LONG-TERM EFFECT OF IMPROVEMENT FACTORS OF NARDUS STRICTA GRASSLANDS, THE MINERAL FERTILIZED VARIANT

Teodor MARUȘCA[1]

Abstract. *On a Nardus stricta subalpine grassland in the Bucegi Massif, located at 1800 m altitude in the juniper floor (Pinus mugo), in 1995 an experiment was set up to improve them through different methods of calcium amendment, overseeding and reseeding, periodically fertilized with mineral fertilizers (NPK). The calcium amendment stimulated on average over the last 5 years (2019 - 2023), of the 28 years since administration, the species Trifolium repens which reaches 9.8% compared to 2.7% for the unamended variants, Poa pratensis to 18.9 % fined vs. absent in unamended and Agrostis capillaris at 26.1% vs. 24.3 in unamended. By amending with 7.5 t/ha of lime dust (CaO), the pastoral value after 24-28 years reaches an average of 77.5 compared to 60.4 in the non-amended variants, 27% higher. Likewise, the production of green mass in the same period reaches 11.79 t/ha for the fined variants compared to 6.72 t/ha for the non-fined ones, with an increase of 81%. Overseeding with grass mixtures has been shown to be better in terms of production than reseeding or natural grassland with wild species. The average production of cow's milk per hectare was evaluated at 3970 litters in the amended variants and 3,120 liters in the unamended one, 850 l/ha more. In the oversown varieties, the average milk production was 3,680 liters per hectare compared to 3460 l/ha, 220 liters more. The factors: calcium amendment and overseeding over a period of almost 30 years in the case of mineral fertilization have the greatest influence on the productivity of subalpine meadows of Nardus stricta in the Carpathians.*

Keywords: subalpine grasslands, calcium amendment, overseeding, reseeding, productivity

DOI 10.56082/annalsarsciagr.2024.2.91

1. Introduction

Permanent grasslands where the grass carpet is dominated by the non-valuable species Nardus stricta L., need to be improved by different methods [1, 2, 5, 7, 8].

The use of mineral fertilizers to improve the grass carpet of a grassland invaded by Nardus stricta is one of the main means known to replace this unwanted species with other valuable forage species [3, 9,10,11,12].

In few cases the experiments on the effect of mineral fertilizers on grasslands dominated by Nardus stricta lasted more than 3-5 years [4, 6].

[1]Researcher PhD. Eng. Teodor MARUȘCA Research and development Institute for Grasslands Brașov, Full Member of The Academy of Romanian Scientists, E-mail: maruscat@yahoo.com

In the present work, the effect of applying mineral fertilizers after 24-28 years was investigated, a period when profound changes occurred in the grassy carpet of grasslands.

2. Materials and methods

The experience was located at the Mountain Grasslands Research Base "Teodor Marușca" Blana-Bucegi, located at 1,800 m altitude.

Fertilization with chemical fertilizers:

- 1996 (150 N, 44 P, 84 K), 1997 (100 N), 1998 (50 N)
- 2004-2006 idem 1996-1998
- 2011-2013 idem 1996-1998
- 2018-2020 idem 1996-1998
- 2024 idem 1996

The experience established in 1995 had the following graduations of factors:

Factor A: **The type of grass carpet**

1. Semi-natural Nardus stricta grassland after juniper (Pinus mugo) deforestation, a century ago;

2. Overseeded grassland after total weeding with "glyphosate" 5 liters per hectare in 1995, plowed at 2-3 cm and sown with a mixture of perennial forage grasses;

3. Reseeded grassland after total herbicide treatment with "glyphosate", processing with a tiller at a depth of 10-12 cm and sowing grasses.

Factor B: **Calcium amendment**

1. Not fined (Witness);

2. Amended to 2/3 Ah.

The composition of the mixture of herbs for oversowing and resowing: *Festuca pratensis* Transylvania variety 40%; *Phleum pratense* Favorite 25%; *Lolium perenne* Mara 5%, *Lotus corniculatus* Orchard 15%; *Trifolium hybridum* Brașov 5%, species that are not found in the spontaneous flora.

The size of a plot is 18 sqm (6x3).

