Productivity and forage quality of a phytodiverse semi-natural grassland under various management regimes

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Introduction:

As mentioned by several authors (among others Flombaum & Sala 2008), biodiversity experiments on permanent grasslands are needed as biodiversity effect may be larger in natural than artificial ecosystems. In the grassland management experiment (GrassMan) species richness was manipulated by herbicide application against a) dicot species and b) monocot species. Different sward types are managed according to agricultural principles by variation of use intensity and nutrient input. We present the aspects of forage production and quality from the biodiversity viewpoint (species richness and functional diversity).

Hypothesis:
Yield and forage quality are influenced by the vegetation composition (sward type and functional groups)

Material and methods

Study area
•Semi-natural permanent grassland in the Solling uplands, Germany, close to Neuhaus (51°44' N, 9°32' E, 490 m a.s.l.)
•Average year temperature 6.9 °C, average precipitation amounts to 1031 mm (1961-1990, German Weather Service)
•Moderately species-rich grassland, plant community *Lolio-Cynosuretum*

Experimental design
•Latin rectangle design: 6 rows and 12 columns (2 columns forming 1 block)
•15x15 m plots
•6 replications

Tab. 1. Experimental factors and their levels.

Factor	Level
Sward type	control (**Co**)
	dicot-reduced (**-Dic**)
	monocot-reduced (**-Mon**)
Cutting frequency	1 cut (**1**)
	3 cut (**3**)
Nutrient input (N,P,K) 180-30-100 kg/year/ha	no nutrients (**x**)
	N,P,K (**NPK**)

Data sampling and measuring
•Harvesting of 20% of the fresh biomass (cutting height 7 cm, Haldrup® harvesting machine), drying of 100-200g subsamples (48h, 60°C) for dry matter yield calculation
•Mixed samples for determining the shares of functional groups (grass, herbs, legumes)
•Forage quality (NIRS)

Results

- Significant differences in yield between the years 2009 and 2010, as well as between different management regimes (Fig. 1)
- Sward type, species number and shares of functional groups had no effect on the yield in 2009; -Mon and -Dic swards had significantly lower yields in 2010 (Tab. 2, Fig. 1)

Tab. 2. Influence of the main experimental factors on the variability of the yield in 2009 and 2010 according to the management factors. ANOVA with block und row as spatial factors. Response variable yield not transformed (2010) and square-root transformed (2009). Asterisks stand for significant influences of the factors on the yield (** P< 0,01, *** P< 0,001).

Factors	% variance explained, 2009	% variance explained, 2010
Block	1.67	3.96 **
Row	2.73	5.0 **
Sward type	0.19	2.34 **
Nutrient input	58.47 ***	34.92 ***
Cutting frequency	10.35***	24.71 ***
Nutrient input:Cutting frequency	8.62 ***	16.96 ***
Residuals	17.96	12.11

- Forage quality of the spring regrowth was significantly influenced by the sward type in both years (Fig 2, 3)
- Crude protein content was lower in plots with high shares of forbs and higher in plots with high shares of herbs ($P = 0.0182$ and $P = 0.224$ accordingly)

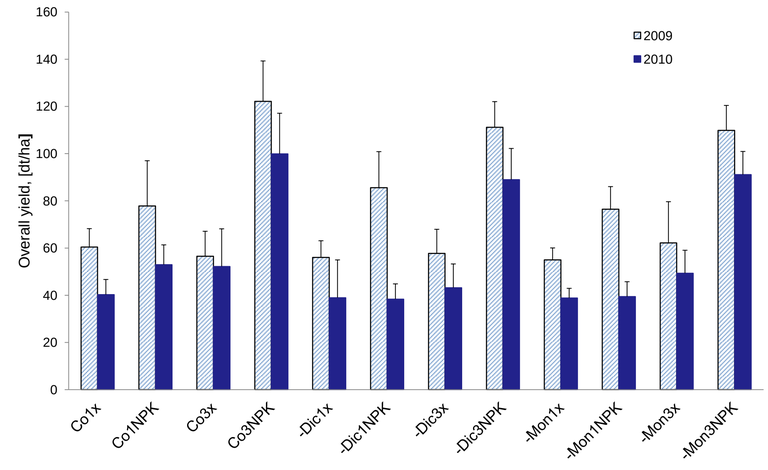

Fig. 1. Means and standard deviations of the yield according to the management regime in 2009 and 2010.

