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Plantago lanceolata L. AS A COMPONENT OF PERMANENT AND RENEWED GRASSLANDS

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Abstract. *Plantago lanceolata* is one of the most common and most valuable dicotyledonous pasture herbs found on meadows and pastures. The aim of this study was to compare the impact of *Plantago lanceolata* on yields and quality of twice harvested semi-natural meadow swards utilized according to agri-environment programme guidelines (P10b variant), as well as on pastures established using mixtures containing *Plantago lanceolata*. On studied meadows, presence of *Plantago lanceolata* in amounts exceeding 3% of the total yield could be seen as an indicator of negative changes in humidity and tropism, causing a reduction in dry mass yields and the deterioration of sward quality after the first harvest. Meanwhile, yields from pastures containing *Plantago lanceolata* were almost four times higher. Furthermore, *Plantago lanceolata* ingested by cows contained more protein, sugars and crude ash including calcium and phosphorus while containing less fiber than *Dactylis glomerata* and *Lolium perenne*. Furthermore, *Plantago lanceolata* was more abundant than *Trifolium repens,* also included in the sowing mixture.

Key words: natural meadow, pasture, ribwort plantain, botanical composition, yield, sward quality

INTRODUCTION

Ribwort plantain (*Plantago lanceolata* L.) is one of the most valuable dicotyledonous pasture herbs. It is commonly found on extensive grasslands within numerous compounds of the *Molinio-Arrenatheretea* class [Kryszak 2001, Ratyńska 2001]. At low levels, *Plantago lanceolata* can improve the quality of the sward while higher levels might lower the yields, as its leaves crumble easily during drying and do not constitute the agricultural yield. Furthermore, *Plantago lanceolata* undergoes generative reproduction easily and thus develops well under conditions with reduced competition from grasses, within habitats deprived of nutrients [Majda *et al*. 2007].

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These drawbacks have a lesser impact in pasture utilisation as foreign reports underline the beneficial role of *Plantago lanceolata* in feeding ruminants and horses [Stewart 1996, Rumball 1997]. Up until now, domestic studies on *Festuca pratensis* and *Lolium perenne* mixtures containing *Plantago lanceolata* were carried out as pot experiments [Grzegorczyk and Gołębiewska 2004]. Later studies focused on harvested swards [Grzegorczyk and Gołębiewska 2008]. *Plantago lanceolata* is well adapted to multiple rounds of regeneration after grazing, while the limited height of succulent leaves makes uptake by animals easier. It would thus be prudent to carry out a study under strict experimental pasture conditions to evaluate the levels of *Plantago lanceolata* within sowing mixtures that would be optimal for maximizing yields and sward quality. Therefore, the aim of this study was to compare the impact of *Plantago lanceolata* on yields and quality of semi-natural meadow swards harvested twice and utilized according to agri-environment programme guidelines (P10b variant), as well as on pastures established using mixtures containing *Plantago lanceolata.*

MATERIAL AND METHODS

The study has been carried out using two independent approaches. The impact of *Plantago lanceolata* on yield and sward quality was evaluated between 2006 and 2011 as part of a larger study conducted on meadows utilised according to agri-environment programme guidelines for semi-natural meadows harvested twice. The study was carried out on 158 ha of meadows which are part of the permanent grassland complex belonging to RZD in Minikowo, Poland. These are located in the central part of the Bydgoszcz Canal Valley, on a meliorated mire formed on a silted, overgrown lake as indicated by a large deposit of gytta which can be found throughout the valley under a 2-5m layer of peat [Łyszczarz and Suś 2009]. These meadows are currently, and have been in the past, the object of studies concerning the undergoing changes in habitat humidity, floristic composition and productivity, resulting from gradual setting of peat [Rogulski 1961, Łyszczarz *et al.* 2006, Łyszczarz and Dembek 2006, Łyszczarz *et al.* 2009].

Our results, grouped by the percentage share of *Plantago lanceolata,* were collected from 41 plots located throughout 17 areas created within a system of melioration ditches supplying water from the Bydgoszcz Canal. The botanical composition of the sward was evaluated yearly by estimating the amount of each component within the dry mass yield from a 200 m^2 area [Filipek 1983]. The yield from each area was evaluated basing on representative samples from four 0.5 m^2 frames (2 m^2 total surface area), collected by cutting the sward at 4 cm. These were used to calculate the dry mass yields and to conduct chemical analyses according to the current guidelines for analysis of feeds at UTP laboratories in Bydgoszcz (analyses of natural meadow swards) and at PODR in Stare Pole (analyses of pasture swards under strict experimental conditions).

