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ANALYSIS OF SWARD MANAGEMENT FACTORS INFLUENCING *Festulolium* AND *Lolium x boucheanum* YIELD FORMATION

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Abstract

Under conditions of the Latvian climate, forage grasses are the main fodder source in cattle breeding. *Festulolium* hybrids are among the most persistent and productive grasses of the grasses used in many Europe countries, especially in adverse environments. The aim of this research was to investigate dry matter yield formation and the sward persistency of *Festulolium* and *Lolium x boucheanum* varieties under the agro-ecological conditions of Latvia. Field trials were established on the sod–podzolic soil and fertilized with N 120 $_{(60+60)}$, N180 $_{(60+60+60)}$, P 78 and K 90 kg ha^{-1}. Forages were harvested three times during the growing season. During the three years of utilization the dry matter yield for *festulolium* and ryegrass swards was reliably ($P<0.05$) dependent on the used variety as well in the nitrogen fertilization rate. The N fertilizer dose increase from 120 to 180 kg ha^{-1} contributed to significantly to the DM yield increase for all investigated varieties. On average the N fertilizer dose increase to 180 kg ha^{-1} contributed to DM yield increase by 1.91 t ha^{-1} or 20 percent. On the basis of the experiments in the years 2003-2006, significant differences in DM yield and winter hardiness were found between first, second and third year of yields. Dry matter yield was found to be strongly dependent on climatic conditions in the particular year of yields and the particular period of regrowth. Analysis of yield distribution between three cuts showed that a year of sward use had a very great effect on the DM yield of the first cut. For the first year it accounted for 51% of the annual yield, in second year the first cut yield reach only 39 % of the annual yield.

Key words

Festulolium, *Lolium hybridum*, productivity, regrowth, photosynthesis.

Introduction

Many producers of dairy husbandry in Latvia are shifting towards intensive systems of production. The slow growing grass species in grasslands have been replaced by species and cultivars with rapid regrowth and high yield potentials. In this regard perennial ryegrasses are gaining popularity in the Baltic region as they are tolerant to intensive management, but are susceptible to drought and have rather poor winterhardiness (Aavola 2005). In Baltic climate conditions hybrid ryegrass is not widely spread besauce they do not winter wed. Sometimes crops considerably suffer even in first winter and suffer decreased productivity (Gutmane, 2006).

Lolium species (considered the ideal grasses for European agriculture) are not sufficiently robust to meet many of the environmental challenges that face agriculture in less favoured areas. Fortunately, adaptations to abiotic and biotic stresses exist amongst *Festuca* species related closely to *Lolium*. The complex of species has an enormous wealth of genetic variability and potentiality for genetic exchange, thus offering unique opportunities for the production of versatile hybrid varieties with new combinations of useful characteristics suited to modern grassland farming (Humphreys *et al*., 1997).

Breeding efforts were mainly developed to improve of productivity. However, in order to conciliate production and environment preservation attributes, increasing the perenniality of sown swards appears to be a critical objective. Perenniality means the achievement of productive and high quality swards maintained over numerous growth cycles and years.

A very important property of forage grasses is their ability to produce stable and high dry matter yields under different environmental conditions. The level of the productivity and stability mostly depends on the genetic potential of the forage grass species (Lemežienė, 2004). *Festulolium* hybrids are among the most persistent and productive grasses of the grasses used in many Europe countries, especially in adverse environments (Adamovich, 2003; Kohoutek, 2004). An important requirement for *Festulolium* is combining such characteristics of ryegrass as productivity, growth potential and feeding quality, and from fescues stress resistance in wintering and resistance to drought during the growth period (Casler, *et al*. 2002).

