From Forest Nursery Notes, Winter 2011

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Nitrogen Release from Slow-Release Fertilizers as Affected by Soil Type and Temperature

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Loss of N from fertilized agricultural soils is a serious problem that can negatively affect environmental quality. Nitrogen loss can be moderated by using slow-release fertilizer (SRF) products (e.g., those created through condensation of urea and formaldehyde) in place of 100% water-soluble N. Release of N from SRFs is affected by the soil environment. To evaluate soil effects on N release, we conducted an incubation study in which temperature and soil type were varied. Four SRFs were studied: liquid Nitamin 30L (L30), liquid Nitamin RUAG 521G30 (G30), granular Nitamin 42G (N42) (all from Georgia Pacific Chemicals, Decatur, GA), and granular Nitroform (NF) (Agrium Advanced Technologies, Loveland, CO). The fertilizers were incubated for 78 d at 20, 25, and 30°C in a sandy soil and at 25°C in a loamy soil. Differential N release kinetics of the N sources were determined by measuring NH_4–N and NO_3–N concentrations throughout the incubation. Net N released as a percentage of total N in the fertilizer was significantly affected by N source, temperature, time, and soil type. Increasing temperature increased net N release. The N release rate decreased in the order N42 > G30 > L30 > NF in the sandy soil and G30 > N42 > L30 > NF in the loamy soil. Overall, the release rates of these fertilizers were greater in the loamy soil. The N release characteristics determined in this study can help in the selection of the appropriate SRF source for crops grown under different soil and climatic conditions to improve N use efficiency and minimize N loss to the environment.

Abbreviations: G30, Nitamin RUAG 52 G30; L30, Nitamin 30L; MU, methylene urea; N42, Nitamin 42G; NF, Nitroform; SRF, slow-release fertilizer.

Increasing N fertilizer use efficiency and preventing fertilizer N loss to the environment are important goals of agronomic nutrient management and environmental protection. A SRF containing the urea-formaldehyde class ("ureaforms") of slowly available N may help achieve efficient N management and reduce the environmental impacts of fertilizer use (Aarnio and Martikainen, 1995). For example, when the proportion of ureaform in N fertilizer applied to flooded rice (*Oryza sativa* L.) was increased, crop uptake of N increased and losses of N from the soil decreased (Carter et al., 1986). Ureaform is manufactured by reacting formaldehyde with excess urea under controlled conditions (pH, temperature, molar proportions, reaction time, etc.), which yields a mixture of methylene ureas (MUs) comprising different long-chain and ring polymers. Ureaform-based products are important because of all the SRFs used worldwide, they occupy the largest market share. The estimated use of MUs is about 0.22 million Mg yr^{-1}, and most of it is used in the United States, western Europe, and Japan. Moreover, MU use is projected to increase in the future (Trenkel, 1997). The potential benefits from using MUs as N fertilizers include increased efficiency of N use by plants, reduced N volatilization, reduced leaching losses, and prolonged availability of N throughout the growing season (Alexander and Helm, 1990).

The rate of available N release from ureaform is related mainly to the proportion of the different MUs in the mixture and the length of the polymer chain and its solubility (Trenkel, 1997; Shaviv, 2001). The main requirement in the

Soil Sci. Soc. Am. J. 74:1635–1641
Published online 3 Aug. 2010.
doi:10.2136/sssaj2008.0363
Received 29 Oct. 2008.
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