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Processed slaughterhouse waste application on calcareous sandy soil

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SUMMARY

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 with 1–6% $CaCO_3$, 1–1.5% humus, 10–15% clay fraction, pH(H_2O): 7.0–7.4 in plough layer. The site was prone to drought. The soil was weakly supplied with N, P and K. Composts were applied once at 5 levels (0, 25, 50, 100, 200 t/ha fresh compost and 0, 2.5, 5.0, 10, 20 t/ha meet powder) in 4 replications making 20 plots for each compost form. The plots had an area of 5 x 8 = 40 m^2 arranged in split-plot. The fertilizing effect of these by-products was pronounced, their N, P, Ca, Zn and Cu content might be many fold compared to manure. In the year of application in 2002 the 25 and 50 t/ha doses showed only slight positive effects on yield, partly due to drought. Extreme doses (100–200 t/ha) of immature and semi-mature compost combined with dry weather in 2002 and 2003 (483 and 337 mm/year) caused depression. Residual effects of composts were pronounced after application in the next growing seasons. 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.
Keywords: 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).

Effect of fertilization using various rates of tannery sewage sludge was studied in a field experiment on crop yields on a calcareous humic sandy soil. The 60 t/ha (15–20 t/ha D.M.) sludge dressing applied for four years completed with phosphorus and potassium fertilizers was found to increase by 23 and 15% the grain yield of spring barley and rye resp. as compared to the fertilized control in the first two years, however in the third and fourth years yield dropped by 20%. Dose of 120 t/ha sludge applied for a four-year period was found to cause yield depression in spring barley in the first year, in further years rye and winter wheat grain yields were roughly equal with those obtained in the fertilized treatment. The 60 + 60 t/ha dose for two-two years did not cause depression and resulted in 2–16% higher yields (*Izsáki* and *Debreceni* 1987). A slight residual effect over 2–3 year of this experiment has been observed in 120 t/ha and 60 + 60 t/ha treatments (*Debreczeni* and *Izsáki* 1989).

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 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 load of slaughterhouse compost resulted in the highest sugar yield of 8.7 t/ha compared to 6.5 t/ha of control. Optimal 25 t/ha dose of sewage sludge enhanced yield to 7.2 t/ha, above this rate N overdose worsened quality parameters. Sludge and compost improved structure, water management and fertility of soil.

Materials 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 5 x 8 = 40 m^2 and arranged in split-plot design. In each experiment the applied rates were 0, 25, 50, 100, 200 t/ha fresh compost. In case of meat powder the doses were 0, 2.5, 5.0, 10.0, 20.0 t/ha. As the soil and the composts were poor in potassium, 200 kg/ha 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 has a bad smell, was rough, heterogeneous, 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 and was rough. Cooked meat based semi-mature compost received 2-month air-exposure and 8-month maturation.

Testing immature and semi-mature composts as well as extreme high application doses served as experimental purposes. Before application 2–2 composite samples (from 20–20 core samples) were taken from the materials. Analyses were made in the Research Institute for Soil Science and Agricultural Chemistry. 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 has 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

The average 20–30 t/ha rate of farmyard manure decays in 3–4 years in soil. About half of its 2.0–3.0% D.M. nitrogen content can be utilized during this time of which 50% in the first year, 30% in the second and 20% in the third (*Sarkadi* 1975).

In 2002 the 200 t/ha immature compost caused depression in yield, otherwise no significant effect could develop. Trends showed that up to 50 t/ha mature compost and 25 t/ha immature compost application resulted in slightly better maize stand. Above ground D.M. yield was 3 t/ha 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, but maximal load boosted the results. 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 to 5.3 t/ha grain *(Table 2.)*.

Table 2. Effect of slaughterhouse composts on air-dried triticale yield, t/ha (Calcareous sandy soil, Őrbottyán)

	Compost t/ha 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

Highest dose of meat powder based semi-mature compost had also strong after effects on triticale and 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 load, but considerably decline did not occur even at higher levels *(Table 4.)*. The soil could have 320 kg/ha N through the applied 5 t/ha meat powder, which could cover the N demand of the higher biomass production (*Kádár* and *Ragályi* 2004).

Table 3. Effect of slaughterhouse composts on air-dried triticale yield, t/ha (Calcareous sandy soil, Őrbottyán)

	Compost t/ha 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

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 a mature compost residual effect weakened and was not able to produce significant differences in yield so further experiments were terminated. Meat powder based semi mature gave the highest yields even in this year, which was 30% less, than in previous year. Maximal doses were able to rise the yield from 5–6 t/ha to 8–10 t/ha. The effects are already significant between 25 and 100 t/ha compost as well as 5 and 20 t/ha meat powder treatment. Lower doses of the applied materials however caused no significant effect any more.

Average yields in 2006 were only half of that in 2005 and treatment effects were just above the significant limit except for meat powder in the case of grain yield.

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

	Meat powder t/ha					**$LSD_{5\%}$**	**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

The main results and conclusions can be summarised as follows:

1. 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.
2. Composts and meat powder have a considerable effect and even after 3–4 years a residual effect on yield.
3. According to results composts can be applied at 25–50 t/ha rate as a fertilizer similarly to manure. On sandy soils, poorly supplied with K, additional K fertilization is recommended. Application above 50 t/ha can cause depression in unfavourable years. 100–200 t/ha doses can also cause environmental risk because of the high N and P content.

Feldolgozott vágóhídi hulladékok alkalmazása meszes homoktalajon

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Összefoglalás

Őrbottyáni meszes homoktalajon vizsgáltuk a különböző minőségű állati eredetű komposztok és húsliszt hatását és utóhatását a kukorica, mustár és tritikálé fejlődésére. A talaj átlagosan 1–6% közötti $CaCO_3$ és 1–1,5% humusz készlettel rendelkezik. A humuszos

szint vastagsága 60–80 cm, a pH(H_2O) 7,0–7,4 közötti értéket mutat. Az agyagfrakció mennyisége 10–15%, a termőhely nitrogén, foszfor és kálium elemekben egyaránt szegény. A talajvíz mélysége 6–8 m. A kísérleteket 2002-ben és 2003-ban 5 kezeléssel és 4 ismétlésben, azaz 20–20 parcellában állítottuk be, melyek 5 x 8 = 40 m^2 területet jelentettek véletlen blokk elrendezésben. Az egyes kísérletek egyszeri 0, 25, 50, 100, 200 t/ha friss komposzt és 0; 2,5; 5; 10; 20 t/ha húsliszt kezelést kaptak. Kísérleti növényként 2002-ben kukoricát, 2003-ban mustárt vetettünk, 2004-től pedig tritikálét.

A vágóhídi hulladékok trágyahatása erős, a N-, P-, Ca-, Zn- és Cu-tartalmuk többszöröse lehet az istállótrágyákéhoz képest. A kijuttatás évében, 2002-ben a 25 és 50 t/ha kezelések részben az aszály miatt csak enyhe pozitív hatással voltak a termésre. Az éretlen és félérett komposztok extrém nagy adagjai (100–200 t/ha) a száraz 2002-ben és 2003-ban (483 és 337 mm/év csapadék) depressziót okoztak. A komposztok utóhatásai azonban a későbbi években jelentősek voltak, a kontroll parcellák termését akár háromszorosára is megnövelték. Az erősebb hatású komposztok még 2006-ban, azaz a kísérlet 4. és 5. évében is szignifikáns termésnövekedést eredményeztek.

Kulcsszavak: komposzt, trágyázás, terméshozam, vágóhídi hulladék.

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