



Lawn P: Where'd It Come From?

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Surveys indicate that 65 to 90% of home lawns contain levels of soil test P that are above what research has shown to be optimum levels for the grass. The assumption among environmentalists is that this "excessive" P is the result of over fertilization of lawns and this is why P application on lawns must be regulated. Ignoring the fact that there is no relationship between soil test levels of P in home lawns and the amounts of P in runoff water, we decided to test the assumption that home owner fertilization of their lawns is what has led to these high soil test levels of P.

Theoretical considerations led us to hypothesize that in most instances fertilizer *is not* the primary source of soil test P in home lawns. To arrive at this hypothesis, we first looked at the relationship between the annual rate of P₂O₅ application and soil P that was developed over several years of research at the O.J. Noer Turfgrass Research and Education Facility. This relationship, shown in Figure 1, says that unless more than 0.98 lb P₂O₅ /1,000 ft² is annually applied when clippings are being removed or more than 0.38 lb P₂O₅ when clippings are not removed, fertilizer is not increasing soil test P. We then selected 29-3-4 as a typical grade of lawn fertilizer and calculated how much P would be applied when the annual N input is 4.0 lb/1,000 ft².

What we're assuming here is that this translates into 4.0 lb actual fertilizer N when clippings are removed and 3.0 lb fertilizer N plus recycling of what research has shown to be an additional 1.0 lb N when clippings are not removed. Under these circumstances, the annual rates of P₂O₅ applied/ 1,000 ft² are 0.41 lb when clippings are removed and 0.31 lb when the lawn is mulch mowed. According to Figure 1, neither rate of P₂O₅ is sufficient to replace what the grass is removing. Rather, there should be a gradual depletion of soil test P.

This conclusion that under many circumstances fertilization of lawns has not increased soil test P led to the question posed in the title of this article: Where'd It Come From? After some discussion, we decided to test the idea that perhaps the P was primarily coming from that "magical" 3 inches of topsoil spread prior to lawn establishment. This made sense given that the topsoil is that being scraped off new areas of housing developments and these developments are taking

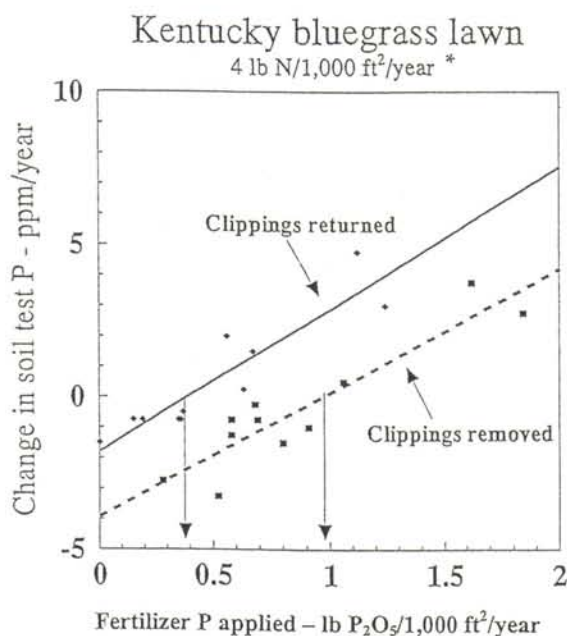


Figure 1. Influence of annual fertilizer P rate on soil test levels of P in a Kentucky bluegrass lawn with clippings returned or removed.



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place on agricultural lands where soil test P levels can be very high. We then set about collecting samples from topsoil stock piles around the fringes of Madison and nearby communities. Bill consulted Madison bus routes and on weekends loaded his bike on busses, went to outlying housing developments, and then rode his bike around collecting topsoil samples. I drove to Fitchburg, Verona, and Oregon and likewise collected samples. After three weekends, we had samples from 18 stockpiles of topsoil. Bill then analyzed the samples in my lab for Bray #1 extractable P.

The results of the analyses of the topsoil samples are shown in Table 1. As you can see, the levels of P ranged all the way from 27 to 173 ppm and averaged 67 ppm for the 18 samples. To put these numbers in perspective, 40 ppm P are considered to be optimum for lawn establishment and 20 ppm are optimum once the grass is established. Therefore, in the eyes of environmentalists, 78% of the samples have "excessive" P for turf establishment and all have excessive P for established lawns. Interestingly, the lowest yet excessive P level of 27 ppm came from the topsoil stockpiled in a housing development taking place in a forested area. While the area may have been farmed many years ago, it certainly has not been fertilized to any notable extent.

The recommended depth of soil sampling for a home lawn is 6 inches and would therefore include some subsoil as well as the topsoil. Assuming equal amounts of each, the P contributed by the topsoil would be one-half the levels shown in Table 1. If we make the ridiculous assumption that there was no P in the subsoil, soil test P levels to a soil depth of 6 inches would be above 20 ppm for 72% of the soils included in this study. Factor in the application of starter fertilizer and some P in the subsoil and this per-

Table 1. Topsoil stockpile soil test P.

