RESEARCHES REGARDING THE VALUING OF THE WEAK FERTILE LANDS OF MOLDAVIAN FOREST-STEPPE, THROUGH THE ESTABLISHMENT OF PERENNIAL CROPS

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Abstract

Valuing the weak fertile lands of the Moldavian forest-steppe is possible by establishing cultures made only of perennial species or of mixtures of perennial graminee and leguminous species. Using fertilizers applied alone or in complex, is an important measure of increasing temporary grasslands' productivity and the nutritive quality of the forage obtained from these grasslands. This paper presents the influence of the simple mixtures of perennial graminee and leguminous species and of fertilization on the dry matter production, forage quality and root mass. The biggest productions for alfalfa were obtained for the fertilization with 20 t manure/ha annually, when the average production was 7.4 t ha^{-1} D.M. For the alfalfa +orchard grass mixture, doubling the manure dose lead to the biggest production increases.

Keywords: weak fertile lands, manure, fertilization, quality, root mass

INTRODUCTION

Nowadays it is considered that major biosphere erosion processes occur on Earth, such as water and aeolian erosion, desertification, forest destruction, permanent grassland grubbing, salinization and abandon of the agricultural fields.

Romania's agriculture is characterized by a very large range of weak productive lands, from the total existing agricultural surface.

The lack of energetic and finance resources impose as a necessity finding technical and economical solutions to make possible the valuing of these weak productive lands.

These solutions are based on creating some sustainable agricultural eco-systems which can produce good quality crops

and also can improve soil's fertility.

In European Union, a series of measures were taken to make possible the switch from the actual conventional agriculture system to the sustainable agriculture one. This system has as central element the rotation, organic fertilization is its main component, and chemical fertilization is moderately used.

Introducing temporary grassland cultures in agricultural rotations represents the only long term viable measure of valuing and improving the weak productive agricultural lands.

The best soil protection against erosion factors and especially against water can be obtained through a well congealed herbaceous coverage, present in well maintained and rationally exploited permanent grasslands or in temporary grasslands.

Establishing temporary grasslands on weak fertile soils imposes the necessity of fertilizer applications, either organic or mineral nature (Alexa I. et. al., 2006; Vîntu V. et al., 2005; Ziegler D., 1994).

Without the nutritive elements income, big productions can not be obtained on these soil types, and the investments made for the temporary grasslands establishment would become unprofitable. The required fertilization is explained by the high consume of nutritive elements extracted from soil by the forage plants composing these temporary grasslands.

The organic fertilization with manure is very important on these weak productive soils with low humus content (Jeangros, B. et. al. 2003; Ryser J.P. et. al. 2001).

The productivity of temporary grasslands is influenced by the soil-climatic conditions, by fertilization, especially the one with nitrogen, as well as by the perennial herbs mixtures used for their establishment. (Goliński P., 2008, Smith H.J. et. al., 2008).

The influence of nitrogen on the temporary grasslands' production is even more important when the perennial graminee species' participation ratio is higher (Baluch-Malecka A. and Oleszewska M., 2007; Carlsson G. et. al., 2008).

The application of nitrogen is indispensable for the grasslands made only of

graminee species and on weak fertile soils.

The quality of the obtained fodder is influenced by the used species and by the applied fertilization type and level (Gierus M., et.al. 2007).

If the influence of fertilization on the production's quantity and quality is not significant on leguminous species' cultures, especially on profound soils, highly fertile, for the temporary grasslands made from mixtures and cultivated on these weak fertile soils, this influence is of major importance.

Knowing the quantity of roots left in the soil was the study and research object for a series of scientists, considering the importance this each specie's morphological feature represents, as the main organic matter resource left in soil.

This paper's aim is to establish some valuing possibilities for the weak productive soils from the Moldavian Central Plateau by using some perennial forage species, cultivated alone or in mixtures.

In order to achieve this goal, we proposed to identify some forage plant species able to value as efficiently as possible these agricultural surfaces, even in the lack of a sustained fertilization.

