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THE BEHAVIOR OF A COMPLEX FORAGE MIXTURE UNDER THE INFLUENCE OF MINERAL FERTILIZATION

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SUMMARY: Grass-legume mixtures have a great economic importance mainly due to the fact that these cultures can storage huge quantities of N without any negative effects on production, being also able to determine an increase in forage nutritional value. This study aims to evaluate the behavior of the mixture consisting in Medicago sativa, Lolium hybridum, Festuca arundinacea and Dactylis glomerata under the influence of mineral fertilization, in the soil-climatic condition specific to Transylvania Plateau, Romania. The experience was established in the spring of 2012, according to the subdivided parcels method, in 8 variants with 4 replications. The mixture was seeded on two different distances between roads, namely 12.5 cm and 25 cm. Four treatments (doses)with mineral fertilization were performed: V_1- control variant, unfertilized, V_2- $N_{50}P_{60}K_{80}$, V_3- $N_{75}P_{60}K_{80}$, V_4- $N_{100}P_{60}K_{80}$. In order to accomplish the objective proposed which is to provide a deep and comprehensive analysis of the forage mixture studied, data related to green mass and DM production and floristic composition are given. This paper summarizes the results registered on 2013. The seeded forage species had a good response to this specific mixture and to the climatic conditions. The results showed that mineral fertilization with N has a significant influence both on species green mass and DM production and on their floristic composition.

Key words: *forage, mixture, behavior, fertilization, production.*

INTRODUCTION

One of the most important tasks ahead for agriculture worldwide is to secure sufficient food for a growing population without further straining our environmental resources. The challenge is to produce more food with less external input (ÁslaugHelgadóttir*et al.*, 2013). The economic and ecologic importance of grassland is outstanding; these huge green surfaces are priceless connected to human life and environment conservation (Rotar, 2010).Nowadays a higher increasingly importance is given to the establishment of seeded grasslands which represent in fact a valuable forage source both from quantitative and qualitative point of view.

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Mixtures of grass and legume species in forage production can contribute to higher yields and reduced needs for fertilizers (Sturludottir*et al.*, 2013). Forage legumes play an invaluable role in the nitrogen balance and in sustainability grassland agriculture encompassing cold to warm climes (Søegaard*et al.*, 2007). Grasses have higher carbohydrate contents and can benefit from the nitrogen fixed by legumes when theyare grown together. Compared with grasses, forage legumes generally have higher content of protein, pectin, lignin, carotene and vitamins (Frame, 2005), and therefore growing grasses and legumes in mixtures can improve herbage nutritive value compared with grass monocultures (Miriam Kizekováet *al.*, 2013). In choosing the grasses and leguminous species in order to form a mixture one should take into account the soil-climate and nutritional demands of each species.

MATERIAL AND METHOD

The present study aims to follow the behavior of a complex forage mixture (formed by *Medicago sativa* (40%), *Lolium hybridum* (15%), *Festuca arundinacea* (15%) and *Dactylis glomerata* (30%)) under the influence of mineral fertilization, in soil-climatic condition specific to Transylvania Plateau, Romania. The experience was installed in the spring of 2012 in the field of Agricultural Research-Development Station, Turda, Romania. The experimental sit is characterized by an annual medium temperature (2013) of 10.4^{0}C and annual precipitations of 523.2 mm. The soil type is phaeozemargiloiluvialvertic.

The experience was installed according to the subdivided parcels method: in 8 variants with 4 replications, each plot having 50 m^2 (10l X 5 L). The species were sown on two different distances between roads, namely 12.5 cm and 25 cm. The mixture was fertilized in the beginning of March month of every year with NPK complex and Ammonium nitrate (33.3%) in 4 different doses: V_1-control variant, unfertilized, V_2- $N_{50}P_{60}K_{80}$, V_3- $N_{75}P_{60}K_{80}$, V_4- $N_{100}P_{60}K_{80}$. Plots were mowed three times/year. Statistical interpretation of data was performed using Polifact program. The present study comprises data registered in 2013, data related to green mass and dry matter (DM) production and floristic composition of the mixture studied.

