IMPROVING THE EFFECTS OF *Nardus stricta* L. SHEEPFOLD THROUGH HERBICIDES, CALCIC AMENDMENT AND OVERSOWING

BLAJ V.A.[*], MARUȘCA T.[*,], ANDREOIU C. Andreea[*]**

[*]*Grassland Research and Development Institute, Brașov*
[**] *Coresponding author e-mail: maruscat@yahoo.com*

Abstract

Degraded grassland of Nardus stricta have a wide spread in the Carpathians of Romania. One of the main methods of improvement is the sheepfold with animals which can improve a maximum of 15 - 20% of the surface. In order to increase the effect of this classical sheepfold method a bi-factorial experience has been placed in the Bucegi Mountains, at 1800 m altitude. The main experimental factor was the total herbicidation with glyphosate, followed by calcium amendment, 4-night sheepfold with a cow on a 6 m^2 surface and over-sowing with perennial herbs in 2009, followed by sheepfold in the autumn of the year 2013.

The 8-year results (2010 - 2013) highlighted the very good effect of herbicide for the success of over-sowing as well as of the calcification amendment on both dry matter production, feed quality and soil agrochemical properties.

Keywords: *Nardus stricta* meadows, paddocking, spraying, liming, over sowing

INTRODUCTION

The improvement of *Nardus stricta* degraded meadows by sheepfold with animals is a method well known in the Carpathians of Romania (Puscaru *et al*., 1956; Bârbulescu and Motcă, 1983).

This method of improvement on a constant surface of *Nardus stricta* grasslands cannot exceed 15-20% of the total surface (Maruşca, 2016).

In order to increase the improved grassland surface, the production and the quality of the feed, additional measures such as herbicide, calcification and over sowing of field are needed, measures less used in research and current practice.

MATERIAL AND METHOD

The experience was placed on a degraded *Nardus stricta* grassland located at 1,800 m altitude, on the subalpine floor at the Base for Mountain Grassland Research Blana – Bucegi.

The experimental plot were the following:

Factor A: Herbicide

a1 – no herbicide

a2 – Glyphosate 5 L/ha

Factor B: Calcic amendment

b1 – no amendment

b2 – amendment with 4 t/ha CaO.

After herbicide and amendment in the summer of 2009 grassland were sheepfold with dairy cows 4 nights / 1 cow / 6 m^2. M. After two days of sheepfold, sowing with a mixture of perennial herbs was carried out and the next two days sheepfold were continued.

The perennial forage mixture consisted of: 30% *Phleum pratense*, 30% *Festuca pratensis*, 10% *Lolium perenne*, 5% *Poa pratensis*, 20% *Trifolium pratense* and 5% *Trifolium repens*. The surface of a plot - replicate had a surface of 9 m^2.

The species over sown by animals trampling have risen up properly and have entered well in the winter.

In the following year, 2010, the production of grass and dry matter yield were determined on 1 m^2, at the end of July beginning of August, after which the rest of the surface was grazed with animals in order to get as close as possible to the practical use of the meadow. Prior to harvesting, floristic observations were made using the percentage participation method in the vegetation cover after KLAPP - ELENBERG.

At the end of the 4th experimental year, in the autumn of 2013, the sheepfold with cow was repeated for 4 nights / one cow / 6 m^2, in order to observe the remaining effect of the herbicide and the amendment.

Between the years 2014 and 2017, floristic observations were continued as well as determination of grass production and sampling for chemical analysis performed after the Near Infrared Spectroscopy Technique (NIRS).

Prior to the start of the experiment in the year 2008 and at the end of the year 2017 soil samples for agrochemical analysis were taken, according to the current methodology of ICPA - Bucharest.

RESULTS AND DISCUSSION

Dry matter production

The experimental factors studied have had a significant influence on the dry matter production of the grassland improved by the above-mentioned methods. Thus, the herbicide treatment of the degraded *Nardus stricta* floristic cover allowed the installation of a higher proportion from the over sowing forage mixture to be achieved, resulting in a 20% higher production in the first 4 years compared to the non-herbicidal variant (table 1).

Table 1

The influence of the experimental factor – herbicide - on dry matter production

Average for 2010 – 2013

Herbicide	DM Production		Difference	Signification
	t/ha	%	t/ha	
No herbicide	2,25	100	Ct.	
Glyphosate 5l/ha	2,71	120	0,46	*

DL 5% = 0,35; DL 1% = 0,81; DL 0,1% = 1,83 t/ha

Calcic amendment gives a significant crop increase only in the second period, namely 2014-2017, the effect of amendment being slower (table 2).

