# Misguided phosphorus restrictions could impact field management

BY **DR. JOHN STIER**

Safe and acceptable quality athletic turf requires good mowing, fertility, and irrigation. State and local regulations are starting to take away the right to use good fertility practices due to concerns about phosphorus (P) in turf fertilizers. Regulations restricting or banning P-containing turf fertilizers have already been enacted in Minnesota and Wisconsin, with Indiana, Michigan, Texas, and other states considering regulations. Sports turf managers need to know why such regulation is occurring and where P is actually coming from to ensure forthcoming regulations actually benefit the environment and allow science-based turf management.

Phosphorus is essential to all life and is contained primarily in DNA and the energy-carrying molecule ATP. Phosphorus is present in turf between 0.25-0.5% by weight. Much of the P and potassium (K) come from the soil but soil P is not always adequate for turf growth. Turf absorbs N-P-K in roughly a 4-1-3 ratio. Inadequate P slows turf growth, enhancing the likelihood of bare soil and weeds especially in high traffic areas.

### Why is P undesirable?

Phosphorus levels > 0.02 ppm in surface waters cause algae to grow (algal "blooms") and sometimes aquatic weeds. In many soils the background level of P is naturally above 0.02 ppm. When rain hits bare soil, some of the P in the soil dissolves into the rainwater; this is known as "soluble P". Since bare soil can't stop water as well as a dense turf, runoff from croplands dwarfs potential runoff from turf (Table 1, p.10). Heavy rainstorms can carry sediment with its attached P-this is known as "sediment P." Both soluble and sediment P can be either inorganic or organic P (from a living or dead organism). Total P is the sum of soluble and sediment P and is usually what is measured in water samples as both soluble and sediment P can become "bioavailable" for algae growth.

### Where is P?

Agriculture and construction account for a majority of P entering surface waters due to the lack of vegetative cover and high sediment loss in runoff. A Kentucky study showed the underlying geography and soil type can dictate the amount of P runoff; 50 years after a wooded watershed was converted to fertilized farmland, P concentrations in the streams remained the same because the soil absorbed P from fertilizer and controlled its release. In 2003 Roger Bannerman from the United States Geological Survey estimated lawns in Madison, WI contributed 1-4% of P entering area lakes but the amount due to turf fertilizer was unclear. Research actually shows a properly fertilized turf has less runoff than non-fertilized turf because the dense turf reduces runoff and sediment loss (Kussow, 1995; 1998). Therefore it may be better for the environment to fertilize turf than to avoid fertilization. Another Wisconsin study in an urban area determined that lawn and garden fertilizers contribute insignificant N and P unless they're applied to paved areas (Lee and Klusner, 1974). A small background level of P will also be present as P is present in dust, pollen, and can be leached from vegetation. Another study determined streets with 80% tree cover had 0.8 ppm P in runoff while street without overhead trees had only 0.1 ppm P in runoff (Waschuch et al., 1999).

### Who is pushing P regulation?

The Environmental Protection Agency has set Total Daily Maximal Loads for


P and other contaminants in certain parts of the country. In many cases local regulation is occurring due to citizen complaints that something be done to reduce algae and weeds in lakes used for recreation. Because the Green Industry is not well organized and is without lobbyists, turf fertilizers are politically a much easier target compared to agriculture or construction. Once a municipality has passed regulation, others are quick to follow in a case of "me-too"ism. Unfortunately banning turf P applications will have no measurable effect on reducing P levels in water. Our surface water quality will continue to deteriorate until officials take steps to combat the major sources of P and redesign urban areas to stop runoff from impervious surfaces such as roads.

Most P in synthetic fertilizers is from monoammonium phosphate and is water soluble. As soon as it contacts soil moisture most of the P is tightly bound to soil. At pH < 7, P binds to iron and aluminum to form insoluble P forms. Above pH 7, P binds to calcium and magnesium to form insoluble P forms. Only a small amount of P is ever found in the soil solution. Natural fertilizers, sometimes mistakenly referred to as "organic" (organic is defined as any carbon-containing molecule, which would include the synthetic fertilizer urea), are usually based on animal or human waste products. Some natural fertilizers include activated sewage sludge, composted turkey manure, and fish or plant by-products.

