FESTULOLIUM AND *LOLIUM X BOUCHEANUM* DRY MATTER YIELD FORMATION UNDER CLIMATIC CONDITIONS OF LATVIA

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Abstract

Under conditions of Latvia′s climate, forage grasses are the main fodder source in cattle breeding. The productivity of grasslands and pastures mostly depends on cultivated grass varieties. The aim of the present research was to study photosynthesis activity and crop yield of *Festulolium* and *Lolium × boucheanum* ryegrass foreign varieties under agro-ecological conditions of Latvia. Field trials were established on sod – podzolic soil fertilized with N120 $_{(60+60)}$, N180 $_{(60+60+60)}$, P78 and K90 kg ha^{-1}. Swards were cut three times during the growing season. The productivity of photosynthesis and biomass were dependent on the variety and mineral fertilizer rates. Some parameters were influenced by genetic characteristics of particular cultivars.

Key words: *Festulolium*, *Lolium × boucheanum*, productivity, photosynthesis

Introduction

Agriculture, especially sustainable, is increasingly being considered as one of the most efficient tools for environmental protection, landscape improvement and the management of natural elements still existing in areas affected by human activities (EU Reg. 1578/99). Sustainability is a measure of our ability to produce food with the maximum of efficiency combined with the minimum of damage to the environment. Grasses that persist from year to year under harsh environments will reduce inputs and costs, and improve predictability and stability of production. Persistency is an essential aspect of sustainability of forage production when environmental conditions are limiting (Ghesquière, 2002).

High quality forage *Lolium* has been bred for intensive systems in benign environments, and have proved to be insufficiently robust to meet many of the environmental challenges in more extreme conditions (Humphreys, 2002). Under Baltic climate conditions, it is not widely spread for the reason of unsatisfactory wintering. Sometimes crops considerably suffer even in first winter and decrease productivity (Nekrošas, 2002).

Improvements in yield, quality and persistence of hybrids between *Lolium multiflorum x Lolium perenne* are being made using new genetic resources. The aim of hybrid ryegrass is to combine the best attributes of Italian and perennial ryegrass. It is less winter hardy but higher yielding than perennial ryegrass (Adamovich, 2003; Gutmane, 2004).

Greater sward productivity may be obtained through use of hybrid combinations of contrasting grass species. For the considerable improvement of perennial ryegrass wintering, ryegrass and fescue crosses were started. For a long time breeders have been trying to put together valuable traits of these genera by crossing. Important requirement for *Festulolium* is combining such characters of ryegrass as productivity, growth potential and feeding quality, and from fescues stress resistance in wintering and resistance to drought during the growth period (Domanski, 1999; Kryszak, 2002).

Lolium × Festuca hybrids have better persistence, disease resistance and winter hardiness than ryegrasses, better season-long productivity and higher forage quality than fescues (Sliesaravicius, 1997). *Lolium × Festuca* hybrids have good agronomical potential especially in adverse environments (Nesheim, 2000). *Festulolium* hybrids can show completely novel characters, but mostly traits are expressed intermediately and sometimes the traits of one parental species dominate. Some varieties are more like the ryegrasses and some more like fescues, depending on the breeding effort following the cross (Zwierzykowsky, 1980; Hahn, 1999).

Efficient farming requires better use of grass. Each region needs varieties combining specialized combinations of stress resistance, more appropriate and more productive for local climate conditions. The aim of present research was to study photosynthesis activity and crop yield of *Festulolium* and *Lolium × boucheanum* ryegrass foreign varieties under agro-ecological conditions of Latvia.

