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EFFECTS OF THE UTILIZATION TERM AND ADDITIONAL SOWING OF *FESTUCA ARUNDINACEA* AND *FESTULOLIUM* ON THE PRODUCTION OF WINTER PASTURE

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Abstract

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The work was carried out to study the influence of additional sowing and differentiated systems of use in the summer period on the production of grass sward in the autumn and winter period. An additional sowing of *Festuca arundinacea* and *Festulolium* was made into the grass stand with dominating *Festuca rubra*, *Taraxacum officinale*, *Agropyron repens*, *Dactylis glomerata*, *Trisetum flavescens*, *Agrostis stolonifera* and *Phleum pratense*. In summer (preparatory cut), the grass stand was utilized in June, July and August. In the autumn (main use), it was utilized in November, December and January. The additional sowing, the preparatory cut and the main use were monitored for their influence on the yield of dry matter. Another assessment was made of the share of *Festuca arundinacea* and *Festulolium* in the harvested herbage. In June 2001, the share of additionally sown herb species in the harvested herbage did not exceed 2%. However, their proportion increased to more than 20% in four years of the study. In the summer period, the additional sowing did not show any significant effect on dry matter yields. The additionally sown herb species exhibited a pronounced dominance in November. The shares of *Festuca arundinacea* and *Festulolium* in the harvested herbage were 80.1% and 71.3%, respectively. Yields from the additionally sown grass stands were higher from the third year of the study (by 1.07–1.26 $t.ha^{-1}$) than those from the grass stand with no additional sowing (0.66–0.97 $t.ha^{-1}$) the variance being insignificant. In the autumn and in winter, a significant decrease ($P < 0.05$) was seen in yields from the grass stand utilized until the beginning of August and the yields further decreased with the proceeding winter.

dry matter yields, *Festuca arundinacea*, *Festulolium*, winter grazing

Apart from usual requirements for growth, endurance, root mat integrity, trampling hardiness, herbage yield and quality (OPITZ VON BOBERFELD, 1994), a herb species suitable for winter grazing should be also cold resistant and capable of growing at low temperatures (WHEELER, 1968). The species frequently advised for winter grazing is *Festuca arundinacea* (KLAPP, 1971; BARHOLOMEW et al., 1997; ACHILLES et al., 2002). It is an upright-growing tolerant green stay species (STÄHLIN & TIRTAPRADJA, 1974). The upright growth enables an accelerated desiccation of dying leaves, which slows down the process of rotting (BOEKER, 1957) and the utilizability at snow cover is higher, too (WILLMS &

RODE, 1998). As compared with other grass species, the intake of *Festuca arundinacea* by the livestock is limited in summer and the summer produce herbage is therefore used for ensilaging (ALERT & BAUER, 1985). Less endangered by winter freezing injury are hybrids of the Festuca and Lolium genera. The hybrids distinguish themselves by high production. The Felina intergeneric hybrid has a higher endurance and a lower production variability (VOROBEL & HARAKAL, 2002). The paper discusses a possibility of using *Festuca arundinacea* and *Festulolium* for additional sowing in permanent grass stands. It attempting at answering a question of what will be the share of the studied herb species in the harvested herbage after the additional sowing, whether the additional sowing and differentiated systems of use in the summer period can affect yields from the grass stand utilized in the autumn and in winter and whether *Festuca arundinacea* and *Festulolium* are herb species suitable for additional sowing in grass stands meant for an extended period of grazing.

MATERIAL AND METHODS

Site description

The experiment was carried out in 2000 in the Bohemian-Moravian Highlands (Czech Republic) at an altitude of 553 m a.s.l. In the period from 1971–2000, the mean annual air temperature was 6.9 °C and the mean annual total precipitation amounted to 617.5 mm. Mean annual air temperatures in 2000, 2001, 2002, 2003 and 2004 were 8.2 °C, 6.8 °C, 7.8 °C, 7.3 °C and 6.8 °C, respectively. Mean annual total precipitation in 2000, 2001, 2002, 2003 and 2004 was 701 mm, 728 mm, 683 mm, 562 mm and 658 mm, resp. Periods of soil temperature below 4 °C were December–March in 2000/2001, November–March in 2001/2002, December–March in 2002/2003 and December–March in 2004/2005. Soil profile: $A_p – E_N – B_M – B/C – C$. Particle-size Class: loamy to silt loam. Soil unit: Dystric Planosol. The species composition of the grass stand under study in 2000, expressed as the proportions of dominant herb species in dry matter was as follows: *Festuca rubra* (21.4%), *Taraxacum officinale* (19.0%), *Agropyron repens* (14.8%), *Dactylis glomerata* (12.4%), *Trisetum flavescens* (9.0%), *Poa* ssp. (7.2%), *Agrostis stolonifera* (6.9%), *Phleum pratense* (6.4%). On 16 June 2000, the existing grass stand was treated with an additional sowing of *Festuca arundinacea* (var. Kora) and *Festulolium* (var. Felina). The amount additionally sown was 35 kg.ha^{-1}. The additional sowing was made by the sowing machine Model Hege 80. The width and depth of tilled furrows were 20 cm and 15 cm, respectively. Each trial plot had two tilled furrows. In spring, the grass stand was fertilized with 50 kg.ha^{-1} N, 30 kg.ha^{-1} P and 80 kg.ha^{-1} K. Management of the trial plots between the last preparatory cut and the main use included a fertilization treatment with 50 kg.ha^{-1} N. The fertilization was given to all plots. The plots were not grazed during the experimental period.

Experimental design

The experiment was established by a method of divided sampling plots in three replications. The size of the experimental plots was 1.4 × 8.0 m. In the course of three years, the individual plots were used in the same way.

Evaluated factors and factor degrees are presented in Tab. I. If the stand was completely covered with snow in the given month, the herbage was harvested immediately after the thaw. Harvest dates are listed in Tab. II.

