CONTRIBUTIONS TO THE IMPROVEMENT OF THE PERMANENT GRASSLANDS FROM THE BOREAL FLOOR OF THE CALIMANI MOUNTAINS

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The permanent grasslands from the boreal floor, spread in the middle and upper part of the Călimani Mountains, occupy wide surfaces and produce 6 – 7 t ha^{-1} green mass. These grasslands present economical and ecological importance, serve multiple purposes, represent habitat and food source for animals, assure the biodiversity for many plant species, protect the soil against erosion, bring a noble feature and beauty to the environment. The organized experiment pursued, during 2007 – 2009, the increase of the productive potential by fertilization with cattle manure 20 – 40 t ha^{-1} and the improvement of the floristic structure and composition. The fertilization lead to the increase of the average production from 1.60 t ha^{-1} D.M. for the untreated control up to 2.87 – 3.02 t ha^{-1} D.M for the variants fertilized with 30 t ha^{-1} manure applied annually and every second year. The grassland's floristic structure improved, after three years of fertilization, meaning that the leguminous species' participation increased from 4 % to 25 – 30 % for the application of 30 t/ha manure every second year and annually.

***Key words**: grassland, fertilization, biodiversity, boreal floor, improvement*

Permanent grasslands are part of the Romania's natural resources' group, with a great valuing potential. These grasslands serve multiple purposes, which harmoniously combine many functions that can be used in the benefit of people and animals: they offer habitat and food source for animals, protect the soil against erosion, assure the biodiversity for at least 70% from all plant species, bring nobility and beauty to the environment and also, a big part of the biomass can be transformed into unconventional energy [4].

We can increase the productivity for this natural patrimony of our country by fertilization and rational use [1].

The researches conducted in the boreal floor of Călimani Mountains had as main objectives the increase of the production by cattle manure fertilization and the improvement of the floristic structure and composition [2, 3].

MATERIAL AND METHOD

The single factor experiment was organized according to the subdivided lots in 4 repetitions, on an *Agrostis capillaris* + *Festuca rubra* permanent grassland, during 2007 – 2009. The cattle manure fertilizer was applied starting with the fall of 2006, in 5 variants:

1 – control;
2 – cattle manure 20 t ha^{-1} annually;
3 – cattle manure 30 t ha^{-1} annually;
4 – cattle manure 30 t ha^{-1} every second year;
5 – cattle manure 40 t ha^{-1} every third year.

The well fermented cattle manure was applied in the fall after the grassland's vegetation stopped growing. The green mass was harvested annually in order to evaluate the production by weighting and also the floristic structure was determined and observations were made on the biodiversity of the component species.

The production was expressed in dry matter and the statistic calcul of the production results was made according to the variance analysis.

RESULTS AND DISCUSSIONS

Production. In 2007, the fertilization with cattle manure influenced less the production because the rainfall sum was small. The production yields were of 0.83 – 1.67 t ha^{-1} D.M., with big increases for the annual application of 20 – 30 t ha^{-1} manure (101 – 79 %).

The fertilization with 30 t ha^{-1} manure every second year and 40 t ha^{-1} manure every third year did not lead to big productions because the plants could not use these quantities without an appropriate amount of water.

In 2008, the climate conditions were favourable, the rainfall level maintained in normal parameters for the boreal floor and the vegetation properly valued the applied manure. Two production cycles were obtained, registering 2.83 t ha^{-1} D.M for the control variant (with an increase of 240% compared to the previous year) and 4.62 – 6.25 t ha^{-1} D.M. for the fertilization with 20 – 40 t ha^{-1} manure. The annual fertilization with 20 – 30 t ha^{-1} manure lead to production yields of 4.62 – 4.71 t ha^{-1} D.M., with increases of 63 – 66% compared to the control variant, and for the application of manure every second or third year, the production yields were of 6.25 – 4.80 t ha^{-1} D.M., with increases of 120 – 70%.

In 2009 we obtained a single production cycle, the results being just a little bit bigger than the first experimental year's ones. The obtained production yields were of 1.13 – 2.40 t ha^{-1} D.M., bigger for the fertilization with 30 t ha^{-1} manure annually, variants that registered a production increase of 112% compared to the control.

The fertilization with 30 – 4 t ha^{-1} manure every second or third year did not bring bigger productions, these having an increase of only 31 – 57% compared to the control variant (*table 1*).

The average productions (2007 – 2009) emphasize the fact that fertilization influenced their level.

