PROJECT
EverGreen
*Because Green Matters.*SM

The Plain Facts About Phosphorus and Lawn Fertilizers

AAPFCO Annual Meeting
Scottsdale, Arizona
August 7, 2001

THE SCOTTS COMPANY
14310 Scottslawn Road
Marysville, OH 43041

Prepared by
Vincent Snyder, Jr. Ph.D.
Senior Technical Associate

EXECUTIVE SUMMARY

Phosphorus (P) is a nutrient that is critical to the growth and vigor of all plants. Numerous university studies have found that phosphorus from lawn fertilizers does not runoff of turf and contribute to phosphorus loading of urban runoff. Unfortunately, not every publication or article alleging that lawn fertilizers are a major source of phosphorus in urban storm water runoff found on the Internet is written by qualified experts or peer-reviewed by impartial panels of scientists. This paper was developed to present the agronomic facts about phosphorus and its importance to all plants while addressing some of the misinformation regarding this essential nutrient that is being cited to support phosphorus restrictions at the local levels of government.

Phosphorus in lawn fertilizers does not move from the lawn after it has been "fixed" by clay particles. Once it is immobilized, the only way fixed phosphorus can move is by soil erosion. Eliminating phosphorus from lawn fertilizer can actually increase the phosphorus loading of streams and lakes due to increased erosion that occurs when turf density decreases. A dense, healthy lawn remains the best defense against phosphorus runoff in the urban environment.

Modern lawn fertilizers are formulated to provide the minimum levels of phosphorus needed to maintain a healthy, dense lawn. The research that was used to support the use of contemporary, low phosphorus formulas makes soil testing of consumer lawns totally unnecessary as well as impractical. Furthermore, improper soil testing by consumers can distort the actual phosphorus content of soils. Applications of lawn fertilizers with low levels of phosphorus that barely replace the amount of this nutrient used by grass plants has eliminated the need to conduct expensive soil testing by consumers.

Urbanization and the development of manmade hard surfaces, such as roofs, streets and driveways, now causes natural phosphorus sources to be redirected into streams and lakes where this essential nutrient now stimulates the growth of aquatic plants and organisms. These hard surface phosphorus sources frustrate many municipalities because it is very costly to treat storm water. Rather than accept the fact that phosphorus in runoff comes from natural sources re-channeled by hard surfaces, a few municipalities have elected to attempt to enact local rules regarding lawn fertilizers instead. This approach will not work as university studies have shown that the use of lawn fertilizers will not materially affect the quality of water that runs into urban storm systems. Since there is no valid scientific evidence that shows

PROJECT EverGreen
Because Green Matters.℠

The Plain Facts About Phosphorus and Lawn Fertilizers

that phosphorus from lawn fertilizers is running off the lawns, the desired improvement in water quality will not be achieved. In plain truth, eliminating the low amounts of phosphorus contained in today's modern lawn fertilizers can actually reduce water quality as a result of the erosion that occurs when turf density decreases. A healthy lawn provides many environmental benefits that cannot be overlooked nor disparaged by the promotion of invalid studies and anecdotal evidence.

INTRODUCTION

"Phosphates are a major source of pollution in lakes and streams, and high phosphate levels support over-production of algae and water weeds. However, many of us have misconceptions regarding the source of polluting phosphates, and many homeowners unknowingly contribute to the problem. Lawn and garden fertilizers often are implicated as the major source of phosphate pollution. However, research clearly demonstrates that with proper application, fertilizer does not pollute. (Emphasis added.) When phosphates are applied to soils, they quickly bind to soil particles, much like a magnet picks up paper clips. Soil-bound phosphates contribute to pollution only when soil erosion occurs. Research studies found little or no difference in the phosphate content of storm runoff from lawn fertilizers with and without phosphate."

So begins the introduction to *Plantalk® Colorado Bulletin #1620*, a publication of the Colorado State University entitled Phosphate fertilizers & water pollution.

Phosphorus, a very important nutrient in lawn and garden fertilizer, has received much attention with regard to water quality. As the above introduction indicates, university research has demonstrated that properly applied fertilizer does not pollute. Unfortunately, not every publication or article alleging that lawn fertilizers are a major source of phosphorus in urban storm water runoff found on the Internet is written by qualified experts or peer-reviewed by impartial panels of scientists. In other words, there's a lot of misinformation out there. Anecdotal evidence implicating lawn fertilizer as a source of phosphorus in runoff is simply being repeated without qualified peer review or scientific validation. The following discussion will look at the facts about phosphorus in lawn and garden fertilizers and explain why this nutrient actually benefits water quality rather than destroys it. In the process, some of the myths or misinformation about this nutrient will also be discussed.