In years 2009-2011 the impact of *Plantago lanceolata* on yield and nutritional values of pasture sward was evaluated on a strict, two-component experimental plot established on September 9th, 2008, and located on highly mineralized organic soil within the Noteć Valley, in Nowe Dąbie. Soil pH was close to neutral (pH 6.6-6.8), phosphorus and potassium levels were low (3.40 mg P·100 g^{-1} and 2.44 mg K·100g^{-1} respectively) while magnesium levels were high (2.74 mg Mg·100 g^{-1}). Sward coverage

on all plots was satisfactory, despite scant rainfall and slightly lower than average air temperatures.

Plantago lanceolata constituted 20 or 40% of grass-legume mixtures with *Lolium perenne* and *Dactylis glomerata* as dominant grass species. Grass-legume mixtures devoid of *Plantago lanceolata* were used as controls (Table 1). The amount of grass and *Trifolium repens* sown was established basing on generally accepted norms. In order to maintain a comparable sowing density for *Plantago lanceolata* and *Trifolium repens*, we calculated that for each 1 ha, the sowing mixture should contain 27 kg of *Plantago lanceolata* seeds with an MTO = 1.5 g. The final amount of *Plantago lanceolata* included in mixtures was 5 and 10 kg·ha^{-1}, and was proportional to the intended *Plantago lanceolata* sward participation of 20 and 40% respectively. The lower percentage corresponded to the typical amount of *Trifolium repens* suggested for pasture mixtures while the higher percentage was comparable to the amount of dominant grass species found in the sward. Such a high amount of *Plantago lanceolata* qualified it as a pasture plant, meant to constitute an important component of the sward.

Table 1. Percentage of components in mixtures
Tabela 1. Procentowy udział komponentów w mieszankach

Mixture component Komponenty mieszanek	Cultivar Odmiana	Seeding standard Normy wysiewu kg·ha^{-1}	Factor A1 – Czynnik A1			Factor A2 – Czynnik A2		
			Dactylis glomerata mixtures – mieszanki (*D*), %			*Lolium perenne* mixtures – mieszanki (*L*), %		
			factor B – czynnik B					
			percentage share of – udział *Plantago lanceolata*					
			D + 0	*D* + 20	*D* + 40	*L* + 0	*L* + 20	*L* + 40
Plantago lanceolata	–	27	0	20	40	0	20	40
Dactylis glomerata (*D*)	Maja	31	40	40	20	–	–	–
Lolium perenne (*L*)	Nera	21	–	–	–	40	40	20
Poa pratensis	Skiz	24	20	10	10	20	10	10
Festuca rubra	Reda	39	20	10	10	20	10	10
Trifolum repens	Haifa	19	20	20	20	20	20	20

The 6 × 6 m plot surface area was 36 m^2. Following hand sowing, a ring roller was used to ensure optimal germination conditions. Fertilization was carried out on a yearly basis using 90 kg N (3 × 30 kg during early growing season and after the third grazing), 100 kg K (2 × during early vegetation period and after the third grazing) and 44 kg P per ha at the beginning of the growing season. The mature pasture sward was grazed six times in 2009, starting on May 7th, June 4th, July 2nd, August 4th, August 26th and September 24th, and five times in each of the following two years: in 2010 starting on May 5th, June 10th, July 21st, August 12th and October 14th; in 2011 starting on May 6th, July 18th, August 5th, August 31st and September 28th. Each grazing period lasted 3 days.

RESULTS AND DISCUSSION

One hundred and nine species of vascular plants comprising the agricultural yield were identified within the studied complex of semi-natural meadows utilised according

to agri-environment programme guidelines, including 19 grasses, 7 legumes, 18 sedge and rush species as well as 65 species representing other families. These were mainly dicotyledons and included two protected species: *Ostericum palustre* and to a lesser extent *Dactylorhiza incarnata* [Krasicka-Korczyńska 2008, Dembek *et al*. 2012]. *Plantago lanceolata* constituted up to 25% of the sward and showed an upward trend in the following six years of studies. Because of this, two separate time periods were distinguished; representing the average results of a simplified botanical composition constructed basing on the percentage share of *Plantago lanceolata* within the sward (Table 2).