Table 1

The influence of organic fertilization on dry matter production

Variant	2007	2008	2009	2007-2009		
				t ha^{-1}	Difference	Significance
Control	0.83	2.83	1.13	1.60	0.0	Mt
20 t/ha manure annually	1.67	4.62	1.67	2.65	1.05	**
30 t/ha manure annually	1.49	4.71	2.40	2.87	1.27	***
30 t/ha manure every second year	1.33	6.25	1.48	3.02	1.42	***
40 t/ha manure every third year	1.41	4.80	1.77	2.66	1.06	**
LSD 5% = 0.62 t ha^{-1} LSD 5% = 0.85 t ha^{-1} LSD 5% 1% = 1.14 t ha^{-1}						

For the annual fertilization with manure 20 – 30 t ha^{-1}D.M. we obtained 2.65 – 2.87 t ha^{-1} D.M., with increases of 66 – 79% compared to the control variant, for the application of manure 30 t ha^{-1} every second year resulted the biggest production yield , of 3.02 t ha^{-1} D.M. with an increase of 89% and for the application of manure 40 t ha^{-1} every third year, the production was of 2.66 t ha^{-1} D.M., with an increase of 66% (*figure 1*).

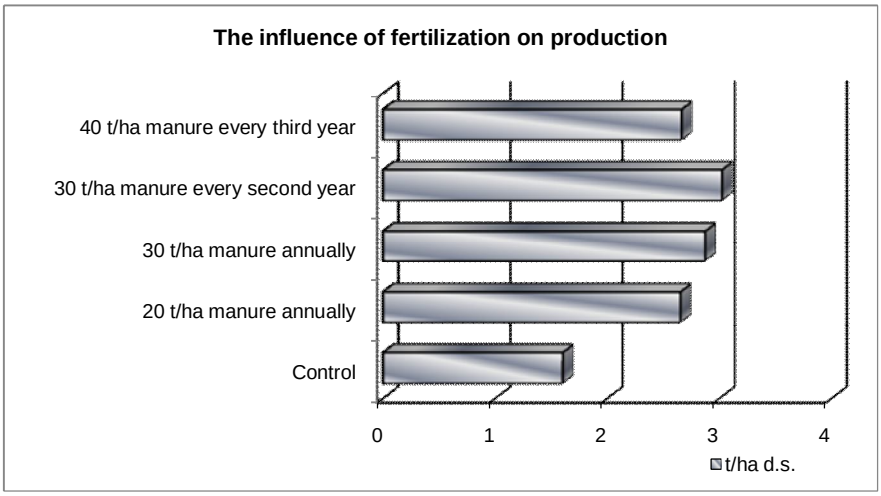

Figure 1 **The influence of organic fertilization on average production values**

Floristic structure. Making a comparative analysis for the species groups' participation in the floristic structure of the grassland's vegetal carpet, during 2007 and 2009 we observed that the percentage of the graminee species increased for the control from 18 to 60%; for the fertilization with manure 20 t ha^{-1} annually, it increased from 15 to 37% and for the other treated variants decreased from 24 – 45% to 16 – 29%; the leguminous species' participation increased, due to fertilization, from 3 – 12% to 7 – 48%, more obvious for the annual fertilization with 30 t ha^{-1} manure; the diverse species' participation decreased from 71 – 80% to 33 – 52%, excepting the variant fertilized with 40 t ha^{-1} manure where their percentage increased from 43 to 61% (*table 2, figure 2*).

Table 2

The influence of organic fertilization on the floristic structure (%)

No crt	Fertilization	Graminee species		Leguminous species		Diverse species	
		2007	2009	2007	2009	2007	2009
1	Control	18	60	3	7	79	33
2	20 t ha^{-1} manure annually	15	37	5	11	80	52
3	30 t ha^{-1} manure annually	24	16	4	48	72	36
4	30 t ha^{-1} manure every second year	27	29	2	23	71	48
5	40 t ha^{-1} manure every third year	45	23	12	16	43	61