Also, we aimed to establish an optimal fertilization system, as a supplementary measure to increase the production.

MATERIAL AND METHOD

The experimental field was created in the spring of 1999 on a land placed into the frame of Valea Babei slope, belonging to S.C. Solaris Amy S.R.L., Bâcu Farm. This slope is placed into the natural frame of the Moldavian Central Plateau, with eastern exposure, having an 18% tilt and a 280 m altitude. The experimental field was a bi factorial one, with subdivided lots, 4 x 6 type, in four repetitions.

The observed experimental factors were:

Factor A – the specie, with 4 graduations:

a_1 = *Medicago sativa*
a_2 = *Onobrychis viciifolia*
a_3 = *Onobrychis viciifolia* 50% + *Festuca arundinacea* 50%
a_4 = *Medicago sativa* 50% + *Dactylis glomerata* 50%
Factor B – fertilization, with 6 graduations:
b_1 = unfertilized control
b_2 = manure 20 t ha^{-1} annually
b_3 = manure 20 t ha^{-1} every other year
b_4 = manure 40 t ha^{-1}annually
b_5 = manure 40 t ha^{-1} every other year
b_6 = complex 200 kg ha^{-1} annually (N_{25}-P_{25}-K_0)

The manure, phosphorus and potassium were applied in autumn, while the nitrogen was applied in spring, before the beginning of the vegetation period.

We harvested when the dominant grasses matured.

At a rate of 1000 kg manure, the chemical composition was of 5 kg N, 3 kg P_2O_5 and 7 kg K_2O.

Root mass analysis was made through the 10/10/10 cm soil cube method, in all three soil profile depths. After drying the soil 4 hours at 105^0C, we determined the dry matter content and then, the root mass, through calculus.

The production was expressed in dry matter (DM) and the statistical interpretation was made through the variance analysis.

RESULTS AND DISCUSSIONS

The influence on the D.M. production

On the lands characterized by a low natural productivity, the productions are small and unprofitable, if there is no intervention on the cultivation technology.

Therefore, it is necessary to apply modern cultivation technologies based on perennial forage cultures and on temporary grasslands, sustained by an organic, mineral or combined fertilization, in economically balanced doses.

Analyzing the influence of specie and fertilization on the dry matter production, we observed significant differences between the productions realized by the studied species or mixtures, for the same fertilization dose (tab. 1).

If we analyze the fertilization variant with manure 20 t ha^{-1} annually applied, we notice that the biggest

production was obtained at sainfoin (7.9 t ha^{-1} D.M.), followed by alfalfa with 7.4 t ha^{-1} D.M. and by the mixture sainfoin + tall fescue with 7.2 t ha^{-1} D.M.

Table 1

The influence of the specie and fertilization on the fodder production (1999-2002)

Fertilization variant	*Medicago sativa*		*Onobrychis viciifolia*		*Onobrychis viciifolia + Festuca arundinacea*		*Medicago sativa + Dactylis glomerata*	
	t ha^{-1}	%	*t ha^{-1}*	%	*t ha^{-1}*	%	*t ha^{-1}*	%
b_1	5.1	100	6.2	100	5.3	100	3.6	100
b_2	7.4*	145	7.9	127	7.2	136	5.9	164
b_3	7.2*	141	7.0	113	6.5	123	5.3	147
b_4	8.9***	175	8.5*	137	7.5*	142	7.7**	214
b_5	8.1**	159	7.4	119	7.0	132	7.2**	200
b_6	6.7	131	6.4	103	6.6	125	6.0*	167
LSD 5%	= 1.7		2.1		2.2		2.4 t ha^{-1}	
LSD 1%	= 2.5		3.0		3.2		3.5 t ha^{-1}	
LSD 0.1%	= 3.6		4.2		4.7		5.0 t ha^{-1}	

Applying manure in dose of 20 t ha^{-1} every other year, the biggest production were obtained at alfalfa (7.2 t ha^{-1} D.M.), followed by sainfoin (7.0 t ha^{-1} D.M.) and by the mixture sainfoin + tall fescue (6.5 t ha^{-1} D.M.).

