09. Controlled release fertilizers and reaction in soil - nitrification inhibitors – criteria and advantages

Controlled-Release Fertilizers Using Zeolites

The U.S. Geological Survey (USGS) has experimented with zeolites to help control the release of fertilizer nutrients in soil. The use of soluble fertilizers can lead to water pollution and to wasted nutrients. Nitrogen, for example, can leach into ground and surface waters, especially in sandy soils, and phosphate may become fixed and unavailable to plants, especially in tropical soils. Zeolites are porous minerals with high cation-exchange capacity that can help control the release of plant nutrients in agricultural systems. Zeolites can free soluble plant nutrients already in soil, and may improve soil fertility and water retention. Because zeolites are common, these unique minerals could be useful on a large-scale in agriculture.

Controlled-Release Nitrogen Fertilizer

Urea is one of the most common nitrogen fertilizers. It is very soluble in water, and can be leached through the root zone. In addition, urea is converted into ammonium ions by an enzyme found in most soils. Soil bacteria then convert these ammonium ions into readily leachable nitrate ions. Using zeolitic rocks in fertilizer can help prevent these nutrient losses.

Controlled-Release Phosphorous Fertilizers

Phosphate (H_2PO_4) can be released to plants from phosphate rock (P-rock) composed largely of the calcium phosphate mineral apatite by mixing the rock with zeolite having an exchange ion such as ammonium. The approximate reaction in soil solution is as follows: (P-rock) + (NH_4-zeolite) = (Ca-zeolite) + (NH_4^+) + ($H_2PO_4^-$).

The zeolite takes up Ca^{2+} from the phosphate rock, thereby releasing both phosphate and ammonium ions.

Growth responses to controlled-release fertilizers

Most controlled-release fertilizers are N-based, and most of the research involving them has evaluated plant responses to N application. Additionally, because most

controlled-release N sources cost several times more per pound of N than the soluble sources, most of the evaluation has been conducted on higher-cash-value crops such as ornamentals, vegetables, citrus and turfgrasses. Little research has been conducted on agronomic crops because their use in this sector is not considered economically feasible. Technologies currently under development may reduce the cost of controlled-release products to the point that they can be used on agronomic crops, but such is not yet the case.

Nitrification inhibitors

It should be non-toxic plants, soil microorganisms,animals,fish and mammals

It should block the conversion of NH_3 to $_{NO3}$ by inhibiting Nitrosomonas activity

It should not interfere with the transformation of NO_3 (nitrite) by Nitrobacter

It should be able to move with the fertilizer so that it will be distributed uniformly through the soil zone contacted by nitrogen fertilizer

It should be stable for the inhibitory action to last for an adequate period of time

It should be relatively in expensive, so that it can be used on a commercial scale

There are various nitrification inhibitors, of which N-Serve or nitrapyrin and AM are most important.

N-Serve- It is 2-choloro-6(trichloromethyl) pyridine and also referred to as nitrapyrin

AM- Chemically it is a substituted pyrimidine (2-amino-4-chloro-6- methyl pyrimidine)