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Research Article

DRY MATTER YIELD OF DIFFERENT VARIETIES OF *DACTYLIS GLOMERATA* AND *FESTUCA PRATENSIS*

Jacek Sosnowski[1], Kazimierz Jankowski[1], Piotr Domański[2], Dorota Herda[1]

[1] Siedlce University of Natural Sciences and Humanities, Prusa 14, 08-110 Siedlce, Poland, e-mail: jacek.sosnowski@uph.edu.pl; kazimierz.jankowski@uph.edu.pl; laki@uph.edu.pl

[2] The Research Centre for Cultivar Testing in Słupia Wielka, 63-022 Słupia Wielka, Poland, e-mail: p.domanski@coboru.pl

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ABSTRACT
The aim of this paper is to analyze yield variation of *Dactylis glomerata* and *Festuca pratensis* varieties grown on organic and mineral soil. This paper has drawn on two field experiments set up and carried out between 2010 and 2013. The experiment was conducted in two experimental stations: one in the Research Centre for Cultivar Testing in Krzyżewo and the other in the Experimental Stations for Variety Testing in Uhinin. The experiment in Krzyżewo was set up on ploughed soil, with spring barley as a forecrop. In Uhnin the experimental plots were located on peat meadow. The experimental plots were sown with varieties of *Dactylis glomerata*: Niva, Tukan, Amila, Crown Royale and with varieties of *Festuca pratensis*: Limosa, Pasja, Anturka, Amelka. The full exploitation of *Dactylis glomerata* varieties was due between 2012 and 2013, whereas for *Festuca pratensis* it was due between 2011 and 2012. In the experimental plots with the varieties of *Dactylis glomerata* the grass was harvested six times a year and chemical analysis of the biomass was done taking dry matter only from five cuts. The varieties of *Festuca pratensis* were harvested four times. Each year in the course of the experiment fresh and dry matter of each cut were weighed. The grass species and their varieties as well as the particular mowing and kind of soil where the grass was grown have an impact on the yield. On mineral soil the yield of *Dactylis glomerata* was higher than *Festuca pratensis*. On organic soil the yield of both species was similar. During the two years of experiment the highest yield among *Festuca pratensis* varieties was noted for Amelka whereas among varieties of *Dactylis glomerata* the yield was similar and differences were not statistically significant.

Keywords: yield, variation, grass, *Dactylis glomerata*, *Festuca pratensis*.

INTRODUCTION

Dactylis glomerata and *Festuca pratensis* are considered to be of major economic importance because of their variable uses as well as durability, vitality, their modest soil requirements and their tolerance to moderate drought stress [Kasperczyk 1994, Kozłowski, Swędrzyński 1997, Grzegorczyk, Gołębiewska 2004, Borawska-Jarmułowicz, 2006, Czyż et al. 2012]. According to Borawska-Jarmułowicz [2011], the yield of different varieties of those grasses is determined by their morphological and biological features and, in particular, according to Rutkowska et al. [1994], by their ability to develop vegetative and reproductive shoots. According to Domański [1997], because of economic and agricultural needs a new variety of a fodder grass should give profitable seed production, high dry matter yield and should provide a farm with good quality fodder. Fodder grass like *Dactylis glomerata*, grown as temporary grass, can give a yield of over 15 t of dry matter per hectare provided that plants will have a sufficient amount of water and nutrients.

The aim of this paper is to analyze yield variation of *Dactylis glomerata* and *Festuca pratensis* varieties grown on organic and mineral soil.

MATERIAL AND METHODS

This paper has drawn on two field experiments set up and carried out between 2010 and 2013 by the Research Centre for Cultivar Testing in Słupia Wielka. The experiment was conducted in two experimental stations: one in the Research Centre for Cultivar Testing in Krzyżewo and the other in the Experimental Stations for Variety Testing in Uhinin, being a branch of the Research Centre for Cultivar Testing in Cicibor Duży. The stations are located in the Podlaskie Woivodeship, the Wysokie Mazowiekie county, in the commune of Sokoły. Uhnin is located in the Lubelskie Voivodeship, the Parczew county and the Dębowa Kłoda commune.

The experiment was arranged and conducted according to Research Centre for Cultivar Testing guidelines [Domański 1998]. The experimental plots were sown with varieties of *Dactylis glomerata*: Niva, Tukan, Amila, Crown Royale and with varieties of *Festuca pratensis*: Limosa, Pasja, Anturka, Amelka (e. AND 1009).

