EFFECT OF MOWING AND MULCHING FREQUENCY ON UNDERGROUND PHYTOMASS OF FLOODPLAIN MEADOW*

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The effect of mowing and mulching frequency on underground phytomass production of floodplain meadow was studied during the years 2005 and 2006. The experiment was carried out on a permanent meadow of *Alopecuretum* community type near the village of Černíkovice (363 m a.s.l.). The following treatments were evaluated: mowing once and twice a year and mulching once and twice a year. Underground phytomass was taken to the depth of 150 mm in spring, summer and autumn using a soil core. Results show that defoliation twice a year led to the increase by 34% of total amount of underground phytomass in comparison with once defoliated plots ($P < 0.001$). An average weight of underground phytomass ranged from 1129 g.m^{-2} on the once mulched plots to 1752 g.m^{-2} on the twice mulched plots. Mulching management increased rhizomes share on the total underground phytomass ($P = 0.001$). Defoliation frequency influenced the amount of underground phytomass more than management type (mulching, mowing).

underground phytomass; rhizomes; roots; mowing; mulching; defoliation frequency

INTRODUCTION

The structure and function of root system play a critical role in carbon and nutrient dynamics of ecosystems and affect species interaction (Jackson et al., 1997). More than 60% of all dry root phytomass of temperate forage grasses is spread to the depth of 0.1 m while roots deeper than 0.5 m are rare (Míka, 1975). Amount of underground phytomass depends on botanical composition of the sward. The development of species composition is influenced by technique of management, exploitation, fertilization and conservative ecological factors but mostly on the water conditions of the site (Mrkvička et al., 2006).

Taking environmental conditions into account, defoliation is one of the major factors affecting root phytomass (Meneses Florián et al., 2003). Grassland communities are sensitive to mowing or grazing impact. This is also reflected in changes in the amount of root phytomass and its distribution through the soil profile (Detling, 1979). Fiala (1997) evaluated the response of underground phytomass to different intensities of mowing and concluded that higher intensity of defoliation usually resulted in decrease of root phytomass. Pecháčková et al. (2004) found that total underground phytomass was almost twice as high in the abandoned stands than in regularly mowed meadow stands. On the contrary, mowing and mulching stimulate an axillary bud what leads to increase of rhizomes amount (Fransen et al., 1998). The underground phytomass yield of *Alopecurus pratensis* dominated meadow ranged from 11.4 to 19.8 t.ha^{-1} after four years of twice cut management with the seasonal maximum from August to November (Velich, 1986).

Mulching affects the nutrition balance of soils due to stepwise decomposition of mulch. This process leads to accumulation of the nutrients in the upper soil layers. Mulch can enhance root growth by creating a favourable microclimate in the rhizosphere and improving the physical, chemical and biological properties of the soil (Meneses Florián, 2005). There is a lack of information about the effect of mulching in comparison with mowing on total amount and vertical distribution of underground phytomass. In this study we evaluated the effect of different mowing and mulching frequencies on the total underground phytomass production and vertical stratification in the years 2005 and 2006 after 5, or 6 years, respectively of exploitation of meadow stand.

MATERIAL AND METHODS

The study was carried out on a meadow near the village of Černíkovice, the district of Benešov (363 m a.s.l.), lat. 49°47′N, long 14°45′E. The experiment was established in spring 2001. Mean annual precipitation is 617 mm and mean annual temperature is 7.8 °C. The vegetation belongs to the *Alopecuretum* stand type. The water regime of the stand is mesohygrophytic with fluctuating underground water level.

The following treatments were evaluated: mowing once a year, mowing twice a year, mulching once a year and mulching twice a year. The biomass was cut and leaved in the plot after mulching. The stand was not fertilized. There were four replications per treatment and the plot size was of 5 x 4.5 m. In the years 2005 and 2006 four soil core samples were taken randomly from each replication in spring, summer and autumn by using a hand driven soil corer (45 mm diameter). The dates of maintenance and samplings are presented in Table 1. Soil with underground phytomass was taken to 150 mm depth and divided into

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Table 1. Date of maintenance and remove samplings terms in the years 2005 and 2006

Maintenance	2005	2006
First cut and mulching of twice defoliated plots; spring roots sampling	April 19	April 19
Summer roots sampling	July 19	July 20
First cut and mulching of once defoliated plots; second cut and mulch of twice defoliated plots; autumn roots sampling	October 16	October 16

three layers 1st 0–50 mm, 2nd 50–100 mm and 3rd 100–150 mm. Underground phytomass (roots and rhizomes) was separated from soil particles by washing and sieving (0.5 mm mesh size). Live and dead phytomass was dried at 65 °C and separated into roots and rhizomes.

