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# Pattern of grassland sward yielding when abandoned or grazed by small ruminants in Kłodzko Valley

Charakterystyka plonowania runi odłogowanej i wypasanej małymi przeżuwaczami w warunkach Kotliny Kłodzkiej

**Summary.** Research was performed on grassland in Kłodzko Valley of the Sudety Mountains on the altitude of 550 m. A paddock of 2.4 ha was fenced on natural grassland which had been fallow for more than 10 years and small ruminants grazed it for 3 years on an all day basis – the stocking rate was from 0.42 LU (spring season) to 0.75 LU (summer-autumn season) where sheep to llamas ratio was as 3 to 1. No fertilizer application was performed. The yielding of grazed and fallow swards were compared in the 4-th year. Data were collected from 9 test plots on the grazed pasture and 9 plots on the fallow grassland. The height of the sward, its yield and basic chemical composition was evaluated 4 times during the growing season, starting in April and ending at the beginning of October. Grazed pasture yielded for the entire growing season 4.4 t of DM while fallow grassland 5.9 t of DM per ha. Daily production of DM per ha till the end of April, May – June, June-July and August-September periods for grazed pasture were as follows: 11, 35, 24 and 18 kg of DM while for fallows grassland: 25, 51, 29 and 17 kg DM. Despite a similar pattern of DM yielding during the vegetation season DM yield per 1 cm of sward height was the effect of grazing. The yield of DM per 1 cm of sward height was lower till the end of April, in June-July periods respectively by: 19 and 33% on the grazed pasture when compared to the fallow while in August-September it was higher by 99%.

**Key words:** pasture, fallow pasture, yield of dry matter, small ruminants

## INTRODUCTION

The problem of fallow of grasslands has the particular importance in the case of the mountain region, where because of the low abundance of soil in nutrients and a relatively harsh climate, are specific species of plants [Kasperczyk and Szewczyk 1999]. These conditions, together with the improper management of meadows, especially in abandonment by mowing, grazing and fertilization, favour the degradation of sward.

Historically, negative changes of meadow ecosystems were resulted primarily by too intensive use, supplemented by high fertilization or organic soil drainage. After 1990 the situation has changed and now the greatest threat for these ecosystems is the lack of rational human action, particularly the cessation of their use, which leads to a transformation of the species composition of grasslands [Dradrach *et al*. 2007, Kryszak 2001, Rogalski 2001]. The objective of the studies were to analyze the sward yielding after three years of grazing use compared to abandoned sward.

## MATERIAL AND METHODS

Tests were carried out on the mountain pasture in Sudety Mountain in the Kłodzko Valley at the average height of 550 m above sea level. The land with an area of 2.4 ha of grassland, abandoned for more than 10 years, was grazed for 3 years by sheep with lambs (2/3 of density) and lamas (1/3 of density) in the 24-hour system – the density of pastures ranged from 0.42 LU (the spring) to 0.75 LU $ha^{-1}$ (the autumn). No mineral fertilization for grassland was applied. In the fourth year (2008), after three years of grazing use, sward yielding when abandoned or grazed by animals was compared. For this purpose, three locations, which differ with position and habitat conditions, were set. In each of these locations 3 plots were demarcated, with dimensions of 1.0 × 0.5 m. of land for pasture and for fallow. In the intervals of about 1.5 months, starting from the end of April and ending in the beginning of October (27 IV, 21 VI, VIII, 3, 5 X), the assess of sward productivity was done using the herbometer of pressure per unit of 8.2 grams per $dcm^2$ of sward. Then plots were mown to determine the yield and the basic chemical composition of sward. In the collected material, the dry matter and basic chemical composition: crude ash, crude protein, crude fiber and carbohydrates (nitrogen free extracts) were determined. The basic chemical composition of the pasture herbage was determined by standard analytical methods: Kjejdahl method for nitrogen content and calculating crude fibre as N × 6.25, Soxchlet method for crude fat, Henneberg-Stohmann method for crude fibre content, crude ash content by weighing when drying at 110$^o$ C and incinerating at 600$^o$C. Nitrogen-free content was calculated – subtracting all determined basic components (ash, fat, protein, fibre) from dry matter content (as 100%). In these studies the botanical-weight method was used and it allowed to specify the botanical composition of sward in the successive stages of the vegetation. The obtained results were basis for calculating the yield of dry matter per 1 ha, the yield per 1 cm of sward height and daily yield of dry matter per 1 ha. For the statistical analysis of the obtained results, double-factor analisis of variation with interaction was used, taking into account the effect of position and the growing season (package Statistica v. 7.1).