Table 2

The influence of calcic amendment on dry matter production

Average for 2014 – 2017

Amendment	DM Production		Difference	Signification
	t/ha	%	t/ha	
No amendment	2,00	100	Ct.	
Amendment with 4 t CaO/ha	2,13	107	+ 0,13	*

DL 5% = 0,11; DL 1% = 0,65; DL 0,1% = 1,21 t/ha

An 8-year average revealed that dry matter production was significant compared to the control (a1b1) only on the herbicide plot and amendment plot (a2b2) where a 32% increase in dry matter production is achieved (table 3).

Table 3

The influence of combined experimental factors on dry matter production

Average for 2010 – 2017

Herbicide	Fertilization	DM prod.	Difference		Signif.
		t/ha	%	t/ha	
a1- No herbicide	**b1**- No amendment	2,05	100	Ct.	
	b2- Amendment with 4 t CaO/ha	2,24	109	0,19	
a2 - Glyphosate 5l/ha	**b1** - No amendment	2,10	102	0,05	
	b2 – Amendment with 4 t CaO/ha	2,70	132	0,65	*

DL 5% = 0,36; DL 1% = 0,60; DL 0,1% = 1,11 t/ha

These production data highlight the combined efficacy of herbicides and amendment, followed by over sowing and sheepfold with

cow in relation to simple sheepfold with cow.

Floral composition

The success of the forage mixture was extremely varied, depending on the experimental factors - herbicide and calcific amendment (table 4). The yearly pre-harvest observations have been synthesized for 2 years in order to reduce the data volume and to observe the dynamics of sown and spontaneous species. After 8 years from over sowing, the only species that are kept in the grassy carpet are: *Phleum pratense* from 30% initially to 26-31% on plots with glyphosate herbicide; *Poa pratensis* from 5% initially increases to 6-7% and *Trifolium repens* from 5% to 9-13% on calcic amendment plots

Of the perennial grasses, *Festuca pratensis* and *Lolium perenne* had the highest regressions in the grassy carpet, which after two years disappeared basically as percentage of participation.

Similarly, *Trifolium pratense* survived two years, from 20% originally managed to install up to 28-37% on the amendment plot, after which only 1-4% remained in the grassy carpet in the following years.

In all the years without exception, oversowing has succeeded better in the herbicide and amendment plots.

On an average of 8 experimental years, the success of over-sowing on herbicide plots was with 74% higher compared to control variant and with 36% higher on amendment plots compared to the no-amendment plot. Similar results were obtained by other researchers (Maruşca and Frame, 2003; Blaj *et al*., 2012) who highlighted that the success of over sowing was extremely influenced by herbicide and the intensity of sheepfold with animals.

As the species sown disappeared, the gaps were supplemented by spontaneous species: *Festuca nigrescens* 12-58%, *Agrostis capillaris* 5-23%, *Ligusticum mutellina* 1-8%, *Deschampsia caespitosa* 1-5% and other species on a percentage between 1- 21%.

On an average of 8 experimental years spontaneous species are maintained at 57% in the grassy carpet, being better represented in the non-herbicide plots sharing 69% of the total compared to 46% of participation on the herbicide plots and a share of 63% of participation on the no-amendment plots compared to 51% in the amendment plots.

Generally the grassy carpet is well-finished, *Nardus stricta* species disappeared and *Deschampsia caespitosa* is on the way to expand on all experimental variants.

Table 4

The success and dynamics of over-sown species depending on herbicide and calcific amendment

