УДК 581.132

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PRODUCTIVITY AND PHOTOSYNTHESIS CHARACTERISTICS OF *Festulolium* AND *Lolium boucheanum* SWARD

The productivity of grasslands and pastures mostly depends on cultivated grass varieties. 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 present research were 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 the loam sod – podzolic soil and fertilized with $N_{120\ (40+40+40)}$ P_{78}, K_{90} *kg/ha*$^{-1}$*. The productivity of photosynthesis and biomass were dependent on the variety. The relationship between net photosynthesis productivity value, leaf area index and DM production was confirmed.*

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

High quality forage *Lolium* have 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 [7]. 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. In 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 [1, 6].

Greater sward productivity may be obtained through use of hybrid combinations of contrasting grass species. *Festulolium* hybrids are among the most persistent and productive grasses of the grasses used in many Europe countries, especially in adverse environments [9]. 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 [3].

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 between a number of process [8]. Leaves development, age,

photosynthetic capacity influences the grass yield. Leaf area index is one of the most significant indicate of photosynthesis [10]. In optimal photosynthetic and moisture conditions perennial grasses can achieve good growth and photosynthetic productivity. The optimal fertilization level can help to improve the photosynthesis [2].

Net assimilation rates for perennial ryegrass, Italian ryegrass, tall fescue and intergeneric hybrids is highest during the recovery period for first cut, and is lower during the periods following the second and third cuts. The difference in net assimilation rates between first and second cuts is highly significant. There is close relationship between net assimilation rate value and DM production. 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 [5].

Materials and methodology of research. Field trials were conducted in Latvia on loam Sod–Podzolic soils (pH_{KCl} 7,1, P 253, K_{198} mg kg^{-1}, organic matter content 31 g kg^{-1} of soils). 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),* 'Hykor' *(L. multiflorum × F. arundinacea)*; hybrid ryegrass – 'Tapirus' *(L. multiflorum × L. perenne)*. The total seeding rate was 1000 germinating seeds per m^{-2}. The plots were fertilized as follows: $N_{108\ (18+90)}$ P_{78} K_{90} (at sowing year); P_{78} and K_{90} kg ha^{-1} and $N_{120(40+40+40)}$ at year of sward use. Dynamics of plant leaf area (LAI) expansion, net photosynthesis productivity (NPP), 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 - 10 day intervals after spring regrowth till first cut. Sampling plot size 0.05 m^{-2} in two replication. The experimental data was subjected to ANOVA analysis, correlation and regression analyses.

Results of research. In Latvian climate condition main part of forage yield is obtained from first cut and it is most important part of dry mater yield formation. Data of the analisys of variance showed that in 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 by nitrogen fertilization rate. 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 1,6 t ha^{-1} or 17 percent (table 1). Increased nitrogen rates positive effect on average was better expressed on hybrid ryegrass, loloid type *Festulolium* and perennial ryegrass cultivars. Dry matter yield was found to be strongly dependent on climatic condition in the particular year of yielding.

1. Average DM yield for three years of sward use, t ha^{-1}

Year of sward use	Nitrogen levels, kg ha^{-1} (F_A)	Varieties (F_B)							
		Spidola	Lofa	Felina	Saikava	Hykor	Perun	Tapirus	Punia
first	N 120	8.10	11.70	15.96	9.45	13.67	13.18	11.12	13.34
	N 180	10.22	13.64	16.85	12.38	15.13	15.66	13.52	15.81
	$LSD_{0.05}$ for DM yield: F_A= 0.28; F_B= 0.56; F_{AB}= 0.79								
second	N 120	5.85	7.61	12.64	6.11	10.95	8.27	7.20	8.36
	N 180	6.40	8.89	14.88	7.45	12.93	10.27	8.64	9.91
	$LSD_{0.05}$ for DM yield: F_A= 0.21; F_B= 0.42; F_{AB}= 0.60								
third	N 120	4.83	6.89	8.49	6.09	10.14	7.67	6.27	6.86
	N 180	5.84	7.72	10.02	7.44	11.48	8.76	7.40	7.86
	$LSD_{0.05}$ for DM yield: F_A= 0.23; F_B= 0.46; F_{AB}= 0.65								

The net photosynthesis productivity and LAI for *Festulolium,* hybrid ryegrass and perennial ryegrass individual grass species were different (table 2).

