EVALUATION OF TOXICITY OF TEXTILE SLUDGE COMPOST ON SEED GERMINATION AND ROOT ELONGATION OF SOYBEAN AND WHEAT

A. S. F. ARAÚJO[1]; F. K. SAHYOUN[2] & R. T. R. MONTEIRO[2]

[1] Universidade Estadual do Piauí – UESPI, Campus de Parnaíba, Av. Nossa Senhora de Fátima, S/N, Parnaíba, PI, 64202-220. E-mail: asfaruaj@esalq.usp.br
[2] Centro de Energia Nuclear na Agricultura - USP, Piracicaba, SP.
Aceito para publicação em: 10/12/2002.

ABSTRACT

The aim of this study was to evaluate the toxicity of textile sludge compost on seed germination and root elongation of soybean and wheat. Aqueous extracts of the compost and textile sludge were prepared by shaking the sample with distilled water (1:2, w/v) and diluted to concentrations of 100%, 50%, 25%, 6.25% and 0% (control). The toxicity was evaluated on 10 seeds, in triplicate, exposed for 5 days, in the dark. The results show that the extract of textile sludge compost did not show inhibitory effects on the seed germination and root elongation of soybean and wheat. On the other hand, there were toxic effects of textile sludge extract to both soybean and wheat tested. The wheat presented more sensitivity to the extracts compared to the soybean. This preliminary study demonstrated that the composting process might be used to eliminate or decrease the biological toxicity of textile sludge. However, others studies is necessary for an complete evaluation of textile sludge compost before applying in soil
Key Words: Phytotoxicity, composting, seed germination, toxicity test.

RESUMO

AVALIAÇÃO DA TOXICIDADE DO LODO TEXTIL COMPOSTADO SOBRE SEMENTES DE SOJA E TRIGO.

O objetivo deste trabalho foi avaliar a toxicidade de lodo têxtil compostado na germinação de sementes e alongamento de raiz de soja e trigo. Extratos aquosos do composto e do lodo têxtil foram preparados, através da agitação de amostras com água destilada (1:2, p/v), e diluídas para concentrações de 100%, 50%, 25%, 6,25% e 0% (controle). A fitotoxicidade dessas concentrações de extrato foi avaliada em 10 sementes, em triplicata, expostas durante cinco dias, no escuro. Os resultados mostraram que o extrato do composto não apresentou efeito inibitório sobre a germinação de sementes e alongamento das raizes de soja e trigo. Por outro lado, houveram efeitos tóxicos do extrato do lodo têxtil para ambas espécies testadas. O trigo apresentou maior sensibilidade aos extratos, comparado com a soja. Este estudo preliminar demonstra que a compostagem pode ser utilizada para eliminar ou diminuir a toxicidade biológica do lodo têxtil. Entretanto, outros estudos são necessários para avaliação completa do composto de lodo têxtil antes da sua aplicação no solo.
Palavras-Chave: Fitotoxicidade, compostagem, germinação de sementes, teste de toxicidade

INTRODUCTION

Composting of industrial waste is increasing because of the recycling requirements set an organic waste. The composting is a biological and exothermic process of a organic substrate in solid state, and during the process several groups of microorganisms biodegraded this substrate, producing water, carbon dioxide and matured organic matter (CARVALHO, 2001). The process was made in aerobic and anaerobic conditions, and according with FRASSINETTI et al. (1990) in aerobic conditions the microorganisms develops and is capable of transforming organic matter and eliminating biological toxicity of wastes. The quality of compost is related to its agronomic and commercial value as an organic solid conditioner (DEGLI-INNOCENTI & BASTIOLI, 1997).

Textile sludge have corants in your composition. Corants is aromatic compounds, constitutes of lignocellulosic material, that can be degraded by microorganisms, mainly the basidiomycetes fungi (BALAN & MONTEIRO, 2001). However, the degradation of organic pollutants in composting is poorly described (KANAPEN & ITAVAARA, 2001).