The plots were randomly selected, 1.5 meters wide and 6.67 m long, with an area of 10 m^2, grouped in blocks with four replications. They were separated by 1 meter pathways between blocks and with 0.5 meter pathways between subblocks. The pathways lay fallow. The experiment in Krzyżewo was set up on ploughed soil, with spring barley as the forecrop. In Uhnin the experimental plots were located on peat meadow. Table 1 and 2 present soil characteristics and mineral fertilizers used.

In the research the amount of seeds of the grass sown varied depending on the variety and the location of the experiment. It was as follows (in $kg \cdot ha^{-1}$): *Dactylis glomerata* – Tukan: 16.3; Amila: 17.5; Crown Royale: 18.8 (Krzyżewo) and 17.6 (Uhnin); Niva: 18.3, *Festuca pratensis* – Pasja: 28.7; Limosa: 29.8 (Krzyżewo) and 27.1 (Uhnin); Anturka: 26.6; Amelka: 27.8 (Krzyżewo) and 27.9 (Uhnin).

The sowing dates for *Dactylis glomerata* were 22 April 2011 (Krzyżewo), 6 May 2011 (Uhnin) for *Festuca pratensis* 22 May 2011 (Krzyżewo) and 29 April 2011 (Uhnin).

In the year when the experiment was set up the grass was not harvested and only weeds were mowed. According to the guidelines of Research Centre for Cultivar Testing in Słupia Wielka, the full exploitation of *Dactylis glomerata* varieties was due between 2012 and 2013, whereas for *Festuca pratensis* it was due between 2011 and 2012. In the experimental plots with the varieties of *Dactylis glomerata* the grass was harvested six times a year and chemical analysis of the biomass was done taking dry matter only from five cuts. The varieties of *Festuca pratensis* were harvested four times. Each year in the course of the experiment fresh and dry matter of each cut were weighed. Research Centre for Cultivar Testing in Słupia Wielka made those measurements available to be used in this paper.

Statistical analysis of the data was done using Statistica 6.0 – 2001, with multifactorial analysis of variance. Tukey's test was used to find means that were significantly different from each other with level of significance $p \leq 0{,}05$.

Climatic conditions of the area where the experiment was carried out are typical for the 9th agricultural and climatic eastern part of Poland. The average annual air temperature varies from 6.7 to 6.9 °C and in the summer season the average 24 hour temperature is 15 °C. The growing season usually starts on 28 March, lasts till 30 October and is 200 to 220 days long [Radzka 2014]. The average climatic water balance during the time of the experiment varied considerably according to the period and location. Annual

Table 1. Soil conditions

Grass	*Dactylis glomerata*		*Festuca pratensis*	
Location	Krzyżewo	Uhnin	Krzyżewo	Uhnin
Soil conditions				
The value of soil according to IUNG	52	50	52	70
Agricultural value	5	1p	5	1z
Type	P	PS	P	PS
Texture	ls	–	ls	–
pH	6.7	5.5	6.7	5.5

Symbols: 1p – good and very good permanent meadow, 5 – good quality rye soil; P – podsolic soil, PS – peaty soil, ls – loamy sand.

Table 2. Mineral fertilizers used in the experiment with varieties of *Dactylis glomerata* and *Festuca pratensis*

Fertilizers [kg·ha^{-1}]				
Nitrogen – N:				
– before sowing,	270	80	80	80
– in consecutive years	245	192		
Phosphorus – P_2O_5:				
– before sowing,	90	100	80	80
– in consecutive years	80	100		
Potas – K_2O:				
– before sowing,	90	100	100	100
– in consecutive years	130	110		

rainfall ranges from 550 to 650 mm, with not frequent but recurrent rain. Water stress was mainly observed in spring while water deficit occurred in July [Radzka 2014].

During the time of the experiment weather data were provided by the Meteorological and Hydrological Stations in Krzyżew and Uhnin. To determine temporal variation of meteorological parameters and their impact on plant growth Sielianinov's hydrothermal index was used [Bac et al. 1993] with the month's classification according to Skowera and Puła [2004]. As it can be seen from table 3 space-time distribution of annual rainfall varied. April was a month of water stress only in 2011 in Krzyżewo (K = 0.86), whereas in May water deficit was noted in Uhnin in 2012 (K = 0,84). Every year in June there was enough rain both in Krzyżewo and Uhnin (K between 1.06 and 2.12). July was either extremely wet (Krzyżewo 2011 K = 3,9, Uhnin K = 3,03) or dry (Krzyżewo and Uhnin 2013). However, on the whole both July and August were rather dry whereas September and October happened to be extremely dry one year each with Sielianinov's hydrothermal index more that 4 (Krzyżewo 2013 and Uhnin 2012).