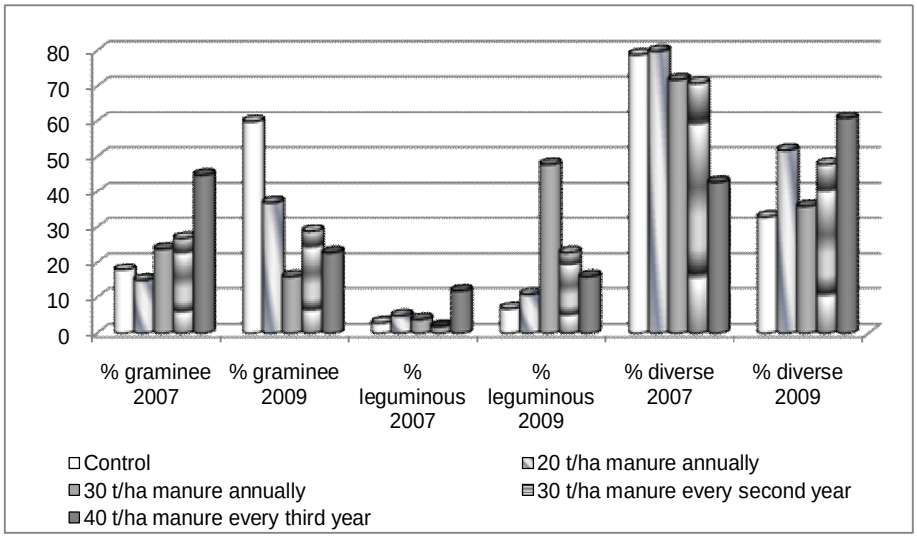

Figure 2 **The influence of organic fertilization on the floristic structure**

Biodiversity includes all plant species and their participation in order to evaluate the vegetation coverage degree. The plant species' biodiversity from the permanent grasslands can be modified by the climate changes, ploughing, uncontrolled waste deposits, road construction and aggressive tourism, without respecting the environment protection standards.

Preserving the biodiversity represents a warranty of the sustainable development of the economical and social system; the quality of he air depends on this biodiversity, it is a food source, it balances the climate, helps to soil formation, to nutrients cycle, to primary production and plays an important esthetical, educational and recreational role.

In the researches conducted during 2007 – 2009, in order to study the grassland's biodiversity, we used the plan metric method. If in 2007, we identified 17 species, from which the graminee species represented 86%, the leguminous species 2% and the diverse species 12%, in 2009, due to fertilization, the biodiversity improved: there were identified 30 – 33 species, with 13 – 16 species more (*table 3*).

Table 3

The influence of organic fertilization on biodiversity

Specie	Abundance – coverage degree %					
	Initial	V_1	V_2	V_3	V_4	V_5
	2007	2009	2009	2009	2009	2009
Agrostis capillaris	-	4	6	12	6	15
Anthoxanthum odoratum	-	4	+	2	2	5
Arrhenatherum elatius	-	+	3	8	2	2
Brachypodium pinnatum	+	+	+	-	+	1
Briza media	-	+	2	7	+	+
Cynosurus cristatus	-	+	+	2	+	3
Dactylis glomerata	-	+	-	+	-	+
Festuca rubra	4	8	6	2	6	8
Holcus lanatus	-	-	-	-	-	1
Nardus stricta	80	70	18	8	35	15
Trisetum flavescens	2	+	10	6	4	10
Graminee species%	86	96	45	47	55	60
Lotus corniculatus	+	+	+	8	1	6
Trifolium pratense	+	2	20	9	4	4
Trifolium repens	2	2	10	8	3	2
Leguminous species%	2	4	30	25	8	12
Achillea millefolium	2	+	+	4	5	5
Alchemilla vulgaris	2	+	+	10	10	8
Campanula persicifolia	2	+	+	+	+	+
Campanula glomerata	-	+	-	+	+	+
Carlina acaulis	-	+	+	6	+	6
Centaurea fritschii	2	+	5	4	15	5
Chrysanthemum leucanthemum	-	+	+	+	+	+
Galium cruciata	-	+	+	+	+	+
Galium verum	+	+	+	+	+	+
Hieracium aurantiacum	-	+	+	+	-	+
Hypericum perforatum	-	+	+	+	+	+
Linum catharticum	-	+	+	+	+	+
Plantago lanceolata	2	+	8	+	5	4
Potentila erecta	+	+	+	+	+	+
Ranunculus acris	+	+	+	+	+	+
Rhinanthus rumelicus	-	+	+	+	+	+
Taraxacum officinale	2	+	+	+	2	+
Thymus pulegioides	-	+	+	+	+	+
Veronica chamaedrys	+	+	+	+	+	+
Diverse species %	12	0	25	28	37	28
Gaps %	0	0	0	0	0	0
Total %	100	100	100	100	100	100
Total species no.	17	32	30	31	30	33
Lost species no.	0	0	0	0	0	0
New species no.	0	15	13	14	13	16

CONCLUSIONS

The permanent grasslands from the boreal floor represent an important source of succulent and fibre full fodder for the animals.

The conducted experiment on an *Agrostis capillaris* + *Festuca rubra* mountain grassland had as main objectives the increase of the productive potential by fertilization with cattle manure and the improvement of the vegetal carpet's floristic structure and biodiversity.

The fertilization favourably influenced the production, registering big increases compared to the control variant, of 79% (2.87 t ha^{-1} D.M.) for the application of 30 t ha^{-1} manure annually and of 89% (3.02 t ha^{-1} D.M.) for the application of 30 t ha^{-1} manure every second year.

The floristic structure modified, due to fertilization, the percentage of the leguminous species increasing in 2009 compared to 2007, from 2 – 12% to 11 – 48%.

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