Scientific Papers. Series A. Agronomy, Vol. LXIX, No. 1, 2026
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

RESEARCH ON THE COMPETITIVENESS OF SOME PERENNIAL GRASS AND LEGUME SPECIES IN SIMPLE MIXTURES, UNDER THE CONDITIONS OF ARDS SECUIENI

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Abstract

The experiment was located within the ARDS Secuieni during the period 2023-2025. The aim of the research was to analyze the competition relationships between the species Phleum pratense L. *and Trifolium pratense* L. *cultivated alone or in simple mixtures, under different fertilization conditions with complex mineral fertilizers. In the second year of vegetation, the RYT (Relative Yield Total) index was calculated, which recorded values >1 except for the unfertilized variant and sown with the mixture of Phleum pratense* L. *(25%) + Trifolium pratense* L. *(75%), showing that the species Phleum pratense* L. *and Trifolium pratense* L. *compete for the same vegetation factors. and the CR index (Competition Rate) for the species Phleum pratense* L. *was higher than for the species Trifolium pratense* L.*, resulting in the grass species being more competitive.*

Key words*: mixtures of species, fertilization, RYT (Relative Yield Total), CR (Competition Rate).*

INTRODUCTION

The composition of mixtures of perennial grasses and legumes, in the technology of establishing temporary meadows, represents the most important work on which the production potential of the meadow, the method of use, the fertilization system, as well as the economic duration of exploitation depend. The composition of the mixtures is made according to scientific criteria based on knowledge of the biology of species and varieties, relationships with environmental factors, use value and other economic characteristics.

For the establishment of temporary meadows, simple mixtures consisting of a small number of species are generally recommended.

The formation of mixtures of perennial grasses and legumes should be conditioned by the biological properties of the species, in accordance with the use and duration of existence of temporary meadows (Maruşca T., 2001; Belesky D.P. et al., 2002; Moisa F. et al., 2018; Bozhanska T. et al., 2024). The ability of each species to compete will also be taken into account when composing mixtures of perennial grasses and legumes. This is a feature of the species, but it is also largely influenced by the pedoclimatic conditions and the mode of exploitation (Skinner R.H. et al., 2006; Lazaridou M., 2008; Saghin et al., 2011; Croitoru A. et al., 2012; Stanciu A.Ş. et al., 2015; Leonte A. et al, 2024).

The production capacity of temporary grasslands is influenced by fertilization, thus obtaining good quality forage (Salis L. et al., 2008; Zou Y. et al., 2010; Yu Y.W. et al, 2011; Ciobanu C., 2014).

Fertilization also leads to a change in the vegetation structure, with grass species usually being favored, and there is also a change in soil properties and soil microbial activity (Kleczek C., 1991; Rotar I., 1993; Rautio, P. et al., 2012; Delevatii L.M. et al., 2019; Simić A. et al., 2020; Mrázková M. et al., 2020).
Through research conducted during 2023-2025, at A.R.D.S. Secuieni, the competitiveness of the species *Phleum pratense* L. and *Trifolium pratense* L., cultivated alone or in simple mixtures, under different fertilization conditions with complex mineral fertilizers, was analyzed.

MATERIALS AND METHODS

The research was carried out during 2023-2025 at the A.R.D.S. Secuieni and aimed to analyze the influence of competition between *Phleum pratense* L. and *Trifolium pratense* L., cultivated in simple mixtures, on the forage production obtained. The biological materials used were the species *Phleum pratense* L. (timophytic), the Rarău variety, homologated in 2002, created at the Agricultural Research and Development Station Suceava, and *Trifolium pratense* L. (red clover), the David Liv variety, homologated in 2015, created at the Agricultural Research and Development Station Livada.
In the spring of 2023, a bifactorial experiment, of the A×B type, was established, being placed in the field according to the method of subdivided plots, in three repetitions. The studied factors were: A - species and simple mixtures of species (perennial grasses and legumes) with five graduations: a_1 - 100% grasses (100% *Phleum pratense* L.); a_2 - 75% grasses (75% *Phleum pratense* L.) + 25% legume (25% *Trifolium pratense* L.); a_3 - 50% grasses (50% *Phleum pratense* L.) + 50% legume (50% *Trifolium pratense* L.); a_4 - 25% grasses (25% *Phleum pratense* L.) + 75% legume (75% *Trifolium pratense* L.); a_5 - 100% legume (100 % *Trifolium pratense* L.); B - fertilization with three graduations: b_1 - $N_0P_0K_0$ (unfertilized); b_2 - $N_{30}P_{30}K_{30}$; b_3 - $N_{50}P_{50}K_{50}$. Sowing was done with the U650 tractor in combination with the Haldrup experimental field seeder (Photo 1).

