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APPLICATION OF FARMYARD MANURE IN GRASSLAND PRODUCTION

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ABSTRACT

This experiment aimed at determining the effect of farmyard manure (FYM) applicationon a natural pasturein Western Serbia, with a 30 t ha^{-1}treatment in comparison to control (no fertilizer added) during two years (2012-2014).The FYM was applied in the autumn of 2012 and the trial plots were harvested twice a year. Dry matter (DM) yield and forage quality - content of crude protein (CP), nonprotein N (%CP), neutral detergent fiber (NDF), acid detergent fiber (ADF) and net energy for lactation(NE_L), were estimated for each production year. Treatment with manure gave a higher DM yield compared to control plots in both experimental years (5.91 t ha^{-1} vs. 3.01 t ha^{-1} in 2013, and 2.76 vs. 2.03 t ha^{-1} in 2014). As expected,the yield in the second cuts of both years was much lower than in the first cuts. The FYM application did not affect chemical composition and net energy concentration of forages, whereas significant effects of different cuts were found, but were inconsistent between the first and second experimental year. In general, it can be concluded that application of FYM did not have a significant effect on forage quality ina permanent grassland, whereas chemical composition was significantly affected by different cuts and experimental years. Based on the results, a grassland may have a good DM yield response if FYM is used as a fertilizer, while the effect on forage qualitymay be much weaker.

Keywords: *manure, pasture, quality, yield.*

INTRODUCTION

One of possible applications of farmyard manure in food production is natural grasslands fertilization (Bukvić *et al*., 2013), in a case when mineral nitrogen (N) use for forage production is prohibited (European Union Council Regulation No 834/2007).Natural grasslands occupy large areas in hilly-mountainous regions of Serbia. Herbage grasses respond favorably to high fertilization by abundant production of vegetative biomass (Vučković *et al*., 2010).The investigation carried out on a natural grassland (Vučković *et al*., 2005) showed that maximum yield is

obtained through high fertilization rate. However, the high fertilization rates are not economically justified, since lower rates produce much higher ratio of biomass per kg of nutrient applied (Vučković *et al*., 2004). Application of mineral fertilizers increases production costs and awareness of economic and environmental consequences of N loss.

In general the permanent grasslands in Serbia are situated on soils with low natural fertility, are of low productivity and have sub-optimal botanical composition. The main means for improving quality of these grasslands include adjusting soil fertility, changing the dominance in the vegetation canopy and a good management. Increased productive potential of grasslands can be achieved through fertilization at different rates and with different types of organic and mineral fertilizers. The investigations carried out to date have shown positive effects of manure application on grasslands (Bouwman *et al*., 2002; Bittman *et al*., 2005).

Animal production is largely dependent upon two factors: energy intake and absorbed protein. These factors are highly dependent upon forage quality as well as the interaction of forage with the rumen microbial population, animal factors and other dietary ingredients (Allen, 1996). Content of crude protein (CP) and nonprotein N, fiber (neutral detergent fiber-NDF and acid detergent fiber-ADF), available energy concentration are important indicators of nutritive value for grazing forages. Pasture is characterized with the higher concentration of soluble and rumen degradable protein than the needs of the high-producing ruminants and rumen bacteria (Stojanović *et al*., 2015). Addition of nitrogen fertilizer increases CP concentration of grasses as well as yield (Buxton, 1996). The effect of N fertilization on NDF and ADF is variable (Coleman *et al*. 2004). Year-to-year and seasonal variation in environment alter forage quality, even when forages are harvested at similar maturity stages (Buxton and Casler, 1993).

In the present study, cattle manure was applied as a sustainable organic fertilizer. The objective of this study was to investigate and launch a sustainable manure-based nutrition for pastures in Serbia.It was therefore expected for the application of manure to increase the forage yield and quality.

MATERIAL AND METHODS

The field trial was established in vicinity of Šabac (Varna, 44°40′40″N 19°39′05″E, 123 asl.), Serbia by the method of RCB design of plots in 4 replications. The experiment carried out in the field included treatments:

a) control (without fertilization);
b) manure fertilization (30 t ha^{-1});

Prior to application, fresh cattle manure was homogenously mixed and fermented during 3 months.The manure was applied in autumn 2012. The decomposition of fermented manure and its contribution tothe nutrients pool was as expected (first year - 50% of manure decomposition, second year - 30% of manure decomposition).

