Original Paper

The influence of mycorrhizal preparations on the growth and production process of turf under non-irrigated conditions

Peter Hric,* Ján Jančovič, Peter Kovár, Ľuboš Vozár

Slovak University of Agriculture Nitra, Slovakia

The aim of this experiment was to determine the influence of mycorrhizal preparations on chosen indicators of the growth and production process of turf. The experiment was realized in the Experimental station of the Department of Grassland Ecosystems and Forage Crops Faculty of Agrobiology and Food Resources Slovak University of Agriculture in Nitra in warm and dry conditions. Four indicators were evaluated: the average height of vegetation, the average daily gain of turfgrass height, the production of dry above-ground phytomass and the average daily gain of dry above-ground phytomass. In the experiment, 4 treatments were evaluated (1. no mycorrhizal preparation 2. the mycorrhizal preparation Turfcomp®, 3. the mycorrhizal preparation Symbivit®, 4. the mycorrhizal preparation Conavit®). The results showed that the lowest rate of the daily gains was detected after the application of the mycorrhizal preparation Symbivit® (4.06 mm day^{-1}). The lowest production was determined in the treatment with the mycorrhizal preparation Turfcomp® (2.40 g day^{-1} m^{-2}). In conclusion, we can say that when it comes to turfgrass, Turfcomp® and Symbivit® proved the most successful.

Keywords: turf, mycorrhiza, mycorrhizal preparations, growth and production process

1. Introduction

Turfs are an indispensable and essential part of the scope of greenery in urban areas. In Slovakia, their quality is low despite some improvements in recent years (Gregorová et al., 2009).

The intensity of turf growth is influenced by habitat conditions, nitrogen nutrition, season, irrigation and frequent mowing (Domański et al., 2011).

Production of the above-ground biomass of turf is given by the amount of removed clippings or mowing. It is influenced not only by fertilization and irrigation but also by other cultural and environmental factors (Turgeon, 2002).

Poaceae creates arbuscular mycorrhiza and the mycelium of *Zygomycetes* fungus grows from microscopic spores in the soil into the intercellular spaces and in the cells of the root cortex. This specific relationship between roots and fungi leads to "enrichment" of the root system of grasses by fine filaments of fungi which essentially act as the finest roots and are many times thinner than root hairs (Oehl et al, 2003; Schmid et al., 2008). Therefore, they can penetrate into the smallest soil pores and absorb more water and nutrients than the roots of grasses alone. Among other things, they promote the formation of soil aggregates, maintain soil structure, allow greater penetration of water and air and prevent erosion (Miller and Jastrow, 1992; Koide and Wu, 2003).

Zygomycetes fungi are supplied to the soil by means of mycorrhizal preparations. This contributes to more efficient revenue of water and nutrients, higher intensity of metabolic processes, increased resistance to stress due to an increase in root biomass and decreased need for irrigation and fertilization and soil protection against certain diseases (Gryndler et al., 2004).

This work is aimed to assess the impact mycorrhizal preparations have on the turf growth and production process.

2. Material and methods

The experiment was realized in the Experimental station of the Department of Grassland Ecosystems and Forage Crops Faculty of Agrobiology and Food Resources Slovak University of Agriculture in Nitra. The experiment was located in a moderate climatic zone in a warm and dry area. The average annual temperature is 9.7 °C and annual rainfall is 560 mm (Špánik, Šiška and Repa, 1996). The average monthly temperature (°C) and rainfall (mm) in the observed vegetation period are shown in Figure 1.

The experiment was based on a clay-loam fluvisol. In the autumn before the beginning of the experiment, we collected 250 g of soil samples from an experimental area from the depth of 0–200 mm. The samples were analyzed in terms of:

- N_{tot} – Kjeldahl method,
- P – spectrophotometrically using the phosphomolybdic method in the leachate by Mehlich III,
- K, Ca – flame-photometrically in the leachate by Mehlich III,
- Mg – spectrophotometrically in the leachate by Mehlich III,
- oxidizable carbon (C_{ox}) – using the Ťjurin method as modified by Nikitin H_m (% humus) = $C_{ox} \cdot 1.724$,
- pH – exchangeable in KCl.

