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THE SHARE OF ROOTS, SWARD AND STUBBLE BIOMASS IN BIOLOGICAL YIELD OF SELECTED GRASS SPECIES

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Abstract. In this study assessed the share of harvested yield and share of root stem bases and stolon biomass in biological yield of 6 grass species grown in pure sowing. The biological yield included harvested yield from 3 regrowth and biomass of RSS (roots, sward and stubble), which was taken after 3th cut. The highest biological yield was observed in *Festuca rubra,* next in *Arrhenatherum elatius* and *Poa pratensis*, and the smallest in *Holcus lanatus* and *Agropyron repens*. In *F. rubra* harvested yield held 13.8% of biological yield, and RSS biomass held 86.2%. In contrast, in *H. lanatus* harvested yield was 44.7% and RSS biomass was 55.3% of biological yield.

Key words: *Agropyron repens, Arrhenatherum elatius, Festuca rubra, Holcus lanatus, Poa pratensis,* biological yield, harvested yield, root, sward and stubble biomass

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Introduction

Productivity of grass is generally evaluated in terms of dry matter yield. Less attention is paid to a total yield (biological yield) produced by the plant species. According to Domański (1998) non-utilization yield (biomass of roots, sward and stubble – RSS) determined the durability of plant and rate of recovery after the winter and each regrowth after harvest. According to Wolski *et al.* (2006) in the grass coverage process the proper development of root system is an essential element in stabilizing the ground horizontally and vertically. RSS biomass determines the level of grass coverage process, the resistance of sod and soil from destruction. The size and location of the root mass is dependent not only on the type of grass but also of abiotic conditions (Głąb *et al.* 2009). Compact and strong sod is the most desired features in places often trampled and exposed to erosion. Thus, the aim of this study was to determine the biological yield, as well as RSS biomass in selected grass species with the ability to display their possibility to utilization in different management areas.

Material and methods

The assesment of species yielding was conducted for 3 years. Experimental field was located in Krakow – Bielany (50°2'9.41 N, 19°49'34.52 E). Experiment was established on the soil which in Polish soil taxonomy from 2011 is set as brown earths. The chemical properties of the soil were: pH(KCl) – 5.34; organic substance – 1.134%, total nitrogen – 0.078%, sulfur – 0.013%; assimilable P, K and Mg – 31.03, 138.46, 86.22 mg · kg^{-1} DM respectively. Following grasses: *Poa pratensis* L., *Holcus lanatus* L., *Festuca rubra* L., *Lolium perenne* L., *Arrhenatherum elatius* (L.) P. Beauv. ex J. Presl & C. Presl. and *Agropyron repens* (L.) P. Beauv. was sown in pure sowing in the early spring of 2010. Above replacement grass seeds come from local ecotypes. Annually grasses received 15 kg · ha^{-1} of P, 30 kg · ha^{-1} of K and 100 kg · ha^{-1} of N.

Phosphorus and potassium was used once in the spring, nitrogen was used in three doses – 40% in the first regrowth and 30% at the second and third regrowth. Sward was mowed three times per year. In the third year of the study participation of species in the sward was follow: *P. pratensis* was 90%, *H. lanatus* – 94%, *F. rubra* – 97%, *A. elatius*

Fig. 1. The holding of the soil by: ***1*** *– Poa pratensis;* ***2*** *– Holcus lanatus;* ***3*** *– Festuca rubra;* ***4*** *– Arrhenatherum elatius;* ***5*** *– Lolium perenne,* ***6*** *– Agropyron repens.*

– 86%, *L. perenne* – 87%, *A. repens* – 90%.

Harvested yield was weighed annually. Third column of Tab. 1 shows the average data for three years. Samples of RSS biomass were collected after third cutting in the third year of experiment (25.09.2012). Because Rutkowska *et al.* (1980) and Tomaškin (1997) shown that grasses after this period have the relation between aboveground and underground biomasses very close to that in perennial meadows and pastures. Roots with stolons were taken with special instrument for collecting plant material (Patent No. 212867). Samples were collected in 10 replicates taken from a depth 0-20 cm. The surface area of ten replicates was 0.25 m^2, and results were calculated per 1 ha. Roots and stolon biomasses from soil and determined dry matter, as well as calculated size of the RSS biomass are shown in Tab. 1. The results were analyzed statistically with ANOVA and LSD difference traits were considered significantly at the level of $p<0.05$ applying Statistica 7.0 software.