THE BENEFITS OF A HEALTHY LAWN

A healthy lawn does a great deal more than improve property value. Healthy lawns also benefit the environment:

- Healthy lawns absorb rainfall more effectively - helping to prevent runoff.
- Healthy lawns help keep us cool. In fact, rural areas are an average 5-7 degrees cooler than urban areas.

TOLL-FREE 877-758-4835 OR 952-758-9135
INFO@PROJECTEVERGREEN.COM

PROJECT EverGreen

Because Green Matters.[SM]

The Plain Facts About Phosphorus and Lawn Fertilizers

- A thick, hardy lawn provides one of the most cost-effective methods to control wind and water erosion, which helps to eliminate dust and mud problems.
- Lawns help to purify water by acting as a filter to clean many types of pollutants.
- Thick, lush lawns absorb noise and reduce glare.

THE ROLE OF PHOSPHORUS IN PLANTS

Before we can discuss lawn fertilizers and phosphorus, it is important to understand how phosphorus functions in plants and how it acts in soils. By first reviewing a few of the unique properties of phosphorus in plants and soils, the plain facts regarding this essential nutrient will become clear when the actual sources of phosphorus found in storm water runoff are discussed a little later.

Phosphorus has many roles in plants and is considered a “macronutrient,” or an element that is required by the plant in relatively large amounts (E. Epstein, 1972). Phosphorus functions in nearly all chemical reactions that take place in the plant that require or involve energy. It is needed for photosynthesis and serves a central role in the conversion of the sugars produced in the leaves into other materials used in the growth of all plant parts...including the roots. Phosphorus is also a critical component in the building blocks that make up the genetic code found in deoxyribonucleic acid ...or “DNA” for short.

Plants have the ability to move phosphorus from older leaves and stems to the younger tissues where metabolism and cell division are occurring at higher rates. As plants mature and change from the vegetative phase of growth to the reproductive phase, phosphorus will move from the older plant parts to the younger cells in the flowers, pollen and seed. Phosphorus then accumulates in these reproductive tissues where metabolism is high and energy is needed. Phosphorus concentrations are generally highest in the reproductive parts of any plant. Seed and pollen contain relatively high concentrations of phosphorus to support the energy needed for cell division and growth. Because phosphorus can move throughout the plant, nature has given the plant the ability to produce a new generation when phosphorus availability in the soil is low. As the supply of phosphorus increases, the number of flowers and seeds produced also increase. Consequently, applications of phosphorus are especially important when fertilizing flowerbeds and vegetable gardens.

Phosphorus is also critical for root growth because the cell division that takes place in the root tip also requires large amounts of energy. Research has shown that fertilizers that apply high amounts of phosphorus during the establishment of lawns dramatically enhance root growth and subsequent fill-in of turf (Turner et al, 1992). Rapid establishment of turf reduces soil erosion and eliminates soil-bound phosphorus from entering storm runoff.

In plain terms, when phosphorus is limited, plants lack the ability to grow, thrive and reproduce. Ornamentals will be less prolific and produce fewer flowers. Vegetable gardens will have much lower yields. Lawns will establish very slowly and be far less

PROJECT EverGreen
Because Green Matters.SM

The Plain Facts About Phosphorus and Lawn Fertilizers

vigorous and dense. As turf density drops, soil erosion and storm water runoff will ultimately increase. To summarize, phosphorus plays a crucial role in the overall health and vigor of all plants.

PHOSPHORUS IN SOILS

Phosphorus is considered by soil scientists to be an "immobile nutrient" (Rosen et al, 1999). When applied to soils, phosphorus from fertilizers is quickly "fixed" or becomes attached to clay particles where it remains relatively insoluble and unavailable to the plant. The chemical reactions responsible for phosphorus immobilization in soils are very rapid. So rapid, in fact, that the migration of phosphorus from fertilizer granules into surrounding soil is typically measured in millimeters, not in feet or even inches. Because of this property, phosphorus is generally applied very close to the root where it can still be absorbed by the plant before it is "fixed."

The fact that soils rapidly immobilize soluble phosphorus from fertilizers is a well-established agronomic principle. The following example will help demonstrate this rule. An acre of soil, six inches deep, weighs approximately 2 to 2.4 million pounds. The total phosphorus contained in this amount of soil may range from 100 to 4,000 pounds with 1,000 pounds generally considered an average for most soils (Rehm et al, 1997). Of this amount, very little is actually available for plant growth at any one time. Because phosphorus is so tightly bound to soil particles, the amount of phosphorus that exists in soil solution (soil water) rarely exceeds 1.0 part per million (PPM)(Black, 1968). As a consequence of this well-known property, phosphorus neither leaches nor runs off in solution. In practical terms, the only way for phosphorus from lawn fertilizers to move from the sight of application is when soils erode and the nutrient is carried along with the soil particles to which it is attached.

