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 Żylka 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 m². 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·m⁻²; red
fescue 6.0 g·m⁻²; common meadow-grass 6.5 g·m⁻²; and common bent 2.5 g·m⁻².

After setting the experimental plots, hydrogel was applied in the amount of 50 g·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, Proćzuk
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 m². 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·100 g⁻¹) and
phosphorus (90 mg P₂O₅·100g⁻¹) contents, and low potassium content (19 mg K₂O·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

<table>
<thead>
<tr>
<th></th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>0.24</td>
<td>0.40</td>
<td>0.32</td>
<td>0.37</td>
<td>0.16</td>
<td>0.51</td>
<td>0.20</td>
</tr>
<tr>
<td>2008</td>
<td>0.30</td>
<td>0.67</td>
<td>0.28</td>
<td>0.37</td>
<td>0.40</td>
<td>0.51</td>
<td>0.01</td>
</tr>
<tr>
<td>2009</td>
<td>0.07</td>
<td>0.53</td>
<td>0.92</td>
<td>0.13</td>
<td>0.45</td>
<td>0.17</td>
<td>1.45</td>
</tr>
</tbody>
</table>

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 m$^{-2}$), although it varied significantly only from the number of shoots formed by common meadow-grass (2561 shoots m$^{-2}$). On the other hand, in 2009 the highest number of shoots was formed by red fescue (6091 shoots 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 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 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 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

<table>
<thead>
<tr>
<th>Specification</th>
<th>2008</th>
<th>2009</th>
<th>Species (A)*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2008</td>
<td>2009</td>
<td>Species (A)*</td>
</tr>
<tr>
<td></td>
<td>Lp</td>
<td>Fr</td>
<td>Pp</td>
</tr>
<tr>
<td>Depth of hydrogel placement (B)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>no hydrogel</td>
<td>2392</td>
<td>3683</td>
<td>3069</td>
</tr>
<tr>
<td>5 cm</td>
<td>3175</td>
<td>2265</td>
<td>2350</td>
</tr>
<tr>
<td>10 cm</td>
<td>3154</td>
<td>2688</td>
<td>2180</td>
</tr>
<tr>
<td>15 cm</td>
<td>3810</td>
<td>3069</td>
<td>2646</td>
</tr>
<tr>
<td>Cover type (C) soil</td>
<td>2678</td>
<td>2667</td>
<td>2159</td>
</tr>
<tr>
<td>peat</td>
<td>3588</td>
<td>3186</td>
<td>2963</td>
</tr>
<tr>
<td>Average per year</td>
<td>3133</td>
<td>2927</td>
<td>2561</td>
</tr>
<tr>
<td>LSD(_{0.05}) for:</td>
<td>A</td>
<td>365</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>460</td>
<td>672</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>685</td>
<td>558</td>
</tr>
<tr>
<td></td>
<td>A × B</td>
<td>507</td>
<td>529</td>
</tr>
<tr>
<td></td>
<td>A × C</td>
<td>286</td>
<td>751</td>
</tr>
</tbody>
</table>

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·m⁻²), and in 2009 by red fescue (271 g·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·m⁻²

<table>
<thead>
<tr>
<th>Specification</th>
<th>2008</th>
<th>Species (A)*</th>
<th>2009</th>
<th>Species (A)*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lp</td>
<td>Fr</td>
<td>Pp</td>
<td>Ac</td>
</tr>
<tr>
<td></td>
<td>mean</td>
<td>mean</td>
<td>mean</td>
<td>mean</td>
</tr>
<tr>
<td>Depth of hydrogel placement (B)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>no hydrogel</td>
<td>233</td>
<td>232</td>
<td>219</td>
<td>237</td>
</tr>
<tr>
<td>5 cm</td>
<td>267</td>
<td>274</td>
<td>254</td>
<td>218</td>
</tr>
<tr>
<td>10 cm</td>
<td>216</td>
<td>222</td>
<td>224</td>
<td>159</td>
</tr>
<tr>
<td>15 cm</td>
<td>251</td>
<td>236</td>
<td>250</td>
<td>228</td>
</tr>
<tr>
<td>Cover type (C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>soil</td>
<td>224</td>
<td>251</td>
<td>219</td>
<td>195</td>
</tr>
<tr>
<td>peat</td>
<td>259</td>
<td>231</td>
<td>254</td>
<td>225</td>
</tr>
<tr>
<td>Average per year</td>
<td>241</td>
<td>241</td>
<td>237</td>
<td>210</td>
</tr>
</tbody>
</table>

LSD₀.₀₅ 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·m⁻²), and in 2009 on the control plot (255 g·m⁻²). Favouable 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·m⁻²), and in 2009 on the plot with cultivated soil cover (261 g·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.

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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.

REFERENCES


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 utworzone przez badane murawy monokulturowe były zróżnicowane w odniesieniu do rodzaju podłoża. W pierwszym roku badań na podłożu z 5 cm głębokości 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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