The highest average net photosynthesis productivity was showed by *Festulolium* cv. Saikava 8.29g m^{-2} day^{-1}. For perennial ryegrass were characteristic not only the lowest NPP average value but also lowest dry matter yield. The highest average values of LAI in four years of trials were achieved by *Festulolium* cv. Hykor (2.91) and Punia (2.66). In spite of the difference between NPP values of investigated varieties and LAI values of investigated varieties the differences for both are not statistically significant (P > 0.05).

2. The net photosynthesis productivity (NPP), g m^{-2} day^{-1} and leaf area index (LAI), (on average for 2003-2006)

Varieties	Spidola	Lofa	Saikava	Hykor	Perun	Tapirus	Punia
NPP	5.63	7.48	8.29	6.99	7.30	7.94	7.85
$S_{\square}$	0.88	0.53	0.79	0.31	0.23	0.17	0.45
LAI	2.01	2.28	1.94	2.91	2.53	1.98	2.66
$S_{\square}$	0.35	0.38	0.38	0.37	0.45	0.25	0.37

Weather condition affects leaf development and their photosynthetic capacity. Dry and hot weather in 2003 summer beginning leads to faster reaching ceiling LAI and it reduction afterwards. The leaf photosynthesis is influenced by the current environment and by the leaf age. Greater leaf area do not provide the increase of plant DM production per leaf area in year 2003. Correlation between leaf area index and dry matter production was not significant (P-value = 0.76 > 0.05).

The highest average net photosynthesis productivity was showed by *Festulolium* cv. Hykor – 6.68 g m^{-2} day^{-1}. All *Festulolium* and hybrid ryegrass cultivars exceeded perennial ryegrass cv. Spidola – 3.37 g m^{-2} day^{-1}. The average net photosynthesis productivity of *Festulolium* cultivars in 2003 was by 74 % higher compared to perennial ryegrass. The close relationship between net

photosynthesis productivity and dry matter yield production was not established in year 2003 with P-value > 0.05 (Fig. 1).

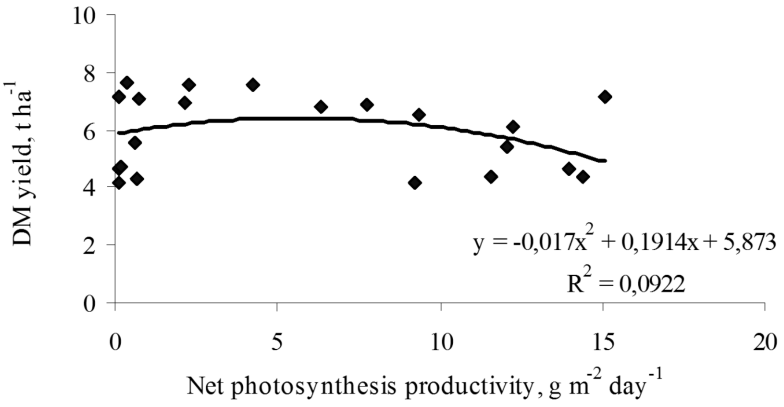

Fig. 1. Dependence between average net photosynthesis productivity g m^{-2} day^{-1} and plant dry matter yield, t ha^{-1}.

Late and cool spring in 2004 leads to slowed formation of leaf area. 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. There was upward trend of plant leaf area expansion over spring growing season till reaching ceiling LAI. As leaves ages, their photosynthetic capacity declines. There was downward trend of net photosynthesis productivity over spring growing season till first cut. NPP was highest during first ten days of spring regrowth and was lower at ear emergence stage (Fig. 2).