The effect of management type (mowing, mulching) and defoliation frequency on underground phytomass was tested using the ANOVA model and Tukey HSD multiple comparison procedure.

RESULTS AND DISCUSSION

The total amount of underground phytomass was significantly dependent on the frequency of management (Table 2). The higher production of underground phytomass was on the twice defoliated plots ($P < 0.001$). Interaction shows that the difference is perceptible in both management types but particularly on mulched plots (Table 3). The higher underground phytomass amount on the plots with more intensive defoliation is at variance with studies of many authors (e.g. Evans, 1973; Fiala, 1997). The fact can be explained by different species composition and coverage of stand. The cut on the once defoliated plots was made at the end of growing season which led to an increase of dicotyledonous species with lower density of roots in upper layer of soil profile. Grasses, with shallow root system, dominates the twice a year mulched treatment. Another reason for higher underground phytomass production on twice defoliated plots is that

Table 2. The effect of treatment and defoliation frequency on underground phytomass (UP), ANOVA results

		F	*p*	Multiple comparison
1st layer (g.m^{-2})	Treatment	0.503	0.480	–
	Frequency	18.225	**0.000**	once < twice
	T x F	4.847	**0.030**	*
2nd layer (g.m^{-2})	Treatment	0.552	0.459	–
	Frequency	6.834	**0.010**	once < twice
	T x F	1.466	0.229	–
3rd layer (g.m^{-2})	Treatment	0.636	0.427	–
	Frequency	0.013	0.911	–
	T x F	1.217	0.273	–
Total (g.m^{-2})	Treatment	0.252	0.617	–
	Frequency	27.973	**0.000**	once < twice
	T x F	6.127	**0.015**	*
UP 1st layer (%)	Treatment	0.040	0.841	–
	Frequency	0.063	0.803	–
	T x F	1.950	0.166	–
UP 2nd layer (%)	Treatment	0.134	0.715	–
	Frequency	1.350	0.248	–
	T x F	0.071	0.790	–
UP 3rd layer (%)	Treatment	0.039	0.843	–
	Frequency	2.366	0.127	–
	T x F	7.765	**0.006**	*
Rhizomes (g.m^{-2})	Treatment	12.984	**0.001**	mow < mulch
	Frequency	41.854	**0.000**	once < twice
	T x F	1.358	0.247	–
Rhizomes (%)	Treatment	21.249	**0.000**	mow < mulch
	Frequency	0.002	0.969	–
	T x F	4.834	**0.030**	*

* multiple comparison in Tables 2 and 3, 1st layer 0–50 mm, 2nd layer 50–100 mm, 3rd layer 100–150 mm, sum 0–150 mm

Table 3. Total amount (g.m^{-2}) and stratification of underground phytomass (UP) in soil profile under different stand management

Treatment	Frequency	UP 1st layer (g.m^{-2})	UP 2nd layer (g.m^{-2})	UP 3rd layer (g.m^{-2})	Total UP (g.m^{-2})	Rhizomes (g.m^{-2})
Mow	2x	1265.6a	231.5a	97.3a	1594.3ab	208.1a
Mow	1x	1104.6ab	181.2a	82.8a	1368.5ac	159.2a
Mulch	2x	1381.8a	301.4a	69.4a	1752.6b	252.2a
Mulch	1x	877.9b	164.4a	87.2a	1129.5c	181.7a

Means followed by the same letter are not significantly different at $P < 0.05$ (Tukey), 1st layer 0–50 mm, 2nd layer 50–100 mm, 3rd layer 100–150 mm, sum 0–150 mm.

Table 4. Vertical distribution of underground phytomass (UP, %) and rhizomes share (%) in soil profile under different stand management

Treatment	Frequency	UP 1st layer (%)	UP 2nd layer (%)	UP 3rd layer (%)	Rhizomes share (%)
Mow	2x	76.6a	16.3a	7.1ab	13.4ab
Mow	1x	81.1a	13.2a	5.7ab	12.0a
Mulch	2x	79.9a	16.5a	3.6a	15.0bc
Mulch	1x	76.7a	14.6a	8.7b	16.4c

Means followed by the same letter are not significantly different at $P < 0.05$ (Tukey), 1st layer 0–50 mm, 2nd layer 50–100 mm, 3rd layer 100–150 mm, sum 0–150 mm.

defoliation can promote tillering and associated new root axes may sustain the root mass (G r e g o r y, 2006). An average weight of underground phytomass ranged from 1129 to 1752 g.m^{-2} depending on treatment (Table 3). These values do not differ from results of V e l i c h (1986) made on the same study site.

