INFLUENCE OF FERTILIZATION AND UTILIZATION ON BOTANICAL COMPOSITION AND YIELD OF SELECTED GRASS MIXTURES.

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ABSTRACT

The objective of this study was to determine the influence of fertilization and system of utilization on feeding value and usability for ensilage of selected grass mixtures, first with advantage of ryegrass (*Lolium perenne L.)*, second with orchard grass (*Dactylis glomerata L.)*, in simulating grazing land utilization (6-cuttings per year) and cutting utilization on hay or silage (3-cuttings per year). It was utilized for four years in using the full seeding method. Based on two grass mixtures and using different systems of utilization and different levels of fertilization was tried to define how to proceed with grassland reclamation or grassland development of new land by using full cultivations method to use in maximum, production potential of plant community.

KEYWORDS

grass mixtures, fertilization, utilization.

INTRODUCTION

In Europe as in Poland there are different points of view on possibilities of permanent grasslands development using extensive or intensive systems. This is a very important problem because feed coming from meadows and pastures is the cheapest, natural way to decrease production costs and increase level of animal production (Boberfeld, 1994), (Boberfeld, 1995; Wasilewski, 1994). Farmers are interested in finding the best method of improvement of production level based on their own feed. One of the way of improving quality of grasslands is to ploughing old sward and seeding new feed grass mixture. Using full seeding new grass on all areas is a radical way of land development, but is not possible for every environment (Mikolajczak, 1983; Boberfeld, 1982). The objective of this elaboration is to research how, during multiannual use of full seeding methods the composition of grass mixture, quantity, quality and dynamics of change of grass mixture yields in using different systems (6-cuttings or 3-cuttings per year) is changing.

METHODS

Research was carried out at Research Station in Linden-Leihgestern owned by Institute of Grassland and Root Crops Cultivation of Justus-Liebig University Giessen, Germany. The subject of this study are two grass mixtures. First **(M-I)** with advantage of Perennial Ryegrass (*Lolium perenne L.*), the second one **(M-2)** with advantage of Orchard Grass (*Dactylis glomerata L.*). Both of them were seeded on experimental lands in two repetitions into completely randomized blocks separate as to simulation of grassland (pastures) utilization (6-cuttings) and separate as to cutting utilization (3-cuttings). For every mixture in 6-cuttings or 3-cuttings utilization were used three levels of fertilization in the following fertilizer rates per year: 120, 240, 360 kg N*ha^{-1}. Phosphorus and potassium fertilization was used in one rate on level 100 kg P*ha^{-1} and 150 kg K*ha$^{-1.}$ There were harvesting in 6-cuttings utilization at 15.05, 10.06, 1.07, 1.08, 15.09, 20.10. For 3-cuttings utilization at 10.06, 1.08, 20.10. Composition of grass mixtures, varieties, quantity of planting seeds are shown in Table 1. Amount of precipitation from April until September was 287-398 mm, and the temperature 14.4 - 15.3 ^{0}C. Results of this research are reflected during first four years of full utilization of grass mixtures, 1987 - 1990. Danish forage harvester "Haldrup" was used. From every experimental plot there was taken 1/10 part of yield for chemical analysis. Samples from every experimental plot were taken independently. A common sample from replications was not made. On samples taken chemical determination was made using Weende-method (Anonymous, 1993) and energy MJ NEL by method HFT using rumen liquid from fistulated sheep (Anonymous, 1993). Estimated energy was based on this by using formula for equation according to the given principle of Menke and Steingass (1987), (for equation 16 e). Digestibility of organic matter was determined by enzymatic method [ELOS%] (Boever et al., 1986; Boever et al., 1988). Usefulness for ensiling was defined by determination of water-soluble sugars using Anthrone method (Yemm and Willis, 1954), and buffer capacity (Weissbach, 1967). In addition was calculated sugar/buffer capacity proportion and sugar/crude protein. Results were statistic elaborated by using three factor analysis of variance and by calculation of statistical difference for p-0,05 (LSD-0,005), separately for individual yield and year (Norman and Hul, 1983), Table 2.

RESULTS AND DISCUSSION

Botanical composition of grass mixtures. Two grass mixtures were the subject of this research. In the first mixture *Lolium perenne L.* was the main species (68% planting seeds), in the second mixture *Dactylis glomerata L.* and *Festuca pratensis Huds.* were adequate 48% and 20% planting seeds. Remaining species from both mixtures were the same: *Phleum pratense L., Poa pratensis L. and Trifolium repens L.*, (16%, 10%, 6%), Table 1. Development of individual species was different and changed in successive years, Graph 1, 2. In the first year for two researching mixtures in 6-cutting use is very characteristically at high in quantity of *Trifolium repens L.,* from 37% to 70%, especially in rate 120 kg N*ha^{-1}. Higher fertilizer rate limited development of this plant very much. In 3-cutting utilization and with fertilizer rate 120 kg N*ha^{-1} quantity of *Trifolium repens L.* was lower 13 - 27%, with higher fertilizer rates this plant does not exist in practice. *Trifolium repens L.* as a component of grass mixture can have an influence on quantity and quality of yield in the first year of use and partly in the second. In following years this plant not does exist.

