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BOTANICAL COMPOSITION AND NUTRITIONAL VALUE OF TWO–COMPONENT MIXTURES CONTAINING RED CLOVER AND DIFFERENT GRASS SPECIES

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ABSTRACT

The field experiments were carried out in 1994–1996 and were aimed at determining the nutritional value of mixtures containing *Trifolium pratense* L. + *Lolium perenne* L., *Lolium multiflorum* Lam., *Lolium multiflorum* Lam. var. *westerwoldicum* and *Lolium* x *boucheanum* Kunth. and *Trifolium pratense* L. + *Festuca pratensis*

Huds.. Based on the botanical analysis, chemical composition and nutritional value, an attempt has been made to determine the variability of the parameters depending on the grass species. The percentages of grasses varied significantly and the variability expressed in the coefficient of variance ranged from 44 to 72.

The coefficient of variance for the basic nutrients showed smaller differences, which ranged from 18.6 to 25.8 for crude protein, 12.1–14.3 for crude fibre, 16.8–20.2 for crude fat and 12.2–14.1 for crude ash.

The energy values of the mixtures calculated in INRA were comparable, while PDIN ranged from 94–110 and PDIE from 88 to 92 g per kg of dry matter.

Key words: *Trifolium pratense* L., grass species, botanical composition, nutritive value.

INTRODUCTION

In the system of integrated agriculture, characterised by high yields, clover–grass mixtures are of particular significance in roughage production [7, 18, 20]. The mixtures are short living, therefore, they can be easily introduced to the crop rotation [5].

Great variations in chemical composition resulting from the differences in grass ratio to clover in the harvested mass are considered unfavourable for such mixtures. Botanical composition of the mixtures is a derivative of the amount of seed material used for sowing, soil fertility and aggressiveness of the plant species [2]. Weather conditions are another factor influencing botanical composition of plants. Unfavourable precipitation levels and high temperatures during the growing season adversely affect the botanical composition of mixtures, consequently reducing their nutritive value [15]. In addition, the nutritive value of the mixture (irrespective of plant species) is affected by harvest dates of the first cut and frequency of harvesting [11, 19].

Hot and dry weather conditions during the growing season of grasses make that less aggressive species are not competitive with *Trifolium pratense* L. High temperatures accelerate the development of grasses, reduce the ratio of leaves to stems as well as digestibility of roughage [2].

Despite the misgivings mentioned above, the mixtures containing papilionaceous and grasses give a possibility to obtain full volume feeds for cows [9], since their effects on the changes in the rumen availability of nutrients are better than those of papilionaceous plants alone [13].

The results obtained in earlier studies also show that the nutritive value is correlated with the selection of grass species [10]. For this reason, it is advisable to select plant species with respect to balanced chemical composition and nutritive value. The purpose of the present study was to determine the changes in chemical composition and the nutritive value of two–component mixtures containing clover + one from 5 grass species.

METHODS

The experiments were carried out at the experimental station of Pawłowice for 3 consecutive years and were aimed at evaluating the tetraploid mixtures of *Trifolium pratense* L. + *Lolium perenne* L., *Lolium multiflorum* Lam., *Lolium multiflorum* Lam. var. *westerwoldicum* and *Lolium* x *boucheanum* Kunth. and *Festuca pratensis* Huds.

The mixtures were sown in different proportions. Prior to harvesting, the samples were collected for determining the botanical composition, and next, chemical analysis was carried out. The latter included the measurements of the basic nutrients using standard methods [1].

The botanical and chemical analysis of each grass species blended with *Trifolium pratense* L. allowed us to determine the variations between the mixtures, which included extreme values, the mean, standard deviation and coefficient of variance, irrespective of the remaining experimental factors. The extreme and the mean values were determined using a "Statistica" package.

The calculations for each mixture were based on 36 data from 180 samples in total.

Concentration of net energy (UFL and UFV) and protein digestible in the intestine (PDI) was assessed using an INRA system [16] and a WINWAR computer programme, with regard to the percentages of *Trifolium pratense* L. and grasses. For estimation of the nutritive value of green forages the digestibility coefficients that were given by Jarrige [6] were used.

The analysis of variance and a T–Student test were used for determining the mean values. Correlation coefficients were calculated to determine the differences between crude protein and PDIN and PDIE.

RESULTS

The two–component mixtures of *Trifolium pratense* L. + grasses showed significant differences in botanical composition. The percentage of grasses (Table 1) averaged from 18.8% (*Festuca pratensis* Huds.) to 53.7% (*Lolium* x *boucheanum* Kunth.). *Trifolium pratense* L. was predominant in the green forage with the least aggressive *Festuca pratensis* Huds., when the percentage of this grass in the mixture was reduced. In 1996 the percentage of *Festuca pratensis* Huds., was the lowest and amounted to 1.1%. The percentages of the grasses in mixtures reached a maximum in the first cut when N fertilizer had been applied, and amounted from 48.9% (*Festuca pratensis* Huds.) to 96% (*Lolium multiflorum* Lam.). A significant decrease of grass portion was observed in the second and third cuts when no N fertilizer had been used. This was likely due to the weather conditions, especially in August, when the precipitation level was low, which consequently reduced the growth of grasses. Selection of the grass species for the mixtures affected the coefficient of variance for botanical composition. The highest coefficient of variance was obtained with *Trifolium pratense* L. + *Festuca pratensis* Huds. (77.9), while the lowest was that of *Trifolium pratense* L. + *Lolium* x *boucheanum* Kunth.(44.4).