In native or undisturbed soils, phosphorus levels are highest near the surface and decrease rapidly with depth. As plant roots explore the soil depths and bring phosphorus to the surface in the form of living tissue, the deeper horizons are eventually depleted of this essential nutrient. Phosphorus is released after the plant dies as tissues decompose, but because this nutrient does not leach, it remains near the soil surface.

When a developer clears the land for a new subdivision or shopping mall, two things quickly happen to deplete the area of much of its native phosphorus. First, topsoil is stripped and sold to defray the cost of earth moving, road construction and installation of storm water control. During construction, many tons of phosphorus-rich top soil can be washed into the newly developed storm systems that will now transport large amounts of native phosphorus bound to soil's particles into lakes and streams. Secondly, the excavation of basements and foundations raise soil that is very low in phosphorus to the surface where it is then spread over the site in place of the native top soil. As a result, new lawns are typically so low in phosphorus that extra applications of the nutrient are needed in the form of a high-phosphorus, starter fertilizer to help stimulate turf development and help prevent



further soil erosion.

THE ROLE OF PHOSPHORUS IN THE GROWTH OF AQUATIC PLANTS

The process by which a barren lake, devoid of nutrients and aquatic organisms, is transformed into a highly productive lake with abundant fish and wildlife (and finally into a body of water clogged with aquatic weeds and algae) is referred to as "eutrophication." Phosphorus plays a major role in this process (Lory, 1999).

Eutrophication, in and of itself, is not entirely a bad thing - but it must be viewed in the proper context. Lakes that are very low in nutrients are pristine but devoid of most wildlife. The lake is very clear, but without nutrients, it cannot support much aquatic life. Insect and fish populations are very low. As nutrient levels increase, populations of aquatic organisms also increase. Fish and plankton become more abundant and plants begin to thrive. As nutrient levels increase further, a point is reached where aquatic plants begin to choke lakes, and recreational activities are impaired. As algae and aquatic plant populations become excessive, problems begin to occur as this vegetation starts to die and decay. Microbes will decompose the dead plant material but will use all of the oxygen dissolved in the water in the process. As the oxygen levels drop, fish and other aquatic animals will also die. The lake is now filled with decaying, malodorous materials, and its recreational value has greatly diminished.

Phosphorus plays a key role in this process as this element is recognized by scientists as the nutrient that is generally most limiting to the growth of aquatic organisms. Other nutrients generally already exist in adequate amounts to support growth. Only the lack of phosphorus is preventing the rapid growth of aquatic plants and organisms.

The chemistry of phosphorus in water is very similar to what occurs in soils. Phosphorus availability is restricted by other compounds that will fix, or in this case, precipitate this nutrient and limit its solubility in water. When large amounts of available phosphorus are added to aquatic systems, both plants and animals will quickly make use of these newfound sources and multiply until all of the new phosphates are used up. The lake will then re-establish a new balance where phosphorus is being recycled as old plants die and new plants absorb the phosphates released through microbial decomposition. The lake will continue to support new aquatic plants as more and more phosphorus is added to the system. Controlling the levels of phosphorus is critical to balancing the productivity of the lake with its recreational uses. In the case of phosphorus, too much of a good thing can ultimately limit the recreational value of the lake.

It is important to note that phosphorus is not toxic to any organism in the aquatic ecosystem. The problems associated with high phosphorus in water are due to the fact that it stimulates plant and animal growth to such levels as the lake ecosystem can no longer remain in balance and support the abundance of life that results from such over-stimulation. References that label phosphorus as a "toxic water pollutant" should be discounted as environmental sensationalism since phosphorus is truly an essential nutrient found in all living things.

— PROJECT —
EverGreen
Because Green Matters.[SM]

The Plain Facts About Phosphorus and Lawn Fertilizers

Before we review studies on lawn fertilizers and water quality, let's briefly summarize the plain facts about the unique properties of phosphorus that have been discussed so far.

- Phosphorus is critical to the growth and vigor of all plants.
- Phosphorus plays a key role in nearly all chemical reactions that involve energy. Phosphorus concentrations are highest in pollen, seed and other reproductive tissues and other fast-growing tissues such as roots.
- Phosphorus is rapidly fixed or immobilized when it comes in contact with soil particles.
- Phosphorus that is fixed does not leach nor run off of soils. The only way for fixed phosphorus to move is when soils are eroded.
- Phosphorus is the nutrient that generally limits the growth of aquatic organisms and plants.
- Phosphorus is not toxic to aquatic organisms and plants.