3. Results and discussions

NPK mineral fertilizers applied in 4 rounds between 1996-2020 and starting the 5th round in 2024, had a strong effect on the natural grass carpet, overseeded and reseeded on unamended and calcium amended soil (Table 1, Part I and II -a).

Thus, on the unamended basis after 24-28 years, the species *Agrostis capillaris* (24.3%), *Festuca nigrescens* (11.9%), *Poa media* (11%) and *Deschampsia flexuosa* (10.5%) dominate.

The unwanted species *Nardus stricta* does not disappear completely participating with 4.2% on the overseeded variants and 12.8% on the natural carpet.

The most valuable species like *Poa pratensis* do not establish themselves from the spontaneous flora and the *Phleum pratense* species sown in 1996 has completely disappeared.

Through calcium amendment, the species *Poa pratensis* reaches 39% in the natural carpet and *Phleum pratense* at 25.6% participation in the overseeded variants.

The *Nardus stricta* species on the amended background has disappeared from the overseeded variants and is still maintained in a small proportion, of 0.8-1.45, on the rest of the grassy carpet variants.

Through calcium amendment, the species *Deschampsia flexuosa*, indicators of strong soil acidity, disappeared from the over-seeded variants and is maintained at a proportion of 0.4-1% in the rest of the grassy carpet variants.

The species *Trifolium repens* on the unamended background barely reaches 2.7% participation and on the amended background it reaches 9.8%, more than 3.6 times higher.

These profound changes in the grass carpet, mainly influenced by the correction of soil acidity by amendment and overseeding as a mode of minimal action on celery influenced the pastoral value and the production of green forage mass (Table 2).

Thus, the highest production was evaluated for the over-sown variants (10.93 t/ha) followed by the resown ones (9.15 t/ha) and those with natural grass carpet (7.7 t/ha).

The calcium amendment factor ensures an 81% increase in green mass compared to no amendment, being the most effective means of improvement along with mineral fertilization.

The pastoral value and the highest milk production were evaluated in the same oversown variants with a 6% increase compared to the natural one and in the amended variants with a 27% increase compared to the unamended ones.

Table 1. Floristic composition, pastoral value and production of green mass of mineral fertilized experimental variants (Blana - Bucegi (2018-2023) – part I

No.	Species	Indices		01 Unamended (%)			
		F	M	11	21	31	Average
1	**Grasses**	**x**	**x**	**72.6**	**78.4**	**87.6**	**79.5**
2	*Agrostis capillaris*	7	5	3.6	34.2	35.2	24.3
3	*Agrostis rupestris*	5	1	3.0	8.0	9.4	6.8
4	*Anthoxanthum odoratum*	5	3	3.0	1.2	0.8	1.7
5	*Deschampsia caespitosa*	3	0	0	0	6.0	2.0
6	*Deschampsia flexuosa*	4	3	13.6	8.2	9.6	10.5
7	*Festuca ovona ovina*	5	4	1.8	0.6	0.2	0.9
8	*Festuca nigrescens*	7	5	19.0	9.4	7.4	11.9
9	*Nardus stricta Poa annua*	3	0	12.8	4.2	8.2	8.4
10	*Poa media*	5	2	12.2	11.8	9.2	11.0
11	*Poa pratensis*	8	6	0	0	0	0
12	*Phleum alpinum*	7	2	3.6	0.8	1.6	2.0
13	*Phleum pratensis* *)	9	8	0	0	0	0
14	**Legumes**	**x**	**x**	**4.4**	**2.2**	**1.4**	**2.7**
15	*Trifolium repens*	8	5	4.4	2.2	1.4	2.7
16	**Other families**	**x**	**x**	**23.0**	**19.4**	**11.0**	**17.8**
17	*Campanula abietina*	3	0	0.2	0.2	0	0.1
18	*Campanula serrata*	3	0	1.8	1.6	1.2	1.5
19	*Geum montanum*	4	1	3.0	0.6	0.2	1.5
20	*Hieracium aurantiacum*	4	2	0.6	0.8	2.0	1.1
21	*Lingusticum mutellina*	7	1	11.6	3.0	1.4	5.3
22	*Potentilla ternata*	4	1	5.4	11.2	3.3	6.6
23	*Rumex acetosella*	3	0	0	0.6	0.2	0.3
24	*Taraxacum officinalis*	7	3	0	0	0	0
25	*Viola declinata*	3	0	0.2	0.6	2.4	1.1
26	Alte specii	3	0	0.2	0.8	0.3	0.3