Table 2. Proportions of the basic components of the sward and yield, depending on the percentage of *Plantago lanceolata*

Tabela 2. Proporcje podstawowych składników runi i plonowanie w zależności od udziału *Plantago lanceolata*

Percentage of Procent *Plantago lanceolata*	Specification Wyszczególnienie	Years – Lata	
		2006-2008	2009-2011
0%	number of objects – liczba obiektów	18	14
	grasses – trawy	41.1	25.5
	legumes – bobowate	2.0	1.5
	sedge and rush families – turzycowate i sitowate	30.4	46.0
	other – inne	26.5	27.0
	yield – plon, Mg·ha^{-1}	**4.03**	**2.77**
	yield variation – zmienność plonów	2.16-7.18	1.73-4.19
1-3%	number of objects – liczba obiektów	9	12
	grasses – trawy	50.6	34.1
	legumes – bobowate	1.2	0.8
	sedge and rush families – turzycowate i sitowate	18.9	35.1
	other – inne	29.3	30.0
	including – w tym *Plantago lanceolata*	1.4	1.7
	yield – plon, Mg·ha^{-1}	**4.15**	**2.79**
	yield variation – zmienność plonów	3.05-5.12	2.00-4.30
4-10%	number of objects – liczba obiektów	10	9
	grasses – trawy	55.0	45.0
	legumes – bobowate	0.8	0.6
	sedge and rush families – turzycowate i sitowate	12.4	14.2
	other – inne	31.8	40.2
	including – w tym *Plantago lanceolata*	5.3	6.8
	yield – plon, Mg·ha^{-1}	**3.68**	**2.62**
	yield variation – zmienność plonów	3.15-4.26	1.82-4.21
11-15%	number of objects – liczba obiektów	4	3
	grasses – trawy	59.9	42.8
	legumes – bobowate	0.5	0.0
	sedge and rush families – turzycowate i sitowate	7.1	6.7
	other – inne	32.5	50.5
	including – w tym *Plantago lanceolata*	11. 9	12.8
	yield – plon, Mg·ha^{-1}	**2.82**	**2.60**
	yield variation – zmienność plonów	2.35-3.15	2.11-3.57
Above Powyżej 15%	number of objects – liczba obiektów	N/A	3
	grasses – trawy		45.0
	legumes – bobowate		0.7
	sedge and rush families – turzycowate i sitowate		4.7
	other – inne		49.6
	including – w tym *Plantago lanceolata*		20.7
	yield – plon, Mg·ha^{-1}		**2.47**
	yield variation – zmienność plonów		2.31-2.68

Plantago lanceolata was not present on plots with the highest humidity, dominated by sedges, particularly *Carex nigra*, *Carex acutiformis* and *Carex gracilis.* With time, the number of such plots decreased and the observed changes in botanic composition were mainly caused by the expansion of *Carex nigra* resulting in reduced yields between 2006 and 2011. At the same time, there was an increase in the number of areas with low amounts (up to 3%) of *Plantago lanceolata.* This was observed on slightly drier plots with more grass species. The recorded yields were comparable to those obtained on plots without *Plantago lanceolata.* The increase in percentage share of the studied species together with a general increase in the percentage share of dicotyledons resulted in a decreased yield. This was particularly true for plots subject to transient drying, with a delaminated soil structure and with poor sward coverage, allowing for expansion of *Plantago lanceolata*. This species preferentially grows in mildly humid habitats and as its percentage share within the botanical composition increased, the percentage share of sedge species (primarily *Carex nigra*, *Carex gracilis* and *Carex acutiformis*) decreased from 47% on areas without *Plantago lanceolata* to less than 15% on areas with large amounts of the herb. At the same time, the percentage share of grasses considered as fenologically early such as *Poa pratensis, Festuca rubra* and *Holcus lanatus* increased from 17 to almost 41%.