LAWNS AND WATER QUALITY

University research has demonstrated that lawn fertilizers do not contribute to the phosphorus loading of storm water runoff. In 1973, a classic study conducted by the University of Minnesota in the City of Minneapolis - the effect of phosphorus from lawn fertilizers on the water quality of storm water collected from two similar neighborhoods - was measured (Shapiro et al, 1973). Homeowners in one neighborhood were given lawn fertilizers that contained phosphorus while other neighbors were given a phosphorus-free product to apply to their lawns. The researchers could find no differences in the phosphorus levels of the storm water runoff between the two neighborhoods. Eliminating phosphorus from lawn fertilizers did not improve water quality. Evidently, the phosphorus found in the storm water must come from sources other than lawn fertilizers.

It should be stated at this point that one of the most common misconceptions regarding storm water runoff and lawns is the amount of water that actually runs off of a lawn after each rainfall event. The plain truth is that very little rainfall ever runs off the lawn at all. A thick lawn will slow the flow of water across the soil to the point where it can penetrate the surface and percolate down to the water table. In a recent study conducted by the University of Wisconsin where the actual amount of water running off of a lawn was measured for a 6-year period, the total annual runoff averaged only 1.3 inches per year (Kussow, 1999).

Since the rainfall averaged 30.9 inches per year, only 4% of the total precipitation actually ran off the lawn. What was even more revealing in this study was the observation that 80 % of the 1.3 inches of runoff measured was collected when the soil was frozen. This means that only one-fourth of an inch of precipitation (0.25 inches) was collected during a period of time when lawns would have been treated with fertilizer.

Critics often suggest that such university research is flawed since the work is conducted under "text book" or ideal management conditions that do not reflect

TOLL-FREE 877-758-4835 OR 952-758-9135
INFO@PROJECTEVERGREEN.COM

PROJECT
EverGreen
*Because Green Matters.*SM



The Plain Facts About Phosphorus and Lawn Fertilizers

real situations. Such criticism does not apply to the above example, for the turf scientist in this study stripped the topsoil off the research area and compacted the subsoil before establishing a lawn to simulate typical new home construction conditions. During the study, the total amount of phosphorus in the runoff was also measured, and the author found only 0.07 pounds of phosphorus per acre running off of non-frozen turf. The total annual phosphorus in the runoff averaged 0.30 pounds per acre, which was very low when compared with field crops that averaged 10 pounds for the same time period. In addition, phosphorus runoff from unfertilized turf was also found to be 41% higher than runoff from fertilized plots. After conducting multiple studies on the subject, the author concluded that the small amount of phosphorus being sampled during the winter was leaching out of dead, desiccated, frozen turfgrass tissue rather than coming from phosphorus fertilizers.

In summary, a dense, healthy, well-fertilized turf reduces the amount of phosphorus on storm water runoff by reducing the total amount of runoff and improves the overall quality of the runoff by preventing soil erosion.

SOIL TESTING

Proponents of phosphorus restrictions in lawn fertilizers often cite soil test results as a means of justifying their assertions that lawns do not require even low levels of annual phosphorus application. The following discussion will examine those studies and explain why misuse of soil test data can actually leave the public with the mistaken impression that phosphorus can be banned without harming turf quality.

In Minnesota, several municipalities have attempted to regulate phosphorus in lawn fertilizers based on the supposition that soil tests had indicated that the soils were adequate in phosphorus and that the soils are already “saturated” with phosphorus. Such accusations demonstrate a complete lack of any understanding of phosphorus and soil chemistry and serve to intentionally mislead the public. Soils have a tremendous ability to “fix” or immobilize phosphorus (Brady et. al, 1996). Yet, phosphorus levels found in soil solution rarely exceed 1 PPM. However, soils analyzed by laboratories may report results from 0 to as high as 100 PPM phosphorus. Depending on the method of the test conducted, soils higher than 25 PPM of extractable phosphorus may be considered very high and may not require additional phosphorus applications (Rosen et. al, 1998). Yet, even at “high to very high levels” of phosphorus, the soils are far from “saturated.”