Interest in the ecological effects of composting has been growing recently, and assessing the phytotoxicity of compost is one of the most important criteria being used to avoid environmental risks before these compost can be recycled back to agricultural land (TIQUIA et al., 1996). Phytotoxicity can be determined as seed germination, root elongation and seedling growth (KAPANEN & ITAVAARA, 2001). Seed germination and root elongation tests have been used as simple, rapid, reliable and reproducible techniques to evaluate the damage caused by toxic compounds present in various wastes (WANG & KETURI, 1990), and according with VERMEULEN et al. (1993) and KEELING et al. (1996) the inhibition of seed germination and effects on root elongation are the main areas of interest in studies on phytotoxicity.

The aim of this study was to evaluate the toxicity of textile sludge compost on seed germination and root elongation of soybean and wheat.

MATERIAL AND METHODS

Textile sludge compost was produced by Bioland® Co., using textile sludge from Teka Textile Company, located at Americana City, SP, Brazil. The composting process lasted for 90 days and composite samples were collected from pile in several sites. Aqueous extracts of textile sludge and compost were prepared by shaking the fresh samples with addition of distilled water at 1:2 w/v (ZUCONNI et al., 1981) for 15 min using a rotatory shaker, then filtered. The filtered extracts, in concentration of 100%, was diluted with distilled water in concentrations of 50%, 25%, 6.25% and 0% (control).

The phytotoxicity of these concentrations of extracts was evaluated by seed germination and root elongation according to procedure summarized in Table 1. Seeds of

soybean (CV IAC Foscarin) and wheat (CV. IAC 305) were used in the test. After 5 days of incubation in the dark, the seed germination, root elongation and germination index (GI, a factor of relative seed germination and relative root elongation) were determined. The percentages of relative seed germination, relative root growth and GI were calculated (TAM & TIQUIA, 1994).

$$\text{Relative seed germination (\%)} = \frac{\text{number of seeds germinated in the extract}}{\text{number of seeds germinated in control}} \times 100$$

$$\text{Relative root length (\%)} = \frac{\text{Mean root length in the extract}}{\text{Mean root length in control}} \times 100$$

$$GI = \frac{\text{(\% Seed germination) x (\% Root growth)}}{100\%}$$

The mean and standard deviation of triplicate samples from each concentration were calculated.

Table 1. Seed germination test conditions.

1. Test type	- Static (batch)
2. Pre-treatment	- Soak in distilled water overnight
3.Temperature	- 27 $\pm$3 ^{o}C
4. light	- None
5. Test vessel	- 1 x 10 cm Petri dish plus Whatman Number 1 filter paper
6. Test volume	- 5 ml per dish
7. Number of seeds	- 10 per dish
8. Replicates	- 3
9. Control	- Distilled water
10. Test duration	- 5 days
11. End point	- Germination, primary root $\geq$ 5 mm

RESULTS AND DISCUSSION

The relative seed germination of wheat and soybean was as high as 90% for all concentrations of compost. The seed germination of wheat increased with the concentrations of compost extracts, reached 116% at concentration of 100% (Figure 1b), while the seed germination of soybean increased gradually and achieved about 100% (Figure 1a). On the other hand, the response of the wheat and soybean to textile sludge were different. The seed germination of wheat was significantly retarded by the concentrations of textile sludge extracts, reached 23% at concentration of 100% (Figure 1b). In the case of soybean seeds, the germination was poorly retarded by the textile sludge, reached 80% at concentration of 100% (Figure 1a).

The response of the of soybean and wheat to concentrations of compost extracts were similar in terms of relative root length, except to soybean at concentrations of 100% that presents root length of 161% in relation to the control (Figure 2a). The compost extract increased the root length of soybean and wheat in all used concentrations. In the case of textile sludge, there was an toxicity effect to root length of soybean and wheat. However, the wheat was most sensitive, compared to soybean, presented an root length of 13% at concentrations of 100% (Figure 2b).