## RESULTS AND DISCUSSION

After three years of separation of grassland to pasture and fallow (Tab. 1) the botanical composition of sward was diversified. The biggest differences in the species composition of both compared swards occurred in June – in the sward of fallow it was observed the lack of 8 species of plants found in pastures, and vice versa the lack of

4 species in pasture. In comparison to the entire growing season, the participation of grasses in the yield, the dry matter yield per 1 ha, the yield per 1 cm of sward height and daily yield of dry matter per 1 ha did not differ significantly pasture from fallow land (Tab. 2). The yield of dry matter for the whole growing period was 4.4 t $ha^{-1}$ to pastures, while 5.9 t $ha^{-1}$ to the fallow land. The lower yielding of pastures may result from the impoverishment of location, as a result of collection of organic matter by animals and the lack of compensation of the nutrients losses by animal faeces and urine because of the low density of pasture. The obtained amounts of yield of mountain grassland for the whole growing period can be regarded as satisfactory. A similar results can be found in the works of Nadolna [1998] and Nowakowski *et al*. [2000].

Table 1. General characteristics of sward during vegetation season
Tabela 1. Ogólna charakterystyka runi w sezonie wegetacyjnym

| Item<br>Wyszczególnienie | Month<br>Miesiąc | Pasture<br>Pastwisko | Fallow<br>Odłóg |
|---|---|---|---|
| Number of plant species (grass species only)<br>Liczba gatunków roślin (w tym traw) | June – czerwiec | 39 (9) | 35 (12) |
| | August – sierpień | 34 (7) | 35 (9) |
| | October – październik | 32 (8) | 33 (8) |
| Number of plant species missing in the neighbour sward<br>Liczba gatunków niewystępujących w pokosie runi sąsiedniej | June – czerwiec | 4 | 8 |
| | August – sierpień | 4 | 3 |
| | October – październik | 5 | 4 |

The period of the vegetation has a significant and statistically confirmed effect on the evaluated parameters of sward. The largest participation of grasses in the yield was found in the periods: the beginning of the season (until the end of April – 65.0%) and the end of the season (from August to October – 44.9%), while the highest yield of dry matter as well as the daily increase and the high of sward were obtained during May and June (Tab. 2).

Although no significant differences of yielding between pastures and fallow, it was observed trends which differentiate them. The fallow in relation to the pasture is characterized by a clearly higher yield of dry matter during the growing season from the beginning of growing season to August, while yielding in the later period, from the beginning of October, was at the similar level.

In the studies a lower height of pasture sward was observed in comparision to the hight of sward on fallow. This change was a result of differences in the botanical composition of both parts of grasslands, where in the part grazed by animals occurred as a result of grazing by animals in the previous growing seasons. The height of fallow sward was always slightly bigger than grazed sward. It was observed the higher yielding of dry matter per 1 cm of sward height in the second part of the growing season. Despite the lack of animals on pasture in the fourth year of studies at the experimental plots, the yield distribution per 1 cm of sward height was an effect of animal grazing in the three years preceding the research (Tab. 2). The yield of dry matter per 1 cm of sward height from the pasture was 19% lower by the end of April and 33% lower in June–July period,

but 99% higher during August–October period in relation to fallow area. The daily yield of dry matter of sward to the end of April, during May – June, June – July and August–September period for pasture was respectively 11, 35, 24 and 18 kg ha$^{-1}$. The daily yield, in confrontation with the standards of the demand for dry matter of feed [INRA 1993], can be regarded as sufficient for the proper functioning of the animals staying in this area, with the density of pastures from 0.42 LU to 0.75 LU ha$^{-1}$. For comparison, in the lowland in the Valley of Warta, where stocking density is maintained at the level of 0,44–1,2 SD ha$^{-1}$, the daily yields of sward ranged from 66,2 ±33,4 kg ha$^{-1}$ for reed canarygrass to 66,2 ±33,4 kg ha$^{-1}$ for creeping bentgrass [Nowakowski *et al*. 2008].

