RESEARCH ON IMPROVING NITROGEN STOCK ON *DICHANTHIUM ISCHAEMUM* (L.) ROBERTY MEADOWS, THROUGH OVERSEEDING

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Abstract

*Nitrogen stocks on grasslands are very important reservoirs with role in plant productivity, soil health and global carbon regulation. Improving nitrogen stocks on meadows by overseeding involves introducing atmospheric N-fixing legumes, such as sainfoin into existing plants cover. The purpose of the research conducted during the 2022-2025 agricultural period, at the Research and Development Station for Meadows Vaslui, was represented by the increasing amount of nitrogen fixed on a degraded Dichanthium ischaemum (*L.) Roberty *meadow by overseeding with the Bromus inermis* Leyss. *(smooth brome) and Onobrychis viciifolia* Scop. *(sainfoin) species. The results obtained have shown that in the second year of overseeding, 2025, from the production of plants has been obtained a quantity of nitrogen 2.5-3.5 times higher than the control variant, and from the productin of roots a quantity of 0.5-0.8 times higher than the control variant. Compared to the soil nitrogen stock, the one obtained from plants production was on average 0.30-0.66 %, and the one obtained from the production of roots was on average 1.04-1.63 %, the average nitrogen stock of the Dichanthium ischaemum* (L.) Roberty *meadow being of 1.663 Mg·ha^{-1} N and as a result the overseeding of the degraded permanent Dichanthium ischaemum* (L.) Roberty *meadow with the Bromus inermis* Leyss. *50 % and Onobrychis vicifolia* Scop. *50 % mixture to achieve the best results in terms of feed production and nitrogen stock, it can be recommended.*

Keywords: plants production, roots production, soil nitrogen stock

INTRODUCTION

Nitrogen stocks on grasslands are very important reservoirs that drive plant productivity, sustain soil health, and regulate global carbon cycles. These stocks, which include organic nitrogen in the soil and above-ground plant biomass, determine the resilience of the ecosystem. The dynamic flow of nitrogen allows grasslands to support livestock grazing, foster plant diversity, and act as significant carbon sinks (Guo L.B., et al, 2007; Ai Z.M. *et al*,

2017: Sariyildiz T. *et al*, 2017; Kizeková M. *et al*, 2024).

Efficient nitrogen retention within the soil-plant system is critical for preventing environmental pollution, such as nitrogen leaching or nitrous oxide emissions. Managing grasslands to maintain robust nitrogen stocks is fundamental for long-term sustainable agriculture, soil fertility, and climate change mitigation (Cong W.F. *et al*, 2014; Dlamini P. *et al*, 2014; Nyameasem J.K. *et al*, 2020).

Improving nitrogen stocks on grasslands involves combining targeted organ and nonorganic additions, biodiversity management, and controlled grazing to build soil organic matter and optimize nutrient cycling (Monaghan R.M. et al, 2005; Liu X. *et al*, 2020; Da Silva L.S. *et al*, 2022; Chen L. *et al*, 2023).

Improving nitrogen (N) stocks on meadows by overseeding involves introducing atmospheric N-fixing legumes, such as sainfoin, clover or trefoil, into existing plants cover. These plants partner with *Rhizobium* bacteria to convert atmospheric nitrogen into plant-available N, improving soil fertility and forage quality without relying on synthetic fertilizers (De Deyen G.B. *et al*, 2009; Juarena M. *et al*, 2016).

The researches carried out in the 2023-2025 agricultural period, within the Soleşti location of the Research and Development Station for Meadows (RDSM), Vaslui, was represented by the increasing the amount of nitrogen fixed on a degraded *Dichanthium ischaemum* (L.) Roberty meadow by overseeding with the *Bromus inermis* Leyss. (smooth brome) and *Onobrychis viciifolia* Scop. (sainfoin) species.

MATERIAL AND METHOD

The research was carried out in the 2023-2025 agricultural period at the Research and Development Station for Meadows (RDSM), Vaslui, Soleşti location.