Despite the generally low productivity of the studied meadows, when comparing both three-year study periods, between years 2009 and 2011 there was an evident decrease in yield from plots either completely devoid of, or with a small amount of *Plantago lanceolata.* These differences were not as significant within areas with a larger percentage share of *Plantago lanceolata*, as even in the first period it developed most extensively on highly mineralized organic soil. The ban on meadow rolling resulted in an increase in areas prone to drying during the summer and as a consequence a decrease in yield and the succession of species that prefer such habitats. Apart from *Plantago lanceolata* and numerous dicotyledons, the following years have seen an increase in the percentage share of *Holcus lanatus* and *Carex hirta* [Dembek *et al*. 2012]. The higher percentage share of *Plantago lanceolata* could be thus seen as an indicator of negative changes in humidity and tropism, causing a reduction in dry mass yields.

While evaluating sward quality after the first harvest, basing on its chemical composition it is evident that the sward does not meet the norms set for cow feeds and can only be used as a low quality supplement in feeding beef cattle [Choromanski *et al*. 1991]. What is more, the increase in percentage share of *Plantago lanceolata* within swards containing dry grasses during the final stages of generative development resulted in lower levels of crude protein, crude fiber, phosphorus, calcium and magnesium (Table 3). The negative impact of *Plantago lanceolata* can be traced back to the plants developmental phases. By the time of the first harvest, most of the leaves have dried out and the dominant part of the yield were inflorescences with fully developed seeds. Cutting and agitating the hay resulted in seed spreading and as a consequence, further expansion of the species. As reported by Majda *et al*. [2007], *Plantago lanceolata* is characterised by relatively high survivability due to seed production and the ability to expand in a range of habitats, including ruderal habitats of low agricultural value. Adhering to the agri-environment programme guidelines and cutting meadows after July 1st, would thus result in a low quality sward with negligible nutritional values well below dietary norms [Antoniewicz and Żebrowska 1997].

Table 3. Chemical composition of the sward, g·kg^{-1} (average for 2006-2008)
Tabela 3. Skład chemiczny runi, g·kg^{-1} (średnio w latach 2006-2008)

Percentage share of Udział *Plantago lanceolata*	Crude protein Białko surowe	Crude fiber Włókno surowe	Soluble sugars Cukry rozpuszczalne	Crude ash Popiół surowy	P	K	Ca	Mg
First harvest – Pierwszy pokos								
0%	94.4	283	81.8	47.6	2.60	13.5	6.42	3.02
1-3%	108.9	279	78.7	49.5	2.63	14.0	6.78	3.11
4-10%	73.9	339	83.0	46.9	2.51	13.2	5.40	2.84
11-15%	72.2	340	81.3	46.2	2.50	12.9	5.15	2.78
Second harvest – Drugi pokos								
0%	137.9	269	56.8	57.9	2.90	14.5	6.32	3.04
1-3%	141.7	264	58.7	59.4	2.97	14.8	6.63	3.11
4-10%	176.9	256	41.3	73.9	3.49	15.9	7.33	3.27
11-15%	180.8	254	40.8	72.9	3.51	15.9	7.34	3.30

The quality of the by-product for production of hey or grass silage obtained from the second harvest was significantly higher and met the basic nutritional norms. In this case, the presence of *Plantago lanceolata* as well as the remaining species at earlier developmental stages than those observed in the first cut increased the amount of crude protein, phosphorus, potassium, calcium and magnesium, while slightly lowering the amount of crude fiber and soluble sugars.

The growth and resilience of plants grown on highly mineralized organic soil (class V) was largely dependent on the amount and distribution of rainfall and air temperature. Low water capacity meant that even short periods of drought had an effect on the botanic composition of the sward, limiting the numbers of more demanding species. In the first year of this study, significant rainfall shortages were observed at the beginning of the growing season as well as in August and September (Table 4). During this period, the proportion between the components of the sward on control plots, devoid of *Plantago lanceolata,* were similar for both dominant grass species. The faster growing *Lolium perenne,* reduced the growth rate of *Trifolium repens* and other weeds, mostly dicotyledons (Table 5).

