Phosphorus Runoff Losses from Lawns

By W.R. Kussow

Simply eliminating phosphorus (P) in lawn fertilizers will not guarantee less P in runoff water. A Wisconsin study found that a major portion of the P in runoff may also originate from the turfgrass itself. Properly maintained lawns have much lower P losses than poorly maintained lawns.

This study was conducted at the Noer Turfgrass Research and Education Facility, near Verona, Wisconsin. The experimental area had been uniformly graded to a 6% slope after which approximately 6 in. of excavated topsoil was replaced. The average Bray P-1 soil test level of the topsoil was 62 parts per million (ppm), 42 ppm above that considered optimum for established lawns.

Turf, a blend of four Kentucky bluegrass cultivars, was established. Runoff was collected with a system constructed of heavy-duty lawn edging extending 1 in. above the soil surface. At the lower end of the plots, edging was attached to 6 ft. wide weirs of a standard USDA-Natural Resources Conservation Service design. Steel chutes with 3-slot sample splitters conveyed runoff into collection devices.

Plots 8 ft. wide by 32 ft. long were fertilized according to the standard University of Wisconsin recommendation of 1.0 lb nitrogen (N)/1,000 ft^2 during the following four periods: May 1 to 15, July 1 to 15, September 1 to 15, and in late October after the last mowing of the season. Plots were mowed to a height of 2.5 in. every 3 to 5 days and clippings removed. With the exception of 1993, plots were irrigated with 0.43 in. of water only when a change in turfgrass color indicated the onset of moisture stress. In 1993, due to a miscommunication, plots were placed on a twice-weekly irrigation schedule.

Results

Early in the study, both total and soluble orthophosphate P were analyzed in runoff water. The results showed that 98 to 100% of the P was water-soluble orthophosphate. This was consistent with the observation that runoff water contained no measurable amounts of soil sediment. Consequently, only water-soluble orthophosphate P was measured during the entire length of the 6-year study. Water volume was multiplied by P concentration to calculate P load. On average, 70% of the runoff water volume and 72% of the P lost during the year came from frozen soil (data not shown).

Table 1. Potential contributions of turfgrass tissue P to runoff P.

Turfgrass clipping status	Leachable P from clippings, lb P_2O_5/A	Percent of observed P load, %
Fresh	0.53	311[1]
Air-dried	2.38	452[1]
Frozen and air-dried	2.20	417[2]

[1]Based on a 6-year average of 0.21 lb P_2O_5/A measured in runoff during the growing season.
[2]Based on a 6-year average of 0.53 lb P_2O_5/A measured in the runoff when the soil was frozen.

Sources of P in runoff water include soil, fertilizer, and turfgrass tissue. Phosphorus can leach out of fresh, living plant tissue as well as dried plant material. Although P sources in runoff were not differentiated in this study, the potential contribution of plant tissue P to P loading was investigated. **Table 1** shows that the amount of leachable P is much lower in fresh tissue, compared to dried and/or frozen tissue. In addition, P leached from plant tissue is capable of accounting for

Table 2. Estimates of lawn maintenance level and fertilizer P application on soluble P loads in runoff water during the growing season.

Maintenance level[1]	Runoff volume, gal/A	Average soluble P, 10^{-5} lb P_2O_5/gal	Runoff P load, lb P_2O_5/A
High + P	4,600	0.75	0.034
High - P	4,600	0.59	0.027
Low + P	23,000	1.70	0.403
Low - P	23,000	0.86	0.197

[1]High indicates maintenance according to University of Wisconsin recommendations.
Low represents composite values for several home lawns.

all of the P observed in the runoff in this study.

Phosphorus loads measured in university research 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 can be made of the role of turf maintenance on runoff P loads. Data from this study (high maintenance level) were compared to results of studies of home lawns (low maintenance level) conducted by the United States Geological Survey and the Wisconsin Department of Natural Resources. The home lawns studied were of a quality slightly above what is considered minimally acceptable by most homeowners.

Table 2 suggests that well-maintained lawns may have P losses that are 86 to 91% lower than low maintenance home lawns. When no P fertilizer is applied to well-maintained lawns, there is a 20% reduction in the runoff P load. This number jumps to a 51% reduction for home lawns.

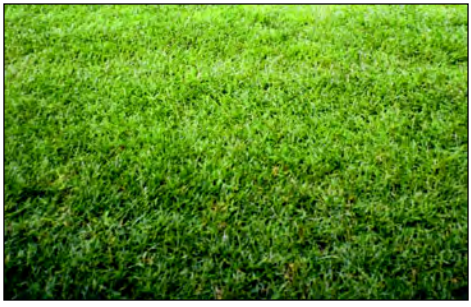
Applying P when it is needed can be important for reducing P loads. **Table 3** shows that while P applications increased the concentration of P in runoff water after a significant rainfall event, they also reduced the total volume of runoff, thereby reducing total P load. Consequently, simply eliminating P from fertilization strategies may actually increase, rather than decrease, P losses.

Summary

Most of the P runoff occurs during the winter months when the soil is frozen. Phosphorus in runoff may originate from soil, fertilizer, and turfgrass tissue. Phosphorus can leach from turfgrass tissue and is of sufficient magnitude to account for all the runoff P observed in this study. Maintenance of lawns is also an important factor in P loading. Properly maintained lawns have much lower P losses than poorly maintained lawns. When needed, P applications may be important for reducing the quantity of runoff water and associated P loads. BC

Table 3. Soluble P concentrations, volumes, and P loads determined in runoff water collected on June 30, 1997 after a 1.43 in. rainfall event.

P fertilizer rate, lb P_2O_5/1,000 ft^2	P concentration, 10^{-5} lb P_2O_5/gal	Runoff water vol., gal/A	P load, lb P_2O_5/A
0.0	2.83	146	0.00413
0.5	3.63	67.4	0.00245
0.8	4.91	57.3	0.00282
1.3	4.43	54.9	0.00243



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