RESULTS AND DISCUSSION

For all varieties and both locations during those three years when the experiment was done (Table 4 and 5) the average annual yield of six cuts of *Dactylis glomerata* was 14.7 t·ha^{-1} of dry matter. In the case of *Festuca pratensis* the annual average yield in Krzyżewo (mineral soil) was 23.5% higher than in Uhnin (organic soil). Moreover, the statistical analysis proved that means of the main effect and interaction were significantly different.

The variety of *Festuca pratensis* with the highest yield of biomass was Amelka (16.3 t·ha^{-1} of dry matter) whereas Limosa gave the lowest yield of 14,8 t·ha^{-1} of dry matter. It is worth noting that the yields of *Dactylis glomerata* were not significantly different.

Rutkowska and Lewicka [1991] as well as Kozłowski and Swędrzyński [1997] did not find significant differences in yield between varieties of *Dactylis glomerata*. The same publications say the average yield of *Dactylis glomerata* is much lower (between 8.51 and 9.60 t·ha^{-1} of dry matter). Observation of yields of *Dactylis glomerata* and *Festuca pratensis* in particular cuts (Table 6 and 7) shows that with six mowings of *Dactylis glomerata* the highest yield (on average 2.99 t·ha^{-1} of dry matter) was form the fifth cut of the grass, while the lowest from the sixth (1,63 t·ha^{-1} of dry matter).

Many publications [Kallenbach et al. 2002, Wilczek, Ćwintal 2002; Kochanowska-Bukows-

Table 3. *Sielianinov's hydrothermal index* (K) during the growing season in the years of the experiment in Krzyżewo and Uhnin

Month	Krzyżewo			Uhnin		
	Year of experiment					
	2011	2012	2013	2011	2012	2013
IV	0.86 (s)	1.63 (dw)	2.50 (w)	1.39 (o)	1.06 (ds)	2.79 (bw)
V	1.64 (dw)	1.09 (ds)	1.80 (dw)	1.09 (ds)	0.84 (s)	2.87 (bw)
VI	1.06 (ds)	1.83 (dw)	1.53 (o)	2.12 (w)	1.92 (dw)	1.74 (dw)
VII	3.90 (sw)	1.55 (o)	1.08 (ds)	3.03 (sw)	0.81 (s)	0.92 (s)
VIII	1.15 (ds)	3.18 (sw)	0.89 (s)	0.79 (s)	1.25 (ds)	0.12 (ss)
IX	0.41 (bs)	0.40 (ss)	4.84 (sw)	0.21 (ss)	0.79 (s)	2.46 (w)
X	0.81 (s)	2.27 (w)	0.48 (bs)	1.27 (ds)	4.90 (sw)	0.46 (bs)

Note: (ss) – extremely dry, (bs) – very dry, (s) – dry, (ds) – quite dry, (o) – optymal, (dw) – quite wet, (w) – wet, (bw) – very wet, (sw) – extremely wet.

Table 4. Annual yield of *Dactylis glomerata* in t·ha^{-1} of dry matter according to the year, variety and location

Variety	Year	Location		Mean
		Krzyżewo	Uhnin	
Niwa	2012	17.68	14.68	16.18
	2013	11.54	15.09	13.31
Tukan	2012	18.54	14.68	16.61
	2013	11.47	14.96	13.19
Amila	2012	16.80	14.32	15.56
	2013	11.31	14.12	12.71
Crown Royale	2012	18.37	14.95	16.66
	2013	11.91	14.87	13.39
Variety means				
Niva		14.61	14.88	14.74
Tukan		14.98	14.82	14.90
Amila		14.05	14.22	15.13
Crown Royale		15.14	14.21	15.02
Mean		14.69	14.70	

$NIR_{0,05}$ for: location × year × variety – NS (not significant); variety × year – NS; location × variety – NS; variety – NS; location – NS.