Numerous studies have shown that, over time and in interaction with exploitation regimes and soil and climate constraints, production and forage quality of the sown swards declined. In grasslands with many species, these changes were associated with changes in botanical composition (Mosimann, 2002). In swards with a single species, and even more with a single variety, the reasons for such changes in agronomic values have still to be identified. They can be associated with the either random death of individual plants as an effect of aging, the plastic response of plants to constraints, the selective adaptation of the plant population to the conditions experienced by the population, or combinations of these mechanisms (Straub, 2005).

Materials and Methods

Field trials were conducted in Latvia on sod–podzolic soils where the pH was 7.1 and phosphorus and potassium level were 253 and 198 mg kg^{-1} respectively, and the organic matter content was 31 g kg^{-1}. Swards were composed of: perennial ryegrass 'Spidola' (control); festulolium 'Perun' *('L. multiflorum x F. pratensis'),* 'Punia' *('L. multiflorum x F. pratensis'),* 'Saikava' *('L. perenne x F. pratensis'),* 'Lofa' *('L. multiflorum x F. arundinacea'),* 'Felina' *(L. multiflorum x F. arundinacea),* 'Hykor' *('L. multiflorum x F. arundinacea')*; hybrid ryegrass – 'Tapirus' *('L. multiflorum x L. perenne')*. Trial were sown in May 2002 and 2003 without a cover crop, the seeding rate was 1000 germinating seeds per m^{-2}. The plots were fertilized as follows: P 78 and K 90 kg ha^{-1} and two N fertilizer treatments-N $120_{(40+40+40)}$ and N $180_{(60+60+60)}$. Swards were cut three times per season. The experimental data was subjected to ANOVA analysis and correlation and regression analyses.

Meteorological conditions were different in wintering and vegetation periods. Black frost and a cold winter in 2003 and a hot July and first part of August were followed by mild temperatures and rainfalls. The mild winter, dry and cool spring of 2004 was followed by a cool and overly high precipitation summer. Early snow cover without frost contributed to snow mildew formation in the winter of 2004/2005. The year 2005 had a late and cool spring, a hot and dry July. A cold and long winter with good snow cover in year 2006 was followed by an extremely hot and dry summer.

Results and Discussion

The longevity of *festulolium* swards were affected by different influences, such as the suitability of each variety to specific conditions, different stress conditions, and the use regime. *Festulolium* hybrids and especially perennial ryegrass often are insufficiently resistant to wintering conditions. Data of the variance analysis showed that in the three years of utilization dry matter yield for *festulolium* and ryegrass swards was reliably ($P<0.05$) dependent on the used variety as well as on the nitrogen fertilization rate. Perennial ryegrass, hybrid ryegrass, and *Festulolium* are grasses that require high nitrogen fertilisation when grown for high dry matter yields. The N fertilizer dose increase from 120 to 180 kg ha^{-1} contributed to a significant DM yield increase for all investigated varieties. On average, the N fertilizer dose increase to 180 kg ha^{-1} contributed to DM yield increase by 1.91 t ha^{-1} or 20 percent. Dry matter yield was found to be strongly dependent on the climatic conditions in the yield year of yielding and the particular period of regrowth (Table 1).

Table 1. Mean squares relevant to the study of dry matter yields of varieties for the 2002 trial year

Source	df	1st year of use, 2003		2 st year of use, 2004		3 st year of use, 2005	
		MS	η^2, %	MS	η^2, %	MS	η^2, %
Variety (V)	6	13.17*	3.7	12.66*	30.8	8.29*	11.4
Nitrogen level (N)	1	11.21*	0.5	18.43*	7.5	3.70*	0.8
Cut (C)	2	976.79*	92.0	6.01*	4.9	171.47*	78.6
Interaction V x N	6	0.09	0.0	0.24	0.6	0.32*	0.4
Interaction V x C	12	3.40*	1.9	9.62*	46.8	1.32*	3.6
Interaction N x C	2	0.47	0.0	0.41	0.3	0.29	0.1
Interaction V x N x C	12	0.25	0.1	0.14	0.7	0.41	1.1
Error	123	0.26		0.17		0.12	

