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PRODUCTION AND PRODUCTIVITY OF A *FESTUCA RUBRA* AND *AGROSTIS CAPILLARIS* GRASSLAND IN THE LĂPUŞULUI MOUNTAINS (MARAMUREŞ COUNTY)

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Abstract: This study aimed to estimate the production and productivity of *Agrostis capillaris* and *Festuca rubra* grasslands from the Lăpuşului Mountains (Maramureş county), as well as the influence of their different uses on these parameters.

Although the results obtained are only guiding, they express both the dynamics of primary productivity and production, and the influence of grazing on the productivity of the analyzed grasslands. Thus, green mass production reaches its highest value in July, after which it decreases, while dry matter production increases over the period of the whole vegetation season. Primary productivity reaches maximum values in June, after which it gradually decreases, and 20% of the species provide approximately 80% of the total phytomass production.

Introduction

Researches on the productivity of grasslands and the effect of grazing on plant communities have stopped being a mere academic exercise, since they have major economic implications. Studies have demonstrated that primary productivity is influenced by incident solar radiation, precipitation, temperature, landscape, type of soil, foliar surface index, number of biologically active days, age of plant communities and use of phytocoenoses, grazing playing an important role in the case of grasslands [2, 4, 6, 8, 9, 16, 30]. Grazing, as an ecological factor, may affect plant communities both structurally [1, 10, 11, 17, 18, 21, 22, 28], by changing the specific and spatial structure, the specific richness of phytocoenoses, etc., and functionally [1, 15, 22], directly (by defoliation, compression, animal dejections), and indirectly, the change in the specific composition resulting in alterations of the interactions between the species. Grazing may favor the local disappearance of some species, as a consequence of their reduced survival capacity and seed production, especially in good fodder plants.

There is no consensus of researchers regarding the influence of grazing on the productivity of grasslands. A first hypothesis, which is the most common, is that grazing is always detrimental to plants [19]. A second hypothesis is that, in the case of a low level of grazing, plants may compensate for phytomass losses, so there are no major differences [3, 19]. The most controversial hypothesis advances the fact that a moderate level of grazing leads to an increase in primary productivity as a result of the capacity of plants to overcompensate for biomass losses [3, 13, 19, 23]. This fact might be due to both intrinsic mechanisms, which act at individual level and involve changes in the physiology and development of plants, and extrinsic mechanisms, at the level of the ecosystem, which involve changes in the ecological factors: increase in the amount of nutritive substances, improvement of the water regime in the remaining tissues, by the increased root/stem ratio and reduced water losses, a better mobilization of litter nitrogen, stimulation of microbial activity in the soil, etc. [1, 10, 11, 13, 19].

The type of response of plant communities to grazing depends on the morphology of plant species, their phenology, the "harvested" amount, the length of the recovery period, the efficacy of the circuit of nutrients in the presence of herbivores [14, 23]. The effect of grazing on the productivity of phytocoenoses also depends on the size of the grazed area, varying from a negative response in the case of small areas to a neutral or positive response in the case of larger areas, which is due to the diminished intensity of the competition between grazed and non-grazed species [31].

Work Method

Our study was carried out on a grassland belonging to the association *Galio veri-Festucetum rubrae* Resmeriță (1965) 1980, situated in the Lăpuşului Mountains (Şatra Mountain), 6 km north from the Ciocotiş village, on the terrace of the Bloaja river, at an altitude of approximately 600 m.s.m. The analyzed grassland has been used for at least the past 30 years as a hayfield, which is grazed in spring (until 10-15 May) and in autumn (after 15 August), and every 5 years it is used exclusively as a pasture.

In order to estimate the production and the productivity of the analyzed pasture, two adjacent test areas, of approximately 180 sq. m. each, were delimited. One of the areas was enclosed (in August 2002) to prevent grazing in spring and autumn, which also allowed to estimate the effect of grazing on the production and productivity of the phytocoenosis concerned.

The structure of phytocoenoses was determined by phytosociological releves, and the Braun-Blanquet scale was used for the evaluation of abundance-dominance, a releve on a surface of 25 sq. m. being performed on each test area (results are shown in Table 1). Releves were taken in June 2003, the period of maximum anthesis for the majority of species. The Bray-Curtis similarity index was used for the calculation of the similarity between the two releves.

