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YIELD OF GRASS BIOMASS AND ERGOSTEROL CONCENTRATION AT THE END OF THE VEGETATION PERIOD

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Abstract

The objective of this paper is to evaluate the dry matter yield and ergosterol content in the forage type *Festulolium*, *Dactylis glomerata* and *Arrhenatherum elatius* obtained from stands harvested at the end of the vegetation period. Stands had different terms of summer harvesting (June or July). The yield and the ergosterol content were monitored during period October – December. Ergosterol ranks amongst the main sterols produced by lower and higher fungi. Due to this specific occurrence it is possible in practice to associate the occurrence of this sterol with the presence of moulds in the analyzed sample. Biomass yield at the end of the growing period was affected by the intensity of use in summer. One-cut grass stands exhibited higher yield than two-cut stands. In October, the yield of one-cut and two-cut stands ranged from 1.91 to 4.39 t/ha⁻¹ and from 0.29 to 1.45 t/ha⁻¹, respectively. Intensity of use in summer had a highly significant (P<0.01) effect on dry matter yield at the end of the vegetation period. On the other hand, the increased ergosterol content (up to 148 mg.kg⁻¹ DM) indicated a higher infestation by fungal diseases in the one-cut stands. The influence of the intensity of use on the ergosterol content was highly significant (P<0.01). The yield showed a decreasing trend during the autumn due to the senescence of leaves with the rate of yield decrease depending on weather conditions. In December, the yields of one-cut and two-cut stands amounted to 0.17 – 3.13 t/ha⁻¹ and 0.10 – 0.92 t/ha⁻¹, respectively. At the same time, the ergosterol content was increasing (up to 276.10 mg/kg⁻¹ DM). The ergosterol content increase during autumn was statistically highly significant (P<0.01). With respect to the content of ergosterol, festucoid hybrids appear more resistant to fungal diseases at the end of the growing season. *Dactylis glomerata* and *Arrhenatherum elatius* exhibit higher ergosterol content.

Keywords: *Festulolium*, *Dactylis glomerata*, *Arrhenatherum elatius*, yield of biomass, ergosterol concentration

Introduction

Yields of grasses at the end of the growing season are affected not only by weather conditions but also by the process of sward ageing and by the share of dead parts of the plants (*Achilles et al.*, 2002). Yield at the end of the vegetation period is affected by the term of the last use (cut) in summer (*Gerrish et al.*, 1994). The development of moulds occurs mainly in extremely overmature forage (*Opitz von Boberfeld*, 2001) or forage growing in extreme conditions. Ergosterol ranks amongst the main sterols produced by lower and higher fungi. Due to this specific occurrence it is possible in practice to associate the occurrence of this sterol with the presence of moulds in the analysed sample (*Marin et al.*, 2007).



The issue of moulds is very topical, in particular with forages from grass stands used at the end of the growing season. Mould-resistance species include *Festuca arundinacea* and its hybrids (*Opitz von Boberfeld* and *Banzhaf*, 2006).

The use of *Dactylis glomerata* at the end of the growing season is mentioned by *Prigge et al.* (1999). *Jancovic et al.* (2003) draws attention to the drop in the quality of *Dactylis glomerata* after exceeding the time limit for harvest in the first cut but adds that thanks to the perennial character, the time limit for the harvest in the next cut is wider. The objective of this paper is to evaluate yield of biomass at the end of growing season at the *Festulolium*, *Dactylis glomerata* and *Arrhenatherum elatius*. Changes of ergosterol content as an indicator of moulds presence were evaluated too.

Material and methods

Site description

The small-plot experiment was established in 2004 in the Bohemian-Moravian Upland at an altitude of 560 m a.s.l. In 1970-2000 mean annual precipitation was 617 mm and mean annual temperature amounted to 6.9 °C. Two years which differed in weather were monitored. In 2006, the total annual precipitation amount was 727.5 mm and the average temperature reached 7.0 °C. In the monitored months of October, November and December, the precipitation amounts amounted to 25.7 mm, 76.6 mm and 22.2 mm and the average daily temperature was 7.75 °C, 4.50 °C and 2.57 °C, respectively. In 2007, the total annual precipitation amount was 705,3 mm and the average temperature reached 6.9 °C. In the monitored months of October, November and December, the precipitation amounts amounted to 23.1 mm, 106.5 mm and 27.0 mm and the average daily temperature was 6.0 °C, 0.2 °C and -2.43 °C, respectively.