Distribution of roots throughout the soil profile is important in determining the availability of water and nutrients to plants (G r e g o r y, 2006). Stratification of underground phytomass in different treatments is presented in Table 3. Table 4 shows that the majority of the underground phytomass is allocated in the highest soil horizon (0–50 mm). Underground phytomass weight in the layer of 0–50 mm ranged from 878 g.m^{-2} to 1382 g.m^{-2}. In this layer, there was significantly lower amount of underground phytomass on plots mulched once than on the plots mulched twice a year ($P < 0.001$) as shown in Fig. 1. The higher weight of roots on twice mulched plots in the first and second layer can relate with the higher nutrients occurrence from decomposed mulch because roots usually proliferate in nutrients rich patches (C a s p e r, J a c k s o n, 1997).

Many authors (V e l i c h et al., 1974; Ú l e h l o v á et al., 1981) claim that higher intensity of management (farming) reduces the depth of growing roots through the soil. The amount of underground phytomass in the third layer (100–150 mm) in our study was not significantly influenced by management type and defoliation frequency. The lowest amount of underground phytomass in this layer was observed in twice mulched plots 69.4 g.m^{-2}.

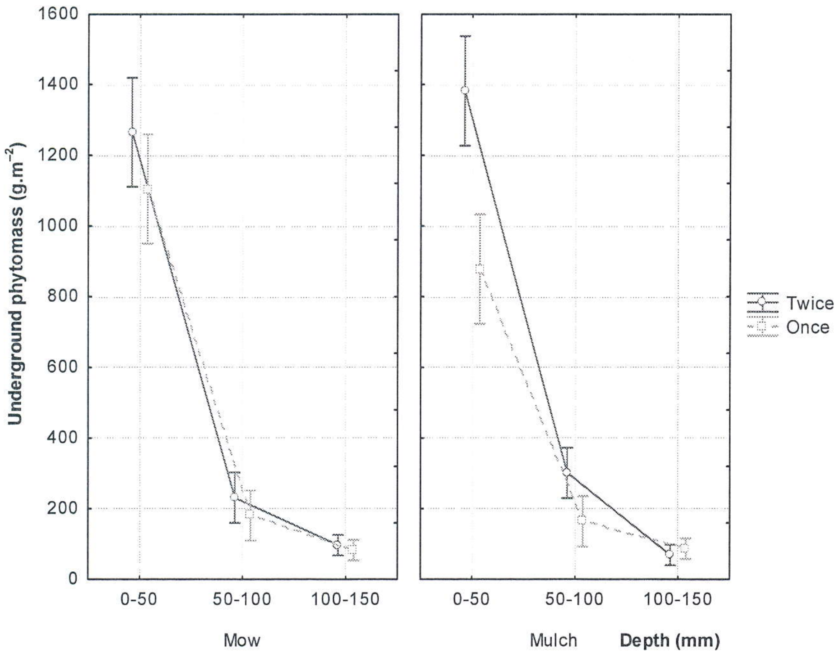

Fig. 1. Vertical distribution of underground phytomass under different defoliation management of meadow stand