* - significant at the 0.05 probability level

Meteorological conditions for high grass yields was most favourable in the year 2004. This year experienced high percipation during the summer. During at both sowing year cycles 2004 produced very high nitrogen fertilization rates – factors influence η^2 % (8 % and 26 %) and equable dry matter yield distribution between cuts. In the less favourable years (2003; 2005; 2006) for the development of grass plants during the hot and dry summers, varieties showed differences in the structure of yield formation. High regrowth factor influence η^2 % (62% - 92%) on dry matter yield was established. The low second cut yield had played a crucial role in the formation of the annual yield. The presence of a reliable interaction between the variety and regrowth after cut (V x C), the nitrogen rate and regrowth after cut (N x C) was established (Table 2).

Table 2. Mean squares relevant to the study of dry matter yields of varieties the 2003 trial year

Source	df	1st year of use, 2004		2 st year of use, 2005		3 st year of use , 2006	
		MS	η^2, %	MS	η^2, %	MS	η^2, %
Variety (V)	6	13.09*	30.0	8.30*	18.2	10.19*	13.8
Nitrogen level (N)	1	67.91*	25.9	15.01*	5.5	7.84*	1.8
Cut (C)	2	18.48*	14.1	83.71*	61.2	158.20*	71.3
Interaction V x N	6	0.34	0.8	0.38*	0.8	0.18	0.2
Interaction V x C	12	3.08*	14.1	0.98*	4.3	1.63*	4.4
Interaction N x C	2	2.51*	1.9	2.22*	1.6	0.86*	0.4
Interaction V x N x C	12	0.30	1.4	0.23	1.0	0.60*	1.6
Error	123	0.23		0.14		0.20	

* - significant at the 0.05 probability level

Analysis of the data showed that at both sowing year cycles in the first year of herbage use *festulolium* and hybrid ryegrass swards gave a higher dry matter yield of the first cut. Dry matter production reduction in the various grasses between the first and third cuts has been mentioned in the literature. The high annual dry matter yields for meadow fescue and perennial ryegrass were predetermined by the higher yields of plants for the first cut (Tarakanovas, 2004).

There is close a relationship between net assimilation rate value and DM production. Net assimilation rates for perennial ryegrass, Italian ryegrass tall fescue and intergeneric hybrids is highest during the recovery period after the first cut, and is lower during the periods following the second and third cuts. The difference in net assimilation rates between the first and second cuts is highly significant Dry mater production in the various grasses declined between the first and third cuts, corresponding with the changes of net assimilation rates over the growing period (Gaborcik, 2006). The leaf area index (LAI) is one of the most significant indicators of photosynthesis. Leaf development, age, photosynthetic capacity all influence the grass yield.

There was an upward trend of plant leaf area expansion over the spring growing season till reaching the ceiling LAI. The determination of *Festulolium* and hybrid ryegrass leaf area dynamics showed that the development of the maximum leaf area index was achieved before ear emergence stage. LAI for *Festuloliu* for hybrid ryegrass and perennial ryegrass the individual grass species index was different. The highest average values of LAI in three years of trials were achieved by *Festulolium* cv. Hykor (3.27) and Punia (3.03). The differences of LAI values between investigated varieties were significant ($P < 0.05$) (Table 3).

Table 3. The leaf area index (on average for 2003-2005)

Varieties	Spidola	Lofa	Saikava	Hykor	Perun	Tapirus	Punia
LAI	2.30	2.65	2.32	3.27	2.91	2.21	3.03
Sx	0.30	0.10	0.04	0.14	0.34	0.12	0.05

There was a significant correlation between the DM yield formation during the spring growing season untill the first cut and the leaf area index for *Festulolium* and hybrid ryegrass swards for the first year of herbage use. It can be characterized by the equation of linear regression, with P-value < 0.01 (Fig. 1).