Applying manure in a bigger dose of 40 t ha^{-1} annually emphasized that alfalfa develops the strongest reaction to fertilization (8.9 t ha^{-1} D.M.), followed by sainfoin (8.5 t ha^{-1} D.M.), the alfalfa + orchard grass mixture (7.7 t ha^{-1} D.M.) and the sainfoin + tall fescue mixture (7.5 t ha^{-1} D.M.).

Applying the same bigger dose every other year lead to production increases, but not so big, that justify the annually application of the manure.

The mineral fertilization with 25-25-0 complex in dose of 200 kg ha^{-1} conducted to the best results for alfalfa (6.7 t ha^{-1} D.M.), followed by sainfoin + tall fescue (6.6 t ha^{-1} D.M.) and by sainfoin (6.4 t ha^{-1} D.M.).

Analyzing the reaction of alfalfa related to the five fertilization variants, we observed that the biggest production belongs to the variant manure 40 t ha^{-1} annually

applied, followed by the variant with manure applied every other year, where the increases were of 75-59% compared to the unfertilized control.

Sainfoin reacts similar to alfalfa, having the biggest production for the variant with manure 40 t ha^{-1} annually applied, where the production was of 8.5 t ha^{-1} D.M. compared to 6.2 t ha^{-1} D.M. for the control.

The mixture sainfoin + tall fescue had the best results for the variant 40 t ha^{-1} manure annually applied, with 7.5 t ha^{-1} D.M. (42% increase), followed by the variant with same dose applied every other year, with 7.0 t ha^{-1} D.M..

The alfalfa + orchard grass mixture had the best results for the variant 40 t ha^{-1} manure annually applied, with 7.7 t ha^{-1} D.M. compared to the control – 3.6 t ha^{-1} D.M., with an increase of 114%.

The influence on fodder quality

The raw protein quantity on the surface unit is a feature of the leguminous specie within the mixture and less a response to the fertilization, especially when its participation percentage in the vegetal carpet's composition is close to 50%.

If the leguminous specie in the mixture is not dominant, the raw protein quantity can be influenced by fertilization, resulting bigger bio mass productions, provided by the graminee species in the mixture.

The data presented in table 2 show that for those 4 studied species and forage mixtures, the raw protein content (%) had increasing values in all 5 fertilization variants, compared to the unfertilized control.

The fodder obtained from the two perennial leguminous species, cultivated alone, realized the best raw protein content (17.03-19.20 %).

The raw cellulose content (%) was differently influenced by fertilization, considering the used specie or mixture, tending to maintain its value close to the one of the control, with small increases or decreases.

The biggest percentage of raw cellulose was realized by the sainfoin + tall fescue mixture (38.28 %), for the fertilization with 20 t ha^{-1} manure every other year.

The raw protein quantity for a hectare was influenced by the percentage of RP obtained by each species and by the quantity of dry matter realized on a surface unit.

Applying organic and mineral fertilizers lead to a significant increase of the RP production for one hectare, for all fertilization variants and for all studied species and mixtures. Under the influence of fertilization, organic or mineral, the plant's protein content does not change substantially, being a feature genetically determined for each cultivated specie, but through fertilization, the bio mass production increases a lot, hence, also does the total raw protein quantity on the surface unit.

Table 2

The influence of the specie and fertilization on the fodder's chemical composition

