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EFFECT OF HYDROGEL AND SOIL COVER ON THE SHOOT NUMBER AND ROOT MASS FORMED BY MONOCULTURE LAWNS

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Abstract. Research was carried out in years 2007-2009 on the basis of field experiment in split-plot design, in three repetitions. Monoculture lawn was set up for the experiment. In pure 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 hydrogel „0" – control plot; b – with the addition of hydrogel 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. In the particular research years, both the number of shoots and root mass formed by the studied monoculture lawns were diversified in relation to the bedding type. In the first research year, on the bedding with 5 cm depth of hydrogel placement, the studied monocultures formed the highest root mass, and in the second year the highest shoot number. Horticultural peat cover in both research years increased both the number of shoots and the root mass of the studied monoculture lawns.

Key words: common meadow-grass, grass root mass, grass shoot number, lawn, perennial ryegrass, red fescue

INTRODUCTION

Among cultivated grasses, perennial ryegrass, red fescue, and common meadow-grass are of great significance and are important components of lawn mixtures [Martyniak 2006]. According to many authors [Rutkowska and Pawluśkiewicz 1996, Martyniak and Żyłka 2001], they are useful for turfness of both decorative and sport lawns. Studies carried out by Martyniak [2005] on perennial ryegrass and red fescue show that tillering depends on plant density per area, emergence, and instalment, and

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consequently affects the shoot number and lawn density. The author also points out the dynamics of tillering, which directly affect the general aspect of lawn. 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 utilisation, 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. They underscore the effectiveness of acrylic polymer (hydrogel), which contributes to the improvement of the root system and above-ground mass development and limits the effect of unfavourable weather conditions.

The aim of the experiment was the determination of the effect of hydrogel placed in the soil bedding and soil cover type on the shoot number and root mass formed by monoculture lawns.

MATERIAL AND METHODS

The experiment was set in 2007 and carried out until 2009 on the experimental plot of the University of Natural Sciences and Humanities in Siedlce. The research was conducted on the basis of a three-factor field experiment in three repetitions. monoculture lawn was set up and the experimental unit was a plot of 1 m^2. In pure sowing, four species of lawn grass were studied.

The experimental factors were as follows:

A – grass species: perennial ryegrass (*Lolium perenne* L.) cultivar Inka (Lp), red fescue (*Festuca rubra* L.) cultivar Nil (Fr), common meadow-grass (*Poa pratensis* L.) cultivar Alicja (Pp), and common bent (*Agrostis capillaris* L.) cultivar Tolena (Ac);

B – bedding type (depth of hydrogel placement in the soil): control plot (no hydrogel), hydrogel at the depth of 5 cm, 10 cm, and 15 cm;

C – soil cover type: cultivated soil, peat.

The following grass sowing norms were applied: perennial ryegrass 15.0 $g \cdot m^{-2}$; red fescue 6.0 $g \cdot m^{-2}$; common meadow-grass 6.5 $g \cdot m^{-2}$; and common bent 2.5 $g \cdot m^{-2}$.

After setting the experimental plots, hydrogel was applied in the amount of 50 $g \cdot m^{-2}$ in the upper soil layer to the proper depth. Sowing was carried out in late April 2007. After sowing, soil surface was randomly powdered with a thin layer of horticultural peat or native cultivated soil. During growth in the research years 2008-2009, the assessment of chosen characteristics of lawn grasses was carried out [Domański 1992, Prończuk 1993], for example monoculture shoot number and their root mass. At the end of each growth period, turf samples with root systems were collected from the studied plots. To that end, a steel sampler was used, a sharpened cylinder 5 cm in diameter and 15 cm in length. Green, living straws were counted, and then, basing on the sample block area, they were calculated according to the shoot number per 1 m^2. Root dry matter was evaluated with the method of root system study [Böhm 1985].

The experiment was set on anthropogenic soil, anthrosol, hortisol type, formed from weakly loamy sand. Soil has alkaline pH, high magnesium (8.4 mg $Mg \cdot 100\ g^{-1}$) and phosphorus (90 mg $P_2O_5 \cdot 100g^{-1}$) contents, and low potassium content (19 mg $K_2O \cdot 100\ g^{-1}$).

In the experiment, Sielianinow's hydrothermal index was calculated [Bac *et al.* 1993], and the variability of the weather conditions that affected plant growth and development in years 2007-2009 was determined (Table 1).

Table 1. Sielianinow's hydrothermal index (K) in the particular months of the growth period in years 2007-2009

Month						
April	May	June	July	August	September	October
			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

K <0.5 high drought, 0.51-0.69 drought, 0.70-0.99 week drought, over 1 – no drought

During the growth seasons, severe drought dominated, which was very unfavourable for plant development.

The obtained results underwent statistical analysis with the use of analysis of variance. For significant variability sources (factors and interactions), detailed comparison of mean values was conducted using the Tukey's test, at the significance level of $P \leq 0.5$ [Trętowski and Wójcik 1992].

