Maryland Professional Lawn Care Manual

UNIVERSITY OF MARYLAND EXTENSION

Solutions in your community

MARYLAND DEPARTMENT OF AGRICULTURE

Contents

Introduction

The Chesapeake Bay is Maryland's greatest economic and environmental treasure. Since the 1950s, the Bay has experienced an alarming decline in water quality because of excess nutrients and sediment entering its waters from a variety of sources. Nutrients—primarily nitrogen and phosphorus—are key ingredients in fertilizer. Over the years, researchers have learned that excess nutrients from farm fields, public parks, golf courses, and hundreds of thousands of urban and suburban lawns are washing off the land and finding their way into the streams and rivers that feed the Bay. Once in our waterways, fertilizers designed to make crops healthy and lawns lush and green fuel the growth of harmful algae. As algae grow, they block sunlight from reaching Bay grasses, rob the water of oxygen, and threaten underwater life.

According to the Maryland Department of Agriculture (MDA), lawn fertilizer now accounts for approximately 44 percent of the fertilizer sold in Maryland. Certain restrictions on fertilizer use have been in place for farmers and larger lawn care companies since 2001. However, additional stakeholder involvement is needed if Maryland is to meet new nutrient and sediment reduction caps established by the U.S. Environmental Protection Agency (EPA) and outlined in the state's Watershed Implementation Plan (WIP) to protect and restore the Bay by 2025. These pollution caps—the Bay's Total Maximum Daily Load (TMDL)—represent the maximum amount of pollution that the Bay can receive and still meet water quality standards.

To that end, the Maryland General Assembly passed the Fertilizer Use Act of 2011 as a key strategy of the Bay's pollution diet. The law includes new restrictions for fertilizer manufacturers and distributors, lawn care professionals, and homeowners.

A major feature of Maryland's new lawn fertilizer law requires MDA—with technical guidance from the University of Maryland (UMD)—to establish a training, certification, and licensing program for professionals hired to apply fertilizer to lawns. Beginning October 1, 2013, all lawn care professionals must be certified by MDA to apply fertilizer. The rules apply to professionals for hire as well as individuals responsible for turf management at golf courses, public parks, airports, athletic fields, businesses, cemeteries, and other nonagricultural properties.

Managing nutrients is an applied science. This manual was developed to give lawn care professionals a comprehensive knowledge of the processes involved, an understanding of the science and reasoning behind the processes, and the skill set needed to pass Maryland's Professional Fertilizer Applicator Certification Exam.

Chapter 1: Environmental Benefits and Risks of Turf as a Ground Cover

BENEFITS

As a landscape cover, turf provides many benefits. Coupled with these benefits, however, are potential water quality challenges associated with turf maintenance and management. The goal of the Professional Fertilizer Applicator Certification Program is improved management and balancing of the agronomic needs of turf and potential water quality impacts.

Hydrologic

Turfgrass is a ground cover composed of close cut, thickly growing, intertwining stems and leaves of grass plants. A distinguishing characteristic of all turfgrasses is their ability to withstand close mowing and still provide a functional, dense, and healthy ground cover. Turf protects nonrenewable soil resources from water and wind erosion. The fibrous root systems of turfgrasses form excellent soil netting that reduces dust and stabilizes soil on both flat and sloping areas. Turf's high shoot density and root mass stabilize surface soil, thereby preventing erosion. Mowed turfgrasses are estimated to have shoot densities ranging from 30 million to more than 8 billion shoots per acre.

Healthy turf has the ability to absorb, conserve, and filter water; consequently, this prevents runoff. This is why turf is often used on slopes, roadsides, and around the perimeters of parking lots. Since turf is a perennial and stable ground cover, it slows stormwater runoff, reduces erosion, and improves the likelihood that water will infiltrate down through the soil. During storms, turf's high biomass matrix provides resistance to lateral surface water flow, which slows otherwise potentially erosive water velocities. Quality turfgrass stands modify the overland process of water flow so that runoff is greatly reduced in all but the most intense rainfall events.

Turf also is used as a vegetative filter strip that greatly reduces sediment transported into surface streams and rivers. The reduction in sediment movement both protects soil resources as well as reduces sediment-linked nonpoint source surface water pollution in rivers, lakes, and streams. In addition to catching and filtering water, turf systems are very efficient at retaining nutrients. Nutrients such as phosphorus do not leach out readily because they are either fixed, held to the soil, or taken up by the plant.

