover it was showed that in the first and third year of study more root mass produced lawn mixtures grown on the object with the cover from arable soil than from peat soil. In the second study year, more root mass produced mixtures grown on the object with peat cover (229.3 g/m^2) than with the cover of arable soil (217.4 g/m^2). Statistical analysis only in 2007 showed significant differences in root mass of lawns between the studied types of soil cover. In the formation of the root mass in all study years it was found significant interaction of investigated lawn mixtures both with the type of subsoil and with soil cover type. According to Dąbrowski and Pawluśkiewicz, (2011) a very important element in the establishment of turf is the ground preparing with a particular abundance of essential nutrients, adequate porosity and permeability (Jeznach, 2002; Pawluśkiewicz, 2009). While on the household lawns can be applied to the substrate reaching of organic matter (peat, compost), whereas for the heavy load turfs is not advisable. The component most commonly used in the construction of the carrier layer of turf lawns is the sand with native soil or peat (Wysocki, 2002; Wolski et al., 2006).

The researches of lawn mixtures (Table 4) show that between mixtures is no significant differences in the amount of produced root biomass, although the most of root biomass produced a mixture M1 with perennial ryegrass dominance (225.7 g/m^2), and the least M4 with domination of common bent (240.1 g/m^2).

Given the subsoil type can be concluded that, compared with the control object (225.0 g/m^2) more root biomass produced tested mixtures on the objects with hydro gel, although significant differences were only on the object at a depth of 5 cm of hydro gel placed (233.2 g/m^2). In Jankowski et al. (2010) study was demonstrated increase in root mass (24-28%) on the object with hydro gel in relation to an object without supersorbent using.

Beneficial effect of hydro gel on increase in root biomass of different plants was also found in other studies (Hetman and Szot, 1994; Jankowski et al., 2011c, 2013; Kościk, Kowalczyk-Juśko, 1998).

The studies have demonstrated a significant effect of interaction of tested mixtures with the type of subsoil. The

Table 4
The root dry mass (g/m^2) of lawn mixtures depending on the type of subsoil and type of soil cover (from the years 2007 - 2009)

		Mixture				
		M1	M2	M3	M4	Mean
Hydrogel, cm (GUH)	„0”	218.7	210.0	229.4	241.7	225.0
	5	234.8	193.4	260.8	243.6	233.2
	10	227.7	231.0	257.7	227.3	235.9
	15	221.7	260.1	237.5	247.7	241.8
Type of soil cover						
Type of soil cover	P	234.0	225.9	252.4	246.6	239.7
	T	217.4	221.5	240.3	233.6	228.2
Mean		225.7	223.6	246.4	240.1	
LSD $_{\leq 0,05}$ for: Mixture (A) - n. i; GUH (B) - 28.8; Type of soil cover (C) - n. i; interaction: (AxB) - 58.8; (CxA) - n.i.						

most root biomass produced mixture M2 with domination of red fescue (260.1 g/m^2) at 15 cm depth of the hydro gel placement. Analyzing the impact of the type of soil cover may be stated that all the tested mixtures more root mass produced on objects with cover from arable soil (239.7 g/m^2) than from peat soil (228.2 g/m^2), although the differences in root mass of lawn mixtures between soil covers were not significant statistically.

The analysis of the linear regression function (Figures 1, 2, 3 and 4), between the dry matter of the roots and the number of shoots developed for analyzed turf lawns showed a significant positive correlation between these characteristics.

This dependence at the coefficient of determination R^2 = 47.6% described the following equation:

$y = -2351.0 + 30.6478 \cdot x$

More than 47% of the value of the determination coefficient proves about a good fit of the calculated regression function to the obtained empirical results. The direction of their variation indicates that the increase in roots dry matter of turf lawns increased the number of shoots developed. Noteworthy is the fact that the experience factors increased strength the relationship between these characteristics. The use of hydro gel in subsoil (Figure 2) or the cover from the arable soil (Figure 3) caused an increase in the R^2 value to more than 50%.

