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PRODUCTIVITY AND QUALITY OF PLANT MASS OF MEADOW ASS. *DANTHONIETUM CALYCINAE* DEPENDING ON THE FERTILIZATION AND UTILIZATION TIME**

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Abstract: Research was carried out on mountain Kopaonik, on two associations *Danthonietum calycinae* (1000 and 1500 m above sea level), in the period from year 2003 to 2004. Production of grassland depending on the fertilization (1. no fertilization, 2. $N_{60}P_{30}K_{30}$, 3. $N_{80}P_{30}K_{30}$, 4. $N_{100}P_{30}K_{30}$), and cutting schedule (I forming of panicles, II beginning of spike forming and III full spike forming) was monitored. Production of grassland and floristic composition demonstrated dynamic changes depending on the year, cutting schedule and applied fertilization treatments. The greatest production of grassland dry mass and crude proteins on both locations was obtained in late cutting, i.e. in the stage of full spike forming of dominant species and in fertilization treatment with $N_{80}P_{30}K_{30}$. Grassland was transformed by fertilization from ass. *Danthonietum calycinae* into ass. *Festucetum rubrae* on both locations.

Key words: Natrual grassland, yield, floristic composition

Introduction

Natural grasslands have the highest share in the structure of agricultural land in Serbia. According to the latest statistical data (Statistical Yearbook, 2007) they are present with 28,3% (1.448.000 ha), and in Central Serbia with 39,1% (1.302.000 ha). Areas increase with the increase of altitude, so in mountainous region they are dominant in agriculture in general. Livestock production in hilly-mountainous region relies on grasslands, but this region, because of depopulation and increase of age structure of households/farms, is

characterized by extensive production. Because of these reasons are grasslands are mainly neglected with very low degree of utilization.

However, every form of intensification of livestock production in mountainous region, or organization of market production, which is inevitable, requires knowledge of production potentials of all plant associations and their dynamic changes during vegetation period in order for livestock production to be planned as precise as possible. On the other hand, different ecological conditions have lead to forming of great number of meadow associations which differ in regard to their productivity not only between the associations (*Stošić et al. 1989, Kojić et al., 1992*) but also between components of the same association (*Lazarević et al., 2003*). However, the greatest presence and economical importance, in case of hilly-mountainous region, have associations *Danthonietum calycinae, Festucetum rubrae, Agrostietum vulgaris* and *Nardetum strictae*. Fertilization has proven to be measure with the fastest and most expressed effect on increase of the grassland productivity (*Lazarević et al. 2003, 2004*). Optimal application of fertilization is different and mainly depends on the association it self or, more precisely, on components of single association. This is, first of all, characteristic for ass. *Danthonietum calycinae* which extends widely in regard to altitude and land.

Objective of the paper was to determine dynamic changes of production and quality of plant mass during vegetation period in different altitude zones and when different quantities of mineral fertilizers are used.

Material and methods

Research was carried out on Kopaonik in two components of association *Danthonietum calycinae* (1000m a.s.l., location Šapido and 1500m a.s.l., location Marinkovac) in period from 2003 to 2004. Twofactorial filed trial was set where the first factor was fertilization (1. no fertilization – control, 2. $N_{60}P_{30}K_{30}$, 3. $N_{80}P_{30}K_{30}$, 4. $N_{100}P_{30}K_{30}$), and the second factor time of cutting (I forming of panicles, II beginning of forming of spikes and III full spike forming of dominant species). All quantities of fertilizer were applied in spring. Size of the main parcel was $10m^2$ in four repetitions. On location Šapido soil was of acid reaction (pH 5,48 in H_2O and 4,16 in KCl) with high total nitrogen content (0,446%) and easy accesible potassium (33,4 mg K_2O), poor in phosphorus (0,8 mg per 100g of soil). Similar characteristics of soil were established on location Marinkovac – pH in H_2O 6,07, in KCl 5,39, content of N 0,57%, P_2O_5 0,1 mg, K_2O 20,8 mg.

Samples for determination of floristic composition were taken by method according to De Vries, and analysis of the chemical composition using standard laboratory methods. Results were processed by variance analysis, and differences were tested using Lsd test.

Results and discussion

Association *Danthonietum calycinae* develops also on moist soils, however the most often habitats are on dryer, shallower and poorer soil types which are dominant in hilly-mountainous region of Serbia. This is the reason for wide extending of thius association in this region of Serbia (*Lazarević et al., 2003*). Locations on which the researches were carried out are precisely like that, and results obtained are presented in tables 1 and 2 and graphs 1 and 2.

