

Fleorage production and quality of mixture of a *Medicago sativa* Linn and *Dactylis glomerata* Linn according to fertilization and harvest cycle

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Abstract

Both *Medicago sativa* L. (alfalfa) and *Dactylis glomerata* L. (orchardgrass) are highly productive forage species, but with some drawbacks when sown in pure culture, like the low content of soluble sugars. In the present work, an attempt has been done to test the hypothesis that by mixing alfalfa with orchard grass and applying fertilizer it can be obtained yields of forage at least as large as of the species grown in pure culture and achieve a more balanced energy-protein feed with a high quality. The highest dry matter productions and crude protein yields were obtained from the mixture of *Medicago sativa* *Dactylis glomerata* (75% + 25%) at all fertilizer rates, but only on the first harvesting cycle. From second to fourth harvesting cycle the highest yields were obtained from *Medicago sativa* (100%). The “Prime” and “Excellent” quality of forage according to RFV (relative forage value) was obtained from *Medicago sativa* (100%), mainly on low fertilization rate on all harvesting cycles, but also both mixtures had “Excellent” to “Good” quality of forage.

Keywords: mixture, *Medicago sativa*, *Dactylis glomerata*, mineral fertilization, production, quality.

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1.0 Introduction

Medicago sativa is very valuable forage specie, with high plasticity, which provides high dry matter production and large quantities of protein and is the leguminous forage plant most often used in animal feeding recipes (Radović J. et al., 2009). Perennial grasses like *Medicago sativa* respond well to nitrogen fertilizer and are suitable for intensification of meadows, and along with modernization of the livestock sector, it is imperative to have intensive meadows. Association in the mixture of *Medicago sativa* with *Dactylis glomerata* is considered one of the best options for the intensification of sown grasslands because grass specie, *Dactylis glomerata*, possesses versatility and a growth rate similar to *Medicago sativa*. Both crops, under optimal conditions, have longevity of at least 4 years (Barbarossa R.A. and Miñon D.P., 2001, Sanderson M.A. et al., 2005, Skinner R.H. et al., 2006). *Medicago sativa* fixes atmospheric nitrogen and can ensure some nitrogen to *Dactylis glomerata*, which can reach up to 80% (Berdahl J. et al., 2004), and consequently reduces the demand for nitrogen fertilizers (Tomić Z. et al., 2011) and reduces the environmental pollution (Bijelić Z. et al., 2011). Mixture of *Medicago sativa* with *Dactylis glomerata* provides a better forage quality than pure cultures (Gil J.L. and Fick W.H., 2001). Due to a high sugar

content of *Dactylis glomerata* plants, these mixtures also can offer the possibility of a more successful ensiling (Vintu V. et al., 2004). A more economic efficient production can be obtained because these mixtures provides better use of nutrients in the soil and needs low rates of fertilizers with nitrogen (Salis L. and Vargiu M., 2008). Therefore, taking into all these descriptions, the two plant species, it was thought worthwhile to test the mixture of mixture *Medicago sativa* and *Dactylis glomerata* which can provide high yields with a more balanced quality of forage than pure cultures.

2.0 Materials and methods

In order to achieve our objectives, it was established an experience on Ezăreni Farm of the Didactic Resort of USAMV Iasi. The experience is placed on a cambium chernoziom soil with pH values between 6.7 and 6.8 and humus content of 2.73-2.93%, 21-25 ppm PAL, 226-232 ppm KAL and 112 - 139 ppm CaO. The present study covers production and quality data of forage samples collected on four production cycles of the experimental year 2011, the second year of crop. The studied factors were: Factor A: type of crop, three graduations: a1- *Medicago sativa* 100% (control), a2- *Medicago sativa* 75% + 25% *Dactylis glomerata*, a3- *Medicago sativa* 50% + 50% *Dactylis glomerata*. Factor B: mineral fertilization with four rates: b1- N0P0 (control), b2- N50P50, b3-

N75P50, b4- N100P50. For sowing mixture of seeds (calculated germinating plants per unit of surface) of Romanian *Medicago sativa* L. Magnat cultivar and seeds of Danish *Dactylis glomerata* L were used. Fertilization was performed only in the early spring to first harvesting cycle and products used for fertilization were ammonium nitrate (N33.5) and nitrogen-phosphorus complex (N20P20). Harvesting was performed on full bloom of *Medicago sativa* 100% unfertilized. During the growing season (April-September), the average temperature was 18.4°C with 1.1°C positive deviation from the annual average (17.3°C).

