STUDY OF THE BEHAVIOR OF SOME SIMPLE MIXTURES OF GRASSES AND PERENNIAL LEGUMES UNDER CLIMATE CHANGE CONDITIONS

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Abstract

Romania has over 4.8 million hectares of permanent grasslands. Permanent grasslands contribute little to animal feed compared to temporary grasslands because they are of poor quality and produce low yields without proper management. Sown temporary grasslands are a good alternative to degraded or deteriorating permanent grasslands, providing high-quality feed in terms of both quantity and quality. To establish the relationship between species in a given pedoclimatic area, periodic research is required to develop and standardize new mixtures of perennial grasses and legumes. This experiment was conducted at the Ezăreni farm of the University of Life Sciences from Iasi. Observations within the sown variants focused on the number of shoots per m², plant height at harvest and dry matter production per hectare. In the first year of vegetation, a single mowing was performed, and yields ranged from 2446.1 kg/ha for variant a_6 to 4653.0 kg/ha for variant a_1. The average number of shoots/m² in the first year of vegetation ranged from 632 shoots/m² in variant a_1 to 2,757 shoots/m² in the case of the mixture variant a_9. In the first year of vegetation, high yields were recorded in the variants where *Onobrychis viciifolia* Scop. accounted for more than 50% of the crop.

Keywords: (temporary meadows, productivity elements, plant height, number of shoots, yield)

In simple or complex mixtures of grasses and perennial legumes, with different proportions of species, it appears that they behave differently over time. Some species can maintain their share in the mixture, while others may reduce their participation in the mixture. These variations in the share of a species in the composition of a mixture are attributed to competition between species.

Experimenting with simple or complex mixtures aims to identify those mixtures of perennial forage plants that can yield high, high-quality crops and in which the plants do not compete too much with each other for light, nutrition, and water (Rechitean, D., & Rechitean, I. I., 2021).

There may also be positive correlations between the percentage of participation in the mixture and the resulting dry matter production, such as the mixture consisting of *Festuca arundinacea* Schreb and *Trifolium pratense* L. in a ratio of 25-75% (Zaiț, T., *et al.*, 2022).

The quality of fodder produced on temporary sown grasslands is influenced by the proportion of different plant species that make up the sown mixture. Some mixtures may be more productive than others due to the plants that make up their composition. A concrete example is the difference in production between two simple mixtures, one consisting of *Onobrychis viciifolia* Scop. and *Bromus inermis* Leyss., which is superior in terms of quantity obtained compared to the mixture consisting of *Medicago sativa* L. and *Dactylis glomerata* L. (Samuil, C., *et al*, 2010, Samuil, C., *et al.*, 2012).

Another concern is the harvesting period, which takes into account the phenophase of the dominant species. Harvesting plants at late stages leads to a reduction in their quality (Türk, M., *et al.,* 2015).

The superiority of fodder in terms of quality and quantity is determined by the individual species and less by the complexity of the mixtures (Deak A *et al.,* 2007).

When making mixtures of grasses and perennial legumes, it must be taken into account that the species used may be influenced by climatic conditions, with qualitative and quantitative indices varying from one pedoclimatic zone to another (Naie M., *et al.,* 2016).

Mixtures of plant species increase productivity compared to pure crops by exploiting the complementarity between species in the use of resources over time and in different areas of space (Evers J. B., *et al.,* 2019).

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Productivity increased proportionally with the diversity of species sown, and this positive relationship remained constant over time. The performance of the mixtures was mainly due to the complementarity between the species in the mixture, rather than the selection effects of individual species (Picasso V. D., *et al.,* 2011).

Several studies have shown that it is difficult to predict the contribution of individual species to the positive relationship between species diversity and biomass production based on their behavior in pure culture (Roscher C., *et al.,* 2007).

Recent studies on forage plant mixtures have analyzed the relationship between environmental gradients and their diversity or productivity, examining how biotic and/or abiotic factors influence these characteristics (Assaf T. A.*, et al.,* 2011).

Species diversity has increasingly powerful ecological effects over time due to the growth of functional complementarity between them. This dynamic allows for more efficient use of limited environmental resources (Reich, P. B., *et al.,* 2012).

Even when resources change, diversity and how species collaborate with each other remain essential for maintaining grassland productivity (Craven D., *et al.,* 2016).

MATERIALS AND METHODS

This research aimed to observe the behavior of simple mixtures of perennial grasses in the context of climate change.

