

ON THE POTENTIAL OF USING ALFALFA FOR RIPARIAN GRASSLAND RENOVATION AND MULTIFUNCTIONAL USE

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Abstract

The objective of the study was to present the cropping results of a selection of alfalfa varieties that were consistently good in fodder quality and agronomic performance. The field trials were performed in Gherghița Plain using more than 20 varieties from which 6 (3 Romanian and 3 foreign varieties) were selected that are deemed to be suitable in mixtures for riparian grasslands renovation or for overseeding operations. The growth rate, average DM yield, and height were presented numerically, while the tillering capacity and forage quality used a five steps rank (1-low; 5-excellent). Then, the multiannual ranks of the characteristics were used in a weighted regression in which more weight was given to the observations with smaller variance. The presented varieties showed good adaptability and biological efficiency potential for using them in the Romanian eco-climatic conditions. Romanian varieties could have a plus for winter hardiness and valorization of excessive moisture existing in riparian grasslands. Future work will consider field trials in representative riparian grasslands with grass-alfalfa mixtures with one variety and various combinations of alfalfa varieties.

Keywords: riparian grasslands, legumes, *Medicago sativa* L., growth rate, renovation, yield ranking

INTRODUCTION

Riparian zones are crucial interfaces between streams and terrestrial ecosystems (LARSON *et al.* 2019). The grasslands located in riparian zones near streams were found to be sensitive to disturbance and likely impart relatively greater influence on stream structure and function than the upslope of the watershed (LARSON *et al.* 2019). The

anthropic influence on this type of grasslands is significant due to various activities such as modifications of floristic composition, water and soil pollution, overgrazing or mismanagement, the existence of gravel pits, etc. (DUNEA *et al.*, 2021; BREȚCAN *et al.*, 2022). The management of grazed riparian areas is critically important to agricultural sustainability and environmental

quality (BUTLER *et al.*, 2008). Furthermore, the role of riparian zones in biogeochemically linking aquatic and terrestrial habitats was clearly underlined in the literature (IORDACHE and NEAGOE, 2023; BUTLER *et al.*, 2008).

Consequently, the vegetation existing in the grasslands has an important ecological role and the presence of the valuable species, either grasses or legumes in proper participation, is required to keep their pastoral value and multifunctional role (BĂRBULESCU *et al.*, 1991; MOTCĂ *et al.*, 1994; DUNEA and DINCĂ, 2014; SAMUIL *et al.*, 2018; COTIGA *et al.*, 2018; NEAGOE *et al.* 2020; PĂCURAR *et al.* 2021).

The grasslands located near streams are intrazonal grasslands having an important economic value because of their high and constant forage yields. Furthermore, the favorable humidity conditions allow the proper growth and development of valuable mesophilic species (ONETE *et al.*, 2022). However, excessive moisture on some lands determines the growing of unpalatable or toxic species (*Glyceria maxima*, *Coronilla varia*, *Gallega officinalis*, *Cicuta officinalis* *Ranunculus sceleratus*, etc.), sedges and bulrushes (species of *Carex*, *Juncus*, *Heleocharis*, *Scirpus*, etc.).

For the grasslands located in riparian zones, the valuable floristic composition should rely on the *Agropyron repens* – *Alopecurus pratensis* – *Agrostis stolonifera* grasses associations (containing *Poa*

pratensis, *Lolium perenne* and *Typhoides arundinacea* as well) with a good ground cover and significant participation (60-70%). Legumes should be present up to at least 30% with various *Trifolium* species, *Lotus corniculatus* and *Medicago lupulina* (BĂRBULESCU *et al.*, 1991).

In this context, our intention is to use a proper alfalfa variety or a combination of varieties (*Medicago sativa* L.) to improve the floristic composition of the partially degraded grasslands from riparian zones. The main reasons are:

- Alfalfa or lucerne is a highly appreciated plant worldwide because it can be used for multiple purposes; compared to other fodder crops, alfalfa is net superior because of significant forage yields, quality of the fodder produced, and its ability to produce for several years with multiple cutting cycles (DINCĂ and DUNEA, 2018).
- Alfalfa is a large water user (DINCĂ *et al.*, 2017) with seasonal water use in excess of 1.000 millimeters per season, or from 9.000 to 14.000 cubic meters per hectare (the average seasonal water need for alfalfa is around 24 mm ha⁻¹ /ton of product (University of Kansas); thus, it may efficiently use the increased moisture from riparian lands.
- The fodder production obtained from the alfalfa crop can be used as green fodder, semi-silage, silage fodder, and dehydrated fodder.