The amount of rainfall (282.6 mm) in growing season was with 52.9 mm lower than the annual average (335.5 mm). Spring was wet, but July, August and September recorded high negative deviations for rainfall, of 19.4 mm, 37.2 mm and 30.6 mm compared to annual average (69.2 mm, 57.6 mm, 40.8 mm), considering it under this

aspect and temperature as a dry period.

Chemical composition of forage was determined using the following methods of analysis: dry matter (DM) by drying at 105°C, total nitrogen (TOTAL-N) by the Kjeldahl method, crude protein (CP) by %TOTAL-N x 6.25, acid detergent fiber (ADF) and neutral detergent fiber (NDF), using Raypa Fiber Test equipment and Van Soest method. Canopy cover structure was determined by gravimetric method at the time of each harvest. The statistical interpretation of data was performed by analysis of variance and differences limit calculation using SPSS software - ANOVA (Statistical Package for the Social Sciences).

Relative feed value (RFV) was calculated using formula (Boman R.L., 2010):

$$RFV = (DDM \times DMI) / 1.29.$$

$$DDM = \text{Digestible Dry Matter} = 88.9 - (0.779 \times \% \text{ ADF})$$

$$DMI = \text{Dry Matter Intake} = 120 / (\% \text{ NDF})$$

Table-1 :*Medicago sativa* and legume-grass mixtures forage classes of quality according to RFV (Canbolat O. et al., 2006)

Class of Quality	CP (% of DM)	NDF (% of DM)	ADF (% of DM)	RFV
0 –Prime	>19	<40	<31	>151
1-Excellent	17-19	40-46	31-40	125-151
2-Very good	14-16	47-53	36-40	103-124
3- Good	11-13	54-60	41-42	87-102
4-Satisfactory	<8	>65	>55	<75

The American Forage and Grassland Council (A.F.G.C) have endorsed to use RFV as a measure.

3.0 Results and discussion

Influence of mixture and fertilization on the production of dry matter (DM)

On cycle I, the largest production of DM was obtained from the two mixtures. Thus, the mixture of *Medicago sativa* and *Dactylis glomerata* (75% + 25%) registered very significant increases, of 125% (7.51 Mg ha^{-1}) at a dose of $\text{N}_{100}\text{P}_{50}$ and 117% DM (7.02 Mg ha^{-1}) at a dose of $\text{N}_{75}\text{P}_{50}$. From cycle II to cycle IV, the highest productions were recorded only on *Medicago sativa* in pure culture, and that because of much slower recovery after mowing of *Dactylis glomerata* plants from those of *Medicago sativa* as mainly due to the effect of drought. On cycles II, III and IV, the two mixtures registered negative deviation from the DM production of the *Medicago sativa* (100%) unfertilized (control). Thus, on the second cycle the maximal production of DM obtained from *Medicago sativa* (100%) was 4.50 Mg ha^{-1} , on variant fertilized with $\text{N}_{100}\text{P}_{50}$, and from the mixtures we obtained 4.17 Mg ha^{-1} and 3.92 Mg ha^{-1} , respectively (Table-2). Analyzing the total DM productions of the four harvesting cycles we observed that they are very close between types of culture. Thus, at the highest fertilization rate, *Medicago sativa* (100%) recorded

of forage quality. The Quality Grading Standard assigned by A.F.G.C. is presented in Table-1.

a total production of 14.67 Mg ha^{-1} DM, mixture *Medicago sativa* and *Dactylis glomerata* (75% + 25%) gave a production of 14.49 Mg ha^{-1} DM and the mixture *Medicago sativa* and *Dactylis glomerata* (50% + 50%) gave a maximal production of 13.69 Mg ha^{-1} DM. Using polynomial regression line it was observed that, on first cycle there was significant correlations between nitrogen fertilization rate and dry matter production only for the two mixtures for $p = 5\%$, $r^2 = 0.999$ (Figure-1).