Photo 1. Field placement of the experience at A.R.D.S. Secuieni

The soil on which the experiment was located was characterized as being well supplied in active humus (2.33 %), very well supplied in phosphorus (189 $mg \cdot kg^{-1}$), potassium (304 $mg \cdot kg^{-1}$), excessively supplied in Mg (253 $mg \cdot kg^{-1}$) and Mn (369 $mg \cdot kg^{-1}$), poorly supplied in nitrogen (9.4 $mg \cdot kg^{-1}$ N -NO_3) and Zn (1 $mg \cdot kg^{-1}$). The sown area of the experimental plot was 12 m^2, of which 10 m^2 was harvested. A complex $N_{15}P_{15}K_{15}$ fertilizer, was used for fertilization. Fertilization was done manually with the Easy Drop device in the first year when preparing the land, and from the second year, mineral fertilizers were administered when the plants started to grow (Photo 2).

Photo 2. Administration of complex fertilizers in the experimental field

The harvesting of the experiments was done using the BCS 615 lawn mower, at a height of 4-5 centimeters from the ground, and the experiment was of the stationary type.

In order to calculate the competitiveness of the species in the two years of study, the Relative Total Yield (RYT) index was calculated, which characterizes the species used in mixtures in terms of the ecological resources used, one in relation to the other, and was performed using equation (1) (Zuo, Y. et al., 2010). Depending on the result obtained, the following three situations can be encountered: RYT > 1, the species occupy different eco-niches; RYT = 1, the species use common resources; and RYT < 1, the species are in an antagonistic relationship.

$$\mathbf{RYT = Y_{AB} \times Y_{AA} - 1 + Y_{BA} \times Y_{BB} - 1}$$

(Equation 1);

where:

Y_{AB} = Q_{GM} for species A, mixed culture;

Y_{AA} = Q_{GM} for species A, in pure culture;

Y_{BA} = Q_{GM} for species B, mixed culture;

Y_{BB} = Q_{GM} for species B, in pure culture;

Q_{GM} = Green mass production ($Mg \cdot ha^{-1}$).

The calculation of the Competition Rate (CR) index characterizes the species used in mixtures in terms of their mutual competitiveness and was performed using equation (2) (Zuo, Y. et al., 2010). Depending on the result obtained, the following three situations can be encountered: CR > 1, species A is more competitive than species B; CR = 1, the species are equally competitive; and CR < 1, species A is less competitive than species B.

$$\mathbf{CR = (Y_{AB} \times Y_{AA} - 1 \times Z_{AB}) \times (Y_{BA} \times Y_{BB} - 1 \times Z_{BA}) - 1}$$

(Equation 2)

where:

Y_{AB} = Q_{GM} for species A, mixed culture;

Y_{AA} = Q_{GM} for species A, in pure culture;

Z_{AB} = proportion of species A and B in the mixture;

Y_{BA} = Q_{GM} for species B, mixed culture;

Y_{BB} = Q_{GM} for species B, in pure culture;

Z_{BA} = proportion of species B and A in the mixture;

Q_{GM} = Green mass production ($Mg \cdot ha^{-1}$).