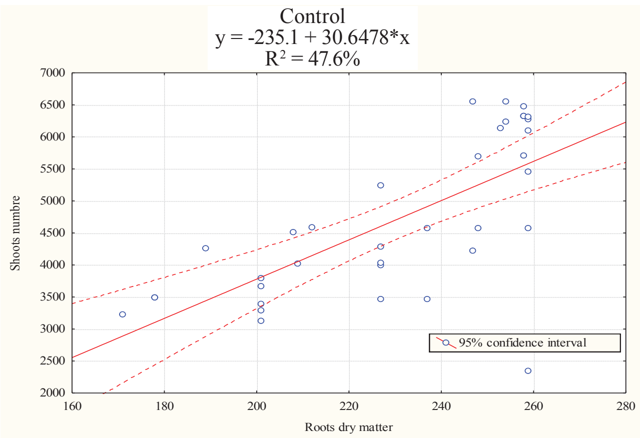

Fig. 1. Linear regression graph of the relationship between the number of shoots and roots dry weight of lawn turfs

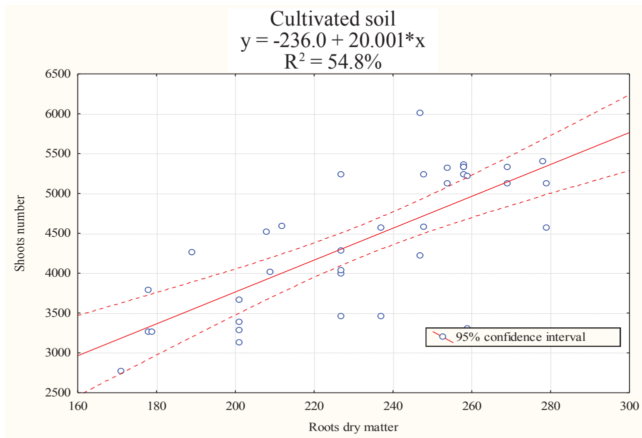

Fig. 3. Linear regression graph of the relationship between the number of shoots and dry of roots weight of lawn turfs covered with cultivated soil

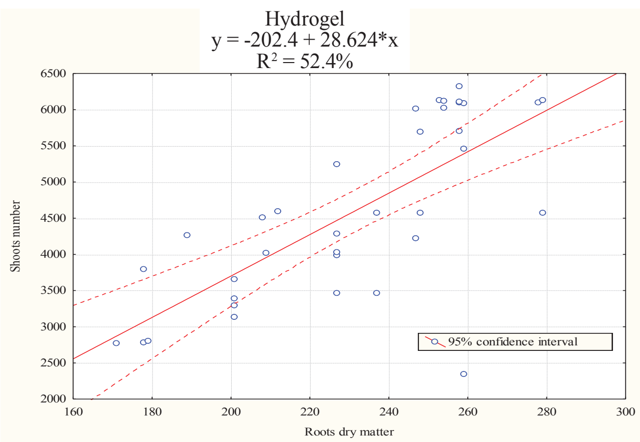

Fig. 2. Linear regression graph of the relationship between the number of shoots and roots dry weight of lawn turfs grown on substrates with a hydro gel

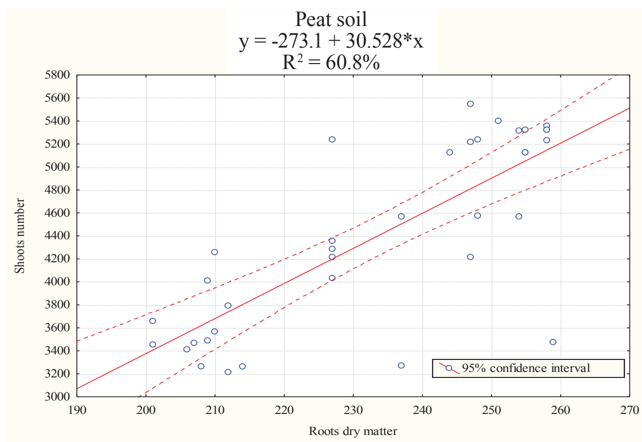

Fig. 4. Linear regression graph of the relationship between the number of shoots and dry weight of roots of lawn turfs covered with peat soil

However, turfs covered by peat, increased the value of the determination coefficient up to 60% (Figure 4).

Conclusions

- Developing of the root biomass by the tested lawn mixtures in subsequent years of the experiment varied in study years and depends on the depth of the hydro gel placement as well as the type of soil cover. On the root biomass production of the tested mixtures the most preferably influenced subsoil with 15 cm depth of hydro gel placement.
- In the first study year the most root biomass, produced mixture with domination of common bent and in the two remaining years, mixture with domination of Kentucky bluegrass. Throughout research period the most root biomass produced a mixture dominated in 40% by Kentucky bluegrass.
- Type of soil cover only in 2007, differentiated significantly the size of the root biomass produced for the benefit of arable soil cover. Also, the average from research years more root biomass was found on the object with the cover of arable soil than with horticulture peat, although these differences were not significant.
- The analysis of the linear regression function between the dry matter of the roots and the number of shoots development for analyzed turf lawns showed a significant positive correlation between these characteristics.

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