*Correspondence: Peter Hric, Slovak University of Agriculture in Nitra, Faculty of Agrobiology and Food Resources, Department of Grassland Ecosystems and Forage Crops, Tr. Andreja Hlinku 2, 949 76 Nitra, e-mail: hric.peter@post.sk

Table 1 Agrochemical properties of soil on the experimental site

N_{tot}.	P	K	Mg	Ca	C_{ox}	pH
mg.kg^{-1}					g.kg^{-1}	
1,823.2	58.3	336	541	6 067	0.77	6.78

Table 2 Dates of height measurement and phytomass sampling in 2012

Order of measurement /sampling	1.	2.	3.	4.	5.	6.	7.	8.	9.
Date of measurement /sampling	2.5.	9.5.	16.5.	28.5.	14.6.	19.6.	28.6.	25.7	25.10.

The soil type is fluvial soil. The agrochemical composition of soil on the experimental site is indicated in Table 1.

The experiment was established on 4th October 2011. We used turf mixture designed for low slowly growing turfs with the following composition: *Lolium perenne* L. (30 %), *Festuca rubra* L. (50 %) and *Festuca ovina* L. (20 %).

The size of the experimental plots area is 2.4 m^2 and each variant was in 3 random replications. Mycorrhizal preparations in a dose of 360 g (150 g.m^{-2}) were applied in the establishment experiment.

In the experiment, there were 4 various treatments:

1. no mycorrhizal preparation (“control”),
2. the mycorrhizal preparation Turfcomp® (“Turfcomp”),
3. the mycorrhizal preparation Symbivit® (“Symbivit”),
4. the mycorrhizal preparation Conavit® (“Conavit”).

Characteristics of used mycorrhizal preparations:

– turfcomp is a grass conditioner consisting of natural argillaceous media, 6 kinds of mycorrhizal fungi, natural ingredients that support mycorrhiza (humates, ground minerals, extracts of marine organisms), biodegradable polyacrylamide granules, sapropel (biological sediment). It contains 1.3 % of N, 0.6 % of P, 3 % of K, 1 % of Mg, 2.8 % of Ca and 0.8 % of S.

Symbivit is based on endomycorrhizal fungi. It contains natural argillaceous media, 6 kinds of mycorrhizal fungi, natural ingredients that support mycorrhiza (humates, ground minerals, extracts of marine organisms) and biodegradable polyacrylamide granules.

Conavit contains mycorrhizal fungi, keratin, natural humates, ground minerals (zeolite, serpentine, apatite) and 5 % of N, 6 % of P, 4 % of K, 2 % of Mg, 2 % of S and 4 % of Ca.

When 80–100 cm high, the turf was mown to reach the height of 50 mm. Before each mowing, the turf height (mm) was determined as an average of 10 measurements in plots and production of above-ground phytomass (g m^{-2}) was determined by sampling the above-ground phytomass with accumulation scissors from the surface of 0.1 × 1 m. Table 2 lists the dates of measurement and sampling of phytomass.

In the present paper, we present the monitoring from year 2012.

The results were evaluated by the software STATISTICA 7.1 and a complete CZ analysis of variance (Fisher LSD test, $\alpha = 0.05$).

3. Results and discussion

On the basis of the values of average height of turf in mowing (Figure 2), we can conclude that the highest average level was reached on the turf treated with the mycorrhizal preparation Conavit (97.86 mm). This variant also reached the highest perennial height of vegetation of 398.6 mm. The smallest average height of vegetation was reached on the turf treated with the mycorrhizal preparation Symbivit (91.08 mm). In this context, it is interesting to note that when the mycorrhizal preparations Turfcomp and Symbivit were applied, lower overall vegetation was recorded than in the control. This can be explained by a very dry year (Figure 1) and it is likely to negatively impact the development of mycorrhiza. The differences between various treatments were insignificant ($F = 0.236$, $p = 0.870$).