RESULTS AND DISCUSSIONS

At the Agricultural Research and Development Secuieni Station in Neamț County, the species *Phleum pratense* L. and *Trifolium pratense* L., cultivated individually or in simple mixtures formed between them, under different fertilization conditions with nitrogen and phosphorus-based mineral fertilizers, were analyzed for their competitiveness, one in relation to the other, and the Relative Total Yield (RYT) index was calculated, which characterizes the species used in mixtures in terms of the ecological resources used. The Competition Rate (CR) index was also calculated, which characterizes the species used in mixtures in terms of their mutual competitiveness.

Analyzing the influence of the interaction between the studied factors (mixture × fertilization) on the interspecific relationships, on average over the two years, but also over the three scythes, it was found that the RYT index recorded values < 1 in all the studied mixture and fertilization variants, with the exception of the variant sown with the of *Phleum pratense* L. (25%) + *Trifolium pratense* L. (75%) mixture, unfertilized.

The value of the RYT index had values ranging from 0.95 in the mixture formed by *Phleum pratense* L. (25%) + *Trifolium pratense* L. (75%) unfertilized and up to 1.88 as recorded in the same mixture but in the variant fertilized with $N_{50}P_{50}K_{50}$. It was found that in all the studied mixtures the RYT index recorded the highest values in the variants that were fertilized with fertilizers of the $N_{50}P_{50}K_{50}$ type. This result indicates that for *Phleum pratense* L. and *Trifolium pratense* L., although they occupy different ecological niches, the resources were insufficient to express the high productive potential. The experience being in the second year of vegetation, the plants of the species *Trifolium pratense* L. have a well-developed underground part, are at their maximum productive potential and are therefore more competitive compared to the plants of the species *Phleum pratense* L.

The CR index was calculated for all the mixtures studied and it was found that it had values ranging from 3.53 to 19.20 for the species *Phleum pratense* L. and from 0.05 to 0.28 for the species *Trifolium pratense* L.. Thus, it is found that this index was higher for the species *Phleum pratense* L. than for the species *Trifolium pratense* L., the grass being more competitive. The variants in which *Phleum pratense* L. had

lower CR index values were those in which the participation percentage was 25%. In this case, *Phleum pratense* L. was considered to be poorly competitive.

As observed, the CR index values for *Trifolium pratense* L. were lower only in the variants with a participation of 25%, which demonstrates a weaker competitiveness compared to *Phleum pratense* L. due to the lower number of individuals. The variants in which *Trifolium pratense* L. presented high values of the CR index were those in which the participation percentage was 75%. In these mixtures, *Trifolium pratense* L. was considered more competitive (Table 1).

Table 1. Competitive relationships between the species *Phleum pratense* L. and *Trifolium pratense* L.

Variant		1st harvest			2nd harvest			3rd harvest			TOTAL		
		RYT	CR *Ph.p.*	CR *T.p.*	RYT	CR *Ph.p.*	CR *T.p.*	RYT	CR *Ph.p.*	CR *T.p.*	RYT	CR *Ph.p.*	CR *T.p.*
a_2 - *Ph.p.* (75%) + *T.p.* (25%)	b_1 - $N_0P_0K_0$	2.41	8.52	0.12	2.20	8.82	0.11	2.55	7.67	0.13	1.19	9.27	0.08
	b_2 - $N_{30}P_{30}K_{30}$	1.52	2.49	0.40	2.12	3.51	0.29	1.93	2.61	0.38	1.24	19.20	0.05
	b_3 - $N_{50}P_{50}K_{50}$	1.34	15.84	0.06	1.10	7.91	0.13	1.55	12.33	008	1.64	12.89	0.11
a_3 - *Ph.p.* (50%) + *T.p.* (50%)	b_1 - $N_0P_0K_0$	2.45	687	0.15	2.69	12.17	0.08	2.63	6.08	0.16	1.25	6.12	0.16
	b_2 - $N_{30}P_{30}K_{30}$	2.45	6.85	0.15	2.79	4.64	0.22	2.48	7.58	0.13	1.24	10.78	0.09
	b_3 - $N_{50}P_{50}K_{50}$	1.21	9.24	0.11	1.23	8.18	0.12	1.08	8.47	0.12	1.40	10.18	0.10
a_4 - *Ph.p.* (25%) + *T.p.* (75%)	b_1 - $N_0P_0K_0$	2.23	4.98	0.20	1.54	8.06	0.12	2.38	4.51	0.22	0.95	3.53	0.28
	b_2 - $N_{30}P_{30}K_{30}$	1.66	5.81	0.17	1.55	7.96	0.13	1.86	5.38	0.19	1.53	3.73	0.27
	b_3 - $N_{50}P_{50}K_{50}$	1.29	7.32	0.14	0.98	7.34	0.14	1.26	7.12	0.14	1.88	8.23	0.12

