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THE EFFECT OF PERMANENT GRASSLAND SWARD ENRICHMENT WITH SPECIAL VARIETIES OF GRASSES AND LEGUMES ON THE QUALITY OF PRODUCED BULK FODDER

Summary

Floristic composition of grasslands is one of the basic indices determining the nutritive value of the sward. It may, however, become simplified or degraded. Direct undersowing may often be sufficient to enrich impoverished sward with special varieties of grasses and legumes. The aim of this study was to assess the effect of meadow sward enrichment through direct undersowing with grass and legume varieties of high nutritive value on the quality of obtained fodder a year after treatment. Static experiment was set up on a meadow of simplified floristic composition in Żuławy Elbląskie situated on alluvial soil. Two weeks before undersowing, weeding was performed by spraying Fernando 225 EC herbicide at a rate of 3 l·ha^{-1}. The meadow was undersown in the end of September 2012. The assessment of nutritive value of so obtained sward with the RFV index showed that the decisive factors a year after treatment were: application of di- and tetraploid varieties of Lolium perenne and Festulolium brauni and the frequency of mowing. Higher nutritive value was obtained after undersowing with a mixture of seeds with 35% contribution of di- and tetraploid varieties and mowing four times a season. Despite lower dry mass yields per hectare, significantly higher potential milk production was obtained.
***Key words**: grasslands, undersowing, fodder quality from grasslands*

WPŁYW WZBOGACANIA RUNI TRWAŁYCH UŻYTKÓW ZIELONYCH SPECJALISTYCZNYMI ODMIANAMI TRAW I MOTYLKOWATYCH NA JAKOŚĆ PRODUKOWANEJ PASZY OBJĘTOŚCIOWEJ

Streszczenie

Skład florystyczny użytków zielonych jest jednym z podstawowych wskaźników określających wartość pokarmową runi, lecz może podlegać upraszczaniu bądź – degradacji. Często wystarczającym zabiegiem, dzięki któremu zubożałą ruń można wzbogacić w komponenty specjalistycznych odmian traw i motylkowatych (bobowatych), może być podsiew bezpośredni. Celem pracy jest wstępna ocena wpływu wzbogacenia runi łąkowej przez podsiew bezpośredni odmianami traw i motylkowatych o wysokiej wartości pastewnej na jakość uzyskanej paszy rok po dokonaniu zabiegu. Doświadczenie statyczne założono na łące o uproszczonym składzie florystycznym w warunkach Żuław Elbląskich, położonej na glebie aluwialnej. Dwa tygodnie przed wykonaniem podsiewu zastosowano oprysk odchwaszczający preparatem FERNANDO 225 EC w dawce 3 l·ha^{-1}. Podsiew wykonano w trzeciej dekadzie września 2012 roku. Ocena wartości pokarmowej paszy z runi podsianej specjalistycznymi mieszankami przy pomocy wskaźnika RFV wykazała, że decydującymi czynnikiem w pierwszym roku po podsiewie były: stosowane do podsiewu odmiany diplo- i tetraploidalne Lolium perenne i Festulolium brauni, oraz częstotliwość koszenia podsianej runi. Wyższa wartość pokarmową paszy uzyskano po zastosowaniu do podsiewu mieszanki nasion, w której komponentami były odmiany diplo- i tetraploidalne Lolium perenne i Festulolium brauni, stanowiące łącznie 35% udziału oraz przy 4. kośnym użytkowaniu. Mimo niższych plonów suchej masy z ha, uzyskano istotnie wyższą potencjalną produkcję mleka.
***Słowa kluczowe**: użytki zielone, podsiew, jakość paszy z użytków zielonych*

1. Introduction

Floristic composition of grasslands is one of the basic indices that determine nutritive value of the sward. At climatic conditions close to the optimum, it is possible to maintain species composition desirable in respect to the quality of produced fodder. However, various unfavourable natural conditions or errors made by the user may easily result in simplification of floristic composition and even in the degradation of meadows and pastures. Then, it is necessary to improve the sward. After application of selective herbicides, primary sward does not often need radical renovation methods. Direct undersowing, thanks to which the impoverished sward is enriched in components of special grass and legume varieties adapted to habitat conditions and local management, may be sufficient [1]. Market competition forces farmers to produce valuable fodder at the lowest cost [2]. Recent technological progress has made direct undersowing an easily available method of the enrichment of grassland sward with the newest, intensive varieties of grasses and legumes. Therefore, the procedure should not be classified as a method of grassland renovation on mineral soils [1, 8]. In the future, it should rather be treated as a nursing treatment repeated regularly every 2-3 years.