- Alfalfa also plays an important role in the rotation of crops being an excellent precursor plant; it accumulates appreciable amounts of nitrogen in the soil and gathers organic substances through the root system contributing to the improvement of the physicochemical properties of soils (MIHALACHE et al., 2015).
- Alfalfa has a good response to fertilization (VÎNTU *et al.*, 2010) and irrigation (LLOVERAS *et al.*, 2008).
- During its long history as a fodder plant, adapted alfalfa varieties to pedo-climatic conditions specific to the geographical area were developed based on numerous naturally selected ecotypes, and reliant local populations (DINCĂ *et al.*, 2021).
- Alfalfa is a valuable component in grass-legume mixtures for pasture renovation due to its ecological plasticity and foliage characteristics (DINCĂ and DUNEA, 2018).
- Alfalfa is a useful plant for carbon storage(<https://www.ars.usda.gov/ARUserFiles/38020/Alfalfa.pdf>)

The objective of the study was to present the cropping results of a selection of alfalfa varieties that were consistently good in fodder quality and agronomic performance. The field trials were performed in Gherghița Plain using more than 20 varieties from which 6 of them were

selected that are deemed to be suitable in mixtures for riparian grasslands renovation or for overseeding operations.

The goal is to establish the relationship between the environmental factors and the dynamics of the growth and development of the canopy specific to riparian grasslands, paying attention to the quantification of the availability of solar radiation resources and the efficiency of conversion to dry matter, and other ecophysiological processes linked to carbon capture and storage.

MATERIALS AND METHODS

The experiments were performed on plots in Puchenii Mari, Gherghita Plain, with more than 20 alfalfa varieties in three replicates (DINCĂ *et al.*, 2021). The collection contained varieties from Romania, Italy, France, and the U.S.A., etc. that are included in the official variety list. All plots have been maintained in the same optimal conditions of fertilization and irrigation during this multiannual experiment. More details can be found in DINCĂ *et al.* (2021) and DUNEA *et al.* (2019).

The agronomic results obtained in alfalfa crops are influenced by a series of biological characteristics specific to the cultivated varieties.

Most studies focus on a series of indicators representative for alfalfa cropping such as:

- growth rate (g Dry Matter (DM)/day);
- average dry matter yield (g DM/m²);
- height of the plants (cm);
- degree of tillering (number of tillers /plant);
- forage quality (a synthetic indicator of fodder quality using a regressive statistical model that uses as variables several indicators determined by specific laboratory analyzes,

respectively dry matter content, crude protein content, crude fat content, crude cellulose content, crude ash content and the digestibility coefficient.

In this work, the growth rate, and average DM yield, and height were presented numerically, while the tillering and forage quality used a five steps rank (1-low; 5-excellent) to screen empirically the performance of each variety in an easier way based on the calculations presented in DINCĂ et al. (2021).

Table 1.

Selected alfalfa varieties tested in the multiannual ranking experiment that can be used for riparian grasslands renovation
(3 Romanian and 3 foreign varieties)

No.	Variety	Maintainer name	Maintainer code*	Country
1	Dobrogea	SC Patru Agro SRL	2782	Romania
2	Valahia	SC Patru Agro SRL	2782	Romania
3	Sandra	INCDA Fundulea	1562	Romania
4	PR55V48	S&W Seed Company/Pioneer Hi-Bred Services GmbH	3133	U.S.A., Austria
5	Pomposa	Gennari & Schiavi	1241	Italy
6	Galaxie	GIE Grass	1266	France

*<https://www.oecd.org/agriculture/seeds/documents/codes-and-schemes-list-of-varieties-eligible-for-seed-certification.pdf>

Then, the multiannual ranks of the characteristics were used in a weighted regression in which more weight was given to the observations with smaller variance (DINCĂ et al., 2021). The classification maintained the scale from 1 to 5.

