Influence of early cutting dates on forage yield and quality of alpine pastures

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Abstract

Alpine pastures are characterised by a diverse botanical composition managed at graduated intensity. Rapid grass growth at the beginning of the vegetation period generally results in fast decline in forage quality. The reduced net energy lactation (NEL) content of the forage complicates its utilisation for higher yielding dairy cattle. The aim of our study was to investigate the influence of early utilisation dates on forage yield and the quality of alpine pastures managed at different intensities. Pastures established for a 60-year-long fertiliser experiment located at 1,400 m a.s.l. were used. The first cut of selected plots (zero fertiliser, NPK and PK) was cut standard (usual beginning of summer pasture), early (21 days before usual beginning of summer pasture) and very early (35 days before usual beginning of summer pasture). The highest dry matter yields (DMY) were found for the standard cutting treatment. At the early and very early cutting dates (21 resp. 35 days before usual beginning of summer pasture) the DMY was significantly influenced by the fertiliser treatment. A significant interaction between fertiliser and cutting treatment was found. DMY was highest for NPK swards and lowest for 0 swards. NEL content was highest at the first cut for the early and very early cutting regimes. The results demonstrate the potential to improve forage quality by earlier utilisation, but also indicate consequences for yield from pastures managed at higher intensity.

Keywords: alpine pasture, fertilisation, cutting date, productivity, nutritional value

Introduction

Thanks to the forage produced on Swiss alpine pastures, an additional 10% of livestock can be fed (Herzog *et al.*, 2013). As a result of the well-managed grazing activities, alpine pastures provide a broad range of ecosystem services. However, during the past decades grassland utilisation in alpine areas has declined and shifted towards more extensive utilisation, leading in some areas to serious scrub and tree encroachment (Mack, 2008). The decline in milk yield during the summer alpine pasture period, with its consequent economic impact, is one of the most important factors in decreasing grassland utilisation in alpine areas (Fischer, 2011). Rapid grass growth at the beginning of the vegetation period results in fast decline in forage quality (Brühlmann and Thomet, 1991) with strongly reduced net energy lactation (NEL) content. The usual beginning of summer pasture on alpine pastures is generally rather late due to risk of a late winter onset and traditional habits. If utilisation of alpine pastures by dairy cows is to be maintained in the future, solutions to improve the inadequate energy supply at the beginning of the summer pasture have to be developed. In this study we examined the influence of different utilisation dates on forage quantity and quality of alpine pastures differing in botanical composition and fertiliser supply.

Materials and methods

The study was carried out at a 60-year-long fertiliser experimental site located on the alpine pasture of the Eggenalp (Zweisimmen BE, Switzerland, 46°33'54' N 7°21'27'E) 1,340 m a.s.l. with an acidic brown earth soil. The original fertiliser experiment involves eight different fertiliser treatments on 5×10 m plots with swards of different botanical compositions in a randomised complete block design with four replications. The three selected treatments (0, NPK, PK) simulated different levels of management intensity. The various fertilisation treatments received the following amount of nutrients: 82 kg N ha^{-1}

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and 180 kg K_2O ha^{-1} each year and 180 kg P_2O_5 ha^{-1} each third year. This lead to subsequent differences in the abundance of grasses, legumes and forbs for the different treatments 0: 43/15/42%, NPK: 55/9/36%, PK: 48/21/31% (assessed with the frequency method of Daget and Poissonet (1969)). Each selected plot was split into subplots where three cutting regimes (very early, early, standard) were applied. In this way, various utilisation dates of first and subsequent utilisations (sample dates cf. Table 1) with respect to the common start date of the summer pasture period (very early: -35 d before, early: -21 d before, standard: 0 d) are simulated. The annual rainfall at the experimental site was approximately 1,900 mm with an average annual temperature of 4 °C. Sward biomass was determined by mowing a 0.7×9 m subplot at a height of 4 cm at each sample date of each fertiliser replication. Dry matter yield (DMY) was determined on a subsample of 300 g by drying for 24 hours at 105 °C. Samples for nutritional analysis were dried for 24 hours at 55 °C before processing. Nutritional content (acid detergent fibre (ADF) and crude protein (CP)) was determined by NIRS and additionally verified by wet chemistry analysis (Agroscope, 2015). NEL was estimated by regression equations in accordance with Daccord *et al.* (2013). Statistical analysis using the statistical software R (R Development Core Team, 2010) was carried out for each sample date separately by fitting a linear mixed model with a random intercept for the block factor and fixed effects for fertiliser, cutting treatment and their interaction.