Table 2. Charakterystyka plonowania pastwiska i odłogu
Tabela 2. Characteristics of grazed pasture vs fallow pasture

| Item<br>Wyszczególnienie | n | Grass share in herbage<br>Udział traw w plonie (%) | | DM yield<br>Plon s.m. (t ha$^{-1}$) | | Sward height at the end of the period<br>Wysokość runi na końcu okresu (cm) | | DM yield per 1 cm of sward height<br>Plon s.m. na cm wys. runi (t cm$^{-1}$ ha$^{-1}$) | | DM daily yield<br>Dobowy przyrost s.m. (kg d$^{-1}$ ha$^{-1}$) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | mean | SD | mean | SD | mean | SD | mean | SD | mean | SD |
| Pasture – Pastwisko | | | | | | | | | | | |
| IV | 3 | 63.2 | 4.59 | 0.325 | 0.109 | 1.7 | 0.58 | 0.215 | 0.102 | 10.8 | 3.6 |
| V–VI | 3 | 38.3 | 14.48 | 1.944 | 0.787 | 22.3 | 4.62 | 0.084 | 0.020 | 35.4 | 14.3 |
| VI–VII | 3 | 29.0 | 17.30 | 1.013 | 0.467 | 6.3 | 2.52 | 0.157 | 0.039 | 23.5 | 10.9 |
| VIII–X | 3 | 47.7 | 5.67 | 1.132 | 0.296 | 4.0 | 2.65 | 0.438 | 0.360 | 18.0 | 4.7 |
| Pasture totally<br>Ogółem pastwisko | 12 | 44.6 | 16.61 | 4.414 | 1.580 | 8.6 | 8.84 | 0.224 | 0.212 | 21.9 | 12.4 |
| Fallow – Odłóg | | | | | | | | | | | |
| IV | 3 | 66.82 | 10.99 | 0.754 | 0.094 | 3.2 | 1.04 | 0.265 | 0.124 | 25.1 | 3.1 |
| V–VI | 3 | 27.7 | 10.03 | 2.779 | 1.347 | 28.3 | 10.26 | 0.125 | 0.110 | 50.5 | 24.5 |
| VI–VII | 3 | 31.1 | 10.13 | 1.258 | 0.461 | 8.3 | 2.52 | 0.149 | 0.018 | 29.3 | 10.7 |
| VIII–X | 3 | 42.1 | 18.90 | 1.093 | 0.319 | 5.5 | 3.04 | 0.220 | 0.078 | 17.4 | 5.1 |
| Fallow totally<br>Ogółem odłóg | 12 | 41.9 | 19.49 | 5.884 | 2.167 | 11.3 | 11.44 | 0.190 | 0.098 | 30.6 | 17.4 |
| Pasture and fallow – Pastwisko i odłóg | | | | | | | | | | | |
| IV | 6 | $65.0^{ABC}$ | 7.79 | $0.540^{A}$ | 0.252 | $2.4^{A}$ | 1.11 | 0.240 | 0.106 | $18.0^{A}$ | 8.4 |
| V–VI | 6 | $33.0^{A}$ | 12.56 | $2.362^{ABC}$ | 1.088 | $25.3^{ABC}$ | 7.84 | 0.104 | 0.074 | $43.0^{ABa}$ | 19.8 |
| VI–VII | 6 | $30.1^{BD}$ | 12.73 | $1.136^{B}$ | 0.436 | $7.3^{B}$ | 2.50 | 0.153 | 0.028 | $26.4^{a}$ | 10.2 |
| VIII– X | 6 | $44.9^{CD}$ | 12.85 | $1.112^{C}$ | 0.276 | $4.8^{C}$ | 2.68 | 0.329 | 0.262 | $17.7^{B}$ | 4.4 |

Means denoted with the same letter differ: capitals at $p \leq 0.01$, small letters $p \leq 0.05$
Wartości średnie oznaczone tymi samymi literami różnią się istotnie: duże litery $p \leq 0,01$, małe litery $p \leq 0,05$

The nutrition value of sward from assessed parts of the grassland, determined by its basic chemical composition, was very similar throughout the entire growing season (Tab. 3) – both fallow and grazed sward contained 12–13% of protein in dry matter. This

is slightly above the level recommended by Preś and Rogalski [1997], who report that the protein content of dry matter for feed for ruminants, determinating a proper conduct of digestion in the rumen, should not be less than 10–12%. At the low concentrations of protein in sward, the low density of animals increases the possibility of the selective collection of feed and allows for the collection of sufficient quantities of nutrients.