The aim of this study was to preliminary assess the effect of meadow sward enrichment through direct undersowing with grass and legume varieties of a high nutritive values on the quality of obtained fodder a year after treatment.

2. Material and methods

The study started in 2012 in Helenowo (Żuławy Elbląskie) on alluvial soil. The experiment was set up on a meadow of simplified floristic composition with the random block method in four replicates according to the scheme presented in table 1. The sward before undersowing was dominated by *Dactylis glomerata* L. and *Phleum pratensis*

L. with a small contribution of *Festuca pratensis* (Huds), *Elymus repens* L. and *Poa pratensis* L. Meadow coverage by grasses was 65-70%, by dicotyledons – 30-35% and legumes were present in trace amounts. The meadow was sprayed with the herbicidal preparation Fernando 225 EC at a dose of 3 l·ha^{-1} two weeks before undersowing which was performed in the end of September 2012.

Mineral fertilisation was applied in 2013. Phosphorus was applied once with 40 kg·ha^{-1} in spring and potassium fertilisation (100 kg·ha^{-1}) was divided into two equal doses in spring and in the middle of the growing season. Nitrogen doses were differentiated into 30 kg·ha^{-1} under regrowth and 40 kg·ha^{-1} under regrowth (N1 and N2, respectively). Experimental scheme is presented in table 1.

Table 1. Scheme of the experiment set up in 2012 on permanent meadow in Helenowo
Tab. 1. Schemat doświadczenia założonego w 2012 roku na łące trwałej w Helenowie

Object	Composition of seed mixtures	Number of cuts	Fertilisation
1	*Festulolium*, white clover, red clover	4	N1PK
2	Hybrid ryegrass, white clover	4	N1PK
3	Hybrid ryegrass, *Festulolium*, red clover	3	N2PK
4	*Festulolium*, white clover, alsike clover, hybrid ryegrass	3	N2PK
5 control	natural sward (old)	3	N2PK
6 control	natural sward (old)	4	N1PK

Source: own study / Źródło: opracowanie własne

The components of applied mixtures were short-lived tetraploid varieties of the perennial ryegrass (*Lolium perenne*), Italian ryegrass *(Lolium multiflorum*), hybrid ryegrass (*Lolium* x *bouchenanum* Kunth) and intergeneric hybrid *Festulolium braunii* (Richt.). Legumes were represented by the Giganteum form of the white clover (*Trifolium repens* L.) and tetraploid variety of the red clover (*Trifolium pratense*). These species and varieties were used to prepare two mixtures of grasses and legumes to undersow fourfold mown plots and two mixtures for plots mown three times. Two control objects were overgrown by old meadow sward of simplified floristic composition dominated by the cocksfoot and timothy grass (table 1).

The meadow is situated 0.40 m below sea level on very heavy shallow alluvial soil underlined by loose sand (8F bc·pl). Soil characteristics are presented in table 2.
Available forms of phosphorus and potassium in soil were determined with the Egner-Riehm method, magnesium – with the AAS spectrophotometry acc. to Schachtschabel. Floristic composition was analysed with botanical-gravimetric method and sward utility value (Lwu) was estimated with the method of Filipek [3].

Plant material sampled from each plot and each cut was used to determine dry mass and then – total protein, crude fibre and its fractions (NDF and ADF), ash, carbohydrates and crude fat with the NIRS method using NIRFlex N-500 apparatus and ready calibrations of the INGOT® firm. Obtained results were used to assess the quality of fodder from sward enriched with special grass and legume varieties. The assessment was performed with the Linn and Martin test [4]. Classifying parameter was the relative feed value (RFV) calculated from the equation:

$$RFV = (DDM \cdot DMI) : 1.29 \quad (1)$$

where: RFV - relative feed value (dimensionless)
DDM - dry mass digestibility calculated from:

$$DDM = (88.9 - 0.779) \cdot ADF\ [\%] \quad (2)$$

DMI - dry mass intake calculated from:

$$DMI = 120 : NDF\ [\%]. \quad (3)$$

Meteorological conditions

Meteorological conditions in 2012 (undersowing was performed in September of this year) and in 2013 (first year of the study) are presented in table 3.

Monthly means of temperature and sums of atmospheric precipitation in the vegetation season were compared with mean values from the long-term period. Selianinov's hydrothermal coefficient [5] was used for detailed assessment of thermal and precipitation conditions:

$$k = \frac{P \cdot 10}{\sum t} \quad (4)$$

where: P - monthly sum of atmospheric precipitation [mm]
Σt - sum of daily mean air temperatures > 0^0C

Moisture characteristics for the vegetation season was estimated acc. to Skonera and Puła [6] and presented in table 4.

