

The Study of Perennial Grasses and Legumes Mixtures in the Environmental Conditions Part 1: The Evolution of Mixtures Productivity from Someșelor Plateau

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Abstract

Lately it is a high interest in the establishing of temporary grasslands, these being considered a valuable source of fodder from the quantitative and qualitative point of view. Temporary grasslands can be established instead of degraded permanent grasslands or in arable lands. In the paper are presented the results of the research which took place in 2010 and 2011, regarding the fodder evolution of a double factor experience; A factor – mixtures (8 complex mixtures of perennial grasses and legumes and one alfalfa pure crop, considered as a witness), B factor – levels of fertilization (0N0P₂O₅, 60N70P₂O₅, 120N70P₂O₅ kg·ha⁻¹).

In 2010 the highest productions (13.16 SU t·ha⁻¹) were obtained at all the cycles from the 5th mixture composed from red clover and 4 species of grasses *Trifolium pratense* L., *Dactylis glomerata* L., *Festulolium* Asch. & Graebn., *Phleum pratense* L., *Lolium perenne* L.). In 2011, mixture number 3, recognized as being recommended for the forest steppe area and composed from *Lotus corniculatus* L., *Onobrychis viciifolia* Scop., *Dactylis glomerata* L., *Festuca pratensis* Huds., *Bromus inermis* Leyss, presented the highest productions (4.82 t·ha⁻¹) for the 60N70P₂O₅ and 120N70P₂O₅ kg·ha⁻¹ levels of fertilization.

Keywords: fodder, mixtures, production, pure crop

1. Introduction

The climate changes more and more pronounced lately had negative effects also over the agricultural production from Romania and the same from Someșelor Plateau. So the extreme meteorological facts (alternation of excessively hot and dry periods with the cold and rainy ones, hail and flooding) affected quite seriously the agricultural producers especially farmers [1]. The grasslands represent a special importance as an ecosystem, hosting a big variety of species, being the main source of grass consumed by the animals in fresh form or conserved in different ways. Also, grasslands play an important role in preventing

and working against erosion, being in the same time a way to improve soil structure and fertility [2]. To prevent the reduction in agricultural output, is looking for new solutions for providing the necessary forage base. by choosing some new varieties or hybrids resistant to such factors [3]. and thus by increasing the attention on the establishment of sown complex grasslands (temporary), which are much more resistant to weather conditions and having the advantage of one high and constant productivity [4, 5, 2]. Grasses and legumes associated increase is based on the complementary behavior of the species belonging to those two families [6].

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2. Material and methods

The experiment took place in the environmental conditions from Jucu, Cluj county, on a sloping land, which has a lean of 6° at 326.6 m altitude. The soil type is clay chernozem, with groundwater located at 10 m depth and the soil texture is loamy-clay. The clay presence gives to this type of soil small capacity for useful water, which leads to a fast transition of this from the saturated state with water to the fading capacity [1]. The content of humus from the soil and nutrients such as nitrogen and potassium shows a good supply, while for phosphorus a deficiency is noted. Multiannual monthly average is 8.3°C; the highest is registered in July (19.3°C), and the lowest one in January (-4.5°C). The first frosts occur between October 10 to 20, and last between 10 to 20 April. The yearly average of rainfall is 612.7 mm, the maximum rainfall in 24 hours taking place at the end of the spring and the beginning of summer (May, June and July) [7].

The research includes an experience with perennial forage grass, organized by the method of subdivided parcels and it's a 9x3 type (9-ways, 3-levels of fertilization). Those 9 versions include 8 complex mixtures composed of perennial fabaceous and poaceous forage, and a witness version represented by pure cultures of alfalfa. Each plot is divided in 3 versions related to 3 levels of fertilization - unfertilized witness version and two stages fertilized with nitrogen and phosphorus. The way of using the grassland is by mowing it. Those 9 version contain the following species and mixtures (A):

A1. *Medicago sativa* L.;

A2. *Medicago sativa* L., *Trifolium alexandrinum* L., *Dactylis glomerata* L., *Lolium hybridum* L.;

A3. *Lotus corniculatus* L., *Onobrychis viciifolia* Scop., *Dactylis glomerata* L., *Festuca pratensis* Huds., *Bromus inermis* Leyss.;

A4. *Medicago sativa* L., *Lotus corniculatus* L., *Dactylis glomerata* L., *Festuca arundinacea* Schreb., *Lolium perenne* L.;

A5. *Trifolium pratense* L., *Dactylis glomerata* L., *Festulolium* Asch. & Graebn., *Phleum pratense* L., *Lolium perenne* L.;

A6. *Lotus corniculatus* L., *Phleum pratense* L., *Dactylis glomerata* L., *Festuca arundinacea* Schreb., *Festuca pratensis* Huds.;

A7. *Trifolium pratense* L., *Lotus corniculatus* L., *Trifolium alexandrinum* L., *Dactylis glomerata* L.,

Festuca pratensis Huds., *Lolium x hybridum* Hausskn.;

A8. *Trifolium pratense* L., *Trifolium repens* L., *Dactylis glomerata* L., *Festuca pratensis* Huds., *Phleum pratense* L., *Lolium x hybridum* Hausskn., *Lolium perenne* L.;

A9. *Medicago sativa* L., *Trifolium repens* L., *Bromus inermis* Leyss., *Festuca arundinacea* Schreb., *Lolium x hybridum* Hausskn.