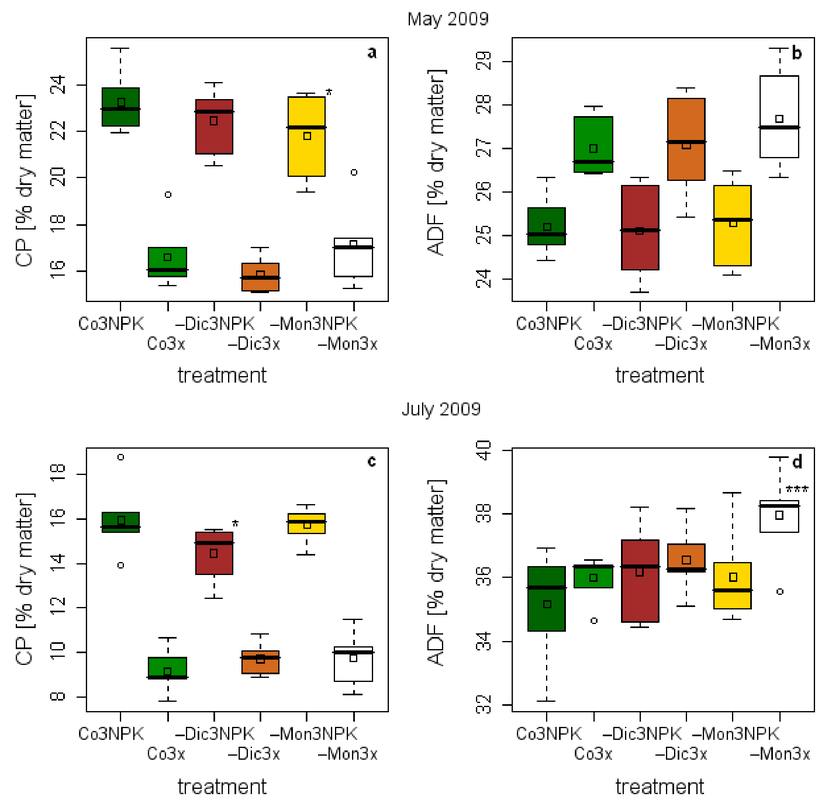

Fig. 2. Forage quality 2009 (May (a, b) and July (c, d)) of the first regrowth of the corresponding nutrient input level and sward type, n=6. Asterisks show significant differences to control sward of the corresponding nutrient input level. *P<0.05, ***P<0.001 . Linear contrasts, response variable not transformed; variance adjusted for ADF July per nutrient input level.

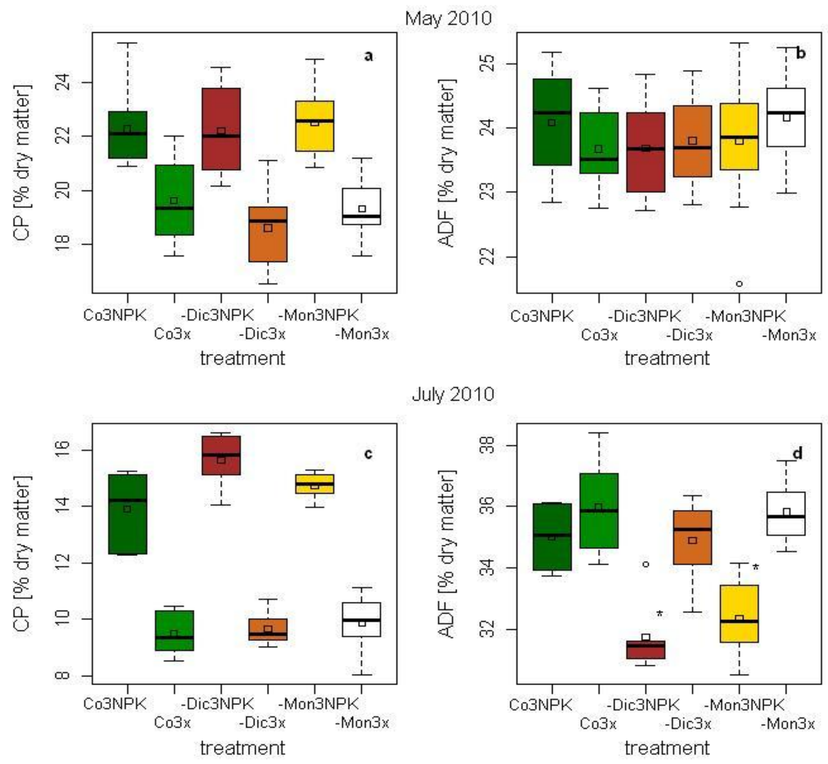

Fig. 3. Forage quality 2010 (May (a, b) and July (c, d)) of the first regrowth depending on the management type, n=6. Asterisks denote significant differences to control sward (Co) of each nutrient input level. ˙P < 0.1, *P < 0.05. Linear contrasts, response variable not transformed.

Conclusions

Overall yields were only slightly influenced by vegetation composition and sward type. Share of herbs in the vegetation composition played an important role in the forage quality. Further analysis will take into consideration weather conditions in spring and summer 2010 due to their unusual character.


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References

FLOMBAUM, P., SALA, O. (2008): Higher effect of plant species diversity on productivity in natural than artificial ecosystems. Proceedings of the National Academy of Science of the United States of America. PNAS 105 (16), 6087-6090.

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