STUDIES CONCERNING THE QUANTITY OF UNDERGROUND PHYTOMASS AND THE FALLOWING RATE OF HIGH MOUNTAIN GRASSLANDS

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Abstract

The anti-erosion role of the fallows from permanent grassland found in the high mountain area is well known. In the Romanian Carpathians there are few studies on the amount of underground phytomass (fallows) from grasslands and not at all related to the rate of its accumulation after sowing. In the Bucegi Mountains, several determinations were made in the year 1993, on the amount of fallows from grasslands (1800 m altitude), and the results revealed 2990 g/sqm of dry matter (DM) for Nardus stricta, 3500 g/sqm DM for Festuca airoides (2200 m alt.) and 1290 g/sqm DM for Carex curvula (2450 m alt.). In the year 1993 a quantity of 2890 g/sqm of underground phytomass was reported on a grassland dominated by Nardus stricta, located at 1800 m altitude, reseeded 30 years ago (1963) and composed by a mixture of perennial grasses, mainly of Festuca rubra. In the same year (1993) on a bare field near the Babele cable car (2200 m altitude), a mixture of herbs dominated by Festuca rubra was sown. After 25 years (in the year 2018) the amount of fallows was quantified again, and the results revealed 2650 g/sqm fallows for Festuca rubra, and 3220 g/sqm of DM for the natural grassland - Festuca aeroides. It is estimated that within 30 years the fallows of sown grasslands, which gets installed very slowly, reaches the level of natural grasslands, with an average rate of 106 g/sqm/year. In addition, the forage quality of Festuca rubra sown grassland is much better than that of Festuca airoides natural grassland. Soil from the unsown grassland surface continued to express higher erosion rates even after 25 years, as there was no protective vegetation cover installed by itself.

Keywords: mountain grassland, underground phytomass, fallow rate, forage quality.

INTRODUCTION

Fallowing is an evolutionary stage of vegetation, resulting from the installation, growth and development of grasses, ciperacee and other species, whose basal shoots, roots, rhizomes, stolons, etc., form a dense network of organic matter (alive and dead, of various thicknesses) in the upper part of the soil.

In the Eurasian areas formed by steppe and northern or alpine tundra, the primary vegetation is composed almost exclusively of grassy species that generate fallows (Iaroshenko, 1962; Ozenda, 1983).

On grasslands located on slopes with different inclination degrees, the role of the fallow soil substrate as a resistant and elastic shield against soil erosion is well known. The protective role of fallow is even more important in the high mountain area, where rain and

wind erosion processes are very active. For the conditions speciffic to our country we have few studies on grasslands fallows (Resmeriță and Texter, 1956; Resmeriță, 1970; Marușca and Oprea, 1996).

This paper establishes the rate of accumulation of underground phytomass after 25 years from the erosion control revegetation (on 2,200 m altitude, at Babele, in the Bucegi Plateau).

MATERIAL AND METHOD

The construction of some access roads, cable transport installations, chalets, ski slopes, etc., in the Bucegi Plateau caused catastrophic erosions, triggered by destroying the protective vegetation/ground cover. These effects were difficult to stop without soil revegetation. As a first step, in the year 1993, 4 types of fallows were studied: some found in grasslands located at 1800 m, dominated by *Nardus stricta* and *Festuca rubra* reseeded 30 years ago, some found in subalpine grasslands located at 2200 m altitude, dominated by *Festuca airoides* and some found in alpine grasslands, located at 2450 m altitude, dominated by *Carex curvula*.

The amount of basal shoots, roots, stolons, rhizomes, etc., that make up the fallows itself were determined following the Stankov method, described in our specialized works (Resmerita and Texter, 1956). Thus, using a metal frame with the dimensions of 333 x 300 mm (1000 sqcm) fixed on the ground, fallows samples were taken on two depths, namely 0-10 and 10-20 cm, whereupon the course particles were removed in order to be easier to carry it with the backpack. Then the samples were kept in water for 24 hours, after which the organic parts of the fallows were removed by washing through a 1 mm sieve. The samples were then dried in air and in an oven at 105°C to determine the dry matter.