During the first year of pasture utilization *Lolium perenne* was more competitive towards *Plantago lanceolata* than *Dactylis glomerata.* Average percentage of *Plantago lanceolata* in the dry mass yield for *Lolium perenne* mixtures was around 15 and 33% and thus did not reach the anticipated 20 and 40%. The slightly slower development of the less competitive *Dactylis glomerata* did not limit the initial growth of *Plantago lanceolata* which, depending on the mixture, constituted 31 and 41% of the dry mass yield. Rainfall deficiency observed towards the end of 2009 combined with a cold winter and a very dry beginning to the summer resulted in the gradual regression of *Lolium perenne* and only a marginal weakening of *Dactylis glomerata* which, being a taller species providing more shade, became competitive towards both *Plantago lanceolata* and *Trifolium repens.* As a result the percentage of *Plantago lanceolata* in the *Dactylis glomerata* mixture yield decreased by half and reached 13.8% and 23.6%. *Lolium perenne* mixture sward contained more *Plantago lanceolata* as its percentage reached 17.3 and 29.8% of the dry mass yield. The ongoing regression of *Plantago lanceolata* from the sward dominated by the more resilient *Dactylis glomerata* resulted

in it becoming a marginal component of the sward. Its regression was not as severe in *Lolium perenne* mixtures. Considering the levels of both dicotyledon species included in the mixtures, within the three year period of study *Plantago lanceolata* was significantly more abundant than *Trifolium repens.*

Table 4. Weather conditions in years 2009-2011
Tabela 4. Warunki meteorologiczne w latach 2009-2011

Month Miesiąc	Precipitation – Opady, mm				Temperature – Temperatura, °C			
	2009	2010	2011	1996-2008	2009	2010	2011	1996-2008
January – styczeń	14.2	22.0	33.3	27.2	-3.4	-7.8	-0.6	-1.9
February – luty	19.4	20.1	14.5	27.1	-0.8	-2.7	-4.7	-0.6
March – marzec	43.7	28.6	11.7	34.9	2.3	2.4	2.2	1.9
January-March Styczeń – marzec	77.3	70.7	59.5	89.2	-0.6	-2.7	-1.0	-0.2
April – kwiecień	0.4	33.8	13.5	32.1	9.8	7.8	10.5	7.7
May – maj	85.3	92.6	38.4	58.7	12.2	11.5	13.5	13.1
June – czerwiec	57.4	18.1	100.8	46.5	14.5	16.7	17.7	16.3
July – lipiec	118.0	107.4	132.5	80.5	18.6	21.6	17.5	18.3
August – sierpień	17.6	150.7	67.7	66.3	18.2	18.4	17.7	17.8
September – wrzesień	34.4	74.7	37.0	44.9	13.7	12.2	14.3	13.0
April-September Kwiecień – wrzesień	313.1	477.3	389.9	329.0	14.5	14.7	15.2	14.4
October – październik	66.2	2.3	13.2	38.3	7.2	5.5	8.4	8.0
November – listopad	40.4	115.0	9.0	27.9	5.2	4.1	2.7	2.9
December – grudzień	35.4	39.9	46.2	34.0	-1.1	-6.7	2.7	-0.6
October-December Październik – grudzień	142.0	157.2	68.4	100.2	3.8	1.0	4.6	3.4
January-December Styczeń – grudzień	532.4	705.2	517.8	518.4	8.0	6.9	8.5	8.0

Table 5. Sward botanical composition, % (annual average)
Tabela 5. Skład botaniczny runi, % (średnio w roku)

Sward component Komponenty runi	Mixtures – Mieszanki *Dactylis glomerata* (*D*) or *Lolium perenne* (*L*) with – z *Plantago lanceolata* (0, 20, 40%)					
	D + 0	*D* + 20	*D* + 40	*L* + 0	*L* + 20	*L* + 40
2009						
Grasses – Trawy	86.3	55.6	45.3	90.9	73.1	55.3
Plantago lanceolata	0.0	31.4	43.7	0.0	15.3	32.9
Trifolium repens	5.1	4.0	4.3	3.3	4.3	4.9
Other – Inne	8.6	9.0	9.8	5.9	7.2	6.9
2010						
Grasses – Trawy	91.8	80.5	60.5	86.1	75.0	61.4
Plantago lanceolata	0.0	13.8	23.6	0.0	17.3	29.8
Trifolium repens	3.3	2.8	2.3	6.0	4.8	4.4
Other – Inne	4.9	3.6	4.4	7.8	3.0	4.4
2011						
Grasses – Trawy	87.4	86.2	84.7	87.4	86.2	84.7
Plantago lanceolata	0.0	3.4	5.1	0.0	7.7	12.8
Trifolium repens	1.9	1.9	1.7	4.8	3.7	3.5
Other – Inne	10.7	8.5	8.6	19.4	13.1	12.5