% of participation

Specification	Var.	2010 2011	2012 2013	2014 2015	2016 2017	Average	%
Phleum pratense TIROM (30%)	a1b1	10	12	6	7	9	100
	a1b2	17	9	15	12	13	144
	a2b1	32	42	28	22	31	344
	a2b2	22	35	36	22	26	289
Poa pratensis COMPACT (5%)	a1b1	5	4	9	4	4	100
	a1b2	8	5	6	4	6	150
	a2b1	2	2	5	5	4	100
	a2b2	8	6	6	6	7	175
Festuca pratensis TRANSILVAN (30%)	a1b1	3	+	1	1	1	100
	a1b2	6	+	+	+	2	200
	a2b1	4	+	+	+	1	100
	a2b2	6	+	+	+	2	200
Lolium perenne MARTA (10%)	a1b1	+	-	-	-	+	
	a1b2	2	+	-	-	+	
	a2b1	2	-	-	-	+	
	a2b2	3	+	-	-	1	
Trifolium pratense PAVO (20%)	a1b1	16	1	1	+	4	100
	a1b2	28	4	3	+	9	225
	a2b1	19	1	1	+	5	125
	a2b2	37	2	2	+	10	250
Trifolium repens RIESLING (5%)	a1b1	4	7	7	6	6	100
	a1b2	8	10	11	7	9	150
	a2b1	8	6	9	10	8	133
	a2b2	8	12	16	15	13	217
Total specii supraînsămânțate (100%)	a1b1	38	24	18	18	24	100
	a1b2	69	28	35	23	39	162
	a2b1	67	51	43	37	49	204
	a2b2	84	55	50	43	59	246
General average	x	65	40	37	30	43	x
No-herbicide average	10	53	26	26	20	31	100
Herbicide average	20	76	53	47	40	54	174
Difference +, - ; (20-10) % (20-10)	x x	+23 143	+27 204	+21 181	+20 200	+23 174	x x
No-amendment average	01	52	37	30	27	36	100
Amendment average	02	77	42	43	33	49	136
Difference +, - , (20-10) % (20-10)	x x	+25 148	+5 114	+13 143	+6 122	+13 136	x x

Forage chemical composition

Forage chemical analyzes along with the floral composition provide additional useful information about the quality of the grassy carpet (table 5).

Table 5

Forage chemical composition of the improved grassland

Years	Plots	Protein %	Ash %	Crude fiber %	ADF %	ADL %	NDF %	DSU
Average 2011-2013	a1b1	8,40	7,10	36,6	41,4	4,74	64,3	50,1
	a1b2	10,14	7,61	34,2	38,7	4,58	60,2	56,0
	a2b1	8,29	6,37	35,6	39,9	4,46	61,1	53,4
	a2b2	9,79	7,00	36,4	41,3	4,61	63,4	55,9
Average 2014 - 2017	a1b1	8,44	6,72	38,0	40,6	5,06	66,2	51,5
	a1b2	10,64	6,79	37,1	40,0	5,12	65,2	52,3
	a2b1	8,65	6,33	38,0	40,2	5,07	65,3	51,5
	a2b2	10,13	6,64	36,5	39,3	5,06	64,1	53,7
Average 2011-2017	a1	9,43	7,01	36,6	40,2	4,91	64,2	52,4
	a2	9,24	6,57	36,7	40,1	4,84	63,7	53,5
	b1	8,46	6,61	37,2	40,5	4,86	64,4	51,6
	b2	10,21	6,97	36,2	39,8	4,88	63,4	54,3
AVERAGE		9,33	6,79	36,7	40,2	4,87	63,9	52,9

Thus, the average content of crude protein, recorded between the years 2011-2017, varies between 8.46-10.21%, the gross fiber between 36.2-37.2 and the digestibility of the dry substance is 51.6-54.3, all of the quality parameters being in normal limits for the climatic conditions specific to the sub-alpine floor. A particular influence on forage quality was performed by the calcic amendment which gave distinct significant differences in content for protein content and significant differences for the digestibility of the dry substance (table 6). The success of over-sowing with more valuable species in herbicide and amendment plots is also reflected in the forage quality of the grassy carpet.

Agrochemical soil indices

Technological factors for the improvement of the grassy carpet, such as sheepfold and amendment, have had a strong influence on the agrochemical properties of the soil (table 7). Depending on these factors, the soil pH from an initial index of 4.6 increases by 0.2-0.4 units, as well as the saturation degree in the bases by 7-12%, the mobile phosphorus with 5.8- 10.4 ppm while mobile potassium remains almost constant.