When tested, soils are generally shaken in an acid or alkaline solution, and the amount of phosphorus dissolved by the acid or base is considered to be representative of a relative amount of phosphorus that a crop might be able to extract during the growth season. As noted earlier, phosphorus dissolved in normal soil solution rarely exceeds 1 PPM. This would still hold true of a soil with extractable phosphorus levels of 25 PPM or higher. The reason phosphorus levels are so low in soil solution is because phosphorus binds with calcium, iron and other elements to form very insoluble



The Plain Facts About Phosphorus and Lawn Fertilizers

compounds in soils. Your teeth are just one example of an insoluble, phosphorus-containing mineral (apatite) that forms in the soil in the presence of calcium. Similar insoluble materials also form in the presence of iron and aluminum. Because these elements are particularly abundant in soils, they serve to rapidly precipitate or “fix” phosphorus and maintain its very low solubility in the soil solution.

The City of Plymouth, MN recently passed an ordinance banning the use of phosphorus-containing fertilizers, because soil tests of the greater Minneapolis area, which included the city, were said to be “high to very high” in general. A review of the actual study has revealed that approximately 40% of the lawns tested from Plymouth would still require additional yearly applications of phosphorus according to the University of Minnesota Extension Service recommendations.

Soil test categories such as “high” and “very high” are only relative terms used by university agronomists to quantify a soil’s ability to provide phosphorus during the growing season of a crop. In Minnesota, soils that test “low” to “high” actually require an annual application to lawns of available phosphate (P2O5) rates ranging from 0.5 to 1.0 pounds per 1,000 square feet according to the recommendations of the University of Minnesota Extension Service. Artificially grouping soil test results into a single “high to very high” group actually deceives the public, since a large percent of the lawns still require annual applications of phosphorus according to university recommendations.

A closer examination of the unpublished “study” that has been cited in support of phosphorus restrictions reveals that volunteers were used to take samples in the Minneapolis area (Hennipen Parks, 1994). A soil test is only as good as the sample submitted. Improper sampling and sample preparation can very easily result in erroneous findings of very high phosphorus. According to the University of Arkansas, the inclusion of small amounts of organic residue (such as from thatch or the shallow roots of turf) can increase phosphorus levels 10 times over samples of the same soils without the organic matter included (Chapman, S.I., 1998). Since consumers usually obtain few core samples, it is very easy to understand how a single, improper core with organic material included can invalidate a soil test for phosphorus. Because multiple volunteer samplers were used in obtaining the samples, as opposed to a trained turf agronomist, the scientific validity and objectivity of the study is left open to question.

Homeowners do not routinely test their soils before applying lawn fertilizers. In a report issued by the University of Minnesota in 1998, only 1,920 consumer soil samples were submitted to the soil testing lab during a 3-year period for an average of 640 samples per year (Swenson, 1998). These samples contained soils taken from lawns, vegetable gardens and flowerbeds. Proponents of phosphorus restrictions in lawn fertilizers cite this study to support their claims that phosphorus is not needed in lawn fertilizers. What is most unfortunate about this study is the fact that the authors failed to distinguish soil samples taken from



The Plain Facts About Phosphorus and Lawn Fertilizers

lawns from those submitted from samples obtained from vegetable gardens and flowerbeds (Rosen, 2000). As noted in earlier discussions regarding the role of phosphorus in plants, flowerbeds and vegetable gardens require much higher levels of phosphorus than lawns. A poll of nearby, Midwestern states that keep records of homeowner soil samples revealed that the majority of samples are submitted to solve problems in vegetable gardens and flowerbeds. If the sampling habits of the people in Minnesota are similar to homeowners in surrounding states, phosphorus levels of lawns are being completely misrepresented because of the failure to separate lawn samples from garden samples. Furthermore, because homeowners are more likely to submit a soil sample to solve an existing problem, using soil test results from problem lawns and gardens further distorts and misrepresents the true phosphorus levels in lawns. Sound public policy should be based on sound science and not on a problem subset of soil samples.

