

SOIL AMENDMENT WITH SEWAGE SLUDGE AND ITS IMPACT ON SOIL MICROFLORA

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ABSTRACT

The objective of this work was to verify the effect of frequent sludge soil amendments on the soil's activity and microbial biomass C. Results showed that the use of excessive sludge doses could be detrimental to the soil's microflora.

Key words: microorganisms, nitrogen, biosolid.

INTRODUCTION

The utilization of sewage sludge in agricultural fields is gaining popularity as a means of waste disposal. This organic material can enhance soil productivity as a consequence of its high organic matter and plant nutrient contents. At the same time, sewage sludge could pose a risk to the ecosystem because of the presence of heavy metals and toxic organics (4). The aim of this work was to evaluate the effects of urban sewage sludge application on the soil's activity and microbial biomass C.

MATERIALS AND METHODS

The experimental site was located in Jaguariúna, State of São Paulo, Brazil on a loamy/clayey-textured Dark Red Dystroferic Oxisol cultivated with maize. The first sludge application was made in April, 1999. The second was made in December, 1999 and the third in October, 2000. The soil's chemical characteristics measured at the beginning of the experiment were: pH H₂O 5.8, OM 2.55%, P 3.5 mg dm⁻³, K 1.51, Ca 27.5, Mg 8.5, Al 1.0, H 35, CEC 73.5 mmol_c dm⁻³ and V 50.8 %. The sludge utilized was an anaerobic sludge from Barueri, State of São Paulo (Table I). The evaluations described in this paper were performed on the first and third cultivations.

The experiment was set up as a completely randomized block design with three replications and the following treatments: control without fertilization or sludge (C), chemical fertilization (CF), sludge dose 1 (1N), sludge dose 2 (2N), sludge dose 3 (4N), and sludge dose 4 (8N). Dose 1 was calculated based on the N content in the sewage sludge and on the amount of N recommended for maize fertilization. Doses 2, 3 and 4 were, respectively, two, four and eight times dose 1. The sludge was always uniformly distributed on the soil surface and rototilled to a 20-cm depth. The first soil evaluation, in April, 1999, was done 14 days after sludge incorporation (DASI), the second 13 days after the first and then at twenty-one-day intervals until 152 DASI. Microbial biomass C (C_{mic}), (5) and the metabolic quotient (*q*CO₂) were measured during this cultivation. The first evaluation was done 7 days before sludge incorporation, in November, 2000. The second was done six DASI and then at twenty-one-day intervals until 132 DASI. The following parameters were measured: microbial biomass C and dehydrogenase activity (1). Four samples per plot were taken in each sampling period at a depth between 0–20 cm; samples were then combined to form a single compound sample.

RESULTS AND DISCUSSION

In April, 1999, the C_{mic} differences in the control treatment, relative to the other treatments, were dependent upon the

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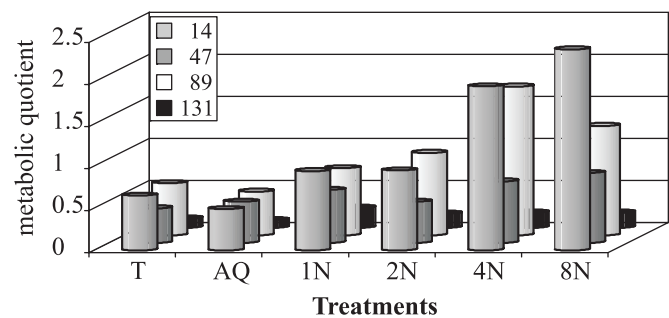
Table 1. Analysis of sewage sludge added to the soil.

Parameter	Unit	First cultivation	Second cultivation	Third cultivation
pH		6.6	6.4	6.4
Nitrogen Kjeldahl	g kg ⁻¹	26.0	26.4	38.5
N-ammoniacal	mg kg ⁻¹	1,566.9	156	2,401.0
Phosphorus	g kg ⁻¹	15.9	31.2	26.9
Magnesium	g kg ⁻¹	3.0	3.7	4.5
Calcium	g kg ⁻¹	40.3	22.8	47.8
Copper	mg kg ⁻¹	1058	1046	953
Nickel	mg kg ⁻¹	518.4	483	605.8
Lead	mg kg ⁻¹	364.4	233	348.9
Cadmium	mg kg ⁻¹	12.8	9.5	9.4
Zinc	mg kg ⁻¹	2821	3335	3372

season in which the evaluation was performed (Table 1). Except for the evaluation performed 68 DASI, the presence of sewage sludge in the soil did not seem to affect Cmic; in this evaluation, plots containing sludge showed a greater amount of biomass, possibly because of the formation of microsites with higher moisture contents formed by the compost; no differences were observed between doses. In the first 27 DASI, the lower Cmic values obtained in the control could be due to the lower degree of initial rooting, because no differences were observed later between treatments. The decrease in Cmic in the last evaluation could also be associated with the low soil moisture content in that season.

