Original scientific paper

Composted slaughterhouse waste as organic fertilizer

Péter Ragályi[1], Márk Rékási[1], Zdenko Lončarić[2], Vlado Kovačević[2]

[1]*Research Institute for Soil Science and Agricultural Chemistry of the Hungarian Academy of Sciences, Herman Ottó Str. 15., Budapest, H-1022, Hungary, E-mail: ragalyi@rissac.hu*
[2]*Josip Juraj Strossmayer University of Osijek, Faculty of Agriculture, Trg Sv. Trojstva 3, HR-31000 Osijek, Croatia*

Abstract

Possible agricultural utilization of four different processed slaughterhouse waste composts and meat powder was examined in a field experiment in 2002-2006. The trial was set up with different crops on a calcareous sandy soil weakly supplied with N, P and K. The site was prone to drought. Composts were applied once at 5 levels (0, 25, 50, 100 and 200 t ha^{-1} fresh compost and 0, 2.5, 5, 10 and 20 t ha^{-1} meet powder) in 4 replications. Extreme doses (100 and 200 t ha^{-1}) of immature and semi-mature compost combined with dry weather in 2002 and 2003 caused yield depression. Residual effects of composts were pronounced. In normal years the yield increased threefold compared to control. Differences were significant in the case of stronger composts even in 2006, in the 4th and 5th experimental years.

Key words: compost, fertilization, crop yield, slaughterhouse waste

Introduction

Fodder use of animal origin wastes is strictly regulated by EU since BSE (bovine spongiform encephalopathy) disease showed up, so alternative utilities have to be found. In Hungary 100-120 million tons of wastes produced of which 5% is so called "hazardous". Hazardous wastes from animal bodies reach 300-400 thousand tons of which 70-90 thousand are composted. After heat treatment these wastes become non-hazardous, and other treatments like composting make land application possible. This practice may improve soil parameters like organic matter, nutrient content, water holding capacity and also reduces the yearly deposited 55 000 tons of slaughterhouse wastes and sewage sludge (Vermes, 1998; Kiss et al., 2001). Burying or incineration of these materials is expensive and can result in environmental pollution (Izsáki, 2000).

Kádár et al. (2002) set up a field experiment with dried communal sewage sludge and slaughterhouse compost with 0, 25, 50, 100, 200 t ha^{-1} rate on clayey brown forest soil applied 5-6 weeks before sowing of sugar beet. Despite of draught the crop could develop well on treated plots while control plants were depressed. The highest 200 t ha^{-1} load of slaughterhouse compost resulted in the highest sugar yield of 8.7 t ha^{-1} compared to 6.5 t ha^{-1} of control. Optimal 25 t ha^{-1} dose of sewage sludge enhanced yield to 7.2 t ha^{-1}, above this rate N overdose worsened quality parameters. Sludge and compost improved structure, water management and fertility of soil.

Material and methods

The long-term field experiment was set up at experimental site of the Research Institute for Soil Science and Agricultural Chemistry at Őrbottyán on a calcareous sandy soil with 1-

6% $CaCO_3$, 1-1.5% humus, 10-15% clay fraction, pH(H_2O): 7.0-7.4 in average in the ploughed layer. The water table was at 6-8 m, the site was prone to drought and weakly supplied with N, P and K. Materials were applied at 5 different levels in 4 replications making 20 plots for each experiment (compost form). The plots had an area of 5x8=40m^2 and arranged in split-plot design. In each experiment the applied rates were 0, 25, 50, 100, 200 t ha^{-1} fresh compost. In case of meat powder the doses were 0, 2.5, 5.0, 10.0, 20.0 t ha^{-1}. As the soil and the composts were poor in potassium, 200 kg ha^{-1} K_2O fertilization was given in all the experiments in spring 2003. The composts were processed by ATEVSZOLG Inc.

The mature compost became friable, inodorous, homogeneous material after 2-month air-exposure and 10-month maturation. Immature compost was odorous and rough, after 6-week air-exposure and without maturation. Meat powder based semi-mature compost was the material of immature compost maturing 6 months more, but had still a bad smell. Cooked meat based semi-mature compost received 2-month air-exposure and 8-month maturation. The average compositions of composts are shown in Table 1.