Our study only included measurements for the above-ground phytomass, without the calculation of the litter amount produced. For this, each month (from May to August), the above-ground phytomass was harvested from 5 randomly selected samples, with a circular surface of 0.25 sq. m. (r = 28.2 cm), from each test area. In order to avoid the alteration of the results by the regeneration of the phytomass as a result of compensatory growth [19, 23], since young tissues have a higher productivity than old tissues [12], the harvesting of the above-ground phytomass from the same areas, at different time periods, was avoided. Within maximum 24 hours after harvesting, the samples were dried in a drying oven, at a temperature of 85^0C, for 24 hours. The samples were weighed before and after drying, and the weight of the green mass and dry matter was thus obtained. Before drying, the material was sorted in 4 groups: Poaceae (**Gr.**), Cyperaceae (**Cy.**), Fabaceae (**Fa.**), and other families (**Af.**).

Based on the values obtained, the monthly value of the crop was determined and the productivity of the phytocoenosis was estimated (organic matter accumulation rate), in kg/ha/day. For the evaluation of monthly productivity, the phytomass difference (in kg/ha), recorded in a certain time interval (days) was considered to represent the organic matter accumulation rate in the plant body.

Based on the results obtained, the monthly dynamics of the (green and dry) phytomass production and of the daily productivity of the analyzed phytocoenosis was graphically represented.

For the estimation of the energy available to the next trophic level (of phytophages), the P/B index [4] was calculated for the months of June, July and August, and its values were also graphically represented, this index being calculated using the formula:

$$P/B = \frac{productivity_{t1-t0}}{phytomass_{t1}},$$

where: - *productivity* $_{t1-t0}$ represents the phytomass accumulated in the time interval t_1-t_0;
- *phytomass* t_1 represents the production of the phytocoenosis at the time t_1.

The pastoral value (V_p), is a synthetic indicator calculated depending on the specific composition of phytocoenoses, AD_m and the fodder value of each species [29]:

$$V_p = \frac{\% \times Is}{100},$$

where: - V_p – pastoral value;
- % - coverage percentage of each species;
- Is – specific quality index of each species (fodder value).

In order to establish the specific quality index of each species (the fodder value), the system proposed by I. Pop was used [24].

Results and Discussion

The analysis of the two releves shows that at the initial stage, no significant differences appear in the coverage percentage, number and AD values of the species (Table 1). The high resemblance between the two plots is also shown by the value of the Bray-Curtis index, which is 89,5%.

Table 1: Initial floristic structure of the analyzed phytocoenoses

	1	2		1	2
Altitude (m.s.m.)	580	580			
Exposure	-	-			
Slope (degrees)	-	-			
Coverage percentage (%)	100	100			
Surface (m^2)	25	25			
No. of species	38	40			
Arr			Stachys officinalis	+	+
Festuca rubra	4	4	Lychnis flos-cuculi	.	+
Agrostis capillaris	2	2	Centaurea jacea	.	+
Carlina acaulis	+	+	Dianthus delthoides	.	+
Cynosurus cristatus	+	+	**Po-Na**		
Knautia arvensis	+	+	Alchemilla monticola	+	.
Crepis biennis	+	+	**Na-Cln**		
M-Arr			Nardus stricta	+	+
Luzula campestris	+	+	Potentilla erecta	.	+
Briza media	+	.	Danthonia decumbens	+	.
Anthoxanthum odoratum	+	+	Hieracium aurantiacum	+	+
Polygala vulgaris	+	+	Euphrasia stricta	+	.
Rhinathus angustifolius	+	+	Carex ovalis	+	+
			Campanula patula ssp abietina	.	+
Plantago lanceolata	+	+	**F-Br**		
Achillea millefolium	+	+	Galium verum	+	+
Centaurea phrygia	+	+	Lotus corniculatus	+	+
Leontodon autumnalis	+	+	Medicago sativa ssp falcata	+	+
Taraxacum officinale	+	+	Dianthus carthusianorum	+	+
Holcus lanatus	+	+	Peucedanum oreoselinum	+	+
Thymus pulegioides	+	+	Hypericum perforatum	.	+
Trifolium pratense	+	+	**Îns.**		
Leucanthemum vulgare	+	+	Prunella vulgaris	+	+
Trifolium repens	+	.	Cruciata glabra	.	+
Rumex acetosa	+	+	Ranunculus polyanthemos	+	+
Stellaria graminea	+	+	Equisetum arvense	+	+