The selected varieties showed very good performances during the multiannual trial (Table 1). **Dobrogea** showed high regeneration capacity, resistance to drought,

resistance to falling and resistance to diseases. The positive results obtained in the test fields including the Romanian ISTIS certify the superior qualities of the newly created variety. At the same time, the results obtained by farmers in production conditions recommend it as a variety with a great perspective especially that has an increased winter resistance. **Valahia** is the newest variety approved in 2021 and

is characterized by a good production potential, and by a superior quality of forage conferred by the high protein content and the high coefficient of digestibility. The adaptability to the cropping conditions in Romania makes it an alternative and therefore a serious competitor of the current alfalfa varieties. **Sandra** is a Romanian variety with a high nutritive value, as is the **PR55V48** variety. Its productive potential is high, as is the productive potential. **PR55V48** is a dormant variety that often allows a late autumn harvest. It has excellent productivity and disease resistance in all types of environments. The variety is widely adapted, characterized by rapid regeneration after harvest and excellent winter hardiness. It is particularly recommended on clay soils where root rot is a problem and 4-6 harvests per year of superior quality can be obtained. **Pomposa** is an Italian alfalfa variety, which stands out for its very good winter resistance, but also for its high production potential. The fodder obtained from this alfalfa variety is of high quality from a nutritional point of view, having a high protein content and very good digestibility. It regenerates quickly after mowing. The optimum duration of exploitation is 4 years (Patru Agro).

variety with a high perenniality, resistance to *Fusarium* wilting and a superior digestibility coefficient. It is a semi-early variety with drought resistance, being successfully cultivated in the plains. It has a long cropping life of 4-5 years. The plant develops a favorable leaf/stem ratio, and the nutritive

RESULTS AND DISCUSSION

The multiannual experimental results showed that the selected varieties reached excellent growth rates (average of varieties – A.V. = 6.9 g DM m⁻² y⁻¹) and high DM yields (A.V. = 1236 g DM m⁻² y⁻¹, Coeff. of var. – C.V. = 6.62%) within the biological potential of alfalfa (Fig. 1). All varieties performed well with a small variance, but Dobrogea, PR55V48 and Sandra were more efficient.

Figure 2 presents the tillering capacity and forage quality, which are important characteristics for selecting the proper varieties for conceiving mixtures adapted to riparian areas. An improved tillering capacity could provide benefits for competition capability and resistance to grazing. Sandra and Pomposa showed better results compared to the rest of the group (C.V. = 28.1%). Concerning the forage quality (C.V. = 10.5%), Valahia, Galaxie, PR55V48, and Dobrogea are varieties of high performance.



Fig. 1. Growth rate and dry matter yield of alfalfa varieties recorded and averaged on multiannual scale for all cutting cycles

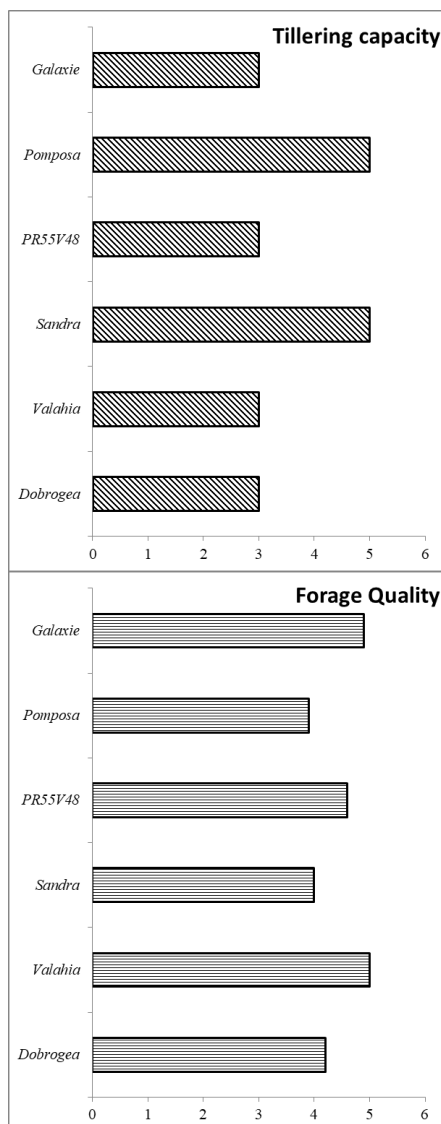


Fig. 2. Tillering capacity and forage quality presented using a synthetic index from 1 to 5 (1-low; 5 – excellent) averaged on multiannual scale for all cutting cycles