Table 1. Percentages of grasses in the mixtures depending on grass species

Species	Min	Max	Average	Standard deviation	Variation coefficient
Lolium perenne L.	2.50	83.40	36.85	23.70	64.30
Lolium multiflorum Lam.	6.10	94.20	46.19	27.03	58.51
Lolium multiflorum Lam. var. *westerwoldicum*	5.70	96.00	44.39	28.56	64.36
Lolium x *boucheanum* Kunth.	18.10	92.60	53.71	23.86	44.43
Festuca pratensis Huds.	1.10	48.90	18.78	13.68	72.88
LSD P = 0.05	–	–	5.5	–	–

Changes in botanical composition affected crude protein content, the main indicator of the nutritive value of the mixtures (Table 2). On average, crude protein concentration in dry matter (DM) was markedly higher in *Trifolium pratense* L. + *Lolium perenne* L. and *Trifolium pratense* L. + *Festuca pratensis* Huds. (17.4 and 17.61%, respectively) than in the other mixtures, in which crude protein ranged from 15.2 to 16.0%. Irrespective of grass species, a maximum crude protein concentration (>21.9%) was generally found in herbage from the third cut. Minimum crude protein content was found in the first and second cut in samples from N fertilized plots.

Table 2. Percentages of crude protein and fibre contents in mixtures depending on grass species (% of dry matter)

Species	Min	Max	Average	Standard deviation	Variation coefficient
Crude protein					
Lolium perenne L.	11.53	23.13	17.40	3.55	20.42
Lolium multiflorum Lam.	7.54	21.99	16.06	3.98	24.82
Lolium multiflorum Lam. var. *westerwoldicum*	7.60	23.38	15.71	4.05	25.79
Lolium x *boucheanum* Kunth.	8.03	21.97	15.16	3.59	23.71
Festuca pratensis Huds.	10.92	23.07	17.61	3.28	18.62
LSD P = 0.05	–	–	0.89	–	–
Crude fibre					
Lolium perenne L.	18.56	30.20	25.82	3.40	13.16
Lolium multiflorum Lam.	19.86	32.73	26.92	3.61	13.41
Lolium multiflorum Lam. var. *westerwoldicum*	20.68	34.50	27.36	3.56	13.00
Lolium x *boucheanum* Kunth.	19.93	31.64	27.05	3.28	12.14
Festuca pratensis Huds.	20.37	34.09	26.24	3.75	14.28
LSD P = 0.05	–	–	0.86	–	–

The mixture of *Trifolium pratense* L. with *Lolium multiflorum* Lam. var. *westerwoldicum* was characterised by the highest minimum, maximum and mean content of crude fibre in DM (20.7, 34.5, 27.4% respectively). Mean content of crude fibre in the above mentioned mixture was significantly higher ($P<0.05$) than in the mixtures with *Lolium perenne* L. (25.8%) and *Festuca pratensis* Huds. (26.2%). Maximum crude fibre concentration, irrespective of grass species in mixtures, was found in N–fertilized plots, which corresponded with the increased percentages of grasses.

No significant differences were found in crude fat content, the percentage of which ranged from 3.2% (*Lolium* x *boucheanum* Kunth.) to 3.7% (*Lolium perenne* L.) in the DM of green forage.

Crude ash content in DM (Table 3) of the mixtures ranged from 10 to 11.1%. The concentration of minerals was the highest in the mixtures containing *Lolium perenne* L. and

Festuca pratensis Huds., therefore, in the mixtures with the highest percentage of *Trifolium pratense* L. in the green forage.

Energy concentration was comparable in all the mixtures. The UFL and UFV content in 1 kg green forage DM ranged from 0.85 to 0.90 and from 0.79 to 0.81, respectively (Table 4).