The experience was instaled at the beginning of April. 2009. Just after the sowing the fertilization of the versions was made, with 2 doses of mineral fertilizer 60N70P₂O₅ kg·ha⁻¹y⁻¹ and 120N70P₂O₅ kg·ha⁻¹. The fertilizers used were ammonium nitrate (33.5% N) and Eurobio (26% P₂O₅; 42% CaO). During the year of 2009 only some cleaning sews were made because the sown species sprang very difficult and the ones who made it were affected by drought. In the second year of vegetation (2010), first year of production, the experimental variants were over-seeded in March. During the poaceous phenophase of earing the first harvest cycle was made and the second two scythes were obtained at intervals of about a month away from one another. Production of each variant was determined gravimetrically.

3. Results and discussions

Based on the dried matter (D.M.) yields obtained at those 9 experimental variants and influence analysis of two factors taken into study is registered an increase in production in all experimental variants due to the mixture and level of fertilization (Tables 1, 2 and 3). In 2010, V2-V9 mixtures obtained high productions at all the fertilization levels, in comparison with V1 mixture (witness) because of the grasses presence; the V5, V7 and V8 mixtures stand out which register considerable differences comparing to witness variant (Table 1). The highest production at the unfertilized variant it was obtained in the mixture number 7 (2.98 t·ha⁻¹ D.M.) almost 4 times bigger comparing to witness variant (0.75 t·ha⁻¹ D.M.), followed by mixture number 5 which registered a production of 2.71 t·ha⁻¹ D.M. This increase is due to the presence of grass and Alexandrin clover (*Trifolium alexandrinum* L.), for mixture 7. Variants V2-V9 achieved higher

production compared to V1, the registered being very significant.

Table 1. The influence of perennial forage mixtures species on D.M. production ($t \cdot ha^{-1}$), Jucu 2010

Mixture	D.M. production		Difference $t \cdot ha^{-1}$	Significant
	$t \cdot ha^{-1}$	%		
V1	6.731	100	mt	
V2	7.295	108.4	0.564	
V3	10.28	152.7	3.549	**
V4	8.904	132.3	2.173	
V5	13.165	195.6	6.434	***
V6	10.328	153.4	3.597	**
V7	12.277	182.4	5.546	***
V8	11.879	176.5	5.148	***
V9	10.288	152.8	3.557	**

DL 5% = $2.56 t \cdot ha^{-1}$; DL 1% = $3.53 t \cdot ha^{-1}$; DL 0.1% = $4.85 t \cdot ha^{-1}$

At the level of fertilization $60N70P_2O_5$ it's recorded a a very significant increase of the variants V2-V9 compared with witness variant, the highest yield was noticed at the V6 variant ($3.88 t \cdot ha^{-1}$ D.M.) and V8 ($3.87 t \cdot ha^{-1}$ D.M.), compared with the witness variant which obtained a production of $1.91 t \cdot ha^{-1}$ D.M. . At the level of fertilization $120N70P_2O_5$ the highest growth was

noticed at variant V6 ($4.17 t \cdot ha^{-1}$ D.M.) followed by V5 ($4.07 t \cdot ha^{-1}$ D.M.), compared with the witness variant which obtained a production of $2.06 t \cdot ha^{-1}$ D.M.; at the witness variant were registered the lowest values compared to the rest of the variants, the differences being very significant. The data are similar to those reported by Vântu et.al. (2010) [8].

Table 2. The influence of fertilization level over the D.M. production ($t \cdot ha^{-1}$), Jucu 2010

Fertilization level	D.M. production		Difference $t \cdot ha^{-1}$	Significant
	$t \cdot ha^{-1}$	%		
$0N0P_2O_5$	9.531	100	m	
$60N70P_2O_5$	10.424	109.4	0.893	***
$120N70P_2O_5$	10.428	109.4	0.897	***

DL 5% = $2.56 t \cdot ha^{-1}$; DL 1% = $3.53 t \cdot ha^{-1}$; DL 0.1% = $4.85 t \cdot ha^{-1}$

Once with the growth of the fertilization level (specially increasing the amount of nitrogen fertilizer) a decrease of productivity is taking place at all the experimental variants compared with the witness variant, while the witness variant shows a growth of productivity direct related to the fertilization dose (Table 3).

