In-vitro digestibility and energy concentration of different legumes - results from the COST 852 experiments in Austria

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ABSTRACT

According to the common protocol of working group 3 within COST 852 two field experiments have been carried out at HBLFA Raumberg-Gumpenstein, Austria. Comprehensive recordings and analyses have been made during 3 years focussing on yield productivity, forage quality and botanical composition of the established mixtures. Special attention was given to different legume species and on their function for grassland ecosystems. Considerable differences between legume species concerning yield, competitiveness, forage quality and energy yield were found.

INTRODUCTION

For most of the Austrian grassland and dairy farmers home-grown forage from meadows and pastures is a substantial element of sustainable farming management. Different measures, aiming at the improvement of forage quality, are therefore of great interest for practice and research. Especially on extensive grassland farming systems, organic farms and integrated farms, biological N-fixation plays an important role in terms of nutrient fluxes and nitrogen budget. Regarding the importance of legumes for agriculture and the insufficiently explained effects of climatic conditions, as the main topic of COST 852, field experiments have been established at the Federal Research and Education Centre for Agriculture at Raumberg-Gumpenstein located in the mountainous region of Austria.

MATERIAL AND METHODS

The field experiment design at Gumpenstein mainly followed the common protocol of working group 3 (*Figure 1*). Both unfertilised field trials were established in 2002, using the below-mentioned seed amounts and kept for three vegetation periods from 2003 to 2005. Besides phenological observations, the proportion of grasses, legumes and herbs have been estimated and measured by separation for each growth. Yield data (fresh mass and dry matter), content of crude nutrients, digestibility of organic matter and energy content have been analysed for all treatments.

The separated forage samples have been analysed for digestibility of organic matter by the two-stage technique for in vitro digestion of forage crops (Tilley and Terry 1963). Energy concentration was predicted on the basis of DOM by means of regression equations.

RESULTS AND DISCUSSION

There were significant differences between the treatments concerning dry matter production within the two cutting systems (*Figure 2*). In the pure grass stands the average yield amoun-

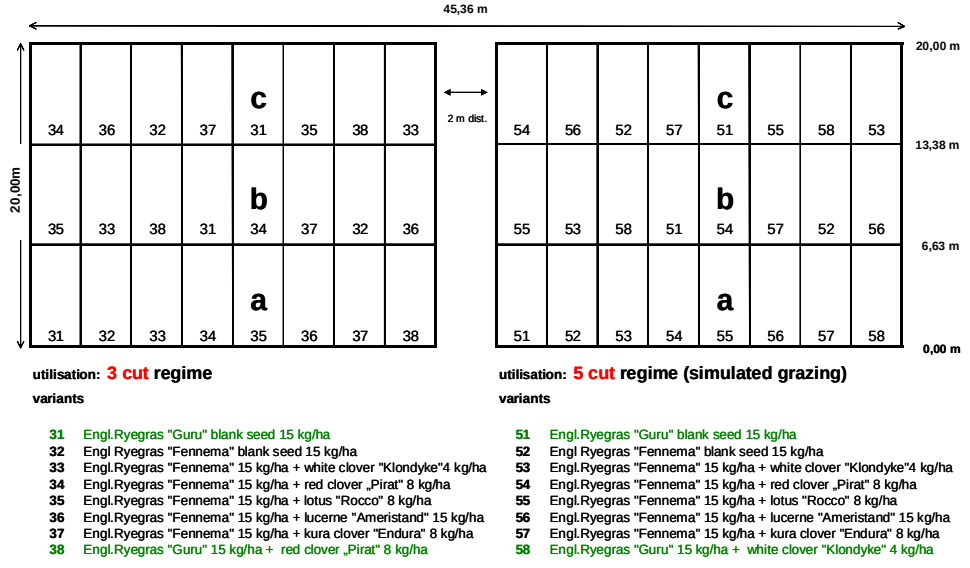

Figure 1: Design of the COST 852 field experiment at HBLFA Raumberg-Gumpenstein

ted to 47 resp. 49 dt dry matter per ha and year which represents the natural potential of the site. The effect of legumes as an important companion plant for grasses is impressively demonstrated by much higher yields for the combination of ryegrass with white clover, red clover and bird´s foot trefoil. The most productive and stable combination during the whole period was ryegrass with white clover both in the 3 cut and in the 5 cut experiment. Bird´s foot trefoil performed sufficiently in the 3 cut system, whereas lucerne showed a disappointing performance at all, mainly caused by a low pH-value (5.0) and by insufficient soil phosphorus content (4 mg P per 100 g fine soil). With the exception of ryegrass in combination with red clover and bird´s foot trefoil, which are sensitive to higher utilisation frequency, there were no significant differences in the yield production between the two cutting regimes.

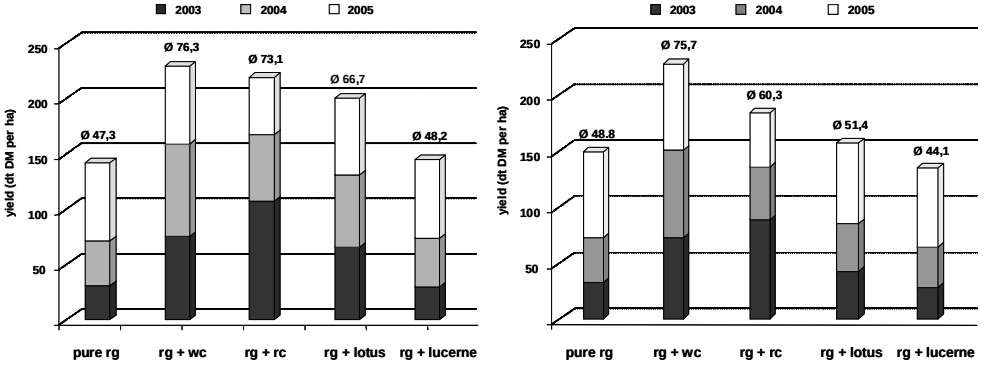

Figure 2: Yield productivity during the observation period (left chart = 3 cut system, right chart = 5 cut system)

These results indicate the limitation of yield production by the site conditions, which in practice lead to a typical 3 cut system with possibly one additional grazing activity in favourable years.