SOIL PHOSPHORUS LEVELS ARE NOT STATIC AND INEXHAUSTIBLE

Municipalities that have restricted phosphorus in lawn fertilizers have done so under the mistaken belief that soil phosphorus levels are static and inexhaustible. Apparently, they feel that phosphorus can be eliminated from lawn fertilizers without affecting turf quality because of the misconception that soils that test “very high” in phosphorus will always test “very high.” Research has demonstrated that soil phosphorus level can decline rather quickly when annual phosphorus applications are eliminated. Studies conducted at the University of Wisconsin on turf that received 4 pounds of nitrogen/year found that soil phosphorus levels dropped approximately 2.4 PPM P per year when the turf clippings were returned by a mulching mower (Kussow, 2001). When the turf clippings were removed, soil phosphorus levels dropped at a rate of 7.3 PPM P per year. In practical terms, these results would indicate that a soil that tested “very high” in soil phosphorus, could drop to “medium” levels of P in only 4 years if clippings are mulched and phosphorus were eliminated from the lawn fertilizer. On the other hand, soil phosphorus levels would practically be depleted during the same 4 years if clippings were bagged. Soil phosphorus levels are simply not static, and annual applications of low levels of phosphorus are needed to maintain proper phosphorus nutrition. Eliminating phosphorus applications to soils that test “very high” may have little effect on turf quality initially, but over time, turf health and vigor will suffer as P levels drop. Without adequate phosphorus, turf does not utilize other nutrients efficiently. As phosphorus levels drop, turf density will decline, and soil erosion will increase thereby increasing phosphorus in urban runoff.

No one can deny that testing of soils for nutrients can be a valuable tool when growing crops or trying to determine why plants are not responding to fertilization properly. However, requiring homeowners to test soils before applying a lawn fertilizer is not only not very practical but also totally



The Plain Facts About Phosphorus and Lawn Fertilizers

unnecessary. Research conducted over 20 years ago by The Scotts Company throughout the country on soils with adequate and deficient levels of phosphorus found that lawn fertilizers required approximately 1 part of phosphorus for every 8 to 11 parts of nitrogen applied to turf to maintain proper growth. Because of this research, most modern lawn fertilizers today now contain fertilizer ratios with low levels of phosphorus: 29-3-4, 32-3-10 , 27-4-4, 27-3-4 etc. When turf scientists measure the amount of phosphorus being removed in the clippings, they find approximately 1 part of phosphorus for every 4 parts of nitrogen contained in the tissue. Since modern lawn fertilizers typically apply 1 part of phosphorus for every 8 to 11 parts of nitrogen, it would appear that the simple act of removing clippings should actually deplete the soil of phosphorus rather than "saturate" the soils as proponents of phosphorus-free fertilizers claim. Because many homeowners still bag their clippings, small amounts of phosphorus will always be needed to maintain a dense, quality turf that prevents soil erosion. Research has shown that quality turf can be maintained under a wide range of soil conditions with today's modern low-phosphorus lawn fertilizers. It is totally unnecessary and impractical to require that homeowners pay up to $25 to test soils before they can purchase a bag of fertilizer that retails for $7.99 in the store.

SO WHERE DOES THE PHOSPHORUS IN OUR STORM WATER COME FROM?

Up to this point, the discussion has been centered on the fact that phosphorus in lawn fertilizers is not a significant source of phosphorus in stormwater runoff.

University studies by Penn State (Watscke, et al, 1989), Wisconsin (Kussow, 1999), and Minnesota (Shapiro et al, 1973) have all shown that banning phosphorus in lawn fertilizers will have no measurable effect on water quality. So if the phosphorus isn't coming from the fertilizer, where is it coming from?

HARD SURFACES AND NATURAL PHOSPHORUS SOURCES

In 1973, the University of Minnesota studied pollen, a natural source of P, in lake sediments in Minneapolis and noted significant changes in the types and levels of pollen entering the lakes beginning around the time of urbanization. As neighborhoods developed and planted elms, for instance, the amount of elm pollen found in the lake sediments increased while native pollen sources such as Russian thistle and other prairie plants decreased. By the 1930s, storm water runoff was now being channeled into the region's lakes, and by the '60s, all of the city's major lakes were receiving runoff from storm systems. (Shapiro et al, 1973)

Urbanization brings with it the development of hard or impervious surfaces. Roofs, sidewalks, parking lots, and streets eventually replace the pervious native vegetation of forests and prairies. The fact that phosphorus is carried on soil particles from construction sites into storm systems and eventually into lakes and streams has already been discussed. What the lay person so often overlooks is the fact that the natural cycle of phosphorus has also been interrupted by the introduction of these hard

The Plain Facts About Phosphorus and Lawn Fertilizers

surfaces. Natural phosphorus sources such as leaf litter, water and airborne soil particles, flowers, seeds and pollen continue to fall onto roofs, sidewalks and driveways instead of falling on the forest floor to be decomposed and re-absorbed by shallow plant roots. Instead of being recycled into the new growth of trees and prairie grasses, much of the phosphorus now finds its way into our lakes and streams via hard surfaces and urban storm water systems. Pristine lakes that were once very low in phosphorus now contain algae and other aquatic plants as a direct result of our storm sewers acting as a conduit of natural phosphorus into these bodies of water.