Between dose of nitrogen applied and total DM production in 2011, we obtained positive correlations ($p = 5\%$) for both mixture *Medicago sativa* and *Dactylis glomerata*, $r^2 = 0.9997$ (75% + 25%), and mixture *Medicago sativa* and *Dactylis glomerata* (50% + 50%), $r^2 = 0.9984$ (Figure-2).

Influence of mixture and fertilization on the yield of crude protein (CP)

On cycle I, the highest average yield of 1377 Kg ha^{-1} CP was obtained from mixture *Medicago sativa* and *Dactylis glomerata* (75% + 25%) with the fertilization rate used of $\text{N}_{100}\text{P}_{50}$, registering an increase of 126% compared to control variant. The mixture *Medicago sativa* and *Dactylis glomerata* (50% + 50%) registered an highest average yield

of 1294 Kg ha⁻¹ CP with an increase of 119% by control using fertilization rate of N₁₀₀P₅₀.

However, at the same nitrogen rate, the second highest yield of CP of 1358 Kg ha⁻¹ on cycle I was obtained from *Medicago sativa* (

100%), with an increase of 125%. With the following cycles, the CP yield gave by the two mixtures gradually decreased, registering negative to highly significantly negative differences by control at all fertilized variants (Table-3).

Table-2: Influence of interaction mixture x fertilization on the dry matter (DM) production

Variants		Cycle I (Mg ha ⁻¹)	Cycle II (Mg ha ⁻¹)	Cycle III (Mg ha ⁻¹)	Cycle IV (Mg ha ⁻¹)	Total (Mg ha ⁻¹)
<i>Medicago sativa</i> (100%) (control)	Control	6.02	4.01	2.19	0.98	13.20
	N ₅₀ P ₅₀	6.15	4.08	2.24	0.99	13.46
	N ₇₅ P ₅₀	6.49*	4.38*	2.31*	1.01	14.19*
	N ₁₀₀ P ₅₀	6.78**	4.50**	2.36*	1.03*	14.67**
<i>Medicago sativa</i> and <i>Dactylis glomerata</i> (75% + 25%)	Unfertilize d	6.39*	3.87	1.98	0.79	13.03
	N ₅₀ P ₅₀	6.68**	3.98	2.00	0.78	13.44
	N ₇₅ P ₅₀	7.02***	4.09	2.04	0.76	13.91*
	N ₁₀₀ P ₅₀	7.51***	4.17	2.07	0.74	14.49**
<i>Medicago sativa</i> and <i>Dactylis glomerata</i> (50% + 50%)	Unfertilize d	6.31	3.72 ^O	1.84	0.61	12.48
	N ₅₀ P ₅₀	6.52*	3.78 ^O	1.85	0.60	12.75
	N ₇₅ P ₅₀	6.84**	3.87	1.89	0.59	13.19
	N ₁₀₀ P ₅₀	7.28***	3.92	1.91	0.58	13.69

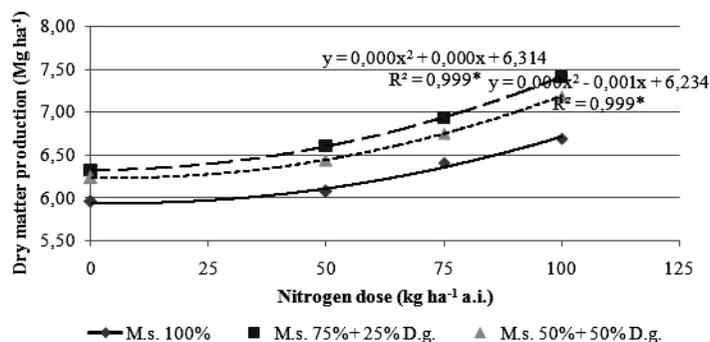


Figure-1: Polynomial regression line of the nitrogen rate on the dry matter production on cycle I