Materials and Methods

Field trials were conducted in Latvia on sod-podzolic soils (pH_{KCl} 7.1, P – 253, K –198 mg kg^{-1}, organic matter content 31 g kg^{-1} of soil). Swards were composed of: perennial ryegrass ‘Spidola’ (control), *Festulolium* – ‘Perun’ *(L. multiflorum × F. pratensis),* ‘Punia’ *(L. multiflorum × F. pratensis),* ‘Saikava’

(L. perenne × F. pratensis) 'Lofa' *(L. multiflorum × F. arundinacea),* 'Felina' *(L. multiflorum × F. arundinacea),* 'Hykor' *(L. multiflorum × F. arundinacea),* hybrid ryegrass – 'Tapirus' *(L. multiflorum × L. perenne),* 'Ligunda' *(L. multiflorum × L. perenne)*.

The total seeding rate was 1000 germinating seeds per m^{-2}. The plots were fertilized as follows: N108 $_{(18+90)}$ P78 K90 kg ha^{-1} (at sowing year), P78 and K90 kg ha^{-1} and two N fertilizer treatments N120 $_{(40+40+40)}$ and N180 $_{(60+60+60)}$ kg ha^{-1} (at first and second year of sward use). Swards were cut three times per season. Dynamics of plant leaf area expansion, net photosynthesis productivity (which characterizes the increase of plant DM production per leaf area unit of time, expressed in g m^{-2} day^{-1}) were determined for first cut. Sampling of plants was carried out in 7 to 10 day intervals.

Results and Discussion

In all grasses the basis of growth is photosynthesis. However, the accumulation of DM is not the result of a single process, but represents the net balance among a number of processes (Robson *et al.*, 1989). Development of leaves, age, and photosynthetic capacity influence the grass yield. Leaf area index (LAI) is one of the most significant indices of photosynthesis (Woledge, 1971; Woledge, 1976).

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. The LAI and net photosynthesis productivity for *Festulolium* and hybrid ryegrass were different.

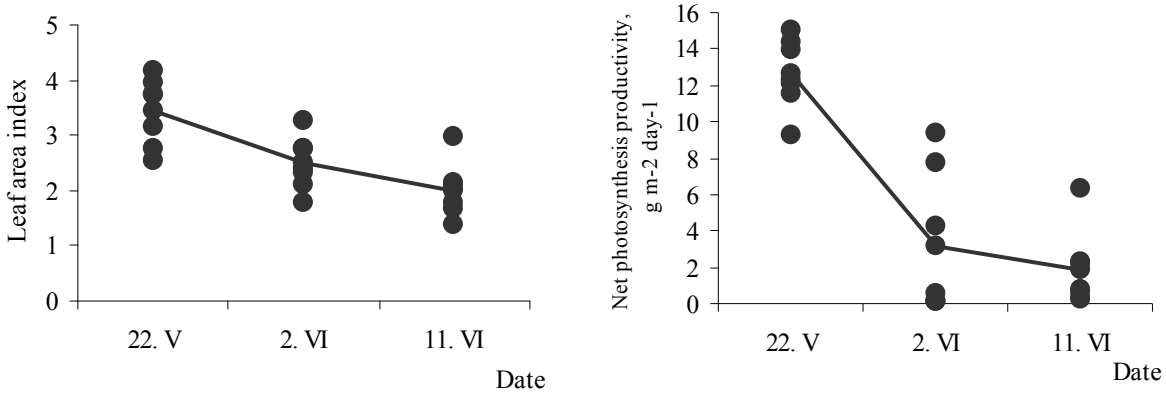

Figure 1. Index of photosynthesis activity for *Festulolium* and hybrid ryegrass swards (2003)

Weather conditions affect development of leaves and their photosynthetic capacity. Dry and hot weather in the beginning of summer 2003 led to faster reaching threshold value of LAI treshold and its reduction afterwards (Fig. 1).

Positive correlation is established between the leaf area and net photosynthesis productivity (r = 0.66) for *Festulolium* and hybrid ryegrass swards in 2003. The maximum average value of LAI – 3.13 was achieved by *Festulolium* cv. Hykor. Small DM yield depending on net photosynthesis productivity was obtained in the year 2003. It is characterized by equation of linear regression, but it has insignificant P-value = 0.0838 > 0.05 (Fig. 2).

