Scientific Papers, UASVM Bucharest, Series A, Vol. LIV, 2011, ISSN 1222-5339

EVALUATION OF EFFECTS OF COMPOSTED SEWAGE SLUDGE ON SOIL CHEMICAL PROPERTIES

VERONICA TĂNASE, M. DUMITRU, NICOLETA VRÎNCEANU, D.M. MOTELICĂ, MIHELA PREDA, ALEXANDRINA MANEA

National Research and Development Institute for Soil Science, Agrochemistry and Environmental Protection of Bucharest

Keywords: *soil, sewage sludge, fertilization, nutrients*

Abstract

Organic wastes can be applied to cropland to supply nutrients. Sewage sludge associated or not with mineral fertilization can be applied to improve soil chemical properties. A field study was carried out to investigate the effects of sewage sludge compost application on some chemical soil characteristics and yields of maize and oat. Experimental results showed that similar to literature data, sewage sludge compost application led to increases of mobile phosphorus contents in soil. Addition of mineral N-P fertilizers into composted sewage sludge increased the crop yield. Considering the accumulation of nutriens from organic wastes in cropland soil and their availabilty for crops, sewage sludge compost should be applied to croplandat high rates.

INTRODUCTION

It was observed that the massive use of mineral fertilizers led in time to lower content of organic matter in soils directly influencing the physical, chemical and biological properties and the risk of degradation of these soils [1]. Sewage sludge is an inevitable by-product of waste-water treatment processes [2]. Sewage sludge composting and its application on agricultural soils have many advantages, which include a whole array of nutrients to the soil. Agricultural use of sewage sludge can be considered both a way to eliminate organic wastes and in the same time, a posibility to use their content of organic matter and nutrients. Soil became the final step in this kind of treatment, capable to recycle nutrients for agricultural production. Composting sewage sludge with wheat straw transforms organic matter into a drier, more uniform and bilogically stable product that could act as a good source of nutrients [3]. The organic fertilization is not used instead of mineral fertilization but it is applied together, in order to meet the nutrient requirements of plants. The evaluation of compost qualities can be made by laboratory analyses and by field experiments. It is necessary to monitor the risk of potentially polluting substances accumulation in soil. It can be establish the evolution of soil chemical characteristics.

The objectves of this study was to measure the effects of different rates of sewage sludge compost associated or not with mineral fertilizer on crop yields and on pH value, nitrogen, organic carbon, phosphorus, potassium contents in soil.

MATERIAL AND METHODS

The experiments were organized on an experimental field at Albota, on a Haplic Luvisols, using subdivided parcels method, studying the two gradients: A factor - organic fertilization in 5 doses and B Factor - mineral fertilization, in 3 doses. There were determined pH values of soil and contents of organic carbon, phosphorus (by colorimetrically method), nitrogen (by Kjledahl method), potassium (by atomic emission spectrophotometry).

RESULTS AND DISCUSSION

The chemical and physical characteristics of soil samples from experimental field showed a low degree of fertility considering plant nutrition. It was a soil with poor aeration, with a high content of clay, with strong possibility of compactness, acidity pronounced and a high content of aluminum. The experiments were organized without irrigation. The chemical characteristics of compost showed that there were not restrictions regarding using it on cropland, this compost being an excelent fertilizer with high contents in nitrogen and phosphorus.

In Table 1 are presented, the effects of organic and mineral fertilization on soil reaction, after the first year of experimentation.

Table 1

Effects of organic and mineral fertilization on pH values of an Haplic Luvisols

Mineral fertilization	Compost fertilization					Mean value mineral fertilization
	Unfertilized with compost	Compost fertilization equivalent to a N rate of:				
		100 kg / ha	200 kg / ha	300 kg / ha	400 kg / ha	
Unfertilized	*5.07*	5.20 a	5.20 a	5.57 a	6.15 a	**5.44 A**[(1)]
N_{50} P_{50}	4.80	5.13 a	5.13 a	6.13 a	6.12 a	**5.46 A**
N_{100} P_{100}	4.75	4.97 a	4.98 a	6.38 a	**6.57** a	**5.53 A**
Mean value compost fertilization	**4.87 W**[(2)]	**5.10 W**	**5.10 W**	**6.03 X**	**6.28 X**	

[(1)] or [(2)] - Values followed by the same letter (A,B,C or W,X,Y) are not significantly different at the p=0.05 level (Tukey's honestly significant procedure)

Organic fertilization with high doses of ompost equivalent to a nitrogen rate of 300 and 400 kg/ha, resulted in statistically significant increases of soil reaction, compared with yhe control.