I: *Experimental factors evaluated and factor degrees*

Additional sowing	**Any kind of additional sowing** **Additional sowing of *Festuca arundinacea*** **Additional sowing of *Festulolium***
Date of preparatory cut (summer utilization)	**June** June + **July** June + **August**
Date of main use (winter utilization)	**November** **December** **January**

II: *Harvest dates in the three years of the experiment*

Year of observation	Summer utilization			Winter utilization		
2001/2002	5 June	11 July	6 August	5 Nov.	30 Jan.	19 Feb.
2002/2003	3 June	9 July	6 August	4 Nov.	2 Dec.	8 Jan.
2003/2004	10 June	8 July	5 August	3 Nov.	1 Dec.	1 April
2004/2005	10 June	8 July	5 August	2 Nov.	1 Dec.	5 Jan.

Measurements

The plots were harvested with a finger cut machine Model MF 120 (working width 1.2 m) with the harvested area being 9.6 m^2. Stubble height was 7 cm. All harvested biomass was weighed. The sample (1 kg) was taken immediately after the harvest and dried at 103 °C. The stand up yield of DM was determined from the sample dried at 103 °C.

The above-ground part of the herbage was sampled from the permanently laid out plots (0.5 m^2) before the harvest in June and November. The samples were sorted out to individual herb species whose biomass was then determined by weighing in dry condition after desiccation at 60 °C. The proportion of the respective species was expressed in per cent from the total mass of dry fodder (RYCHNOVSKÁ, 1987).

Statistic analysis

The results were statistically analyzed by ANOVA and Tukey HSD test operated under Statistika 6.0.

RESULTS AND DISCUSSION

Dry matter yields in Year 1 following after the additional sowing (2001/2002) were balanced in summer (Tab. III). Average yields from the grass stand with no additional sowing, grass stand with the additional sowing of *Festuca arundinacea*, and grass stand with the additional sowing of *Festulolium* were 4.94 $t.ha^{-1}$ DM, 4.81 $t.ha^{-1}$ DM, and 4.99 $t.ha^{-1}$ DM, respectively. The additional sowing did not show any significant effect on the dry matter yields (Tab. V). As expected, the only very highly significant effect ($P < 0.001$) was that of the intensity of use in the summer period. The grass stand utilized in June and August exhibited significantly ($P < 0.05$) higher yields than the grass stand utilized in June and July or only in June (Tab. VI).

In November, the yields of dry matter from the additionally sown grass stands were on average lower than those from the grass stand with no additional sowing (Tab. IV). The grass stand with no additional sowing had yields ranging from 0.37–2.35 $t.ha^{-1}$ DM in dependence on the term of preparatory cut. In contrast, the grass stands with the additionally sown *Festuca arundinacea* and *Festulolium* exhibited yields of dry matter from 0.33–1.41 $t.ha^{-1}$ DM and from 0.27–1.56 $t.ha^{-1}$ DM, respectively. The yield decrease was not significant according to results from the analysis of variance (Tab. VII). The autumn and winter yields were very highly significantly ($P < 0.001$) affected by the term of preparatory cut with a significant variance ($P < 0.05$) existing between all terms of preparatory cut (Tab. VIII). The higher yields with the preparatory cut in June than those with the preparatory cut in August correspond well with the conclusions of Archer and Decker (1977), Collins and Balasko (1981) or Gerrish et al. (1994) according to which the early saving of the stand in the growing period results in increased autumn and winter yields. A very highly significant effect on the yields was also that of the term of main use. A significant variance ($P < 0.05$) existed between the yields in November and December, and between the yields in November and January. No significant variance was observed between the yields in December and January (Tab. IX).

Similarly as in the preceding year, no significant variance was found in summer 2002 (Tab. III) between the grass stands with and without the additional sowing. Once again, the only highly significant effect ($P < 0.01$) on yields was that of the intensity of use in the summer period.

As compared with 2001/2002, the produce from the additionally unsown grass stand and from the grass stands with the additional sowing was balanced in the autumn and in winter 2002/2003. Average yields of dry matter (Tab. IV) in the grass stand with no additional sowing, in the grass stand with additionally sown *Festuca arundinacea* and in the grass stand with additionally sown *Festulolium* amounted to 1.51 $t.ha^{-1}$ DM, 1.57 $t.ha^{-1}$ DM, and 1.59 $t.ha^{-1}$ DM, respectively. This could have been a reflection of a higher stand closure of disturbed areas arisen in connexion with the additional sowing as well as an increased share of *Festuca arundinacea* and *Festulolium*. While the share of *Festuca arundinacea* in the harvested herbage ranged between 19.0–51.8% in November 2001, the figure increased to 28.9–61.8% in November 2002 (Fig. 1). The share of *Festulolium* in herbage ranged between 13.0–52.5% in November 2001, and the figure increased to 35.8–60.2% in No-

vember 2002 (Fig. 2). Similarly as in 2001/2002, the yields of dry matter in 2002/2003 were very highly significantly affected ($P < 0.001$) by the term of preparatory cut (Tab. VII). A significant variance ($P < 0.05$) was observed between all terms of preparatory cut (Tab. VIII). Also, the term of main use was found to have a very highly significant effect ($P < 0.001$) on the yields. A significant variance ($P < 0.05$) was found between all terms of the main use (Tab. IX).

