

BENZOTRIAZOLES—BENEFICIAL NITRIFICATION INHIBITORS OR UNDESIRABLE SOIL AND WATER CONTAMINANTS?

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Abstract

Benzotriazoles (Bz) have been used as corrosion inhibitors for decades. The 4- and 5-methylbenzotriazoles (MeBz) are found in aircraft deicing fluids and antifreeze. Large quantities enter the environment, and recent needs for environmental impact statements require that pathways for their degradation be identified. The parent Bz is an effective nitrification inhibitor and recent work from India shows that it is effective in field settings in a warm climate. Delay of nitrification may be desirable in agriculture to optimize fertilizer use and reduce nitrate movement to groundwater, but undesirable in wastewater processes where excess ammonia is to be removed by sequential nitrification and denitrification. The inhibitory effect of Bz, MeBz, and two other derivatives, 5-chloro-Bz (CBz) and 1-OH-Bz (HBz), was tested over a four-week period for four agricultural soils treated with urea fertilizer. The HBz was ineffective, but the other three compounds significantly inhibited nitrification of 100 mg urea-N/kg soil when present at 10 mg/kg soil. The inhibitory capability depended on composition of the soil, primarily organic matter (O.M.) content. In sandy soil with only 0.3% O.M., inhibition of nitrification was about 90%; while in soil with 2.3% O.M. inhibition was only 20-30%. On a mass basis, Bz had the greatest effect; but considered on a molar basis, the extent of inhibition was comparable for the three effective compounds. Relative solution concentration as a function of soil organic matter was determined. The soil-solution concentration for 50% inhibition of nitrification is several hundred micromolar, but Bz is relatively low in price. A major concern is its environmental fate when repeatedly applied to soil, because Bz is inhibitory to plant growth at concentrations comparable to those that are effective as nitrification inhibitors.

Key words: benzotriazoles, nitrification inhibitors, organic matter content, sorption, urea