RESULTS AND DISCUSSION

Lawn density expressed as the number of shoots per area is an important usable characteristic applied for the evaluation of the usefulness of lawn cultivars and hybrids [Domański 1992].

When comparing the number of shoots formed by monoculture lawns (Table 2), it may be stated that, regardless of the applied study factors, in 2008 it was almost two times lower than in 2009. It was shown that the number of shoots formed by the particular hybrids of lawn grass varied significantly. The highest number of shoots in 2008 was formed by perennial ryegrass (3133 shoots$\cdot$m^{-2}), although it varied significantly only from the number of shoots formed by common meadow-grass (2561 shoots$\cdot$m^{-2}). On the other hand, in 2009 the highest number of shoots was formed by red fescue (6091 shoots$\cdot$m^{-2}), and no significant differences were found between the remaining lawn grass species. Martyniak [2006] states that the standard value of plants that results from the optimum amount of seed sowing of lawn grass should oscillate between 3855 and 22900 seeds$\cdot$m^{-2}. In the present experiment, the number of shoots in the studied lawns fell within the given range. Taking into account the soil type, it was found that in 2008 the highest number of shoots was formed by the lawns (regardless of the grass species) on the control plot (3212 shoots$\cdot$m^{-2}), which was significantly different from the cultivation on the bedding with 5 cm and 10 cm depth of hydrogel placement. On the other hand, in 2009 the highest number of shoots was formed by lawns on the bedding with 5 cm depth of hydrogel placement (6403 shoots$\cdot$m^{-2}), which differed significantly from the lawns grown on the bedding with 10 cm depth of hydrogel placement (5641 shoots·m^{-2}) or on the control plot (5493 shoots·m^{-2}). It was also found in the research by Jankowski *et al*. [2011a, b] that the number of shoots per 1 m^2 of lawn was significantly higher on the plots with hydrogel in the bedding in relation to the number of straws obtained on the control plot with no sorbent. Diversification significance of the studied characteristic in the whole study cycle for those lawns reached circa 10%. However, Wolski *et al*. [2006], while studying lawns, showed that the introduction of hydrogel into the soil caused a 20% increase in the shoot number.

Table 2. Shoot number per 1 m^2 of lawn depending on the grass species, depth of hydrogel placement, and soil cover type

Specification		2008					2009				
		Species (A)*									
		Lp	*Fr*	*Pp*	*Ac*	mean	*Lp*	*Fr*	*Pp*	*Ac*	mean
Depth of hydrogel placement (B)	no hydrogel	2392	3683	3069	3704	3212	5630	5461	5630	5249	5493
	5 cm	3175	2265	2350	2731	2630	5948	6456	6477	6731	6403
	10 cm	3154	2688	2180	2688	2678	5609	6117	5355	5482	5641
	15 cm	3810	3069	2646	3027	3138	6329	6329	5969	6033	6165
Cover type (C)	soil	2678	2667	2159	2783	2572	5503	5821	5450	5810	5646
	peat	3588	3186	2963	3291	3257	6255	6361	6265	5937	6204
Average per year		3133	2927	2561	3037	2915	5879	6091	5858	5874	5925
$LSD_{0.05}$ for:											
A						365					ns
B						460					672
C						685					558
A × B						507					529
A × C						286					751

ns – non-significant difference
* *Lp – Lolium perenne*, *Fr – Festuca rubra*, *Pp – Poa pratensis*, *Ac – Agrostis capillaris*

Taking into account soil cover type, it was demonstrated that both in 2008 and 2009 significantly higher number of shoots was formed by lawns with peat cover than with cultivated soil cover. In both research years, significant relation was found between monoculture type and the depth of hydrogel placement. Both in 2008 and 2009, the highest number of shoots was formed by perennial ryegrass (respectively 3810 and 6329 shoots·m^{-2}) grown on soil with 15 cm depth of hydrogel placement. In 2008, the highest number of shoots was formed by perennial ryegrass on the plot with peat cover (3588 shoots·m^{-2}), and in 2009 by red fescue also on the plot with peat cover (6361 shoots·m^{-2}).

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].

Lawn grasses differ between one another in regard to resistance to drought, ability to uptake nutrients from the soil, and response to fertilisation [Falkowski *et al*. 1994], which indicates that an important role in plant adaptation to stressful conditions is played by the roots. Root system is one of the important factors that decide upon plant survival during drought [Böhm 1985]. Also root biomass is of great significance as the most important element that stabilizes turfed areas.