RESULTS

The complex forage mixture formed by alfalfa (*Medicago sativa* (40%)), hybrid ryegrass (*Lolium hybridum* (15%), tall fescue (*Festuca arundinacea* (15%)) and cocksfoot(*Dactylis glomerata* (30%)) has a good response to mineral fertilizers. The yield increase registered (Table 1) is higher on variant V_3, fertilized with $N_{75}P_{60}K_{80}$, where we have a difference in yield of 9.37 t green mass/ha. An increaseof fertilizer doses up to $N_{100}P_{60}K_{80}$ is not justified since caused a decrease in green mass production from 35.50 t green mass/ha (V_3) to 27.89 green mass/ha (V_4).

Dry matter production follows, as expected, the green mass production. The third fertilization graduation, V_3, registered the highest DM harvest of 13.62 t DM/ha.

Increasing the dose up to $N_{100}P_{60}K_{80}$ leads to a decrease in DM harvest up to 10 t DM/ha (on V_4).

The variants sown on 25 cm distance between roads had different reaction to the same dose of fertilizer when compared to the variants sown on 12.5 cm distance between roads (Table 2). On V_2- $N_{50}P_{60}K_{80}$ green mass harvest difference is 4.04 t green mass/ha while on maximum dose of fertilizer this parameter reaches up to 11.82 t green mass/ha. Increasing fertilizer dose up to $N_{100}P_{60}K_{80}$ caused increases both on green mass and DM production.

The analyses of green mass and DM production (Table 3) highlights that the variants sown on 25 cm distance between roads are superior to those sown on 12.5 cm distance between roads. The highest green mass yield increase (8.95 t/ha) was registered on the variant V_4, fertilized with maximum dose of $N_{100}P_{60}K_{80}$ and is very significant statistically ensured when compared with the average of the two sown distances. Same reaction is observed also on DM harvest where on V_2 was registered a yield difference of 1.32 t DM/ha and 2.32 on V_4.

Analysesof the complex mixture formed by alfalfa, hybrid ryegrass, tall fescue and cocksfoot highlighted variations in species composition as a result of fertilizers doses applied. On 12.5 cm distance between roads the highest percentage was occupied by alfalfa on all 4 doses of fertilizer, which registered values between 58.06% on V_4 and 72.40% on V_1 (Figure 1). The smallest results were registered by tall fescue (10 % average/4 fertilization graduation), which participation percentage varies between 5.82% on V_2 and 15.21% on V3.

The influence of mineral fertilizer is felt also on the variants sown on 25 cm distance between roads (Figure 2). When plant feeding space is changed also the percentage in species composition of the mixture changes.

The only species whose percentage of participation decreases is alfalfa (from 65%- the average/4 fertilization graduation of the variants sown on 12.5 cm distance between roads to 53% on those sown on 25 cm) while all the other species met a small increase. Cocksfoot showed a good response to fertilization with $N_{50}P_{60}K_{80}$ on both distances between roads.

DISCUSSION

Starting from the installation capacity of the species taken into mixture, the evolution of floristic composition shows a different behavior to the technological input used in our study. A relevant example in this direction is the behavior of *Medicago sativa*. Alfalfa's high capacity of competition is more than obvious (aspect highlighted also by Deak, 2012). Alfalfa occupies the highest percentage of participation both on variants sown on 12.5 cm distance between roads and on variants sown on 25 cm distance between roads. Mineral fertilization leads to a decrease in the percentage of participation of alfalfa. This could be explained by the fact that the input of fertilizer stimulated competition between species, which met an

increase in the percentage of participation in mixture (hybrid ryegrass increased its share from 10.83% on V_1 to 17.84% on V_4). The behavior of tall fescue must be noted as well. Tall fescue according to scientific literature (Peeters, 2004; Deak, 2012) has small installation capacity and competitiveness.

While on the variants sown on 12.5 cm distance between roads tall fescue occupies only 8.67% (V_1) once with the grow of plants feeding space (variants sown on 25 cm distance between roads) the percentage of tall fescue grows as well to 29.69% (V_1). Variations on tall fescue percentage of participation in mixture were produced also as a result of mineral fertilization. Under the influence of mineral fertilizers this species percentage of participation grows from 8.67% (V_1)to 15.21% (V3). The intensification of the system stimulatedspecies competitivenesswhich leads to a decrease of tall fescue percentage of participation. *Dactylis glomerata* has a good response to fertilization with$N_{50}P_{60}K_{80}$ (V_2) which stimulates this species competitiveness.The percentage of this species grows on V_2 (both on the variants sown on 12.5 cm and 25 cm distances between roads) in the detriment of hybrid ryegrass and tall fescue which are dominated by this species. On the variants sown on 12.5 cm between roads tall fescue showed more competitiveness oncocksfoot than hybrid ryegrass, while on the variants sown on 25 cm between roads the proportions are reversed (hybrid ryegrass registered the highest percentage from all other experimental variants).

