

# YIELD FORMATION AND CHANGES IN QUALITY IN LEGUME-GRASS MIXTURES AS AFFECTED BY N-FERTILIZATION, IRRIGATION AND GRASS SPECIES

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## ABSTRACT

In the years of 1984 to 1992 field experiments have been conducted with different legume-grass mixtures at a location in north-east Germany. Dry matter yield, crude protein and crude fibre content in legume-grass mixtures changed by N-fertilization, grass species, duration of utilization and irrigation. First this was caused by the effect of these factors on yield proportion.

The variation of N-fertilization and irrigation influenced red clover grown in a mixture with grass more than lucerne-grass mixture. Irrigation of red clover-grass mixture supported the yield proportion of legume whereas N-fertilization and duration of utilization supported the grass species. Yield proportion, crude protein and crude fibre content were less affected by irrigation and N-fertilization, when lucerne dominated the mixture. The yield proportion of lucerne increased with the duration of utilization and the length of growing season. *Festulolium braunii* proved to be a more competitive companion than *Lolium perenne* and *Festuca pratensis*. In the first year this competition resulted in higher yield proportion of grass and in better dry matter yield of the mixture. The higher yield proportion of grass reduced crude protein of legume-grass mixture and increased crude fibre content.

## KEYWORDS

legume-grass mixtures, red clover, lucerne, *Festulolium braunii*, *Festuca pratensis*, N-fertilization, irrigation, grass species

## INTRODUCTION

The yield proportion of legume and grass determine dry matter yield, crude protein content and crude fibre content of legume-grass mixtures. External factors like weather and cultivation management (N-fertilization, cutting system, species of legume and grass, irrigation) immediately affect the forage quality, but also change yield proportion of legume and grass (Meinsen, 1983). Furthermore interactions between legume and grass grown in a mixture in comparison to pure grass stands are explained by N-transfer (Lampeter, 1959/60; Lehmann and Meister, 1978) and by the increased soil volume the grass plants can profit from.

Furthermore legumes and grasses compete for light. Less light intensity affects N-content and water soluble carbohydrates (Jelmini and Nösberger, 1978).

The following results show to what extent dry matter yields respond to N-fertilization, grass companion, duration of utilization and irrigation.

## MATERIAL AND METHODS

The field experiments dealing with legume-grass mixtures were carried out from 1984 to 1992 (Schmalzer, 1988; Schmalzer et al., 1992). The site for these experiments was located in Berge in the north-east plains of Germany. It is characterized by an average precipitation of 503 mm per year and an annual mean temperature of 8.5°C. Sandy loam soils are predominant.

The overall number of test data was n=1135 concerning dry matter yield, yield proportion of legume, contents of crude protein and crude

fibre of *Medicago x varia Martyn* and *Trifolium pratense* L. (4n) in pure and mixed stands with *Festulolium braunii* (RICHT.)A. CAMUS, *Festuca pratensis* Huds. and *Lolium perenne* L. Test factors were N-fertilization (unfertilized, fertilized by 60 and 120 kg/ha), grass species (*Festulolium braunii*, *Festuca pratensis*), year of utilization (first and second harvest year) and irrigation (unirrigated and irrigated). These factors were checked for both pure legume and legume-grass mixture. According to the varied factors the relative frequencies were determined. The directions of its effects were evaluated.

## RESULTS AND DISCUSSION

**Dry matter yield.** Pure red clover cut three times per year yielded an average of 12.0 t/ha DM when unfertilized and unirrigated. Lucerne treated in the same way and cut four times per year yielded an average of 13.8 t/ha DM. In the first year *Festulolium braunii* increased yields of legume-grass mixtures strongest because it is more competitive than the other grass species. In red clover-grass association *Festulolium braunii* had a yield level of 13.8 t/ha DM and 14.2t/haDM in lucerne-grass association respectively. In comparison to the first harvest year in the second year pure red clover and mixed red clover and grass responded with a 91 to 96 per cent yield decrease. On the other hand pure lucerne and mixed lucerne and grass reached the maximum yield in the second year (17.2 and 16.8 t/ha DM respectively).

As the relative frequency of single cut yields showed, N-fertilization in lucerne-grass mixture and irrigation of clover-grass mixture increased yields most (Figure 1). Especially the yield of the first and second cut per year was influenced by grass species in mixed lucerne and grass. This effect weakened in the course of the growing period and the number of years.