Legend: 1 – enclosed area; 2 – area grazed in spring and autumn; **Arr.**- Arrhenatheretalia, **M-Arr.**- Molinio-Arrhenatheretea, **F-Br.**- Festuco-Brometea, **Po-Na.**- Potentillo ternatae-Nardion strictae, **Na-Cln.**- Nardo-Callunetea, **Îns.**- Accompanying

There are no significant differences in the pastoral values of the two test areas, 2.61 for the enclosed area and 2.57 for the area grazed in spring and autumn. The bonitation scores of the two areas vary between 61-70, which places them in the category of good grasslands, quality class IV.

For *Agrostis capillaris* and *Festuca rubra* mountain grasslands, the literature reports mean production values between 3500-21800 kg g.m./ha [8, 20, 25, 26, 27], which is in accordance with the values obtained by us.

As expected, the mean green mass and dry matter production (Fig. 1 and 2) recorded in May in the non-grazed area is higher than that recorded in the samples of the area grazed in spring and autumn. Except for the month of July, when green mass production in the non-grazed samples is slightly higher than in the grazed samples, the green mass and dry matter production in the grazed samples is higher than in the non-grazed samples. This could be due to the higher productivity of young tissues during the regeneration process [12], as well as to the nitrogen enrichment of the soil from animal dejections.

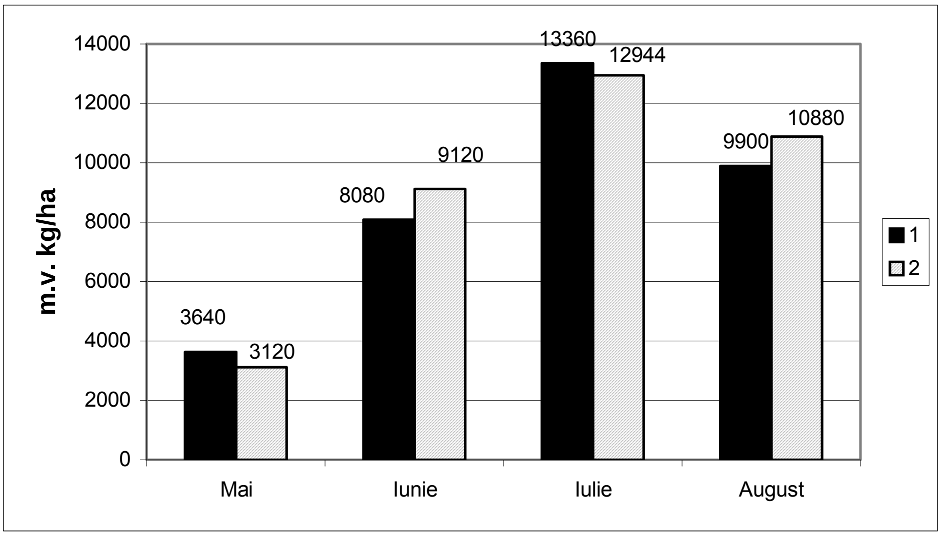

Fig. 1: Monthly dynamics of green mass production
(1 – non-grazed; 2 – grazed)