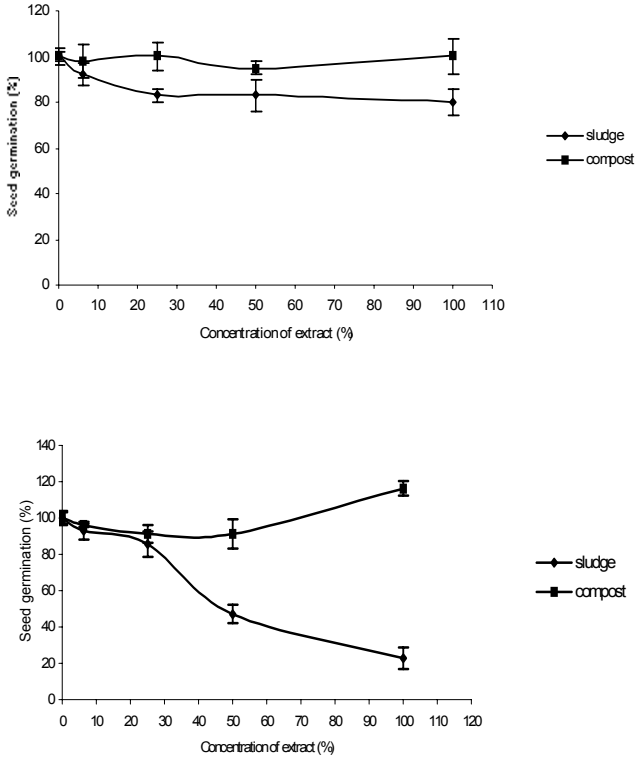

Figure 1. Seed germination percentages of soybean (a) and wheat (b) treated with concentrations of compost and textile sludge.

The seed germination and root length technique has been devised to evaluate the damaging effects and toxicity of compost (WONG, 1985). These results indicated non inhibitory effect of the compost on plant species used and suggest that the composting process eliminated the biological toxicity of textile sludge. On the other hand, the results shows that the textile sludge was toxic for all concentrations evaluated. The wheat seeds were most sensitive, while the soybean seeds were the least sensitive. The soybean have a large quantity of reserve and their seeds are two time higher compared to wheat seeds. According to CHEUNG et al. (1989) the sensitivity of a plant specie to toxicity depends on the quantity of its food reserves.

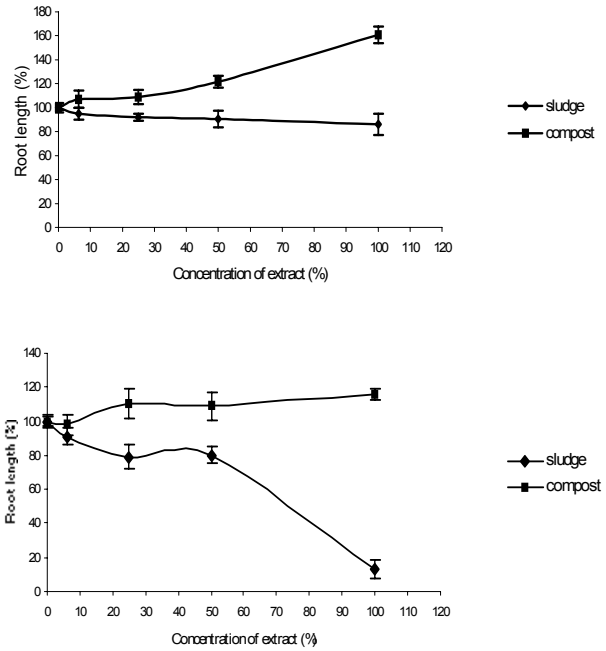

Figure 2. Root elongation of soybean (a) and wheat (b) treated with concentrations of compost and textile sludge.

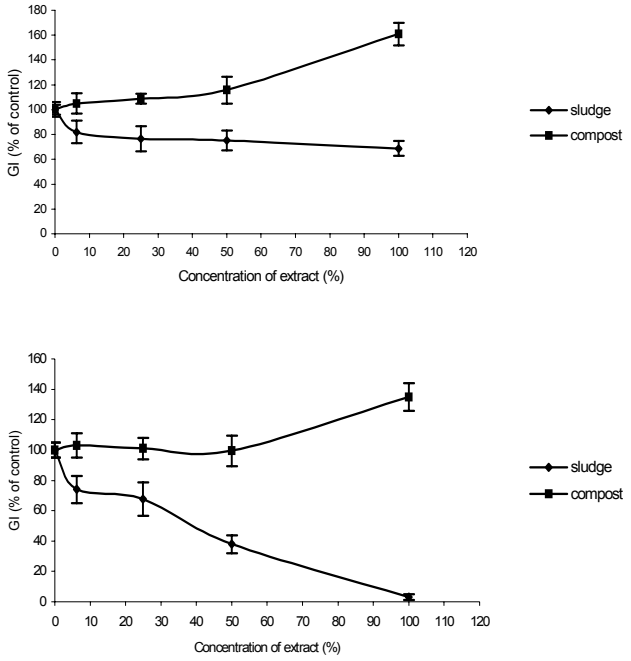

Figure 3. Germination indices of soybean (a) and wheat (b) treated with concentrations of compost and textile sludge.

