DRAFT

Hamilton County Soil & Water Conservation District Soil Fertility Study

By Holly Utrata-Halcomb, District Administrator

Introduction

The Ohio State University Extension halted soil fertility testing in 1994 when they determined that it would be too costly to retool their soil quality lab located at the Ohio Agriculture Research and Development Campus in Wooster, Ohio. Instead, Extension issued a referral sheet to landowners listing private labs that would test soils for a fee.

Over the next 10 years, our District received calls on a regular basis from bewildered landowners seeking advice on how to interpret their test results. It was noted that several landowners had costly and extensive testing that were not required for a simple backyard garden. Many of the test results gave fertilizer recommendation per acre and recipients did not know how to make the conversion from acre to feet. It became clear that the current practice of referring landowners to independent labs did not offer the needed follow up support that was once supplied by the OSU Extension office.

Another intriguing element was that the samples reviewed by District staff seemed to show a pattern of high pH, very high Phosphorus and low Potassium levels for landscape crops. The recommendations offered did not fit any ready-made commercial fertilizer. This was yet another frustration for the landowners trying to improve their landscape.

In response to the 1999 mandates of the United States Environmental Protection Agency, National Pollution Discharge Elimination System - Phase II Storm Water Program, the Hamilton County Board of County Commissioners created and established the Hamilton County Storm Water District February 12, 2003. The Board of County Commissioners formed the Hamilton County Storm Water District under the legal authority of the Ohio Revised Code Section 6117. The Hamilton County Engineer is responsible for the overall management of the Storm Water District. It was anticipated that portions of the Phase II program would be performed by the Hamilton County Department of Public Works, the Hamilton County Soil and Water Conservation District, and the Hamilton County General Health District.

The regulations require six minimum controls:

1. Public Information & Education –Develop brochures, create web-based library of educational materials on storm water, present information to community groups, adopt or prepare K-12 educational materials, and develop press releases.

   Hamilton County Soil & Water Conservation District (SWCD) became the responsible Department for this component.

2. Public Involvement & Participation

   Establish hotline and complaint database, form a storm water advisory group, coordinate and finance storm drain labeling and watershed signage, and train watershed groups.

   Hamilton County Soil & Water Conservation District became the responsible Department for this component.

3. Illicit Discharge Detection

   Prepare county-wide storm water map, locate priority pollution areas, enact illicit discharge ordinance and implement a spill detection and elimination plan, prepare a septic system management plan, perform dry weather screening of storm sewers, and educate local government employees, businesses, and the public.

   Hamilton County Public Health Department became the responsible Department for this component.

4. Construction Site Runoff Control

   Enforce erosion & sediment ordinance including site plan review and inspection, and implement a BMP manual.

   Hamilton County Soil & Water Conservation District became the responsible Department for this component.

5. Post Construction Runoff Control

   Implement structural BMPs, prepare sensitive areas plan, develop ordinances for riparian corridor protection, post construction runoff control, and long-term inspection of BMPs.

   Hamilton County Department of Planning and Development became the responsible Department for this component.

6. Pollution Prevention & Good Housekeeping

   Prepare local government maintenance plan and train government employees on pollution prevention

   Hamilton County Public Health Department became the responsible Department for this component.

The Education and Community Involvement components of the Districts new role in the Storm Water District caused the SWCD staff to evaluate what existing programs met these requirements. The challenge was to show how both that the education provided and the community involvement activities offered led to behavior change in our residents that would improve water quality.

Since the two major chemical pollutants detected in our waterways are Nitrogen and Phosphorus and it is said that residential landowners apply up to 7 times the amount of fertilizer/acre compared to agricultural land use, the soil fertility-testing program appeared to be one natural point of focus.

The District met with agents from OSU Extension – Hamilton County in 2004 to discuss the need and benefits of assisting landowners in understanding their impact on water quality and their use of fertilizer. While the Extension Agents agreed that there was a need they preferred not to re-establish the program. They did, however, enthusiastically support the SWCD taking on the program.

