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Yield, forage quality, residue nitrogen and nitrogen fixation of different forage legumes

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Introduction

In many organic farms, mixtures of forage legumes and grasses are both a major nitrogen source and an important component in winter feeding. For the design of crop rotations it is necessary to evaluate the influence of seed mixture and management on yield, forage quality, residue nitrogen and nitrogen fixation. Studies which analyse simultaneously the effects of different management factors on the parameters listed are rare. Therefore a multifactorial field experiment was conducted to analyse the impact of forage legume species, seed mixtures and management simultaneously on DM-yield, legume content, forage quality parameters and nitrogen fixation.

Material and methods

From 1997 to 1999 a multifactorial field study with different grass/clover swards was conducted on a sandy, loamy cambisol (14% clay) near Kiel in Northern Germany (9°37'E, 54°21'N). Experimental factors were: (i) legume species (red clover, alfalfa, white clover), (ii) seed mixture (pure legume, mixtures with perennial ryegrass) and (iii) management (forage use, green manure). In all swards the following parameters were investigated: harvestable biomass, legume content, organic matter of stubble, roots and mulch, N-content of all plant material, $CaCl_2$-extractable mineral and organical soil N as well as nitrogen fixation. In addition forage quality of the cropped swards was determined by crude protein content (CP) and digestibility.

Results and discussion

The table shows significant effects of all experimental factors on the estimated parameters with the exception of the crude protein content. Under the same management swards with red clover and alfalfa reached more harvestable biomass and higher legume contents than swards with white clover. While mulched legume swards left at least 200 kg N · ha^{-1} N as mulch, stubble and roots, most cropped swards left not more than 115 kg N · ha^{-1} as plant residues after the last cut. Here it was the grass/white clover mixture which left with 296 kg N · ha^{-1} the by far highest amount of N in form of plant residues on the field. Swards used for forage had a higher N fixation than those grown as green manure. While in swards used for forage red clover and alfalfa showed a much higher N fixation than white clover, green manure management favoured N fixation by white clover. There was no effect of legume species on crude protein concentration in the harvested plant material. Due to lower DM-yields swards with white clover had lower crude protein yields than those with alfalfa or red clover.

Table: Effect of seed mixture and management on harvestable biomass, legume- and CP-content, N in plant residues and N fixation of different grass/legume swards (1997)

Seed mixture	(management)	Harvestable biomass [t DM · ha^{-1}]	Legume content [% of DM]	Crude protein content [% of DM]	N in plant residues [kg N · ha^{-1}]	N fixation [kg N · ha^{-1}]
White clover/grass	(forage use)	6.04c	66.9c	17.9a	117.2c	248.4b
White clover/grass	(green manure)	3.63d	47.9d	-	296.2a	208.8c
Red clover/grass	(forage use)	9.46a	79.0a	18.2a	111.7c	342.7a
Red clover/grass	(green manure)	9.25a	66.5c	-	219.9b	154.2d
Alfalfa/grass	(forage use)	7.53b	73.9b	18.7a	114.6c	320.3a
Alfalfa/grass	(green manure)	8.57a	71.3b	-	199.0b	136.2d

(Means with the same letter are not significantly different, Student-Newman-Keuls test, $\alpha = 0,05$)

Conclusions

The results show that biomass production, forage yields, residue nitrogen and N fixation of grass/legume mixtures can be influenced by various combinations of legume species and management. The factors listed have to be considered carefully when planning crop rotations.

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