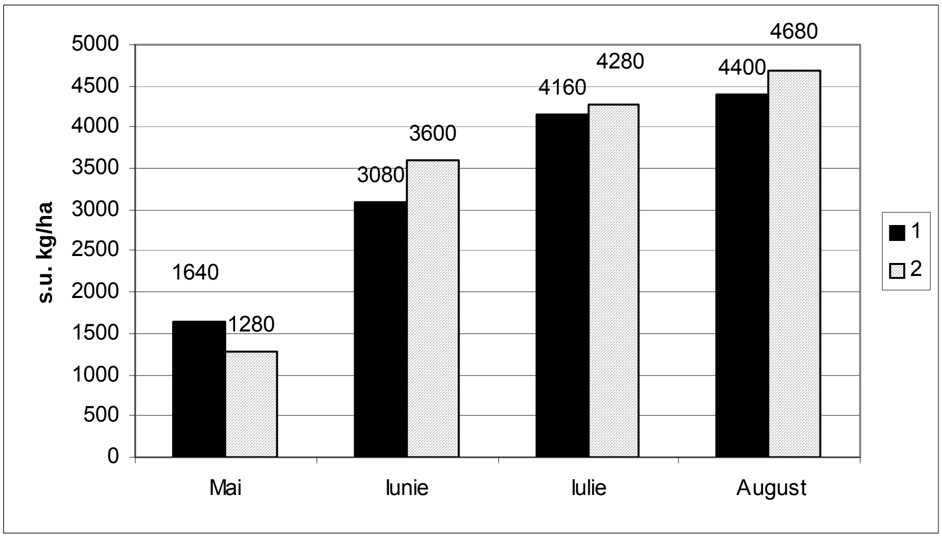

Fig. 2: Monthly dynamics of dry matter production
(1 – non-grazed; 2 – grazed)

The regression in August of the green mass amount and the increased dry matter amount in both areas can be explained by the dissemination of mature fruit and seeds, the reduction in the water content from the tissues of the different plant organs, as well as by the natural dynamics of the physiological processes under the general and local edaphoclimatic conditions.

The composition by taxonomic categories of the analyzed samples (expressed in dry matter percentages), as shown in Table 2, is clearly dominated by Graminaceae, followed by plants grouped in “other families”, Fabaceae and Cyperaceae.

In the analyzed grassland, Graminaceae species represent 18.4%, 17.5%, respectively, of the floristic composition, and they provide approximately 85% of the total dry matter production, which is close to the well known law 20/80 [8].

In the case of both test areas included in the study, a decrease in the productivity of phytocoenoses is found (Fig. 3), decrease that can be attributed on the diminished intensity of photosynthesis with the aging of tissues, as well as to the diminution of the day duration. The maximum productivity value is found in June, 48 kg/ha/day for the non-grazed area, and 77.3 kg/ha/day for the area grazed in spring and autumn. The highest productivity of the samples grazed in spring and autumn might be due, like in the case of phytomass production, to the higher intensity of photosynthesis in young tissues during the regeneration process [12], and to the nitrogen enrichment of the soil from animal dejections. At the same time, a “recovery strategy” might be adopted by the grazed phytocoenosis, in order to fulfil the reproductive function of its components, the month of June being generally the month when the majority of species reach the peak of their anthesis.

Table 2: Composition by taxonomic categories of the samples from the non-grazed and grazed areas (% of dry matter)

Month	MAY				JUNE				JULY				AUGUST			
	Gr.	**Cy.**	**Fa.**	**Af.**	**Gr.**	**Cy.**	**Fa.**	**Af.**	**Gr.**	**Cy.**	**Fa.**	**Af.**	**Gr.**	**Cy.**	**Fa.**	**Af.**
1.	88.4	1.03	1.24	9.33	86.5	1.26	2.61	9.63	88.1	1.46	2.65	7.75	90	1.88	1.95	6.13
2.	86.8	1.13	2.35	9.76	89	1.27	1.86	7.9	89	1.85	2.01	7.14	86.5	2.35	3.89	7.28

Legend: 1. – non-grazed; 2. – grazed.

A similar dynamics has the P/B index (Fig. 4), the maximum value of the energy available to the upper trophic level, of phytophages, is highest in June (0.468, 0.644, respectively), after which it decreases in August to values of only 0.085, 0.055, respectively.

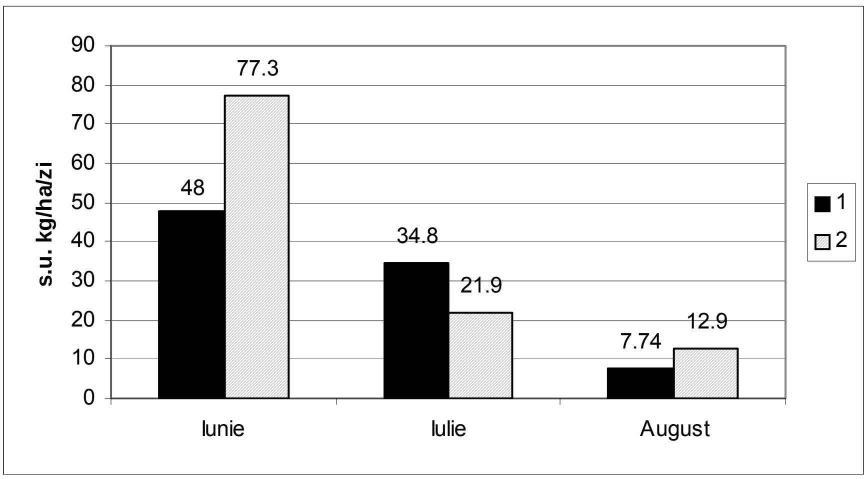

Fig. 3: Estimation of the monthly variation in the daily productivity of *Agrostis capillaris* and *Festuca rubra* phytocoenoses (1 – non-grazed; 2 – grazed)