The legumes present in the vegetation cover recorded values ranging between 37% in the variant sown with the mixture *Phleum pratense* L. 75% + *Trifolium pratense* L. 25%, fertilized with $N_{50}P_{50}K_{50}$ and 71% in the variant sown with *Phleum pratense* L. 75% + *Trifolium pratense* L. 25% and fertilized with $N_{30}P_{30}K_{30}$. The species in the miscellaneous group had values ranging between 1% and 45%.

Analyzing the variants sown with *Phleum pratense* L. 100% in pure culture, it can be seen that the participation percentage remained constant at 100%, and in the case of the variants sown with the species *Trifolium pratense* L. 100%, the lowest percentage was recorded in the unfertilized variant, at 55% (Figure 1).

Regarding the data obtained at the second mowing, it is found that the percentage of grasses was between 36% as recorded in the variant sown with the mixture of *Phleum pratense* (25%) + *Trifolium pratense* (75%) and fertilized with $N_{50}P_{50}K_{50}$ and 59% as recorded in the variant sown with the mixture of *Phleum pratense* (25%) + *Trifolium pratense* (75%) and fertilized with $N_{30}P_{30}K_{30}$. The percentage of participation of species from the miscellaneous group was between 1% and 41% (Figure 2).

Analyzing the influence of the species and the cultivated mixture (*Phleum pratense* L. + *Trifolium pratense* L.), on the evolution of the structure of the vegetal carpet, it can be observed that in row I, on average over the two years, the percentage of participation of the species *Phleum pratense* L. recorded values ranging between 28% in the variant sown with the mixture *Phleum pratense* L. 75% + *Trifolium pratense* L. 25% and fertilized with $N_{30}P_{30}K_{30}$ and 52% in the variant sown with the mixture *Phleum pratense* L. 75% + *Trifolium pratense* L. 25% and fertilized with $N_{50}P_{50}K_{50}$ (Figure 3).

Analyzing the data obtained in the third mowing, it is found that the percentage of participation of the species *Phleum pratense* L. recorded values ranging from 31% as recorded in the variant sown with the mixture *Phleum pratense* L. 75% + *Trifolium pratense* L. 25%, fertilized with $N_{30}P_{30}K_{30}$ and 44% as recorded in the variant *Phleum pratense* L. 75% + *Trifolium pratense* L. 25%, unfertilized. The highest percentage of species in the diverse group was 77%, this value being recorded in the variant sown with the species *Trifolium pratense* L., unfertilized variant.