Table 1. Production of grassland on Sapido location (tha^{-1} DM)

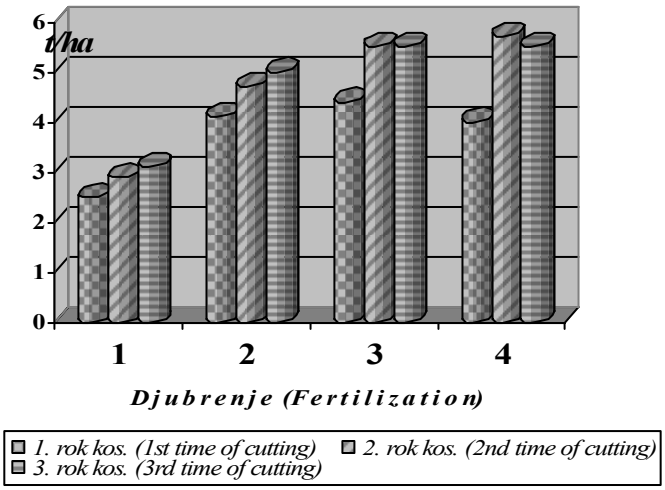
2003					
Time of cutting	Fertilization				Average
	1	2	3	4	
I	2,62	3,54	3,92	3,53	**3,4**
II	2,77	3,73	3,97	4,33	**3,7**
III	2,85	3,3	4,05	3,95	**3,54**
Prosek Average	**2,75**	**3,52**	**3,98**	**3,94**	
Lsd	5%	0,46		0,40	
	1% Fertilization	0,61	Times of cutting	0,53	
2004					
I	2,49	4,75	4,86	4,49	**4,15**
II	3,06	5,80	7,14	7,08	**5,77**
III	3,44	6,68	7,03	7,11	**6,06**
Average	**3,0**	**5,74**	**6,34**	**6,23**	
Lsd	5%	0,43		0,37	
	1% Fertilization	0,57	Times of cutting	0,50	

In both investigation years one cut per year was realized except first time of cutting in 2003 which was the single case of regeneration and second cutting. Production in the first year didn't differ much per cutting times. Lower yield obtained in the first cutting was annulled by regeneration in the second cutting, so total production was equal to other cutting times. However, in the 2. and 4. fertilization treatment the highest yield was realized in the second cutting time. In the second year only one cutting was obtained so production had

tendency of increase per cutting times, but it was more distinct between the second and first (from the statistical point of view) than between the third and the second.

By fertilization the yield of grasslands increased in the first year by 28% in the 2. treatment and 44,7% in the third. Differences between treatments 2 and 3, or N_{60} and N_{80} were on the limit of significance. In case of treatment 4 (N_{100}) slight decrease of production occurred. In the second year differences were more expressed. In treatment 2, yield increased by 91,3%, in treatment 3 by 111,3% and treatment 4 by 107,6% compared to control parcel, or, in other words, slight depression occurred when the highest quantity of N was applied.

Production of grasslands in 2004 was higher compared to previous year, on fertilized as well as controlled parcels and in all times of cutting, so average (2003-2004) production has the same tendencies depending on the fertilization treatment as described per years (graph 1.). However, in lower N cquantity production increased per times of cutting, whereas in case of higher quantities of N the highest production was realized in the second time of cutting.



Graph 1. Average (2003-2004) production of grassland on Sapido location

On location Marinkovac (1500 m a.s.l.) in the first year two cuts were realized, and in the second only one (tab. 2). By late cutting the production of grassland increased in the first cut, and in the second it was equal so total production was the highest in the third time of cutting and the lowest in the first time of cutting. Similar results were obtained in the second year of research,

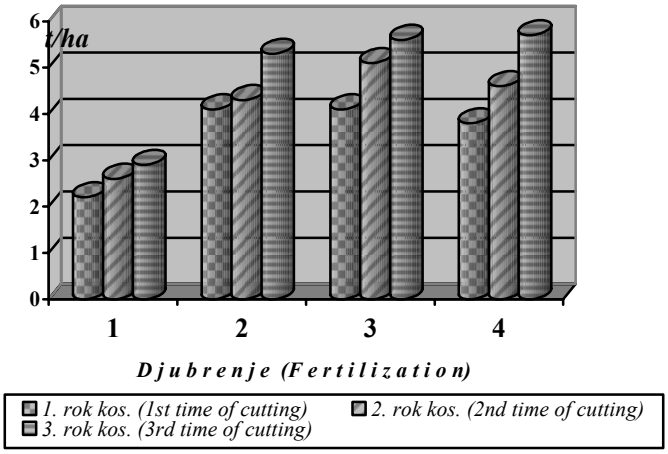
but, like on location Šapido, production was higher than in the first, which is consequence of favorable weather conditions.

Fertilization, like on the previous location, increased the production of grassland and reaction was more expressed in the second year of research. In the first year, total yield obtained in treatment 2 increased by 32,9%, treatment 3 by 46,7% and treatment 4 by 39,6%. In the second year, by fertilization the yield increased in treatment 2 by 120,1%, in treatment 3 by 131,4% and in treatment 4 by 122,7% compared to control. On this location also depression of productivity occurred when the highest quantity of N was applied (100 $kgha^{-1}$).

