CHANGES IN GRASSLAND YIELD AND BOTANICAL COMPOSITION UNDER CONTRASTING MANAGEMENTS

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Abstract: The objective of the current field study was to examine the effect of nitrogen (N) application (0-N_0 and 150 kg ha^{-1} $year^{-1}$-N_{150}) and rotational grazing by cattle (C) and sheep (S) on grassland dry matter (DM) yield and botanical composition. A higher total DM yield was obtained under sheep grazing ($P<0.05$) than under cattle grazing, whereas grazing by cattle resulted in higher values of dead plant material compared to grazing by sheep ($P<0.01$). Application of 150 kg ha^{-1} N resulted in 19.2 % higher grassland DM yield in comparison with N_0 ($P<0.01$). Sheep grazing was less detrimental to legumes DM yield than was cattle grazing ($P<0.05$), whereas omission of N application (N_0) resulted in higher legumes DM yield and their contribution to total DM yield compared to N_{150} ($P<0.01$). A grazing management x N rate interaction ($P<0.05$) was recorded for legumes DM yield and their contribution to total DM yield. Application of 150 kg ha^{-1} N resulted in 29% higher grasses DM yield and 9% in higher grasses contribution to total DM yield in comparison with N_0 ($P<0.01$). As the grass content increased, the contribution of legumes and forbs declined when fertilized with 150 kg ha^{-1} N.

Keywords: botanical composition, nitrogen, sheep grazing, cattle grazing, yield

Introduction

In intensive grassland management systems, high N application increases forage yield and nutritive value, but the disadvantages of using high level of N fertilizers to the environment become more and more apparent. N fertilization increase yield and quality of different species (Varga et all., 2007, Izsaki, 2007). Rational use of soils and the maintenance of their multifunctionality, "quality", fertility and agricultural productivity are important elements of sustainable (agricultural) development (Várallyay, 2006). The use of grass/white clover swards in temperate grazing systems is receiving interest, as they afford opportunity to develop grazing systems that require low inputs of mineral N but are still productive in terms of both herbage and animal output and reduce adverse effects on the environment (Yarrow and Penning, 2001). Grass/white clover swards, continuously stocked with sheep, had up to 80% of the lamb liveweight output ha^{-1} of swards receiving 420 kg of N ha^{-1} $year^{-1}$(Orr et al.,1990). As a result of artificial fertilizers, the number of species in the grassland decrease, although the diversity decrease, the feeding value and yield of improved grassland increase (Szeman, 2007). Very little information exists about plant relations in grass-legume swards grazed under controlled rotational management with paddocks, using recovery periods that vary according to plant regrowth vigour, and under high stocking densities in Croatia.

The objective of the current field study was to examine the effect of N application (N_0; N_{150}) and rotational grazing by cattle and sheep on grassland DM yield and botanical composition.

Materials and methods

The three-year experiment (2000-2002) was conducted in north-western Croatia, at the Faculty of Agriculture experimental station, on brown acid soil (pH 5.3, 650 m altitude, 1230 mm average annual precipitation, 6.6 °C mean annual temperature). A mixture of 12 kg ha^{-1} cocksfoot (*Dactylis glomerata* cv. Amba), 6.4 kg ha^{-1} smooth-stalked meadow grass (*Poa pratensis* cv. Balin) and 6.4 kg ha^{-1} white clover (*Trifolium repens* cv. Rivendel) was sown in August 1998, with a seedbed dressing of 40 kg N, 130 kg P_2O_5 and 130 kg K_2O ha^{-1}. Potash and phosphate dressings were repeated at the same rates in the autumn of 1999, 2000 and 2001. During 1999, the sward was topped regularly to control annual weeds. In 2000, the total experimental area (0.6 ha) was divided into 12 equal paddocks (0.05 ha). The experiment consisted of all combinations of (i) two grazing managements (rotational grazing by cattle and sheep) and (ii) two annual N application rates: 0 kg N ha^{-1} and 150 kg N ha^{-1} in six equal applications from spring to autumn. The layout was a randomized-block design with three replications. The grazing regime was imposed when the mean sward height was 17-20 cm for cattle and 13-15 cm for sheep and continued until a post-grazing height of 5 cm was attained. Grazing was applied for a maximum of 24 hours with 10-12 Charolais heifers and 35-40 Charolais ewes plus lambs, depending on the herbage available. Grassland herbage production was measured before each of the grazing cycles (rotations), from April to October, by cutting at random fifteen quadrats (1 x 0.3 m) per paddock to ground level. Cut herbage was weighed and a 200 g subsample was taken and hand separated into legumes (mainly white clover), grass, forbs and dead plant material. Herbage samples were oven-dried at 105 ^{0}C for 24 h and dry weights were recorded. There were 5-7 rotations per year, depending on the year and grazing treatment. All data were subjected to the analysis of variance using the GLM procedure of SAS (SAS Institute, 1997). All variables were transformed by square root transformation. Upon the analysis of variance, a multiple comparison test of average values, along with the Bonferroni correction method, was conducted for the significant effects and interactions.