In 1971, a Wisconsin researcher studying nutrient sources for Lake Wingra in Madison, Wis., found that unusually high levels of phosphorus in May and November could be attributed to flower parts and tree seeds, leaf piles and debris in street gutters which were thought to be leaching phosphorus from these sources (Kluesener, 1971). A more recent study conducted in Madison, Wis. by the USGS reported a highly significant, direct correlation between the concentration of phosphorus in street runoff samples with the percent of over-head tree canopy (Waschbusch, et al, 1999). When no trees were present, phosphorus concentrations fell below 0.1 PPM of phosphorus. As the overhead tree canopy increased to 80%, the phosphorus concentrations sampled in street runoff exceeded 0.8 PPM. Obviously, trees are a significant source of natural phosphorus that is overlooked by the lay person.

The mere presence of leaves in a gutter also represents a major source of phosphorus in storm water runoff. These leaves are not inert but can contain up to 260 PPM of soluble phosphorus that can leach out of the leaf and into storm water systems (Dorney, 1986). To illustrate just how large the contribution is that these materials can represent, a study conducted by the University of Minnesota found that the simple act of sweeping the streets could reduce phosphorus loads in storm water runoff by up to 42 % (Shapiro et al, 1973).

Building codes also influence phosphorus in storm water runoff. To obtain a dry basement, builders channel rooftop runoff away from the foundation as quickly as possible. Often, this is accomplished by running drain tiles directly to the street curbs or into storm water systems. Phosphorus from leaves, airborne soil particles, and tree flowers and pollen are now being channeled off the rooftops and into the lakes and streams as quickly and efficiently as possible.

Earthworm casts are another much-overlooked source of phosphorus in urban runoff. These lowly creatures excrete as much as 8/10ths of a pound of casts per square foot of turf per year, or approximately 17.4 tons/acre (Beard, 1973). Furthermore, these worm casts are recognized for being up to 7 times higher in available phosphorus than the original soils they were derived from. In addition, the form of available phosphorus is mobile in that these casts are deposited on the surface where they can be eroded by rainfall. Phosphorus from traditional lawn fertilizers is soluble and rapidly fixed to soils. Worm

The Plain Facts About Phosphorus and Lawn Fertilizers

casts, on the other hand, are already fixed to clays and organic matter and have been reported to contain 150 PPM available phosphorus while the soils they were derived from averaged 20.1 PPM available phosphorus (Collins, date unknown). A quick calculation using the above information reveals the startling fact that earthworm casts in a lawn would account for 5.2 pounds of mobile phosphorus per acre per year.

Dog feces are another major source of phosphorus that finds its way into lakes and streams. According to the North Carolina Cooperative Extension Service, dog manure is approximately 10 % P_2O_5 (Zublena et al, 1991). In a study conducted to evaluate the impacts of various urban sources of nutrients on water quality, Four Mile Run near Washington, D.C., the Environmental Services Division of the Northern Virginia Regional, estimated a population of 11,400 dogs in the area generated 5,000 pounds of solid waste every day (or 1,000 tons per year over a 20-square-mile area). If we assume that the waste was 15% dry matter, by using the above information from North Carolina, it can be calculated that the average dog is responsible for approximately 2.6 pounds of P_2O_5 per year. Where Fido “deposits” his annual phosphorus contribution is of significant importance to the water quality of the region. Proper pet sanitation must not be overlooked when seeking means to reduce phosphorus contributions from urban runoff.

Any paper on phosphorus and water quality would not be complete without a brief discussion regarding the significance of waterfowl. Canadian geese and other waterfowl are very significant sources of phosphorus that are often overlooked by the lay person. Their droppings are very rich in phosphorus that can add significant amounts to the total phosphorus loading of lakes. Sherer, et al (1995) reported that the average goose produced 82 grams (dry weight) of fecal material per day. The average phosphorus content was reported at 1.3%. A quick calculation demonstrates that a single Canadian goose would account for nearly 2 pounds of P205/year in its droppings. Not all of this amount is necessarily deposited in lakes and streams, but a significant amount is certainly added since nearly all waterfowl roost in colony fashion on water. Phosphorus is added to aquatic ecosystems when these animals feed on land and deposit their fecal material in lakes, streams or ponds. Clearly, as the urban resident waterfowl populations continue to climb in our cities, the annual phosphorus contributions to streams and lakes from these animals will also soar.