After much research and surveying of private soil testing labs and university soil testing labs, The District selected Michigan State University as the lab of choice for the SWCD soil fertility-testing program. In the spring of 2005, The SWCD began selling soil fertility test kits to landowners. To date, over 2,300 test kits have been sold and 1,171 test results have been processed. Of the 1,171 results received, 1,114 are useful for our study. The others were excluded because they were from our-of-county landowners or were for unusual specialty crops.

Environmental Impacts of Fertilizer

Fertilizers are used by homeowners to maintain and improve landscape beauty and quality. In recent years, increased use of home lawn and garden fertilizers has caused concern over pollution of lakes and groundwater. Proper fertilizer application can enhance plant growth without polluting the environment. Yet, misuse of fertilizer may not only harm the environment—especially ground and surface water—but may in fact result in injury to landscape plants as well (Rosen and White,1999).

Fertilizers and Fertilizer Ingredients

The two primary fertilizer nutrients are nitrogen and phosphorus. Fertilizers used in both agricultural and non-agricultural settings contain essentially the same ingredients. Phosphorus and nitrogen compounds are needed by all plants for vigorous growth. In a non-agricultural setting, the impact of fertilizers may seem small, isolated to one lawn or garden. However, the total area of lawns and gardens in urban environments may be significant, creating a cumulative effect that is effectively quite large (Rosen and White,1999).

Phosphorus occurs naturally in rocks and other mineral deposits. During the natural weathering process, the rocks gradually release the phosphorus. Phosphorus is one of the nutrients necessary for plant growth. Inorganic phosphorus moves very slowly in soil, and when applied as a fertilizer it is quickly bound by soil. If not mixed into the soil, phosphorus from lawn clippings and tree leaves left in the streets and gutters is soluble and a potential pollution source. (Rosen and White, 1999). It is essential in several biochemicals that control photosynthesis, respiration, cell division, and many other plant growth and development processes. Phosphorus is concentrated in the seed and fruit, and strongly affects seed formation. Since the primary functions of P involve energy and growth regulation, deficiencies affect vegetative growth and yield more than quality, but in seed crops, quality can also be affected.

In Hamilton County, Phosphorus appears to be plentiful in the soil. However, unless it is available in solution, it is not usually available to plants and remains bound to the soil. Even though phosphorus is not easily leached from soils, it can be a potential pollutant of surface waters. Phosphorus enters surface water through soil erosion. Even though bound tightly to soil surfaces under aerated conditions, P availability can dramatically increase once deposited in water. Thus, erosion results not only in loss of the most productive and fertile soil, it can contribute to water quality problems through enrichment of ecosystems developed under low P conditions.

Nitrogen - Nitrogen is present naturally in soils as nitrate ion, ammonium ion, and as a component of soil organic matter. Ammonium is readily converted to nitrate in all but the wettest and driest soils. Nitrogen generally produces the greatest growth response in plants of all fertilizer nutrients. Unlike phosphorus, nitrogen in its nitrate form is completely soluble and highly mobile in soil. It thus can readily leach downward and contaminate groundwater supplies (Rosen and White, 1999).

Too much nitrogen, as nitrate, in drinking water can be harmful to young infants or young livestock. Excessive nitrate can result in restriction of oxygen transport in the bloodstream. Infants under the age of 4 months lack the enzyme necessary to correct this condition ("blue baby syndrome"). In parts of Eastern Europe where ground water is contaminated with 50-100 milligrams per liter (mg/L) of nitrate, pregnant women and children under 1 year of age are supplied with bottled water.

In addition, excess N may cause plants to remain in a vegetative growth stage and delay initiation of flowering or fruiting, resulting in lowered yields of some crops. Excess N can also encourage tender, succulent plant growth that may be more susceptible to certain plant diseases.

Due to the relative instability of Nitrogen, levels are not determined in a standard soil fertility test. Recommendations are based the levels of other nutrients tested. In providing test result interpretations, it is stressed that the recommended Nitrogen application can be cut in half if grass clippings are returned to the soil.