The germination index (GI) values of soybean and wheat increased with the increase of concentration of compost extract (Figure 3). In case of textile sludge, the soybean behaved differently from the wheat. The soybean presents a GI about 80% at concentration of 6.25% to 100% from textile sludge extract. On the other hand, GI of wheat decreased with the increase of concentration of textile sludge, reaching 3% at concentration of 100%.

The increase of GI suggested that the waste did not pose any toxicity on the plant growth as phytotoxicity inhibitors had been eliminated (TIQUIA et al., 1996). This results indicated that the compost not have toxic effect on the soybean and wheat seeds. The composting is an important process that have to eliminate toxic compounds presents in industrial wastes. According TIQUIA et al. (1996), the aeration is a significant factor in the destruction of lethal levels of toxic compounds and organic phytotoxins.

This preliminary study demonstrated that the composting process might be used to eliminate or decrease the biological toxicity of textile sludge. However, others studies is necessary for an complete evaluation of textile sludge compost before applying in soil.

REFERENCES

BALAN, D.S.L.; MONTEIRO, R.T.R. Decolorization of textile indigo dye by lignolytic fungi. **J. Biotechnol**., v.89, p.141-145, 2001.

CARVALHO, P.C.J. Compostagem. In: TSUTIYA, M.T. et al. (Eds.) **Biossólidos na Agricultura**. São Paulo: ABES, 2002. 468p.

CHEUNG, Y.H.; WOANG, M.H.; TAM, N.F.Y. Root and shoot elongation as an assessment of heavy metal toxicity and. 'Zn equivalent value' of edible crops. **Hydrobiol**., v.188, p.377-383, 1989.

DEGLI-INNOCENTI, F.; BASTIOLI, C. Definition of compostability criteria for packaging: Initiatives in Italy. **J. Environ. Polym. Degrad**., v.5, p.183-189, 1997.

FRASSINETTI, S.; CITTERIO, S.; NAPPI, P. Chemical changes in sludge stabilization. **BioCycle**, v.31, p.50-52, 1990.

KAPANEN, A.; ITAVAARA, M. Ecotoxicity tests for compost applications**. Ecotoxicol. Environ. Safety,** v.49, p.1-16, 2001.

KEELING, A.A.; GRIFFITHS, B.S.; RITZ, K.; MYERS, M. Effect of compost stability on plant growth, microbiological parameters and nitrogen availability in media containingmixed garden-waste compost. **Bioresource Technol**., v.54, p.279-284, 1995.

TAM, N.F.Y.; TIQUIA, S.M. Assessing toxicuty of 'spent sawdust pig-litter'using seed germination technique. **Resour. Conserv. Recycl**., v.11, p.261-274, 1994.

TIQUIA, S.M.; TAM, N.F.Y.; HODGKISS, I.J. Effects of composting on phytotoxicity of spent pig-manure sawdust litter. **Environ. Pollut**., v.93, p.249-256, 1996.

VERMEULEN, J.; HUYSMANS, A.; CRESPO, M.; VAN LIERDE, A.; DE RYCKE, A.; VERSTRAETE, W. Processing biowaste by anaerobic composting to plant growth substrate. **Water Sci. Technol**., v.27, p.109-119, 1993.

WANG, W.; KETURI, P.H. Comparative seed germination tests using ten plants species for toxicity assessment of a metal engraving effluent samples. **Wat., Air, Soil Pollut**., v.52, p.369-376, 1990.

WONG, M.H. Effects of animal manure compost on tree (*Acacia confusa*) seedling growth. **Agric. Wastes**, v.13, p.261-272, 1985.

ZUCCONI, F.M.; PERA, A.; FORTE, M.; DE BERTOLDI, M. Evaluating toxicity of immature compost. **BioCycle**, v.22, p.54-57, 1981.