Figure 3 is showing the proportion of grasses, legumes and herbs within the different treatments of the 3 cut regime during the whole observation period. Generally the proportion of herbs decreased in all treatments, whereas grasses and legumes developed variably. In the unfertilised pure grass stand there was an increasing invasion of white clover over the years, which certainly has positively influenced yield production. The treatment with ryegrass and white clover showed a very stable botanical situation during the years, whereas red clover and bird´s foot trefoil declined. The proportion of lucerne increased but there was also a stronger invasion of white clover. Generally the proportion of legumes in the observed treatments has been reflected in the yield productivity of the different mixtures.

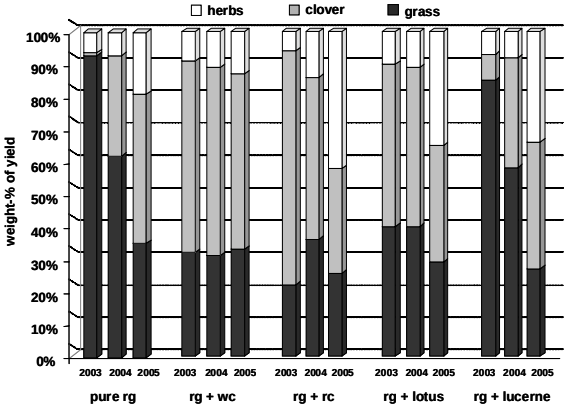

Figure 3: Proportion of grass, legumes and herbs during the observation period from 2003-2005

Table 1 and *2* include the results of the different legumes and of ryegrass (both from the blank seed and from the mixtures) for the years 2003 and 2004.

In both years the digestibility of organic matter of the forage samples was low but with the exception of white clover within the range of the data given in the German feeding value table (DLG-Futterwerttabelle 1997), which is also used in Austria for feeding calculations. This is mainly caused by the relatively long growth period, which leads to higher contents of hardly digestible or indigestible substances in plants. Bird´s foot trefoil showed significantly lower digestibility values than all other legumes, which might have been caused by a higher concentration of condensed tannins. There was a significant impact of the companion legumes on the quality of ryegrass, which once more underlines the importance of legumes for agriculture.

Table 1: Digestibility of Organic Matter (DOM %) - average of three cuts/year

	white clover	red clover	bird´s foot trefoil	lucerne	ryegrass (blank seed)	ryegrass (from mixtures)
2003	71.4	68.6	57.8	65.0	70.5	71.5
2004	72.4	66.0	57.4	62.8	72.4	74.0
DLG	80-81	61-79	n.a.	57-75	68-83	n.a.

Table 2: Energy concentration (MJ Net Energy Lactation/kg DM) - average of three cuts/year

	white clover	red clover	bird´s foot trefoil	lucerne	ryegrass (blank seed)	ryegrass (from mixtures)
2003	5.8	5.5	4.3	5.1	5.8	5.9
2004	6.0	5.2	4.3	4.9	6.0	6.3
DLG	6.5-7.1	5.0-6.9	n.a.	5.1-6.3	5.5-7.1	n.a.

The energy concentrations for the analysed samples are low compared with DLG data and show great differences within the legumes (*Table 2*). Again the positive impact of legumes on the quality of the companioned grass is visible by higher energy concentration especially in 2004.

The product of dry matter yield and energy concentration results in the energy yield (MJ NEL/ha), which is presented in *Figure 4*. The pure, unfertilised grass stand amounted to app. 15,000 MJ NEL/ha and year, which is comparable with the data of extensively managed alpine and mountainous grassland in Austria. The highest energy yield resulted from the mixture of ryegrass and red clover in 2003 with more than 55,000 MJ NEL/ha, which is within the range of ley farming areas and intensively used grassland. Mixtures with ryegrass and white clover or red clover showed the best overall productivity for the two years period followed by mixtures with ryegrass and bird´s foot trefoil or lucerne.

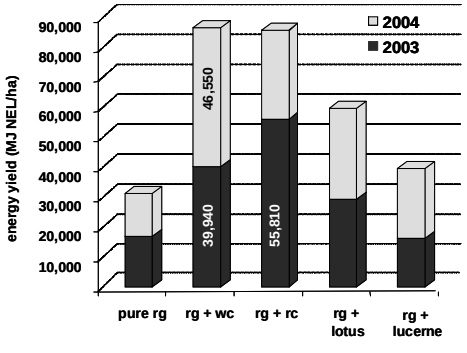

Figure 4: Quality yield (MJ NEL/ha) during the observation period from 2003-2004

CONCLUSIONS

The results of the Austrian field experiment within COST 852 clearly demonstrate the function and importance of legumes for grassland ecosystems. There were considerable differences between legume species concerning dry matter yield, competitiveness, forage quality and energy yield production. All these aspects have to be considered for the selection of legumes and for their usage in seed mixtures. Concerning the relatively low digestibility and energy concentration, grass and legume cultivars have to be chosen, which are well adapted to the site conditions.

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