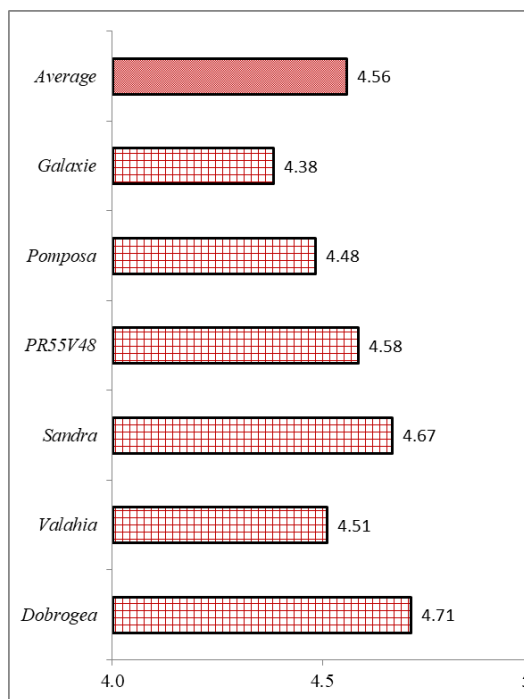


Fig. 3. Overall results based on weighted regression of the considered variables (1-low; 5 – excellent)

Regarding the average height of the plants, the selected varieties fitted in the range of 65 and 75 cm. A tall plant with well-disposed foliage will have a better competition capacity within riparian grasslands where tall grasses and other species exist. Dobrogea, Galaxie and PR55V48 had the tallest height within the group.

Figure 3 presents the overall results provided by the weighted regression. The average of varieties was 4.5 (C.V. = 2.6%) which confirms the promising biological potential of the selection for future utilization in riparian grasslands renovation. All varieties have useful traits that can recommend the specific use of a variety in various eco-pedoclimatic

conditions according to the region of the riparian area. Various combinations of the selected varieties should be tested in riparian areas to observe the potential benefits.

CONCLUSIONS

The grasslands from riparian areas are characterized by a constant regime of high humidity, the specific soils being of alluvial type. They can be used either by mowing, grazing, or even in mixed regime. Yields are good, reaching 2 tons DM/ha in grazed pastures and over 3 tons DM/ha in hayfields. Maintenance works are necessary by removing excess moisture, combating pests and weeds and species without fodder value, application of fertilizers, specific mechanical operations, etc. Thus, forage yields can improve substantially. The use of rational grazing is effective to avoid soil compaction and the formation of pits where water collects. Using one or more varieties of alfalfa in mixtures can improve the multifunctional value of the riparian grasslands. The presented varieties showed good adaptability and agronomic potential for using them in the Romanian eco-climatic conditions. Romanian varieties could have a plus for winter hardiness and valorization of excessive moisture existing in riparian grasslands. Future work will consider field trials in representative riparian grasslands with grass-alfalfa mixtures with one variety and various combinations of alfalfa

varieties from the presented six varieties. The most efficient mixture will be further developed to a commercial product.

Besides the pastoral value, alfalfa can provide ecological and environmental benefits if its participation is increased in the floristic composition. Further interdisciplinary studies are required to elucidate such important aspects of climate change and environmental protection. An improved monitoring

network based on wireless sensors (CASADEI *et al.*, 2021) combined with remote sensing products that are able to provide reliable vegetation indicators, and advanced modeling of growth and development parameters (DUNEA and MOISE, 2008) could elucidate the missing points of the complex interactions occurring in the riparian areas.

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