In this same year, the high qCO_2 obtained on the treatments with the highest sludge doses suggest a microbial biomass with high energy requirements (Fig. 1). Although a high qCO_2 is common in communities at the initial stages of development and in communities with a large ratio of active to dormant biomass (2) it can also mean a metabolic stress (3).

In October 2000, based on the evaluation made 10 days before sludge application to the soil, it was verified that, in spite of the two previous compost applications, there was no Cmic effect between the different treatments. At 6 DASI there was an unexplainable decrease in Cmic for all

**Figure 1.** Metabolic quotient ($\mu\text{g CO}_2\text{-C}$ evolved in 10 days g^{-1} soil/ $\mu\text{g biomass C g}^{-1}$ soil) in a soil amended with different sludge doses.**Table 2.** Microbial biomass C ($\mu\text{g C g}^{-1}$ soil) in a soil amended with different sludge doses.

Treatments ¹	Days after soil sludge incorporation (April, 1999)							
	14	27	47	68	89	110	131	152
C	61.35	121.97	204.40	123.71	210.87	191.77	217.5	148.23
CF	136.88	160.30	208.21	122.02	210.45	211.16	248.58	131.75
1N	106.58	157.66	191.95	176.27	207.67	216.11	260.78	137.76
2N	133.87	186.11	226.47	185.12	180.37	242.86	240.09	177.37
4N	93.41	148.79	229.50	163.38	202.58	217.21	244.17	148.08
8N	139.19	194.39	207.91	190.93	221.83	-	275.48	107.33
DMS								

Treatments ¹	Days after soil sludge incorporation (October, 2000)							
	BI ²	6	27	48	69	90	111	132
C	164.47	115.29	177.99	178.48	166.75	107.66	141.44	134.31
CF	186.75	92.97	201.92	172.01	227.16	128.12	115.90	101.67
1N	181.37	86.16	225.37	204.33	178.99	96.14	120.03	119.76
2N	202.74	91.04	236.60	254.27	210.17	138.69	207.12	143.32
4N	192.54	59.34	243.58	182.75	230.44	157.41	173.24	152.11
8N	171.54	72.19	259.55	231.57	287.02	153.14	200.58	163.07
DMS								

¹T, control; CF, chemical fertilization; 1N, sludge dose 1; 2N, sludge dose 2; 4N, sludge dose 3; 8N, sludge dose 4; ²BI, measurement made 7 days before sludge incorporation.

treatments. In this cultivation season, contrary to what had occurred in 1999, from 27 to 111 DASI there was a trend toward obtaining a smaller C_{mic} value in the control treatment and higher C_{mic} values in the two highest sludge doses. Considering, however, the magnitude of the difference in terms of C organic addition to the soil, in the two highest sludge doses relative to the control treatment, we can conclude that the addition of excessive sludge doses to the soil could be somehow detrimental to the soil's microflora. This hypothesis is backed up by soil dehydrogenase activity data, in which a tendency to obtaining smaller values at the higher sludge doses was verified (Table 3).

Table 3. Dehydrogenase activity (TPF per dry weight; $\mu\text{g g}^{-1}$) in a soil amended with different sludge doses.

Treatments ¹	Days after soil sludge incorporation						
	6	27	48	69	90	111	132
C	2.14	3.84	5.53	9.19	9.24	9.63	11.65
CF	1.66	2.04	4.32	11.57	11.98	12.62	8.07
1N	3.15	4.89	4.60	13.41	13.07	9.97	11.93
2N	3.70	4.88	5.40	14.73	14.21	12.74	11.82
4N	3.30	2.49	3.99	10.81	12.07	7.88	10.60
8N	2.43	3.41	3.51	9.64	5.94	8.43	8.25
DMS							

¹For abbreviations see Table 2.

RESUMO

Adubação do solo com lodo de esgoto e seu impacto na microflora do solo

O objetivo deste trabalho foi verificar o efeito de freqüentes aplicações de lodo ao solo na atividade e no C da biomassa microbiana. Os resultados demonstraram que a utilização de doses excessivas de lodo pode prejudicar a microflora do solo.

Palavras-chave: microrganismos, nitrogênio, biossólido.

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