Microbial Activity and Nitrogen Mineralization in a Soil Treated with Silage Effluent

J. E. Cooper

Agricultural and Food Bacteriology Department Queen's University of Belfast, and Department of Agriculture, Newforge Lane, Belfast BT9 5PX, Northern Ireland

INTRODUCTION

Amongst effluents produced on farms, the liquid which flows from ensiled grass is potentially the most serious pollutant. It is an acidic fluid with a high concentration of lactic and acetic acids and soluble carbohydrates. BOD levels may be as high as 70,000 ppm and the discharge of even small volumes into water courses can cause severe oxygen depletion. For this reason, the effluent must be collected and stored, and careful consideration given to methods of disposal.

If the pollution load of the material can be reduced by the activities of the soil microflora then land spreading is the simplest means of disposal. Grassland would be suitable provided the effluent is diluted sufficiently to prevent scorching of the vegetation. Since silage effluent contains roughly the same amounts of N, P and K as some animal slurries, land spreading has the advantage of providing nutrients for plant growth. In contrast to animal slurries, however, most of the nitrogen in silage effluent is in the organic form, and crop response to applications will be largely dependent on the speed with which it is mineralized.

This paper describes an experiment designed to determine changes in microbial activity and the pattern of nitrogen mineralization in a soil treated with diluted silage effluent.

MATERIALS AND METHODS

A medium loam soil (pH 5.8) of grassland origin was chosen for the experiment, and was air-dried and sieved to pass a 2 mm screen before use. Effluent was collected from autumn-ensiled grass at Greenmount Agricultural College, Co Antrim, and diluted, two-fold, with deionised water. This was added to 10 g portions of soil in 125 ml medical flats so as to bring the soil almost to field capacity. Controls, using deionised water instead of effluent, were included and the moist soil was spread in a thin layer on the flat sides of the bottles. Bottles were incubated in a humidity cabinet (95% RH) at 27°C with loosely fitted metal caps drilled with an ⅛" central hole. Enough bottles were prepared to allow duplicates of both treatments to be sampled

Bulletin of Environmental Contamination & Toxicology, Vol. 18, No. 1 © 1977 by Springer-Verlag New York Inc.

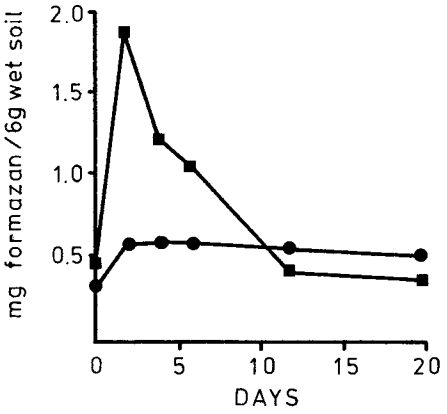

Fig.1. Formazan production from the reduction of 2,3,5-triphenyltetrazolium chloride by dehydrogenase in effluent-treated (■——■) and control (●——●) soil.

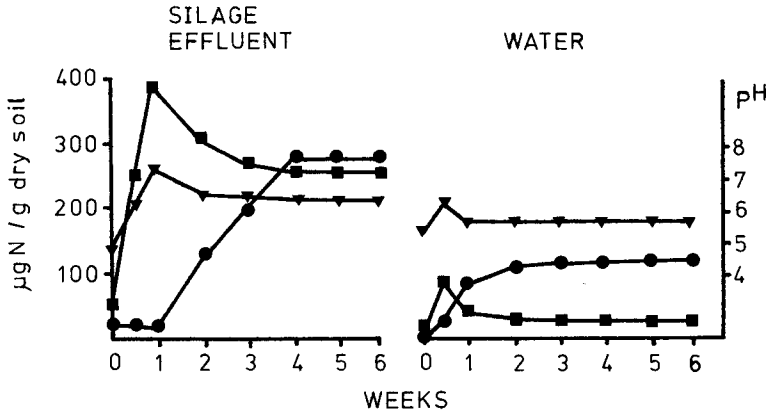

Fig.2. Nitrogen mineralization and pH changes in effluent-treated and control soil during a 6 week incubation.

■——■ NH_4^+-N; ●——● NO_3^--N;

▼——▼ pH.

weekly for mineral-N content and pH status over a period of 6 weeks. To determine mineral-N content, soil was shaken for 1 h in a 1:10 soil, 2N-KCl suspension followed by filtration through Whatman No 42 paper. Filtrates were analysed for NH_4-, NO_2- and NO_3-N using a MgO-Devarda alloy method (BREMNER and KEENEY 1965). All pH measurements were made with a glass electrode in a 1:3 suspension of soil in deionised water.

Microbial activity in both treatments was estimated by dehydrogenase assay, using the method of CASIDA et al (1964). For this purpose a further series of bottles was prepared to allow more frequent sampling during the first 20 days of the incubation period.

RESULTS AND DISCUSSION

Dehydrogenase activity in both treatments is shown in Fig 1. The increase in activity in the first 2 days is characteristic of the response shown by air-dried soils on remoistening (STEVENSON 1956) and the peak dehydrogenase activity measured in the effluent-treated soil was similar to that detected by CASIDA et al (1964) in a soil amended with a readily metabolised mixture of ammonium nitrate and dextrose. No evidence of an inhibitory effect was detected and the results suggest that the soil microflora can quickly degrade the organic components of silage effluent.

Mineral-N and pH changes in both treatments are presented in Fig 2. Mineralization of organic nitrogen was rapid in the effluent-treated soil but nitrification was delayed, most likely, by the initial drop in pH of the soil. After 4 weeks, nitrification ceased and the amounts of NH_4-N and NO_3-N remained steady for the remainder of the incubation. Only trace quantities of NO_2-N were detected in both treatments. The amount of mineral-N in the soil at the end of the experiment was greater than in the same soil incubated with a two-fold dilution of pig slurry (COOPER 1975) and also greater than in a soil incubated with digested sewage sludge at the rate of 2 ml sludge/10 g soil (PREMI and CORNFIELD 1969). Silage effluent, therefore, can provide as much nitrogen for plant uptake as other farm and domestic wastes which have been proposed as supplements or replacements for inorganic nitrogen fertilizers.

REFERENCES

BREMNER, J.M. and D.R. KEENEY: In BLACK, C.A., Ed. Methods of soil analysis, part 2. American Society of Agronomy, Madison. 1195 (1965).

CASIDA. L.E., D.A. KLEIN and T. SANTORO: Soil Sci. 98, 371 (1964).

COOPER, J.E.: Soil Biol. Biochem. 7, 119 (1975).

PREMI, P.R. and A.H. CORNFIELD: Soil Biol. Biochem. 1, 1 (1969).

STEVENSON, I.L.: Pl.Soil 8, 170 (1956).