**Proportion of legume and forage quality.** At the trial location lucerne dominated in the lucerne-grass mixtures. That's why the grass could only change the forage quality insignificantly. In comparison to *Festuca pratensis* the more competitive grass *Festulolium braunii* decreased yield proportion of lucerne and crude protein content. N-fertilization also decreased yield proportion of legume but increased the protein content in mixture. Irrigated lucerne-grass mixtures and forage growing in the second year showed increased yield proportion of lucerne and protein content. As Figure 2 shows grass more often dominated in clover-grass mixtures, and in comparison to mixed lucerne and grass other reactions of test factors existed. N-fertilization decreased protein content of forage and increased fibre content. Mixtures grown with more competitive *Festulolium braunii* or in the second year showed higher crude fibre content and lower protein content. Irrigation increased the yield proportion of red clover and the content of crude protein and crude fibre.

A summary of crude protein contents depending on yield proportion of legumes is shown in Figure 2. The results concerning 100 per cent yield proportion are valid for pure legume stands. Yield proportion of legume of less than 60 per cent were observed more frequently in clover-grass mixture. However, in the first year after sowing *Festulolium braunii* induced a decrease in yield proportion of lucerne. As noted in Figure 2, crude protein contents were

distributed asymmetrically. There is a positive correlation between yield proportion of the legume and crude protein content of the mixture. The distribution of crude protein data makes clear that other factors also determined the variation of chemical composition. Such factors like weather (growth conditions, seasonal growth) also influenced the forage quality, but this is not the scope of this paper.

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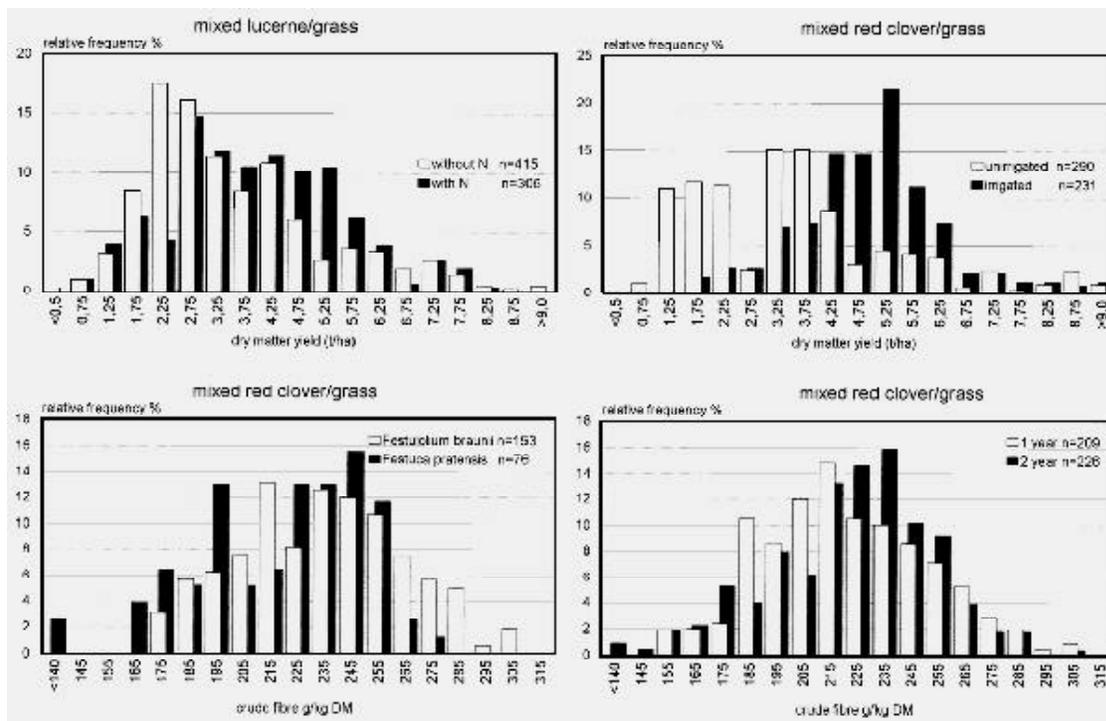
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**Figure 1**

Relative frequency of dry matter yields in legume-grass-mixtures as affected by N-fertilization and irrigation and contents of crude fibre of mixed red clover/grass as affected by grass species and year of utilization



**Figure 2**

Crude protein content of legume-grass mixtures as affected by yield proportion of legumes and linear correlation coefficient  $r$  between yield proportion of legumes and crude protein content