Table 6

The influence of calcic amendment on forage quality

Average for 2011 – 2017

Specification	Experimental plots	Indices	Difference		Sem nific.	Limit difference DL
			%	Valoric		
Protein content % CP	b1- No amendment	8,46	100	martor		DL 5% = 0,75 DL 1% = 1,24 DL 0,1% =2,31
	b2- Amendment with 4 t CaO/ha	10,21	121	1,75	**	
Fiber content % CF	b1- No amendment	37,2	100	martor		DL 5% = 0,56 DL 1% = 0,93 DL 0,1% =1,74
	b2- Amendment with 4 t CaO/ha	36,2	97	- 1,0	oo	
Dry matter digestibility DSU	b1- No amendment	51,60	100	martor		DL 5% = 1,84 DL 1% = 3,04 DL 0,1% =5,69
	b2- Amendment with 4 t CaO/ha	54,26	105	2,66	*	
	b2- Amendment with4 t CaO/ha	51,18	106	3,0	*	

Note: * = significant positive difference; **= distinguished significant positive difference; oo=distinguished significant negative difference;

Table 7

Soil agrochemical indices for the year 2017 according to the experimental plots after 9 years

Indices	UM	Initial 2008	a1b1	a1b2	a2b1	a2b2
pH in water	ind. dif. +, –	4,6 0	4,8 + 0,2	4,9 + 0,3	4,8 + 0,2	5,0 + 0,4
V_{Ah}	% dif. +, –	31 0	38 + 7	41 + 10	40 + 9	43 + 12
Humus	% dif. +, –	10 0	11,9 + 1,9	11,8 + 1,8	11,9 + 1,9	11,9 + 1,9
P – AL	ppm dif. +, –	10,6 0	17,9 + 7,3	16,4 + 5,8	17,2 + 6,6	21 + 10,4
K – AL	ppm dif. +, –	97 0	111 + 14	96 - 1	97 0	96 -1
Al^{+++}	me/100 g sol dif. +, – %	6,8 0 100	4,3 - 2,5 63	4,4 - 2,4 65	5,0 - 1,8 73	4,0 - 2,8 59

A particular effect exercised by the grassland improving technology experimented was observed on toxic mobile aluminum, which decreases by 1.8-2.8 me / 100 g of soil, which is very important for the normal growth and development of grassland plants.

CONCLUSIONS

- Simple sheepfold with animals, 4 nights/1 cow or 1 sheep/6 m^2 can be improved by herbicide treatment of the degraded *Nardus stricta* grassland followed by calcic amendment and over sowing prior to the removal of the animals from the field:
- Glyphosate herbicide with 5 l/ha give 20% increases in dry matter production by increasing the success of over sowing with 74% compared to no-herbicide plots;
- Amendment with of 4 t/ha CaO ensures a better installation of perennial legumes, increasing the protein content of the feed and the digestibility of the dry matter, as well as correcting the acidity of the soil;
- The most suitable species for over sowing were *Phleum pratense, Poa pratensis, Trifolium pratense* and *T. repens* and among the spontaneous species the most widespread after grassland improvement were *Festuca nigrescens, Agrostis capillaris* and others;
- Improving the traditional sheepfold of *Nardus stricta* degraded grassland could lead to 4-5 times increases in the production and quality of forage, which can attract allow a greater number of animals per hectare in the mountain area, able to continue the sheepfold on bigger surfaces of degraded grasslands.

REFERENCES

1. Bărbulescu C., Motcă Gh. (1983) High mountain grasslands. Ed. Ceres, Bucureşti.
2. Blaj A.V, Maruşca T., Mocanu V., Haş E.C., Constantinescu S.C. (2012) The combined effect of paddoking, phosphorus fertilization and over sowing on degraded *Nardus stricta L.* pastures. Journal of Mountain Agriculture on the Balkans, vol. 15, nr.3, 2012 pp. 563-575, Published by: Research Institute of Mountain Stockbreeding and Agriculture, Troyan, Bulgaria, ISSN 1311 – 0489.
3. Maruşca T., Frame J. (2003) Pasture improvement strategies in the Carpathians pacage with dairy cows. EGF – 2003, Bulgaria, Optimal Forage Systems for Animal Production and the Environement, Grassland Science in Europe , 8: 219-221.

4. Marușca T. (2016) Paddocking – a model of agricultural best practice on mountain meadows. Muntele Vol. VI – 2016, Journal of Montanology (J-Mont), Revista de Montanologie, pp.87-92.
5. Puşcaru D., Puşcaru-Soroceanu Evdochia, Păucă A., Şerbănescu I., Beldie Al., Ştefureac Fr., Cernescu N., Saghin F., Creţu V., Lupan L., Taşcenco V. (1956) Alpine grassland from Bucegi Mountains. Edit. Acad. R.P.R., Bucureşti.