Cooling

It is widely recognized that cities are warmer than rural areas. In major cities, the term urban heat island is used to characterize this temperature increase. On warm summer days, the temperature in the city can be 10 degrees warmer than the surrounding areas.

A 5,000-square-foot Kentucky bluegrass lawn contains 9 million shoots, while an average creeping bent grass putting green contains 72 million shoots. Each of these plant shoots engages in a cooling process called transpiration. Transpiration helps reduce temperatures in urban areas by dissipating high levels of radiation. To that end, turf is considerably cooler than other natural surfaces. Researchers at Brigham Young University have recorded turf temperatures that are 20 degrees cooler than bare soils and 40 degrees cooler than synthetic turf. (Williams and Pulley, 2002)

Transpirational cooling depends upon an adequate supply of water. Rainfall provides water for turfgrass and is sometimes supplemented by irrigation. Factors that influence the need for irrigation include length of the growing season, temperature, evapotranspiration rates, soil type, turf species, and management practices. It is estimated that turf—including residential and commercial lawns, golf courses, sports fields, and parkland—is the largest single irrigated crop in the United States. While residential landscapes are typically watered using municipal sources, irrigation water for golf courses comes primarily from on-site ponds, lakes, wells, and streams.

Carbon Sequestration

Carbon sequestration, or carbon storage, is the process of converting carbon dioxide (CO_2) into a form that is fairly stable. Turfgrasses, like all plants, capture atmospheric carbon dioxide and use it via photosynthesis to create usable energy in the form of sugars and carbohydrates. With increasing levels of atmospheric CO_2 associated with global warming, turfgrasses serve as a source of carbon storage, or sequestration. Most of the turf volume, or biomass, is below ground. As a perennial plant, turf serves as a significant carbon sink by storing carbon in its root mass and creating organic matter in the soil. An average-sized healthy lawn is a carbon sequestering system that can capture as much as 300 pounds of carbon per year, while a golf course fairway can capture 1,500 pounds of carbon per year.

Research shows that the carbon storing capacity of turf is comparable to the rate of carbon storage on land enrolled in the United States Department of Agriculture's (USDA's) conservation programs. For example, one soccer field can offset the carbon produced by a car driven 3,000 miles. Although positive carbon sequestration occurs in a turf system, maintenance practices that require the use of fossil fuels, such as mowing, offset this benefit. It also is offset by the fertilizer manufacturing process.

Reducing carbon emissions during turf management is a consideration for both professional turf managers and homeowners alike. New research findings have concluded that practices such as mowing, returning clippings to the turfgrass system, and feeding and watering will, in fact, increase turf's ability to sequester carbon. The healthier the turf, the more carbon it can store.

Aesthetics

The aesthetic value of turf has been recognized for thousands of years beginning with the emperors in China (157-87 B.C.) who maintained extensive grassy areas for beauty and enjoyment. Today, most Americans maintain lawns around their homes and enjoy turfgrass systems established and maintained in public parks. In urban America, lawns provide a link to nature and have been shown to reduce stress.

Quiet grassed areas affect people's moods, creating feelings of serenity, privacy, thoughtfulness, happiness, or sadness, depending upon location. Home lawns, roadside rest areas, city parks, golf courses, memorial parks, and cemeteries may elicit such feelings in the population. Moreover, lawns are among the first areas to green up in spring, providing urban inhabitants with relief from cabin fever.

Safety

Sports playing surfaces are made safer when grassed with sure footing and cushioning sod that add to the quality of play. A soft, resilient turfgrass surface buffers injuries in sports and games. Harper et al. (1984) indicated that poor field conditions were responsible for approximately 20.9 percent of high school football injuries. Worldwide, golf is a popular game played by millions of people for exercise and relaxation and, also, as an avenue for business transactions. In the United States, there are more than 14 million golfers that enjoy highly groomed grass on golf courses. Young and old enjoy volleyball, badminton, croquet, bocce, and other games on grassed areas. No other surface material feels as good on bare feet or provides a better surface for playing games and even turning somersaults.

Oxygen

Oxygen generation by turfgrasses helps make our environment habitable. A 50-foot × 50-foot lawn produces enough oxygen for a family of four. Maryland has approximately 1.15 million acres of managed turf (2005 Turf Survey). Maryland turf generates sufficient oxygen for approximately 80 million people.

