Nitrogen mineralisation potential in two typical soils of Thessaly in central Greece amended with sewage sludge

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INTRODUCTION

Sewage sludge (SS) contains appreciable amounts of nitrogen (N) and phosphorus (P) and may effectively replace equal amounts of of N and P fertilizers. Sludge application to soil also conserves organic matter and thus provides an alternative of a beneficial re-use of SS in agriculture, forestry or land reclamation instead of its disposal to dumps .

However, the application rate of sewage sludge to soil must be determined on the basis of crop N requirement to avoid potential hazards associated with excessive release of NO_3 in soil. Since about 50–90% of the N in SS is in organic form, it is necessary to know the rate of N mineralisation in order to predict N availability during a crop season. Assessment of the relative amounts of N that will become available when SS are applied to soil will allow use of these materials in a more efficient and economical way, and minimize potential NO_3 losses to groundwater (Smith 1996). The objectives of this study were to determine the influence of soil type and sewage sludge application rate on the rate and extent of N mineralisation in soils amended with sewage sludge, and to estimate the potential mineralized N (N_0) and the mineralization rate constant (k), by using the reference method of Stanford and Smith (1972).

MATERIAL AND METHODS

Two representative soils of Thessaly plain in central Greece, classified as Typic Xerofluvents were selected: one Clay Loamy and the other Clayey, were mixed with SS of the municipality of the city of Larissa at rates of 0, 8000 kg/ha (SLA) and 10000 kg/ha (SLB) (dry weights). Control and amended soils were placed in plastic tubes for incubation in a controlled incubation chamber. The samples were incubated aerobically under a non-leached procedure for 30 weeks at 35 ^{0}C. The soil moisture content was maintained at 60% of field capacity. Mineralised N (NO_3- and NH_4^+) was determined at the starting of the experiment and after 2, 4, 8, 14, 18,24 and 30 weeks of incubation.

RESULTS AND DISCUSION

After 30 weeks of incubation the clayey soil produced 33% more mineral nitrogen than clay loamy soil with no sludge amended. In contrast, amended clay loamy soil produced 28% - 30% more mineral nitrogen than clayey soil for the low and high rate respectively. The incorporation of sewage sludge into the soils resulted in an immediate increase in inorganic nitrogen. Total increases in soil inorganic N ranged from 119,3 mg/kg (SLA) to 252 mg/kg (SLB) for the clay loamy soil and from 120,3 SLA to 205,6 SLB for the clayey soil. These increases were mainly due to the $N0_3$-N as the application of sewage sludge increased only slightly the content of ammonium–N in soil.

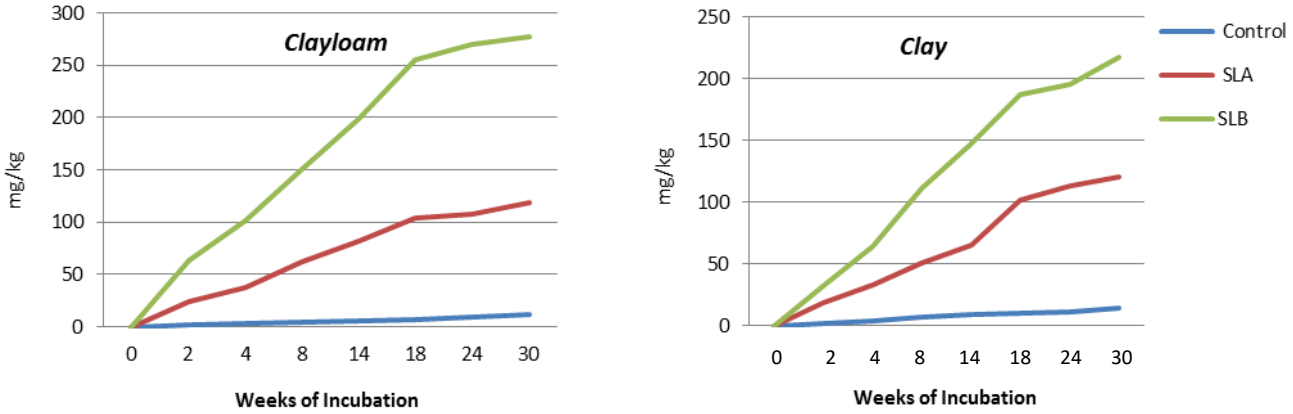

Figure 1. Accumulated mineral nitrogen produced in the 30 weeks of incubation

Potentially mineralized nitrogen (No) and rate constant (k) for sludge organic nitrogen mineralization were estimated by the non linear regression mathematical model described by Stanford and Smith (1972). In the clay loamy soil, No increased from 16,39 mg/kg to 126,70 mg/kg and 296,62 mg/kg for SLA and SLB respectively. Sewage sludge application in the clay loamy soil increased No from 16,18 mg/kg to 150,5 mg/kg and 236,5 mg/kg for SLA and SLB respectively. The rate constant k was affected by the application rate of SS and the type of soil. N_0 and K values were greater for clay loamy soil only for the SLA application rate indicating that a higher proportion of N from aerobically digested sludge could be transformed into inorganic forms and at higher rates for this soil compared to the clayey soil. In contrast SLB application rate revealed greater N_0 and K values for clayey soil.

CONCLUSIONS

From the data obtained in this study, it can be concluded that net sludge organic N mineralisation in sewage sludge- treated soils, is highly dependent on the type of the soil and the SS application rate. In the soils studied with SS application accumulated much more inorganic nitrogen than the unamended soils, confirming the fertilising value of sludges. Mineralisation of organic N form SS however, has to be seriously considered when determining the annual amount of sewage sludge to be applied to agricultural soils.

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