Potassium - Most of the functions of K in the plant are indirect in that K is necessary for other chemical reactions to operate properly. Some 60 enzymes require the presence of K, with high concentrations of K found in the active growing points and immature seeds. Plants deficient in potassium are stunted and develop poor root systems. Deficiency symptoms are most obvious on the older, lower leaves since this element is readily translocated within the plant. Symptoms begin as interveinal chlorosis or "bronzing" near the edges of lower leaves, and develop into a firing or scorch as the deficiency continues. This firing moves inward until the entire leaf dies and is shed. Since K deficiency can result in leaf shedding, it reduces the ability of the plant to produce carbohydrates, and ultimately, yields.

In Hamilton County, 14% of soil test samples were deficient in Potassium. Since the cost of Potassium has tripled over the past few years, 86% of landowners will save money by not applying this nutrient.

The Effects on Water Quality

Groundwater - Lawn and garden chemicals, such as fertilizers enter the groundwater in two ways. In the first method, the chemicals can enter the groundwater by rainwater into a stream as runoff. This is especially problematic in urban environments where hard-surfaced roads allow rainwater to move over them without benefit of soil acting as a filter (Rosen and White, 1999). The water in streams replenishes groundwater, so the chemicals are absorbed into the groundwater as well. The second method of contamination is through leaching, which is the downward movement of a substance through the soil. The fertilizer may also dissolve into the surface water, which recharges the groundwater (Virginia Cooperative Extension, 1996).

Nitrate is highly soluble and readily leaches into groundwater. Water with over 10 parts per million nitrate-nitrogen can cause methemoglobinemia, an inability to use oxygen in infants.

Surface Water

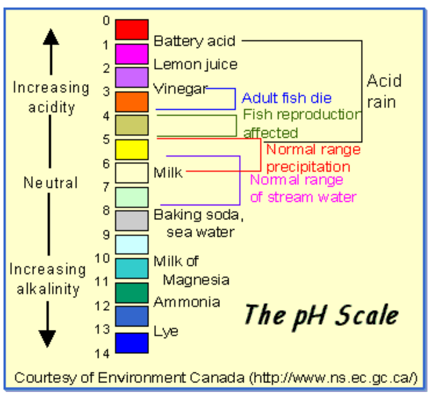
The nutrient phosphorus harms clear, fresh water by creating algal blooms. This process, known as eutrophication, turns the water green, clouds the water, causes odor problems, and depletes the oxygen for fish and other species, effectively suffocating them (Lake Champlain Basin, 1998). In 1979, Lake Erie exhibited a green blanket of algae off the shores of Cleveland that stretched ½ mile from shore due to eutophication.

Interim Conclusions

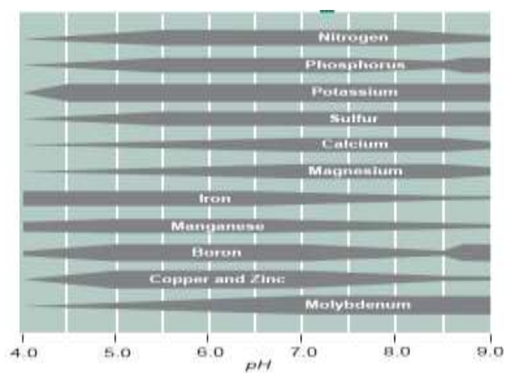
The soil fertility test results have been analyzed in several different ways. Charts were developed reflecting the levels of pH, Phosphorus and Potassium based on levels below optimum, Within Optimum and Above Optimum. Individual or groups of the listed results were then plotted on a map by U.C. Graduate Students under the supervision of the CAGIS staff of the City of Cincinnati. Topographic and soil layer information was integrated into these maps.

Elements Graphed and Mapped

pH - pH is a unit that expresses the strength of a solution based on its acidic or basic properties. Aquatic organisms can only function in a particular range of pH, and become forced to relocate when the surrounding water changes. Pollution from burning fossil fuels increases the amounts of sulfur and nitrogen oxides introduced into the water, thereby increasing the overall acidity. pH is a measure of acidity or Alkalinity of the solution through hydrogen ion concentration and is expressed as the molar concentration of the hydrogen ion as its negative logarithm (pH= -log[H+]).