Experimental factors

The first experimental factor was the grass species (S). The monitored species were *Festulolium* (FS) cv. Felina, *Dactylis glomerata* (DGS) cv. Vega, *Arrhenatherum elatius* (AES) cv. Median. The second experimental factor was the intensity of use in summer (CS), when the sward was used as a single-cut stand (1CS) only in June or as a double-cut stand (2CS) in June and at the end of July. The third experimental factor was the time of harvest in the autumn (A). The sward was harvested either in October (OA), November (NA) or December (DA).



The time of the autumn harvest corresponded to the time of sampling for the chemical analyses. The experiment was repeated in two subsequent years (Y) 2006 (1Y) and 2007 (2Y).

Monitored characteristics

The monitored characteristics were dry matter yield (in years 2006 and 2007) and ergosterol content (in year 2006). Samples dried at 60 °C and homogenised to a particle size of 1 mm were analyzed. Ergosterol was determined by using the liquid chromatograph HP1100 (Dohnal *et al.*, 2006).

Statistical evaluation

The obtained results were analyzed using the ANOVA and by subsequent verification based on the Tukey Test.

Results and discussion

Biomass production of one-cut swards (1CS) in October, November and December 2006 amounted to 4.39 – 3.11 t.ha⁻¹, 4.16 – 2.59 t.ha⁻¹ and 3.13 – 2.47 t.ha⁻¹, respectively (Figure 1).

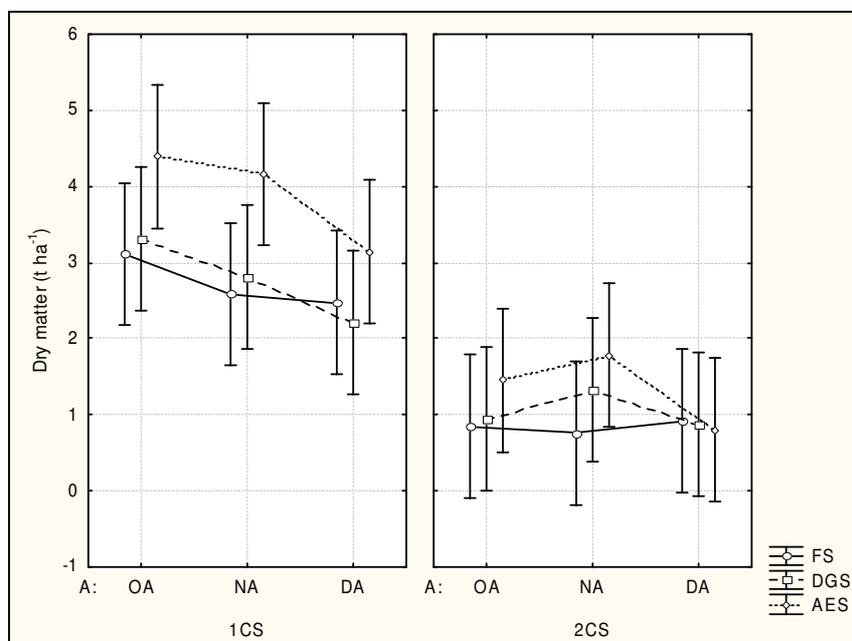


Figure 1. Effect of the intensity of use in summer (CS) and harvest date (A) on dry matter yields in the herbage of *Festulolium* (FS), *Dactylis glomerata* (DGS) and *Arrhenatherum elatius* (AES) in 2006



Biomass production of two-cut swards (2CS) in October, November and December 2006 amounted to 0.85 – 1.46 t.ha⁻¹, 0.76 – 1.78 t.ha⁻¹, and 0.80 – 0.92 t.ha⁻¹, respectively. Although the biomass yields were decreasing from October to December, there were no statistically significant differences between the studied months (A).

Yields of *Arrhenatherum elatius* were significantly higher ($P < 0.01$) than those of *Dactylis glomerata* and *Festulolium*. Significantly higher yields ($P < 0.01$) were recorded at the end of the growing season also in swards used in summer as one-cut stands than in swards used in summer as two-cut stands (Table 1). The fact was corroborated by *Opitz von Boberfeld and Banzhaf* (2006) Moreover, *Tasi et al.* (2003) or *Opitz von Boberfeld et al.* (2006) observed a significant ($P < 0.01$) decrease of yields during the autumn due to the senescence of leaves. Our experiment did not corroborate the fact statistically in 2006 (Table 1) with a possible reason being average temperatures at the end of year 2006.

