SHOULD P BE BANNED FROM LAWN FERTILIZER?

Wayne R. Kussow [1/]

"Banned" is the term being used in newspapers, but it is incorrect. The proper term is "regulated." Legislation already passed in various parts of the country and being proposed for Dane County lawns and, under NK151, turf areas over 5 acres, mandates that P appli-cation on turfgrass be according to soil tests. Phosphate cannot be applied when soil test P exceeds what is considered to be the optimum level for established turfgrass.

There are two reasons for regulating P application — agronomic and environmental. Research has answered the question of whether or not application of P to turfgrass estab-lished on soil with more than adequate soil test P benefits the grass. It is the environmental consequences of continuing to apply fertilizer P that are highly controversial.

The Agronomic Side

Annual rates of N applied to turfgrass typically range between 2 and 5 lb/M (M = 1,000 ft^2). This is one-fourth to one-third the amount of N required to achieve maximum biomass production. Therefore, when all other nutrients are in adequate supply, nitrogen drives growth and, in turn, the uptake of the other nutrients. This is what is known as "nutrient demand." The data in Table 1 illustrate nutrient demand. In this case, for turfgrass being grown on soil with P and K levels well above their optimum levels, tissue P and K concentrations increased as the annual N rate was increased.

The other side of nutrient demand is shown by the data in Table 2. With soil test P and K levels above the optimum and the annual N rate held constant, applications of liberal quantities of fertilizer P and K had no real influence on tissue concentrations of these nutrients. With nutrient demand being satisfied by soil P and K, the turfgrass had no need for the fertilizer P and K. In other words, the evidence is that there is no agronomic benefit derived from applying fertilizer P and K when soil test P and K levels are adequate.

There is some concern about the reliability of our current soil tests for P and K and their interpretations for turfgrass. Prior to 1993, the optimum soil test P for established turfgrass was set at 75 ppm. This seemed very high and a literature review was conducted to provide a new basis for interpreting soil tests for turfgrass. The result was a drastic reduction in the optimum soil test P level, all the way down to 20 ppm. Was this change justifiable? Research currently underway is showing that when soil test P exceeds 20 ppm, turfgrass tissue P concentrations level off at about 0.4% for lawn grasses and 0.6% for bentgrass. Researchers in Iowa and Minnesota have established 20 and 25 ppm P, respectively, as

[1/] Professor, Dept. of Soil Science, Univ. of Wisconsin-Madison.

Table 1. Effect of nitrogen rate on P and K concentrations in turfgrass grown on a soil with very high levels of soil test P and K.

	Clipping nutrient concentrations		
Annual N rate	Nitrogen	Phosphorus	Potassium
lb/M†	---------------------------- % ---------------------------------		
2	3.99	0.42	2.39
4	4.34	0.44	2.62
8	5.28	0.48	2.91
LSD (p = 0.05)	0.31	0.02	0.22

† M = 1,000 ft^2.

Table 2. Effects of fertilizer P and K applications on P and K concentrations in turfgrass grown on a soil with very high levels of soil test P and K.

	Clipping nutrient concentrations		
$N-P_2O_5-K_2O$ applied	Nitrogen	Phosphorus	Potassium
lb/M†	---------------------------- % ---------------------------------		
4 – 0 – 0	4.15	0.44	2.87
4 – 1 – 0	4.22	0.43	2.95
4 – 0 – 3	4.24	0.45	2.97
4 – 1 – 3	4.02	0.44	2.95
LSD (p = 0.05)	0.31	0.02	0.22

† M = 1,000 ft^2.

optimum soil tests for turfgrass. Thus, the evidence and consensus are that 20 ppm P is a reasonable optimum value.

The Environmental Side

The claim is that the P in runoff water from turf areas is a significant contributor to the P loads going into lakes and, therefore, is at least partially responsible for excessive algae growth, the leading cause of the deterioration of lake water quality. This is where the controversy begins.

Researchers do not agree on the P loads in runoff water from turfgrass or the sources of that P. These disagreements arise primarily from major differences in the types of sites monitored, the time frame during which data were collected, and how P loads were determined. University researchers establish research plots on areas of uniform soil type and slope, and maintain the turfgrass by applying recommended cultural practices. Others monitor home lawns where soil type, slope, and turf quality are highly variable. In several studies, monitoring of runoff water has been confined to the period of approximately May to November. This ignores the fact that in our climate 70% or more of the annual runoff from turf occurs during the period of January through March. The biggest source of discrepancies in turf runoff P loads is how the loads were determined. To arrive at P loads, one has to know the P concentration in runoff water and the water volumes. Only university researchers have directly measured the volumes of runoff water. Others have used computer models to estimate volumes of runoff water or have simply assumed that a fixed amount of annual precipitation will runoff.

