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Nitrogen Release from Slow-Release Fertilizers in Soils with different Microbial Activity

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ABSTRACT

Soil microbial activity is recognized as an important factor affecting nitrogen release from slow-release fertilizers. However, studies on the effect of size and activity of soil microflora on fertilizers degradation provided contrasting results. To date, no clear relationships exist between soil microbial activity and the release of nitrogen from slow-release fertilizers. Hence, the aim of this study was to better understand such relationships by determining the release of nitrogen from three slow-release fertilizers in soils with different microbial activity. Soils were amended with Urea-formaldehyde, Isobutylidene diurea, Crotonylidene diurea. Urea, a soluble fertilizer, was used as positive control. Fertilized soil samples were placed in a leaching system and the release of nitrogen was determined by measuring ammonium-N and nitrate-N concentrations in the leachates during 90 days of incubation. Non-linear regression was used to fit nitrogen leaching rate to a first-order model by non-linear regression. In all the treated soils, nitrogen was released according to the order Urea (89-100%) > IBDU (59-94%)> UF (46-73%) > CDU (44-56%). At the end of incubation, nitrogen released from CDU did not differ ($p>0.05$) among soils. On the contrary, Urea-formaldehyde and Isobutylidene diurea released lower ($p<0.05$) amounts of nitrogen in the soil with the higher microbial activity and lower pH. The rate constant (K_0) for UF was lower ($p<0.05$) in the soil with the lower pH. Taken together, our results indicate . that the size and the microbial activity of the soils used had a marginal effect on fertilizers mineralization.

Keywords: slow-release fertilizers, nitrogen release, soil microbial activity, soil nitrogen, Urea-formaldehyde.

INTRODUCTION

Slow-release fertilizers (SRFs) are condensation products obtained by reacting urea, the most common mineral fertilizer characterized by a high nitrogen (N) content and a relatively low cost, with several aldehydes. These SRF-N-fertilizers release N at slower rates compared to conventional N-fertilizers such as urea (that release N rapidly from urea hydrolysis), thus in theory facilitates better N uptake and utilization by crop plants. Therefore, potential benefits from SRFs include improved nitrogen use efficiency (NUE), reduction of volatilization loss and nitrate leaching, availability of N during plant growing season, and reduced costs of application (i.e. multiple-applications of conventional N-fertilizers *vs* single-time application of SRFs) (Allen, 1986). Among SRFs, Urea-formaldehyde (UF), Isobutylidene diurea (IBDU) and Crotonylidene diurea (CDU) have gained attention (Trenkel, 1997). Urea-formaldehyde is obtained by reacting urea with formaldehyde and consists in a mixture of chain polymers with different lengths. The degradation and subsequent N release from UF is driven by the size and activity of soil microflora (Alexander and Helm, 1990) and by those factors that influence the microbial activity, like soil moisture and temperature. Crotonylidene diurea, a ring-structured compound, is produced by condensation of urea with acetic aldehyde. Both the microbial activity and the hydrolysis driven the degradation of this fertilizer. Thus, soil moisture,

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