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THE EVOLUTION OF THE FLORISTICAL COMPOSITION AND DRY MATTER YIELD IN A *FESTUCA RUBRA* MOUNTAIN PASTURE AS INFLUENCED BY SOME TECHNOLOGICAL INPUTS

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Abstract. The paper presents the results of research regarding the evolution of both forage yield and floristic composition, as influenced by mineral fertilization (N_{100}, P_{50}, K_{100}), organic fertilization (sheepfold), liming ($CaCO_3$) and over-sowing, on a long-term experiment, conducted on a *Festuca rubra* pasture from the Cindrel Mountains, Romania. Four years after experiment installation, the obtained results show that the most important modifications concerning both floristic composition and forage yield levels were produced in the case of the complete fertilized ($N_{100}P_{50}K_{100}$) and liming variant, respectively in case of $P_{50}K_{100}$ fertilized + over-sowing with *Trifolium repens* variant placed on limed soil. After eight years, the research results distinguish interesting modifications for $N_{100}P_{50}K_{100}$ and $P_{50}K_{100}$ fertilized variants, as well as for the organic fertilized variant, all of them on limed soil.

Key words: *Festuca rubra*, yield, floristic composition

INTRODUCTION

The *Festuca rubra* type can be considered valuable, among the existing types of pastures in the boreal level from the Romanian Carpathians, due to its production potential (Ţucra et al., 1987; Rotar et al., 2005). The floristic composition of these pastures is quite poor, considering the valuable fodder species, while the quantity and quality of forage yield is much limited (Cardaşol et al., 1979; Maruşca, 2001; Sima et al., 2002). The improvement of pasture soil pH, respectively of its N, P, K supply status can determine both the increment of valuable species ratio in the canopy sward (*Agrostis capillaris,Phleum pratense, Poa pratensis*), as well as the installation of some new species (ex. *Trifollium repens*).

MATERIALS AND METHODS

The experiment was conducted on a *Festuca rubra* pasture in the Cindrel Mountains, Romania, at a 1348 m altitude on a Districambosoil (brown acid) type of soil, characterized by an acid pH and a low level of phosphorus and potassium supply. The experimental factors were represented by two-rate liming and by five-rate fertilization. 10 variants thus resulted, which were randomly placed, in three replicates each one, by blocks method. The experimental variants were the following: V_1 – natural pasture, V_2 – $N_{100}P_{50}K_{100}$, V_3 – sheepfold, V_4 – $P_{50}K_{100}$ + *T. repens*, V_5 – $P_{50}K_{100}$, all of them placed on unlimed soil, respectively the same variants on limed soil (V_1' – V_5').

The fertilizations were applied, each spring at the beginning of vegetation, while liming and over-sowing were applied once at the beginning of the experiment, in 1998. Yield was determined by the gravimetric method, while the floristic composition was determined by the geobotanical method. The pasture was used only by cutting. The statistical interpretation of results was done using the ANOVA model.

RESULTS AND DISCUSSIONS

In the first experimental year, the most important modifications were produced only on the forage yield, both on limed and on unlimed soil. All technological inputs determined very significant yield efficiencies (table 1 and 2). The yield efficiency provided only by liming was of about 0.3 t/ha dry matter in the first year. For 1 kilogram active substance of nitrogen, the yield efficiency was about 14.8 kg dry matter. The highest forage yield, respectively 4.96 t/ha dry matter, was obtained for the variant fertilized with $N_{100}P_{50}K_{100}$.

Table 1

Dry matter yield (1998) as influenced by fertilization applied on without liming soil

Variant	DM yield ($t.ha^{-1}.an^{-1}$)	Relatively yield (%)	Difference (+/-)	Signification
V_1	1.74	100.0	0.00	-
V_2	4.25	244.3	+2.51	xxx
V_3	2.03	116.7	+0.29	xxx
V_4	2.68	154.0	+0.94	xxx
V_5	2.77	159.2	+1.03	xxx

DL (p 5%) = + 0.11 DL (p 1%) = +0.15 DL (p 0.1 %) = +0.20

Table 2

Dry matter yield (1998) as influenced by fertilization applied on liming soil

Variant	DM yield ($t.ha^{-1}.an^{-1}$)	Relatively yield (%)	Difference (+/-)	Signification
V_1'	2.04	100.0	0.00	-
V_2'	4.96	243.1	+2.92	xxx
V_3'	2.37	116.2	+0.33	xxx
V_4'	3.30	161.8	+1.26	xxx
V_5'	3.25	159.3	+1.21	xxx