Table 5. Annual yield of *Festuca pratensis* in t·ha^{-1} of dry matter according to the year, variety and location

Variety	Year	Location		Mean
		Krzyżewo	Uhnin	
Limosa	2011	20.3	13.6	17.00
	2012	11.0	11.37	11.19
Pasja	2011	21.0	13.6	17.30
	2012	14.6	10.64	12.62
Anturka	2011	21.2	13.5	17.40
	2012	14.6	10.93	12.77
Amelka	2011	20.8	14.3	17.60
	2012	15.0	12.12	13.56
Variety mean				
Limosa		15.70	12.49	14.10
Pasja		17.80	12.12	14.96
Anturka		17.90	12.22	15.05
Amelka		17.90	13.21	15.50
Mean		17.30	12.52	

$NIR_{0,05}$ for: location × year × variety – 2.7; variety × year – NS; location × variety – 1.6.; variety – 1.3; location – 3.1

ka 2003, Gaweł 2005, Mastalerczuk 2007, Nowak, Sowiński 2007] say that the number of grass cuts affects yield and content of nutrients of the fodder but also influences the concentration of some macro elements. To determine the nutritional value of the feed the balance between nutrients is important because a lack of such balance may deteriorate nutrient utilization and lead to metabolic disorders in animals [Urban et al. 2003, Nowak, Sowiński 2007, Mastalerczuk 2007, Gaweł 2009]. In the plots with *Festuca pratensis*, no matter what variety or location, with four mowings there were significant differences in yield. The considerable proportion of the annual yield, over 37.5%, was the first mowing in spring (5.75 t·ha^{-1} of dry matter). There were no significant differences between mowings 2, 3 and 4, with the lowest yield of the second cut of 2.71 t·ha^{-1} of dry matter.

Table 6. Yield of dry matter [t·ha^{-1}] of *Dactylis glomerata* according to a cut and location (average from all the years of the experiment)

Variety	Mowing	Location		Mean
		Krzyżewo	Uhnin	
Niva	I	2.64	2.83	2.74
	II	2.23	1.86	2.05
	III	2.85	2.28	2.57
	IV	3.15	2.78	2.97
	V	3.04	3.43	3.24
	VI	1.08	1.76	1.42
Tukan	I	2.53	2.90	2.72
	II	2.18	1.94	2.06
	III	2.59	2.26	2.43
	IV	3.03	2.81	2.92
	V	2.73	3.05	2.89
	VI	1.01	1.61	1.31
Amila	I	2.72	3.12	2.92
	II	2.21	2.07	2.14
	III	2.70	2.22	2.46
	IV	3.10	2.65	2.88
	V	2.83	2.90	2.87
	VI	1.07	1.87	1.47
Crown Royale	I	3.12	3.12	3.12
	II	2.12	1.68	1.90
	III	2.68	2.10	2.39
	IV	1.54	2.98	2.26
	V	2.81	3.13	2.97
	VI	2.31	1.87	2.09
Mowing means				
I		2.75	2.99	2.87
II		2.19	1.89	2.04
III		2.71	2.22	2.47
IV		2.70	2.81	2.76
V		2.85	3.13	2.99
VI		1.47	1.78	1.63

$NIR_{0,05}$ for: location × mowing × variety – 0.29; variety × mowing – 0.27; mowing × location – 0.30; mowing – 0.26

Table 7. Yield of dry matter [t·ha^{-1}] of *Festuca pratensis* according to a cut and location (average from all the years of the experiment)

Variety	Mowing	Location		Mean
		Krzyżewo	Uhnin	
Limosa	I	7.10	4.21	5.66
	II	2.06	3.22	2.64
	III	4.52	3.74	4.13
	IV	3.79	–	3.79
Pasja	I	7.14	4.03	5.59
	II	2.11	3.31	2.71
	III	4.58	3.37	3.98
	IV	3.99	–	3.99
Anturka	I	7.23	3.93	5.58
	II	2.24	3.32	2.78
	III	4.51	3.57	4.04
	IV	3.92	–	3.92
Amelka	I	7.64	4.69	6.17
	II	2.04	3.34	2.69
	III	4.30	3.78	4.04
	IV	3.93	–	3.93
Mowing means				
I		7.28	4.22	5.75
II		2.11	3.31	2.71
III		3.33	3.62	3.48
IV		3.91	–	3.91

$NIR_{0,05}$ for: location × mowing × variety – 2.60; variety × mowing – 1.25; mowing × location – 1.1; mowing – 2.10

CONCLUSIONS

1. The grass species and their varieties as well as the particular mowing and kind of soil where the grass was grown have an impact on the yield.
2. On mineral soil, the yield of *Dactylis glomerata* was higher than *Festuca pratensis*. On organic soil, the yield of both species was similar.
3. During the two years of experiment the highest yield among *Festuca pratensis* varieties was noted for Amelka, whereas among varieties of *Dactylis glomerata* the yield was similar and differences were not statistically significant.

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