Table 1. The F-test for dry matter yields and ergosterol content in herbage

Source of variability	DF	Dry matter				Ergosterol	
		2006		2007		2006	
		MS	F	MS	F	MS	F
S	2	3.6813	5.6940**	0.1371	0.9089	11343.3	5.9837**
CS	1	56.7758	87.8175**	13.6438	90.4057**	17555.9	9.2609**
A	2	1.9010	2.9404	5.4531	36.1331**	105049.2	55.4144**
S x CS	2	0.8595	1.3295	0.0276	0.1828	6338.5	3.3436*
S x A	4	0.4079	0.6309	0.1041	0.6898	12280.7	6.4782**
CS x A	2	0.7608	1.1767	3.1958	21.1759**	5990.7	3.1602
S x CS x A	4	0.0286	0.0442	0.0392	0.2595	2177.7	1.1488
Error	36	0.6465		0.1509		1895.7	

* = $P \leq 0.05$; ** = $P \leq 0.01$

The average monthly temperature in 2006 did not fall below 0 °C in the studied months. Results of year 2006 can be compared with those of 2007 (Figure 2). The colder autumn of 2007 with average monthly temperatures decreasing to 0 °C in October and below 0 °C in December reflected in a more pronounced decrease of yields from October to December. Differences were observed especially between the production of one-cut stands in November and December. While the biomass yields in October were 1.91 – 2.33 t.ha⁻¹ and 1.20 – 1.73 t.ha⁻¹ in November, the December yield amounted to only 0.16 – 0.21 t.ha⁻¹. Biomass production of two-cut stands (2CS) in October, November and December 2007 was 0.30 – 0.59 t.ha⁻¹, 0.13 – 0.26 t.ha⁻¹, and 0.10 – 0.15 t.ha⁻¹, respectively.



The term of use in the autumn (A) as well as the term of use in the summer (CS) had a statistically highly significant influence ($P < 0.01$) on biomass production at the end of the growing season.

As compared with year 2006, the yields of *Arrhenatherum elatius* equalized with those of *Festulolium* and *Dactylis glomerata*, which may be a consequence of the weakened *Arrhenatherum elatius* in the third year after sowing due to unfavourable climatic conditions at an altitude of 560 m a.s.l.

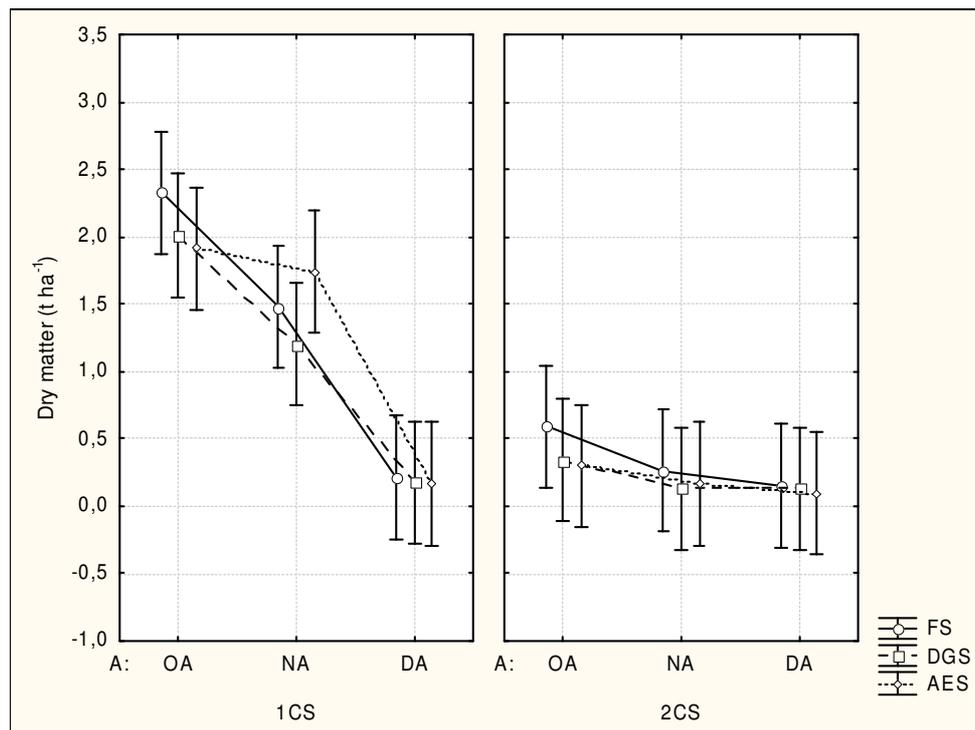


Figure 2. Effect of the intensity of use in summer (CS) and harvest date (A) on dry matter yields in *Festulolium* (FS), *Dactylis glomerata* (DGS) and *Arrhenatherum elatius* (AES) in 2007

