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DETERMINATION OF RELEVANT QUALITY CRITERIA TO PREDICT C AND N MINERALISATION OF SEWAGE SLUDGES IN SOIL

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INTRODUCTION

One way to eliminate urban and agro-industrial sewage sludges is the recycling in agriculture, provided that they are innocuous for health and environment. Another major issue is their fertiliser value that can be profitable for the farmers using those wastes. This study is a part of a research programme whose aim is to understand and predict C and N mineralisation of agro-industrial and urban wastes in soil. One of our aim is to identify relevant composition criteria which influence C and N biotransformations of wastes in soil.

MATERIALS AND METHODS

Five agro-industrial (B1, B2, B3, B22, B23) and 12 urban (B5 to B11, B14 to B17, B24) sewage sludge were sampled in various French sewage treatment plants.

Soil incubations

Soil incubations in controlled conditions were carried out using a highly calcareous. The sludges were incorporated into the soil, and inorganic N was added to the mixture to avoid N soil limitation of residue decomposition. A treatment without residue was included as a control soil. For incubation, soil moisture and temperature were respectively fixed to 240 g kg^{-1} soil and 28°C. During 6 months, CO_2 emissions and inorganic N soil contents were measured at different dates.

Analytical determinations

Inorganic and organic C and N sludge contents were determined. Biochemical fractionation were performed using 3 different methods: solubility in water at 20 and 100°C temperatures (AFNOR, 1988), solubility in acid (Bremner, 1965), Van Soest fractionation procedure (1963). C and N contents were determined for each fraction obtained with the different methods.

Statistical analyses

Correlation and multiple linear regressions were performed with SAS Software (SAS Institute, 1987) to establish relationships between incubation results and sludge composition criteria.

RESULTS

Sewage sludge composition

The composition of the sewage sludge varied and was largely influenced by the origin and

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process. Organic N content ranged from 10.6 to 80.1 g kg^{-1} d.m., and organic C:N ratio from 5.0 to 18.8. Different proportions of C and N forms in the residues were revealed by the 3 fractionation procedures.

Carbon mineralisation
C mineralisation varied in great proportions. Initial decomposition rate (14 d) was linked to N of the ADL fraction and the C:N ratio of the NDF fraction (Van Soest method), acid soluble and non distillable N, and acid insoluble N ($p=0.05$). Multiple linear regression analysis allowed to develop models expressing the decomposition rates in function of several sludge characteristics.

Nitrogen mineralisation
Amounts and kinetics of N mineralisation from sludge were extremely variable. Net N mineralisation rates (14 d and 168 d) were strongly linked with the organic C:N ratio of sludge ($p=0.01$). Multiple regression analysis showed that net N mineralisation from sludges were related to organic C:N ratio and water soluble C (14d), organic C:N ratio and N in ADL fraction (168 d).

CONCLUSION

Our work showed that C and N mineralisation of sewage sludge in soil was related to some quality criteria such as simple analytical determinations or C and N present in fractions defined by biochemical fractionation procedures. These identified criteria will be then taken into account in decomposition models to simulate the fate of C and N after incorporation of wastes in soil.