Phosphorus Fertilization of Turfgrass and Potential Impacts on Water Quality

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Phosphorus (P) is one of the 16 essential plant nutrients. In turfgrass, it is the nutrient needed in the third highest amount, behind nitrogen (N) and potassium (K). Most soils contain P, many at high enough levels to provide adequate nutritional amounts. It is usually recommended that phosphorus be applied when soil test results indicate insufficient levels. The primary exception to this is during turf establishment, either from seed or sod. Phosphorus is important in root development, and encouraging rapid root growth during establishment will have many long-term benefits to the turf stand.

Fertilization

When soil P levels are adequate, it is often difficult to find lawn fertilizers that do not contain P, especially for homeowners. We recommend looking for fertilizers with N-P_2O_5-K_2O ratios in the range of 3-1-2 to 4-1-2. (P and K are always represented in the oxide forms on fertilizer labels and in fertilizer application recommendations). In the absence of soil testing (which is rarely performed by homeowners), turfgrass fertilization recommendations are generally based on N nutrition, since this is the nutrient needed in the greatest amounts. If a homeowner applies 4 pounds of N per 1000 square feet of lawn per year, this would result in applying 1 lb of P_2O_5 per 1000 square feet, or 0.44 lb of elemental P (based on a 4-1-2 ratio fertilizer). This is probably more N than most homeowners apply, so annual P use is probably correspondingly lower. Residential properties serviced by professional lawn care companies usually receive 4 to 6 lbs of N per 1000 sq ft annually. Even in this case, the amount of supplemental P applied is low. The exception to this could be when organic fertilizers are used. Organic sources usually have P levels very close to N levels, in the 2-1 to 1-1 (N-P_2O_5) range. In areas where P load is a concern, organic fertilizer sources should probably be used sparingly or avoided altogether. Research has shown that these types of fertilizers result in greater P runoff than synthetic fertilizers (1).

Solubility, mobility, and soil immobilization

Phosphorus is generally considered to be a relatively immobile nutrient. Orthophosphate is the most soluble and mobile species, and is the one most targeted in research studies. Phosphorus can also be present in inorganic forms, and adsorbed onto surfaces of soil particles. Particulate organic or soil particles can move in surface runoff, but his is usually not a concern in turf due the dense plant canopy. Phosphorus adsorbed onto particulate surfaces is usually very strongly bound and therefore stabilized. Phosphorus can also react with iron and or calcium in soils, forming very insoluble precipitates. Iron often predominates in acidic pH soils, while calcium is usually present in neutral to alkaline soils in this region.

Runoff

From a water quality standpoint, P is of greatest concern in surface waters, and so surface runoff is generally of primary concern. Research has shown that the turfgrass plant community provides a large impediment to runoff due largely to shoot density and thatch disrupting sheet flow. A dense, fibrous root system also promotes infiltration into the soil. To create measurable runoff using rainfall simulators, various researchers have applied precipitation rates ranging from 1 inch per hour for 1 to 2 hours (4) to 3 to 4 inches of water per hour for periods of 15 minutes to 1.5 hours (shorter periods for higher precipitation rates) (2,3). Concentrations of soluble P in runoff varied from non-detectable levels up to 8 parts per million (ppm) under the most extreme

conditions. Studying natural rainfall conditions, other researchers found runoff volumes to range from 1 to 16 % of the incident precipitation, depending on the storm event (1). Concentrations of soluble P in runoff were below 1 ppm for all events. All of these studies were conducted on well-fertilized turf, often under conditions to create worst-case scenarios. We have been conducting research on a golf course near Port Orchard, collecting shallow subsurface flow of water between a sand cap and the underlying native soil. Over 80% of the nearly 400 samples collected over 2 years have had P concentrations below 0.05 ppm (E. Miltner, unpublished data). Based on current knowledge, runoff of P (and other nutrients) from mature turf is considered to be negligible under proper management and naturally occurring conditions.

Leaching

Leaching of P into groundwater is not generally a concern from a drinking water quality standpoint. However, once P moves beneath the plant root zone, it may be subject to movement into surface waters by lateral subsurface flow or groundwater flow. Published research on P leaching from turf is minimal because of the lack of concern in the past. Researchers in New York, studying leaching of five different types of fertilizer in a sandy loam soil (moderate to high permeability), recovered an average of 3.6% of the fertilizer P they applied to mature turf over a one year period. On a mass basis, this was equivalent to approximately 0.04 lb P per 1000 sq ft. Recovery of P in leachate from unfertilized turf was 0.026 lb per 1000 sq ft. Adjusting for this, the fertilizer contribution to leachate P was 0.014 lb P per 1000 sq ft, equivalent to approximately 1.5% of the applied fertilizer P (1). This research suggests that the risk of leaching loss of fertilizer P is minimal.

Summary

Research has shown that the risk of surface or groundwater contamination from fertilizer phosphorus applied to mature turfgrass is minimal. The risk is greater during the establishment period due to limited canopy and root development. Still, it is essential to apply P during this time in order to speed development of the stand. Avoiding application prior to forecasted heavy rains, and judicious irrigation during establishment will help to conserve fertilizer P. In mature turf, P should be applied based on soil test recommendations if available. The greatest risk for surface water contamination from fertilizer P is probably due to application to hardscapes (streets, driveways, sidewalks, etc.) in the vicinity of the lawn. It is essential to sweep or blow fertilizer back into the turf area when this happens.

References

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