Municipal waste composts in organic agriculture, aiming to the future

This Finnish study shows possibilities for using high quality municipal waste composts as fertilizers without any negative effects on soil heavy metals, hygienic quality or microbiological functions.

Municipal waste composts are suspected to have a negative effect on agricultural soil or to be products of too unreliable quality and thus often redirected to landscaping. Although the quality of waste composts has continuously improved, the field of organic production still considers the municipal waste sorting measures inadequate. Despite of the controversial basis, a three-year research project was funded by the Organic farming research program 2003–2005 of the Finnish Ministry of Agriculture and Forestry and completed this year. The aim was to define the biological, chemical and hygienic effects of waste composts applied in organically managed field experiment. The scope of the research was further ahead in the future, aiming to the time when the sorting measures of the municipal waste management have improved even more.

Multiple compost applications in crop rotation

A field trial was conducted on a fine sandy moraine field with a history of compost applications in a previous compost fertilization experiment in Juva. Except for the application of waste composts, the experiment complied with the principles of organic agriculture and no mineral fertilizers or chemical pesticides were used. The studied compost types were municipal biowaste compost (Bio) and municipal biowaste-sewage sludge compost (BioSludge) compared to farm-composted cattle manure (Manure). The starting materials of the waste composts were source-separated and separately collected municipal biowaste and digested sludge from a wastewater treatment plant. Commercial composting partners processed the waste materials in their normal tunnel composting processes and selected the high quality compost batches for our study. The crop rotation during the experiment was barley – potato – legume / grass / mixture with composts applied according to recommended fertilization for potato in 2004 and for the establishing legume-grass with nurse crop in 2005. Until the year 2004 the application levels were determined by the nutrient limits of environmental aid and nitrate directive, with total N content used for N-limit. For potato the intended normal fertilization ("high") from composts was 70 kg total N and 35 kg P per hectare. In 2005 the composts were applied at considerably higher amounts as the N limit was interpreted as soluble N. For legume-grass establishment the intended "high" fertilization was 70 kg

2004		total	soluble N	total							
	C	N	($NH_4^+ + NO_3^-$)	P	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Compost	kg/ha				g/ha						
Manure 5 t/ha	713	48	10	7	0,5	17	88	0,3	24	19	449
Manure 9 t/ha	1283	86	17	13	0,9	30	158	0,6	44	34	808
Bio 3 t/ha	503	57	8	14	0,9	123	173	0,4	49	29	430
Bio 6 t/ha	1006	113	16	27	1,8	247	345	0,8	98	57	860
BioSludge 3 t/ha	409	41	4	27	1,4	112	269	0,8	51	38	681
BioSludge 5 t/ha	681	69	7	45	2,4	187	449	1,3	85	64	1135

Dry matter contents of composts: Manure 22 %, Bio 53 %, BioSludge 48 %

2005		total	soluble N	total							
	C	N	($NH_4^+ + NO_3^-$)	P	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Compost	kg/ha				g/ha						
Manure 25 t/ha	3676	194	64	33	1	77	362	2	49	77	1830
Manure 50 t/ha	7352	389	127	65	1	153	724	3	98	154	3660
Bio 26 t/ha	3399	294	41	125	8	873	2230	7	330	362	4176
Bio 52 t/ha	6797	588	81	250	16	1747	4461	14	660	724	8352
BioSludge 23 t/ha	3364	347	88	204	9	791	2336	8	243	288	4925
BioSludge 46 t/ha	6728	693	175	409	18	1582	4673	17	487	577	9850

Dry matter contents of composts: Manure 25 %, Bio 34 %, BioSludge 36 %

Table 1. Nutrients and heavy metals applied in composts in 2004 and 2005.

soluble N. The "low" level was half of the high levels for both years.

