BIOLOGICAL FIXATION OF THE NITROGEN (NFB) IN THE TEMPORARY GRASSLANDS WITH *Festuca rubra L.*

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ABSTRACT
In the conditions from our country, even *Festuca rubra* is a well spread species in the permanent grasslands from mountains it was less studied in different structures of mixtures for the setting of the temporary grasslands. From this point of view the realised researches had as main purpose the estimation of the fixation capacity of the biological nitrogen (NFB) in the framework of the studied floristic structures. The experiment consisted of a bi-factorial experiment, with the following factor graduations: A- Mixture types: a_1 = *Festuca rubra* L. (100%); a_2 = *Festuca rubra* L. (60%) + *Trifolium repens* L. (40%); a_3 = *Festuca rubra* L. (60%) + *Lotus corniculatus* L. (40%); a_4 = *Festuca rubra* L. (60%) + *Trifolium repens* L. (20%) + *Lotus corniculatus* L. (20%) and B- Nitrogen rates: $b_1 = N_{0;}$ $b_2 = N_{50;}$ $b_3 = N_{100}$. The mixtures of *Festuca rubra* L. and of the legume species we studied produced between 14.03 and 52.25 kg of NFB per ha per year. With no nitrogen fertilisation, the amount of NFB ranged between 14.03 and 48.01 kg/ha/year. The largest amounts of NFB were produced by the complex mixture, where the share of legumes and of dry matter also was higher than in the other types of mixtures we analysed.

Keywords: *Festuca rubra* L., *Lotus corniculatus* L., *Trifolium repens* L., biologically fixed nitrogen

INTRODUCTION

Within the floral structure of the permanent grasslands, red fescue (*Festuca rubra* L.) can be an important species due to both its higher adaptation to different ecological conditions and to its longer longevity compared to other similar species.
I the soil and climate conditions of Romania, though *Festuca rubra* L. is a very widespread species, it has been less studied as a cultivated species in different mixture compositions in the establishment of temporary grasslands. Within the gramineae – legume associated crops and, implicitly, within the mixtures destined to the crops of temporary grasslands, the share of legume species is the most important factor in achieving large amounts of biologically fixed nitrogen (NFB) (DRAGOMIR AND DRAGOMIR, 2012). Our research aim at estimating the amounts of biologically fixed nitrogen (BFN) with the participation of a certain percentage of legumes to the floristic composition of three types of mixtures based on *Festuca rubra* L.

MATERIAL AND METHOD

Research was carried out within the Grassland Research-Development Station in Timisoara, on a brown eumesobasic moderately vertic-gleyied soil, with deep alkalinisation (poor below 100 cm), moderately decarbonised, strongly clogged by water, on medium fine / medium fluviatile deposits, medium loam / medium clayish loam.
The experiment consisted of a bi-factorial experiment, with the following factor

graduations:
A. Mixture types:
a_1 = *Festuca rubra* L. (100%);
a_2 = *Festuca rubra* L. (60%) + *Trifolium repens* L. (40%);
a_3 = *Festuca rubra* L. (60%) + *Lotus corniculatus* L. (40%);
a_4 = *Festuca rubra* L. (60%) + *Trifolium repens* L. (20%) + *Lotus corniculatus* L. (20%);
B. Nitrogen rates: $b_1 = N_{0;}$ $b_2 = N_{50;}$ $b_3 = N_{100}$

The experiment was set in the field after the subdivided plot method, with four replicas, on 20 m^2-experimental plots.
Sowing was done in spring, with an experimental pneumatic cultivator on 8 rows. Before sowing, we applied 250 kg of complex fertilisers (15:15:15) per ha. In the first vegetation year, we mowed twice to destroy the weeds without measuring the yield. Starting with the second vegetation year, the nitrogen rates were applied as follows: N_{50} at the beginning of spring, and N_{100} in two rates (N_{50} at the beginning of spring and N_{50} after the first harvest). The biological material used in sowing consisted of the Romanian varieties Pastoral (*Festuca rubra* L.), Carmen (*Trifolium repens* L.) and Nico (*Lotus corniculatus* L.).
During vegetation periods, we measured the yield of fodder biomass per vegetation year and per harvest, and we assessed the amount of biologically fixed nitrogen (NFB).
In order to assess the amount of biologically fixed nitrogen (NFB), we used the nitrogen balance method calculating the difference between the total amount of nitrogen exported from the mixture of *Festuca rubra* L. and the species of perennial legumes, and the total amount of nitrogen exported by the pure crop of *Festuca rubra* L. (GRANSTEDT, 1992; RAZEC ET AL., 2001, KRISTENSEN ET AL., 2004; DRAGOMIR ET AL., 2009).