The average daily gain of turrfgrass height was the second evaluated feature (Figure 3). At the beginning of vegetation, its values ranged in the scale from 7.0 mm day^{-1} (Symbivit) to 10.19 mm day^{-1} (control). Subsequently, the intensity of height growth was decreasing with a transient slight increase in the second half of May. The minimum average daily gain of turfgrass height (approximately 3 mm day^{-1}) was recorded in the first half of June. At the next mowing (19th June), the intensity of growth increased significantly from the level of 6.74 mm day^{-1} (control) to 10.86 mm day^{-1} (Conavit). This increase can be explained by better conditions for the development of mycorrhiza

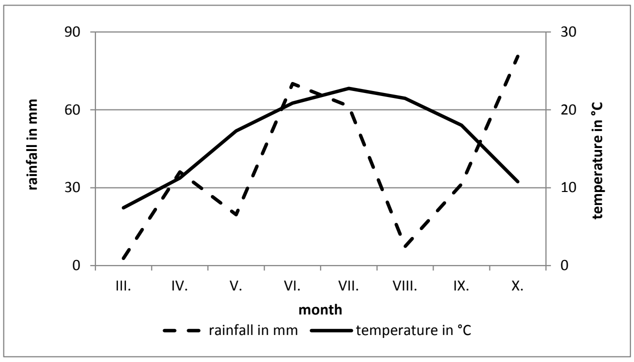

Figure 1 Average monthly temperature and rainfall in the vegetation period of 2012
Source: Department of Biometeorology and Hydrology, Horticulture and Landscape Engineering Faculty, Slovak University of Agriculture in Nitra

triggered by intense rainfall (Figure 1). Since the end of the 2nd decade of June, the average daily gain of turfgrass height gradually decreased in all treatments and among individual treatments, we observed only minimal differences. In the yearly comparison, the fastest growing turf was the one treated with the mycorrhizal preparation Conavit (4.77 mm day^{-1}). The slowest growing turf was the one treated with Symbivit (4.06 mm day^{-1}). When comparing the values of average daily gain of turfgrass height with the values of the Descriptor for *Poaceae* family (Ševčíková, Šrámek and Faberová, 2002), we found out that the vegetation had "*moderate*" growth (4.1–5.0 mm day^{-1}), i. e. achieved 3 points on the point scale where 1 is the worst and 9 the best rating level. The differences between treatments were insignificant (F = 1.504, p = 0.24). However, we found a significant effect of mowing on the average daily gain of turfgrass height (F = 70.590, p = 0.000).

The values of yearly production of above-ground phytomass (Figure 4) showed that the highest production was reached in the control treatment (277.3 g m^{-2}). The lowest production of above-ground phytomass was produced in the treatment with the mycorrhizal preparation Turfcomp (219.5 g m^{-2}). The lowest average production of above-ground phytomass (24.39 g m^{-2}) was characteristic for this treatment. Comparing the values of yearly production of above-ground phytomass showed that the control treatment and the turf treated with the mycorrhizal preparation Conavit according to the Descriptor for *Poaceae* family (Ševčíková, Šrámek and Faberová, 2002) was characterized by "low to very low" phytomass production (250–400 g m^{-2}). Treatments with the mycorrhizal preparations Turfcomp and Symbivit had "very low" phytomass production (to 250 g m^{-2}). This effect is positive because the aim of turf growing is to obtain and maintain satisfactory turf – adequately dense, colour-balanced, uniform, wear-resistant – without high production of above-ground phytomass (Turgeon, 2002; Cagaš and Macháč, 2005). Treatments with mycorrhizal preparations were characterized by low production of above-ground phytomass when compared to the control treatment during the observed period. It is inconsistent with the results achieved by Martincová and Ondrášek (2009). They detected a higher production of above-ground phytomass in the treatments with mycorrhizal preparations. After the application of Turfcomp and Symbivit, we recorded a lower overall production of above-ground phytomass in comparison with the control treatment. This fact we again explain by a substantially dry year (Figure 1). The differences between treatments were insignificant (F = 0.570, p = 0.639).