It is an experiment established in 2024, in three replicates, of the subdivided plot type. It was established on the Ezăreni teaching farm, which belongs to the "Ion Ionescu de la Brad" University of Life Sciences in Iași. The farm's coordinates are 47°05'-47°10' north latitude and 27°28'-27°33' east longitude, which makes it part of the forest-steppe area of Moldova. The factor studied is represented by simple and complex species and mixtures as follows:

Factor A: species/mixture sown: a_1 – *Onobrychis viciifolia* Scop. (100%) (control); a_2 – *Onobrychis viciifolia* Scop. (75%) and *Bromus inermis* Leyss. (25%); a_3 - *Onobrychis viciifolia* Scop. (50%) and *Bromus inermis* Leyss. (50%); a_4 - *Onobrychis viciifolia* Scop. (25%) and *Bromus inermis* Leyss. (75%); a_5 – *Medicago sativa* L. (100%); a_6 – *Medicago sativa* L. (75%) and *Festuca pratensis* (25%); a_7 – *Medicago sativa* L. (50%) and *Festuca pratensis* (50%); a_8 – *Medicago sativa* L. (25%) and *Festuca pratensis* (75%); a_9 – *Medicago sativa* L. (20%), *Lotus corniculatus* L. (15%); *Festuca pratensis* (30%); *Lolium perenne* L. (10%) and *Dactylis glomerata* L. (25%) and a_{10} – *Onobrychis viciifolia* Scop. (20%), *Lotus corniculatus* L. (15%); *Agropyron pectiniforme* L. (30%); *Bromus inermis* Leyss. (25%) and *Lolium perenne* L. (10%).

The varieties used for the experiment are Romanian, well adapted to the soil and climate conditions of the experimental area.

The number of shoots per square meter and the height of the plants were determined in the experimental field.

The dry matter was determined in two stages: sampling in the field and processing in the university laboratory. In the laboratory, these samples were placed in an oven and dried for three hours at 105°C; standard - SR ISO 6496/2001.

The program used for statistics is ANOVA, and the test applied is LSD (Least Significant Difference).

RESULTS AND DISCUSSIONS

Analyzing the influence of the species or mixture of perennial grasses and legumes on the average number of shoots/m² in the first year of vegetation, it was found that the values obtained ranged from 632 shoots/m² in variant a_1, species *Onobrychis viciifolia* Scop. (100%) and 2757 shoots/m2 in the case of the complex mixture a_9, the mixture consisting of the species *M.s*. (20%) + *L.c*. (15%) + *F.p*. (30%) + *L.p*. (10%) and *D.g*. (25%) (*table 1*).

The data obtained in the first year of vegetation show that the highest number of shoots was obtained in the variants where the species *Medicago sativa* L. and *Festuca pratensis* L. were present, cultivated in simple and complex mixtures in different proportions (*table 1*).

Analyzing the influence of the species or mixture of grasses and perennial legumes on the average plant height, it was found that the values obtained ranged from 42.1 cm in variant a_8, the simple mixture consisting of the species *M.s*. (25%) + *F.p*. (75%) and 75.0 cm in variant a1, the species *Onobrychis viciifolia* Scop. (100%) (*table 2*).

From a statistical point of view, compared to the control variant, all other variants studied showed insignificant, distinctly significant, and highly significant negative differences (*table 2*).

In terms of the influence of the cropping system used on dry matter production at mowing I, in the first year of vegetation, the differences from the control in all variants analyzed were negative, with high yields recorded in the variants where the species *Onobrychis viciifolia* Scop. had a share of more than 50%. At mowing I, the highest production was obtained in the control variant a_1 - *Onobrychis viciifolia* (100%) (mt.) cultivated alone in unfertilized conditions, where a production of 4653kg/ha was recorded. (*table 3*).

Table 1

Influence of grass and legume species or mixtures on the number of shoots/m2 at the first cut in the first year of vegetation

Variant*	Number of shoots	Difference		Significance
	Shoots/m2	Shoots/m2	%	
	Control: a_1 - *O.v.* (100%)			
a_1 - *O.v.* (100%) (mt.)	632	Control	100	Control
a_2 - *O.v.* (75%) + *B.i.* (25%)	986	354	156.0	*
a_3 - *O.v.* (50%) + *B.i.* (50%)	1187	555	187.8	**
a_4 - *O.v.* (25%) + *B.i.* (75%)	819	187	129.6	
a_5 - *M.s.* (100%)	1506	874	238.3	***
a_6 - *M.s.* (75%) + *F.p.* (25%)	2192	1560	346.8	***
a_7 - *M.s.* (50%) + *F.p.* (50%)	2138	1506	338.3	***
a_8 - *M.s.* (25%) + *F.p.* (75%)	2437	1805	385.6	***
a_9 - *M.s.* (20%) + *L.c.* (15%) + *F.p.* (30%) + *L.p.* (10%) + *D.g.* (25%)	2757	2125	436.2	***
a_{10} - *O.v.* (20%) + *L.c.* (15%) + *A.p.* (30%) + *B.i.* (25%) + *L.p.* (10%)	1692	1060	267.7	***
	LSD 5% =	324		
	LSD 1% =	444		
	LSD 0.1% =	604		

* *Onobrychis viciifolia (O.V.); Bromus inermis (B.i.); Medicago sativa (M.s.*); *Festuca pratensis (F.p.); Lolium perenne (L.p.); Lotus corniculatus (L.c.*); *Dactylis glomerata (D.g.); Agropyron pectiniforme (A.p.)*

