Fertilizer Nutrients--Where Do They Go?

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Introduction

Turf utilizes nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), zinc (Zn), manganese (Mn), iron (Fe), copper (Cu), boron (B), molybdenum (Mo) and chlorine (Cl). For many of these nutrients (S, Zn, Mn, Fe, Cu, B, Mo, and Cl), we neither worry about the source nor the fate since nature usually furnishes an adequate supply and we thus assume that there is no environmental impact for these nutrients from growing turf.

We may add K, Ca, and Mg frequently in turf management but again we have little concern about the fate of these nutrients because they are common in natural soils and waters hence the impact of some additional quantity from turf production (or other activities of man) will have little environmental impact.

In recent years, all who utilize N and P fertilizers have come under criticism for possibly contaminating the environment. This has included sod producers, golf courses managers and even home owners. Certainly commercial producers of agronomic and horticultural crops have also be criticized. To minimize the environmental impact of fertilizers it is necessary to understand their fate once applied to the soil and to develop best management practices to assure that a minimum of the fertilizer N and P are lost to the environment.

Phosphorus

From an environmental viewpoint, we are concerned about P because of surface water contamination and because of contamination of wetlands. Additions of P will increase the growth of biological organisms in either case and in addition has been suggested to alter species growing in wetlands. There is little concern about P moving to groundwater although considerable evidence exist showing movement of P to depths of 2 to 4 feet in soil profiles in heavily fertilized soils.

Fertilizer P that is added to the soil even if it is initially water soluble will partition strongly to the soil phase. In developing best management practices for fertilization with P we must realize that fertilizer applications are generally made to the soil surface and that P will accumulate at the soil surface. The greatest potential for P loss will then be by surface runoff.

Two things must be done to safely fertilize with P. First, soil test and follow the soil test recommendations. There is little evidence in Michigan of response to P for grass species if the soil test is above 20 pounds Bray Pl/acre and no evidence of a response if the test is above 50 pounds/acre. For most soils, if the soil test is less than 50 pounds per acre the level of P in solution is so low that movement of P into surface waters or wetlands is significant only if erosion of soil particles occurs. Secondly, one must prevent surface runoff to reduce erosion and transport of recently applied fertilizer P.

Nitrogen:

Environmentally we are concerned about N primarily because of groundwater contamination although we also are somewhat concerned about N loss to surface waters. It has been very easy to document nitrate levels in groundwater that exceed the drinking water standard of 10 mg N/liter in Michigan as well as in other areas of the United States. Petrovic (1989 and 1990) has done an excellent job in reviewing literature concerning the fate of N fertilizer applied to turf. Once N has been applied as fertilizer there are four possible fates: (1) incorporation into a living plant (turf), (2) incorporation into the soil mass (thatch and/or soil), (3) return to the atmosphere as a gaseous nitrogen compound, or (4) leaching from the rooting zone of the soil.

Studies have shown that between 25 and 99 percent of the N added as fertilizer is incorporated into the turf. This quantity is quite variable and depends upon a number of factors, for example species of grass, rate and perhaps time of application, and soil conditions.

From 36 to 47 % of N added in fertilizer has been reported to be stored in the soil and thatch. It is likely that this figure is only applicable to a short-term study. As nitrogen accumulates in the soil, more N will be released during the growing season from the soil and thatch which will then furnish some of the nitrogen for the turf.

Fertilizer N may be lost to the atmosphere by volatilization or by denitrification. It has been shown that up to 40 % of surface applied urea can be lost to the atmosphere. The quantity that is lost is increased if surface applications are made under dry conditions and not watered into the soil. High soil pH's would favor this loss but pH becomes higher during the conversion of urea to ammonia so the pH after surface applied urea converts to ammonia will be sufficiently high to favor volatilization. Although ammonia discharged to the atmosphere is not desirable from an environmental viewpoint, the quantity that would be lost is likely not significant. Denitrification can lead to returning large quantities of N to the atmosphere as nitrogen gas. This occurs when nitrate form of N is present and the soil becomes anaerobic. If adequate carbon (organic matter) is present the nitrate is reduced to nitrogen gas. Although this converts N to a chemical form that the plant cannot use, it is not an environmentally damaging process.

Finally, N can be lost from the root zone by leaching. The form of N that is readily leached is nitrate. Since nitrate moves with the water in a soil, anytime that leaching occurs nitrate could be expected to move with the water. The amount of N that has been reported to leach under turf is variable. This is not likely do to faulty experiments but rather to uncontrolled conditions and different climatic and soil conditions. Our concern must then be to develop best management practices (BMP) to limit leaching of nitrate. These practices will be site specific but some guidelines may be given.

To use N fertilizers with a minimum impact on the environment we should:

1. Apply N when Turf need N.

2. Apply N at a rate that the turf can use.

3. Do not overwater.

Although these are easy rules, there are certain troubles in integrating these rules with management practices. For example, Turf needs adequate N in the fall to develop and maintain a strong rooting system. But it is difficult to predict when the temperature of the soil will become sufficiently low so that the root system will become inactive. Excess nitrate left in the soil after the turf quits absorbing N is susceptible to leaching. In most areas of Michigan we get adequate moisture between the time when turf becomes inactive in the Fall and when it becomes active in the Spring to move the excess nitrate below the root zone. The second major problem is limiting excess moisture. We can and should control irrigation scheduling so that we prevent excessive leaching. But uncontrolled rain storms will produce leaching and move nitrate below the root zone. The impact of this can be lessened by more frequent, lower applications of fertilizer. Finally, very sandy soils are more difficult to handle because leaching will occur with a lower input of water.

References

Petrovic, Martin. 1989. Golf course management and nitrates in groundwater. Golf Course Management. Sept. 1989. p51.

Petrovic, Martin. 1990. The fate of nitrogenous fertilizers applied to turfgrasses. J. Envir. Qual. 19:xxx.