Table 3. Basic chemical composition of sward DM (%) (mean ± SD)
Tabela 3. Podstawowy skład chemiczny suchej masy runi (%) (wartość średnia ± SD)

| Month of harvest Miesiąc zbioru | Grassland Użytek zielony | Crude ash Popiół surowy (%) | Crude protein Białko surowe (%) | Crude fibre Włókno surowe (%) | Carbohydrates Węglowodany (%) |
|---|---|---|---|---|---|
| June Czerwiec | pasture pastwisko | 7.50 ± 0.34 | 12.60 ± 0.70 | 27.69 ± 0.96 | 49.83 ± 2.49 |
| | fallow odłóg | 8.19 ± 0.28 | 13.98 ± 0.06 | 27.89 ± 0.54 | 47.60 ± 1.71 |
| August Sierpień | pasture pastwisko | 9.68 ± 0.13 | 13.07 ± 0.21 | 24.45 ± 0.36 | 50.55 ± 1.66 |
| | fallow odłóg | 8.96 ± 0.07 | 13.80 ± 0.18 | 26.23 ± 0.28 | 48.77 ± 2.44 |
| October Październik | pasture pastwisko | 18.63 ± 0.24 | 12.05 ± 0.01 | 21.87 ± 0.36 | 45.12 ± 1.80 |
| | fallow odłóg | 8.16 ± 0.23 | 11.35 ± 0.17 | 29.96 ± 0.09 | 48.58 ± 1.39 |

The pasture sward at the end of the growing season (October) was characterized by more than twice higher levels of crude ash in relation to fallow sward and to sward in the other periods. Such a high level of crude ash in the dry matter of sward was an effect of generally low height of sward and probably arousing the dust by grazed animals in the vicinity of experimental plots.

Summarizing the results of studies it can be brought about the fairly rapid change in yielding as a result of grazing on mountain grasslands. The observed yielding values were obtained without the application of mineral fertilization and were only a result of weather and habitat, including grazing. The three-year-long grazing of animals at the grassland, in contrast to the fallow area, caused the changes in the ability of sward yielding, particularly in the seasonal distribution, and also changes in the botanical composition and heigh of sward.

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**Streszczenie.** Badania zostały wykonane na pastwisku górskim w Sudetach, w Kotlinie Kłodzkiej, na średniej wysokości 550 m n.p.m. Teren o powierzchni 2,4 ha, wygrodzony z trwałego użytku zielonego (UZ) odłogowanego przez ponad 10 lat, był przez 3 lata wypasany małymi przeżuwaczami w systemie całodobowym – obsada pastwiska wynosiła od 0,42 SD (okres wiosenny) do 0,75 SD · $ha^{-1}$ (okres letnio-jesienny) w proporcji owiec do lam jak 3 : 1. Na UZ nie stosowano żadnego nawożenia mineralnego. Po trzech latach użytkowania pastwiskowego porównano plonowanie runi z terenem UZ odłogowanym. Ogółem dane o charakterystyce runi zebrano z 9 poletek pastwiska i 9 z terenu odłogowanego. Poczynając od kwietnia i kończąc na początku października, dokonywano oceny wysadności runi oraz określano plon i podstawowy skład chemiczny. Plon za cały okres wegetacyjny wyniósł dla pastwiska 4,4 t · $ha^{-1}$, natomiast dla odłogu 5,9 t suchej masy. Dobowy przyrost suchej masy runi do końca kwietnia, w okresie maj–czerwiec, czerwiec–lipiec oraz sierpień–wrzesień dla pastwiska wyniósł odpowiednio: 11, 35, 24 i 18 kg · $ha^{-1}$, natomiast dla terenu odłogowanego: 25, 51, 29 i 17 kg · $ha^{-1}$. Mimo podobnego plonowania obu badanych terenów rozkład plonu na 1 cm wysokości runi był efektem pasienia zwierząt w trzech latach poprzedzających badanie. Plon suchej masy na 1 cm wysokości runi z pastwiska był niższy niż plon z terenu odłogowanego o 19% do końca kwietnia i o 33% w okresie czerwcowo-lipcowym, natomiast wyższy o 99% w okresie sierpień–październik.

**Słowa kluczowe**: pastwisko, pastwisko odłogowane, plon suchej masy, małe przeżuwacze