Scientific Papers. Series A. Agronomy, Vol. LVI, 2013
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

INFLUENCE OF FERTILIZATION WITH SEWAGE SLUDGE AND MANURE ON ALFALFA DM PRODUCTION AND CHEMICAL CONTENT IN ROMANIA

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Abstract

Romania has to react to increased urbanization, and to increased demands from the European Union. Municipal waste recovery requires solutions and the reintroduction of city sludge into agricultural production systems is one of the possibilities. This could be used for forage fertilization due to its composition, rich in both macro-and micronutrients. In this study we compared the effect of sewage sludge fertilization with manure application to alfalfa culture. Sewage sludge comes from the treatment plant Tetarom III of Cluj Napoca, Romania. In our experiment we analysed 8 variants fertilized with different doses of sludge and manure. The sludge and manure were applied once (in the spring of 2010) and their effects were observed over a period of 2 experimental years, from 2010-2011. The results show a significant increase in alfalfa production following sludge fertilization, while the effect of manure at equivalent doses resulted in lower production.

Key words: *city sludge, manure, alfalfa, Romania.*

INTRODUCTION

Almost all of the wastewater treatment processes resulted from industry produce a sludge which has to be disposed of in some way. If we follow the entire treatment of sewage we can notice that the cost for it is huge. Conventional secondary sewage treatment plants generate a primary sludge in the primary stage of process (sedimentation stage) and a secondary (biological) sludge in the final stage after the biological process (Leonard et al., 2007). Approximately one half of the costs of operating secondary sewage treatment plants in Europe can be associated with sludge treatment and disposal. Due to its chemical composition, sewage sludge has valuable agronomic properties. Therefore comes the possibility of using treated sewage sludge in land fertilization and thru these reduce significantly the sludge disposal cost component of sewage treatment, as well as providing a large part of the nitrogen and phosphorus requirements of many crops. As Romania faces, as well, with large quantities of wastewater resulted to the increased urbanization, one valuable solution to dispose of it could be the reintroduction of city sludge into agricultural production systems. Around these frame we aimed by this study to compare the effect of sewage sludge fertilization with manure application to alfalfa culture.

MATERIALS AND METHODS

The experiment was conducted on an *argic faeoziom* soil type in eight variants and four repetitions after the improved Latin Rectangle Method, as follows: variant V1-control, V2-20 Mg ha^{-1} sludge, V3-30 Mg ha^{-1} sludge, V4-40 Mg ha^{-1} sludge, V5-60 Mg ha^{-1} sludge, V6-20 Mg ha^{-1} manure, V7-40 Mg ha^{-1} manure, V8-60 Mg ha^{-1} manure. We used alfalfa (Madalina variety) as biological material. Sludge and manure application was made in a single installment every two years in the spring of 2010. The used sewage sludge treatment plant comes from Tetarom III from Cluj, Romania, and the bovine manure from farmers. Both were analyzed in terms of physicochemical characteristics and the results are presented on Table 1. In order to analyze forage quality the following parameters were determined: crude protein, NDF content, ADF content, lignin, digestibility. The analyses were performed by using NIR method.

Table 1. Characteristics of city sludge and manure

Analysis	City sludge	Manure	Element analysis	City sludge	Manure
Humidity (%)	50.91	44.82	Zn (mg kg^{-1})	1145	894
Organic matter	67.50	45.9	Fe (mg kg^{-1})	20.79	14.4
pH (pH units)	7.40	8.04	Mn (mg kg^{-1})	536	314
N total (%)	3.56	0.65	Pb (mg kg^{-1})	801	-
P total (%)	1.16	0.47	Cd (mg kg^{-1})	32.5	13.8
K total (%)	0.73	0.71	Co (mg kg^{-1})	29.01	25
Mg (mg kg^{-1})	0.27	0.22	Ni (mg kg^{-1})	103	-
Cu (mg kg^{-1})	352	418	Cr (mg kg^{-1})	256.7	-

RESULTS AND DISCUSSIONS

In the first year the highest yield was recorded in the variants treated with 40 and 60 Mg ha^{-1} sewage sludge (respectively 9.16 and 9.10 Mg ha^{-1} DM with a difference of 1.69 and 1.63 Mg ha^{-1} DM compared to the control treatment, Table 2). In the variants fertilized with manure, the highest yield of 8.88 mg ha^{-1} was obtained using 40 Mg ha^{-1}, showing a difference of 1.41 Mg ha^{-1} compared to the control fertilized.