The content of soil in organic carbon under organic and mineral fertilization had a relatively high variability (Table 2).

Table 2

Effects of organic and mineral fertilization on organic carbon content in soil

Mineral fertilization	Compost fertilization					Mean value mineral fertilization
	Unfertilized with compost	Compost fertilization equivalent to a N rate of:				
		100 kg / ha	200 kg / ha	300 kg / ha	400 kg / ha	
	%					
Unfertilized	*1.41*	1.48	1.56	1.53	1.56	**1.51 A**(1)
N_{50} P_{50}	1.59	1.46	1.53	1.53	1.52	**1.53 A**
N_{100} P_{100}	1.44	1.45	1.56	1.47	*1.49*	**1.48 A**
Mean value compost fertilization	**1.48 W**(2)	**1.46 W**	**1.55 W**	**1.51 W**	**1.52 W**	

(1) or (2) - Values followed by the same letter (A,B,C or W,X,Y) are not significantly different at the p=0.05 level (Tukey's honestly significant procedure)

The highest value of total nitrogen content in soil was observed in variant fertilized with at a dose of compost equivalent to 200 kg N/ha (Table 3) plus mineral fertilization ($N_{100}P_{100}$). It was noticed a slight upward trend in mean values of nitrogen content with increasing dose of compost applied, but increases are not statistically significant.

Table 3

Effects of organic and mineral fertilization on total nitrogen content in soil

Mineral fertilization	Compost fertilization					Mean value mineral fertilization
	Unfertilized with compost	Compost fertilization equivalent to a N rate of:				
		100 kg / ha	200 kg / ha	300 kg / ha	400 kg / ha	
	%					
Unfertilized	*0.179*	0.181	0.187	0.177	0.178	**0.180 A**(1)
N_{50} P_{50}	0.179	0.183	0.184	0.183	0.160	**0.178 A**
N_{100} P_{100}	0.182	0.180	0.188	0.168	*0.186*	**0.181 A**
Mean value compost fertilization	**0.180 W**(2)	**0.181 W**	**0.186 W**	**0.176 W**	**0.175 W**	

(1) or (2) - Values followed by the same letter (A,B,C or W,X,Y) are not significantly different at the p=0.05 level (Tukey's honestly significant procedure)

The compost is considered mainly an important source of phosphorus so that, organic fertilization led to statistically significant increases compared to the unfertilized variant, at doses of compost application of 200 kg N/ha, 300 kg N/ha and 400 kg N/ha (Table 4). The highest values of mobile phosphorus in the soil

were recorded in variants fertilized with high doses of compost plus mineral fertilizer.

Table 4

Effects of organic and mineral fertilization on mobile phosphorus content

Mineral fertilization	Compost fertilization					Mean value mineral fertilization
	Unfertilized with compost	Compost fertilization equivalent to a N rate of:				
		100 kg / ha	200 kg / ha	300 kg / ha	400 kg / ha	
	mg / kg					
Unfertilized	*38*	42	46	47	53	**45 A**[1]
N_{50} P_{50}	48	47	48	50	55	**50 A**
N_{100} P_{100}	40	43	44	55	**54**	**47 A**
Mean value compost fertilization	**42 W**[2]	**44 WX**	**46 WX**	**51 WX**	**54 X**	

[1] or [2] - Values followed by the same letter (A,B,C or W,X,Y) are not significantly different at the p=0.05 level (Tukey's honestly significant procedure)

The content of mobile potassium did not change statistically significant (Table 5) as a result of fertilization with composted sewage sludge and mineral N-P fertilizers. The average values of potassium content in soil ranged between 73 mg/kg - 81 mg/kg. The combination of organic (400 kg N/ha) and mineral fertilization ($N_{100}P_{100}$) led to the highest content of mobile potassium in the soil.