During evaluation of the composition of grass mixtures during 4-years utilization it was noted that mixture-1 has had the most varied botanical composition, especially in 3-cutting use. During the first year of use *Poa pratensis L.* (15-18%), *Lolium perenne L.* and *Phleum pratense L.* have developed. All of these appeared proportionally and in high quantity in all durations of this study. Not noted was main limitation or domination of any grass species. Changes in botanical composition which appeared could result from species characters of individual plants and some variety's character. For *Lolium perenne L.* the optimal period of utilization passed after 3-4 years. It can be the reason for gradually lower appearance in swards. This grass is shadow sensitive and this fact can be combined with increasing of quantity of *Phleum pratense L.* During the following years content of *Poa pratensis L.* increased. The reason is a longer period until full development, 3-4 years. Within this species is high specialization of varieties which depend on utilization. Based on this research we can recognize that using the early maturing variety "Union" in extensive utilization in mixtures (3-cutting) contributes to fast development of *Poa pratense L.* in the first year. This happened provided there was proper selection of remain components of the grass mixture. *Poa pratense L.* developed very well together with

Lolium perenne L and *Phleum pratense L.*, (mixture - 1). In mixture - 2 *Poa pratense L.* could develop very fast only with *Dactylis glomerata L.* in 3-cutting use during the first year. During the second year development of this grass was limited very much by *Dactylis glomerata L.* Characterizing experimental mixtures for all 4-years of the period of utilization it was confirmed that *Trifolium repens L.* had a high influence on quality of yield in every grass mixture in the first year. In the second year in mixture-1 with 6-cutting utilization predominant species were *Lolium perenne L.* (53-70%) and *Poa pratense L.* (14-38%). In 3-cutting utilization also *Phleum pratense L.* had high dominance (13-40%). From the second year of utilization we can assess the quantity and quality of yield of mixture-2 as a monoculture of *Dactylis glomerata L.* Remaining species of grass are found totally at 5-20% in all systems of utilization. Based on botanical composition we can recognize that during the first year of use of grass mixtures there was a lack of influence of internal and external competition between species. Plants can develop as far as their possibility potential is limited. It can be one of the reason for high yield mixtures in the first year of utilization. During the second year of use there was dynamic change of botanical composition which had an influence on grass mixtures yield. Estimating influence of botanical composition on yield we could note rapid changes of botanical composition during the second year of utilization. Based on the above we can recognize the reason for decreasing yield could be ability to compete between plants and to not depend on fertilizer rates during the second year. In third and fourth year the yield increased gradually, but only with higher nitrogen rates.

Dry matter yield. Dry matter yield of grass mixtures used in an extensive way (3-cutting per year) is much higher then others. Immediate reason for the above is duration of regrowth of sward between every cutting. Assume the first cutting as date 0, every following cutting was taken off, in 6-cutting system of utilization, after 26, 20, 30, 45, 35 days from previous cutting date and adequately, in a 3-cutting system, after 50 and 80 days. Using intensive utilization system plants have to in a short time produce as high a quantity of yield as in an extensive system. The first regularity which was noted was that the highest yield of dry matter was taken off in the first year of utilization (Barchart 3). In the second year the yield of dry matter decreased by 25% to 35% and during the following years of utilization yields decreased by 6% to 20% but only on plots with the smallest nitrogen rate (120 kg $N*ha^{-1}$). Research proves that grass mixtures fertilization in 6-cutting system with a rate of 240 kg $N*ha^{-1}$ during the first three years did not affect increasing of dry matter yield, because 1 kg of nitrogen in a rate 120 kg affects 12-45 kg increasing of dry matter yield. This covers a milking cow's requirement for 1-3 days. Second significant regularity which was observed was the difference in yields of dry matter between grass mixtures. It happens especially in 1, 3 and 4 year of utilization. In these years mixtures with Orchard grass (*Dactylis glomerata L.*) had higher yields of dry matter.