Table 2. Dry matter production (2010)

Variant	Production (Mg ha^{-1})	% compared to control	Difference compared to control	Significance of difference	Duncan Test
V1-control	7.47	100	0	Mt.	A
V2-20 Mg ha^{-1} sludge	8.92	119.4	1.45	***	C
V3-30 Mg ha^{-1} sludge	8.45	113.1	0.98	**	BC
V4-40 Mg ha^{-1} sludge	9.16	122.6	1.69	***	C
V5-60 Mg ha^{-1} sludge	9.10	121.8	1.63	***	C
V6-20 Mg ha^{-1} manure	8.84	118.4	1.37	**	C
V7-40 Mg ha^{-1} manure	8.88	118.8	1.41	***	C
V8-60 Mg ha^{-1} manure	8.06	107.8	0.59	**	AB
DL (p5%) 0.7; DL (p1%) 0.97; DL (p0,1%) 1.31			DS 0.71-0.81		

In the second year the largest dry matter productions were recorded in the variants treated with 40 Mg ha^{-1} sewage sludge and 40 Mg ha^{-1} manure (respectively 11.64 and 11.33 Mg ha^{-1} DM with a difference of 3, respectively 27 and 2.96 Mg ha^{-1} DM compared to the control treatment). At these doses equivalent to 40 Mg ha^{-1} manure and sewage sludge to obtain a difference of 0.31 Mg ha^{-1} DM for variant treated with sewage sludge.

In all experimental variants obtained, a very significant production increase from unfertilized control variant was observed, with increases ranging from 2.18 Mg ha^{-1} DM (in variant treated with 20 Mg ha^{-1} city sludge) and 3.27 Mg ha^{-1} DM (the variant fertilized with 40 Mg ha^{-1} city sludge, Table 3).

Comparing the results obtained in the two experimental years on sludge fertilization effect on DM production in alfalfa, we find superiority variant V4 (40 Mg ha^{-1} sludge) that determines the highest production increases, the application of higher doses of 40 Mg ha^{-1} sludge is justified in terms of growth of output.

In the first experimental year (2010, Table 4) in which concerns the protein content was noticed that there were no significant differences between fertilized variants and control variant.

Table 3. Production of dry matter in alfalfa (2011)

Variant	Production (Mg ha^{-1})	% compared to control	Difference compared to control	Significance of difference	Duncan Test
V1-control	8.37	100	0	Mt.	A
V2-20 Mg ha^{-1} sludge	11.17	133.45	2.80	***	C
V3-30 Mg ha^{-1} sludge	10.55	126.04	2.18	***	B
V4-40 Mg ha^{-1} sludge	11.64	139.06	3.27	***	C
V5-60 Mg ha^{-1} sludge	10.75	128.43	2.38	***	B
V6-20 Mg ha^{-1} manure	10.71	127.95	2.34	***	B
V7-40 Mg ha^{-1} manure	11.33	135.36	2.96	***	C
V8-60 Mg ha^{-1} manure	10.88	129.98	2.51	***	BC
DL (p5%) 0.39; DL (p1%) 0.56; DL (p0.1%) 0.72			DS 0.39-0.46		

Table 4. Fertilization influence upon alfalfa protein content (2010)

Variant	Protein (%)	% compared to control	Difference compared to control	Significance of difference	Duncan Test
V1-control	18.38	100	0	Mt.	B
V2-20 Mg ha^{-1} sewage sludge	17.92	97.5	-0.46	-	B
V3-30 Mg ha^{-1} sewage sludge	17.76	96.6	-0.62	-	AB
V4-40 Mg ha^{-1} sewage sludge	17.38	94.6	-1.00	-	AB
V5-60 Mg ha^{-1} sewage sludge	17.10	93.0	-1.28	-	AB
V6-20 Mg ha^{-1} manure	16.34	88.9	-2.05	0	A
V7-40 Mg ha^{-1} manure	17.31	94.2	-1.08	-	AB
V8-60 Mg ha^{-1} manure	17.86	97.1	-0.53	-	B
DL (p5%) 1.13 DS					
DL (p1%) 1.54 1.13-1.30					
DL (p0.1%) 2.08					

The variant fertilized with 20 t/ha manure registered a small increase, insignificant from statistical point of view (a difference of -2.05% compared with control variant, unfertilized).

Analysing forage quality fertilized with sewage sludge compared to organic fertilization we observed that there were insignificant changes in the chemical composition of alfalfa feed. The only exception was lower protein content compared to the control, however the difference had only a significant effect at doses of sludge of 60 Mg ha^{-1}. In other words, excessive fertilization (60 Mg ha^{-1} sewage sludge) may, in time, decreases in protein content, which could cause a decrease in long-term quality of alfalfa forage.

The results obtained after the first year of sludge confirms data obtained by other researchers (14.78%-19.78%, Brogna et al., 2009, 12.60%-24.20%, Walshaw et al., 1998), showing that in the first year of application of sludge, the chemical composition of alfalfa was less influenced.

CONCLUSIONS

Fertilizing alfalfa with sewage sludge and manure gave the highest DM yield when 40 Mg ha^{-1} of sludge/year was applied. Taking into consideration that increased production was achieved at equivalent doses of manure and sewage sludge (of 40 Mg ha^{-1}) we can recommend the fertilization with sewage sludge as a successfully replacement for the fertilization with manure.

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