Results and discussion

The NPK treatment resulted in the highest and the 0 treatment in the lowest total DMY (Table 1). A significant effect of the fertiliser treatment on DMY was found at sample date one, two, and four. At date three a significant interaction between fertiliser and cutting treatment could be observed. This indicates the dissimilar response of the different swards to the different cutting regimes for the first cut and highlights the importance of the time of the first cut for the total DMY. For the fertilised plots (NPK, PK), the very early and early cutting treatment was similar and resulted in a notably lower total DMY than the standard treatment. The NPK sward was dominated by early and productive grasses such as

Table 1. Net energy for lactation (NEL), acid detergent fibre (ADF), crude protein content (CP) and dry matter yield (DMY) of different fertilised (F) swards of a 60-year-old fertiliser experiment on an alpine pasture managed under a standard (first utilisation at usual beginning of summer pasture), an early and a very early (first utilisation 21 resp. 35 days earlier) cutting regime (C).[1,2]

Treatment		Sample date 1: -35 days				Sample date 2: -21 days				Sample date 3: 0 days/standard				Sample date 4: +35 days				Total
C	F	NEL[1]	ADF[2]	CP[2]	DMY[3]	NEL[1]	ADF[2]	CP[2]	DMY[3]	NEL[1]	ADF[2]	CP[2]	DMY[3]	NEL[1]	ADF[2]	CP[2]	DMY[3]	DMY[3]
Very early	0	6.25	234.8	159.1	0.4	6.26	226.0	151.6	0.6	5.75	288.2	150.7	4.0	5.724	276.8	163.6	6.0	10.4
	NPK	6.44	200.4	207.9	5.1	6.20	201.3	189.1	1.9	5.70	300.7	170.2	10.2	6.073	259.4	202.9	14.4	31.6
	PK	6.30	192.4	185.3	1.2	6.12	208.9	175.8	0.7	5.69	299.6	169.5	8.5	5.863	267.4	167.7	10.5	20.5
Early	0					5.90	226.8	148.5	2.9	5.63	299.2	149.2	5.8	5.772	271.9	160.6	5.7	14.4
	NPK					6.14	214.7	170.6	8.7	5.74	296.8	157.9	8.3	5.898	268.2	192.8	13.6	30.6
	PK					6.02	216.4	159.1	3.5	5.75	297.9	164.6	9.0	5.848	271.0	171.7	8.9	21.4
Stan-dard	0									5.35	307.4	133.3	9.4	5.645	279.8	158.5	6.6	16.1
	NPK									4.98	340.0	114.3	34.5	5.883	262.4	187.4	15.5	50.0
	PK									5.32	317.1	135.9	18.2	6.091	247.3	180.8	9.0	27.2
P-value	C	–	–	–	–	0.303	0.250	**	***	***	**	**	***	0.805	0.450	0.642	0.528	***
	F	0.367	**	***	***	0.305	0.230	***	*	0.410	0.259	**	***	**	*	***	***	***
	CxF	–	–	–	–	0.883	0.810	0.426	0.126	0.236	0.516	**	***	0.125	0.199	*	0.806	**

[1] NEL: MJ NEL kg^{-1} DM; ADF: g kg^{-1} DM; DMY: kg DM ha^{-1}.

[2] Sign. *** $P<0.001$, ** $P<0.01$, * $P<0.05$.

Dactylis glomerata L. and *Festuca pratensis* Huds.. PK and 0 swards were characterised by fewer grasses and grasses with later heading dates such as *Festuca rubra* L. or *Agrostis capillaris* L. and a higher proportion of legumes. The high NEL content of 6.2-6.4 MJ kg^{-1} DM for all fertiliser treatments at sample date one show the potential of considerable milk yields from the forage for the very early cutting treatment. In contrast, at sample date three the NEL content of the standard treatment was substantially lower (NPK: 5.0 MJ NEL kg^{-1} DM, PK: 5.3 MJ NEL kg^{-1} DM and 0: 5.4 MJ NEL kg^{-1} DM). The significant higher ADF content of the NPK swards for the standard cutting regime resulted in a pronounced decline in the NEL content. This was most likely the effect of an increased lignification of the early grasses intensified through N fertilisation (Caputa, 1966). Similarly the slower drop in CP due to a higher proportion of legumes and forbs led to a distinctly slower decline in the NEL content for PK and 0 treatments (Schubiger *et al.,* 1998). At date four there was a significant effect of fertiliser treatment for NEL, ADF and DMY, but no effect of cutting treatment, indicating the decreasing importance of the cutting regime when the preceding cutting date was the same.

Conclusions

Regarding the use of alpine pasture, the importance of the date of the first cut depends on the characteristics of the sward. While intensive swards (high nutritional status, high proportion of early grasses) require earlier utilisation to provide forage of a high quality, less intensive swards are more flexible with respect to yield and quality changes at differing first utilisation dates. The results demonstrate the potential to improve forage quality by earlier utilisation, but also indicate the lower yield as a consequence for pastures managed at higher intensity.

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