Overall on the fourth cycles, because of the highest TOTAL-N content of *Medicago sativa* plants, the largest total yield of CP in 2011 was obtained from in *Medicago sativa* 100 (2614 kg ha⁻¹ CP), but it was tightly followed by the total yield of mixture *Medicago sativa* and *Dactylis glomerata* (75% + 25%) (2426 kg ha⁻¹ CP).

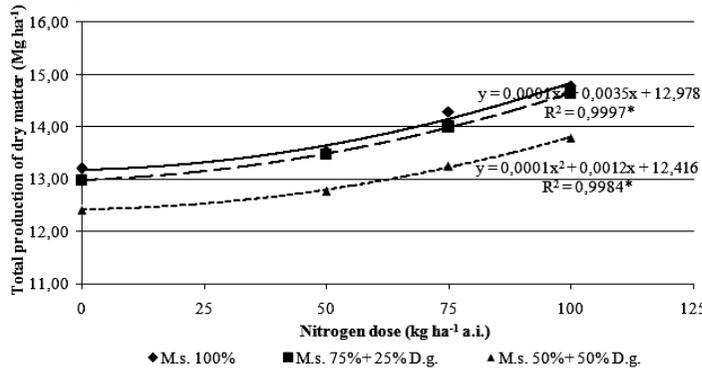


Figure- 2: Polynomial regression line of the nitrogen rate on the total dry matter production in 2011

Significantly positive correlation between the rate of nitrogen and the yield of CP were recorded on cycle I, on both *Medicago sativa* and on the two mixtures. Thus, for $p = 5\%$, *Medicago sativa* (100 %), $r^2 = 993^*$, for mixture *Medicago sativa* and *Dactylis glomerata* (75% + 25%), $r^2 = 999$ and for *Medicago sativa* and *Dactylis glomerata* (50% + 50%), $r^2 = 998^*$ (Figure-3). Between the rate of nitrogen applied and the total yield of CP in 2011, positive correlations ($p = 5\%$) was observed only for the two mixtures, *Medicago sativa* and *Dactylis glomerata* (75% + 25%) is $r^2 = 0.999^*$ and $r^2 = 0.996^*$ for the mixture *Medicago sativa* and *Dactylis glomerata* (50% + 50%) (Figure-4).

Increasing rate of nitrogen applied decreased the participation of *Medicago sativa* plants in both mixtures canopy coverage and increased the participation of *Dactylis glomerata* plants as a better response to nitrogen fertilizer, but generally, the share of *Dactylis glomerata* did not exceed the sowing rate. Because of drought, *Dactylis glomerata* plants had a slow recovery after mowing and its share in the structure of mixtures declined from cycle I to cycle IV. Only the mixture of *Medicago sativa* and *Dactylis glomerata* and only on the first cycle had a higher proportion of participation in the mixture compared with *Medicago sativa* and with the sowing ratio of 55% and 61% in fertilized variants with N₇₅P₅₀ and N₁₀₀P₅₀.

Influence of mixture and fertilization on the canopy cover structure

In 2011, *Medicago sativa* plants were those who dominated in mixtures canopy, the share of weeds was insignificant in all variants.