One of the factors contributing towards fresh sward uptake by cattle is its dry mass content. Satisfying the nutritional requirement of ruminants is only possible with a sufficient dry mass concentration, which in case of a typical pasture is approx. 150 $g \cdot kg^{-1}$ [Antoniewicz and Żebrowska 1997, Strzetelski *at al*. 1997]. Our results indicate that the concentration of dry mass within the basic components of the sward was lower than this figure (Fig. 1). Grasses contained roughly twice as much dry mass as dicotyledon species. On average, during the first year of grazing, the concentration of dry mass in *Dactylis glomerata* was 17.7 $g \cdot kg^{-1}$ higher than in *Lolium perenne. Plantago lanceolata* contained on average 11 $g \cdot kg^{-1}$ more dry mass than *Trifolium repens* and 8.6 $g \cdot kg^{-1}$ more than other dicotyledon species. These components should be seen as playing a role in increasing the succulence of the fresh sward and limiting the amount of dry mass taken up from the pasture. During hot periods animals prefer succulent swards as these partially cover their need for water. According to Kostuch [2000], water is an important element of pasture management and thus its surplus within the sward might have a beneficial effect on feeding, particularly during periods of high air temperature.

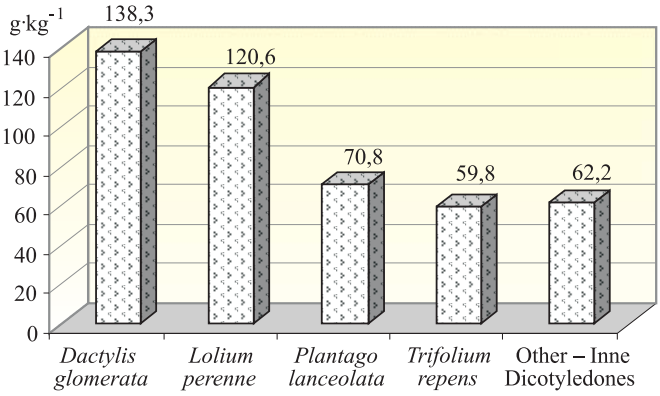

Fig. 1. Average dry mass content in sward components in 2009
Rys. 1. Średnia zawartość suchej masy w komponentach runi w 2009 roku

Green mass yields were largely dependent on the botanical composition and the differences in dry mass composition within the sward. Because of this, mixtures containing *Plantago lanceolata,* especially those containing 40% of the species, provided higher yields over three individual years as well as on average throughout the entire study period (Table 6). During the first two years, the yields were dependent on the development of dominant grass species. The more rapid development of *Lolium perenne* after sowing ensured higher yields from *Lolium perenne* mixtures in 2009. In the following year, higher yields were obtained from mixtures containing *Dactylis glomerata,* a species that is better accustomed to the particular soil conditions and the local rainfall deficiencies. This trend was maintained throughout the third year of grazing.

Table 6. Yield of green pasture, Mg·ha^{-1}
Tabela 6. Plony zielonki pastwiskowej, Mg·ha^{-1}

Mixtures – Mieszanki		Year – Rok			Mean Średnia
		2009	2010	2011	
A1	*D* + 0	82.7	60.6	58.9	67.4
	D + 20	89.8	66.8	57.6	71.4
	D + 40	99.4	74.2	66.5	80.0
	mean – średnia	90.7	67.2	61.0	72.9
A2	*L* + 0	86.3	62.5	53.9	67.6
	L + 20	98.2	62.3	52.8	71.1
	L + 40	97.3	70.7	57.6	75.2
	mean – średnia	94.0	65.1	54.8	71.3
B	*D/L* + 0	84.5	61.6	56.4	67.5
	D/L + 20	94.0	64.5	55.2	71.2
	D/L + 40	98.4	72.4	62.0	77.6
	mean – średnia	92.3	66.2	57.9	72.1
$LSD_{0.05}$ $NIR_{0,05}$	A	2.74	1.05	ns – ni	ns – ni
	B	4.57	5.12	4.82	4.02
	B/A	6.47	ns – ni	ns – ni	ns – ni
	A/B	7.80	ns – ni	ns – ni	ns – ni

ns – ni – non-significant differences – różnice nieistotne, *D – Dactylis glomerata*, *L – Lolium perenne*