DL (p 5%) = + 0.11 DL (p 1%) = + 0.15 DL (p 0.1 %) = + 0.20

In the 2002, important modifications concerning the floristic composition (with respect to grasses) were observed in case of the V_2'variant (table 3), which determined the decrease of the *F. rubra* rate with 40% for fertilization and liming and the increase of the *A. capillaris* rate at 65%, the last one starting to become dominant. In case of variants fertilized with $P_{50}K_{100}$ and respectively with $P_{50}K_{100}$ + over-sowed with *T. repens* (V_4 – V_4' and V_5-V_5'), the increase of legumes rate from 5% to 75% was observed (table 4, 5). Also, a 5% rate of legumes presented the variant with sheepfold on limed soil (table 9).

Table 3

The evolution of floristic composition in V2 and V2' variants

Year / Ec. group (%)	V2			V2'		
	1998	2002	2006	1998	2002	2006
Grasses	85 F.r. 65; A.c. 15; Ph.p. 5	85	100 F.r. 25; A.c. 75	85 F.r. 60; A.c. 15; Ph.p. 10	85 F.r. 20; A.c. 65	95 F.r. 5; A.c. 90
Legumes	+	+	-	+	+	+
Other botanical families	15	10	+	15	10	5

Table 4

The evolution of floristic composition in V4 and V4' variants

Year / Ec. group (%)	V4			V4'		
	1998	2002	2006	1998	2002	2006
Grasses	70	70	85	80	20 F.r. 5; A.c. 15;	85
Legumes	+	15	+	+	75	5
Other botanical families	15	5	+	15	+	5

Table 5

The evolution of floristic composition in V5 and V5' variants

Year / Ec. group (%)	V5			V5'		
	1998	2002	2006	1998	2002	2006
Grasses	70	70	85	75	80	75 F.r. 20; A.c. 55;
Legumes	+	5	5	+	5	15
Other botanical families	15	+	5	15	10	5

Regarding the quantity of yield, all mineral fertilized variants recorded proved very significant yield efficiencies (table 6, 7). A special situation was observed in the case of the sheepfold variant placed on unlimed soil, which, in 2002, for the presence of *Rhinantus minor* species determined a very significant yield decrease. The yield efficiency following liming, after 4 years, was about 0,74 t/ha dry matter while that one following fertilization, with 1 kg active substance of nitrogen, was about 15 kg/ha dry matter.

Table 6

The influence of fertilization on dry matter yield – without liming block, 2002

Variant	DM yield $t.ha^{-1}.an^{-1}$	Relatively yield %	Difference (+/-)	Signification
V_1	4.25	100.0	0.00	-
V_2	7.48	176.0	+3.23	xxx
V_3	3.70	87.1	-0.55	000
V_4	5.88	138.4	+1.63	xxx
V_5	4.99	117.4	+0.74	xxx

DL (p 5%) = + 0.06 DL(p 1%) = + 0.08 DL(p 0.1%) = + 0.11

Table 7

The influence of fertilization on dry matter yield – liming block, 2002

Variant	DM yield $t.ha^{-1}.an^{-1}$	Relatively yield %	Difference (+/-)	Signification
V_1'	4.99	100.0	0.00	-
V_2'	7.68	153.9	+2.69	xxx
V_3'	5.00	100.2	+0.01	-
V_4'	6.66	133.5	+1.41	xxx
V_5'	6.40	128.3	+1.67	xxx

DL (p 5%) = +0.06 DL(p 1%) = +0.08 DL(p 0.1%) = +0.11

After eight experimental years (2006), *Agrostis capillaris* became dominant in the V_1 liming variant (table 8) and in the $N_{100}P_{50}K_{100}$ fertilized variants (V_2 and V_2'), both on limed and an unlimed soil (table 3). Legumes had a more important rate (15%), in the case of mineral ($P_{50}K_{100}$) and organic fertilized variants, on limed soil (V_5' and V_3'– table 5, 9).