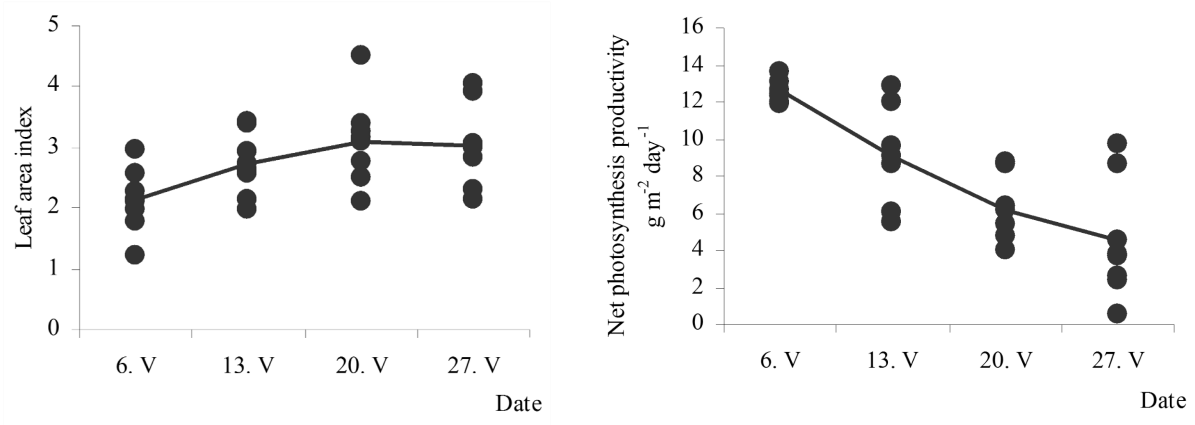

Fig. 2. Indicates of photosynthesis activity for *Festulolium* and hybrid ryegrass swards

The highest average net photosynthesis productivity was showed by *Festulolium* cv. Saikava 8.97 g m^{-2} day^{-1}. There was a significant negative corre-

lation between the DM yield formation during spring growing season till first cut and the net photosynthesis productivity with P-value = 0.001 < 0.05 for *Festulolium* and hybrid ryegrass swards in 2004.

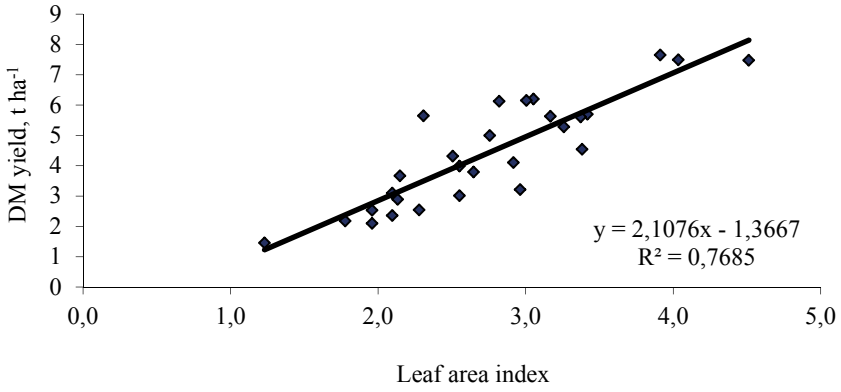

Fig. 3. Equation of linear regression between leaf area index (LAI) and plant dry matter yield, t ha^{-1}

It was also confirmed close relationship between leaf area index and dry matter production. It was characterize by equation of linear regression, with P-value < 0.01 (Fig. 3). Positive correlation between leaf area index and dry matter for tall fescue cultivars and their intergenetic hybrids is mentioned in literature [5]. Maximum value of LAI – 3.6 in year 2004 was achieved by *Festulolium* cv. Perun.

Generally similar weather condition in spring 2005 causes similar tendencies of net photosynthesis productivity and leaf area dynamics as in year 2004. Maximum leaf area index was achieved before ear emergence stage. There was upward trend of plant leaf area expansion over spring growing season till reaching ceiling LAI. There was downward trend of net photosynthesis productivity over spring growing season till first cut. NPP was highest during first part of spring regrowth and was lower at ear emergence stage (Fig. 4).

The highest average net photosynthesis productivity was showed by hybrid ryegrass cv. Tapirus 9.23 g m^{-2} day^{-1}. All *Festulolium* and hybrid ryegrass cultivars exceeded perennial ryegrass cv. Spidola – 5.53 g m^{-2} day^{-1}. The average net photosynthesis productivity of *Festulolium* cultivars was by 45 % higher compared to perennial ryegrass.