Influence of fertilization on yield of nitrogen. If we use a method of full cultivation of grassland reclamation or grassland development nitrogen, fertilization of grassland will have higher and higher importance in upcoming years. Using adequate fertilization we can maximize production potential of grass mixtures. Reaction of every grass mixture on nitrogen fertilization is different and depends on the year of utilization and botanical composition. It means substantially that in 6-cutting utilization of mixtures during the first 2 years the rate 120-140 kg $N*ha^{-1}$ fully covered plant's requirements and guaranteed an optimum yield of dry matter. The lower rate is recommended for mixtures with the advantage of *Lolium perenne L.*, higher rates for mixtures with *Dactylis glomerata L*. In the third year for all mixtures there is a need for substantial increasing of rates of nitrogen fertilization up to 150, in fourth up to 190 kg $N*ha^{-1.}$ In extensive utilization of mixtures (3-cutting per year) in year 1 and 2 year for two testing mixtures the optimum yearly nitrogen rate should be 140-150 kg $N*ha^{-1.}$ In 3^{d} and 4th year rates should be diversified in depending on mixture variety. For mixtures with the advantage of *Lolium perenne L.* the rate should be 160 kg $N*ha^{-1}$, for second mixtures with the advantage of *Dactylis glomerata L.*, - 170-190 kg $N*ha^{-1.}$ This diversification of yearly nitrogen during the following 4 years of utilization results from botanical composition, which very clearly is changing after 2 years. Another reason could be plants' senescence, losses of one variety (i.e. *Lolium perenne L.*) and development of other (i. e. *Poa pratensis L.*). Using high nitrogen rates can be logical only when 1 kg of nitrogen used over 120 kg makes an increased of yield in 6-cutting utilization of 20-28 kg of dry matter, and in 3-cutting - 23-45 kg of dry matter. Application of such high nitrogen rates can be logical in 3-cutting utilization during the first year, in 6-cutting utilization only during the third year. Applying high nitrogen rates we have to remember the possibility of destructive nitrates. This fact can limit suitableness of use of such high quantities of nitrogen. In plant cultivation, uptake and production of nitrogen by plants during following years is an important factor. Botanical composition and its variation in individual years decided quantity of nitrogen absorption by plants. First year of utilization, by use of full seeding a new mixture, creates a grass - papilionaceous crops plant community. During the first year of utilization, nitrogen absorption (yearly yield/6.25) great by exceeds using rates 120, 240, 360 kg $N*ha^{-1}$. Even with the lowest rate of 120 kg $N*ha^{-1}$ for 6-cutting mixtures the yield was 370-400kg $N*ha^{-1}$, for 3-cutting utilization the yield was lower - 170-210 $N*ha^{-1}$ (Barchart 4.). The reason for such a high yearly yield of nitrogen (2-3 times in excess of fertilizer rates) is the quantity of white clover in mixtures during 1st year of full utilization which was 37-70% (Barchart 1,2). Using full cultivation method to improve grassland reclamation or grassland development of new land, we should expect a distinct decrease of yield during second year of full cultivation (starvation years of grass mixtures) and gradual increase over the next years with the proper level of fertilization. Tolerance of other grass species is very characteristic for perennial ryegrass as a main component, especially in 3-cutting utilization. Quite opposite is orchard grass, which after 2-3 years period can dominate the environment. Botanical composition researching grass mixtures growing on new developing grass land is changing very clearly after 2 years use. In common with a way of utilization and fertilization level this is a deciding factor which has influence on yield quantity and quality. In extensive fertilization of grass lands of 120 kg $N*ha^{-1}$ (less then 30 $N*ha^{-1}$ in four times of fertilization) we achieve 50-70% of potential possibilities of dry matter production. Intensive fertilization on grass land in rates of 240 kg $N*ha^{-1}$, not only stopped yield decrease but also effected its increase. Especially substantial is the use of higher fertilizer rates in 3-cutting utilization. One way of improving grass land development is to seed new mixture for its reclamation, yield increase and improved feed quality. During four years research with grass mixtures (first with domination of *Lolium perenne L.*, and second one with domination of *Dactylis glomerata L.*) its influence on yields quantity and yield distribution of individual cut was proven. In this elaboration is shown botanical and chemical composition, green crops feeding value and ensilage usability. It was confirmed that in mixture with domination of *Dactylis glomerata L.* we achieved higher dry matter yield, but mixtures with domination of *Lolium perenne L.* characterize higher crops feeding value and better ensilage usability. During the first two years of grass mixtures utilization *Trifolium repens L.* plays an important role.