ENVIRONMENTAL RISKS

As stated in the introduction, nutrients—primarily nitrogen (N) and phosphorus (P) —along with sediment pose a major threat to water quality in the Chesapeake Bay and its tributaries.

Nutrients are beneficial and even essential to plants. They become a problem, however, when they are transported to stream systems.

Water Pollution in the News

When oil-soaked debris caught fire in the Cuyahoga River (Cleveland, Ohio, June 1969), it drew national attention and spurred an environmental movement. In the 1960s, Lake Erie was declared dead when toxic substances and excess nutrients overwhelmed the ecology of the lake. Here in Maryland, bald eagles and osprey suffered near-demise from a combination of factors including hunting, habitat loss, and the use of the pesticide DDT.

Today, due to government intervention and conservation actions by the public, the fire in the Cuyahoga River is contained, Lake Erie is alive, and bald eagles and ospreys are once again thriving in the Chesapeake Bay. Environmental focus has now shifted to nutrient pollution in our streams, rivers, and the Chesapeake Bay. This threat to water quality, along with images of major fish kills and closed swimming holes, is making front-page news on a regular basis.

The relationship between nutrients and turf management is complex. Certainly, the ecology of our waterways has been altered since Europeans first colonized this continent. Excess nutrients and sediment pollute water systems to the extent that nursery areas for fish and shellfish are diminished drastically.

The mechanics of proper turf management are a mystery to the general public. To be successful in protecting and restoring the health of our waterways, the turf industry must be proactive in its approach to managing nutrients and educating the public on environmentally-healthy lawn care practices.

Factors Leading to a Decline in Water Quality

The following quotes appeared nearly 30 years ago.

"An increasing number of algal or dinoflagellate blooms was observed in the Bay in recent years."

"Submerged aquatic vegetation declined in abundance and diversity throughout the Bay."

"Oyster harvests decreased throughout the Bay…over the last 10 years."

"More recently, the catch of freshwater species in many of the tributaries has declined and the harvest of crabs is in decline."

Although these quotes are nearly three decades old, they could have been written last week. Understanding the dynamics of the many components that link together to form an ecosystem is essential to restoring the health and vitality of the Bay system. The following section describes how some of the components work together.

Effects of Excess Nutrients

Nutrients, specifically nitrogen and phosphorus, were at very low levels in the Bay prior to colonization in the 16th century. As the population grew and human activity in the watershed increased, native plant life in the Bay and its tributaries became well fed from increased nutrient runoff. In fact, the subsequent explosions of some life forms in the Bay from excess nutrients are not an invasion at all; they can be likened to an obesity problem.

Excess Nutrients Stimulate Algae Growth

The algae that bloom in the Bay and its tributaries are native species and not an imported problem. These algae originally evolved to consume nutrients in the water at a time when nutrients were very scarce in the Bay ecosystem. When excess nutrients found their way into waterways as a result of man's activities on the land, the algae simply continued to consume every nutrient introduced into their ecosystem. The result is the algae blooms that we hear so much about on the news. In fact, nutrients applied to the land to stimulate crop growth also stimulate algae growth when transported to waterways. As algae grow, they block sunlight needed by underwater plants.

Excess Nutrients Reduce Light Infiltration

When light cannot penetrate the water, submerged aquatic vegetation (SAV) dies off. A poor stand of SAV has several effects. First, there is less physical filtering of the water because SAV acts like a grassed buffer by filtering particulate matter. Second, SAV is a food source for some aquatic species. The loss of SAV means that some species go hungry or disappear altogether. Finally, SAV provides shelter and a nursery area for fish, crabs, and shellfish. With the loss of this critical habitat, the Bay harvest declines.

Excess Nutrients Reduce Dissolved Oxygen in the Water

When algae die, they are decomposed in a process that depletes the water of oxygen. Hypoxia refers to low dissolved oxygen in the water and anoxia refers to the complete absence of oxygen in the water. Fish and crabs typically avoid hypoxic zones. However, oysters, clams, worms, and other creatures that are bound to the Bay's bottom cannot escape and, therefore, die in hypoxic conditions. When bottom-dwelling creatures die, fish and crabs will not return to that portion of the Bay's bottom; and the affected area ultimately becomes a desert that is barren of all life except bacteria.