The plots were harvested in May and July of both vegetation seasons; dry matter (DM) of the harvests was measured.All samples were air-dried before chemical analyses. Parameters of proximate analysis were determined.Analytical DM content of air-dried samples were determined by oven-drying at 105^{o}C for 5 h. Neutral detergent fiber (NDF), acid detergent fiber (ADF) and lignin (ADL) were determined according to procedure by Van Soest (1991); protein fractions (true protein and NPN) were determined as described by Licitra *et al*. (1996). The net energy concentration of forage was determined according to the Nutrient Requirements of Dairy Cattle Seventh Revised Edition (NRC, 2001). The main characteristics of the soils were determined (tab. 1) and meteorological data (tab. 2)for experimental field was collected from the Sremska Mitrovica Weather Station, located near the experimental site. Total DM yield and pasture DM quality in each of the two cuts were analyzed through analysis of variance (ANOVA) and LSD test, in order to recognize significant effects of fertilization treatments.

Table 1. Chemical properties of soil

Depth	pH		OM %	AL-P_2O_5 mg/100g	AL-K_2O mg/100g	Total C %	Total N %
	$CaCl_2$	H_2O					
0-20 cm	5.07	5.73	4.31	1.98	11.51	1.37	0.16

Soil from experimental field had a low P content and moderately acidic pH.

Table 2. Average monthly temperature, ^{0}C and monthly precipitation sum, mm (2012-2014)

Production year	VIII	IX	X	XI	XII	I	II	III	IV	V	VI	VII	Total
Temperatures - ^{o}C													
First	23.8	19.3	12.8	9.3	1.1	3.2	3.9	6.3	13.1	17.2	19.9	21.2	12.6
Second	15.9	13.7	8.4	1.7	4.2	6.8	9.5	13.3	16.1	19.8	21.9	21.2	12.7
Precipitation sum - mm													
First	1.0	17.6	36.2	24.0	57.5	56.2	47.8	65.3	32.0	119	62.0	44.5	563
Second	61	71.6	34.1	5.8	51	17	47	76	188	38	75	56	720

According to the meteorological data, the total precipitation was 563 mm in the first vegetation season, and 720 mm in the second vegetation season. The maximum and minimum temperatures were registered in August and December of the first vegetation season, and in July and November of the second vegetation season.

RESULTS AND DISCUSSION

Forage yield

Fertilizer treatment with manure affected yield in 2013, especially in the case of the first cut: the yield was more than doubled by fertilization, in comparison to control (Table 3). Manure also showed an extended effect in the second cut (1.38 vs 1.02 t ha^{-1}), but without a statistical significance. In total, both cuts and fertilization treatment showed significant effect on the DM yield in 2013.

Table 3. Forage yield (t ha^{-1}) and quality from permanent grassland in 2013 year, Western Serbia (% DM)

treatments	DM yield	CP	NPN	EE	Ash	NDF	ADF	Lignin	NE_L
I cut									
Control	1.99	9.71	26.37	2.66	7.67	62.8	38.4	5.70	4.53
Manure	4.53	10.1	35.21	2.83	7.99	63.9	38.7	6.17	4.40
LSD 0,05	*****	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
II cut									
Control	1.02	9.04	15.77	4.25	9.13	69.5	37.1	6.07	4.23
Manure	1.38	9.72	26.07	4.13	9.35	66.7	38.8	6.73	4.15
LSD 0,05	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Cut									
I cut	3.26	9.89	30.79	2.74	7.83	63.4	38.6	5.94	4.47
II cut	1.20	9.38	20.92	4.19	9.24	68.1	38.0	6.40	4.19
LSD 0,05	*****	**NS**	**NS**	*****	*****	*****	**NS**	**NS**	**NS**
Fertilizer									
Control	1.51	9.37	21.07	3.45	8.40	66.2	37.8	5.89	4.38
Manure	2.95	9.89	30.64	3.48	8.67	65.3	38.7	6.45	4.28
	*****	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

DM – dry matter (t ha^{-1}), CP – crude proteins (% DM), NPN-non protein nitrogen (% of crude proteins), EE–Ether extract (% DM), NE_L – Net energy lactation (MJ/kg DM)

In the second production year, the effect of applied manure on pasture yield was diminished, but again with significant effect on total DM yield of two cuts (Table 4). Generally, it seems that manure application was a good way to increase yield on a permanent grassland during two years. The positive effects of manure applied on grasslandsagree with earlier studies performed byBouwman *et al*., 2002 and Bittman *et al*., 2005.