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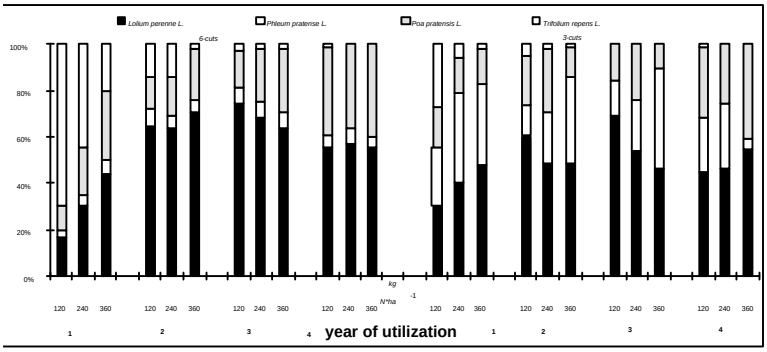
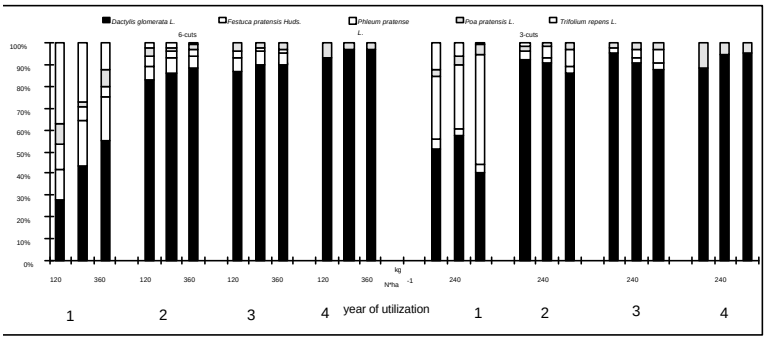
Barchart 1

Botanical composition of grass mixtures with advantage of *Lolium perenne* L. (M - 1)



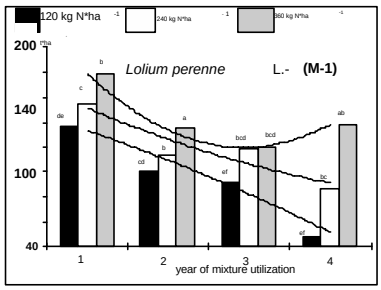
Barchart 2

Botanical composition of grass mixtures with advantage of *Dactylis glomerata* L. (M - 2)

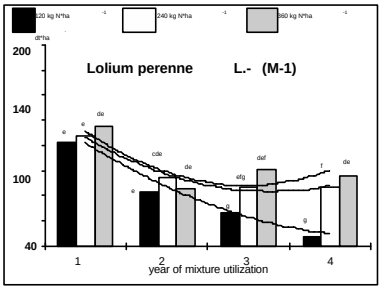


Barchart 3

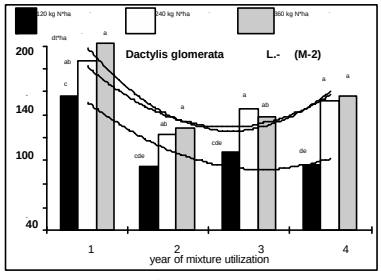
Dry matter yields of grass mixtures; (M-1) - *Lolium perenne* L., (M-2) - *Dactylis glomerata* L.



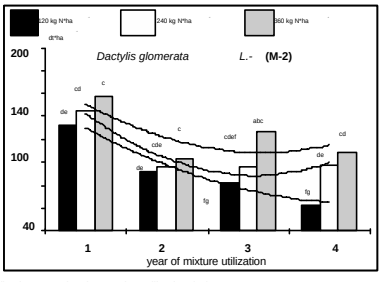
a) mixtures-1 (M-1), 3-cutting utilization (3x)



b) mixtures-1 (M-1), 6-cutting utilization (6x)



c) mixtures-2 (M-2), 3-cutting utilization (3x)



d) mixtures-2 (M-2), 6-cutting utilization (6x)

Table 1
Composition of experimental mixtures.

Species	Varieties	Quantity of seeding kg*ha^{-1}	
		M-1	M-2
Dactylis glomerata L.	Lidacta, Algekkamp	0	14
Festuca pratensis Huds.	Fiola, Budny	0	6
Lolium Perenne L.	Gremie, Liherska, Donata	22	0
Phleum pratense L.	Phlewiola	5	5
Poa pratensis L..	Union	3	3
Trifolium repens L	NFG Gigant	2	2

M-1- mixture-1 with *Lolium perenne* L.
M-2- mixture-2 with *Dactylis glomerata* L.

Table 2
Factors and vectors of this experiment.

Factors	Vectors
1. System of utilization	1.1 6-cuttings
	1.2 3-cuttings
2. Fertilization	2.1 120 kg N*ha^{-1}
	2.2 240 kg N*ha^{-1}
	2.3 360 kg N*ha^{-1}
3. Mixture	3.1 Mixture -1
	3.2 Mixture -2