Table-3: Influence of interaction mixture x fertilization on the crude protein (CP) yield

Variants		Cycle I (Kg ha ⁻¹)	Cycle II (Kg ha ⁻¹)	Cycle III (Kg ha ⁻¹)	Cycle IV (Kg ha ⁻¹)	Total (Kg ha ⁻¹)
<i>Medicago sativa</i> 100% (control)	Control	1090	692	366	171	2319
	N ₅₀ P ₅₀	1159*	691	368	171	2389
	N ₇₅ P ₅₀	1264***	721	371	173	2529*
	N ₁₀₀ P ₅₀	1358***	715	368	173	2614**
<i>Medicago sativa</i> 75% + 25% <i>Dactylis glomerata</i>	Unfertilized	1043	651	303	131	2128
	N ₅₀ P ₅₀	1141*	656	300	127	2224
	N ₇₅ P ₅₀	1246**	653	298	121	2318
	N ₁₀₀ P ₅₀	1377***	641	292	116	2426
<i>Medicago sativa</i> 50% + 50% <i>Dactylis glomerata</i>	Unfertilized	983	600	277	93	1953
	N ₅₀ P ₅₀	1070	596	272	90	2027
	N ₇₅ P ₅₀	1175*	589	269	87	2120
	N ₁₀₀ P ₅₀	1294***	572	261	83	2209
	LSD 0.05	54	34	18	9	115

On the canopy structure of mixture of *Medicago sativa* 75% + 25% *Dactylis glomerata* the ratio between plants of *Medicago sativa*/ *Dactylis glomerata*/ weeds on first cycle ranged from 80/18/2% (unfertilized variants) to 74/26/0% (fertilized variants with N₁₀₀P₅₀). On the second cycle the ratio it ranged from 88/11/1% (unfertilized variants) to 77/23/0% (on variants treated with N₁₀₀P₅₀), on the third cycle, it ranged from 91/8/1% (unfertilized) to 80/20/0% on variant fertilized with N₁₀₀P₅₀ dose and on cycle IV, from 92/7/1% on unfertilized variant to 83/17/0% on the variant fertilized with rate of N₁₀₀P₅₀. On the canopy structure of mixture of of

Medicago sativa 50% + 50% *Dactylis glomerata*, the ratio between plants of *Medicago sativa*/ *Dactylis glomerata*/ weeds on first cycle ranged between 58/41/1% (unfertilized) and 39/61/0% (fertilized with N₁₀₀P₅₀). On the second cycle it ranged between 70/29/1% (unfertilized) and 52/48/0% (fertilized with N₁₀₀P₅₀), on the third cycle, between 80/19/1% on the variant unfertilized and respectively 66/34/0% on variant fertilized with N₁₀₀P₅₀ dose. On cycle IV, it ranged between 82/17/1% on the variant unfertilized and 69/31/0% respectively on the variant fertilized with rate of N₁₀₀P₅₀.

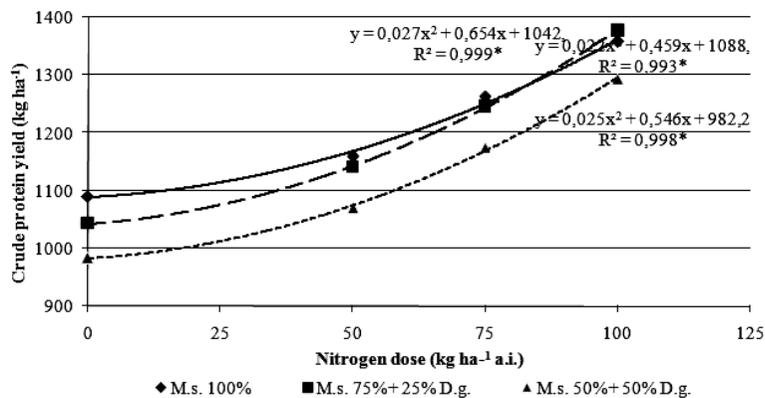


Figure-3: Polynomial regression line between nitrogen rate and the crude protein yield on cycle I
Combined influence of factors on the forage quality

The differences between plant species maturity stages at harvest time had some influence over the quality of forage. On the first harvest cycle, *Dactylis glomerata* plants were fully flowered with influence mainly on the cell walls content and plants of *Medicago sativa* were in the stage of fully bud with high contents of TOTAL-N. Influence over the quality of forage had the canopy cover structure as well. On cycle I, it was a domination of *Dactylis glomerata* plants in canopy with influence on cell walls contents of forage from mixtures.