Specie	Fertilization dose	R.P. (%)	R.C. (%)	Ash (%)	Raw fat (%)	R.P.	
						kg ha^{-1}	%
Alfalfa	Control	14.43	24.98	7.08	2.18	735	100
	Manure 20 t ha^{-1} annually	14.74	28.64	7.09	1.72	1090	148
	Manure 20 t ha^{-1} ev. oth. y.	16.53	24.31	7.02	1.66	1190	162
	Manure 40 t ha^{-1} annually	15.63	24.58	7.56	2.57	1391	189
	Manure, 40 t/ha ev. oth. y.	16.25	26.61	7.43	2.33	1316	1790
	200 kg ha^{-1} Complex	16.15	29.15	7.12	2.32	1082	147
Sainfoin	Control	15.63	31.67	5.92	0.92	969	100
	Manure 20 t ha^{-1} annually	17.03	25.44	5.23	0.82	1475	152
	Manure 20 t ha^{-1} ev. oth. y.	16.16	25.01	6.34	1.06	1131	117
	Manure 40 t ha^{-1} annually	14.73	30.77	5.25	0.81	1252	129
	Manure, 40 t/ha ev. oth. y.	14.64	29.77	5.29	0.85	1083	112
	200 kg ha^{-1} Complex	15.63	24.22	7.22	1.06	1000	103
Sainfoin + tall fescue	Control	12.69	28.43	5.33	1.03	672	100
	Manure 20 t ha^{-1} annually	12.06	30.25	5.78	0.90	868	129
	Manure 20 t ha^{-1} ev. oth. y.	10.81	38.28	5.88	0.94	702	104
	Manure 40 t ha^{-1} annually	10.38	37.65	5.85	0.98	779	115
	Manure, 40 t/ha ev. oth. y.	14.02	27.59	5.30	1.01	981	146
	200 kg ha^{-1} Complex	10.55	32.73	5.75	1.06	696	103
Alfalfa + orchard grass	Control	12.41	27.46	7.54	1.51	446	100
	Manure 20 t ha^{-1} annually	10.39	33.50	6.98	2.00	613	111
	Manure 20 t ha^{-1} ev. oth. y.	12.75	27.97	6.98	2.19	675	151
	Manure 40 t ha^{-1} annually	10.56	31.48	6.95	1.96	824	122
	Manure, 40 t/ha ev. oth. y.	12.51	27.74	8.15	2.13	888	199

	200 kg ha^{-1} Complex	11.95	27.48	6.64	1.87	717	160

The influence on root mass

Root mass represents the total quantity of roots left in soil by a plant during its vegetation cycle and it is determined by a series of factors which depend on the morphological and physiological features of each plant specie, being a feature genetically determined in what regards the root form.

Considering the actually growing and developing of the root and the rot volume on a surface unit, differences appear between the plant species, as well as within the frame of the same specie, related to the soil – climate conditions.

Analyzing the influence of the specie on the root mass obtained on one hectare, as well as the ration between root mass and bio mass production, we observed that alfalfa is the forage culture with the biggest root mass, respectively 6.78 t ha^{-1} D.M., compared to sainfoin which realized 5.32 t ha^{-1} D.M. (tab. 3).

Table 3

The influence of the specie and fertilization on the root mass (t ha^{-1})

Specie	Fertilization dose	Root mass	Bio mass production	Root mass/D.M. production
Alfalfa	Control	3.96	5.1	0.78
	Manure 20 t ha^{-1} annually	5.85	7.4	0.79
	Manure 20 t ha^{-1} ev. oth. y.	5.43	7.2	0.75
	Manure 40 t ha^{-1} annually	8.10	8.9	0.91
	Manure, 40 t/ha ev. oth. y.	6.78	8.1	0.83
	200 kg ha^{-1} Complex	6.10	6.7	0.90
Sainfoin	Control	2.60	6.2	0.42
	Manure 20 t ha^{-1} annually	4.13	7.9	0.52
	Manure 20 t ha^{-1} ev. oth. y.	3.56	7.0	0.51
	Manure 40 t ha^{-1} annually	5.32	8.5	0.62
	Manure, 40 t/ha ev. oth. y.	4.13	7.4	0.56
	200 kg ha^{-1} Complex	4.35	6.4	0.68
Sainfoin + tall fescue	Control	2.49	5.3	0.47
	Manure 20 t ha^{-1} annually	3.26	7.2	0.45
	Manure 20 t ha^{-1} ev. oth. y.	3.13	6.5	0.48
	Manure 40 t ha^{-1} annually	4.59	7.5	0.61
	Manure, 40 t/ha ev. oth. y.	3.40	7.0	0.49
	200 kg ha^{-1} Complex	3.82	6.6	0.58
Alfalfa + orchard grass	Control	2.68	3.6	0.74
	Manure 20 t ha^{-1} annually	3.70	5.9	0.63
	Manure 20 t ha^{-1} ev. oth. y.	3.35	5.3	0.63
	Manure 40 t ha^{-1} annually	5.41	7.8	0.69
	Manure, 40 t/ha ev. oth. y.	5.22	7.1	0.74
	200 kg ha^{-1} Complex	3.52	6.0	0.59