In summer 2003 (Tab. III), average yields from the additionally unsown grass stand and from the grass stand with the additionally sown *Festuca arundinacea* were 4.95 t.ha^{-1} DM and 5.04 t.ha^{-1} DM, respectively. Although the grass stand with additionally sown *Festulolium* exhibited lower yields (av. 4.2 t.ha^{-1} DM), the difference between the yields was insignificant. A similarly balanced production of the grass stands with- and without the additional sowing (5.40 t.ha^{-1} DM, 5.35 t.ha^{-1} DM and 5.87 t.ha^{-1} DM, resp.) was observed in summer 2004. However, the share of additionally sown herb species in the harvested herbage changed in the course of the four years (Fig. 1 and Fig. 2). In June 2004, the share of *Festuca arundinacea* and *Festulolium* in herbage was 24.9% and 23.1%, resp. In 2001, the share of these species was up to 2%. This indicates that the share of additionally sown herb species increased in four years by more than 20%. Results of other authors claim that the share of additionally sown Felina was not higher than 3% in long-term experiments in June (UHLIAROVA, 2002; VOROBEL & HARAKAL, 2002). In our experiments, the share of additionally sown herb species in the harvested forage was increasing since 2001 but did not markedly show in summer yields. The only very highly significant effect ($P < 0.001$) on the yields was that of the intensity of use (Tab. V). It is also possible to make a statement that the late utilization of the grass stand (in December and in January) did not reflect in the subsequent summer produce in either years under study.

In the autumn and in winter of 2003/2004 and 2004/2005 (tab. IV), the yields from additionally sown *Festuca arundinacea* (1.15 t.ha^{-1} DM and 1.11 t.ha^{-1} DM) and *Festulolium* (1.26 t.ha^{-1} DM and 1.07 t.ha^{-1} DM) were higher than in the control (0.97 t.ha^{-1} DM and 0.66 t.ha^{-1} DM). The year of 2003/2004 witnessed a repeatedly increased dominance of the additionally sown herb species. The share of *Festuca arundinacea* (Fig. 1) in herbage harvested in November ranged from 47.7%–71.1% and the share of *Festulolium* (Fig. 2) was 58.2–61.4%. The increased dominance of additionally sown herb species reflected in yields especially in the June-July and June-August systems of preparatory cuts. The share of *Festuca arundinacea* was further increasing in November 2004/2005 from 72.8–80.2% in dependence on the intensity of use. On the other hand, the share of *Festulolium* was increased only in the June–August system of preparatory cuts (71.3%). In the system of one preparatory cut in June and in the system of two preparatory cuts in July–August, the share of *Festulolium* began to decrease from Year 4. The dominance of *Festuca arundinacea* and *Festulolium* was in the course of the four years under study more supported by the utilization in June and then in August than by the utilization in June and than in July, or only in June. It is also possible to claim that *Festuca arundinacea* and *Festulolium* exhibited a greater dominance in November than in June. Considering the fact that the intake of *Festuca arundinacea* by animals is limited in the summer period (WACKER, 1983; ALERT & BAUER, 1985) but the species is important in the extension of the grazing period thanks to its cold hardiness (BARTHOLOMEW et al., 1997; OPITZ VON BOBERFELD, 2001) makes its application desirable in the autumn. Although the yields of additionally sown grass stands were in most variants higher than those of grass stands with no additional sowing from Year 3, the increase was statistically insignificant. In 2003/2004 and 2004/2005, the term of preparatory cut had a very highly significant effect ($P < 0.001$) on dry matter yields (Tab. VII). A significant variance ($P < 0.05$) was observed between all terms of preparatory cut (Tab. VIII). The term of main use was observed to have a significant effect ($P < 0.05$) on the yields of dry matter in 2003/2004 and 2004/2005. The yield drop from November to January that was clearly obvious already in 2002/2003 corresponds with the findings of WOLF (2001) and WÖHLER (2003). Dry matter losses with the proceeding winter can be derived from a higher rate of dying and decomposing leaves and from the restricted growth of leaves (ARCHER & DECKER, 1977; ACHILLES et al., 2002). As compared with the grass stands with no additional sowing, higher yields from the additionally sown grass stands can also relate to the fact that the leaves of both *Festuca arundinacea* and *Festulolium* are harder and their decomposition is therefore slower.

Considerable production variances were recorded between the years of study. November yields (one preparatory cut in June) from the grass stand with no additional sowing were 0.68 t.ha^{-1}, 2.30 t.ha^{-1}, 1.63 t.ha^{-1} and 1.06 t.ha^{-1}. The same system of utilization in the grass stand with additionally sown *Festuca arundinacea* gave yields of 0.40 t.ha^{-1}, 2.06 t.ha^{-1}, 2.35 t.ha^{-1} and 2.33 t.ha^{-1}. The inter-annual fluctuation of yields could have resulted from different weather conditions in the respective years. According to PRIGGE et al. (1999), the yield difference of individual years results from the influence of winter freezing injury with this injury occurring at the stage of growth and development prior to the winter use and also in winter, being most likely of decisive importance.

III: *Dry matter yields of preparatory cuts (t.ha^{-1}) from grass stands with no additional sowing, with additionally sown Festuca arundinacea and with additionally sown Festulolium in 2001–2004*