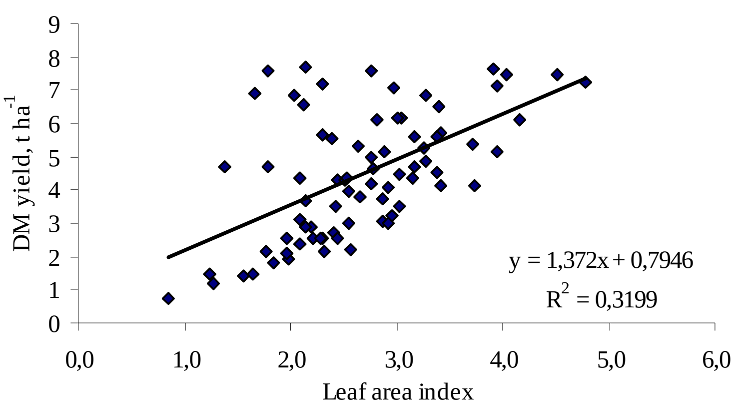

Figure 1. Equation of linear regression between net LAI and plant DM yield, t ha^{-1}

The great effect of the sward utilization year on the dry matter yield of *Festulolium* hybrids and especially *Lolium perenne* has been mentioned in the literature. In Lithuania, the dry matter yield of *Festulolium* hybrids declined over 30 % in the second year of sward use (Lemežiene, 2004). Our results show a substantial decrease in the DM yield even between the first and second year of yield years. The average DM yield distribution during the yield years showed significant differences. The maximum yield was obtained in the first year of sward use in both sowing years. This is typical for perennial forage grasses. During the first year of utilization grasses are at the initial stage of their growing and development and have only slightly been exposed to negative effects, such as unfavorable growing or wintering conditions, disease invasion and inefficient utilization. For the 2002 sowing year, maximum yield differences were observed between the second and third year of sward use. Whereas for the 2003 sowing year, maximum yield differences were observed between the first and second year of sward use, which corresponds to the year 2005 when snow mildew formation and negative humidity conditions for sward growth during the spring and summer were observed.

The highest average DM yield in all years of sward use was provided by cultivars the 'Hykor' and 'Felina' (Fig. 2). The same cultivars had the highest plant height before harvesting. These findings are in correspondence with plant morphological character – cv. 'Hykor' and 'Felina' represent the festucoid type of *Festulolium*. During three years of herbage use the lowest yield was provided by the perennial ryegrass 'Spidola'. This can be explained by the fact of rather poor ower-wintering of *Lolium perenne* and plant height. *Lolium perenne* is attributed to short grasses, while the *Festulolium* and hybrid ryegrass to tall grasses. Insufficient resistance of the loloid *Festulolium* cultivar 'Saikava' to wintering conditions resulted to the greatest reduction (50 %) of second year DM yield.