From the obtained data we observed that the root mass realized at the two studied mixtures is smaller than the one realized at the simple cultures of alfalfa and sainfoin.

From the presented data we can observe that the dry matter production and also the root mass have a specific feature for each species, with a different response to fertilization and especially to the process of valuing the less favourable conditions of these highly eroded lands.

The two used mixtures realized similar root masses:

thus, for the alfalfa + orchard grass mixture, the root mass was of 4.59 t ha^{-1} D.M., and for the sainfoin + tall fescue mixture, the root production was of 5.41 t ha^{-1} D.M..

Analyzing the obtained data regarding the quantity of the roots left in soil by the plant species, cultivated alone or in mixture, we draw the conclusion that the biggest root quantity is left by the perennial leguminous cultures, followed by the simple mixtures made of these two leguminous species and two perennial graminee species (alfalfa + orchard grass, respectively sainfoin + tall fescue).

The ratio between the obtained root mass and bio mass production has sub unitary values, the biggest being registered for the pure alfalfa culture (0.91), followed by the alfalfa + orchard grass mixture (0.74).

Analyzing the values of the three studied indicators, we can conclude that between the realized bio mass production and the root mass there is a tight relation – for a high bio mass production, a well developed root system can be observed, and the biggest this is, the greater the bio mass production is registered; the ratio between the root production and the bio mass is bigger.

In order to realize big bio mass productions, we recommend assuring the optimal physiological soil conditions, for the development of a strong root system.

CONCLUSIONS

For alfalfa, the application of the same doses, but every other year, lead to similar average production levels, respectively for the variant with 20 t ha^{-1} manure annually we obtained an average production of 7.4 t ha^{-1} D.M., compared to the variant where 20 t ha^{-1} were applied every other year and the production was of 7.2 t ha^{-1} D.M.

Without fertilization, the valuing process of these lands can be done through establishing sainfoin cultures (*Onobrychis viciifolia*), that offer good productions, close to other species, organic or chemical fertilized.

For the alfalfa + orchard grass mixture, doubling the manure dose is justified by the highly increased obtained crops. Thus, for the variant using 40 t ha^{-1} manure every other year, the realized average production was of 7.1 t ha^{-1} D.M., compared to the variant with 20 t ha^{-1} manure applied every other year, where the production was of 5.3 t ha^{-1} D.M.

We observed that for the sainfoin + tall fescue mixture, the obtained production was net superior related to the vegetation years and also compared to the alfalfa + orchard grass mixture, due to the superior valuing of these lands by the sainfoin.

The quality of the forage obtained from the temporary grasslands was influenced by the species and the participation percentage, type and level of fertilization and by the climatic conditions of the exploitation period.

The biggest raw protein content was obtained for the perennial leguminous species in pure culture, and for the forage mixtures, the protein percentage is smaller, of 15.60 g kg^{-1}, respectively 11.42 g kg^{-1}.

The protein content (%) obtained for the 4 studied species and forage mixtures had increasing values in all 5 fertilization variants, compared to the unfertilized control. The raw cellulose content (%) was differently influenced by fertilization, related to the used specie and mixture, tending to maintain its value close to the one of the control, with small increases or decreases.

The raw protein quantity per hectare was influenced by the percentage obtained by each specie and by the dry matter quantity realized on a surface unit.

The biggest root mass is left behind by the perennial leguminous cultures, followed by the simple mixtures.

The ration between root mass and bio mass production positively changed (increased), for all considered species, under the influence of organic or mineral fertilization.

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