The aim of the research was to increase the amount of nitrogen fixed on a degraded *Dichanthium ischaemum* (L.) Roberty meadow by overseeding with the *Bromus inermis* Leyss. and *Onobrychis viciifolia* Scop. species.

In order to achieve the proposed goal and objectives, in the experimental field (from the Solesti commune) of RDSM Vaslui was placed an experience, organized according to the method of randomized blocks, with 5 variants, in 3 replications.

The area of each variant was 100 m^2 (10 m × 10 m), and the harvestable area was 81 m^2 (9 m × 9 m). The total experience area was 1600 m^2 (50 m × 32 m).

Experimental factor was

applied management, with five graduations:

v_1 - abandonment;

v_2 - harvested by mowing (control variant);

v_3 - overseeded with *Bromus inermis* Leyss. 100%, harvested by mowing;

v_4 - overseeded with *Bromus inermis* Leyss. 75 % and *Onobrychis vicifolia* Scop. 25 %, harvested by mowing;

v_5 - overseeded with *Bromus inermis* Leyss. 50 % and *Onobrychis vicifolia* Scop. 50 %, harvested by mowing.

Biological material used for overseeding was represented by the *Bromus inermis* Leyss. Mihaela variety and *Onobrychis vicifolia* Scop. Anamaria variety, varieties created at RDSM, Vaslui, Romania. The species in the mixture are best adapted to the climatic conditions and soil in the study area. Overseeding was performed in March 2024.

In this paper are presented the results from the first year and the second year from the overseeding, respectively the years 2024 and 2025.

Initially, in the *Dichanthium ischaemum* (L.) Roberty meadow plants cover, 55 species were identified, 7 species have very good feed value, 3 species have good value, 15 species have medium value, 4 species have low value, 6 species have very low value, 13 species are without fodder value, 5 species are harmful (harming products obtained from animals: 3 species depreciate the wool of animals, 1 species depreciates the quality of milk and 1 species that harm grassland vegetation), and two species are toxic.

In general, the agricultural year 2023-2024 was rainy, with high rainfall, only that the lack of rainfall in the periods from over-seeding, to starting in vegetation, were small, led to a water stress, and during periods of high rainfall they had an uneven distribution. The same happened in the agricultural year 2024-2025, which was a rainy year, with precipitation in large quantities in some periods, but also with periods of water stress, the vegetation conditions being not ideal.

The nitrogen stock in the grassland was assessed by summing up the amount of nitrogen obtained by harvesting the production of dry matter, the amount of nitrogen obtained from the evaluation of the root system and the unharvested aerial part by mowing and the existing nitrogen stock in the soil.

The evaluation of the root quantity was made by harvesting, from each variant, monoliths with dimensions of 0.027 m^3 (0.3 m × 0.3 m × 0.3 m), followed by root recovery through wetting, drying and weighing and analysis

The dry matter content (DM) was determined by SR ISO 6496/2001 standard.

Total nitrogen content from plant and root samples was

determined using the Vario MCRO Cube elemental analyzer - PT 162 by SR ISO 10694/1998 standard.

The nitrogen content from the soil was determined using the Kjeldahl method by STAS 7184/2-85, PTL 09 standard.

Final results were statistically interpreted by analyzing the variance and calculating the least significant differences.

RESULTS AND DISCUSSIONS

In the two years of research, the results obtained were different, because in 2024 the work of over-seeding was reallized, and the plants were poorly developed, their productive potential manifesting in 2025, which was year 2 of vegetation. Also, climatic conditions played a very important role in plant growth and development, in 2025 the conditions being more favorable.

In 2024, the average plants production was 0.501 Mg·ha^{-1} DM, ranging from 0.426 Mg·ha^{-1} DM to the abandonment variant, to 0.565 Mg·ha^{-1} DM to the overseeded with *Bromus inermis* Leyss. 50 % and *Onobrychis vicifolia* Scop. 50 %, harvested by mowing variant.

