IFA International Workshop on Enhanced-Efficiency Fertilizers
Frankfurt, Germany, 28-30 June 2005

SLOW-RELEASE FERTILIZERS AS TOOLS

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History

The roots of the modern fertilizer industries can be traced back to the earliest records of civilization and the development of agricultural practices (Nelson 1990). Organic farming by the Greeks and Romans in B.C. is documented; however, early civilizations lacked a scientific understanding of plant nutrition. There is clear documentation in the 11th and 12th centuries in European agriculture describing the use of animal manures and waste products. A lack of knowledge in the areas of chemistry and plant physiology delayed real progress in the development of fertilizers. Alchemists in the sixteen-hundreds provided some accomplishments that proved useful in the development of the fertilizer industry. Simple plant experiments combined with by-products of general chemistry experiments contributed to significant advancements in the sixteen- and seventeen hundreds. In the early to mid-eighteen hundreds use of bones, nitrate of soda, sulfate of ammonia and guano were common. In 1852 the first field experiments with fertilizers were established at the Rothamsted Experiment Station. In the U.S., the Morrill Act of 1862 that established a system of agricultural colleges, made a huge impact on plant nutrition research in the U.S.. Significant development in the later half of the 1900's on a large number of slow- or controlled-release fertilizers has expanded and improved the efficient use of fertilizers worldwide. Overall, the modern fertilizer industry has been successful in achieving its overall goal.

Goal of the fertilizer industry?

What is, or should be, the overall goal of the global fertilizer industry? A likely goal is to provide optimum levels of nutrients that match a plant's needs. An alternative version of this goal is to match the kinetics of nutrient release with the kinetics of plant growth. Rarely do we discuss our goal in terms of kinetics, but both plant growth or plant nutrient uptake and nutrient release by fertilizers can be described by kinetics.

Soluble and slow-release fertilizer sources are quite different. Nutrient release from soluble sources is simply 'controlled' by application methods or manipulation of post-nutrient release by various methods. A major justification for developing and using slow- or controlled-release fertilizers is to provide a reduction in nutrient loss, reduced application frequency, and more uniform plant growth. There are a number of excellent reviews on the many types of slow-release (SR) or controlled-release (CR) fertilizers (_____ 1979, Goertz 1993, Landels et 1990, Maynard and Lorenz 1979).

Definition of CR/SR

A problem exists in that there is no worldwide standard definition of slow- or controlled-release fertilizers. Both the International Fertilizer Association (IFA) and the Association of American Plant Food Control Officials (AAPFCO) have valid definitions for these fertilizer terms. However, they are not identical.

Challenges to achieving fertilizer industry goal

The global fertilizer industry faces a number of significant challenges in achieving their goal of providing optimum levels of nutrients that match a plant's needs. The first challenge is that we are dealing with an extremely large number of different plants that likely have different needs for nutrients in terms of specific nutrients and the quantity and timing of nutrients. While it is easy to measure or describe actual root or shoot growth, it is more important to understand the actual nutrient uptake by plants. Far less research has been conducted on the actual uptake (timing and quantity) of nutrients by different plants (Cabrera et al. 1995, Hershey and Paul 1983). A second challenge in achieving this goal is the immense impact of the environment on the release and potential availability of nutrients released by fertilizers (Mosier et al. 2002). Interaction of the nutrients with their environment has a significant impact on the ultimate Fertilizer Use Efficiency (FUE) (Craig 2003, Rose 1999, Thomson 1990). The third challenge relates to the complex nuances of the various technologies themselves (Husby 2003). For example, with most coated fertilizers, individual nutrients are not released at the same rate (Hanafi 2002, Mickler and Ruter 2003).

Fertilizers as tools

Even accepting all of the challenges, the global fertilizer industry has made significant advances in the development of CR/SR fertilizers for practical use in agriculture. This arsenal of CR/SR materials should be viewed as management 'tools'. Having a clear understanding of how nutrient release kinetics are influenced by such factors as temperature, moisture, microbes, pH, and particle size, can help agricultural producers make a more educated match of the right SR/CR fertilizer 'tool' to their specific crop situation (Harada 1995).

_____. 1979. Organic Nitrogen Compounds for use as Fertilizers. Intern. Fert. Devel. Cntr.

Cabrera, R.I., et al. 1995. Nitrogen Partitioning in Rose Plants Over a Flowering Cycle. Scientia Hort. 63: 67-76.

Craig, J.L. et al. 2003. Nutrient Uptake and Dry Weight Patterns of Three Container-grown Woody Species. J. Environ. Hort. 21: 209-215.

Goertz, H.M. 1993. Controlled-release Technology. In: Kirk-Othmer Encyclopedia of Chemical Technology, 4th ed.. pp. 251-274.

Hanafi, M.M. et al. 2002. Evaluation of Controlled-release Compound Fertilizers in Soil. Comm. Soil Sci. Plant Anal. 33:1139-1156.

Harada, G. 1995. Nitrogen Fertilization: Slow Release Nitrogen Fertilizers. Turf Tales Mag. Summer. Pp. 4-9.

Hershey, D.R. and J.L. Paul. 1983. Ion Absorption by a Woody Plant with Episodic Growth. HortScience 18: 357-359.

Husby, C.E. et al. 2003. Influence of Diurnal Temperature on Nutrient Release Patterns of Three Polymer-coated Fertilizers. HortSci. 38:387-389.

Landels, S.P., A. Leder, and N. Takei. 1990. CEH Marketing Research Report: Controlled Release Fertilizers.

Maynard, D.N. and O.A. Lorenz. 1979. Controlled-release Fertilizers for Horticultural Crops. In: Horticultural Reviews, Vol. 1, AVI Publ., Westport, CT, pp. 79-140.

Mickler, K.D. and J.M. Ruter. 2003. Slow-release Comparisons. NM Pro. 19(3): 51.

Mosier, A.R. et al. 2002. Managing Soil Denitrification. J. Soil Water Conserv. 57:505-513.

Nelson, L.W. 1990. History of the U.S. Fertilizer Industry. Tenn. Valley Authority.

Rose, M.A. 1999. Nutrient Use Patterns in Woody Perennials: Implications for Increasing Fertilizer Efficiency in Field-grown and Landscape Ornamentals. HortTechn. 9:613-617.

Thomson, T.W. 1990. Fertilizer Use Efficiency of Container-grown Junipers. M.S. thesis. Oregon State University.