Vertical bars donate 0.95 confidence intervals

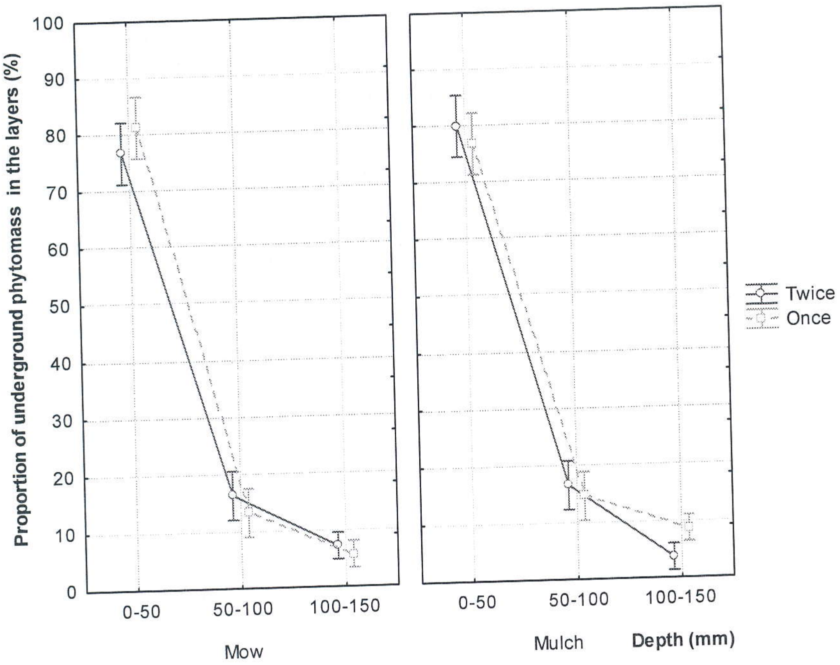

Fig. 2. Proportion of underground phytomass (%) in soil layers under different defoliation management of meadow stand

Vertical bars donate 0.95 confidence intervals

No clear relationship was found between proportion of underground phytomass in layers and defoliation practices. Nonsignificant influence of factors on underground phytomass proportion in the first and second layer can be caused by the response of underground plant phytomass to environmental conditions as water and nutrient surplus or deficiency because vertical localization of roots is flexible according to nutrients occurrence as mentioned by Úlehlová et al. (1981) and Klapp (1971). Than on underground phytomass was influenced by defoliation management only in the layer 100–150 mm (Fig. 2) where significantly lower proportion of underground phytomass (3.6%) was on twice mulched than on once mulched plots (8.7%). No significant differences were found between mowed plots.

The total amount of rhizomes phytomass varied in dependency on the management type ($P = 0.001$) and frequency of defoliation ($P < 0.001$) as shown in Table 2. The highest total rhizomes phytomass occurred in twice mulched treatment 252.2 g.m^{-2}. The increase of rhizomes amount on this plot in comparison to others may indicate the presence of rhizomatous species or the need of vegetative means of reproduction (Meneses Florián, 2005). The proportion of rhizomes on total underground phytomass in examined soil profile (0–150 mm) is documented in Table 4. The rhizomes share on the total underground phytomass reached the highest value (16.4%) at once mulched treatment. Generally mulching led to higher rhizomes share on the total underground phytomass in comparison to mowed treatments. In opposite to findings of Meneses Florián (2005) twice mowed treatments provided higher amount of rhizomes phytomass in comparison to once mowed treatments.

CONCLUSION

Amount of dry underground phytomass was influenced by the management type (mulching, mowing) and frequency of defoliation (once, twice a year). Higher frequency of mowing and mulching led to an increase of root phytomass in the layer 0–150 mm and the highest amount of underground phytomass was present in twice mulched variant. The effect of defoliation frequency influenced the amount of underground phytomass more than management type – mulching or mowing.

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Vliv frekvence sečení a mulčování na podzemní fytomasu lučního porostu.

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V letech 2005–2006 byl zkoumán vliv různé frekvence sečení a mulčování trvalé louky porostového typu *Alopecuretum* na množství a distribuci podzemní fytomasy. Porovnávány byly tyto varianty: dvakrát mulč, dvakrát seč, jedenkrát mulč a jedenkrát seč. Podzemní fytomasa byla odebírána na jaře, v létě a na podzim metodou odběru půdních monolitů do hloubky 150 mm. Stratifikace podzemní fytomasy byla zjištěna rozdělením odebraných monolitů na tři vrstvy 0–50 mm, 50–100 mm a 100–150 mm. Celkové množství podzemní fytomasy na sledovaných variantách bylo v rozmezí od 1 129 do 1 752 $g.m^{-2}$. Na variantách využívaných dvakrát ročně bylo zaznamenáno vyšší množství podzemní biomasy (o 34 %) než na variantách využívaných jedenkrát ($P < 0.001$). Mulčování dvakrát za vegetaci vedlo ke zvýšení množství podzemní fytomasy ve vrstvě 0–100 mm v porovnání s ostatními variantami. Vyšší množství rhizomů bylo zaznamenáno na variantách dvousečné (208,1 $g.m^{-2}$) a dvakrát mulčované (252,2 $g.m^{-2}$), což bylo o 48,9 $g.m^{-2}$, resp. o 70,5 $g.m^{-2}$ více než na variantách jednosečné a jedenkrát mulčované. Vyšší podíl rhizomů (o 2,5 %) byl zjištěn na variantách mulčovaných v porovnání se sečenými. Frekvence defoliace porostu ovlivnila množství podzemní biomasy významněji než způsob využívání porostu – sečení a mulčování.

podzemní biomasa; rhizomy; kořeny; sečení; mulčování; frekvence defoliace

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