Table 2. Production of grassland on Marinkovac location (tha^{-1} DM)

1st cut (2003)					
Time of cutting	Fertilization				Average
	1	2	3	4	
I	1,3	2,04	2,32	1,91	**1,89**
II	1,34	2,26	2,18	2,13	**1,98**
III	2,29	3,29	3,7	3,35	**3,16**
Average	**1,64**	**2,53**	**2,73**	**2,63**	
Lsd	5%	0,50		0,43	
	1% Fertilization	0,67	Time of cutting	0,58	
2nd cut (2003)					
I	0,79	0,94	0,99	1,2	**0,98**
II	1,14	0,86	1,19	1,0	**1,05**
III	0,78	0,77	0,83	1,09	**0,87**
Average	**0,9**	**0,86**	**1,0**	**1,1**	
Lsd	5%	0,16		0,14	
	1% Fertilization	0,22	Time of cutting	0,19	
Total (2003)					
I	2,09	2,98	3,31	3,11	**2,87**
II	2,48	3,12	3,37	3,13	**3,02**
III	3,07	4,06	4,53	4,44	**4,02**
Average	**2,55**	**3,39**	**3,74**	**3,56**	
Lsd	5%	0,63		0,54	
	1% Fertilization	0,84	Times of cutting	0,73	
Total (2004)					
I	2,42	5,27	5,04	4,61	**4,33**
II	2,76	5,54	6,67	6,07	**5,26**
III	2,73	6,63	6,61	6,97	**5,73**
Average	**2,64**	**5,81**	**6,11**	**5,88**	
Lsd	5%	0,63		0,55	
	1% Fertilization	0,84	Time of cutting	0,73	

Obtained results on both location are similar to previously obtained results (*Stošić, 1972; 1974*). However, in these results it is clear that N_{80} is top limit for fertilization of grasslands, since further increase of the nitrogen quantity within $P_{30}K_{30}$ decreases the yield. Reason for such results probably is in high N content in the soil, on one hand and lack of P in soil on the other, which are becoming limiting factor for further increase of yield. Phosphorus has no considerable effect on increase of yield of grasslands (*Stošić et al., 2004*), but due to the lack of P the effect of nitrogen will not be expressed.



Graph 2. Average(2003-2004) production of grassland on Marinkovac location

Yield of raw proteins has similar tendency as the yield of dry matter in regard to fertilization as well as time of cutting (tab.3). The highest yield of raw proteins was realized on treatments with the highest quantity of N in average in both years 568,1 $kgha^{-1}$ in the second time of cuttin on location Šapido and 552,3 $kgha^{-1}$ in the third time of cutting on location Marinkovac. Slight deviation of the yield of protein in regard to dry matter in treatments with the highest quantity of nitrogen is consequence of slightly higher content of protein in these treatments.

Table 3. Crude protein yield (kgha^{-1})

Time of cutting	Fertilization	Šapido			Marinkovac		
		2003	2004	Average	2003	2004	Average
I	1	353,1	293,6	323,3	280,0	251,9	265,9
	2	480,0	490,2	485,1	401,0	472,7	436,8
	3	519,6	524,4	522,0	476,3	438,9	457,6
	4	521,4	514,5	517,9	437,6	495,1	466,3
II	1	304,4	293,4	298,9	272,4	247,3	259,8
	2	422,9	558,5	490,7	363,0	457,0	410,0
	3	474,4	645,5	559,9	443,0	559,6	501,3
	4	519,6	616,7	568,1	328,3	530,5	429,4
III	1	316,9	317,9	317,4	349,2	253,9	301,5
	2	358,0	503,7	430,8	467,2	489,3	478,2
	3	468,7	615,1	541,9	493,4	554,6	524,0
	4	478,2	539,6	508,9	526,2	578,5	552,3

Floristic composition of grasslands is characterized by dynamic changes depending on the applied treatments, as well as, according to years and not only in applied treatments, but also on control parcels. High content of nitrogen in soil deposited in humus and degree of its mineralization influenced the change of floristic composition from year to year between associations *Danthonietum calycinae* and *Festucetum rubrae* on both locations. In year 2003, presence of species *Danthonia calycina* and *Sieglingia decumbens* was considerably higher (15,5-24,3%) compared to year 2004 (5,2-8,5%) when species *Festuca rubra* (28,3-31,2%) was dominant. This reflected also on production of grassland which was higher in 2004. Application of fertilization lead to decrease of number of species in the grassland and increased the share of species from the family *Poaceae* (tab. 4), primarily *Festuca rubra* (25,1-60,1%) and *Agrostis vulgaris* (11,4-22,3%), especially on treatments with higher quantity of N fertilizer. In case of fertilized tratments grassland transofrmed very quickly from ass. *Danthonietum calycinae* into ass. *Festucetum rubrae* which is in accordance with results obtained by *Stošić et al. (1989)*.