How pH Influences Nutrients



pH is one of the main indicators used for evaluating surface water suitability and quality and is important because aquatic organisms are sensitive to pH changes, especially acidity, in water. Many aquatic organisms respond best to a near neutral pH, but can withstand a range of 6-8.5. pH is an extremely important indicator of water quality because the toxicity of other toxic compounds can be altered if a change in pH occurs.

The type of parent material present primarily dictates soil pH. It is not surprising that in Hamilton County Ohio our pH averages between 7 – neutral and 7.8 – relatively high in alkalinity. If the pH is too low – below 5.5; or too high – above 7.5, the pH can have a major impact on the availability of nutrients. Soil labs give recommendation on how to increase pH, however, recommendations for decreasing pH with sulfur is not provided. This is a critical piece of information our landowners need in order to obtain success in their landscape.

Phosphorus – It is very apparent that a very small number landowners need to add lime to increase their pH when growing turf. This is likewise true for the addition of Phosphorus and Potassium. Of 328 samples tested, only 10 required the addition of Phosphorus.

This trend can be also seen in tests run for vegetable gardens. This reinforces the need for testing. Most fertilizers available for turf have already reduced or completely removed Phosphorus from the formulation. However, all commercial fertilizers available specifically for vegetable gardens include high levels of Phosphorus.
Annual and perennial flower garden results were almost evenly split on the need for Phosphorus. 52 of the samples had above optimum levels and 22.5 were right at optimum. 71.5 of the samples showed below optimum levels. Here again, the need for testing will be key.

Potassium - Turf soil samples showed that 304 samples were above or at optimum levels for potassium. Only 17 samples showed the need for additional Potassium.

Vegetable crops samples showed that 340 samples were at above or optimum levels for Potassium and 41 required additional Potassium to be added.

Once again, due to the nutrient requirements of annual and perennial flowers, 95 soil samples revealed a need for additional Potassium while 52 soil samples registered at or above optimum.

The mapping of the sample points and their corresponding pH and nutrient levels did not reveal any conclusive determinations on trends across the County. The primary difficulty is the presence of so much Urban Land Complex soil and the level of impervious surface and developed land. After consulting with Dr. William Schuster, Soil Scientist and Agronomist with USEPA, I was advised to offer my 6 years worth of data to a Geography Graduate student at the University of Cincinnati for further analysis. Dr. Liz Kolbesh, Geography Professor at U.C. has invited me to present my findings to her Graduate students Winter Quarter 2012. She suggested that they would be interested in conducting Geostatistical measurements.

Dr. Schuster and Dr. Kolbesh also requested that I contact landowners that submitted samples in 2005 – 2006 and suggest that they resample. This will determine if the suggested nutrients were added and if they continued to follow through consistently. They also suggested that I advertise and push for test results in the western portion of the County.

The Soil Fertility Testing Program is an ongoing effort in Hamilton County. Additional data will be added each year. One definite conclusion can be drawn from the results to date. One formula of fertilizer should not be used for every lawn and garden within a geographical area. There is a need to individually test each plot in order to achieve good horticultural results and to protect our waterways from runoff and infiltration pollution.

References

1) Best Management Practices for Turf Grass, Joe Boggs, OSU Extension – Hamilton County
2) Fundamentals of Soil Science – 5th edition, H.D. Forth; L.M. Turk
3) The Ohio State University – OHIOLINE - http://ohioline.osu.edu 5. David K. Mueller and Dennis R. Helsel - “Nutrients in the Nation's Waters--Too Much of a Good Thing?” U.S. Geological Survey Circular 1136
4) Rosen, C. J. and D.B. White. 1999. "Preventing Pollution Problems from Lawn and Garden Fertilizers." University of Minnesota Extension Service.
5) Virginia Tech Cooperative Extension Publication Number: 452-129; 2002, J.R. Hunnings and S. J. Donohue, Extension Specialists;

For more detailed information on Soil Fertility Basics, go to http://www.plantstress.com/Articles/min_deficiency_i/soil_fertility.pdf

David K. Mueller and Dennis R. Helsel - “Nutrients in the Nation's Waters--Too Much of a Good Thing?” U.S. Geological Survey Circular 1136

Virginia Cooperative Extension, 1996).