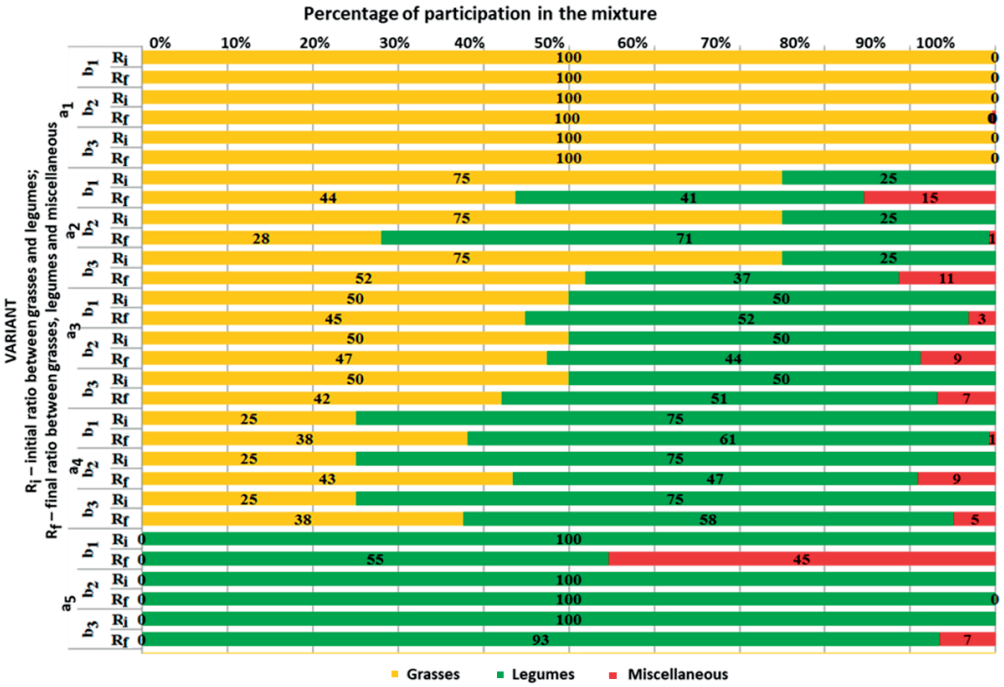

Figure 1. The influence of the cultivated species or mixture
on the evolution of the structure of the vegetation cover, at the first harvest

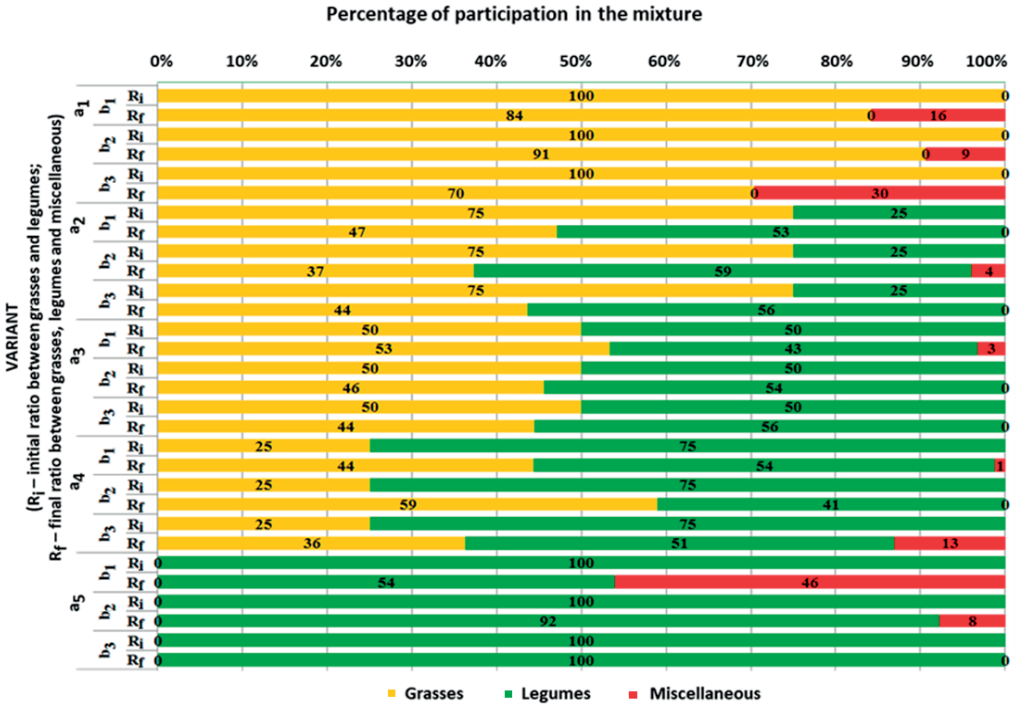

Figure 2. The influence of the cultivated species or mixture
on the evolution of the structure of the vegetation cover, at the second harvest