RESULTS

The legume species in the floristic composition of temporary grasslands produce symbiotically important amounts of biologically fixed nitrogen of which some is used in the plants' own metabolism and the rest is supplied to the gramineae. This amount of nitrogen transferred to the gramineae represents, through the decomposition of part of the legumes' roots during vegetation, 20-30% of the total amount of biologically fixed nitrogen. This amount of nitrogen covers up to 50% of the necessary amount of nitrogen on temporary grasslands, where legume species play an important role.

Table 1. The influence of mixture type and of nitrogen fertilisation on the biologically fixed nitrogen (NFB) (first year of production)

Mixture type	N rate	Dry matter (kg/ha)	Nt (%)	Total N (kg/ha)	NFB (kg/ha)
Festuca rubra* L. *(100%)	N_0	2800	1.56	43.68	0.00
	N_{50}	3500	1.60	56.00	0.00
	N_{100}	4375	1.81	79.19	0.00
Festuca rubra* L. *(60%)* + *Trifolium repens* L. *(40%)	N_0	3400	1.60	54.40	10.72
	N_{50}	4500	1.73	77.85	21.85
	N_{100}	4800	1.98	95.04	15.85
Festuca rubra* L. *(60%)* + *Lotus corniculatus* L. *(40%)	N_0	5100	1.62	82.60	38.92
	N_{50}	5500	1.72	94.60	38.60
	N_{100}	6350	1.86	118.11	38.92
Festuca rubra* L. *(60%)* + *Trifolium repens* L. *(20%)* + *Lotus corniculatus* L. *(20%)	N_0	5400	1.74	93.96	50.28
	N_{50}	6000	1.83	109.80	53.80
	N_{100}	6400	2.05	131.20	52.01

Quantifying fixed nitrogen in the first production year by applying the reference species determination method (in our case, *Festuca rubra* L.), pointed out rather large amounts of NFB – 10.72 – 53.80 kg/ha – depending on the following factors: share of legumes, nitrogen fertilisation, dry matter production, and total amount if nitrogen in the fodder (Table 1.).

In the variants not fertilised with nitrogen, the amount of NFB differentiated depending on the mixture type, as follows: the mixture of *60% Festuca rubra* L. *+ 40% Trifolium repens* L. produced 10.72 kg of NFB per ha; the mixture of *60% Festuca rubra* L. *+ 40% Lotus corniculatus* L. produced 38.92 kg of NFB per ha; the mixture of *60% Festuca rubra* L. *+ 20% Trifolium repens* L. *+ 20% Lotus corniculatus* L. produced 50.28 kg of NFB per ha.

Table 2. The influence of mixture type and of nitrogen fertilisation on the biologically fixated nitrogen (NFB) (second year of production)

Mixture type	N rate	Dry matter (kg/ha)	Nt (%)	Total N (kg/ha)	NFB (kg/ha)
Festuca rubra* L. *(100%)	N_0	3095	1.56	48.28	0.00
	N_{50}	3800	1.60	60.80	0.00
	N_{100}	4513	1.81	81.69	0.00
Festuca rubra* L. *(60%) + Trifolium repens* L. *(40%)	N_0	4268	1.60	68.29	20.01
	N_{50}	4800	1.73	83.04	22.24
	N_{100}	5263	1.98	104.21	22.52
Festuca rubra* L. *(60%) + Lotus corniculatus* L. *(40%)	N_0	5100	1.62	82.62	34.34
	N_{50}	5708	1.72	98.18	37.38
	N_{100}	6525	1.86	121.37	39.68
Festuca rubra* L. *(60%) + Trifolium repens* L. *(20%) + Lotus corniculatus* L. *(20%)	N_0	5688	1.74	98.97	50.69
	N_{50}	6560	1.83	120.08	59.28
	N_{100}	6813	2.05	139.67	57.98

In the second production year, the amount of NFB ranged between 20.01 and 59.28 kg/ha. In the variants not fertilised with nitrogen, these amounts ranged between 20.01 and 50.69 kg/ha. Within each mixture type, nitrogen fertilisation had no high impact on the amount of NFB, the values reached being rather close to the control variants. Among mixtures, we noted the mixture *60% Festuca rubra* L. *+ 20% Trifolium repens* L. *+ 20% Lotus corniculatus* L. which produced between 50.69 and 59.28 kg of NFB per ha (Table 2).