Results

Fig. 1 shows how root systems of grasses holding the soil. *F. rubra* roots the best penetrate the soil profile horizontally as well as vertically (Fig. 1 *3*). In this species most roots are developed in the soil up to 18 cm and strongly holding the soil. In second place in this respect was *P. pratensis* (Fig. 1 *1*) and *A. elatius* (Fig. 1 *4*). In these species, most roots reached up to 18 cm, but holding of the soil was worse. In the next position in terms of the above-mentioned features were *H. lanatus* (Fig. 1 *2*) and *A. repens* (Fig. 1 *6*). The shallowest root system has *L. perenne* (Fig. 1 *5*). In this first species roots were developed in the soil up to 5 cm and only to this depth they well hold the soil.

The data of Tab. 1 show that the highest biological yield was produced by *F. rubra* – 29 $t \cdot ha^{-1}$ DM. Almost 20% smaller biological yields were in *P. pratensis* and *A. elatius*, about half less – in *H. lanatus, A. repens* and *L. perenne*.

The highest harvested yield was produced by *A. elatius* (8.5 $t \cdot ha^{-1}$, and 38.2% of biological yield). Harvested yields of *H. lanatus* and *L. perenne* were lower than the yield of *A. elatius* by 34%, and of *P. pratensis* and *A. repens* – by 42%. The smallest yield was in *F. rubra* – just 4 $t \cdot ha^{-1}$. However, the RSS biomass of *F. rubra* was more than in 6 times higher than the harvested yield, and it was the largest among studied species.

Biomass of RSS of *P. pratensis* comparing the harvested yield was almost 3.5 times higher, while in the other species this value was ranged

Table 1. Biological and harvested yield, and RSS biomass of selected grass species.

Species	Biological yield	Harvested yield	RSS biomass	The share of RSS biomass in the biological yield, %
	$t \cdot ha^{-1}$ (DM)			
Poa pratensis	22.1b	5.0	17.1b	77.3
Holcus lanatus	14.6d	6.5b	8.1d	55.3
Festuca rubra	29.0a	4.0d	25.0a	86.2
Arrhenatherum elatius	22.3b	8.5a	13.8	61.8
Lolium perenne	16.2c	6.5b	9.7c	59.9
Agropyron regens	14.7d	5.0c	9.7c	65.9

*Means within the column followed by the same letter are not significantly differ by Tukey's Multiple Range Test at P≤0.05.

from 1.2 to 1.9 times. The share of RSS biomass in the biological yield was the highest in *F. rubra* and amounts up to 86.2%, in the second position was *P. pratensis* – 77.3%. In the rest species the share of RSS biomass in biological yield was on 1/3 lower than in *F. rubra*.

Discussion

The roots of *F. rubra, P. pratensis* and *A. elatius* are very well developed vertically. However, in two last species roots weakly holding the soil what indicates the lower horizontal development. According to Turgeon (2005) and Wolski *et al.* (2006) in most species of grasses roots are developed in orthotropic way. The research of Rychnowska (1983) and Jankowski *et al.* (2012) shown that main root mass is located in the soil up to 20 cm, but their horizontal arrangement shows wide variability.

Presented study on RSS biomass in share of biological yield in *H. lanatus, L. perenne, A. repens* and *A. elatius* is similar to the results represented by Pechačkova & Krahulec (1995) in the meadows with mixed sward. According to Janicka (2004) RSS biomass in the yield of the most grasses is about 70%. It corresponds to our observations for *P. pratensis* and *A. repens*, while for *F. rubra* the value was about 1/5 higher than obtained by Janicka (2004).

Conclusions

1. Location of grass roots in the soil profile is a feature which mostly depends from species.

2. There was no obtained strong correlation between harvested yield and RSS biomass.

3. Biomass of biomass of roots, sward and stubble (RSS) in *Festuca rubra* was the largest and was in 3 times higher than in *Holcus lanatus*.

4. The smallest harvested yield provided by *Festuca rubra*, and the largest – by *Arrhenatherum elatius*. The yield of these species differs more than twice.

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