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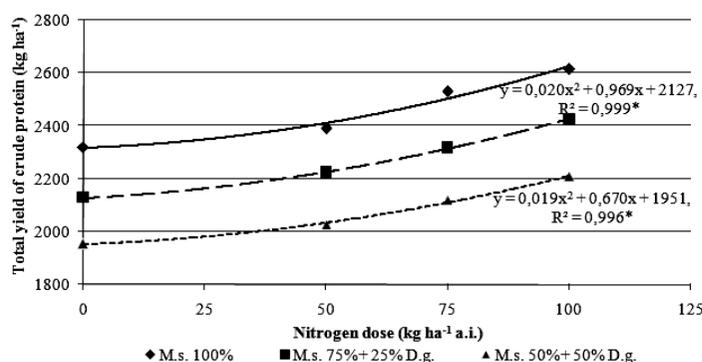


Figure- 4: Polynomial regression line between nitrogen rate and the total crude protein yield in 2011

With the following cycles the drought reduced the participation rate of *Dactylis glomerata* plants in mixtures canopy structure, but raised the cell

walls contents in all plants (Table-4). In general, increasing rate of nitrogen applied caused high TOTAL-N contents in both plants of *Medicago sativa* and of *Dactylis glomerata* on cycle I, but increased the cell walls as well. Thereby, the best quality of forage was registered on unfertilized variants of all culture types. *Medicago sativa* 100% had generally at first cycle a “Prime” and “Excellent” forage (154-124 RFV).

Table-4: Influence of interaction mixture x fertilization on the chemical composition of forage, DM based, and on the RFV (2011)

Variants		Cycle I		Cycle II		Cycle III		Cycle IV	
		NDF %	ADF %	NDF %	ADF %	NDF %	ADF %	NDF %	ADF %
<i>Medicago sativa</i> 100%	Control	39,24	30,97	38,36	30,71	37,69	30,50	36,60	29,57
	N ₅₀ P ₅₀	41,59*	32,89*	39,51	31,78	38,45	31,20	36,97	29,93
	N ₇₅ P ₅₀	43,16*	34,15*	40,66*	32,70*	38,82	31,56	37,33	30,25
	N ₁₀₀ P ₅₀	45,52*	35,92*	41,43*	33,31*	39,20	31,87	37,52	30,37
	Unfertilized	42,28*	32,46	40,28*	31,64	39,97*	31,08	39,33*	31,41*
<i>Medicago sativa</i> 75% + 25%	N ₅₀ P ₅₀	45,24*	35,06*	42,29*	32,95*	41,56*	32,47*	40,11*	32,10*
	N ₇₅ P ₅₀	47,78*	37,00*	43,90*	34,20*	42,36*	33,13*	41,29*	33,10*
<i>Dactylis glomerata</i>	N ₁₀₀ P ₅₀	50,31*	38,95*	45,11*	35,14*	43,56*	34,09*	42,08*	33,76*
	Unfertilized	44,77*	33,64*	43,03*	33,00*	42,60*	32,89*	40,74*	32,50*
<i>Medicago sativa</i> 50% + 50%	N ₅₀ P ₅₀	48,35*	36,50*	45,61*	35,31*	44,30*	34,37*	41,96*	33,58*
	N ₇₅ P ₅₀	51,49*	39,02*	47,76*	36,79*	45,58*	35,42*	43,18*	34,62*
<i>Dactylis glomerata</i>	N ₁₀₀ P ₅₀	54,17*	41,04*	49,66*	38,24*	47,29*	36,80*	44,41*	35,62*
		TN %	RFV	TN %	RFV	TN %	RFV	TN %	RFV
<i>Medicago sativa</i> 100%	Control	2,90	154	2,76	158	2,67	161	2,80	167
	N ₅₀ P ₅₀	3,01	142	2,71	151	2,63	156	2,76	165
	N ₇₅ P ₅₀	3,12*	134	2,64	145	2,57	154	2,73	163
	N ₁₀₀ P ₅₀	3,20*	124	2,54	141	2,50	152	2,68	162
<i>Medicago sativa</i> 75% + 25%	Unfertilized	2,61	140	2,69	148	2,45	151	2,65	152
	N ₅₀ P ₅₀	2,73	127	2,64	139	2,40	142	2,60	148
<i>Dactylis glomerata</i>	N ₇₅ P ₅₀	2,84	117	2,56	132	2,34	139	2,56	142
	N ₁₀₀ P ₅₀	2,93	108	2,46	127	2,26	133	2,50	138
<i>Medicago sativa</i> 50% + 50%	Unfertilized	2,49	130	2,58	137	2,41	138	2,46	145
	N ₅₀ P ₅₀	2,63	116	2,52	125	2,35	130	2,41	139
<i>Dactylis glomerata</i>	N ₇₅ P ₅₀	2,75	106	2,44	117	2,28	125	2,35	133
	N ₁₀₀ P ₅₀	2,84	98	2,33	111	2,18	118	2,28	128