The average daily gain of dry above-ground phytomass (Figure 5) was the next evaluated feature. At the beginning of vegetation, we detected a generally mild initial decrease in gains among treatments. In mid-June, the production of the phytomass increased in all treatments. The highest value was achieved in the turf treated with mycorrhizal

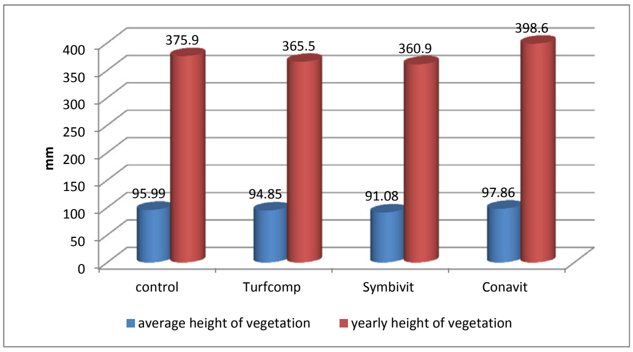

Figure 2 Average height of vegetation and yearly height of vegetation

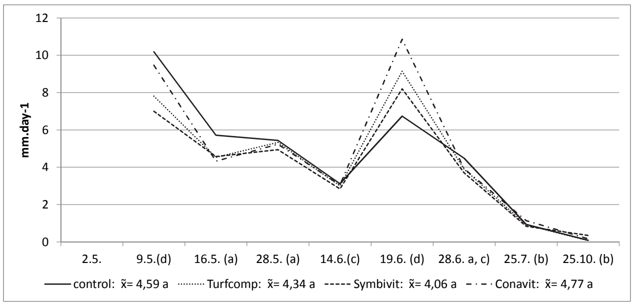

Figure 3 Average daily gain of turfgrass height in mm.day^{-1}
Different indexes (a–f) with average values in the rows represent a significant difference (Fisher test α = 0.05)

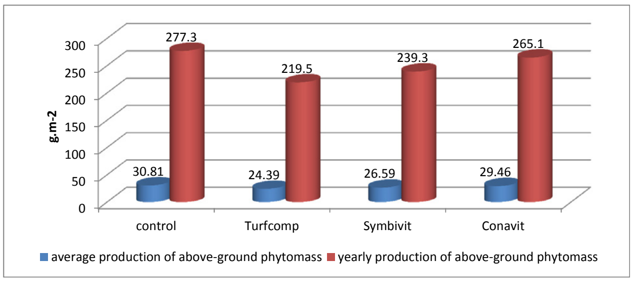

Figure 4 Average production of above-ground phytomass in g.m^{-2} and yearly production of above-ground phytomass in g.m^{-2}

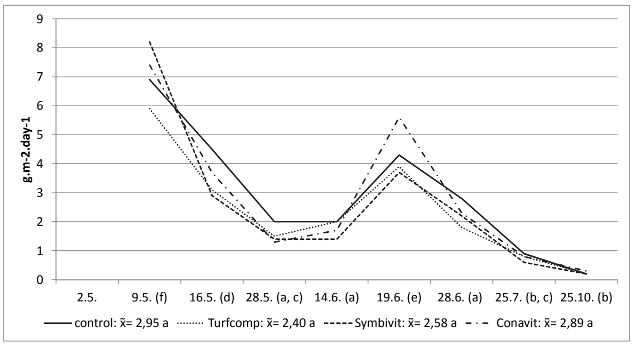

Figure 5 Average daily gain of dry above-ground phytomass in g.day^{-1}.m^{-2}
Different indexes (a–f) with average values in the rows represent a significant difference (Fisher test α = 0.05)

preparation Conavit (5.60 g day^{-1} m^{-2}). Then, the intensity of vegetable matter gradually declined and this trend was maintained until the end of the observed period. In the yearly average, the highest dynamics of daily production of above-ground phytomass was recorded in the control treatment (2.95 g day^{-1} m^{-2}). However, the lowest average daily gain of dry above-ground phytomass was recorded in the turf treated with the mycorrhizal preparation Turfcomp (2.40 g day^{-1} m^{-2}). Overall, we can say that using mycorrhizal preparations had a statistically insignificant impact on the taverage production of above-ground phytomass (F = 1.99 and p = 0.146). Each mowing had a statistically significant effect on the evaluated indicator (Figure 5), where we found F = 70.65 and p = 0.000.