Table 1: Composition of composts and meat powder in D.M. with cc.HNO_3+cc.H_2O_2 digestion

Measured parameters	Unit	Mature compost	Immature compost	Semi-mature compost mp*	Semi-mature compost cm**	Meat powder
Dry Matter	%	38.9	45.8	60.0	55.7	95.0
ORG. MATTER	***%***	***26.3***	***41.7***	***40.3***	***43.8***	***58.6***
Organic C	%	15.2	24.1	23.3	25.3	33.9
C/N RATIO		***7.5***	***7.7***	***7.1***	***8.7***	***5.3***
Ca	%	9.31	12.65	11.25	11.69	7.02
P	%	2.22	5.56	4.26	5.26	4.06
N	%	2.04	3.12	3.26	2.89	6.41
K	%	0.76	0.76	0.83	0.50	0.41
Mg	%	0.70	0.36	0.37	0.54	0.18
Na	%	0.52	0.79	0.69	0.63	0.45
S	%	0.50	0.70	0.62	0.75	0.60
Zn	mg/kg	540	270	164	237	104
Cu	mg/kg	109	46	19	42	13
NH_4-N	mg/kg	169	3006	941	882	167
NO_3-N	mg/kg	2480	1135	61	122	1

*meat powder based, **cooked meat based

In the first experimental year (2002) maize (*Zea mays*), in the second mustard (*Sinapis alba*) and from the third year triticale (*X Triticosecale*) monoculture were grown. The amount of precipitation on sandy soil had strong effect on yields. The years 2002 and 2003 were dry. The maize received 237 mm and the mustard 52 mm of precipitation during their growing season. Between 2004 and 2006 the triticale had a satisfactory amount of precipitation evenly distributed.

Results and discussion

In 2002 the 200 t ha^{-1} immature compost caused depression in yield, otherwise no significant effect could develop. Trends showed that up to 50 t ha^{-1} mature compost and 25 t ha^{-1} immature compost application resulted in slightly better maize stand. Above ground

D.M. yield was 3 t ha^{-1} as an average. Drought season continued in 2003 when mustard yields were economically negligible.

Effects of the composts were enhanced in 2004 as the crop received sufficient precipitation during the 9 months growing season. The plantation could develop better and reach higher yields even at lower doses of the applied materials. The 2nd year residual effect of mature compost was moderate, but significant. Immature compost could increase 3-fold the control yield, that is from 1.6 t ha^{-1} to 5.3 t ha^{-1} grain (table 2).

Highest dose of meat powder based semi-mature compost doubled the yield of control, while the cooked meat based one increased it with nearly 50% (table 3). Meat powder had also similar positive effects, maximal yield could be reached at 5 t ha^{-1} load, but considerably decline did not occur even at higher levels (table 4). The soil could have 320 kg ha^{-1} N through the applied 5 t ha^{-1} meat powder, which could cover the N demand of the higher biomass production (Kádár and Ragályi, 2004).

Table 2: Effect of slaughterhouse composts on air-dried triticale yield, t ha^{-1} (Calcareous sandy soil, Őrbottyán)

	Compost t ha^{-1} fresh material					$LSD_{5\%}$	Mean
	0	25	50	100	200		
Mature compost (applied 09 May 2002)							
TRITICALE 2004							
Grain	2.2	2.2	2.0	2.9	2.6	0.6	2.4
Straw	3.8	3.8	3.3	4.8	4.5	1.0	4.0
Total	6.0	6.0	5.3	7.6	7.1	1.4	6.4
Triticale 2005							
Grain	1.7	1.9	1.7	2.2	2.3	0.6	1.9
Straw	2.8	2.9	2.6	3.6	3.5	1.1	3.1
Total	4.5	4.8	4.2	5.8	5.8	1.6	5.0
Immature compost (applied 09 May 2002)							
Triticale 2004							
Grain	1.6	2.8	3.2	4.5	5.3	1.8	3.5
Straw	2.8	4.5	5.0	6.7	8.0	2.8	5.4
Total	4.4	7.3	8.2	11.2	13.4	4.6	8.9
Triticale 2005							
Grain	1.8	1.9	2.2	3.1	3.2	1.2	2.4
Straw	2.6	2.7	3.1	4.9	5.3	1.8	3.7
Total	4.4	4.6	5.2	8.0	8.5	3.0	6.1
Triticale 2006							
Grain	0.8	0.8	1.1	1.1	1.5	0.4	1.1
Straw	1.5	1.8	2.1	2.2	3.1	1.2	2.1
Total	2.3	2.6	3.2	3.4	4.6	1.5	3.2

Comparing the composts the most effective was the meat powder based semi mature one, but the other semi mature and the meat powder had also significant effects. Mature and immature composts were applied one year earlier so they had milder effects.

In 2005, in the 3rd - 4th years of the treatments mature compost residual effect weakened and no significant differences in yield were found so further experiments were terminated. Meat powder based semi mature compost gave the highest yields even in this year, which was 30% less, than in 2004. Maximal doses raised the yield from 5-6 t ha^{-1} to 8-10 t ha^{-1}. The effects were already significant between 25 and 100 t ha^{-1} compost as well as 5 and 20 t ha^{-1} meat powder treatment. Lower doses of the applied materials however caused no significant effect. Average yields in 2006 were only half of that in 2005 and the effects were just above the significant limit except for meat powder in the case of grain yield.