Although, the level of cell walls from plants of *Dactylis* was high it did not exceed the limits, so the mixture *Medicago sativa* 75% + 25% *Dactylis glomerata* had as well an “Excellent” and “Very good” forage (140-108 RFV). On cycle I, the mixture *Medicago sativa* 50% + 50% *Dactylis glomerata* registered an “Excellent” to “Good” forage (130-98 RFV). With the following harvest cycles better quality of forage was obtained on mixtures because of the vegetative state of *Dactylis* plants at harvest time. Generally, the quality of forage from *Medicago sativa* 100 was “Prime” and “Excellent”, from mixture *Medicago sativa* 75% + 25% *Dactylis glomerata* it was “Excellent” and from mixture *Medicago sativa* 50% + 50% *Dactylis glomerata* it was “Excellent” and “Very good” (Table-4). Remains the farmers choice what type of culture and variant satisfies best their requirements, a better quantity of forage or a better quality.

4.0 Conclusion

The highest DM productions and CP yields were obtained from the mixture of *Medicago sativa* 75% + 25% *Dactylis glomerata* at all fertilizer rates, but only on the first harvesting cycle. At the highest fertilization rate, *Medicago sativa* 100% recorded a total production of 14.67 Mg ha⁻¹ DM, mixture *Medicago sativa* 75% + 25% *Dactylis glomerata* gave a total production of 14.49 Mg ha⁻¹ DM

and the mixture *Medicago sativa* 50% + 50% *Dactylis glomerata* gave a maximal production of 13.69 Mg ha⁻¹ DM. With the second and following cycles, the CP yield gave by the two mixtures gradually decreased, registering negative to highly significantly negative differences by control for all their variants. Increasing rate of nitrogen applied decreased the participation of *Medicago sativa* plants in both mixtures canopy coverage and increased the participation of *Dactylis glomerata*, but generally, the share of *Dactylis glomerata* did not exceed the sowing rate. Because of drought *Dactylis glomerata* plants had a slow recovery after mowing and its share in the structure of mixtures declined from cycle I to cycle IV.

Only the mixture of *Medicago sativa* 50% + 50% *Dactylis glomerata* and only on the first cycle had a higher proportion of participation in the mixture compared with *Medicago sativa* and with the sowing ratio, of 55% and 61% in fertilized variants with N₇₅P₅₀ and N₁₀₀P₅₀. The best quality of forage was registered on unfertilized variants of all culture types. *Medicago sativa* 100% had generally at first cycle a “Prime” and “Excellent” forage (154-124 RFV).

Generally, the quality of forage from *Medicago sativa* 100 it was “Prime” and “Excellent”, from mixture *Medicago sativa* 75% +

25% *Dactylis glomerata* it was “Excelent” and from mixture *Medicago sativa* 50% + 50%

Dactylis glomerata it was “Excelent” and “Very good”.

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