Table 3. The influence of mixture type and of nitrogen fertilisation on the biologically fixated nitrogen (NFB) (third year of production)

Mixture type	N rate	Dry matter (kg/ha)	Nt (%)	Total N (kg/ha)	NFB (kg/ha)
Festuca rubra* L. *(100%)	N_0	2580	1.56	40.25	0.00
	N_{50}	3465	1.60	55.44	0.00
	N_{100}	4038	1.81	73.09	0.00
Festuca rubra* L. *(60%) + Trifolium repens* L. *(40%)	N_0	3225	1.60	51.60	11.35
	N_{50}	3948	1.73	68.30	12.86
	N_{100}	4200	1.98	83.16	10.07
Festuca rubra* L. *(60%) + Lotus corniculatus* L. *(40%)	N_0	4530	1.62	73.39	33.14
	N_{50}	5083	1.72	87.43	31.99
	N_{100}	5570	1.86	103.60	30.51
Festuca rubra* L. *(60%) + Trifolium repens* L. *(20%) + Lotus corniculatus* L. *(20%)	N_0	4788	1.74	83.31	43.06
	N_{50}	5280	1.83	96.62	41.18
	N_{100}	5843	2.05	119.78	46.69

Assessing the amount of NFB in the third production year pointed out a slight decrease because of the decrease of the dry matter production (Table 3.). Thus, the variation limits of this parameter ranged between 10.07 and 46.69 kg of NFB per ha. In the control variants, the amounts of NFB ranged between 14.03 and 48.01 kg/ha. This year too, the complex mixture of *60% Festuca rubra* L. *+ 20% Trifolium rubra* L. *+ 20% Lotus corniculatus* L. produced the highest amounts of NFB (between 41.18 and 46.69 kg/ha).

Table 4. The influence of mixture type and of nitrogen fertilisation on the biologically fixated nitrogen (NFB) (multiyear average)

Mixture type	N rate	Dry matter (kg/ha)	Nt (%)	Total N (kg/ha)	NFB (kg/ha)
Festuca rubra* L. *(100%)	N_0	2825	1.56	44.07	0.00
	N_{50}	3588	1.60	57.41	0.00
	N_{100}	4308	1.81	77.97	0.00
Festuca rubra* L. *(60%) + Trifolium repens* L. *(40%)	N_0	3631	1.60	58.10	14.03
	N_{50}	4416	1.73	76.40	18.99
	N_{100}	4754	1.98	94.13	16.16
Festuca rubra* L. *(60%) + Lotus corniculatus* L. *(40%)	N_0	4910	1.62	79.54	35.47
	N_{50}	5430	1.72	93.40	35.99
	N_{100}	6148	1.86	114.35	36.38
Festuca rubra* L. *(60%) + Trifolium repens* L. *(20%) + Lotus corniculatus* L. *(20%)	N_0	5292	1.74	92.08	48.01
	N_{50}	5947	1.83	108.83	51.42
	N_{100}	6352	2.05	130.22	52.25

Data presented in Table 4. show that, on the average for the three production years, the mixtures of *Festuca rubra* L. and the legume species studied produced between 14.03 and 52.25 kg of NFB per ha. When there was no nitrogen fertilisation, the amount of BFN ranged between 14.03 and 48.01 kg/ha/year. The largest amounts of NFB were produced by the complex mixture where the share of legumes and the production of dry matter were higher than in the other types of mixtures we studied (between 48.01 and 52.25 kg of NFB per ha).

CONCLUSIONS

The mixtures of *Festuca rubra* L. and of the legume species we studied produced between 14.03 and 52.25 kg of NFB per ha per year. With no nitrogen fertilisation, the amount of NFB ranged between 14.03 and 48.01 kg/ha/year. The largest amounts of NFB were produced by the complex mixture, where the share of legumes and of dry matter also was higher than in the other types of mixtures we analysed.

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