Table 3: Effect of slaughterhouse composts on air-dried triticale yield, t ha^{-1} (Calcareous sandy soil, Őrbottyán)

	Compost t ha^{-1} fresh material					$LSD_{5\%}$	Mean
	0	25	50	100	200		
Meat powder based semi-mature compost (applied 18 Nov 2002)							
Triticale 2004							
Grain	2.4	3.8	4.3	4.4	5.4	1.7	4.1
Straw	3.9	5.9	6.3	6.5	8.1	2.1	6.2
Total	6.3	9.7	10.6	10.9	13.6	3.8	10.2
Triticale 2005							
Grain	2.3	2.2	3.0	3.3	3.2	0.9	2.8
Straw	3.3	3.2	4.3	5.2	5.6	1.3	4.3
Total	5.6	5.4	7.3	8.5	8.8	2.2	7.1
Triticale 2006							
Grain	1.2	1.2	1.4	1.5	1.6	0.4	1.4
Straw	2.3	2.4	2.9	3.0	3.4	1.1	2.8
Total	3.5	3.6	4.3	4.5	5.0	1.4	4.2
Cooked meat based semi-mature compost (applied 06 May 2003)							
Triticale 2004							
Grain	3.2	3.1	3.8	4.7	4.6	0.9	3.8
Straw	4.9	5.0	5.7	6.6	6.7	1.2	5.8
Total	8.1	8.0	9.4	11.3	11.4	2.0	9.6
Triticale 2005							
Grain	2.5	2.4	2.3	3.0	3.2	0.5	2.7
Straw	3.9	3.7	3.3	4.5	5.1	0.9	4.1
Total	6.5	6.1	5.6	7.5	8.3	1.3	6.8
Triticale 2006							
Grain	1.1	1.0	1.0	1.4	1.4	0.2	1.2
Straw	2.3	2.1	2.0	2.6	2.6	0.5	2.3
Total	3.4	3.2	3.0	4.0	4.0	0.7	3.5

Table 4: Effect of meat powder on air-dried triticale yield, t ha-1. Applied 18 Nov 2002 (Calcareous sandy soil, Őrbottyán)

	Meat powder t ha^{-1}					$LSD_{5\%}$	Mean
	0	2.5	5	10	20		
Triticale 2004							
Grain	2.7	2.8	4.7	4.5	4.2	1.3	3.8
Straw	4.6	5.0	6.9	6.9	7.0	1.7	6.1
Total	7.3	7.8	11.6	11.4	11.2	3.0	9.9
Triticale 2005							
Grain	1.9	2.0	1.9	3.0	3.9	1.3	2.6
Straw	3.0	3.2	2.7	4.4	6.7	2.5	4.0
Total	4.9	5.2	4.6	7.4	10.6	3.7	6.6
Triticale 2006							
Grain	1.0	0.9	1.0	1.1	1.2	0.4	1.1
Straw	1.6	1.6	1.9	1.8	2.3	0.6	1.8
Total	2.6	2.5	3.0	2.9	3.5	1.0	2.9

Conclusions

Composts and meat powder are valuable fertilizers having much higher content of N, P, Ca, Zn and Cu compared to the farmyard manure. These materials could be used in crops having a large fertilizer demand like sugar beet and also fibre crops or cereals.

Composts and meat powder have a considerable effect and even after 3-4 years a residual effect on yield.

Acknowledgement

This work is an output from research project CRO-13/06 and OTKA 49042.

References

Izsáki Z., (2000): Collecting, disposal and utility of agricultural wastes. Tessedik Sámuel Főiskola, Szarvas. 94 pp. (in Hungarian)

Kádár I., Hámori V., Morvai B., Petróczki F. (2002): Soil load and pollution limit values; sewage sludge and slaughterhouse waste compost effect on sugar beet. In: Cukorrépa termesztési/termeltetési tanfolyam és tanácskozás. (ed. Várnainé J.A.) pp. 37-40. Cukoripari Egyesülés. Budapest. (in Hungarian)

Kádár I., Ragályi P. (2004): Final report in 2004 about long-term field experiments set up with slaughterhouse composts. In: MAE Talajtani Társaság Talajvédelmi Klub. FVM Növény és Talajvédelmi Szolgálat. Budapest. 6 pp. (in Hungarian)

Kiss J., Simon M., Horváth Z., Kádár I., Kriszt B., Szoboszlay S., Morvai B., Csomor L. (2001): Biological degradation of animal origin fatty wastes. In: XVI. Országos Környezetvédelmi Konferencia. (ed. Elek Gy.) pp. 351-360. Siófok. (in Hungarian)

Vermes L. (1998): Waste management, waste utility. Mezőgazda Kiadó. Budapest. 201 pp. (in Hungarian)