From fertilization factor analysis (Table 2) for the entire experience, there is significant differences between variants of fertilization $60N70P_2O_5$ and

$120N70P_2O_5$ compared to unfertilized variant (version control).

The D.M. production in 2010, shows a general upward trend once with increasing the fertilizer (especially nitrogen content increase) in all variants, except V8 version, where the highest production was recorded at the level of fertilization $60N70P_2O_5$. The highest yield was obtained at the variants V6 and V5.

Table 3. The significance of differences between D.M. yields ($t \cdot ha^{-1}$) under the mixtures interaction and fertilization levels, Jucu 2010

<i>Mixture</i>	Fertilization level	D.M. production		Difference $t \cdot ha^{-1}$	Significant
		$t \cdot ha^{-1}$	%		
V1	0N0P ₂ O ₅	0.756	100	m	
V2	0N0P ₂ O ₅	1.224	161.90	0.468	***
V3	0N0P ₂ O ₅	2.262	299.21	1.506	***
V4	0N0P ₂ O ₅	1.663	219.97	0.907	***
V5	0N0P ₂ O ₅	2.71	358.47	1.954	***
V6	0N0P ₂ O ₅	2.392	316.40	1.636	***
V7	0N0P ₂ O ₅	2.981	394.31	2.225	***
V8	0N0P ₂ O ₅	2.304	304.76	1.548	***
V9	0N0P ₂ O ₅	2.327	307.80	1.571	***
V1	60N70P ₂ O ₅	1.91	100	m	
V2	60N70P ₂ O ₅	2.125	111.3	0.215	*
V3	60N70P ₂ O ₅	3.352	175.5	1.442	***
V4	60N70P ₂ O ₅	3.448	180.5	1.538	***
V5	60N70P ₂ O ₅	3.513	183.9	1.603	***
V6	60N70P ₂ O ₅	3.88	203.1	1.97	***
V7	60N70P ₂ O ₅	3.418	179.0	1.508	***
V8	60N70P ₂ O ₅	3.877	203.0	1.967	***
V9	60N70P ₂ O ₅	2.716	100.0	0.806	***
V1	120N70P ₂ O ₅	2.066	76.1	m	
V2	120N70P ₂ O ₅	2.818	103.8	0.752	***
V3	120N70P ₂ O ₅	3.542	130.4	1.476	***
V4	120N70P ₂ O ₅	3.762	138.5	1.696	***
V5	120N70P ₂ O ₅	4.079	150.2	2.013	***
V6	120N70P ₂ O ₅	4.171	153.6	2.105	***
V7	120N70P ₂ O ₅	3.834	141.2	1.768	***
V8	120N70P ₂ O ₅	2.694	99.2	0.628	***
V9	120N70P ₂ O ₅	3.251	119.7	1.185	***

DL 5% = 0.3 $t \cdot ha^{-1}$; DL 1% = 0.65 $t \cdot ha^{-1}$; DL 0.1% = 0.53 $t \cdot ha^{-1}$

In 2011 (tables 4, 5 and 6) for the unfertilized variant, the production of witness variant was by general lower compared to the rest of the variants, the only exception were V2 and V4 which had a production of 3.47 $t \cdot ha^{-1}$ D.M. and 3.11 $t \cdot ha^{-1}$ D.M. compared to the witness variant which obtained a

production of 3.86 $t \cdot ha^{-1}$ D.M. Based on the D.M. yields obtained at those 9 experimentals variants it is showed that at the influence of mixture factor, significant distinguished yields, beside the witness variant are obtained just in case of the mixtures V6 and V3 (Table 4).

Table 4. The influence of perennial forage mixtures species on D.M. production ($t \cdot ha^{-1}$), Jucu 2011

Mixtures	D.M. production		Difference $t \cdot ha^{-1}$	Significant
	$t \cdot ha^{-1}$	%		
V1	4.6	100	m	
V2	4.172	90.7	-0.428	
V3	7.059	153.5	2.459	**
V4	4.373	95.1	-0.227	
V5	5.816	126.4	1.216	
V6	7.138	155.2	2.538	**
V7	6.09	132.4	1.49	
V8	5.394	117.3	0.794	
V9	5.501	119.6	0.901	

DL 5% = 1.72 $t \cdot ha^{-1}$; DL 1% = 2.37 $t \cdot ha^{-1}$; DL 0.1% = 3.26 $t \cdot ha^{-1}$