Toghther with the fallow samples, soil samples were also taken from the field, at 0-10 and 10-20 cm depth, with an agrochemical probe for laboratory analysis.

A mixture of herbs dominated by *Festuca rubra* was sown on a bare ground, at 2200 m altitude, near the Babele cable car station. This surface was then fertilized with 500 kg/ha NPK complex chemical fertilizers (15-15-15) along with the natural grassland dominated by *Festuca airoides*. After 25 years, in the year 2018, the amount of underground phytomass accumulated was determined according to the same Stankov method described above. For the above-ground phytomass, the forage quality was the only parameter determined, as the unfenced grassland was used by continuous grazing with animals, especially sheeps.

RESULTS AND DISCUSSION

The agrochemical characteristics of the soil found in the 4 stations with fallows from Bucegi Plateau are described in Table 1.

From these data results that the soil has a strong acid reaction with a high content of crude humus and mobile aluminum, respectively a low content of fertilizers elements, phosphorus and potassium. Higher content of raw humus and PK was recorded at 0-10 cm depth and lower at 10-20 cm depth in the soil in grasslands dominated by *Carex curvula*, *Festuca airoides* and *Nardus stricta*. In general, higher acidity and aluminum content are recorded at the surface (0-10 cm depth) except for the reseeded grassland dominated by *Festuca rubra*, where the soil was mixed by plowing and harrowing.

The amount of underground phytomass from 1800 - 2450 m altitude is influenced by climatic conditions and the type of grassy carpet with primary or reseeded vegetation (Table 2).

Table 1

The agrochemical characteristics of the soil (0-20 cm) found under different types of grassy carpet from Bucegi Plateau - 1993 -

Mention	*Carex curvula* (2450 m alt.)		*Festuca airoides* (2200 m alt.)		*Nardus stricta* (1800 m alt.)		*Festuca rubra* (1800 m alt.)	
	0-10	10-20	0-10	10-20	0-10	10-20	0-10	10-20
pH in H_2O	4.1	4.4	5.2	5.3	4.0	4.1	4.8	4.5
Base saturation (%)	15	11	35	29	21	19	3.9	24
Humus (%)	> 25	15	17	15	> 25	14	> 25	11
P_{AL} (ppm)	19	13	10	9	29	12	15	9
K_{AL} (ppm)	87	40	50	50	167	95	147	109
Al^{3+} (mg/100g soil)	6.6	3.8	1.0	1.8	5.5	4.8	2.4	1.6

Table 2

The amount of underground phytomass acumulated in soil under different types of grassy carpet from Bucegi Plateau - 1993 -

Altitude (m)	Fallow from:	Depth (m)		TOTAL (DM g/mp)	%
		0 - 10	10 - 20		
2450	*Carex curvula*	1170	120	1290	48
2200	*Festuca airoides*	3100	400	3500	132
1800	*Nardus stricta*	2770	220	2990	112
1800	*Festuca rubra* (resown 1963 - 93)	2590	300	2890	109
Average		2400	260	2660	100
Ammounts, considering depth (%)		90	10	100	x

Thus, the highest amount of fallows was recorded in the subalpine grasslands dominated by *Festuca airoides* (3500 g/sqm) and the lowest in *Carex curvula* (1290 g/sqm). On *Nardus stricta* grasslands from the Bucegi Plateau, an ammount of 2990 g/sqm DM was determined in the underground phytomass compared to 3176 g/sqm air-dried fallow found in the same type of grassy carpet located in the Apuseni Mountains (Resmeriță, 1970). By comparison in the Alps an ammount of 2200 g/sqm DM was found in *Carex curvula* and only 1500 g/sqm DM in pastures dominated by *Nardus stricta* (Haid, 1982; Ozenda, 1989).

On the land without vegetation from Babele, resown 25 years ago with a suitable mixture, the acid reaction of the soil improved due to the calcareous substrate, as well as the degree of base saturation (Table 3).