Heavy metals below limits

The nutrient contents varied in the composts and typically the BioSludge compost containing sewage sludge contained higher amount of P, whereas Bio compost contained high amount of N. Heavy metal contents of the composts were below the limits of compost applied in organic production, except for Cu and Zn. The stage of compost maturity varied, as Manure compost in 2004 and Bio compost in 2005 had some lower maturity indicators. The applied amounts of nutrients and heavy metals are presented in table 1. As the total nutrients applied in composts varied, also the amount of soluble N (determined as sum of ammonium and nitrate) at the time of application fluctuated highly. There were no significant effects on nutrient contents in soil (N, P, and C). Although the heavy metal load on soil was higher with the waste composts than with Manure compost, no differences between compost types were found in the heavy metal contents of soil.

Good hygienic quality

Not even the largest quantities of composts used in the experiment had any negative effect on the hygienic quality of soil and crop. Samples of compost, soil and potato tubers were determined for their faecal coliforms, enterococci, clostridia, coliphages and salmonellae. Soil was sampled both before and twice after compost applications. Minor amounts of faecal coliforms were found on each compost type and also from most of the compost fertilized plots. On the whole, the intestinal contamination was low according to the investigated indicator microbes. In addition, some improvement of compost hygienic level was found between the composts applied in 2004 and 2005. There were no indicator microbes found from the potato tubers fertilized with waste composts. Also the taste of cooked potato was similar with all compost types.

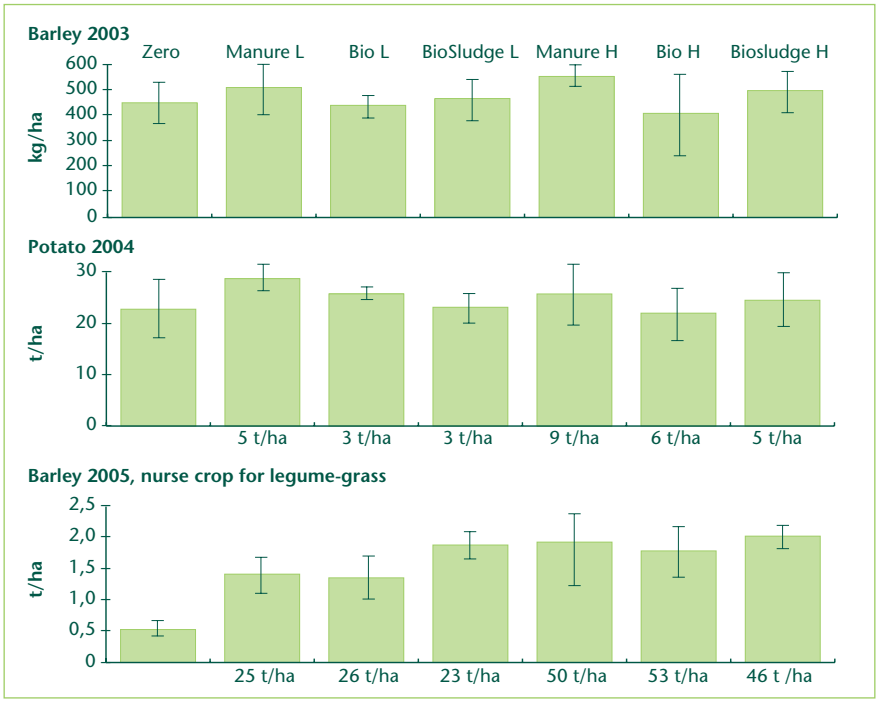

Figure 1. Plant yields in the crop rotation of compost experiment in the low (L) and high (H) application levels. The compost types for barley 2003 refer to the compost applications in the previous research. The same types were applied for the corresponding plots at the presented amounts of compost fresh matter in 2004 and 2005.

Plant yields increased by composts

Compost fertilization yielded generally higher crops compared to unfertilized soil. The residual effect of the previous red clover-grass was low and thus apparent lack of soil N together with leaf spot diseases led to very low grain crop yields of barley on every plot during 2003 (figure 1). Potato crop yield was relatively high on the compost-fertilized soil in 2004 compared to the average potato yields in organic agriculture. Manure compost produced higher potato yields than waste composts. The high tolerance of Appell variety to the potato late blight (*Phytopthora infestans*) was especially valuable during the high occurrence of late blight in 2004. Barley was grown as a nurse crop for the establishing legume-grass in 2005 and composts increased the grain yield compared to the yields on non-fertilized soil. The lower amount of BioSludge compost (23 t/ha) also increased grain yields compared to the other composts on the low application level.