Table 2. Physical and chemical soil characteristic of experimental meadow in Helenowo
Tab. 2. Charakterystyka fizykochemiczna gleby na doświadczeniu w Helenowie

Depth [cm]	Bulk density [g·cm^{-3}]	pH 1 N KCl	Concentration of available components [mg·kg^{-1} soil dry mass]		
			P	K	Mg
0-20	1.295 (block A and B)	4.88	42	411	50
	1.269 (block C and D)	5.29	31	327	52
21-40	1.315 (block A and B)	5.36	45	206	52
	1.307 (block C and D)	5.32	39	243	48
41-60	1.307 (block A and B)	6.31	43	111	17
	1.378 (block C and D)	6.33	23	79	21

Source: own study / Źródło: opracowanie własne

Table 3. Meteorological conditions (monthly mean temperatures and sums of precipitation) in the study period
Tab. 3. Warunki meteorologiczne (średnie dobowe wartości temperatury i sumy opadów) w okresie prowadzenia badań

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec	Mean/sum	
Year													Apr.-Sep.	Year
Temperature [°C]														
2012**	-0.8	-6.1	4.2	8.3	14.1	15.7	19.2	18.5	14.4	8.5			15.0	
2013**	-3.5	-0.1	-1.5	7.1	15.6	18.0	18.7	18.9	13.0	10.2			15.2	
1971-1995*	-1.9	-1.6	1.8	6.2	11.9	15.0	17.0	16.7	12.6	8.1	3.0	0.0	13.2	7.4
Precipitation [mm]														
2012**	59.8	31.8	22.2	33.0	18.4	82.6	88.2	38.1	27.9	37.6			288.2	
2013**	33.5	14.9	7.5	26.8	40.9	37.8	95.2	34.1	14.7	39.2			249.5	
1971-1995*	17.3	12.7	16.6	22.6	40.4	67.6	66.7	71.5	70.1	47.9	38.5	25.8	338.9	484.6

Source: own study based on:/ Źródło: opracowanie własne na podstawie:
** - data from the Sea Branch of Institute for Meteorology and Water Management in Gdynia;*
*** - data from meteorological station of Żuławy Branch of the Institute of Technology and Life Sciences in Helenowo near Elbląg*

Table 4. Thermal and moisture conditions in Helenowo during vegetation seasons 2012 and 2013
Tab. 4. Warunki pluwiotermiczne w okresie wegetacji w 2012 i 2013 roku w Helenowie

Month	April	May	June	July	August	September	October
2012							
Sielianinov's coefficient	1.32	0.42	1.75	1.48	0.66	0.64	1.42
Moisture characteristic	optimum	very dry	fairly wet	optimum	very dry	very dry	optimum
2013							
Sielianinov's coefficient	1.26	0.85	0.70	1.64	0.58	0.38	1.25
Moisture characteristic	fairly dry	dry	very dry	fairly wet	very dry	extremely dry	fairly dry

Source: own study / Źródło: opracowanie własne

Thermal and moisture conditions were not favourable for sprouting and further growth of grass and legume seeds introduced through undersowing. There was nearly two-month long drought preceding the undersowing performed in September 2012. Nevertheless, sprouting of sown plants was observed in the end of October because pluviometric conditions in this time were optimum (table 4). Next year was unfavourable for the growth and development of sward, particularly for undersown legume components.

Assessment of the feed value of the sward

Feed value was estimated as a potential amount of milk obtained from fodder harvested from 1 ha of meadow. Calculations were based on NEL and on the assumption that if 1 kg of dry feed mass contains 3.17 MJ-NEL, the amount of energy will suffice to produce 1 kg of milk of 4% fat content [7].

3. Results and discussion

Herbicide spraying with selective preparation Fernando 250 EC made in the beginning of September eliminated dicotyledons which contributed in 30-35% to the sward. Resulting gaps in the sward were filled with undersown grass and legume mixtures. Due to unfavourable meteorological conditions in August and September 2012 and in the whole vegetation season 2013 (table 4), undersown legumes did not appear (table 5). Very high utility value (Lwu) [3] was noted, however, of the sward in all study objects.

Assessment of the changes in nutritive quality of fodder from enriched sward with the RFV index showed that, apart from applied special grass varieties, the frequency of mowing was a decisive factor. Linn and Martin's test [4] demonstrated that the fourfold mown sward may provide fodder suitable for feeding highly milking cows (RFV>151). Lower values of RFV were found in only few cases. At threefold mowing, the value of RFV for fodder from the 1st and 2nd cut varied between 125 and 151. Therefore, the quality of this fodder was appropriate for cows of moderate milking efficiency and for young heifers. Fodder of the highest RFV value at threefold mowing was obtained only from the 3rd cut. There was no difference in the RFV index between undersown and control sward at both three- and fourfold mowing.