4. Conclusions

In the turf experiment, we evaluated the effect of 3 different mycorrhizal preparations on selected indicators of turf growth and production process. Each experimental treatment was conducted in 3 replications. We conducted 9 measurements in the period from 2nd May 2012 to 25th October 2012. Turf growing is not aimed at producing a large amount of green matter as it is in forage crops. Also, rapid growth of green matter and the associated mowing is undesirable for each turf grower. During their cultivation, the emphasis lies on the turf quality and its non-productive functions (insight, colour...). On the basis of the results, we found out that the turf treated with the mycorrhizal preparation Turfcomp® produced the least above-ground phytomass (2.40 g day^{-1} m^{-2}). While evaluating the average height of the turf, we found out that the slowest growth was achieved with the application of the mycorrhizal preparation Symbivit® (4.06 mm day^{-1}). Results show that the best preparations for the selected goal are Turfcomp® and Symbivit®. Globally, very few studies were focused on the use of mycorrhizal preparations in turfs.

5. References

CAGAŠ, B. and MACHÁČ, J. (2005) Turfgrass protection against diseases, pests, weeds and abiotic damages. České Budejovice: Kurent (in Czech).

DOMAŃSKI, P. J., ANDRZEJEWSKA, J. and IWICKI, R. (2011) Effect of utilization intensity on growth of lawn cultivars of kentucky bluegrass (*Poa pratensis* L.). In Acta scientiarum polonorum, vol. 10, no. 3, pp. 15–26.

GREGOROVÁ, H. (2009) Turfgrass response to compaction. In Turfgrasses in the 21st century: workoshop proceedings. Nitra, Cabaj-Čápor, November 12, 2009. Nitra: SUA (in Slovak).

GRYNDLER, M. et al. (2004) Mycorrhizal symbiosis. Praha: Academia (in Czech).

KOIDE, R. and WU, T. (2003) Ectomycorrhizas and retarded decomposition in a Pinus resinosa plantation. In New Phytologist, vol. 158, no. 3, pp. 401–407.

MARTINCOVÁ, J. and ONDRÁŠEK, Ľ. (2009) Impact of special microbial preparates on the yield and soil characteristics under climatic change conditions. In Effect of abiotic and biotic stress factors on the plant characteristics: proceedings from the 7th workshop, 26th November 2009. VURV: Praha–Ruzyně, pp. 313–317 (in Czech).

MILLER, R. M. and JASTROW, J. D. (1992) The role of mycorrhizal fungi in soil conservation. In Proceedings of a symposium on mycorrhizae in sustainable agriculture, ASA Special Publication, no. 54, pp. 29–44.

OEHL, F. et al. (2003) Impact of land use intensity on the species diversity of arbuscular mycorrhizal fungi in agroecosystems of Central Europe. In Applied and environmental microbiology, vol. 69, no. 5, pp. 2816–2824.

SCHMID, T., OEHL, F. and SCHNUPFER, R. (2008) Application of arbuscular mycorrhizal fungi for the revegetation of raw soils. In 1st European Turfgrass Society conference proceedings, vol. 1, pp. 167–168.

STATISTICA (data analysis software system). Version 7.0 [Online]. Stat Soft-ME. Available from: http://statsoft-me.com/. [Accessed: 1st June 2013].

ŠEVČÍKOVÁ, M., ŠRÁMEK, P. and FABEROVÁ, I. (2002) Descriptor for Poaceae family. Zubří: OSEVA PRO.

ŠPÁNIK, F., ŠIŠKA, B. and REPA, Š. (1996) The Nitra 1995 agroclimatic characteristics no. 5. Nitra: VŠP (in Slovak).

TURGEON, A. J. (2002) Turfgrass management. 6th edition. New Jersey: Prentice Hall Upper Saddle River.