Table 4. Forage yield (t ha^{-1}) and quality from permanent grassland in 2014 year, Western Serbia (% DM)

treatments	DM yield	CP	NPN	EE	Ash	NDF	ADF	Lignin	NE_L
I cut									
Control	1.24	8.95	33.3	3.15	7.50	59.7	35.0	5.46	4.89
Manure	2.09	9.18	31.9	3.16	7.84	60.2	35.3	5.44	4.85
LSD 0,05	*****	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
II cut									
Control	0.79	11.8	26.0	2.72	9.84	55.9	36.8	7.54	4.36
Manure	0.67	10.5	27.5	2.55	9.71	58.8	39.5	7.48	4.26
LSD 0,05	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Cut									
I cut	1.67	9.07	32.6	3.16	7.67	59.9	35.2	5.45	4.87
II cut	0.73	11.15	26.8	2.63	9.77	57.3	38.2	7.51	4.31
LSD 0,05	*****	*****	**NS**	**NS**	*****	**NS**	*****	*****	*****
Fertilizer									
Control	1.02	10.39	29.7	2.93	8.67	57.8	35.9	6.50	4.62
Manure	1.38	9.82	29.7	2.86	8.77	59.5	37.4	6.46	4.55
	*****	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

DM – dry matter (t ha^{-1}), CP – crude proteins (% DM), NPN-non protein nitrogen (% of crude proteins), EE–Ether extract (% DM), NE_L – Net energy lactation (MJ/kg DM)

Forage quality

This research showed no significant effect of manure fertilization on forage quality, neither in the first nor the second year of the experiment.

According to an earlier study (Puoli *et al*., 1991), proper N fertilization of grasses generally increases CP. But the effect of N fertilization on NDF and ADF is variable. Higher N rates tended to increase the NDF concentrations of the plants in wetter years resulting from change in the leaf:stem ratio in favour of less digestible stems (Buxton and Fales, 1994). In contrast, Coleman *et al*. (2004) reported that higher N rates provided a delayed plant maturity for later harvests and in turn increased total plant digestibility. A better understanding of the nutritive values of grasses as affected by N fertilization can be helpful in making grassland management decisions.

A significant effect of different cuts on chemical composition and quality of herbage was found. In the first experimental year the determined values were significantly higher in the second than in the first cutfor NDF (7.41%) and ether extract content (52.92%). In the second experimental year, significantly higher values for CP (22.93%), ADF (8.50%) and lignin content (37.80%) and lower value for net energy concentration (11.50%) were recorded in the second compared to the first cut.

These findings agree with earlier studies (Mandaluniz *et al*. 2015, Müller and Jänicke, 2015), with the exception of CP concentration in the second experimental year. Mandaluniz *et al*. (2015) reported that the CP content decreased (21.4%), while NDF and ADF content increased (10.4% and 18.1%) for grazing herbage mass during the spring grazing period (April-June), when the grazing management regime is characterized by 20-25 days of grazing and resting period, in total. The highest crude protein concentrations of grass pasture are found in spring and autumn (Van Vuuren and Van Den Pol 2006). The increase of CP content within the second cut of second production year could likely be a result of other environmental conditions and possibly changes in botanical composition of herbage mass.

There were no significant differences between treatments (without and with manure fertilization) and between different cuts, for NPN (%CP) concentration, however, results indicate higher values for the first cut in both experimental years, also for the herbage with manure application in the first production year.

Results obtained for herbage NE_L concentration indicate no significant effect of fertilization. Considering different cuts, results of this study agree to an extent with findings of Van Vuuren and Van Den Pol (2006) who reported that the energy value (NEL) of grass pasture is the highest in April, but remains rather stable throughout the year.

The differences in forage chemical composition between production years could be explained by different environmental factors. The change in forage quality in grasses investigated at the same day of different years indicating their maturation had the greatest effect on whole-plant nutritive values (Waramit *et al*., 2012). The most important environmental factors are temperature, water deficit, solar irradiation, and soil nutrient availability (Buxton and Fales, 1994). Among these environmental factors, temperature usually has the greatest influence over forage quality.

CONCLUSION

In general, it can be concluded that applying farmyard manure did not have a significant effect on forage quality ina permanent grassland, whereas chemical composition was significantly affected by different cuts and experimental years. Based on the results, a grassland may have a good DM yield response if farmyard manure is used as a fertilizer, while the effect on forage quality could be much weaker . Also, manure can be recommended for agricultural purposes in terms of sustainable fertilizing and improving the system cattle farm – manure - organic fertilizer for forage crops. Future studies should focus on including additional sites with different soil types in areas with contrasting climate.

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