Table 2

Influence of grass and legume species or mixtures on plant height at first mowing in the first year of vegetation

Variant*	Plant height	Difference		Significance
	cm	cm	%	
	Control: a_1 - *O.v.* (100%)			
a_1 - *O.v.* (100%) (mt.)	75.0	Control	100	Control
a_2 - *O.v.* (75%) + *B.i.* (25%)	71.6	-3.4	95.4	
a_3 - *O.v.* (50%) + *B.i.* (50%)	69.5	-5.6	92.6	
a_4 - *O.v.* (25%) + *B.i.* (75%)	72.8	-2.3	96.9	
a_5 - *M.s.* (100%)	46.1	-29.0	61.4	oo
a_6 - *M.s.* (75%) + *F.p.* (25%)	45.5	-29.6	60.6	oo
a_7 - *M.s.* (50%) + *F.p.* (50%)	49.8	-25.2	66.4	oo
a_8 - *M.s.* (25%) + *F.p.* (75%)	42.1	-32.9	56.1	ooo
a_9 - *M.s.* (20%) + *L.c.* (15%) + *F.p.* (30%) + *L.p.* (10%) + *D.g.* (25%)	45.3	-29.8	60.3	oo
a_{10} - *O.v.* (20%) + *L.c.* (15%) + *A.p.* (30%) + *B.i.* (25%) + *L.p.* (10%)	60.3	-14.8	80.3	
	LSD 5% =	16.1		
	LSD 1% =	22.1		
	LSD 0.1% =	30.1		

* *Onobrychis viciifolia (O.v.); Bromus inermis (B.i.); Medicago sativa (M.s.*); *Festuca pratensis (F.p.); Lolium perenne (L.p.); Lotus corniculatus (L.c.*); *Dactylis glomerata (D.g.); Agropyron pectiniforme (A.p.)*

Table 3

Influence of grass and legume species or mixtures on dry matter production at the first cut in the first year of vegetation

Variant*	Production of DM	Difference		Significance
	kg/ha	kg/ha	%	
	Control: a_1 - *O.v.* (100%)			
a_1 - *O.v.* (100%) (mt.)	4653.0	Control	100	Control
a_2 - *O.v.* (75%) + *B.i.* (25%)	4249.1	-403.9	91.3	o
a_3 - *O.v.* (50%) + *B.i.* (50%)	3443.5	-1209.4	74.0	ooo
a_4 - *O.v.* (25%) + *B.i.* (75%)	4096.0	-557.0	88.0	oo
a_5 - *M.s.* (100%)	3979.4	-673.5	85.5	oo
a_6 - *M.s.* (75%) + *F.p.* (25%)	2446.1	-2206.8	52.6	ooo
a_7 - *M.s.* (50%) + *F.p.* (50%)	2887.5	-1765.5	62.1	ooo
a_8 - *M.s.* (25%) + *F.p.* (75%)	2642.3	-2010.7	56.8	ooo
a_9 - *M.s.* (20%) + *L.c.* (15%) + *F.p.* (30%) + *L.p.* (10%) + *D.g.* (25%)	4072.9	-580.0	87.5	oo
a_{10} - *O.v.* (20%) + *L.c.* (15%) + *A.p.* (30%) + *B.i.* (25%) + *L.p.* (10%)	3656.4	-996.5	78.6	ooo
	LSD 5% =	365.2		
	LSD 1% =	500.9		
	LSD 0.1% =	681.8		

* *Onobrychis viciifolia (O.v.); Bromus inermis (B.i.); Medicago sativa (M.s.*); *Festuca pratensis (F.p.); Lolium perenne (L.p.); Lotus corniculatus (L.c.*); *Dactylis glomerata (D.g.); Agropyron pectiniforme (A.p.)*

CONCLUSIONS

The average number of shoots/m² in the first year of vegetation ranged from 632 shoots/m² in variant a_1, species *Onobrychis viciifolia* Scop. (100%) and 2757 shoots/m2 in the case of the Complex a_9 mixture - the mixture consisting of the species *M.s*. (20%) + *L.c*. (15%) + *F.p*. (30%) + *L.p*. (10%) and *D.g.* (25%).

The best results in terms of shoot number were obtained in the variants that included *Medicago sativa* L. and *Festuca pratensis* in the simple and complex mixtures.

The highest plant height values (75 cm) were recorded when the species *Onobrychis viciifolia* Scop was present (variant a_1), the minimum value being 42.1 cm in variant a_8-– *Medicago sativa* L. (25%) and *Festuca pratensis* (75%).

In terms of yield, the highest yield was recorded in variant a1 with the species *Onobrychis viciifolia* Scop 100% (4653 kg/ha), with all other variants having lower yields than the control variant.

Although simple and complex fodder mixtures provide a more varied range of plants in their composition, they do not guarantee higher yields at harvest, which may be exceeded by species grown alone, as is the case with the variant sown with *Onobrychis viciifolia* Scop 100%, which obtained some of the best values for the indices monitored.

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