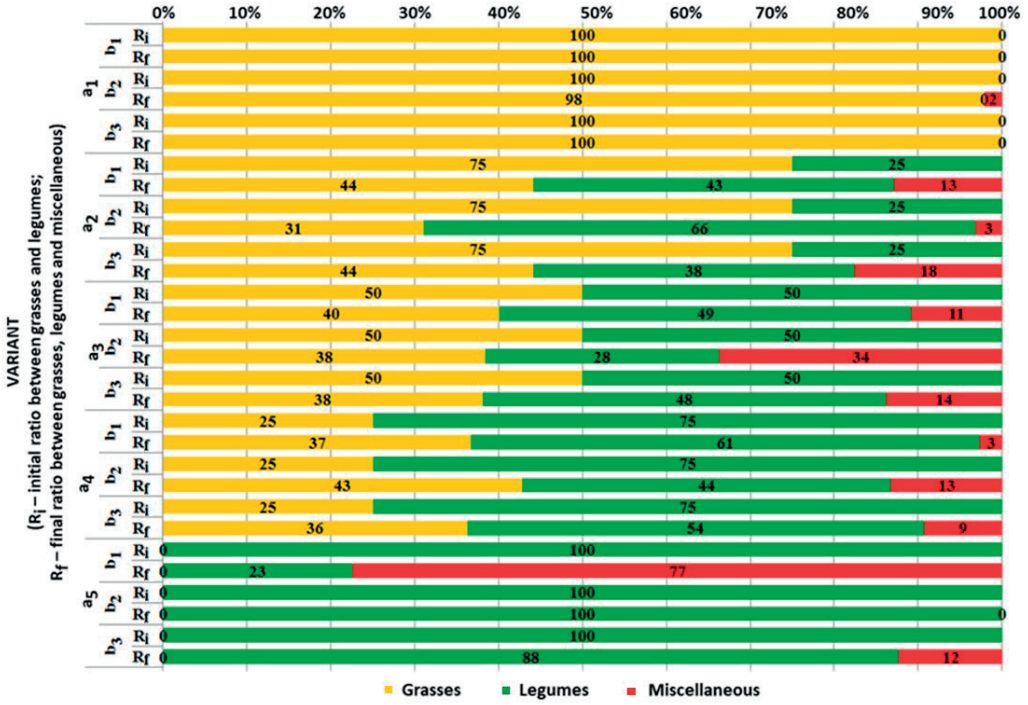

Figure 3. The influence of the cultivated species or mixture on the evolution of the structure of the vegetation cover, at the third harvest

Intraspecific competition occurs between individuals of the same species and is a consequence of the mass effect for space, minerals, water, and light. This mass effect of intraspecific competition is regulated by homeostatic mechanisms or by human intervention, indicating that individuals can maintain a stronger species. Interspecific competition can determine which species and how many species can coexist within the same community but can affect population dynamics by modifying species structure and community structure.

CONCLUSIONS

The analysis of the influence of the interaction between the mixture used and fertilization with mineral fertilizers (nitrogen, phosphorus and potassium) on interspecific relationships in the two years of vegetation showed that the RYT index recorded values > 1, except for the variant sown with the mixture formed by *Phleum pratense* L. (25%) + *Trifolium pratense* L. (75%) and unfertilized, showing that the species *Phleum pratense* L. and *Trifolium pratense* L. compete for the same vegetation factors.

During the analyzed period, the CR index for the species *Phleum pratense* L. was higher than for the species *Trifolium pratense* L., but lower values of the CR index were recorded in the variants in which the percentage of participation in the mixture of the species *Phleum pratense* L. was lower.

The variants in which the species *Phleum pratense* L. recorded low values of the CR index were those in which the participation percentage was 50% and 25%, respectively, in which case the species is considered to be poorly competitive. These aspects were highlighted inversely proportionally in the case of the species *Trifolium pratense* L.

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