Results and discussion

The total precipitation during 2000 (995.6 mm) was 19% less than the long-term average (1230.9 mm) and the mean annual temperature (8.4 ^{0}C) was 27% higher than average (6.6 ^{0}C) and it caused the lowest DM yield in 2000 (9.11 t ha^{-1}) compared to 2001 and 2002 (13.43 and 11.2 t ha^{-1}, respectively) which were more humid (+104.6 and +20 mm, respectively) and warmer than the long-term average. August 2000, with only 0.5 mm precipitation and 2.8 ^{0}C higher temperature than average, was especially dry and warm. Averaged over all years, a higher total DM yield was obtained under sheep grazing ($P<0.05$) than under cattle grazing which is consistent with the results of Murphy et al. (1995), whereas grazing by cattle resulted in higher values of dead plant material compared to grazing by sheep ($P<0.01$) (Table 1). Application of 150 kg ha^{-1} N resulted in 19.2 % higher grassland DM yield in comparison with N_0 ($P<0.01$). Szeman (2007) found that fresh and DM grassland herbage yield increased as the nitrogen supply

improved and the increase of yield improved the carrying capacity of the grassland. Sheep grazing was less detrimental to legumes DM yield than was cattle grazing ($P<0.05$), whereas omission of N application (N_0) resulted in higher legumes DM yield and their contribution to total DM yield compared to N_{150} ($P<0.01$). A grazing management x N rate interaction ($P<0.05$) was recorded for legumes DM yield and their contribution to total DM yield. The highest legumes content were recorded in SN_0 which is contrary to the results of Briseno de la Hoz and Wilman (1981), Evans et al. (1992) and Murphy et al. (1995), who reported that cattle grazing depressed clover content less than sheep grazing in ryegrass/white clover swards. Close sheep grazing favours white clover growth and production by decreasing the shading of growing points by companion grasses. More intensive sheep grazing that was imposed during the present study, compared to cattle grazing, probably created better light conditions in the sward that resulted in better clover growth. Floristic changes due to nutrient additions is thought to be caused by the faster and more intensive growth of some species (usually grasses) compared to other species (mostly dicotyledonous) when well-fertilized (van der Bergh, 1991; Knežević, 2007, Szeman, 2007). This was also confirmed in this research where application of 150 kg ha^{-1} N resulted in 29% higher grasses DM yield and 9% in higher grasses contribution to total DM yield in comparison with N_0 ($P<0.01$). As the grass content increased, the contribution of legumes and forbs declined when fertilized with 150 kg ha^{-1} N, which is due to the results of Griffin et al. (2002) and Knežević (2007). Cattle grazing resulted in 40 % higher values of dead plant material compared to sheep grazing ($P<0.01$). If grasses such as *Dactylis glomerata* L. and *Poa pratensis* L. are not grazed during the first one or two spring rotations because of initial repugnance around dung pats, they quickly mature, become increasingly rank and tend not to be grazed at all during the rest of the season (Murphy et al., 1995).

Table 1. Effects of grazing treatments and N fertilizing on herbage dry matter yield (DMY), DMY of legumes, grasses, forbs and dead plant material and their contribution to total DM yield 2000-2002.

Treatment	DMY	Legumes		Grasses		Forbs		Dead plant material	
	t ha^{-1}	t ha^{-1}	%	t ha^{-1}	%	t ha^{-1}	%	t ha^{-1}	%
Cattle (C)	10.96	0.13	1.40	9.34	85.14	0.64	5.92	0.84**	7.53**
Sheep (S)	11.54*	0.21*	1.96	9.90	85.56	0.85	7.25	0.58	5.23
N_0	10.26	0.25**	2.50**	8.39	81.80	0.98**	9.29**	0.65	6.41
N_{150}	12.23**	0.09	0.86	10.85**	88.90**	0.52	3.88	0.77	6.35
CN_0	9.73	0.14 ^{b}	1.67 ^{b}	7.98	82.29 ^{b}	0.85	8.50	0.76	7.54
CN_{150}	12.18	0.11 ^{bc}	1.13 ^{bc}	10.70	87.99^{a}	0.44	3.35	0.93	7.52
SN_0	10.79	0.35^{a}	3.32^{a}	8.79	81.32 ^{c}	1.10	10.08	0.54	5.28
SN_{150}	12.28	0.07 ^{c}	0.59 ^{c}	11.00	89.80^{a}	0.60	4.42	0.61	5.18
Significance									
Grazing (G)	*	*	NS	NS	NS	NS	NS	**	**
Nitrogen (N)	**	**	**	**	**	**	**	NS	NS
G x N	NS	*	*	NS	**	NS	NS	NS	NS

* Significant at the 0.05 level ** Significant at the 0.01 level NS Non significant

The differences between the values with the same letters are statistically insignificant at P=0.05.

Conclusions

A higher total DM yield was obtained under sheep grazing than under cattle grazing, whereas grazing by cattle resulted in higher values of dead plant material compared to grazing by sheep. Application of 150 kg ha^{-1} N resulted in 19.2 % higher grassland DM yield in comparison with N_0 ($P<0.01$). Sheep grazing was less detrimental to legumes DM yield than was cattle grazing , whereas the absence of fertilizer N resulted in higher legumes DM yield and their contribution to total DM yield compared to N_{150}. A grazing management x N rate interaction was recorded for legumes DM yield and their contribution to total DM yield. N_{150} treatment resulted in 29% higher grasses DM yield and 9% in higher grasses contribution to total DM yield in comparison with N_0. As the grass content increased, the contribution of legumes and forbs declined when fertilized with 150 kg ha^{-1} N.

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