Advantages for microbiological functions in soil

Even the largest quantities of composts used in the experiment had no negative effect on soil biological functions. Composts tended to increase the CO_2 production compared to the non-fertilized soil. BioSludge or Manure composts increased the mineralization of nitrogen compared to the non-fertilized soil, also some soil enzyme activities were increased. The analysis of particulate organic matter (POM) describes the amount of organic matter usable to microbes. A clear increase was found on the higher compost application level compared to the non-fertilized soil in 2005. According to

our determinations of microbial activity and total amount of microbes the waste compost applications increase the potentially mineralizable organic matter and nutrient reserves in the soil.

Possibilities for recycling

High quality municipal waste composts could be utilized as fertilizers and for soil enrichment without any significant negative effects on soil heavy metals, hygienic quality or microbiological functions. However, in the short term the advantages are mainly modest. Applying waste composts as a sole nutrient source according to their total N contents appears to supply too low amount of N for plants. Utilization of composts could partly compensate for the use of other fertilizers and at the same time restore soil organic matter withdrawn with the crop. There are only a few studies made on biological quality and functionality of soil in the context of compost fertilization. This research was the first of the kind in Finland to determine the amount of organic matter usable to microbes by particulate organic matter (POM) analysis. Overall, the possibilities of waste compost utilization discovered in this research advise us to further the recycling of waste and nutrients within both organic and conventional agriculture. ■

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Literature

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Röta slakteriavfall – bra men dyrt

Att röta eller kompostera slakteriavfall från småskaliga slakterier är bättre för miljön än att skicka det till förbränning. Men det blir inte billigare och tar tid att sköta, konstaterar forskare vid JTI - Institutet för jordbruks- och miljöteknik i Uppsala.

I dag förbränner små slakterier sitt slakteriavfall i speciella anläggningar tillsammans med vissa avfallskategorier från stora slakterier. Avfallsflödet från småskalig slakt är litet. Därför blandas allt avfall av ekonomiska skäl och då kräver reglerna att avfallet bränns. Detta sätt att ta hand om avfallet är dyrt, och har pekats ut som en begränsande faktor för etableringen av nya småskaliga slakterier.

Forskare vid JTI har tillsammans med Sveriges småskaliga kontrollslakteriers förening försökt hitta alternativa, billigare metoder för att ta hand om slakteriavfallet. De har beräknat kostnader för lokal rötning, lokal våtkompostering, lokal förbränning och regional rötning.

-Kostnaderna sjunker med våtkompostering och rötning, men bara om den alstrade energin kan ersätta inköpt energi som el, olja eller pellets, säger Ola Palm, FoU-chef vid JTI.

Lokal förbränning vid slakteriet är inte en ekonomiskt realistisk metod, eftersom det krävs stora insatser för övervakning och analys av rökgaserna.

Att leverera det animaliska avfallet till en regional biogasanläggning sänker kostnaderna, men förutsätter att det animaliska avfallet mals och konserveras så att det kan långtidslagras vid slakteriet och transporteras.

Slutsatsen blir att ett småskaligt slakteriföretag som beslutar sig för att investera i en egen biologisk behandlingsanläggning för sitt avfall tar en stor ekonomisk risk. Därför anser forskarna att det behövs bättre beslutsunderlag. Det kan man få till exempel genom att det görs praktiskt inriktade studier för malning och lagring av animaliska biprodukter, och att man undersöker förutsättningarna för en gemensamhetsanläggning som behandlar slakteriavfall från flera småskaliga slakterier.

Undersökningen och slutsatserna presenteras i JTI:s rapportserie K&A nr 37: ”Metoder för avfallshantering vid småskalig slakt”. Rapporten kan laddas hem som pdf-fil från JTI:s webbplats, eller beställas från JTI:s publikationsservice, tel + 46 (0)18-67 11 00, e-post: bestallning@jti.slu.se ■

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