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Plant Nutrition TODAY
Better Crops, Better Environment...through Science

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HIGHER EFFICIENCY FERTILIZERS, HOW THEY WORK AND COULD YOU REDUCE FERTILIZER RATES IF AN INCREASED EFFICIENCY FERTILIZER IS USED?

There is much discussion about increasing the efficiency of fertilizers. It is useful to understand what is meant by efficiency. The main meaning is that fertilizer use by the target crop is improved and results in improved crop yields and/or quality of the harvested portion of the crop. Another important meaning is that lower amounts of nutrients are lost from the plant-soil system. Loss means that nutrients from applied fertilizers are released into water, air, or soil out of reach by crop plants. Nutrients stored in crop residue and soil within rooting depth of crop plants is not considered lost but is largely available for future crop use. Of the three primary fertilizer nutrients, N is most subject to potential losses. Phosphorus losses are comparatively lower than N losses, but are still of concern environmentally. Potassium losses are minimal and tend to be of little concern environmentally.

Increased efficiency fertilizers are formulated in three main ways. The first is to apply a physical coating with controlled release properties so the nutrients are released over time based on temperature and soil moisture content. The second way is to supply nutrients in a less soluble form that needs to be converted chemically or biologically over to a more soluble and available form. This is not a controlled release, but is more accurately called a delayed release. The third way is to add an inhibitor product that blocks or at least delays the action of biochemical or biological processes that transform a fertilizer product into a form more susceptible to losses. Whether the fertilizers are controlled release, delayed release, or treated with an inhibitor, the nutrients are less soluble and available initially compared to regular soluble fertilizers. Hopefully, the nutrients become available in time and quantity to satisfy crop needs while decreasing potential losses before crop use.

Nitrogen can be lost from a field through ammonia (NH_3) volatilization, leaching of nitrate (NO_3^-) into groundwater, and gaseous emissions of nitrous oxide (N_2O) and di-nitrogen (N_2). Ammonia is a gaseous form of N that can float into and mix with the air, then be carried downwind. It can originate from crop residues relatively high in protein as they begin to decompose on the soil surface, or hydrolysis of urea (splitting of the urea molecule into CO_2 and NH_3), contained in urea fertilizer or livestock manures, that are applied to field surfaces. The hydrolysis of urea is facilitated by the action of the urease enzyme present in soils, and crop vegetation and residues. This loss process is delayed and reduced by treating urea-containing fertilizers (e.g. 46-0-0) with a **urease inhibitor.** Leaching of N occurs when NO_3^- ions dissolved in water move downward and out of the rooting zone of crops in the soil, with the saturated flow of water. Both N_2O and/or N_2 gases are emitted from soils when oxidized N in the form of nitrite (NO_2^-) or NO_3^- are converted over to the N_2O or N_2 gases by soil bacteria experiencing low oxygen conditions due to wet soil conditions. Nitrous oxide is one of the atmospheric gases considered contributing to greenhouse gas warming of the earth. While N_2 is not a greenhouse gas, losses of N in this form still represent less efficient use of applied N fertilizer. Urea or other ammonium (NH_4^+) producing N fertilizers can be treated with **nitrification inhibitors** that keep the N in the ammonium form and prevent the stepwise conversion by certain soil bacteria from NH_4^+ to NO_2^- and finally to NO_3^-.

Rates of nutrients applied using increased efficiency fertilizer products should normally not be reduced unless there are actual reduced losses of nutrients to the surrounding environment. For example, an increased efficiency P fertilizer may help increase the uptake of this year's applied P into crop plants. However, if there are no significant changes in overall P losses from the crop-soil system, long-term P fertilizer rates should be maintained close to harvested crop P removal rates. If losses by NH_4^+ volatilization, leaching, or gaseous N_2O and N_2 emissions are actually reduced, the rate of N applied can probably be reduced proportionally.

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Abbreviations: N = nitrogen; P = phosphorus; K = potassium.

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