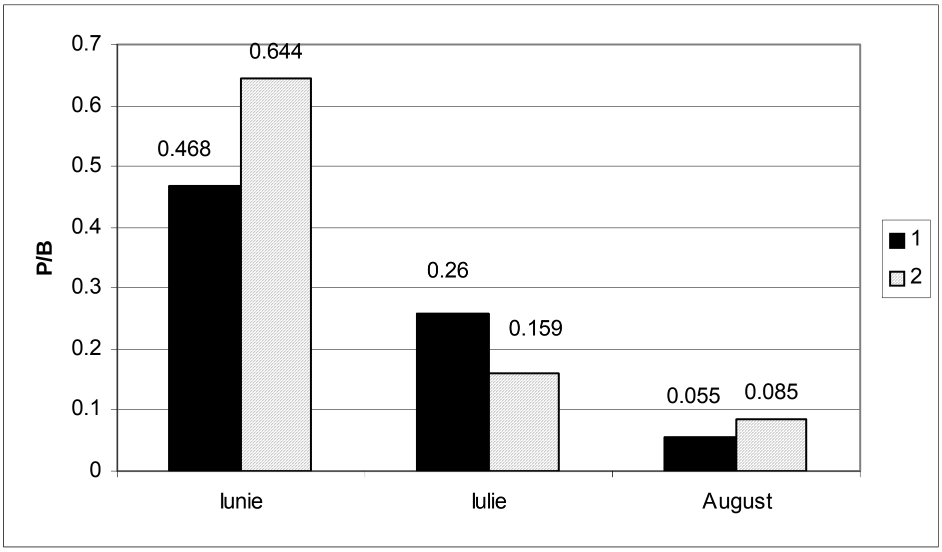

Fig. 4: Monthly variation of the P/B index (1 – non-grazed; 2 – grazed)

From an energetic and economic point of view, the above presented data show that the samples taken in late June – early July, period which coincides with the hay mowing period, have the highest fodder value.

Conclusions

The green mass production increases until July, when it reaches maximum values, after which it decreases, while the dry matter production increases over the course of the whole vegetation season.

Primary productivity reaches maximum values in June, after which it gradually decreases, the same tendency manifesting in the case of the energy amount available to the upper trophic level (P/B).

Moderate grazing (in spring and autumn) causes an increase in primary production and productivity, probably as a result of the capacity of plants to overcompensate for phytomass losses (which is due to both the higher intensity of photosynthesis in young tissues during the regeneration process, and to the nitrogen enrichment of the soil from animal dejections).

From the point of view of the composition by different taxonomic categories of *Agrostis capillaris* and *Festuca rubra* grasslands, Graminaceae represent the highest proportion. Moderate grazing, at least for short time periods, does not significantly influence the specific composition of phytocoenoses, the two test areas being highly similar.

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PRODUCŢIA ŞI PRODUCTIVITATEA UNEI PAJIŞTI EDIFICATE DE *FESTUCA RUBRA* ŞI *AGROSTIS CAPILLARIS*, DIN MUNŢII LĂPUŞULUI (JUD. MARAMUREŞ)

(Rezumat)

Acest studiu a urmărit estimarea producţiei şi productivităţii pajiştilor edificate de *Agrostis capillaris* şi *Festuca rubra* din Munţii Lăpuşului (Maramureş), precum şi influenţa diferitelor moduri de utilizare a lor asupra acestor parametri.

Rezultatele obţinute, deşi orientative, surprind atât dinamica productivităţii şi a producţiei primare, cât şi influenţa păşunatului asupra productivităţii pajiştilor analizate. Astfel, producţia de masă verde atinge maximul în luna iulie după care scade, în timp ce producţia de substanţă uscată înregistrează o creştere pe perioada întregului sezon de vegetaţie. Productivitatea primară atinge valori maxime în luna iunie după care scade treptat, iar 20% din specii realizează aproximativ 80% din totalul producţiei de fitomasă.