Table 5. Contribution of plant groups to the sward and its utility value after direct undersowing
Tab. 5. Udział grup roślin w runi oraz jej wartość użytkowa po podsiewie bezpośrednim

Plant group	Objects – contribution to the sward [%]				
	1	2	3	4	5 and 6
Grasses	94	96	89	99	98.5
Legumes	0	0	0	0	0
Dicotyledons	6	4	11	1	1.5
Lwu	***8.79***	***8.92***	***8.75***	***9.17***	***9.00***

Source: own study / Źródło: opracowanie własne

Undersowing significantly improved yielding but the yields from sward mown four times a season were smaller compared with those mown three times. Potential milk production calculated per fodder from 1 ha depended on applied seed mixture and on the frequency of mowing. Higher nutritive value of fodder obtained from fourfold mowing

gave significantly higher potential milk (4% fat content) production despite smaller dry mass yields per ha. Notably favourable was a mixture with 35% combined share of di- and tetraploid *Lolium perenne* and *Festulolium brauni* varieties.

It was found that, apart from appropriate selection of intensive grass species suitable for direct undersowing, the quality of fodder depended also on the frequency of mowing – a factor often neglected in the assessment of fodder quality.

Now, due to easily available technical possibilities of enriching the sward with most valuable grass and legume varieties, such a treatment may be applied every 2-3 years. One of the main reasons of grassland sward degradation in Żuławy is a decreased intensity of utilisation and systematic drying of habitats resulting from intensive drainage [8]. Hence, regular enrichment of sward through direct undersowing of the newest intensive varieties of grass and legume species and their hybrids together with fourfold mowing should markedly improve the quality of produced bulk fodder for ruminants.

4. Conclusions

1. Despite unfavourable meteorological conditions, preliminary results indicate positive effect of direct undersowing on yielding and the quality of produced fodder.
2. A great usefulness was demonstrated of intensive, short-lived di- and tetraploid varieties of the perennial ryegrass (*Lolium perenne*) and *Festulolium brauni* for the enrichment of meadow sward through direct undersowing after herbicide spraying.
3. Positive effect of undersowing was observed already a year after treatment.

5. References

[1] Kozłowski S.: Czynniki warunkujące podsiew użytków zielonych – roślina. W: Łąkarstwo w Polsce [Eactors affecting undersowing grasslands – plant. In: Grassland Science in Poland] 1998, Nr 1, 31-44.

[2] Mikołajczak Z: Czynniki warunkujące podsiew użytków zielonych – agrotechnika. W: Łąkarstwo w Polsce [Factors affecting undersowing grasslands – agri-technique. In: Grassland Science in Poland] 1998, Nr 1, 53-64.

[3] Filipek J.: Projekt klasyfikacji roślin łąkowych i pastwiskowych na podstawie liczb wartości użytkowej. [Classification of meadow and pasture plants based on the numbers of utility value] Post. Nauk Roln., 1973, z. 4, 51-68.

[4] Linn J.G., Martin N.P.: Forage quality test and interpretation. Univ. Minnesota 1989, 385-393.

[5] Bac S., Koźmiński C., Rojek M: Agrometeorologia. [Agrimeteorology] PWN Warszawa 1993, 32-33.

[6] Skonera B., Puła J.: Skrajne warunki pluwiotermiczne w okresie wiosennym na obszarze Polski w latach 1971-2000. [Extreme pluviometric conditions in spring seasons 1971-2000 in Poland] Acta Agrophysica 2004, 3 (1) Lublin, 171-177.

[7] DLG – tabele wartości pokarmowej pasz i normy żywienia przeżuwaczy. [DLG – tables of nutritive values of fodder and feeding norms for ruminants] Uniwersytet Hohenheim przy współpracy z Komisją do Spraw Norm Towarzystwa Fizjologii Zwierząt. Wydawn.: Przedsiębiorstwo Produkcyjno.-Handlowe VIT-TRA PL-86-022. Kusowo 1997, 13-19. ISBN 83-910414-2-5

[8] Szwoch R., Terlikowski J., Szweda S., Terlikowska K: Zalecenia w zakresie gospodarki na użytkach zielonych na Żuławach. [Recommendations for grassland management in Żuławy] Mat. Inst.. nr 110. Wydawn. IMUZ Falenty 1995.