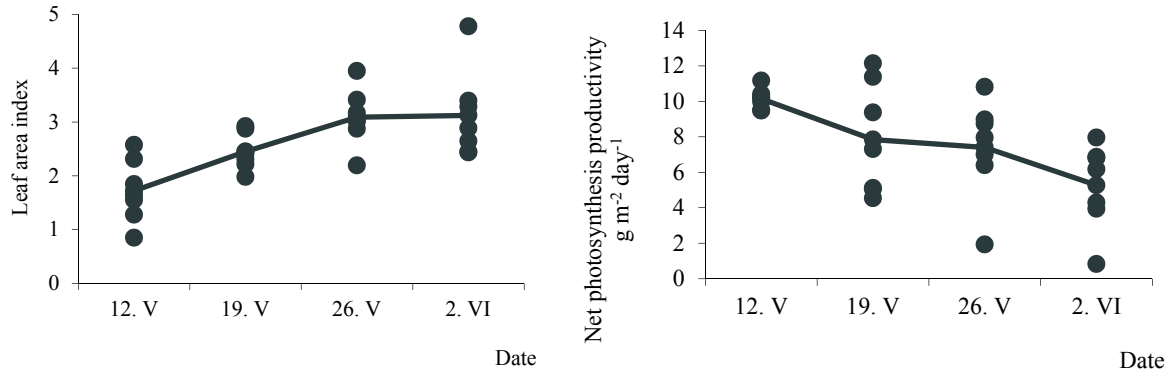

Fig. 4. Indicates of photsythesis activity for *Festulolium* and hybrid ryegrass swards

There was a significant correlation between the DM yield formation during spring growing season till first cut and the net photosynthesis productivity with P-value = 0.043 < 0.05 for *Festulolium* and hybrid ryegrass swards in 2005. It was also confirmed close relationship between leaf area index and dry matter production. It was characterize by equation of linear regression, with P-value < 0.01 (Fig. 5). Maximum value of LAI – 3.5 in year 2005 was achieved by *Festulolium* cv. Hykor.

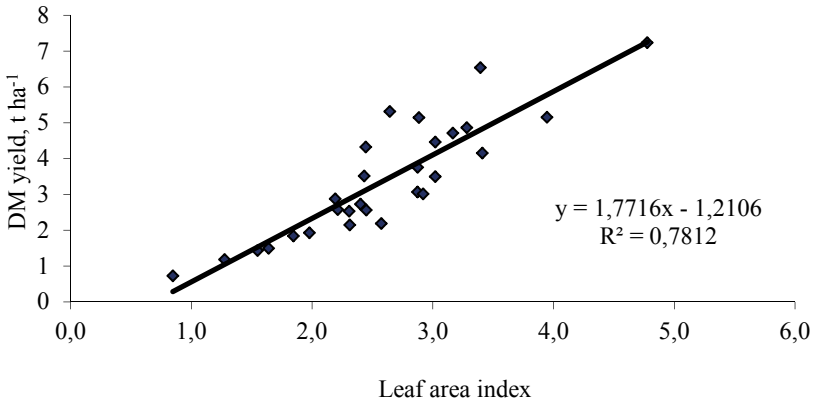

Fig. 5. Equation of linear regression between leaf area index (LAI) and plant dry matter yield, t ha^{-1}.

Dry and hot weather in 2006 summer beginning leads to smallest average leaf area formation for all investigated varieties. Plant leaf area expansion over spring growing season till reaching ceiling LAI were slower (Fig. 6). This year all varieties show lowest LAI values.

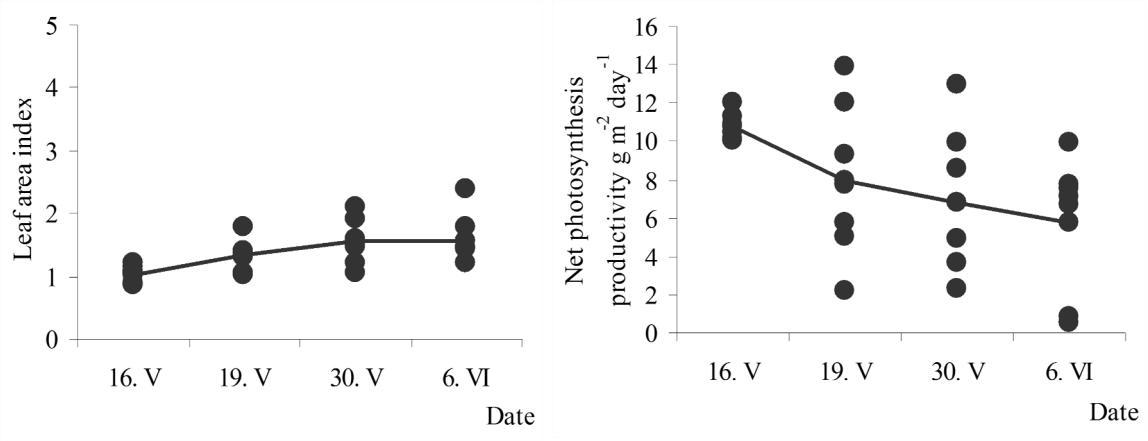

Fig. 6. Indicates of photosynthesis activity for *Festulolium* and hybrid ryegrass swards.

