The effects of heavy metals, ammonia and electrical conductivity in compost derived from swine solid fraction on seed germination and root elongation of *Lepidium sativum* L.

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Introduction

Compost derived from swine solid fraction can be re-used as a new resource material, such as soil fertilizer and conditioner, to substitute for the more costly commercial fertilizers for crop production.

However, non-composted manure or immature compost could generate adverse effects on plant growth and/or seed germination. Phytotoxic effects of organic wastes are the result of the combination of several factors like ammonia (Wong *et al.*, 1983) and heavy metals (Wollan *et al.*, 1978). These factors have been shown to be responsible for inhibitory effects (Gouider *et al.*, 2010).

Pig manure often contain high concentrations of Cu and Zn compared with other animal manures, because Cu and Zn supplements are normally added to pig rations. These elements, at high concentrations, can impose detrimental effects on seed germination, development of young seedlings, maturation, root and shoot growth.

Objective

In the present study, seed germination and root elongation of cress (*Lepidium sativum* L.) have been used to evaluate the toxicity of different composts derived from swine solid fraction and to verify if the composts could effect plant growth.

The compost were chemically analyzed for total N, NH4+, Electrical Conductivity (EC), pH and heavy metals and correlate to phytotoxicity indexes.

Materials and methods

4 types of materials have been used

1) Swine Solid Fraction Compost (SSFC)
2) Wheat Straw Compost (WSC)
3) Wood-Chips Compost (WCC)
4) Sawdust Compost (SC)

Some chemical characteristics of SSFC, WSC, WCC and SC

Compost	Compost Sample[a]			
	NH_4^+ (mg/g)	Total N (mg/g)	Ext. Zn[b] (mg/kg)	Ext. Cu[b] (mg/kg)
SSFC	2.9	11.1	24.0	4.0
WSC	2.9	14.6	16.0	2.8
WCC	4.0	17.3	18.0	1.9
SC	5.2	25.5	22.0	3.2

[a] All characteristics are on dry weight basis
[b] Ext.: water extractable

Composts water extracts have been used in four different concentration (75%, 50%, 25% and 10%)

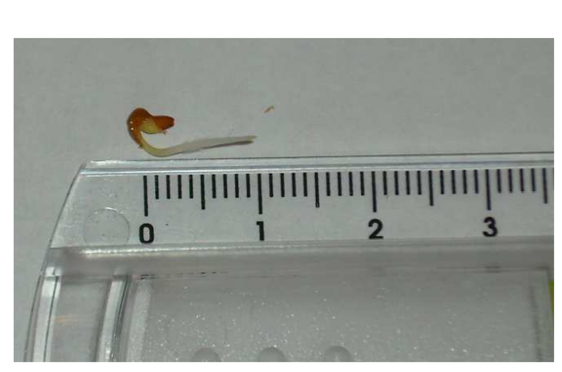
Some chemical characteristics of SSFC, WSC, WCC and SC water extracts

Compost	Compost Extract							
	Electrical Conductivity ($\mu S \cdot cm^{-1}$)				pH			
	75%	50%	25%	10%	75%	50%	25%	10%
SSFC	3890	2830	1561	748	6.7	6.5	7.1	6.4
WSC	1904	1308	692	292	6.6	6.7	7.2	6.7
WCC	1688	1156	608	277	5.5	5.4	5.7	6.1
SC	7960	5690	1970	1160	7.4	6.3	6.3	5.9

Ten cress seeds were placed on layer of filter paper in 90 mm Petri dishes and 1 ml of each concentration was added.

Distilled water was used as a control.

The Petri dishes were incubated in a growth chamber at 72±2°C and 70% relative humidity without photoperiod.



The percentages of relative seed germination (RSG), relative root growth (RRG) and germination index (GI) after 72 h of exposure to composts extract were calculated.

Results

Linear correlations (shown by asterisks) between RSG, RRG and GI at four compost concentrations with five parameters of the compost extracts

Concentration		NH_4^+	Total N	Ext. Zn	Ext. Cu	EC
10%	RSG	0.21 NS	0.22 NS	-0.08 NS	-0.14 NS	0.19 NS
	RRG	-0.14 NS	-0.24 NS	0.52**	0.63**	0.34 NS
	GI	-0.06 NS	-0.16 NS	0.49*	0.56**	0.37 NS
25%	RSG	-0.21 NS	-0.19 NS	-0.05 NS	-0.01 NS	-0.29 NS
	RRG	0.03 NS	-0.04 NS	0.34 NS	0.31 NS	0.20 NS
	GI	-0.01 NS	-0.08 NS	0.34 NS	0.32 NS	0.16 NS
50%	RSG	-0.34 NS	-0.32 NS	-0.02 NS	0.04 NS	-0.46*
	RRG	0.01 NS	-0.04 NS	0.20 NS	0.20 NS	0.13 NS
	GI	-0.05 NS	0.09 NS	0.20 NS	0.21 NS	0.05 NS
75%	RSG	-0.27 NS	-0.25 NS	-0.06 NS	0.02 NS	-0.43 NS
	RRG	-0.01 NS	-0.11 NS	0.37 NS	0.32 NS	0.08 NS
	GI	-0.08 NS	-0.17 NS	0.38 NS	0.34 NS	0.01 NS

* $p < 0.05$
** $p < 0.01$

Salinity can have a detrimental effect on seed germination and plant growth. In general, salinity effects are mostly negligible in extracts with EC readings of $2000 \mu S \cdot cm^{-1}$ or less. (Hoekstra *et al.*, 2002). This critical level was exceeded in the SC and SSFC extracts in the 50 and 75% concentrations.

Concentration of water-extractable Cu, which was highest in SSFC, appeared to be positively correlated with RRG and GI at the 10% concentration. However it is known that metals can cause a marked delay in germination and that they can inhibit plant growth severely (Wollan *et al.*, 1978). Concentration of water-extractable Cu in the compost extracts was maximally 0.21 $\mu g \cdot ml^{-1}$, whereas 0.04 $\mu g \cdot ml^{-1}$ of Cu inhibited root growth of plants (Hoekstra *et al.*, 2002). However, it should be mentioned that critical concentrations of heavy metals for toxicity in compost extracts are likely to be higher than critical values mentioned in literature, because of the relatively high amount of organic compounds, which can bind heavy metals (Hoekstra *et al.*, 2002).

Water-extractable Zn showed a high and significant positive correlation with RRG and significant but less high correlation with GI at the 10% concentration. Concentration of water-extractable Zn was below phytotoxic levels as mentioned in the literature. The maximum concentration of water-extractable Zn in the compost extracts was 1.2 $mg \cdot l^{-1}$ compared to critical values ranging from 75 to 600 $mg \cdot l^{-1}$ (Hoekstra *et al.*, 2002). This might explain the fact that no significant negative correlations of water-extractable Zn with RSG, RRG and GI were found.

Conclusions

The mature compost extract may have stimulatory effects on plant growth due to the presence of mineral nutrients, beneficial microorganisms, humic substances and the physical characteristics of mature compost. From the results it may be concluded that the four composts could be used as a soil amendment with positive effects on seed germination and plant growth.