Chapter 2: How Grass Grows

HISTORY

Grass is the common name for a family of plants known as Poaceae (also called Gramineae or true grasses), which includes more than 10,000 species worldwide. Wheat, rye, oats, sugar cane, and bamboo are all members of the Poaceae family, as are the turf-type grasses that are widely used as a landscape cover in Maryland and throughout the United States. However, most of the species of turfgrass that we are familiar with today were introduced into the United States from Europe, Asia, and Africa and are the result of many years of selective breeding, cross-pollination, and accidental introduction.

STRUCTURE OF GRASS PLANTS

A mature, unmowed grass plant is composed of leaves, roots, stems, and a seed head (Figure 1). Some grass species do not have all the structures shown, and mowed grasses typically lack flower stems and seed heads.

Soil conditions, moisture, aeration, drainage, nutrients, and sunlight all play a role in the health and vitality of different varieties of turfgrasses. Differences exist in growth habits, color, texture, growth cycle, optimum mowing height, water requirements, and needed nutrients as well as susceptibility to pests, weeds, and diseases.

Although there are many varieties of turf-type grasses, all fall into one of two classifications: cool-season grasses, which, as the name suggests, grow well in the cooler months, and warm-season grasses, which turn brown when

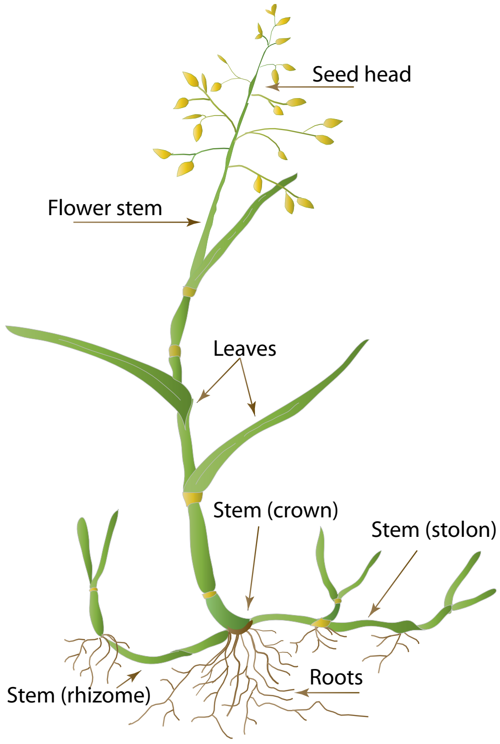


Figure 1: Diagram of a mature grass plant

cooler temperatures arrive. Maryland is located in a transition zone. Both cool-season and warm-season turfgrasses can grow; but Maryland's climate does not favor growing either group of grasses throughout the entire year.

COOL-SEASON GRASSES

Cool-season grasses grow best in cool weather. These grasses turn green in spring and stay green longer in the fall months because they prefer cooler temperatures. Common kinds include bluegrass, fine fescue, tall fescue, red (creeping) fescue, and perennial ryegrass. Shoots of cool-season grasses grow actively in the spring, representing 60 percent of all top growth (Figure 2). This top growth slows in the fall, but root growth continues. Because Maryland weather is variable, these grasses may show growth at any time of the year. Summer dormancy is a survival response to heat and drought and presents itself as off-color or browning. Most of the total fertilizer applied to cool-season grasses during the year should be spread in the fall to support root health and to help the grass recover from summer stresses. Applying fertilizer during periods of prolonged heat and drought stresses cool-season grasses and increases the potential for unused nutrients to wash into storm drains and waterways.