The differences in dry mass yield were smaller and statistically insiginficant (Table 7). On average, during the period of study, mixtures containing *Dactylis glomerata* provided yields higher by almost 0.6 Mg·ha^{-1}. Furthermore, these mixtures were characterized by higher resilience and a more even distribution of yield throughout the vegetative season, particularly during periods of rainfall deficiency. One could conclude that the amount of *Plantago lanceolata* within the sward does not significantly affect the dry mass yield. Even at high levels, its low dry mass concentration negates any influence on annual yield.

Table 7. Yield of dry mass, Mg·ha^{-1}
Tabela 7. Plony suchej masy, Mg·ha^{-1}

Mixtures – Mieszanki		Year – Rok			Mean Średnia
		2009	2010	2011	
A1	*D* + 0	10.14	10.08	9.73	9.98
	D + 20	9.69	9.98	9.80	9.82
	D + 40	9.89	10.37	10.56	10.27
	mean – średnia	9.91	10.14	10.03	10.03
A2	*L* + 0	9.52	9.32	9.32	9.39
	L + 20	10.08	9.01	9.01	9.37
	L + 40	9.48	9.71	9.71	9.63
	mean – średnia	9.69	9.35	9.35	9.46
B	*D/L* + 0	9.83	9.70	9.52	9.68
	D/L + 20	9.89	9.50	9.41	9.60
	D/L + 40	9.69	10.04	10.14	9.95
	mean – średnia	9.80	9.75	9.69	9.74
$LSD_{0.05}$ $NIR_{0,05}$	A	ns – ni	0.216	ns	0.492
	B	ns – ni	ns – ni	0.619	ns – ni
	B/A	0.609	ns – ni	ns – ni	ns – ni
	A/B	ns – ni	ns – ni	ns – ni	ns – ni

ns – ni – non-significant differences – różnice nieistotne, *D – Dactylis glomerata*, *L – Lolium perenne*

Chemical composition analysis of the basic grass species and *Plantago lanceolata* has revealed that during the first year of grazing *Plantago lanceolata* had a positive impact on sward quality (Fig. 2). Compared to grasses, it contained more crude ash, crude protein, soluble sugars, calcium and phosphorus while containing less crude fiber. Rumball *et al*. [1997] have pointed out that apart from the numerous dietary benefits, *Plantago lanceolata* also increases the variety of the diet, particularly within regions with little rainfall. Due to cows' high requirement for phosphorus and calcium, *Plantago lanceolata* is a valuable component of the sward, increasing the amount of ingested macro elements. According to INRA norms, in order to produce 1 kg of milk, the cow needs to ingest 3.5 g of calcium and 1.7 g of phosphorus [Strzetelski *et al*. 1997]. The important role of phosphorus in animal feeding has been also brought up by Kostuch [2000] in his meta-analysis of domestic achievements in terms of pasture management. One could thus conclude that the presence of *Plantago lanceolata* within the sward can potentially increase milk cow productivity.