Stockpile	Soil P ppm	Stockpile	Soil P ppm
1	173	10	44
2	41	11	91
3	31	12	65
4	73	13	97
5	64	14	45
6	93	15	54
7	38	16	38
8	50	17	130
9	51	18	27

Table 2. Characteristics of lawns sampled.

Number	Age years	How established	Cultural practices
1	2	Seed	No fertilizer or irrigation; mulch mowed at 3 inches
2	2	Sod	Starter fertilizer only first year; irrigated daily; mulch mowed at 2.5 inches
3	13	Sod	Starter fertilizer only; irrigated to overcome moisture stress; mulch mowed at 3 inches
4	14	Sod	Fertilized four to five times per year; irrigated weekly to prevent moisture stress; mulch mowed at 2.0 to 2.5 inches
5	37	Sod	Fertilized three to four times per year with high-N lawn fertilizer for first 30 years, only N since then; clippings removed first 25 years; generally mulch mowed since then; mowing height of 2.5 or 3 inches; irrigated at onset of moisture stress
6	35	Sod	Fertilized following a four-step program; irrigated to prevent stress; mowed at 2.5 to 3.0 inches; clippings generally removed

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centage could easily increase to 90 or more, which is the percentage of Madison lawns that reportedly have excessive P and can only be fertilized with "zero" P fertilizer.

All of this information clearly suggested that topsoil, not lawn fertilizer, is the primary source of the soil test P in at least the more recently established Madison area lawns. But we decided to take our study one step further. We located some lawns of different ages and management and took soil samples at 1-inch increments down to and including the subsoil. The rationale we applied here was that, given the textures of the topsoils we examined, these soils would have such high P sorption capacities that the chances of fertilizer P migrating much below the top inch would be slight to none at the soil test P levels observed. Therefore, the P levels at the 2- or 3-inch soil depths should represent the amounts of P originally present in the topsoil. Subtracting this amount of topsoil P from the amount in the top 1 inch of soil then provides an indication of how much P has been added through fertilization.

The general features of the 6 lawns sampled are listed in Table 2. Analyses of the soil samples collected appear in Table 3. Note that the P in the top inch of soil from the 4 lawns ranging in age from 2 to 14 years was well above the optimum of 20 ppm but in the much older lawns the P was at or below this optimum level. This observation immediately casts doubt on the assumption that fertilization is the cause of high P levels in home lawns.

As explained in Table 3, the data can be used to calculate the percentage of P in the top inch of soil that is likely derived from the topsoil brought in for establishment. These numbers range from 49% for lawn #3 that is 13 years old to 100% in the 2-year-old lawn that was

Table 3. Lawn soil test P. †

Lawn number	Topsoil depth			Subsoil
	1 inch	2 inches	3 inches	
----- ppm of P -----				
1	79	83	80	31
2	45	36	34	31
3	89	69	44	37
4	85	79	—	43
5	13	10	9	15
6	19	20	16	12

† Bray #1 method.

never fertilized. Averaging over all six lawns, the estimate is that 78% of the P in the top 1 inch of soil can be traced back to the topsoil. This leaves 22% that may attributed to fertilization. Research indicates that sod can also contribute significant amounts of P. We were unable to find any lawns where the sod contribution of P could be isolated from the influence of starter fertilizer application.

The lawns 35+ years in age (#5 and #6) are of particular interest. For much of their lifetimes, they were fertilized with a fertilizer whose grade was 29-3-4 or something very similar to this and clippings were removed. Both were found to have less than the optimum 20 ppm P in the top inch of soil (Table 3). How can this be? This confirms the validity of the information given in Figure 1. When clippings are removed and 4 lb N/1,000 ft² are being applied, the phosphorus removal rate is about 0.98 lb P₂O₅ per year. With the 29-3-4 fertilizer, only 0.41 lb P₂O₅ is being applied. The resulting deficit of 0.47 lb P₂O₅ caused the soil test P to decrease by around 1.6 ppm per year. This suggests that both lawns started out with 72 to 75 ppm P, which are very reasonable numbers according to the amounts of P we found in the stockpiled

topsoil (Table 1). Had regulations regarding P use on lawns been in effect when these lawns were established and zero P fertilizer applied, the rate of decline in soil test P would have been 3.9 ppm (Figure 1), and P deficiency would likely have occurred within 13 to 14 years after establishment.

Our main conclusions from this study are:

1. Topsoil accounts for the majority of the soil P in many Madison area lawns.
2. Applying a typical high-N lawn fertilizer such as 29-3-4 cannot increase soil test P when a lawn is mulch mowed and will decrease soil P by about 1.6 ppm per year if clippings are removed.
3. Unless Dane County home owners are diligent and have their lawn soils tested every few years, P deficiencies are inevitable when following regulations that prevent fertilizer P application. Research indicates that the result will be a decline in lawn quality, leading to increases in runoff loss of P.

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