Preparatory cut	Main use											
	Any kind of additional sowing				Additional sowing of *Festuca arundinacea*				Additional sowing of *Festulolium*			
	November	December	Januar	Mean	November	December	Januar	Mean	November	December	Januar	Mean
	x ± se	x ± se	x ± se	x ± se	x ± se	x ± se	x ± se	x ± se	x ± se	x ± se	x ± se	x ± se
2001												
June	4.41 ± 0.62	3.64 ± 0.30	3.91 ± 0.29	3.99 ± 0.24	4.36 ± 1.29	3.41 ± 0.68	4.02 ± 0.84	3.93 ± 0.50	3.17 ± 0.44	3.23 ± 0.30	4.14 ± 0.76	3.51 ± 0.31
June + July	4.67 ± 1.04	5.60 ± 1.03	4.46 ± 0.13	4.91 ± 0.46	5.16 ± 1.18	4.84 ± 0.69	4.59 ± 1.12	4.86 ± 0.52	4.20 ± 0.16	5.96 ± 0.26	4.35 ± 0.19	4.84 ± 0.30
June + August	5.61 ± 0.70	6.66 ± 0.75	5.47 ± 0.62	5.91 ± 0.39	5.70 ± 0.81	5.67 ± 0.63	5.53 ± 1.02	5.64 ± 0.42	5.84 ± 0.39	7.40 ± 0.73	6.62 ± 0.69	6.62 ± 0.38
Mean	4.89 ± 0.44	5.30 ± 0.58	4.61 ± 0.30		5.08 ± 0.59	4.64 ± 0.47	4.71 ± 0.54		4.40 ± 0.43	5.53 ± 0.66	5.04 ± 0.50	
	4.94 ± 0.26				4.81 ± 0.30				4.99 ± 0.33			
2002												
June	4.34 ± 0.87	4.98 ± 0.97	4.39 ± 0.81	4.57 ± 0.45	4.66 ± 1.64	3.67 ± 1.34	4.56 ± 1.97	4.29 ± 0.51	4.15 ± 1.42	3.81 ± 0.87	3.59 ± 0.84	3.85 ± 0.54
June + July	5.00 ± 0.96	5.67 ± 1.27	5.12 ± 1.34	5.27 ± 0.61	5.19 ± 2.32	4.92 ± 2.15	5.23 ± 2.34	5.11 ± 0.66	4.79 ± 0.93	4.98 ± 1.27	5.60 ± 0.77	5.13 ± 0.52
June + August	6.05 ± 1.68	6.30 ± 1.30	6.44 ± 0.86	6.26 ± 0.66	6.54 ± 1.97	6.09 ± 2.12	5.99 ± 1.93	6.20 ± 0.59	6.28 ± 0.81	5.97 ± 0.53	6.95 ± 0.25	6.40 ± 0.32
Mean	5.13 ± 0.66	5.65 ± 0.62	5.32 ± 0.60		5.46 ± 0.64	4.89 ± 0.65	5.26 ± 0.64		5.08 ± 0.63	4.92 ± 0.56	5.38 ± 0.59	
	5.37 ± 0.35				5.20 ± 0.36				5.13 ± 0.33			
2003												
June	4.00 ± 0.74	5.04 ± 0.85	4.88 ± 1.28	4.64 ± 0.52	4.68 ± 1.42	5.20 ± 0.90	4.01 ± 0.73	4.63 ± 0.56	3.46 ± 1.15	3.10 ± 0.93	4.00 ± 0.89	3.52 ± 0.51
June + July	5.15 ± 0.84	5.20 ± 0.92	4.98 ± 1.09	5.11 ± 0.48	5.90 ± 1.25	5.06 ± 1.27	4.71 ± 1.34	5.22 ± 0.67	4.09 ± 0.86	4.06 ± 1.35	4.73 ± 0.95	4.29 ± 0.55
June + August	5.39 ± 1.03	4.99 ± 0.78	4.95 ± 0.98	5.11 ± 0.47	5.55 ± 0.66	5.32 ± 1.39	4.90 ± 0.66	5.26 ± 0.49	4.63 ± 0.56	4.33 ± 0.43	5.37 ± 0.52	4.78 ± 0.30
Mean	4.85 ± 0.49	5.08 ± 0.43	4.93 ± 0.56		5.38 ± 0.60	5.19 ± 0.60	4.54 ± 0.50		4.06 ± 0.48	3.83 ± 0.52	4.70 ± 0.45	
	4.95 ± 0.28				5.04 ± 0.32				4.20 ± 0.28			
2004												
June	4.24 ± 0.09	4.90 ± 1.05	3.72 ± 0.03	4.29 ± 0.35	4.65 ± 0.53	3.54 ± 0.73	4.40 ± 0.36	4.20 ± 0.32	5.09 ± 0.42	4.06 ± 0.08	4.55 ± 0.18	4.57 ± 0.20
June + July	5.63 ± 0.72	5.43 ± 0.32	6.10 ± 0.96	5.72 ± 0,37	5.40 ± 0.33	6.06 ± 0.80	5.20 ± 0.46	5.55 ± 0.31	5.33 ± 0.26	5.64 ± 0.55	7.09 ± 0.29	6.02 ± 0.33
June + August	6.54 ± 1.08	5.86 ± 0.23	6.20 ± 0.54	6.20 ± 0.37	6.03 ± 0.16	6.55 ± 0.45	6.37 ± 0.52	6.32 ± 0.22	7.26 ± 1.23	6.59 ± 0.43	7.25 ± 0.29	7.03 ± 0.40
Mean	5.47 ± 0.50	5.39 ± 0.35	5.34 ± 0.52		5.36 ± 0.27	5.38 ± 0.57	5.32 ± 0.36		5.89 ± 0.51	5.43 ± 0.42	6.30 ± 0.46	
	5.40 ± 0.26				5.35 ± 0.23				5.87 ± 0.20			

IV: *Autumn and winter dry matter yields (t.ha^{-1}) from grass stands with no additional sowing, with additionally sown Festuca arundinacea and with additionally sown Festulolium in 2001–2005*