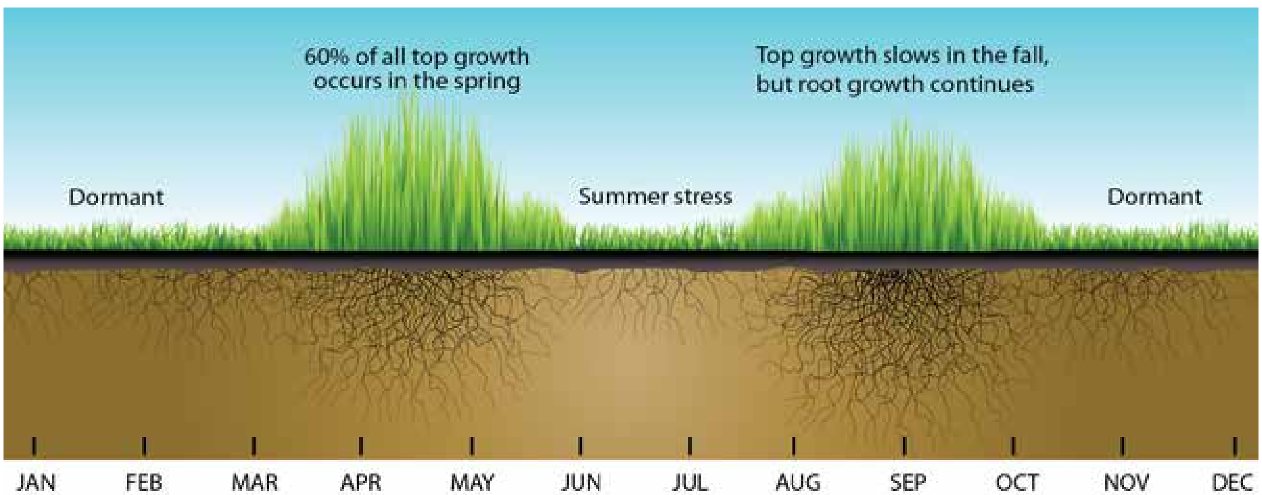


Figure 2: Growth characteristics of cool season grasses

WARM-SEASON GRASSES

The most popular warm-season grasses found in Maryland are zoysiagrass and bermudagrass. These grasses grow best in the summer. They turn brown or straw colored when cooler temperatures arrive in the fall, usually at the first frost. These sun-loving plants also green up later in the spring—typically June 1—as compared to cool-season grasses whose season lasts from late spring until early fall.

Material in this chapter adapted from Goatley, M. and K. Hensler (eds.). (2011). Urban Nutrient Management Handbook. Publication 430-350. Virginia Cooperative Extension, Blacksburg, VA.

Chapter 3: Soils and Fertility

INTRODUCTION

Soil fertility and its management is a complex process that involves numerous factors above and beyond fertilizer applications. The interactions between soil texture and structure, organic matter content, water retention, cation exchange capacity, pH, and nutrients determine the appropriate nutrient applications and how plants will respond after nutrients have been applied. Although not a comprehensive overview, this brief introduction to soils and fertility is designed to help the user make educated decisions when applying nutrients to turf.

A soil profile (Figure 3) reveals the various layers in the soil, called horizons. Soil scientists have mapped more than 70,000 types of soil in the United States. Maryland has more than 300 different soil types.

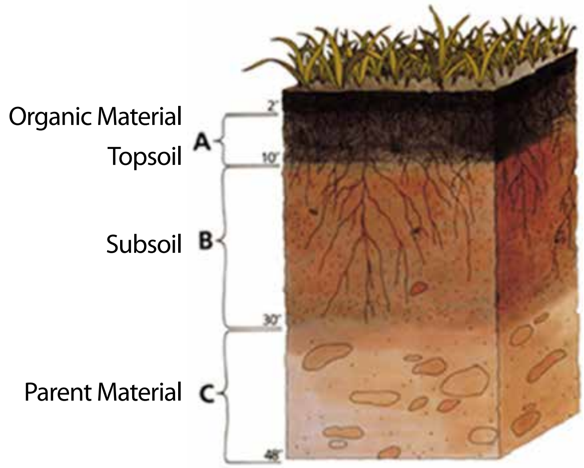


Figure 3: A soil profile

(Source: USDA Natural Resources Conservation Service)

SOIL TEXTURE AND STRUCTURE

The terms soil structure and soil texture do not mean the same thing. Soil structure refers to the arrangement of soil particles into groupings or aggregates. It describes the way soil particles are bound together and how larger, aggregated particles function. Iron and organic matter are the glues that bind these aggregates together. More aggregates result in better tilth and pore spaces that improve air movement, moisture retention, and moisture availability (Bandel et al., 2002; Goatley and Hensler, 2011).

Soil texture refers to the relative proportions of different sized mineral particles present in the soil (particle-size distribution). From smallest to largest, these mineral particles are classified as clay, silt, and sand. There is a wide variation in particle sizes. Clay is the smallest particle of a soil. Clay particles are less than 0.002 millimeters (mm) in size. Soils rich in clay are called heavy soils. They can hold abundant nutrients, but it is difficult for air and water to penetrate them. Silt is smooth and powdery. It is not as fine as clay and its particles range in size from 0.05 mm to 0.002 mm. Sand is the largest particle of a soil, ranging in size from 0.05 mm to 2.0 mm. It has more pore spaces, and water and nutrients move through it quickly.