Table 3. Percentages of raw fat and ash depending on grass species

Species	Min	Max	Average	Standard deviation	Variation coefficient
Crude fat					
Lolium perenne L.	2.54	4.75	3.69	0.63	16.95
Lolium multiflorum Lam.	2.28	4.59	3.35	0.62	18.52
Lolium multiflorum Lam. var. *westerwoldicum*	2.13	4.57	3.30	0.55	16.79
Lolium x *boucheanum* Kunth.	2.06	4.61	3.24	0.65	20.19
Festuca pratensis Huds.	2.12	4.72	3.44	0.69	20.02
Crude ash					
Lolium perenne L.	8.24	13.48	11.05	1.36	12.33
Lolium multiflorum Lam.	7.75	12.20	10.21	1.24	12.20
Lolium multiflorum Lam. var. *westerwoldicum*	6.57	11.96	9.99	1.40	14.02
Lolium x *boucheanum* Kunth.	8.00	12.56	10.34	1.36	13.12
Festuca pratensis Huds.	7.19	14.39	11.02	1.55	14.07
LSD P = 0.05	–	–	0.37	–	–

Table 4. The nutritive value of mixtures depending on grass species

Species	Min	Max	Average	Standard deviation	Variation coefficient
UFL					
Lolium perenne L.	0.77	0.90	0.85	0.03	3.89
Lolium multiflorum Lam.	0.84	0.92	0.90	0.02	2.15
Lolium multiflorum Lam. var. *westerwoldicum*	0.83	0.92	0.87	0.02	2.42
Lolium x *boucheanum* Kunth.	0.83	0.89	0.86	0.02	1.81
Festuca pratensis Huds.	0.82	0.90	0.86	0.02	2.70
LSD P = 0.05	–	–	0.01	–	–
UFV					
Lolium perenne L.	0.68	0.84	0.79	0.04	4.48
Lolium multiflorum Lam.	0.78	0.86	0.80	0.02	2.49
Lolium multiflorum Lam.	0.78	0.86	0.81	0.02	2.62

var. *westerwoldicum*					
Lolium x *boucheanum* Kunth.	0.77	0.83	0.80	0.02	2.11
Festuca pratensis Huds.	0.75	0.84	0.79	0.03	3.59
LSD P = 0.05	–	–	0.01	–	–
PDIN					
Lolium perenne L.	72.60	145.20	109.20	22.29	20.41
Lolium multiflorum Lam.	43.30	138.00	100.46	25.47	25.35
Lolium multiflorum Lam. var. *westerwoldicum*	50.30	146.90	99.00	24.82	25.07
Lolium x *boucheanum* Kunth.	50.80	137.90	94.01	22.93	24.39
Festuca pratensis Huds.	68.60	144.80	110.92	20.75	18.71
LSD P = 0.05	–	–	5.59	–	–
PDIE					
Lolium perenne L.	77.80	103.00	91.13	7.01	7.69
Lolium multiflorum Lam.	72.80	102.30	90.00	8.13	9.03
Lolium multiflorum Lam. var. *westerwoldicum*	74.50	104.20	89.65	7.99	8.91
Lolium x *boucheanum* Kunth.	73.80	102.00	87.97	7.00	7.95
Festuca pratensis Huds.	82.50	104.60	92.44	6.12	6.62
LSD P=0.05	–	–	1.67	–	–

The mixture with *Festuca pratensis* Huds, in which the papilonaceous plant was predominant, exhibited the highest PDIN (110.9 g) and PDIE (92.4 g) in 1 kg DM.

In all mixtures tested there the considerable differences between the means of PDIN and PDIE values occurred. The lower values of PDIE in relation to PDIN must be taken into account while selecting of other feeds for ruminants.

High correlation was found between protein value, expressed in PDIN and PDIE and crude protein concentrations of the mixtures (Table 5).

Table 5. The matrix of correlation coefficients between crude protein content and crude protein value expressed in PDIN and PDIE

Species	PDIN	PDIE
Lolium perenne L.	0.9999	0.9533
Lolium multiflorum Lam.	0.9990	0.9933
Lolium multiflorum Lam. var. *westerwoldicum*	0.9970	0.9846
Lolium x *boucheanum* Kunth.	0.9632	0.9640
Festuca pratensis Huds.	0.9949	0.9577

DISCUSSION

The results obtained in the study show that some two–component mixtures of clover and grasses are likely to become a mainstay in animal diets. Nitrogen fertilizer rates can be then successfully reduced [21]. Besides, the data reported by other authors [8, 9] show that such mixtures fed to ruminants can be considered full–valuable feed in these investigations. The changes observed in botanical composition of the mixtures depended to a large extent on selection of the plant species. Moreover, the changes were also affected by alleopathic properties of the components as well as their competitive nature. The latter applies, in particular, to the low percentage of *Festuca pratensis* Huds. (18.8% on average) in the mixture. For this reason, such a composition cannot be recommended for agricultural use. N rates reduced the amount of clover in the mixtures, which consequently increased crude fibre, but reduced crude protein content of the mixture. Similar tendencies were also observed in other experiments [3, 4, 12, 14, 17]. Moreover, the changes in botanical composition resulting from N rates reduced the content of crude ash (minimal values). This was likely due to smaller amounts of clover rich in Ca as compared with grasses. A similar relationship has also been reported by Olszewska [17].

CONCLUSIONS

1. Meadow fescue shows low competitiveness against *Trifolium pratense* L., therefore, this grass species cannot be recommended for use in a two–component mixture.
2. The amount of protein really digested in the intestine, especially PDIN was highly correlated with crude protein content of the mixture.

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