Main use	Preparatory cut											
	Any kind of additional sowing				Additional sowing of *Festuca arundinacea*				Additional sowing of *Festulolium*			
	June	July	August	Mean	June	July	August	Mean	June	July	August	Mean
	x ± se	x ± se	x ± se	x ± se	x ± se	x ± se	x ± se	x ± se	x ± se	x ± se	x ± se	x ± se
2001/2002												
November	2.35 ± 0.38	0.73 ± 0.10	0.37 ± 0.03	1.14 ± 0.33	1.41 ± 0.11	0.56 ± 0.07	0.33 ± 0.10	0.77 ± 0.17	1.56 ± 0.29	0.53 ± 0.15	0.27 ± 0.06	0.79 ± 0.22
December	0.68 ± 0.18	0.32 ± 0.09	0.19 ± 0.03	0.40 ± 0.08	0.40 ± 0.10	0.25 ± 0.03	0.17 ± 0.03	0.27 ± 0.04	0.72 ± 0.05	0.29 ± 0.03	0.15 ± 0.02	0.38 ± 0.10
Januar	1.06 ± 0.15	0.36 ± 0.01	0.15 ± 0.01	0.52 ± 0.14	0.54 ± 0.02	0.33 ± 0.01	0.30 ± 0.02	0.39 ± 0.05	0.49 ± 0.03	0.23 ± 0.02	0.18 ± 0.02	0.30 ± 0.05
Mean	1.36 ± 0.28	0.47 ± 0.09	0.24 ± 0.05		0.78 ± 0.16	0.38 ± 0.06	0.26 ± 0.03		0.92 ± 0.19	0.35 ± 0.05	0.20 ± 0.02	
	0.69 ± 0.13				0.48 ± 0.07				0.49 ± 0.09			
2002/2003												
November	3.13 ± 0.18	2.07 ± 0.20	1.61 ± 0.27	2.27 ± 0.25	3.07 ± 0.03	1.66 ± 0.03	1.36 ± 0.16	2.03 ± 0.28	3.14 ± 0.19	2.41 ± 0.15	1.38 ± 0.04	2.31 ± 0.26
December	2.30 ± 0.14	0.89 ± 0.16	0.65 ± 0.08	1.28 ± 0.27	2.06 ± 0.24	1.67 ± 0.04	0.47 ± 0.03	1.40 ± 0.24	1.92 ± 0.03	1.37 ± 0.31	0.84 ± 0.01	1.38 ± 0.20
Januar	1.36 ± 0.32	0.82 ± 0.13	0.75 ± 0.20	0.97 ± 0.14	2.05 ± 0.16	1.15 ± 0.02	0.63 ± 0.03	1.27 ± 0.21	1.54 ± 0.02	1.05 ± 0.24	0.64 ± 0.03	1.08 ± 0.13
Mean	2.26 ± 0.28	1.26 ± 0.21	1.00 ± 0.19		2.39 ± 0.18	1.49 ± 0.11	0.82 ± 0.15		2.20 ± 0.25	1.61 ± 0.22	0.95 ± 0.13	
	1.51 ± 0.17				1.57 ± 0.15				1.59 ± 0.15			
2003/2004												
November	2.39 ± 0.40	1.31 ± 0.07	0.47 ± 0.05	1.39 ± 0.30	2.35 ± 0.27	1.18 ± 0.24	0.65 ± 0.19	1.39 ± 0.28	2.38 ± 0.18	1.51 ± 0.18	0.71 ± 0.17	1.53 ± 0.26
December	1.63 ± 0.47	0.78 ± 0.33	0.30 ± 0.17	0.90 ± 0.26	2.35 ± 0.85	1.20 ± 0.40	0.44 ± 0.23	1.33 ± 0.39	2.02 ± 0.27	1.29 ± 0.35	0.61 ± 0.29	1.31 ± 0.25
Januar	1.15 ± 0.29	0.42 ± 0.16	0.26 ± 0.14	0.61 ± 0.17	1.30 ± 0.34	0.69 ± 0.30	0.19 ± 0.07	0.73 ± 0.21	1.59 ± 0.47	0.84 ± 0.36	0.40 ± 0.17	0.94 ± 0.25
Mean	1.72 ± 0.27	0.84 ± 0.17	0.34 ± 0.07		2.00 ± 0.33	1.02 ± 0.18	0.43 ± 0.11		2.00 ± 0.20	1.21 ± 0.18	0.57 ± 0.12	
	0.97 ± 0.15				1.15 ± 0.18				1.26 ± 0.15			
2004/2005												
November	2.53 ± 0.41	0.57 ± 0.07	0.26 ± 0.10	1.12 ± 0.37	2.78 ± 0.47	1.04 ± 0.36	0.59 ± 0.16	1.47 ± 0.38	2.42 ± 0.21	1.05 ± 0.10	0.59 ± 0.09	1.35 ± 0.28
December	1.06 ± 0.46	0.14 ± 0.03	0.13 ± 0.08	0.44 ± 0.20	2.33 ± 0.24	0.54 ± 0.12	0.26 ± 0.09	1.05 ± 0.33	1.85 ± 0.42	0.56 ± 0.17	0.23 ± 0.06	0.88 ± 0.28
Januar	1.16 ± 0.10	0.06 ± 0.06	0.01 ± 0.01	0.41 ± 0.19	1.85 ± 0.06	0.34 ± 0.06	0.22 ± 0.05	0.80 ± 0.26	2.42 ± 0.20	0.45 ± 0.06	0.12 ± 0.03	0.99 ± 0.36
Mean	1.58 ± 0.30	0.25 ± 0.08	0.13 ± 0.05		2.32 ± 0.20	0.64 ± 0.15	0.36 ± 0.08		2.23 ± 0.18	0.69 ± 0.11	0.31 ± 0.08	
	0.66 ± 0.16				1.11 ± 0.19				1.07 ± 0.18			

V: *Analysis of variance for dry matter yields in the summer period*

Source of variability	df	2001/2002			2002/2003			2003/2004			2003/2004		
		Sum of Square	Mean of Square	F	Sum of Square	Mean of Square	F	Sum of Square	Mean of Square	F	Sum of Square	Mean of Square	F
Block	2	35.050	17.525	3.340	156.254	78.127	37.646 **	53.314	26.657	1.229	7.742	3.8709	0.823
Additional sowing (A)	2	0.456	0.228	0.044	0.823	0.411	0.198	11.565	5.782	0.267	4.422	2.2109	0.470
Error of plots	4	20.985	5.246		8.301	2.075		86.758	21.689		18.822	4.7056	
Preparatory cuts (P)	2	68.097	34.049	8.896 ***	56.725	28.363	8.101 **	9.197	4.598	1.488	65.394	32.6970	9.012 ***
Harvest dates (H)	2	2.448	1.224	0.320	0.380	0.190	0.054	0.050	0.025	0.008	0.889	0.4443	0.122
P x H	4	8.354	2.088	0.546	0.918	0.229	0.066	1.525	0.381	0.123	2.995	0.7488	0.206
P x A	4	5.369	1.342	0.351	1.880	0.470	0.134	1.623	0.406	0.131	0.901	0.2253	0.062
H x A	4	6.453	1.613	0.422	3.390	0.848	0.242	7.346	1.836	0.594	2.583	0.6457	0.178
P x H x A	8	1.521	0.190	0.050	2.620	0.327	0.094	2.246	0.281	0.091	8.439	1.0548	0.291
Error of sub-plots	48	30.101	3.827		24.298	3.501		19.839	3.091		27.426	3.6283	
Total	80	178.834			255.588			193.463			139.613		