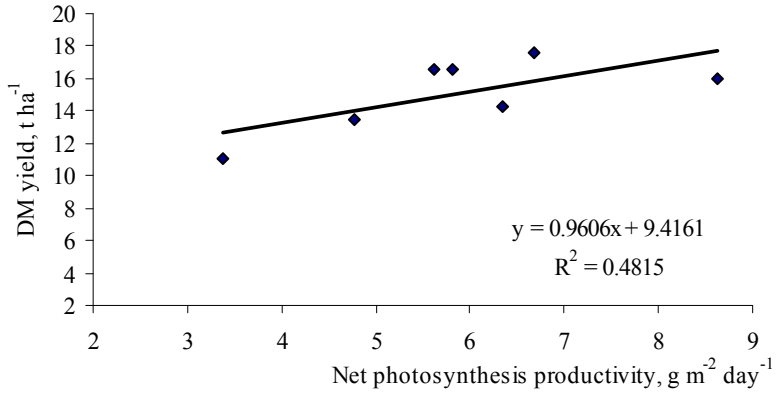

Figure 2. Equation of linear regression between net photosynthesis productivity and plant DM yield (2003)

Late and cool spring in 2004 led to slowed formation of leaf area. Negative correlation is established between the leaf area and net photosynthesis productivity (r = –0.37) for *Festulolium* and hybrid ryegrass swards in 2004. As leaves aged, their photosynthetic capacity declined (Fig. 3). Maximum values of LAI in both trial years were achieved by *Festulolium cv.* Punia accounting for 4.03 to 4.16 and *cv.* Perun accounting for 3.95 to 4.51.

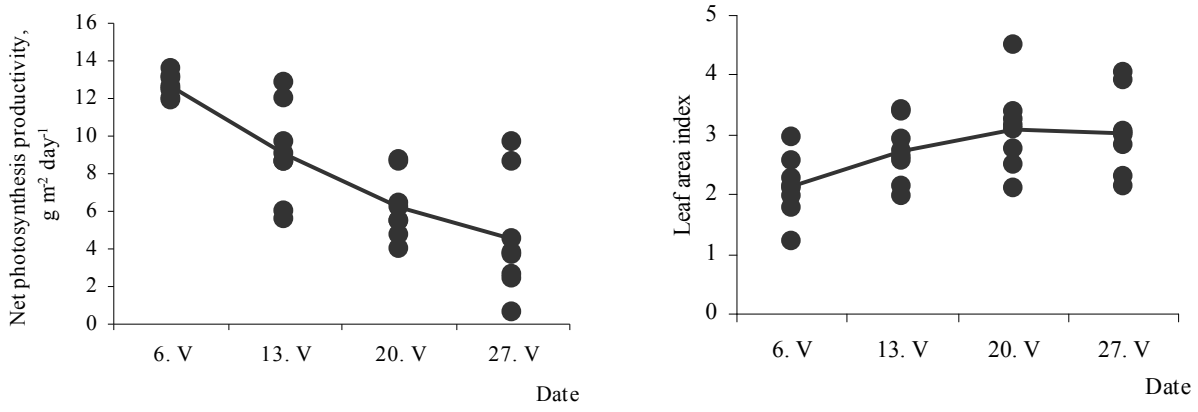

Figure 3. Indices of photosynthesis activity for *Festulolium* and hybrid ryegrass swards (2004)

Significant DM yield depending on leaf area index was obtained in the year 2004. It is characterized by equation of linear regression, with P-value = 0.0121 < 0.05 (Fig. 4).