27	**Pastoral value** (ind.)	**59.5**	**62.7**	**60.4**	**60.9**
28	**Green mass production** (t/ha)	**5.45**	**7.42**	**6.71**	**6.52**

*) *Phleum pratense* cultivated by over or reseeding

Table 1. Floristic composition, pastoral value and production of green mass of mineral fertilized experimental variants (Blana - Bucegi (2018-2023) – part II

Nr. crt	02 Amended (%)				Diff. 02-01(%)	Average (%)			Difference (%)		
	12	22	32	Average		10	20	30	20-10	30-10	30-20
1	**59.2**	**82.6**	**84.6**	**75.5**	**95**	**65.9**	**80.5**	**86.1**	**122**	**131**	**107**
2	2.2	27.6	48.6	26.1	107	2.9	30.9	41.9	1,066	1,444	136
3	0.6	5.6	9.2	5.1	75	1.8	6.8	9.3	378	517	137
4	0.2	0.4	0.9	0.2	12	1.6	0.3	0.9	50	56	113
5	0.6	0.4	0	0.3	15	0.3	0.2	3.0	67	1,000	1,500
6	1.0	0	0.4	0.5	5	7.3	4.1	5.0	56	68	122
7	0.4	0	0	0.1	11	1.1	0.3	0.1	27	9	33
8	11.8	11.0	5.6	9.5	80	15.4	10.2	6.5	66	42	64
9	1.4	0	0.8	0.7	8	7.1	2.1	4.5	30	69	214
10	0.6	1.6	3.6	1.9	17	6.4	6.7	6.4	106	100	96
11	39.0	10.0	7.6	18.9	189	19.5	5.0	3.8	26	19	76
12	1.4	0.4	1.4	1.1	55	2.5	0.6	1.0	24	40	167
13	0	25.6	7.4	11.0	110	0	12.8	3.7	1,280	370	29
14	**12.4**	**8.0**	**9.0**	**9.8**	**363**	**8.4**	**5.1**	**5.2**	**61**	**62**	**102**
15	12.4	8.0	9.0	9.8	363	8.4	5.1	5.2	61	62	102
16	**28.4**	**9.4**	**6.4**	**14.7**	**82**	**25.7**	**14.4**	**8.7**	**44**	**32**	**60**
17	0	0.2	0.4	0.2	50	0.1	0.2	0.8	200	200	100
18	5.0	1.4	0.6	2.3	153	3.4	1.5	0.9	44	26	60
19	1.8	0.6	0.4	0.9	60	2.4	0.6	0.3	25	13	50
20	0.8	0.2	0.4	0.5	36	0.7	0.5	1.2	71	171	240
21	12.0	2.0	1.4	5.1	96	11.3	2.5	1.4	21	12	56
22	3.2	2.2	2.0	2.5	38	4.3	0.7	2.7	156	63	40
23	0.0	0.2	0	0.1	33	0	0.4	0.1	40	10	25
24	1.4	0.6	0	0.6	60	0.7	0.3	0	43	0	0
25	0	0.6	1.0	0.5	45	0.1	0.6	1.7	600	1,700	283
26	4.2	1.0	0.2	1.8	67	2.2	0.9	0.2	41	9	22

27	**75.8**	**80.8**	**76.0**	**77.5**	**127**	**67.6**	**71.8**	**68.2**	**106**	**101**	**95**
28	**9.96**	**14.43**	**11.59**	**11.79**	**181**	**7.70**	**10.93**	**9.15**	**142**	**119**	**84**

Table 2. The influence of improvement factors on cow milk production in mineral fertilized variants.