The rate of photosynthesis which a leaf exhibits in high light intensities declines faster with age. Smaller increase of leaf area, and better light saturation in sward did not lead to higher photosynthetic capacity. The highest average net photosynthesis productivity was showed by hybrid ryegrass cv. Tapirus and *Festulolium* cv. Punia - 9.27 and 9.11 g m^{-2} day^{-1}, respectively. All *Festulolium* and hybrid ryegrass cultivars exceeded perennial ryegrass cv. Spidola – 5.98 g m^{-2} day^{-1}. The average net photosynthesis productivity of *Festulolium* cultivars was by 36 % higher compared to perennial ryegrass. Correlation between net photosynthesis productivity and dry matter yield production was not significant (P-value = 0.32 > 0.05). Leaf area expansion leads not only to higher dry matter production but either to greater shadow in swards. Shadow conditions in swards leads to photosynthesis productivity decline. This is reason for different data regarding correlation between net photosynthesis productivity and dry matter yield production. Some data show significant positive correlation between NPP and DM production [5]. Other investigation do not confirm confirmed close relationship between NPP and DM production [4].

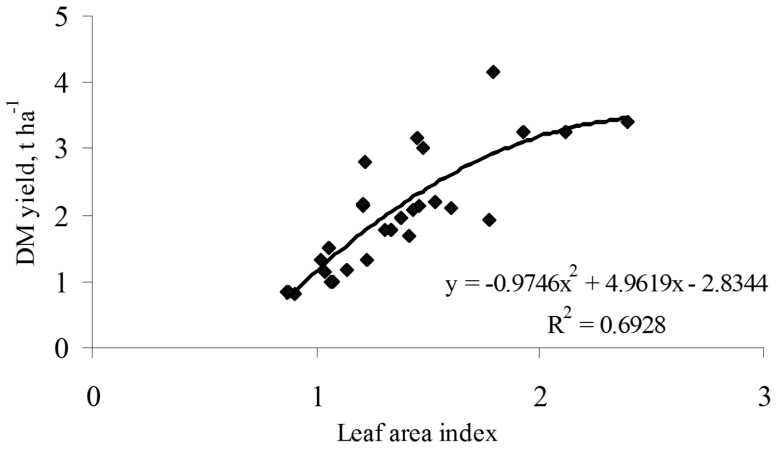

Fig. 7. Dependence between leaf area index (LAI) and plant dry matter yield, t ha^{-1}.

There was a significant correlation between leaf area index and dry matter production, with P-value < 0.01 (Fig. 7). Maximum value of LAI – 1.8 in year 2006 was achieved by *Festulolium* cv. Hykor.

Conclusion

1. The productivity of grass biomass were dependent on the cultivar to be used and the nitrogen fertilization rates.

2. Significant differences in *Festulolium* and *Lolium x boucheanum* DM yield were found between first, second and third year, with the highest yield in the first harvest year.

3. The average net photosynthesis productivity for *Festulolium,* hybrid ryegrass and perennial ryegrass cultivars was in range from 5.63 to 8.29 g m^{-2} day^{-1}. The lowest average net photosynthesis productivity in all years of investigation show perennial ryegrass cv. Spidola. Difference between NPP values of investigated varieties are not statistically significant (P > 0.05).

4. The average leaf area index wes in range from 1.94 to 2.91 for *Festulolium,* hybrid ryegrass and perennial ryegrass cultivars. Difference between LAI values of investigated varieties are not statistically significant (P > 0.05).

5. Significant correlation (P-value < 0.05) between DM formation during spring growing season till first cut and leaf area index were established in three years of trials.

6. Net photosynthesis productivity of *Festulolium* and hybrid ryegrass swards is decreased over period of growth.

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