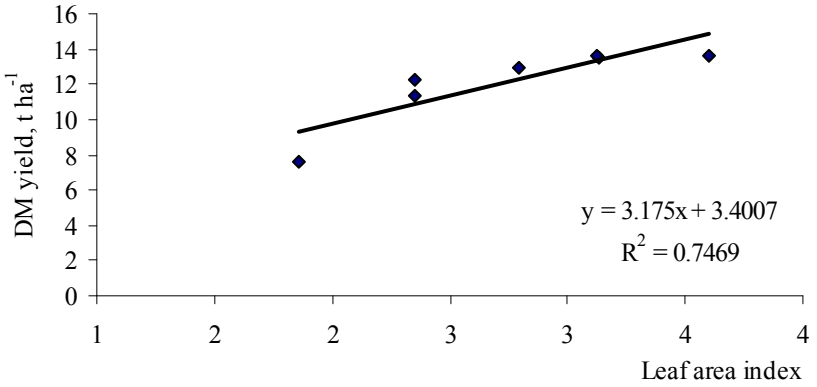

Figure 4. Equation of linear regression between net LAI and plant DM yield, (2004)

The highest average net photosynthesis productivity in both trial years was achieved by *Festulolium cv*. Saikava 8.97 g m^{-2} day^{-1}. All *Festulolium* and hybrid ryegrass cultivars exceeded perennial ryegrass cv. Spidola – 5.5 g m^{-2} day^{-1}. The average net photosynthesis productivity of *Festulolium* cultivars was by 13% higher compared to hybrid ryegrass, and by 38% higher compared to perennial ryegrass.

Unfavorable weather conditions in 2002–2003 didn't cause winterkilling of the studied cultivars except for early heading hybrid ryegrass *cv.* Ligunda. The average DM yield distribution between years showed that the maximum yield was obtained in the 1st year of sward use reaching 44% from total sward DM yield in both N treatments (Table 1).

Table 1. Distribution of DM yield between years, t ha^{-1}, (2002–2004)

Nitrogen rate, kg ha^{-1} (F_A)	Varieties (F_B)	DM yield in sowing year		DM yield in 1st year of sward use		DM yield in 2nd year of sward use	
		t ha^{-1}	%	t ha^{-1}	%	t ha^{-1}	%
N120	Spidola	5.20	100	11.09	100	8.64	100
	Lofa	8.38	161	14.30	129	12.03	139
	Felina	4.60	88	15.96	144	12.64	146
	Hykor	6.64	128	17.55	158	16.13	187
	Perun	8.50	163	16.61	150	12.05	139
	Tapirus	7.84	151	13.43	121	11.15	129
	Punia	7.91	152	16.58	150	12.04	139
N180	Spidola	5.20	100	12.91	100	10.05	100
	Lofa	8.38	161	15.73	122	13.47	134
	Felina	4.60	88	16.86	131	14.88	148
	Hykor	6.64	128	18.88	146	17.38	173
	Perun	8.50	163	18.46	143	14.54	145
	Tapirus	7.84	151	15.07	117	13.80	137
	Punia	7.91	152	18.46	143	14.48	144
$LSD_{0.05}$ for DM yield: F_A				0.32		0.33	
$LSD_{0.05}$ for DM yield: F_B		0.41		0.46		0.62	
$LSD_{0.05}$ for DM yield: F_{AB}				0.61		0.88	

The highest yield of DM 8.5 t ha^{-1} for the sowing year was provided by DLF-Trifolium *Festulolium cv.* Perun. In the 1st and 2nd years of sward use the highest DM yields were provided by DLF-Trifolium *Festulolium cv.* Hykor with N180 kg ha^{-1} applied – 18.9 and 17.4 t ha^{-1}, respectively.