CONCLUSION/SUMMARY

In the final analysis, urbanization and the development of manmade hard surfaces, such as roofs, streets and driveways, now causes natural phosphorus sources to be redirected into streams and lakes where this essential nutrient now stimulates the growth of aquatic plants and organisms. These hard-surface phosphorus sources frustrate many municipalities in that it is very costly to treat storm water. Rather than accept the fact that phosphorus in runoff comes from natural sources re-channeled by hard surfaces, a few municipalities have elected to attempt to enact local rules regarding

PROJECT
EverGreen
*Because Green Matters.*SM



The Plain Facts About Phosphorus and Lawn Fertilizers

lawn fertilizers instead. This approach will not work as university studies have shown that the use of lawn fertilizers will not materially affect the quality of water that runs into urban storm systems. Since there is no valid scientific evidence that shows that phosphorus from lawn fertilizers is running off the lawns, the desired improvement in water quality will not be achieved.

In plain truth, eliminating the low amounts of phosphorus contained in today's modern lawn fertilizers can actually reduce water quality as a result of the erosion that occurs when turf density decreases. A healthy lawn provides many environmental benefits that cannot be overlooked nor disparaged by the promotion of questionable studies and anecdotal evidence that such reports cause.

LITERATURE CITED

Beard, J.B. 1973. Turfgrass: Science and Culture. Prentice-Hall, Inc., Englewood Cliffs, N.J.

Black, C.A. 1968. Soil-Plant Relationships. John Wiley & Sons, Inc., New York

Brady, N.C. and R.R Weil. 1996. The Nature and Properties of Soils. Prentice Hall, N.J.

Chapman, S. L. Water Quality Newsletter, September 1998. Vol. 6, No. 5. University of Arkansas Extension Service

Collins, R.R. Date unknown. Earthworms and Nauvik. University of Alaska. http://sedona.uafphys.alaska.edu/~isecco/new/papers/earthwmpaper.html

Dorney, J.R. 1986. Leachable and Total Phosphorus in Urban Street Tree Leaves. Water, Air and Soil Pollution vol. 28, D. Reidel Publishing Company.

Epstein, E. 1972. Mineral Nutrition of Plants: Principles and Perspectives. John Wily and Sons, Inc. New York

Hennepin Parks. 1994. Suburban Lawn Fertility Study.

Kluesner, J. 1971. Nutrient transport and transformation in Lake Wingra, Madison. Report Water Chem. Program, University of Wisc.-Madison.

Kussow, W.R. 1999. Contributions of Nitrogen and Phosphorus to Surface and Groundwater from a Kentucky bluegrass Lawn. University of Wisconsin-Madison.

Kussow, W.R. 2001. University of Wisconsin-Madison. Personal communications.

Lory, J.A. 1999. Agricultural Phosphorus and Water Quality. University of Missouri Extension Agricultural Publication G98181

Rehm, G. and M Schmitt. 1997. Understanding Phosphorus in Minnesota Soils. University of Minnesota Extension Publication FO-07992-GO

Rosen, C.J. 2000. (personnel communication).

Rosen, C.J., P.M. Bierman, and R. D. Eliason. Soil Test Interpretations and Fertilizer Management for Lawns, Turf, Gardens, and Landscape. University of Minnesota Extension Publication BU-1731-GO. 1998.

TOLL-FREE 877-758-4835 OR 952-758-9135

INFO@PROJECTEVERGREEN.COM

  

The Plain Facts About Phosphorus and Lawn Fertilizers

Rosen, C. J. and D.B. White. 1999. Preventing Pollution from Lawn and Garden Fertilizers. University of Minnesota Extension Publication FO-2923-GO

Shapiro, J. and H Pfannkuck. 1973. The Minneapolis Chain of Lakes, a study of Urban Drainage and its Effects. Interim Report No. 9, Limnological Research Center, University of Minnesota.

Swenson, J. .1998. Urban Landscapes as a Source of Phosphorus in Surface Waters. University of Minnesota.

Tisdale, S.L. and W. L. Nelson. 1975. Soil Fertility and Fertilizers. Macmillan Publishing Co, Inc., New York

Turner, T.R. and N.W. Hummel, Jr. 1992. Nutritional Requirements and Fertilization. In Turfgrass. American Society of Agronomy, Inc. Madison, WI

Waschbusch, R., W.R. Selbig and R.T. Bannerman. 1999. Sources of Phosphorus in Stormwater and Street Dirt from Two Urban Residential Basins in Madison, Wisconsin, 1994-95. USGS Water Resources Investigations Report 99-4021. Middleton, WI.

Zublena, J.P., J.V. Baird and J.P. Lilly. 1991. Soil Facts-Nutrient Content of Fertilizer and Organic Materials. North Carolina Cooperative Extension Service publication AG-429-18.

TOLL-FREE 877-758-4835 OR 952-758-9135

INFO@PROJECTEVERGREEN.COM