* Significant at 0.05 level of probability **Significant at 0.01 level of probability ***Significant at 0.001 level of probability

VII: *Analysis of variance for dry matter yields in the autumn and in winter*

Source of variability	df	2001/2002			2002/2003			2003/2004			2004/2005		
		Sum of Square	Mean of Square	F	Sum of Square	Mean of Square	F	Sum of Square	Mean of Square	F	Sum of Square	Mean of Square	F
Block	2	0.039	0.020	0.215	0.099	0.049	0.785	10.190	5.095	19.734 **	0.025	0.012	0.027
Additional sowing (A)	2	0.779	0.390	4.279	0.092	0.046	0.731	1.189	0.595	2.303	3.394	1.697	3.635
Error of plots	4	0.364	0.091		0.251	0.063		1.033	0.258		1.867	0.467	
Preparatory cuts (P)	2	9.334	4.667	18.037 ***	25.401	12.701	24.516 ***	29.181	14.591	16.220 ***	49.670	24.835	36.211 ***
Harvest dates (H)	2	4.958	2.479	9.581 ***	17.850	8.925	17.228 ***	6.341	3.170	3.524 *	5.568	2.784	4.059 *
P x H	4	3.357	0.839	3.244 *	1.213	0.303	0.586	1.159	0.290	0.322	0.783	0.196	0.285
P x A	4	0.961	0.240	0.929	0.823	0.206	0.397	0.152	0.038	0.042	0.779	0.195	0.284
H x A	4	0.369	0.092	0.356	0.807	0.202	0.389	0.471	0.118	0.131	0.527	0.132	0.192
P x H x A	8	0.341	0.043	0.165	1.579	0.197	0.381	0.446	0.056	0.062	1.706	0.213	0.311
Error of sub-plots	48	1.852	0.259		3.761	0.518		5.102	0.900		5.279	0.686	
Total	80	22.355			51.876			55.264			69.598		

* Significant at 0.05 level of probability **Significant at 0.01 level of probability ***Significant at 0.001 level of probability

VI: *Effect of the term of preparatory cut on summer yields of dry matter*

	2001/2002	2002/2003	2003/2004	2004/2005
June	3.81[a]	4.24[a]	4.26[a]	4.35[a]
June + July	4.87[b]	5.17[a]	4.87[a]	5.8[b]
June + August	6.05[c]	6.29[b]	5.05[a]	6.5[c]

The letters a, b and c implies in a column followed by the same letter are not significantly different (P>0.05)

VIII: *Effect of the term of preparatory cut on winter yields of dry matter*

	2001/2002	2002/2003	2003/2004	2004/2005
June	1.02[a]	2.28[a]	1.91[a]	2.04[a]
June + July	0.4[b]	1.45[b]	1.02[b]	0.53[b]
Juni + August	0.23[c]	0.93[c]	0.45[c]	0.27[c]

The letters a, b and c implies in a column followed by the same letter are not significantly different (P>0.05)

IX: *Effect of the term of main use on dry matter yields in the autumn and in winter*

	2001/2002	2002/2003	2003/2004	2004/2005
November	0.9[a]	2.2[a]	1.51[a]	1.31[a]
December	0.35[b]	1.35[b]	1.18[a]	0.79[b]
Januar	0.4[b]	1.11[c]	0.76[b]	0.74[b]

The letters a, b and c implies in a column followed by the same letter are not significantly different (P>0.05)

CONCLUSIONS

The share of *Festuca arundinacea* and *Festulolium* was increasing from 2001. Four years after additional sowing the shares of the two herb species in herbage harvested in June were over 20%. In spite of these facts, the increasing dominance of the species in summer did not reflect in yields. The shares of *Festuca arundinacea* and *Festulolium* in herbage harvested in November were increasing until Year 4 and Year 3 after the additional sowing, respectively. The shares of *Festuca arundinacea* and *Festulolium* in herbage harvested in November reached up to 80.1% and 71.3%, resp. The yields of additionally sown grass stands were higher from Year 3 after the additional sowing than those from the grass stand with no additional sowing but the difference was statistically insignificant. The grass stands used in June at the latest were observed to provide higher yields in the autumn and in winter than the grass stands with the latest utilization in August. The production was observed to decrease from November to January due to the dying and decomposition of plant biomass. It is possible to conclude on the basis of the above results that *Festuca arundinacea* and *Festulolium* are herb species suitable for additional sowing in grass stands meant for an extended period of grazing.