Not actually measuring the amounts of runoff water cannot only lead to highly suspect P loads, but very erroneous conclusions regarding the influences of cultural practices on the P loads. Ths is illustrated by the data in Table 3. Had the assumption been that the amount of runoff was the same from all plots, the conclusion would be that fertilization of lawns markedly increases the P load in the runoff water. But because the actual amounts of runoff were very different for the various treatments, the truth is that fertilizer application reduced the P load.

Table 3. Runoff water soluble P concentrations, volumes, and P loads measured on June 30, 1997 after a 1.43-inch rainfall.

	Runoff water		
Fertilizer P_2O_5 applied	Phosphorus	Volume	Phosphorus load
lb/M/yr	mg/L	liters †	mg
0	1.48	3.62	5.36
0.5	1.90	1.67	3.17
0.8	2.57	1.42	3.65
1.3	2.32	1.36	3.16

† Per 285 ft^2 plot.

There is also an endless debate over estimates of the potential impacts of P regulation on lake water quality. What often gets lost in this debate is the fact that each and every lake is unique. Lakes vary greatly in annual P loading rates and where in the watershed the P is coming from. Lakes also vary in the extent to which the annual P load influences algae growth. One has to consider the amount of biologically available P in the lake sediments, the volume of the lake, existing levels of soluble N and P, and the lakes hydraulic residence time, which is how long it takes incoming water to exit the lake. Unless all of these variables are taken into account and there are reliable data for P loads from lawns, one cannot readily demonstrate if and when regulation of P use on lawns will have a positive impact on lake water quality.

The final issue here is how regulation of P use on lawns influences the P load of runoff water. This is yet another contentious topic. Some people maintain that there are just two sources of P in lawn runoff water — soil and fertilizer. There is ample evidence to add to this list the turfgrass itself. Phosphorus does leach out of both fresh, living plant tissue and dried plant material. These provide a background level of P that cannot be controlled. My estimates of the potential leaching rates of P from fresh and dried turfgrasses are presented in Table 4 along with comparison with the P loads in runoff water that I observed over 6 years for a properly maintained stand of Kentucky bluegrass growing on a 5 to 6% slope. As indicated, turfgrass-derived P has the potential of accounting for all of the P in runoff water collected during the growing season and from spring snow melt.

Table 4. Potential contributions of turfgrass tissue P to runoff P.

Turfgrass clipping status	Clipping leachable P	Percent of runoff P
	lb/acre	%
Fresh	0.23	311 †
Air-dried	1.04	452 †
Frozen & dried	0.96	417 ‡

† Based on 6-yr average of 0.09 lb P/acre measured during the growing season.

‡ Based on 6-yr average of 0.23 lb P/acre measured when the soil was frozen.

Lawn runoff P leads measured by university researchers are invariably less than estimates for home lawns. Turf quality may account for much of the difference observed. Research is lacking in this regard, but estimates of the role fo turn maintenance on runoff P loads can be derived from various sources of information. One such set of estimates is shown in Table 5. These estimates suggest that when no fertilizer P is applied to well-maintained areas, there is a 20% reduction in the runoff P load. This number jumps to a 51% reduction for low maintenance home lawns. Comparisons between the well and poorly maintained lawns result in a 86 to 91% reduction in runoff P loads. The indication here is quite clear — improvements in lawn maintenance practices have the potential of bringing about larger reductions in runoff P load than does the regulation of fertilizer P use.

Table 5. Estimates of the effects of lawn maintenance level and fertilizer P application on soluble P loads in runoff water during the growing season.

Maintenance level	Runoff volume	Mean soluble P	Runoff P load
	inch/acre	mg/L	lb/acre
High† + P	0.17	0.39	0.015
High – P	0.17	0.31	0.012
Low‡ + P	0.84	0.92	0.176
Low – P	0.84	0.45	0.086

† Lawns maintained per University of Wisconsin recommendations.

‡ Composite values for several home lawns.