All living organisms contain P. Fertilizers made from dead organisms or their waste products have a relatively high P to N ratio. Natural products displaying an analysis of 10-0-0 will still contain P; the manufacturer has simply decided to not claim the P, which is perfectly legal. The high P:N ratio causes more P to be applied when natural products are used compared to most synthetic turf fertilizers that have a low P:N ratio (starter fertilizers being an exception). For example, application of 1 lb N/1000 ft2 using a 25-3-12 product would supply 0.12 lb P expressed as P2O5 per thousand square feet. The actual amount of P applied would be only 0.05 lb since P is only 44% of P2O5. In contrast a natural organic fertilizer with a 6-2-0 analysis would provide 0.33 lb P2O5 per thousand square feet, roughly 3 times as much P as the synthetic fertilizer. While a University of Wisconsin study showed no difference in P runoff when natural and synthetic P-containing fertilizers were used on turf (Kussow, 1998), it seems silly to think of natural fertilizers as "better" when they actually supply more P than synthetic fertilizers.

**Table 1. Phosphorus in runoff from crops, turf, and grassland prairies**

| *Investigators* | *Situation* | *Average Phosphorus loss (lb/A/yr)* |
|---|---|---|
| **Burwell et al., 1975** | Corn or corn-oat-hay (10 yrs) | 10 |
| **Kussow, 1995** | Lawn turf, compacted soil (2 yrs) | 0.3 |
| **Sharpley et al., 1992** | Native grassland (5 yrs) | 0.2 |

### What about soil testing?

Soil tests use chemicals to strip P from soil so it can be measured. Different procedures give different results: a lab which uses the Bray P1 method may show 60 lb P/acre, another lab using the Mehlich III method may show 108 lb P/acre, while a third lab using the Olsen method may show 56 lb P/acre for the same soil sample (Carrow et al., 2001). (Some labs report P as parts per million, or ppm. Multiply by 2 to convert lb/acre to ppm.)

The type of test used should depend on the type of soil, amount of organic matter, and soil pH. It is up to the soil lab to determine the appropriate method, however, many labs only use one method. A bigger problem is that all soil tests results are based on data collected over numerous years of correlating crop yields (e.g., bushels of corn produced per acre) with soil test results. Turf is grown for quality, not yield, and the required soil test calibrations have not been developed for turf. All current recommendations are a "best guess" based on crop yields, so no, current soil tests cannot reliably measure P needs for turf. However, they are the best tools we have. Regulations in some areas allow fines to be levied for persons who apply P when a soil test indicates it isn't needed. Until soil tests are calibrated for turf, soil tests should be used as a guideline for fertilization rather than a regulatory tool.

Allowing P fertilizer to be used even when a soil test indicates levels are sufficient is important for other reasons. Phosphorus is needed to re-establish turf roots of plants damaged by root rot diseases such as summer patch and necrotic ring spot. Without an adequate root system, diseased plants cannot access P in the soil and need the quick access to P provided by fertilizer. Furthermore, P uptake is reduced in cold soils which is why turf leaves may appear purple in the early spring. Sports turf with events in the spring may benefit from P fertilization regardless of soil test results. Lastly, research has shown starter fertilizer applications improve turf establishment from seed. Recent work conducted by Dr. Frank Rossi at Cornell University shows regular overseeding of athletic fields during the growing season helps maintain a denser turf (personal communication, 2005). Regulations that allow starter fertilizer applications whenever an area is being established or overseeded are critical for maintaining high quality athletic fields with reduced reliance on herbicides.

Phosphorus enters surface waters from a variety of sources, with bare or exposed soil causing the majority of runoff. Agricultural operations and building construction are the two greatest contributors, though the soil geology of the area can dictate the amount of P in the runoff. Organic sources include pollen, seeds, leaves, and even wild animal waste: 100 Canada geese produce over 5 oz of P per day (Sherer et al., 1995), while a pet dog contributes 2.6 lb P2O5 annually which is over 5 times more than a typical turf fertilization program would add to the soil. Unfertilized turf contributes more P and runoff than properly fertilized turf because dense turf slows runoff and prevents sediment P from leaving the site.

In northern climates approximately 75% of the annual P runoff from turf and prairie systems occurs during winter when the ground is frozen, having nothing to do with fertilization. A small amount of P runoff will always be present as P is leached from leaves of all vegetation (trees, etc.).

In our urban environment, runoff is often funneled directly to lakes, ponds and streams where wetlands once existed to intercept and filter runoff before it entered surface waters. Ultimately there is no vegetation type better adapted to intercepting runoff from rooftops, parking lots, and roads on a wide scale than turf. Athletic fields, because of the amount and timing of play, need flexibility to apply P to maintain safe playing conditions. As state and local proposals are developed to limit or ban P applications to turf, athletic field managers will need to partner with other Green Industry groups (golf courses, lawn care companies, etc.) to ensure passage of practical and environmentally sound regulations based on science. ST

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