EFFECT OF TANNERY SLUDGE ON THE CELLULOSE DECOMPOSTION IN THE SOIL

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Aceito para publicação em: 15/03/2006.

ABSTRACT

The effect of tannery sludge on the cellulose decomposition was studied in the laboratory as a dose-response experiment. Cellulose decomposition rates were determined by the weight loss from cellulose filter disks buried in soil samples. The amount of tannery sludge used were 0, 11, 22, 44, 88 and 172 Mg ha^{-1}, and, corresponded, respectively, to incorporation of 250, 500, 1,000, 2,000 and 4,000 mg Cr^{3+} kg^{-1} of soil. The cellulose filter disks presented different degrees of decomposition with application of tannery sludge. After 30 days of incubation the cellulose decomposition rate, corresponding to application of 11, 22 and 44 Mg ha^{-1} were higher than soil untreated (control), respectively 5%, 20% and 10%, but the difference was only significant for the 22 Mg ha^{-1}. There was a significant decrease of 50% in the cellulose decomposition, compared to untreated soil (control), with application of 172 Mg ha^{-1} of tannery sludge. This study has demonstrated that cellulolytic activities are susceptible to be inhibited by high rates of tannery sludge. When applied to low amounts, tannery sludge did not affect cellulose decomposition by the soil microflora.

Key words: Industrial waste, soil microbial activity, dose-response

RESUMO

EFEITO DO LODO DE CURTUME SOBRE A DECOMPOSIÇÃO DA CELULOSE NO SOLO

O efeito do lodo de curtume sobre a decomposição da celulose foi avaliado em laboratório. A taxa de decomposição da celulose foi determinada através da perda de peso de discos de celulose incorporados em amostras de solo. As quantidade de lodo de curtume usadas foram 0, 11, 22, 44, 88 e 172 Mg ha^{-1}, e corresponderam, respectivamente, a incorporação de 250, 500, 1.000, 2.000 e 4.000 mg Cr^{-3+} kg^{-1} de solo. Os discos de celulose apresentaram diferentes graus de decomposição com a aplicação de lodo de curtume. Após 30 dias de incubação, as taxas de decomposição da celulose, correspondentes a aplicação de 11, 22 e 44 Mg ha^{-1} foram maiores que o solo não tratado (controle), respectivamente, 5%, 20% e 10%, mas a diferença somente foi significante para a aplicação de 22 Mg ha^{-1}. Houve um significativo decréscimo de 50% na decomposição da celulose, comparado ao solo controle, com a aplicação de 172 Mg ha^{-1}. Este estudo demonstrou que a atividade celulolítica é susceptível a inibição por altas doses de lodo de curtume. Aplicado em baixa quantidade, o lodo de curtume não afeta a decomposição da celulose pela microbiota do solo.

Palavras-chave: Resíduos industriais, atividade microbiana do solo, dose-resposta

INTRODUCTION

Soil fertility and plant growth are governed by biochemical process and the majority of biochemical transformations in soil results from microbial activity. Microorganisms mineralize, oxidize, reduce and immobilize mineral and organic materials in soil (KENNEDY & DORAN, 2002). Any

compounds which alters the number or the activity of microorganisms can be therefore affect soil biochemical process and ultimately influence soil fertility and plant growth (MUNIER-LAMY & BORDE, 2000).

Tannery sludge presents high organic and inorganic content, plus trivalent chromium (Cr^{3+}) used in the process of tanning (CASTILHOS et al., 2002). According to FERREIRA et al. (2003), application of tannery sludge in agricultural soils can be an alternative for chemical fertilization, mainly in relation to macronutrients. However, the use of sludge in agricultural soils needs of defined action, in order to not cause damage to soil biological activity (COSTA et al., 2001).

As on one hand, cellulose is one of the major components of plant residues, the cellulose decomposing ability of soil is an important index of its biological activity (MUNIER-LAMY & BORDER, 2000). Much of the literature focuses on the methodology for examining the side effect of tannery sludge on soil microorganisms (ANDRÉ & MATTIAZO, 1997; KONRAD & CASTILHOS, 2001). One of the most widely methods used to asses the effects of tannery sludge on carbon turnover is soil respiration measure, as an integrated measure of microbial activity. Others methods using added organic substrate indicate the microbial activity. The aim of this paper was to evaluate the effect of tannery sludge on the cellulolityc activity of the soil microbial.

MATERIAL AND METHODS

The experiment was conduced out at Soil Quality Lab of Piauí State University, located at Parnaíba, Piauí, Brazil. The soil was collected from the top 0-0.01 m layer, then sieved at 2 mm. Plastics pots (300 mL) was used for this study and received, each, 100 g of soil.