The highest production was registered at V6 variant (7.53 t·ha⁻¹ D.M.), with 95 percent bigger compared with the witness variant, followed by V3, which obtained a production of 6.70 t·ha⁻¹ D.M. In case of 60N70P₂O₅ fertilization, the lowest production was registered at the variants V2 and V4 with 4.11 t·ha⁻¹ D.M. and 4.56 t·ha⁻¹ D.M. The highest production registered at the variant V3 (7.34 t·ha⁻¹ D.M.), followed by V6 (7.06 t·ha⁻¹ D.M.), the last one being with 50 percent bigger compared with the witness variant which obtained a production of 4.71 t·ha⁻¹ D.M. In case of 120N70P₂O₅ fertilization, the lowest production was registered at the variant V2 (4.93 t·ha⁻¹ D.M.), while the productions with the highest values being registered at V3 and V6 variants with 7.12 t·ha⁻¹ D.M. and 6.81 t·ha⁻¹ D.M.,

compared to the witness variant which registered a production of 5.22 t·ha⁻¹ D.M. During the experimental period was observed an upward trend of production once with the growth of the fertilization level except V6 variant where was registered a decrease of production once with the increasing of the fertilization level. V3 variant showed also an increase of production in case of fertilized variants compared with the witness, best results being obtained at 60N70P₂O₅ fertilization compared with 120N70P₂O₅ one.

From fertilization factor analysis (Table 5) for the entire experience. There are significant differences between the levels of fertilization 60N70P₂O₅ and 120N70P₂O₅ compared to unfertilized variant (version control).

Table 5. The influence of fertilization level over the D.M. production (t·ha⁻¹). Jucu 2011

Fertilization level	D.M. production		Difference t·ha ⁻¹	Significant
	t·ha ⁻¹	%		
0N0P ₂ O ₅	4.965	100	m	
60N70P ₂ O ₅	5.678	114.4	0.713	***
120N70P ₂ O ₅	6.071	122.3	1.106	***

Table 6. Significance of differences between D.M. yields (t·ha⁻¹) under the mixtures interaction and fertilization levels, Jucu 2011

Mixture	Fertilization level	D.M. production		Difference t·ha ⁻¹	Significant
		t·ha ⁻¹	%		
V1	0N0P ₂ O ₅	3.862	100	m	
V2	0N0P ₂ O ₅	3.47	89.8	-0.392	
V3	0N0P ₂ O ₅	6.705	173.6	2.843	***
V4	0N0P ₂ O ₅	3.114	80.6	-0.748	00
V5	0N0P ₂ O ₅	5.367	139.0	1.505	***
V6	0N0P ₂ O ₅	7.532	195.0	3.67	***
V7	0N0P ₂ O ₅	5.492	142.2	1.63	***
V8	0N0P ₂ O ₅	4.718	122.2	0.856	**
V9	0N0P ₂ O ₅	4.429	114.7	0.567	*
V1	60N70P ₂ O ₅	4.711	100	m	
V2	60N70P ₂ O ₅	4.11	87.2	-0.601	0
V3	60N70P ₂ O ₅	7.344	155.9	2.633	***
V4	60N70P ₂ O ₅	4.569	97.0	-0.142	
V5	60N70P ₂ O ₅	5.898	125.2	1.187	***
V6	60N70P ₂ O ₅	7.067	150.0	2.356	***
V7	60N70P ₂ O ₅	6.39	135.6	1.679	***
V8	60N70P ₂ O ₅	5.416	115.0	0.705	**
V9	60N70P ₂ O ₅	5.599	118.8	0.888	**
V1	120N70P ₂ O ₅	5.228	100	m	
V2	120N70P ₂ O ₅	4.937	94.4	-0.291	
V3	120N70P ₂ O ₅	7.126	136.3	1.898	***
V4	120N70P ₂ O ₅	5.434	103.9	0.206	
V5	120N70P ₂ O ₅	6.184	118.3	0.956	***
V6	120N70P ₂ O ₅	6.816	130.4	1.588	***
V7	120N70P ₂ O ₅	6.387	122.2	1.159	***
V8	120N70P ₂ O ₅	6.049	115.7	0.821	**
V9	120N70P ₂ O ₅	6.474	123.8	1.246	***

By analyzing the variation of D.M. production under the mixtures interaction and fertilization levels from 2011 (table 6) it can be seen a general upward trend of production, once with the growth of fertilization level, except V6 where it can be seen a smooth decrease of production at the fertilized variants compared to the unfertilized variant but the values being very close.

4. Conclusions

In 2010 there was an increase in productivity resulting from the use of fertilizers, V2-V9 variants recorded significantly higher yields compared with the witness variant. The D.M. production had an upward trend directly dependent on the level of fertilization, although compared with the witness variant, the production decreased with increasing the levels of fertilization.

In 2011 there was a decline in production for variants V2 and V4 compared with the witness variant at all the levels of fertilization, noticing an increase in productivity for all mixtures once with increasing the fertilization level. The D.M. production had a general upward trend except V6, where was registered a smooth decrease at the maximum level of fertilization (120N70P₂O₅). The mixtures which came out through a high production level, on 2011 were the mixture number 3 and 6.

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