Table 5

Effects of organic and mineral fertilization on mobile potassium content

Mineral fertilization	Compost fertilization					Mean value mineral fertilization
	Unfertilized with compost	Compost fertilization equivalent to a N rate of:				
		100 kg / ha	200 kg / ha	300 kg / ha	400 kg / ha	
	mg / kg					
Unfertilized	*78*	79	78 a	67 a	*79* a	**76 A**[1]
N_{50} P_{50}	73	73	78 a	73 a	79 a	**75 A**
N_{100} P_{100}	79	78	73 a	73 a	81 a	**77 A**
Mean value compost fertilization	**77 W**[2]	**77 W**	**76 W**	**71 W**	**80 W**	

[1] or [2] - Values followed by the same letter (A,B,C or W,X,Y) are not significantly different at the p=0.05 level (Tukey's honestly significant procedure)

As expected, under the mineral and organic fertilization the yield oat increased statistically significant compared to control (Table 6). The highest oat yield (3710 kg/ha) was obtained in variant fertilized with highest doses of fertilizers.

Table 6

Effects of organic and mineral fertilization on oat yield

Mineral fertilization	Compost fertilization					Mean value mineral fertilization
	Unfertilized with compost	Compost fertilization equivalent to a N rate of:				
		100 kg / ha	200 kg / ha	300 kg / ha	400 kg / ha	
	kg / ha					
Unfertilized	*1659*	2121	2260	2410	2516	**2193 A**[1]
N_{50} P_{50}	1960	2338	2480	2795	3038	**2522 B**
N_{100} P_{100}	2059	2540	2856	3322	**3710** e	**2897 C**
Mean value compost fertilization	**1893 W**[2]	**2333 X**	**2532 Y**	**2842 Z**	**3088 U**	

[1] or [2] - Values followed by the same letter (A,B,C or W,X,Y) are not significantly different at the p=0.05 level (Tukey's honestly significant procedure)

A similar situation was obtained at maize yield, statistically significant increases of maize yield, compared with unfertilized variant, being recorded after both, mineral and organic fertilization (Table 7).

Table 7

Effects of organic and mineral fertilization on maize yield

Mineral fertilization	Compost fertilization					Mean value mineral fertilization
	Unfertilized with compost	Compost fertilization equivalent to a N rate of:				
		100 kg / ha	200 kg / ha	300 kg / ha	400 kg / ha	
	kg / ha					
Unfertilized	*5867*	6014	6119	6234	6393	**6125 A**[1]
N_{50} P_{50}	5890	6077	6275	6431	6679	**6270 B**
N_{100} P_{100}	6124	6381	6569	6858	**7277**	**6642 C**
Mean value compost fertilization	**5960 W**[2]	**6157 X**	**6321 XY**	**6508 Y**	**6783 Z**	

[1] or [2] - Values followed by the same letter (A,B,C or W,X,Y) are not significantly different at the p=0.05 level (Tukey's honestly significant procedure)

The highest yield maize (7277 kg/ha) was obtained in variant fertilized with highest doses of fertilizers.

CONCLUSIONS

1. In order to maximize the benefits of nutrients from sewage sludge compost, it should be applied as close as possible to the period of time in which the crop use these nutrients and in doses that take into account crop nutrient needs.
2. It can be said that sewage sludge compost fertilization had positive effects on yields and soil quality and by composting organic waste, it is assured a high recovery of municipal wastewater treatment plants.

ACKNOWLEDGEMENTS

The research was supported by the Research Program Agral, Contract 82.

REFERENCES

1. Tejada M., M.M. Dobao, C. Benitez, J.L. Gonzales, 2001. *Study of composting of cotton residues*. Biores. Technol. 79 (pp. 199-202).
2. Wei J., Y. Liu, 2004. *Effects of sewage sludge compost application on crops and cropland in a 3-year field study*. Elseviere, Chemosphere, 59 (2005) (pp. 1257-1265).
3. Sullivan D.M., A.I. Bary, D.R. Thomas, S.C. Fransen, C.G. Cogger, 2002. *Food waste effects on fertilizer nitrogen efficiency, availabile nitrogen, and tall fescue yield*. Soil Science Society of America Journal 66 (pp. 154-161).