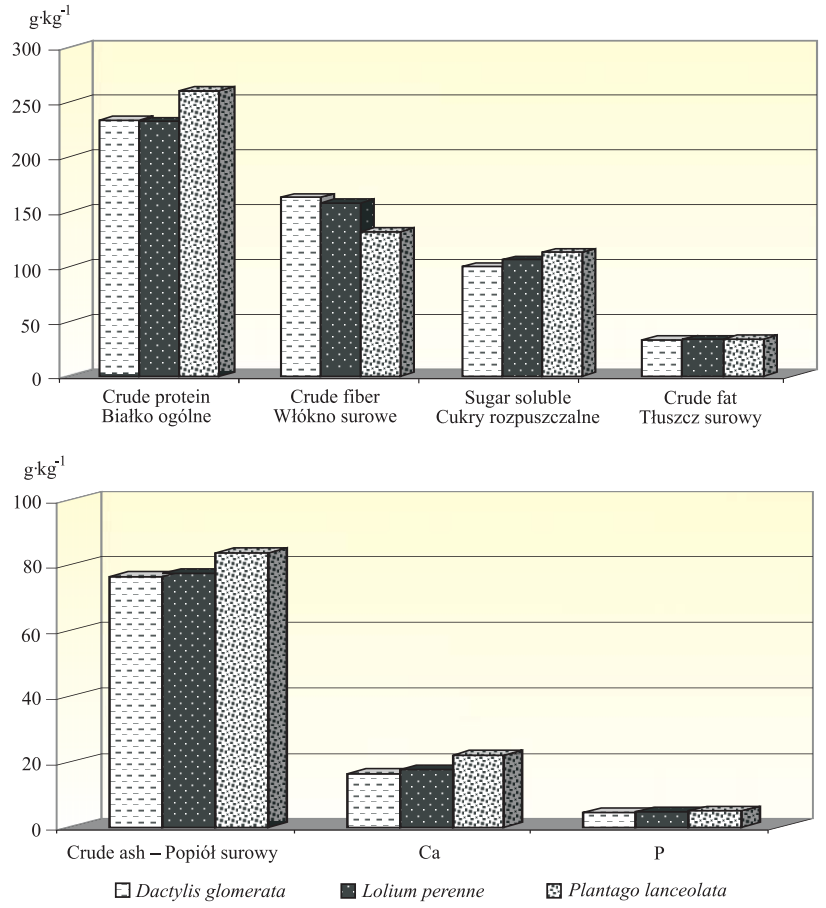

Fig. 2. Comparison of the chemical composition of the basic components of mixtures in 2009
Rys. 2. Porównanie składu chemicznego podstawowych komponentów mieszanek w 2009 roku

CONCLUSIONS

1. On twice harvested meadows utilized according to agri-environment programme guidelines (P01b), presence of *Plantago lanceolata* in amounts exceeding 3% of agricultural yield can be considered as an indicator of negative changes in humidity and tropism, resulting in a reduction in dry mass yields.

2. An increase in *Plantago lanceolata* levels within swards of natural meadows cut late coincided with lower nutritional parameters for sward obtained after the first cut while increasing these parameters for sward obtained after the second cut.

3. The percentage share of *Plantago lanceolata* within renewed pasture swards was largely dependent on the growth rate and the resilience of the primary grass components.

4. The percentage share of *Plantago lanceolata* within the pasture sward was higher than that observed for *Trifolium repens*, which was sown in similar amounts

5. The dry mass yield from grass-legume mixtures and mixtures containing *Plantago lanceolata* were similar.

6. Under conditions of limited humidity, mixtures containing *Dactylis glomerata* provided slightly higher yields.

7. When compared to the two basic grass components, *Plantago lanceolata* contained less crude fiber, more soluble sugars, phosphorus and calcium.

8. *Plantago lanceolata* can be an additional component of grass-legume mixtures, particularly on areas exposed to seasonal drying.

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Plantago lanceolata L. JAKO KOMPONENT TRWAŁYCH I ODNAWIALNYCH UŻYTKÓW ZIELONYCH

Streszczenie. *Plantago lanceolata* jest jedną z najwartościowszych i powszechnie występujących na łąkach i pastwiskach roślin dwuliściennych, zaliczanych do ziół pastewnych. Celem badań było porównanie wpływu *Plantago lanceolata* na parametry plonu i jakości runi półnaturalnych łąk dwukośnych użytkowanych według zasad programu rolnośrodowiskowego (pakiet P10b) oraz pastwisk założonych z wykorzystaniem mieszanek z jej udziałem. Na badanych łąkach udział *Plantago lanceolata* przekraczający 3% plonu rolniczego można uznać za wskaźnik niekorzystnych zmian wilgotnościowych i troficznych, wpływających na obniżkę plonów suchej masy oraz pogorszenie jakości runi pierwszego odrostu. Tymczasem plony pastwisk z udziałem *Plantago lanceolata* były prawie czterokrotnie większe, a pobierana przez krowy babka lancetowata zawierała więcej białka, cukrów i substancji popielnych, w tym wapnia i fosforu, oraz mniej włókna niż *Dactylis glomerata* i *Lolium perenne.* Babka lancetowata okazała się również gatunkiem występującym w większych ilościach niż wysiana w mieszankach *Trifolium repens*.

Słowa kluczowe: babka lancetowata, jakość runi, łąki naturalne, pastwiska, plon, skład botaniczny

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