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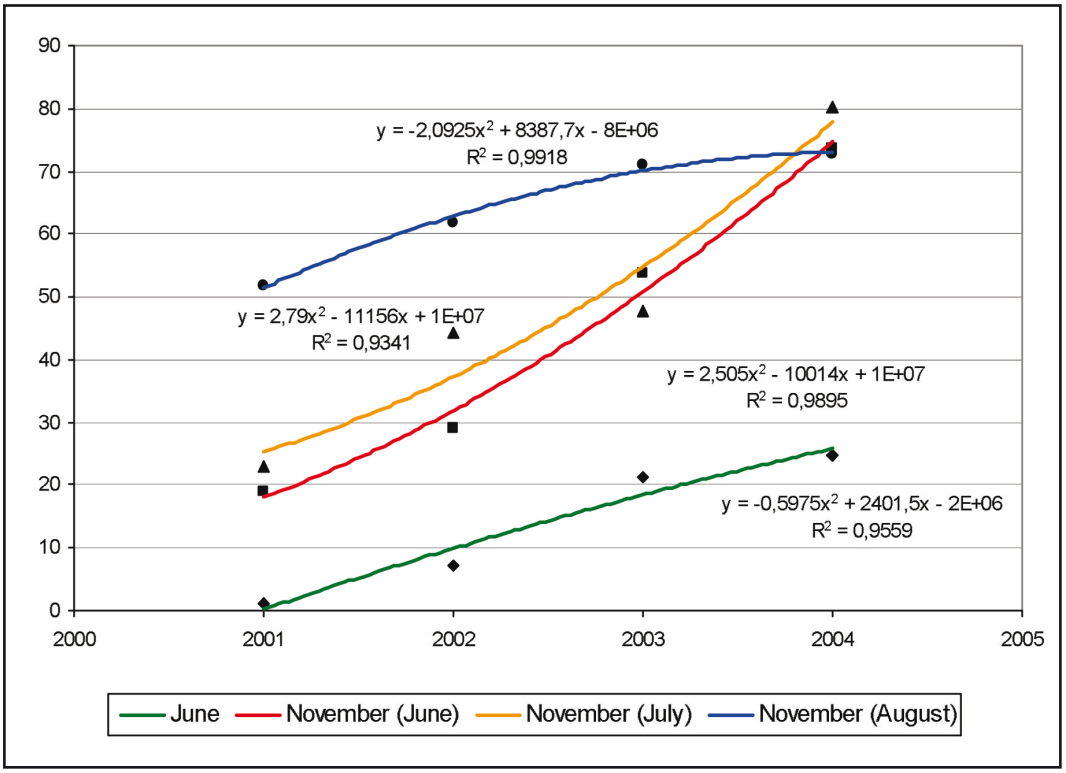
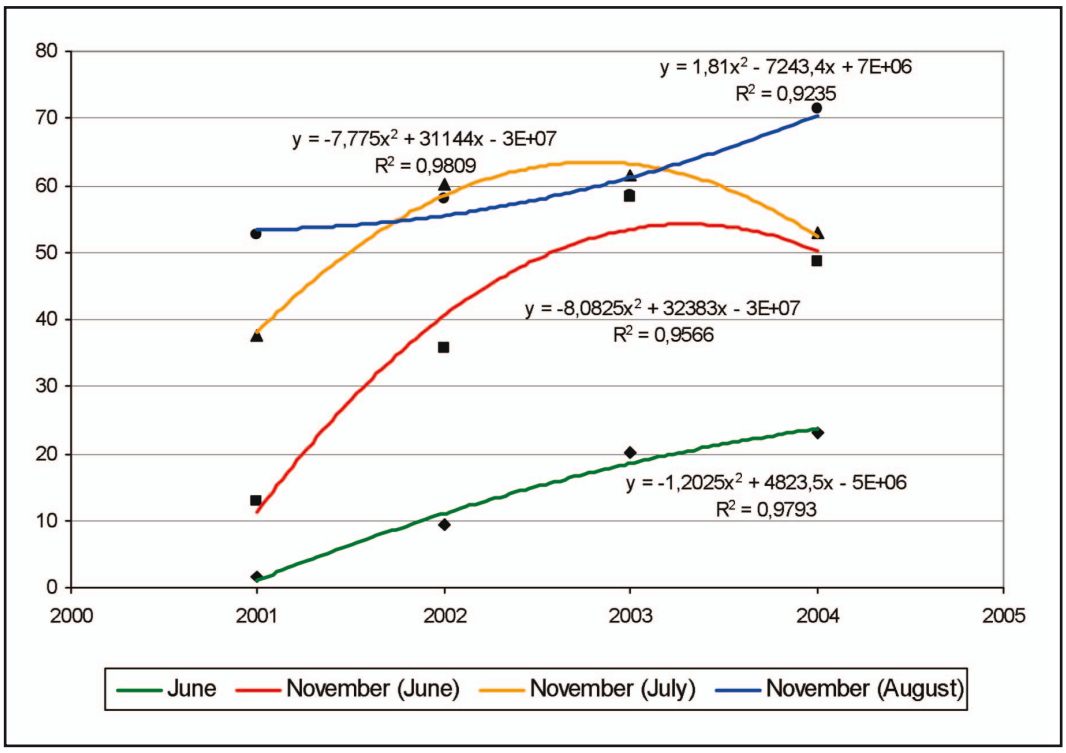


1: *The share of Festuca arundinacea in herbage harvested in June and in November 2001–2004*



2: *The share of Festulolium in gerbage harvested in June and in November 2001–2004*

SOUHRN

Vliv termínu využití a přísevu *Festuca arundinacea* a *Festulolium* na produkci zimní pastviny