The total nitrogen content of plants varied between 0.95-0.99 %, being higher in the case of abandonment variant and to the overseeded with *Bromus inermis* Leyss. 100 %, harvested by mowing variant and there was no direct correlation with the applied management.

From the production of plants has been obtained a quantity of nitrogen that varied between 0.0040-0.0053 Mg·ha^{-1} N, the highest values being obtained at the variants where overseeded was made.

The average roots production was 3.571 Mg·ha^{-1} DM, ranging from 3.555 Mg·ha^{-1} DM to the control variant (harvested by mowing), to 3.578 Mg·ha^{-1} DM to the overseeded with *Bromus inermis* Leyss. 75 % and *Onobrychis vicifolia* Scop. 25 %, harvested by mowing variant.

The total nitrogen content of roots varied between 0.47-0.48 %.

From the production of roots has been obtained a quantity of nitrogen that varied between 0.0167-0.0172 Mg·ha^{-1} N, the highest values being obtained at the variants where overseeded was made.

Both in the case of plants, but also in the case of roots the N production increased due to the increase of the dry mass production and this increased due to the presence of the two species within the meadows vegetation coverage and they contribute with biomass to the formation of production.

Compared to the nitrogen stock in plants and roots, the soil stock is huge. The values were

between 1.557-1.652 Mg·ha^{-1} N. The contribution of the two species with which the grassland was overseeded, even if it was a small one, it was statistically ensured, in the case of total nitrogen production, where, in the case of v_4 and v_5 variants the differences were very significant, most likely due to the presence of *Onobrychis vicifolia* Scop. species, is known to be a nitrogen-fixing one.

On average, in 2024, 98.66 % of nitrogen stock came from soil reserve, 1.04 % from root production and 0.60 % from plant production (table 1).

In 2025, the average plants production was 0.810 Mg·ha^{-1} DM, ranging from 0.395 Mg·ha^{-1} DM to the abandonment variant, to 1.188 Mg·ha^{-1} DM to the overseeded with *Bromus inermis* Leyss. 50 % and *Onobrychis vicifolia* Scop. 50 %, harvested by mowing variant.

The total nitrogen content of plants varied between 0.85-1.54 %, being higher in the all overseeded variants and there was a direct correlation with the applied management. From the production of plants has been obtained a quantity of nitrogen that varied between 0.0034-0.0183 Mg·ha^{-1} N, the highest values being obtained at the variants where overseeded was made (2.5-3.5 times higher than the control variant).

The average roots production was 5.537 Mg·ha^{-1} DM, ranging from 3.492 Mg·ha^{-1} DM to the abandonment variant, to 7.651 Mg·ha^{-1} DM to the overseeded with *Bromus inermis* Leyss. 50 % and *Onobrychis vicifolia* Scop. 50 %, harvested by mowing variant.

The total nitrogen content of roots varied between 0.47-0.41 %, and from the production of roots has been obtained a quantity of nitrogen that varied between 0.0164-0.0375 Mg·ha^{-1} N, the highest values being obtained at the variants where overseeded was made.

Both in the case of plants, but also in the case of roots the N production increased due to the increase of the dry mass production and this increased due to the presence of the two species within the meadows vegetation coverage and they contribute with biomass to the formation of production.

The largest growths were in the case of roots, due to the fact that in the *Bromus inermis* Leyss. species the plants begin to develop stolons, and in the case of *Onobrichys vicifolia* Scop. species root thickens year after year, being a taproot system.

In the case of total nitrogen production, difference in production in the case of v_3 variant was significat, and in the case of v_4 and v_5 variants the differences were very significant, the contribution being of both species with which it was overseeded.

On average, in 2024, 97.71 % of nitrogen stock came from soil reserve, 1.63 % from root production and 0.66 % from plant production (table 2).