The stress exercised by mineral fertilization on alfalfa is notable also on green mass and DM production. From the variants sown on 12.5 cm between roads the highest yields are registered on the variants fertilized with $N_{100}P_{60}K_{80}$ An increase of fertilizer dose is not justified because this caused decreases on both green mass and DM production. Similar results were reported also by previous researchers (Talpan*et al.*, 2007). This dose of fertilizer had a positive influence on hybrid ryegrass and tall fescue whose percentage of participation in mixture grows (according to floristic composition analysis). Hybrid ryegrass showed a behavior in accordance with the scientific literature (Peeters, 2004) where is highlighted the fact that this species has high demands on fertilization input. So hybrid ryegrass expresses its full potential on the variants fertilized with the highest doses. From the variants sown on 25 cm distance between roads the highest green mass and DM production were registered on the variants fertilized with $N_{100}P_{60}K_{80}$ (V_4). This treatment had a positive influence on cocksfoot and hybrid ryegrass. It was noticed that hybrid ryegrass registered high percentage of participation in the variants which registered the highest yields (both on the variants sown on 12.5 cm and 25 cm distance between roads). *Dactylis glomerata* was more competitive than tall fescue and is the species responsible for the superiority of the variants sown on 25 cm distance between roads.

CONCLUSION

The results showed that fertilization had a high influence on the mixture studied (both on species productivity and floristic composition).

Floristic composition analysis showed that under the influence of mineral fertilization the species with high demands in mineral nutrients are favored. The species studied had a behavior in accordance with previous researches. From all the species taken in study *Medicago sativa* was the most competitive and dominated the other species.

Green mass and dry matter production analysis showed that the variants sown on 25 cm distance between roads is superior on all fertilization doses to the variants sown on 12.5 cm distance between roads.

From the variants sown on 12.5 cm distance between roads the highest yields were registered on the variants fertilized with $N_{75}P_{60}K_{80}$ while from the variants sown on 25 cm between roads the highest yields were registered on the variants fertilized with $N_{100}P_{60}K_{80}$.

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Tables and figures

Table 1. The influence of mineral fertilization on green mass and DM production on the variants sown on 12.5 cm distance between rows

Fertilization doses	Production [t/ha]		Percent		Difference		Significance	
	Green mass*	DM**	Green mass*	DM**	Green mass*	DM**	Green mass*	DM**
V_1-0 kg/ha	26,12	9.86	100,0	100,0	0,00	0,00	Mt	Mt
V_2- $N_{50}P_{60}K_{80}$	25,57	9.92	97,9	100.7	-0,56	0.07	000	000
V_3- $N_{75}P_{60}K_{80}$	35,50	13.62	135,9	138.2	9,37	3.76	***	***
V_4- $N_{100}P_{60}K_{80}$	27.89	10.70	106,8	108.6	1,76	0.85	***	***

*DL (p 5%)0,08 DL (p 1%)0,12 DL (p1%)0,18
**DL (p 5%) 0.32 DL (p 1%)0.47 DL (p 0.1%)0.69

Table 2. The influence of mineral fertilization on green mass and DM production on the variants sown on 25 cm distance between rows

Fertilization doses	Production [t/ha]		Percent		Difference		Significance	
	Green mass*	DM**	Green mass *	DM**	Green mass *	DM**	Green mass *	DM**
V_1-0 kg/ha	33,97	10.25	100,0	100,0	0,00	0,00	Mt.	Mt.
V_2- $N_{50}P_{60}K_{80}$	38,01	12.55	111,9	122.5	4,04	2.30	***	***
V_3- $N_{75}P_{60}K_{80}$	36,09	13.18	106,2	128.5	2,12	2.92	***	***
V_4- $N_{100}P_{60}K_{80}$	45,79	15.46	134,8	150.8	11,82	5.21	***	***

*DL (p 5%) 0,00 DL (p 1%)0,00 DL (p 0.1%)0,00
**DL (p 5%) 0,08 DL (p 1%) 0,12 DL (p 0.1%) 0,7