Table 8

The evolution of the floristic composition in V1 and V1' variants

Year / Ec. group(%)	V1			V1'		
	1998	2002	2006	1998	2002	2006
Grasses	70 F.r. 60; A.c. 5; P.p. 5	65	70	70 F.r. 60; A.c. 5; P.p. 5	70	75 F.r. 15; A.c. 60;
Legumes	+	-	-	+	+	+
Other botanical families	20	5	5	15	5	5

Table 9

The evolution of the floristic composition in V3 and V3' variants

Year / Ec. group (%)	V3			V3'		
	1998	2002	2006	1998	2002	2006
Grasses	65	50	70	70 F.r. 55; A.c.10; P.p. 5	70	65
Legumes	+	+	+	+	5	15
Other botanical families	15	10	5	20	10	10

The best dry matter yields were obtained in 2006 for the mineral fertilized variants placed on limed soil (table 10, 11). These yield efficiencies obtained were statistically authenticated. The liming pasture in the 8^{th} year brought a dry matter efficiency of about 1.07 t/ha. The fertilization with 1 kg active substance of nitrogen determined an efficiency of about 42 kg dry matter, the highest so far.

Table 10

The influence of fertilization on dry matter yield – without liming block, 2006

Variant	DM yield $t.ha^{-1}.an^{-1}$	Relatively yield %	Difference (+/-)	Signification
V_1	3.24	100.00	0.00	-
V_2	8.47	261.50	+5.23	xxx
V_3	3.65	112.60	+0.41	-
V_4	5.10	157.50	+1.86	x
V_5	4.27	131.70	+1.03	-

DL (p 5%) = + 1.60 DL(p 1%) = +2.21 DL(p 0.1%) = +3.04

Table 11

The influence of fertilization on dry matter yield – liming block, 2006

Variant	DM yield $t.ha^{-1}.an^{-1}$	Relatively yield %	Difference (+/-)	Signification
V_1'	4.31	100.00	0.00	-
V_2'	10.08	234.10	+5.78	xxx
V_3'	4.59	106.60	+0.28	-
V_4'	7.27	168.80	+2.96	xx
V_5'	7.51	174.30	+3.20	xxx

DL (p 5%) = + 1.60 DL(p 1%) = +2.21 DL(p 0.1%) = +3.04

CONCLUSIONS

1. The application of 5.5 t/ha $CaCO_3$ on the *F. rubra* pasture in Păltiniş determined a yield efficiency of about 1.07 t/ha dry matter and a strong increase of *A. capillaris* rate in the canopy sward (60%), a species which became dominant.

2. Yearly organic fertilization and liming, after eight years, determined the installation of some perennial legumes (*T. repens*, 15%) in the canopy sward.

3. Yearly mineral fertilization with $P_{50}K_{100}$ on limed soil determined the increase of *A. capillaris* rate on a long term (after eight years), which became dominant, and also the installation of legumes (*T. repens*, 15%) in the canopy sward.

4. The effect of over-sowing was strongest in the 4^{th} year (*T. repens*, 75%) and it decreased a lot afterwards.

5. Fertilization with $N_{100}P_{50}K_{100}$, on limed soil, determined the obvious change of the dominant ratio, favorable to *A. capillaris* species starting with the 4^{th} year. After eight years, this fertilization determined the increase of *A. capillaris* rate on limed soil, which became dominant.

6. The highest yields, with very significant yield efficiencies, were obtained in case of the complete fertilized ($N_{100}P_{50}K_{100}$) variants.

7. The variants cultivated on limed soil present a practical importance for the *F. rubra* pastures, from the Cindrel Mountains area,

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REZUMAT

EVOLUŢIA COMPOZIŢIEI FLORISTICE ŞI A PRODUCŢIEI, ÎNTR-O PAJIŞTE MONTANĂ DE *FESTUCA RUBRA*, SUB INFLUENŢA UNOR INPUTURI TEHNOLOGICE

În lucrare sunt prezentate rezultatele unui experiment de lungă durată efectuat pe o pajişte de *F. rubra* din Munţii Cindrel. Obiectivele cercetării au fost reprezentate de studiul evoluţiei recoltei de furaj şi a compoziţiei floristice sub influenţa fertilizării minerale (N_{100}, P_{50}, K_{100}), fertilizării organice (târlit), amendării (CaCO3) şi supraînsămânţării. După patru ani de la instalarea experienţei, rezultatele cercetării au demonstrat că cele mai importante modificări asupra compoziţiei floristice şi nivelului recoltelor de furaj s-au produs pe agrofond amendat în varianta cu fertilizare completă ($N_{100}P_{50}K_{100}$), respectiv în cea cu fertilizare $P_{50}K_{100}$ + supraînsămânţare cu *T. repens*. După opt ani, rezultatele cercetării au evidenţiat modificări interesante în variantele fertilizate cu $N_{100}P_{50}K_{100}$, $P_{50}K_{100}$ şi în cea cu fertilizare organică, toate pe sol amendat.