The ergosterol content analyzed in biomass samples in 2006 suggested the presence of fungi in the studied sward. Ergosterol contents in the herbage of *Festulolium*, *Dactylis glomerata* and *Arrhenatherum elatius* were 20.38 – 163.12 mg.kg⁻¹ DM, 27.44 – 256.18 mg.kg⁻¹ DM and 43.49 – 276.07 mg.kg⁻¹ DM (Figure 3). The ergosterol content in the *Festulolium* herbage was significantly lower ($P < 0.01$) than in the herbage of *Dactylis glomerata* and *Arrhenatherum elatius*. The ergosterol content was significantly ($P < 0.01$) increasing during the autumn (A) and was significantly ($P < 0.01$) affected also by the intensity of use in the summer (CS), (Table 1). The increased ergosterol content, namely between November and December, indicates the increasing occurrence of fungal organisms.



The higher biomass yields at the end of the vegetation period resulting from the more extensive use of the stand in summer (1CS) entail also the increased ergosterol content (up to 276.07 mg.kg⁻¹ DM). The ageing sward is exposed to a higher risk of infestation by fungi. The increasing trend of ergosterol content during autumn and winter was reported also by *Opitz von Boberfeld et al.* (2006) or *Bajnok* (2003).

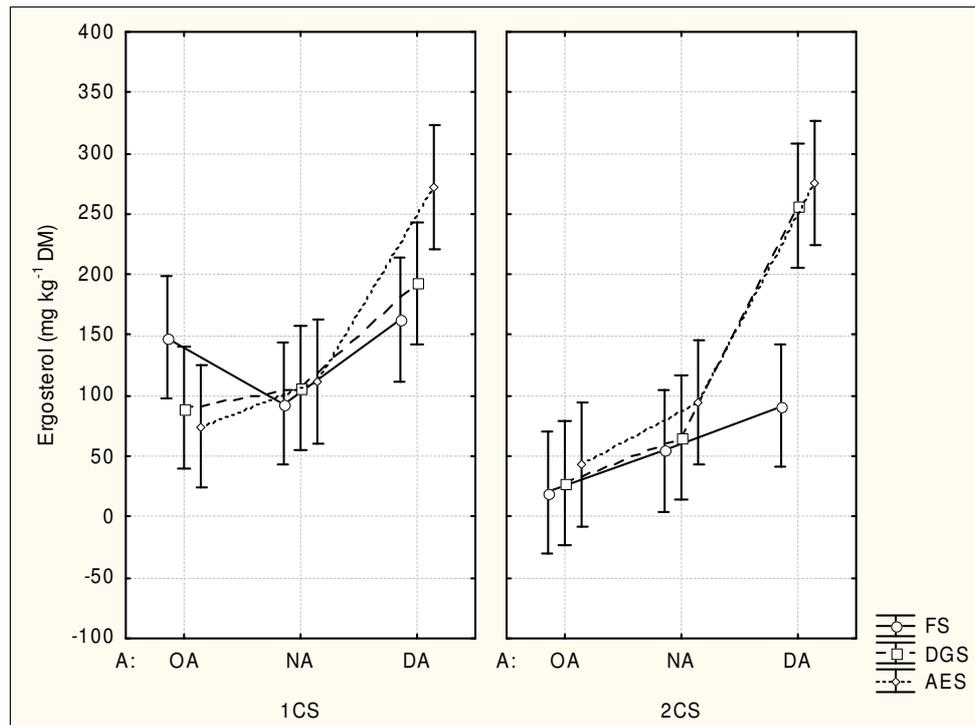


Figure 3. Effect of the intensity of use in summer (CS) and harvest date (A) on the ergosterol content in the herbage of *Festulolium* (FS), *Dactylis glomerata* (DGS) and *Arrhenatherum elatius* (AES) in 2006

Conclusion

Biomass yields at the end of the growing season are affected by the intensity of sward use in summer. Yields of one-cut grass stands are higher than yields of two-cut stands. On the other hand, the increased ergosterol content indicates a greater infestation by fungal diseases. Due to the senescence of leaves, a decreasing trend occurs in yields during the autumn, the rate of which depends on weather conditions. At the same time, the content of ergosterol is increasing. With respect to the content of ergosterol, festucoid hybrids appear more resistant to fungal diseases at the end of the growing season. *Dactylis glomerata* and *Arrhenatherum elatius* exhibit a higher content of ergosterol.



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