In all production years the average productivity of *Festulolium* accounted for 36.4 t ha^{-1} DM with N120 kg ha^{-1} applied. The N-fertilizer dose increased to 180 kg ha^{-1} contributed to DM yield increase by 3.4 t ha^{-1} or 9 per cent. Total DM yield of hybrid ryegrass accounted for 32.4 t ha^{-1} with N120 kg ha^{-1} added. The N fertilizer dose increased to 180 kg ha^{-1} contributed to DM yield increase by 4.3 t ha^{-1} or 13 per cent. The total DM yield of perennial ryegrass accounted for 24.9 t ha^{-1} with N120 kg ha^{-1} applied. The N fertilizer dose increased to 180 kg ha^{-1} contributed to DM yield increase by 3.2 t ha^{-1} or 13 per cent (Fig. 5).

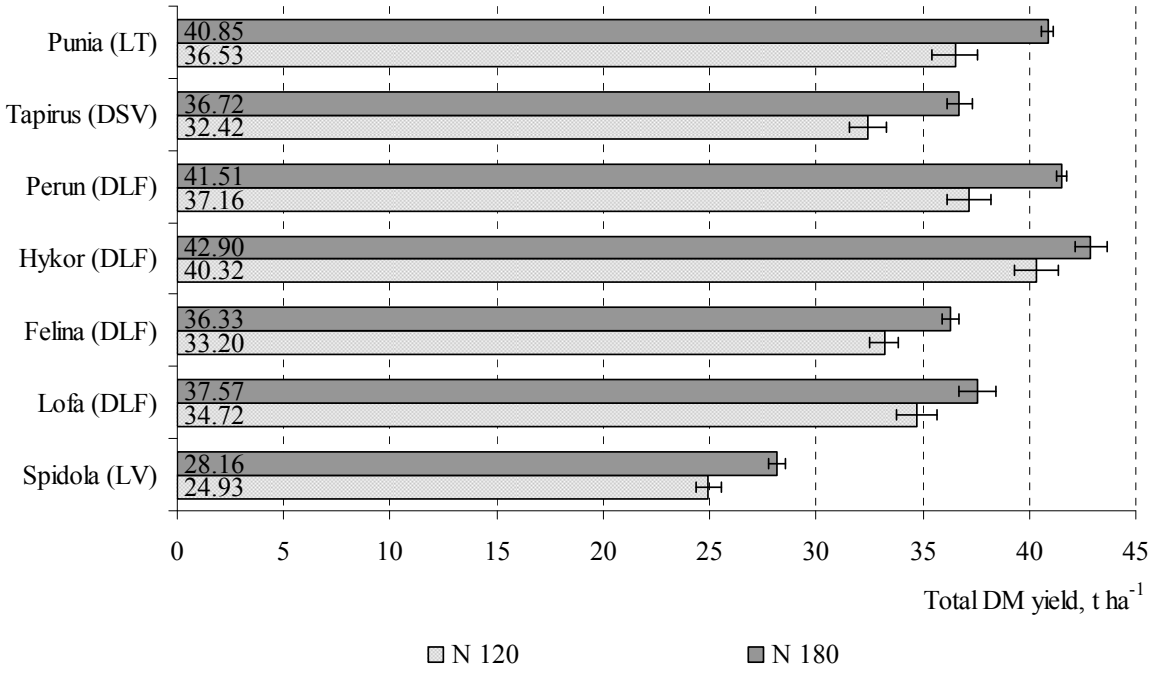

Figure 5. Total DM yield of *Festulolium* and *Lolium × boucheanum*, t ha^{-1}, (2002–2004)

The average DM yields of *Festulolium* cultivars was by 11.6 t ha^{-1} or 44%, but those of hybrid ryegrass by 8.0 t ha^{-1} or 30% higher compared to perennial ryegrass.

Conclusions

Cultivars of *Festulolium* and *Lolium × baucheanum* in Latvia are promising species of fodder grasses. Due to its competitive productivity, *Festulolium* may be equally ranked with the main forage grasses timothy and meadow fescue grown in climatic zone of Latvia.

Early heading hybrid ryegrass cultivars are less appropriate for Baltic climate conditions than the latest ones.

Further research results will show the possibilities of using *Festulolium* and hybrid ryegrass in grassland development.

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