Table 3

The agrochemical characteristics of the soil from Babele - Bucegi (2200 m alt.) after 25 years

Mention	MU	*Festuca airoides*			Empty, reseeding		
		1993	2018		1993	2018	
		0 - 10	0 - 10	10 - 20	0 - 10	0 - 10	10 - 20
pH in H_2O	ind.	5.2	5.8	5.7	5.3	5.9	6.4
Base saturation (BS)	%	35.1	52.5	55.6	29.2	65.1	87.1
Humus (%)	%	7.8	8.1	6.0	5.4	3.5	3.1
P_{AL}	ppm	10.2	7.9	4.4	9.0	6.3	9.1
K_{AL}	ppm	50.0	34.0	24.0	35.0	83.0	38.0
Al^{3+}	mg/100g	1.0	0.2	0.1	1.8	-	-

The content of fertilizers elements (N, P, K) are generally lower in the year 2018 compared to the year 1993 on the primary grassland of *Festuca airoides* and slightly higher on the *Festuca rubra* grassland, due to chemical fertilization at sowing.

The amount of underground phytomass in the sown *Festuca rubra* grassland was 2650 g/sqm DM, with an accumulation rate of 106 g/sqm/year, reaching 82% of the 3220 g/sqm DM determined in *Festuca airoides* grassland (Table 4). Results that the grassland sown at 2200 m can end up having the same amount of underground phytomass as the primary meadow just after 30 years from the establishment.

Fallow chemical analyzes show a lower crude protein content and a higher crude fiber and ash content in *Festuca airoides* natural grassland compared to the sown *Festuca rubra* grassland.

Finally, the forage quality of the sown meadow grass are superior to those recorded by the permanent grassland (Table 5).

Thus, an increase with 66% in crude protein content and with 42 - 80% in digestibility were found in

the grassy carpet from *Festuca rubra* grassland compared to *Festuca airoides* grassland. On control plot, unsown there was no vegetation installment and thus the soil erosion processess are very active in these areas.

Table 4

The production and quality of underground phytomass (fallow) after 25 years from resowing the empty soil from Babele - Bucegi - 2018 -

Mention	MU	A. *Festuca airoides*			B. Resowing *Festuca rubra*		
		0-10	10-20	Total (Average)	0-10	10-20	Total (Average)
Dry matter (DM)	g/sqm	3170	50	3220	2570	80	2650
Acumulation rate	g/year/sqm	x	x	x	x	x	106
Difference B - A	%	x	x	100	x	x	82
Crude protein (CP)	%	14.2	15.4	14.2	16.0	13.8	15.9
Difference B - A	%	x	x	100	x	x	112
Crude fiber (CF)	%	27.8	29.5	27.8	26.7	30.0	26.8
Difference B - A	%	x	x	100	x	x	96
Crude ash (CA)	%	16.1	12.6	16.0	14.4	13.2	14.4
Difference B - A	%	x	x	100	x	x	90

Table 5

The forage quality of overground phytomass from permanent and sown grassland located in Babele - Bucegi (2200 m alt.) - 2018 -

Mention	A. Natural grassland *Festuca airoides*	B. Semi-natural grassland *Festuca rubra*	Difference B - A	
			+, -	%
Crude protein (CP)	8.6	14.3	+ 5.7	166
Crude ash (CA)	6.4	10.3	+ 3.9	161
Crude fiber (CF)	43.7	21.2	- 22.5	49
Celulosys+Lignin (ADF)	50.8	29.7	- 21.1	59
Lignin (ADL)	10.5	5.1	- 5.4	49
Hemicelulosys+ Celulosys+Lignin (NDF)	75.6	49.9	- 25.7	66
Dry matter digestibility (DDM)	47.6	67.4	+ 19.8	142
Organic matter digestibility (DOM)	34.3	61.7	+ 27.4	180

CONCLUSIONS

The study of underground phytomass characteristics from subalpine and alpine grasslands represents a special importance for soil anti-erosion protection.

In the conditions speciffic to Bucegi Mountains, the highest amount of fallows of 3500 g DM/sqm was registered in *Festuca airoides* grasslands while the lowest of 1290 g DM/ha was recorded in *Carex curvula* grasslands.

After resowing the lands without vegetation, it takes 30 years to reach the level of underground phytomass of the destroyed natural fallows, registering a rate of approx. 110 g DM/sqm/year, meaning that fallow recovery is very slowly.

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