Table 4. Floristic composition of grassland (%)

Species	Šapido							
	2003				2004			
	1	2	3	4	1	2	3	4
Poaceae	38,17	45,69	52,40	56,09	39,12	65,30	78,23	80,11
Fabaceae	8,19	9,83	2,70	2,81	6,22	3,31	2,14	2,88
Ostale	53,64	44,48	44,90	41,10	54,66	31,39	19,63	17,01
Marinkovac								
Poaceae	50,40	61,39	62,40	69,11	50,95	72,79	84,19	80,41
Fabaceae	0,10	1,31	0,11	1,23	7,05	2,49	2,09	2,41
Ostale	49,50	37,30	37,49	29,66	42,00	24,72	13,72	17,18

Conclusion

Based on obtained results of the research the following conclusions can be made:

Production of grasslands and floristic composition showed dynamic changes depending on the year, time of cutting and applied fertilization treatment. The highest average grassland production on both locations was realized by later cutting of grasslands, in the stage of forming of spikes of dominant species.

Fertilization increased the production of grasslands, and the best result was realized by treatment $N_{80}P_{30}K_{30}$, 44,7% in the first and 111,3% in the second year on location Šapido, and 46,7 % and 131,4% on location Marinkovac. Increase of the quantity of N from N_{80} to N_{100} within P_{30} andK_{30} caused decrease of production on both locations.

Yield of crude proteins had similar tendency as yield of dry matter. The highest yield of crude proteins was realized in treatments with the highest quantity of N in average in both investigation years 568,1 $kgha^{-1}$ in the second time of cutting on location Šapido and 552,3 $kgha^{-1}$ in the third time of cutting on location Marinkovac.

Floristic composition changed from year to year depending on the meteorological conditions. Fertilization caused reduction of number of species. The share of species *Danthonia calycina* was reduced and presence of species *Festuca rubra* and *Agrostis vulgaris* increased. Grassland transofrmed from ass. *Danthonietum calycinae* into ass. *Festucetum rubrae* on both locations.

PRODUKTIVNOST I KVALITET BILJNE MASE LIVADSKE ASS. *DANTHONIETUM CALYCINAE* U ZAVISNOSTI OD ĐUBRENJA I VREMENA ISKORIŠĆAVANJA

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Rezime

Istraživanja su izvršena na Kopaoniku u dve sastojine asocijacije *Danthonietum calycinae* (1000 lokalitet Šapido i 1500 m.n.v. lokalitet Marinkovac) u periodu od 2003-2004. godine. Postavljen je dvofaktorijalni poljski ogled gde je prvi faktor bio đubrenje (1. bez đubrenja (kontrola), 2. $N_{60}P_{30}K_{30}$, 3. $N_{80}P_{30}K_{30}$, 4. $N_{100}P_{30}K_{30}$), a drugi rok kosidbe (I vlatanje, II početak klasanja i III puno klasanje dominantnih vrsta).

Produkcija travnjaka i floristički sastav su pokazali dinamičke promene u zavisnosti od godine, rokova kosidbe i primenjenih tretmana đubrenja. Najveća prosečna produkcija travnjaka na oba lokaliteta dobijena je kasnijom kosidbom travnjaka, odnosno u fazi klasanja dominantnih vrsta.

Đubrenjem je povećana produkcija travnjaka, a najbolji učinak je imao tretman $N_{80}P_{30}K_{30}$, 44,7% u prvoj i 111,3% u drugoj godini na lokalitetu Šapido, odnosno, 46,7 % i 131,4% na lokalitetu Marinkovac. Povećanje količine N od N_{80} na N_{100} na fonu P_{30} i K_{30} je dovelo do smanjenja produkcije na oba lokaliteta.

Prinos sirovih proteina ima sličnu tendenciju kao i prinos suve mase. Najveći prinos sirovih proteina je ostvaren na tretmanima sa najvećom količinom N i to prosečno u obe godine 568,1 $kgha^{-1}$ u drugom roku kosidbe na lokalitetu Šapido i 552,3 $kgha^{-1}$ u trećem roku kosidbe na lokalitetu Marinkovac.

Floristički sastav se menjao po godinama u zavisnosti od meteoroloških uslova. Đubrenjem je smanjen broj vrsta. Smanjeno je učešće vrste *Danthonia calycina*, a povećano učešće vrste *Festuca rubra* i *Agrostis vulgaris*. Travnjak je transformisan iz ass. *Danthonietum calycinae* u ass. *Festucetum rubrae* na oba lokaliteta.

Ključne reči: Prirodni travnjak, prinos, floristički sastav

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