Tato práce se zabývá vlivem přísevu a diferencovaného systému využití v letním období na produkci píce z polopřirozeného travního porostu využívaného pozdě na podzim a v zimě. Do travního porostu s dominací *Festuca rubra*, *Taraxacum officinale*, *Agropyron repens*, *Dactylis glomerata*, *Trisetum flavescens*, *Agrostis stolonifera* a *Phleum pratense* byl proveden přísev *Festuca arundinacea* a *Festulolium*. V létě (přípravná seč) byl travní porost využíván v červnu, červenci a srpnu. Na podzim (hlavní využití) byl travní porost využíván v listopadu, prosinci a lednu. Sledován byl vliv přísevu, přípravné seče a hlavního využití na výnosy sušiny. Vyhodnocen byl také podíl *Festuca arundinacea* a *Festulolium* ve sklizené píci. V červnu 2001 nepřekročil podíl přisetých druhů ve sklizené píci 2 %, ale v průběhu čtyř let se zvýšil na víc než 20 %. V letním období neměl přísev statisticky průkazný vliv na výnosy sušiny. Přiseté druhy výrazně dominovaly v listopadu. Podíl *Festuca arundinacea* ve sklizené píci dosáhl hodnoty 80,1 % a podíl *Festulolium* 71,3 %. Výnosy přisévaných travních porostů byly od třetího sledovaného roku vyšší (od 1,07 t.ha^{-1} do 1,26 t.ha^{-1}) než u nepřisévaného travního porostu (od 0,66 t.ha^{-1} do 0,97 t.ha^{-1}), ale tento rozdíl nebyl statisticky průkazný. Statisticky průkazný ($P < 0,05$) vliv na výnosy v podzimních a zimních měsících měl termín přípravné seče. Při systému jedné přípravné seče v červnu byly výnosy sušiny od 1,02 do 2,28 t.ha^{-1}. Při systému dvou přípravných sečí v červnu a srpnu byly od 0,23 do 0,93 t.ha^{-1}. Statisticky průkazný ($P < 0,05$) byl také pokles výnosů od listopadu do ledna. Zatímco v listopadu byly výnosy od 0,9 do 2,2 t.ha^{-1}, v prosinci klesly na 0,35 až 1,35 t.ha^{-1} a v lednu na 0,4 až 1,11 t.ha^{-1}. Na základě dosažených výsledků je možné konstatovat, že *Festuca arundinacea* a *Festulolium* jsou vhodné druhy pro přísev do travních porostů určených pro prodlužování pastevního období.

výnosy sušiny, *Festuca arundinacea*, *Festulolium*, zimní pastva

REFERENCES

ACHILLES, W., GOLZE, M., HERRMANN, H. J., OPITZ VON BOBERFELD, W., WASSMUTH, R.: *Ganzjährige Freilandhaltung von Fleischrindern*. Darmstadt: KTBL, 2002. 103 s.

ALERT, H. J., BAUER, U.: Futtereinsatz und Anbau von Rohrschwingel (*Festuca arundinacea Schreb*.). *Tierzucht*, 1985, vol. 39, 126–127.

ARCHER, K. A., DECKER, A. M.: Autumn-accumulated tall fescue and orchadgrass. I. Growth and quality as influenced by nitrogen and soil temperature. *Agron. J*., 1977, vol. 69, 601–605.

BARTHOLOMEW, H. M., BOYLES, S. L., CARTER, B., VOLLBORN, E., MILLER, D., SULC, R. M.: Experiences of eigh Ohio beef and sheep producers with year-round grazing. In *Proc. 18th Intern. Grassl. Congr*. Saskatoon, 1997, vol. 29, 127–128.

BOEKER, P.: Ganzjähriger Weidegang in Großbritanien durch Winterweide nach dem Foggage-system. *Landw. Angew. Wiss*., 1957, vol. 67, 85–123.

COLLINS, M., BALASKO, J. A.: Effects of N fertilization and cutting shedules on stockpiled tall fescue. I. Forage yield. *Agron. J*., 1981, vol. 73, 803–807.

GERRISH, J. R., PETERSON, P. R., ROBERTS, C. A., BROWN, J. R.: Nitrogen fertilization of stockpiled tall fescuein the midwestern USA. *J. Prod. Agric*., 1994, vol. 7, 98–104.

KLAPP, E.: Wiesen und Weiden. 4. vyd. Berlin; Hamburk: Verl. Paul Parey, 1971.

OPITZ VON BOBERFELD, W.: Grassland management aspects for year-round outdoor stock keeping of suckler cows. *Grassl. Sci. in Poland*, 2001, vol. 4, 137–147.

OPITZ VON BOBERFELD, W.: *Grünlandlehre*. Stutgartt: Verl. Eugen Ulmer, 1994. 336 s.

PRIGGE, E. C., BRYAN, W. B., GOLDMANN-INNIS, E. S.: Early and late season grazing of orchadgrass and fescue hayfields overseeded with red clover. *Agron. J*., 1999, vol. 91, 690–696.

RYCHNOVSKÁ, M.: *Metody studia travních ekosystémů*. Praha: Academia, 1987. 269 s.

STÄHLIN, A., TIRTAPRADJA, H.: Ein Vergleich von Rohrschwingel (*Festuca arundinace Schreb*.) und Wiesenschwingel (*Festuca pratensis Huds*.) in chemischer Hinsicht. *J. Agron. Crop Sci*., 1974, vol. 140, 100–116.

UHLIAROVÁ, E.: Development of seminatural, oversown and temporary grassland phytocenoses. In *Ekológia trávneho porastu VI*. Banská Bystrica: VUTPHP, 2002, 242–257.

VOROBEL, M., HARAKAL, V.: Ecosystem studies of permanent, oversown and temporary grasslands in the "Laborecká vrchovina" highlands. In *Ekológia trávneho porastu VI*. Banská Bystrica: VUT-PHP, 2002, p. 288–299.

WACKER, G.: Futterwert von Rohrschwingel und Empfehlungen zu seinem Anbau. *Feldwirtschaft*, 1983, vol. 24, 151–153.

WHEELER, J. L.: Major problems in winter grazing. *Herb. Abstr*., 1968, vol. 38, 11–18.

WILLMS, W. D., RODE, L. M.: Forage selection by cattle on fescue prairie in summer or winter. *J. Range Manage*., 1998, vol. 51, 496–500.

WÖHLER, K.: *Zur Qualität und Masse von Winterweidefutter in Abhängigkeit von Standort, Pflanzengesellschaft und Bewirtschaftung*. Dissertation. Giessen: Justus-Liebig Universität, Institut für Pflanzenbau und Pflanzenzüchtung II – Grünlandwirtschaft und Futterbau, 2003. 134 s.

WOLF, D.: *Zum Effekt von Pflanzenbestand, Vornutzung und Nutzungstermin auf Qualität und Masse von Winterweidefutter*. Dissertation. Giessen: Justus-Liebig Universität, Institut für Pflanzenbau und Pflanzenzüchtung II – Grünlandwirtschaft und Futterbau, 2002. 127 s.

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