The improvement factor	Technology variants	Green mass production		Pastoral value (ind)	Milk production	
		t/ha	%		L/ha	%
A. The type of grassy carpet	1. Natural	7.70	100	67.6	3,460	100
	2. Overseeding	10.93	142	71.8	3,680	106
	3. Reseeding	9.15	119	68.2	3,500	101
B. Calcium amendment	1. Not amended	6.52	100	60.9	3,120	100
	2. Amended	11.79	181	77.5	3,970	127

The average milk productions of 3680 liters per hectare on the oversown variants and of 3,970 liters per hectare on the amended variants, after 24-28 years of application, are extremely edifying, for the influence of the two improvement factors of the subalpine Nardus stricta grasslands located at 1,800 m altitude in the Bucegi Massif.

Conclusions

(1). Subalpine grasslands invaded by *Nardus sticta* can be improved by calcium amendment, overseeding and mineral fertilization;

(2). The most important factors with a long-term effect, in addition to mineral fertilization, are calcium amendment that can ensure a production of 3970 liters of cow's milk per hectare and overseeding with 3680 liters per hectare on average from 24-28 years after application:

(3). The long-term effect on the production of green mass and milk per hectare also affects the conservation of biodiversity and the protection of the environment.

R E F E R E N C E S

[1] Cernelea E., Bistriceanu C, Cultura și exploatarea pajiștilor montane Culture and mountaneous grasslands management, “Ceres” Publishing House, București. (1977).

[2] Marușca T., Sisteme de înfiinţare a pajiştilor temporare pe suprafețele dominate de Nardus stricta L. Lucrări ştiinţifice ale SCCP Măgurele Braşov, vol.III, pag.35-49, Redacția materiale de propagandă agricolă, Bucureşti, (1977).

[3] Marușca, T., Mocanu, V., Blaj, V. A., Effect of improvement tehnologies on subalpine pastures in milk production of dairy cows. Proceedings of the 19th General Meeting of the

European Grassland Federation, Multi – Function Grasslands, Grassland Science in Europe, Vol. 7, pp 1052-1053, La Rochelle, France (2002).

[4] Marușca, T., Blaj, V. A., Mocanu, V., Andreoiu, A.C., Zevedei, P. M., Long term influence of botanical composition of alpine pastures on cow milk production, Proceedings of the 27th General Meeting of the European Grassland Federation, EGF, Vol. 23, pp. 283-285, Cork, Ireland, 17-21 iunie, (2018).

[5] Marușca, T., Contributions to the evaluation of pasture productivity using the floristic relevee, Romanian Journal of Grassland and Forage Crops No. 19, Cluj – Napoca, pp. 33-47, (2019).

[6] Marușca, T., Long-term effect of technological improvement factors of subalpine grasslands of Nardus stricta from the Carpathians Mountains, Romanian Journal of Grassland and Forage Crops, Cluj Napoca, no.26 pp.15-25 (2022).

[7] Niedermaier, K., Marușca, T., Ecology of sward types in some zones of Romania and their yield potential, Experiment results obtained in the Brașov district, when changing Nardus stricta swards into productive swards. Use and management of natural resources. Contribution of Romania to the International Biological Programme for 1968 an 1969, pp. 5-6, Bucharest 1970, (1969).

[8] Obrazencu, Gr., Răspândirea și combaterea speciei *Nardus stricta*, Agricultura Nouă no.6, pp.185-194, București (1941).

[9] Puşcaru, D., Puşcaru- Soroceanu, E., Păucă, A., Şerbănescu, I., Beldie, Al., Ştefureac, Tr., Cernescu, N., Saghin, F., Creţu, V., Lupan, L., Taşcenco, V., Păşunile alpine din Munţii Bucegi, Edit. Acad. Române, Bucureşti (1956).

[10] Rezmeriță, I., Pajiștile Masivului Vlădeasa, Flora, vegetația și potențialul productiv, Teză de doctorat, Institutul Agronomic Timișoara (1969).

[11] Safta, I., Pavel, C., Pavel, A., Procedeul Rânca pentru combaterea năgarei (Nardus stricta) și pentru ridicarea productivității pajiștilor de munte, ”Probleme actuale de biologie și științe agricole”, Editura Academiei RSR, București (1960).

[12] Samoilă, Z., (sub coord.), Pajiştile din Banat, sporirea producţiei şi îmbunătăţirea calităţii lor, Redacţia de propagandă tehnică agricolă, București (1979).