Table 1

The influence of the applied management on the nitrogen stock of the *Dichanthium ischaemum* (L.) Roberty meadow, in 2024

2024	Plants production			Roots production			Soil N production	Total N production
Variant	Mg·ha^{-1} DM	N %	Mg·ha^{-1} N	Mg·ha^{-1} DM	N %	Mg·ha^{-1} N	Mg·ha^{-1} N	Mg·ha^{-1} N
v_1	0.426	0.98	0.0042	3.588	0.47	0.0169	1.557	1.578^{ns}
v_2 $^{(C)}$	0.427	0.94	0.0040	3.555	0.47	0.0167	1.577	1.598^{C}
v_3	0.525	0.99	0.0052	3.578	0.48	0.0172	1.593	1.615^{ns}
v_4	0.560	0.95	0.0053	3.569	0.48	0.0171	1.649	1.671***
v_5	0.565	0.94	0.0053	3.566	0.48	0.0171	1.652	1.674***
Average	0.501	0.96	0.0048	3.571	0.48	0.0170	1.606	1.627*
%			0.30			1.04	98.66	100

^{c} - control variant; ^{ns} - not significant;
LSD 0.5 = 0.020 Mg·ha^{-1} N; LSD 0.1 = 0.031 Mg·ha^{-1} N; LSD 0.01 = 0.046 Mg·ha^{-1} N.

Table 2

The influence of the applied management on the nitrogen stock of the *Dichanthium ischaemum* (L.) Roberty meadow, in 2025

2025	Plants production			Roots production			Soil N production	Total N production
Variant	Mg·ha^{-1} DM	N %	Mg·ha^{-1} N	Mg·ha^{-1} DM	N %	Mg·ha^{-1} N	Mg·ha^{-1} N	Mg·ha^{-1} N
v_1	0.395	0.85	0.0034	3.492	0.47	0.0164	1.576	1.596^{ns}
v_2 $^{(C)}$	0.511	1.05	0.0054	4.061	0.51	0.0207	1.596	1.622^{C}
v_3	0.850	1.49	0.0127	6.080	0.48	0.0292	1.612	1.654*
v_4	1.104	1.39	0.0153	6.399	0.50	0.0320	1.668	1.716***
v_5	1.188	1.54	0.0183	7.651	0.49	0.0375	1.671	1.727***
Average	0.810	1.26	0.0110	5.537	0.49	0.0272	1.625	1.663**
%			0.66			1.63	97.71	100

^{C} - control variant; ^{ns} - not significant;
LSD 0.5 = 0.024 Mg·ha^{-1} N; LSD 0.1 = 0.037 Mg·ha^{-1} N; LSD 0.01 = 0.055 Mg·ha^{-1} N.

Compared to the year 2024, in the year 2025, at each of the variants where it was overseeded, both plant production, but especially root production, contributed to the increase of nitrogen stock in the *Dichanthium ischaemum* (L.) Roberty meadow. If plant production, along with its nitrogen stock, by being valued as feed, leaves the meadow, the roots remain and replenishes the soil's N stock year by year. Thus, it turns out that the overseeding of degraded permanent meadows with mixtures consisting of perennial grasses and legumes for feed will lead to an increase in nitrogen stock.

CONCLUSIONS

In the 2023-2025 agricultural period nitrogen stock of the *Dichanthium ischaemum* (L.) Roberty meadow grew as a result of the work of overseeding with the species *Bromus inermis* Leyss. and *Onobrychis vicifolia* Scop., in various proportions.

In the second year of overseeding, 2025, from the production of plants has been obtained a quantity of nitrogen 2.5-3.5 times higher than the control variant, and from the productin of roots a quantity of 0.5-0.8 times higher than the control variant.

Compared to the soil nitrogen stock, the one obtained from plants production was on average 0.30-0.66 %, and the one obtained from the production of roots was on average 1.04-1.63 %, the average nitrogen stock of the *Dichanthium ischaemum* (L.) Roberty meadow being of 1.663 $Mg \cdot ha^{-1}$ N.

Following the results obtained, it can be recommended the overseeding of the degraded permanent *Dichanthium ischaemum* (L.) Roberty meadow with the *Bromus inermis* Leyss. 50 % and *Onobrychis vicifolia* Scop. 50 % mixture to achieve the best results in terms of feed production and nitrogen stock.

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