Analysis of the results of the root dry matter of the studied lawns obtained in the consecutive research years revealed that in 2008 the greatest amount of root mass was formed by perennial ryegrass (241 $g \cdot m^{-2}$), and in 2009 by red fescue (271 $g \cdot m^{-2}$) (Table 3). In the studies by Jankowski *et al*. [2011c] it was demonstrated, however, that in the case of lawn grass mixtures, higher proportion of red fescue seeds guaranteed higher root biomass. Also in the studies by Wolski *et al*. [2006] of the stabilization of the slopes of post-flotation tailing landfills, red fescue, among others, was characterized by the greatest growth.

Table 3. Root dry matter of monoculture lawns depending on the bedding type and soil cover, $g \cdot m^{-2}$

Specification		2008					2009				
		Species (A)*									
		Lp	*Fr*	*Pp*	*Ac*	mean	*Lp*	*Fr*	*Pp*	*Ac*	mean
Depth of hydrogel placement (B)	no hydrogel	233	232	219	237	230	223	286	257	252	255
	5 cm	267	274	254	218	253	289	248	248	196	245
	10 cm	216	222	224	159	205	238	285	223	232	244
	15 cm	251	236	250	228	241	235	264	243	263	252
Cover type (C)	soil	224	251	219	195	222	269	259	284	231	261
	peat	259	231	254	225	242	224	282	201	241	237
Average per year		241	241	237	210	232	246	271	243	236	249
$LSD_{0.05}$ for:											
A						ns					ns
B						36					ns
C						ns					ns
A × B						65					89
A × C						56					57

ns –non-significant differences
* *Lp – Lolium perenne*, *Fr – Festuca rubra*, *Pp – Poa pratensis*, *Ac – Agrostis capillaris*

Regardless of the grass species, in 2008 the highest amount of root mass was formed by lawns on the bedding with 5 cm depth of hydrogel placement (253 $g \cdot m^{-2}$), and in 2009 on the control plot (255 $g \cdot m^{-2}$). Favourable effect of supersorbent application on the growth of root mass in different plants was also found in other studies [Hetman and Martyn 1996, Jankowski *et al*. 1999, 2010, 2011c, Kościk and Kowalczyk-Juśko 1998].

On the other hand, soil cover type did not show an unambiguous effect on the quantity of root mass formed in the consecutive research years. So, in 2008 more root mass was formed by lawns on the plot with horticultural peat cover (242 $g \cdot m^{-2}$), and in 2009 on the plot with cultivated soil cover (261 $g \cdot m^{-2}$). Moreover, in both research years, significant interaction between the root mass for a given lawn grass species and both soil type and soil cover type was found.

CONCLUSIONS

1. In the particular research years, both the number of shoots and root mass formed by the studied monoculture lawns were diversified in relation to the bedding type. In the first research year, on bedding with 5 cm depth of hydrogel placement, the studied monocultures formed the highest root mass and in the second one, the highest shoot number.

2. From the studied soil cover types, in general horticultural peat in both research years affected more favourably both the number of shoots and root mass of the studied lawns.

3. From the studied lawns, in the first research year, the highest number of shoots and root dry matter was formed by perennial ryegrass, and in the second one by red fescue.

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WPŁYW HYDROŻELU I OKRYWY GLEBOWEJ NA LICZBĘ PĘDÓW I MASĘ KORZENIOWĄ WYTWORZONĄ PRZEZ TRAWNIKI MONOKULTUROWE

Streszczenie. Badania realizowano w latach 2007-2009 na podstawie doświadczenia polowego prowadzonego w układzie split-plot, w trzech powtórzeniach. W tym celu założono trawnik monokulturowy. W siewie czystym badano cztery gatunki traw gazonowych: życicę trwałą, kostrzewę czerwoną, wiechlinę łąkową i mietlicę pospolitą. W doświadczeniu zastosowano następujące czynniki badawcze: 1) rodzaj podłoża: a – bez hydrożelu „0" – kontrola; b – z dodatkiem hydrożelu umieszczonego na głębokości: 5; 10; 15 cm; 2) okrywa glebowa: a – gleba uprawna (P); b – torf ogrodniczy (T). Pod koniec każdego okresu wegetacji z poletek pobierano próbki darni wraz z systemem korzeniowym na głębokość 10 cm. Na ich podstawie dokonywano oceny suchej masy korzeni oraz na każdym krążku darni wyliczono liczbę pędów. W poszczególnych latach badań zarówno liczba pędów, jak i masa korzeniowa wytworzone przez badane murawy monokulturowe były zróżnicowane w odniesieniu do rodzaju podłoża. W pierwszym roku badań na podłożu z 5 cm głębokością umieszczenia hydrożelu badane monokultury wytwarzały największą masę korzeniową, a w drugim – liczbę pędów. Okrywa z torfu ogrodniczego w obu latach badań korzystniej wpływała zarówno na liczbę pędów, jak i masę korzeniową testowanych muraw monokulturowych.

Słowa kluczowe: kostrzewa czerwona, liczba pędów traw, masa korzeniowa traw, trawnik, wiechlina łąkowa, życica trwała

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