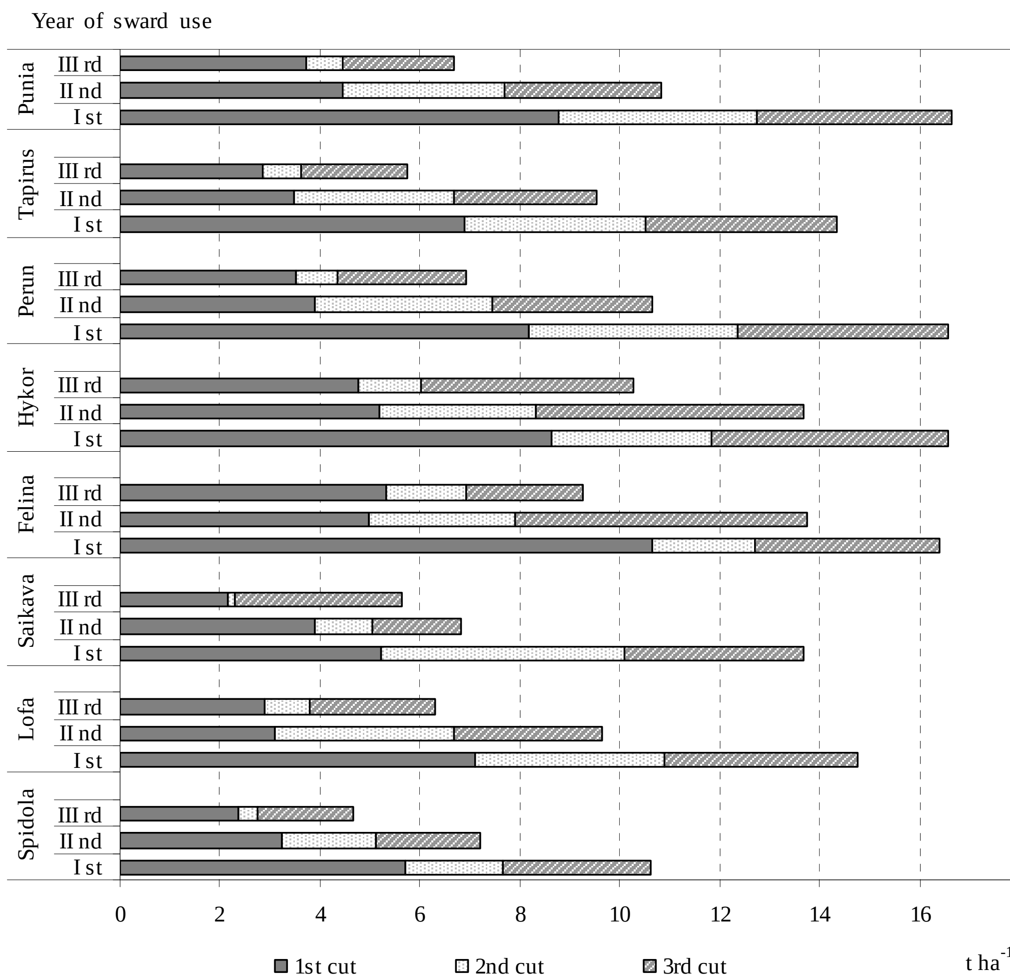

Figure 2. Average DM yield performance (t ha^{-1}) for three years of sward use

Differences between hybrid varieties in DM yield were highly significant and kep up a similar tendency during three yield years. The average DM yields of *Festulolium* cultivars were 3.99 t ha^{-1} or 53 %, but those of hybrid ryegrass - 2.37 t ha^{-1} or 32 % higher compared to perennial ryegrass.

Conclusion

The productivity of grass biomass was dependent on the cultivar to be used and the nitrogen fertilization rates. Dry matter yield was found to be strongly dependent on climatic conditions in the particular yield years and the particular period of regrowth.

The productivity of photosynthesis and biomass were dependent on the hybrid variety and there is a close relationship between leaf area index and dry matter production.

Significant differences in '*Festulolium*' and '*Lolium x baucheanum*' DM yield were found between first, second and third yield years.

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THE POLISH CULTIVARS OF *X TRITICOSECALE* WITTM. IN LITHUANIA – EFFECTS ON BIOLOGICAL PROPERTIES AND RESISTANCE TO DISEASES

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Abstract

During the period 2001–2002 and 2004–2005 experiments were carried out at the Vėžaičiai Branch of the Lithuanian Institute of Agriculture with a view to studying the differences of the biological properties and the disease incidence between the *xTriticosecale* Wittm. cultivars 'Tewo', 'Alzo' and 'Tornado'. According to the research data, the triticale cultivar with a higher than 1000 grain weight value was 'Alzo' and the cultivar 'Tewo' has a higher number of grain per ear, but this cultivar was most prane to diseases. The researchers also studied the ecological significance of perennial grasses used as green manure for the biological properties of triticale 'Tewo' too.