The study was performed as a dose-response experiment. Doses of tannery sludge used were 0, 11, 22, 44, 88 and 172 Mg ha^{-1}, and, corresponded, respectively, to incorporation of 250, 500, 1,000, 2,000 and 4,000 mg Cr^{3+} kg^{-1} of soil. Tannery sludge used in this study presented chemical composition of: pH 7.7; Organic matter 407.4; N 22.9; P 1.3; K 6.4; Ca 46.4; Mg 27.2; Na 4.2 and Cr 43.0 g kg^{-1}. Cellulose filter disks (4 cm^2) were dried at 65 ^oC for 24 hours and weighed. The disks were incorporated to soil in the plastics pots. Distilled water was then added to bring the soil moisture content to 60% of field capacity, which was maintained during the incubation period by daily addition of distilled water.

The cellulose decomposition was evaluated thirty days after incubation. The filter disks were removed, washed with distilled water and dried (24 h at 65 ^oC), then weighed. The rate of decomposition was expressed by the percentage loss in dry weight of filter disks after an incubation period prior to burial, as follows (MUNIER-LAMY & BORDER, 2000).

$$\% \text{ weight loss} = (w_0 - w_t) \times 100 / w_{0,}$$

where, w_0 and w_t were the weight of the filter disk at time 0 and t, respectively. For each treatment, the relative weight loss was calculated as the mean value of the three replications.

RESULTS

The cellulose filter disks presented different degrees of decomposition with application of tannery sludge (Figure 1). According to regression analysis, there was a quadratic response of application of tannery sludge. There was an increase in the cellulose decomposition with application of 11 to 44 Mg ha^{-1} of tannery sludge and decreasing with increase of the rate.

The results suggest that the organic matter, N and P content presents in tannery sludge favored the soil microbial activity and the cellulose decomposition. According to MUNIER-LAMY & BORDER (2000), the loss of weight of cellulose corresponded to the consumption, by the soil

microbial, of available carbon. In addition, the was not negative effects of tannery sludge, applied in low rates, on soil microorganisms. On the other hands, the application of tannery sludge in high rates shows as inhibitory effect on cellulose decomposition.

The ratios of the cellulose decomposition rate in soil samples treated with tannery sludge (Mg ha^{-1}) to that in the control untreated soil (0 Mg ha^{-1}) are given in Table 1. After thirty days of incubation the cellulose decomposition rate, corresponding to application of 11, 22 and 44 Mg ha^{-1} were higher than soil untreated (control), respectively 5%, 20% and 10%, but the difference was only significant for the 22 Mg ha^{-1}. On the other hand, there was a significant decrease of 50% in the cellulose decomposition, compared to untreated soil (control), with application of 172 Mg ha^{-1} of tannery sludge.

The decrease of cellulose decomposition is due, probably, the reduction in the number of fungi and a concomitant rise in the number of heterotrophic bacteria (ANDERSON et al., 1981) and decrease in fungal population could be directly caused by the tannery sludge applied in high rates. Although in our experiment, the number of fungal and bacteria were not evaluated.

In this paper, tannery sludge had significant effect on the cellulose decomposition when applied at eight-fold the initial rates. Others studies observed a depression of the mineralization of cellulose with application on fungicides at ten-fold the recommended rates of field application, but the inhibition is temporary and associated with the effect on cellulolityc fungi (ATLAS et al., 1978; ELMHOT & HELWEG, 1991).

This study has demonstrated that cellulolytic activities are susceptible to be inhibited by high rates of tannery sludge. When applied to low amounts, tannery sludge did not affect cellulose decomposition by the soil microflora.

Table 1. Ratios of the cellulose decomposition rate in soil samples treated with tannery sludge (Mg ha^{-1}), R_t, to that in the control untreated soil (0 Mg ha^{-1}), R_0.

Rate of tannery sludge (Mg ha^{-1})	R_t / R_0
0	1.0 b
11	1.05 b
22	1.2 a
44	1.1 b
88	0.9 b
172	0.5 c

Means followed by the same letter do not differ statistically (P<0.05) from each other, according to Duncan's Test.

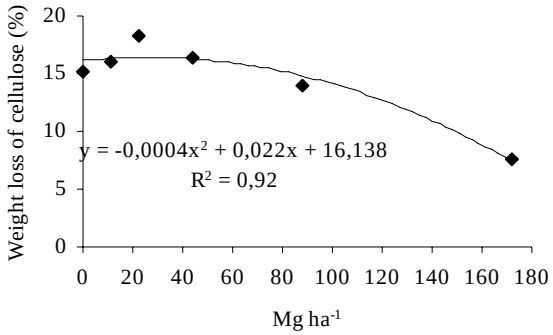

Figure 1. Effect of different rates of tannery sludge on the cellulose decomposition estimated from the weight loss of cellulose filter disks buried in a soil.

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