Table 3. Interactions distance between roads-fertilization doses

Symbol		Variant		%		Difference		Significance	
Fertilization doses	Distancebet weenrows [cm]	Green mass*	DM**	Green mass*	DM**	Green mass*	DM**	Green mass*	DM**
V_1-0 kg/ha	D0-average	30,05	10,05	100,0	100,0	0,00	0,00	Mt.	Mt.
	12.5	26,13	9,86	98,0	98,0	-3,92	-0,20	000	-
	25	33,97	10,25	102,0	102,0	3,92	0,20	***	-
V_2-$N_{50}P_{60}K_{80}$	D0-average	36,76	11,24	100,0		0,00	0,00	Mt.	Mt.
	12.5	35,50	9,92	88,3	100,0	-1,26	-1,32	000	0
	25	38,01	12,55	111,7	88,3	1,26	1,32	***	*
V_3-$N_{75}P_{60}K_{80}$	D0-average	30,83	13,40	100,0	111,7	0,00	0,00	Mt.	Mt.
	12.5	25,57	13,62	101,7		-5,26	0,22	000	-
	25	36,09	13,18	98,3	100,0	5,26	-0,22	***	-
V_4-$N_{100}P_{60}K_{80}$	D0-average	36,84	13,08	100,0	101,7	0,00	0,00	Mt.	Mt.
	12.5	27,89	10,70	81,8	98,3	-8,95	-2,38	000	00
	25	45,79	15,46	118,2		8,95	2,38	***	**

*DL (p 5%) 0,10 DL (p 1%) 0,16 DL (p 0.1%) 0,32
**DL (p 5%) 1,01 DL (p 1%) 1,82 DL (p 0.1%) 3,98

Figure 1. The influence of mineral fertilization on floristic composition of the variants sown on 12.5 cm distance between rows

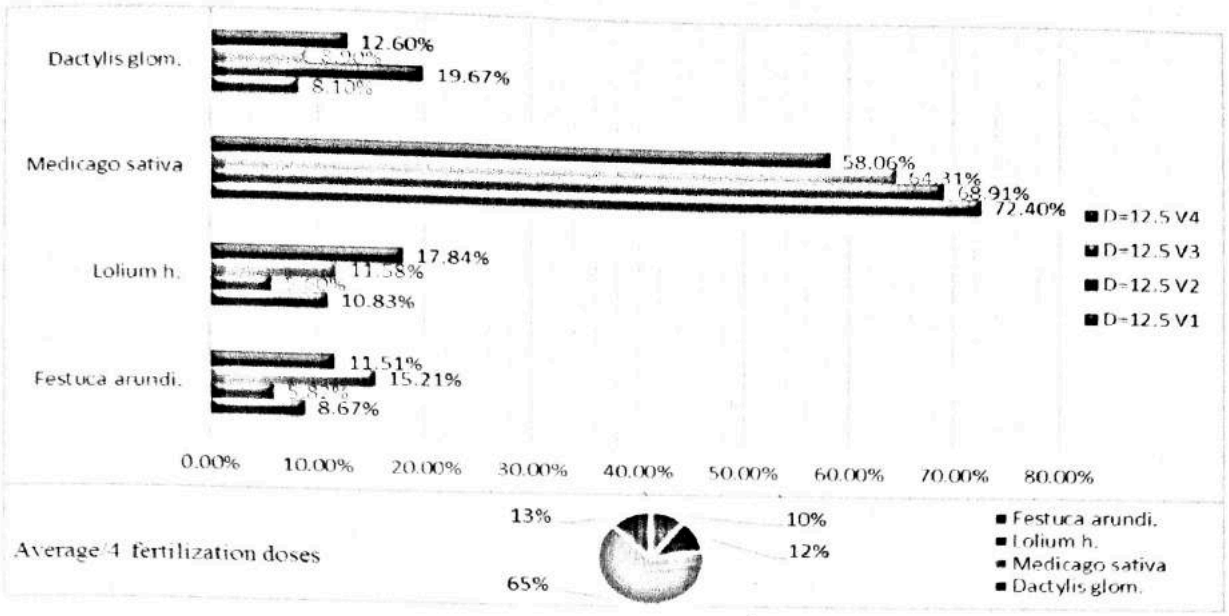

Figure 2. The influence of mineral fertilization on floristic composition of the variants sown on 25 cm distance between rows