Soil texture affects both the water-holding capacity of the soil as well as the soil's water-release capacity. A clay soil holds more water than a sandy soil. However, a clay soil may not readily release the water for plant use because the force created by the capillary action in the small pores of the clay can be greater than the force exerted by a root system as it tries to take water in, resulting in no or low water release.

POROSITY AND BULK DENSITY

Soil porosity is the open pore space between the soil particles that is filled by water and air. The ideal soil porosity is 50 percent solids and 50 percent pore space. Pore space is affected by soil texture, aggregation, amount of organic matter, compaction, and soil management practices.

Macropores (larger than 0.05 mm) allow air, roots, and water to move freely. In contrast, micropores (smaller than 0.05 mm) permit little air and water movement. Micropores are dominant in fine-textured clay soils. As a result, fine-textured clay soils tend to restrict air and water movement even though they have a large total volume of pore space. This is because the small pores of clay soils often remain full of water. The movement of air—especially in the subsoil—is reduced greatly and can be inadequate for root development and microbial activity. The rule of thumb is that, when soil particles are packed closely together as in well-graded surface soils and compact subsoils, total porosity is low. This is often the condition found in new developments when establishing new lawns.

Bulk density is the dry mass of soil solids per unit volume of soil. Bulk densities of mineral soils are usually in the range of 1.1 to 1.7 grams per cubic centimenter (g/cm^3). A soil with a bulk density of about 1.32 g/cm^3 generally will possess the ideal soil condition of 50 percent solids and 50 percent pore space. Bulk density varies depending upon factors such as texture, aggregation, organic matter, compaction and consolidation, soil management practices, and soil horizon. In general, root penetration through soils will be limited in sandy soils when the bulk density approaches 1.75 g/cm^3 and in clayey soils at 1.40 g/cm^3 (Brady and Weil, 2008). However, water, air, and roots can penetrate high-bulk-density soils that have a well-developed structure with interconnected macropores.

SOIL ORGANIC MATTER

Soil organic matter is closely related to soil productivity. Nearly all soils contain some form of organic matter. This organic matter is comprised of soil microorganisms and decaying plant and animal materials, including roots, litter, leaves, insects, and worms. These organic energy sources provide food for soil organisms such as earthworms, insects, bacteria, and fungi. In turn, nutrients released from the digestive processes of these organisms are made available to growing plants.

Soil humus is highly decomposed and stable organic matter that is derived primarily from the bodies of soil microbes and fungi. Humus is

the most reactive and important component of soil organic matter. It makes up between 60 to 80 percent of soil organic matter and is typically reported as organic matter on soil test reports.

In Maryland soils, soil organic matter usually ranges between 0.5 to 8 percent. Soils that have been planted with grass for a long time usually have a higher percentage of organic matter. The addition of organic matter improves the soil and results in increased water infiltration and improved soil tilth. Organic matter also improves soil fertility because plant nutrients are released as the organic matter decomposes.

In coarse-textured soils, i.e., sand, organic material bridges some of the space between sand grains. In turn, this increases the soil's water-holding capacity. In fine-textured heavy soil, organic material helps maintain porosity by keeping very fine clay particles from packing too tightly together, thereby enhancing porosity.

Soils that are tilled frequently usually contain less organic matter. Tillage increases the amount of oxygen in the soil, which increases the speed with which organic matter decomposes. The detrimental effect of tillage on organic matter is particularly pronounced in very sandy, well-aerated soils because the exposure to oxygen enables organic matter oxidation which converts the organic matter carbon to carbon dioxide (Goatley and Hensler, 2011).

SOIL pH

Soil pH is a measure of a soil's acidity or alkalinity. The pH scale ranges from 1.0 to 14.0. A soil pH of 7.0 is considered neutral. Anything below 7.0 is considered acidic and anything above 7.0 is considered basic or alkaline. Keep in mind that the pH scale is a logarithmic scale, which means that the difference between pH values varies by a factor of 10. For example, a soil with a pH of 6.0 is 10 times more acidic than a soil with a pH of 7.0.

Many soil chemical elements change form as a result of chemical reactions in the soil. Plants are not able to use elements in some of these forms. Soil pH influences the form and availability of elements in the soil. The result is that the availability of some plant nutrients and minerals changes with pH. Figure 4 illustrates the relationship between soil pH and the relative plant availability of nutrients and minerals.

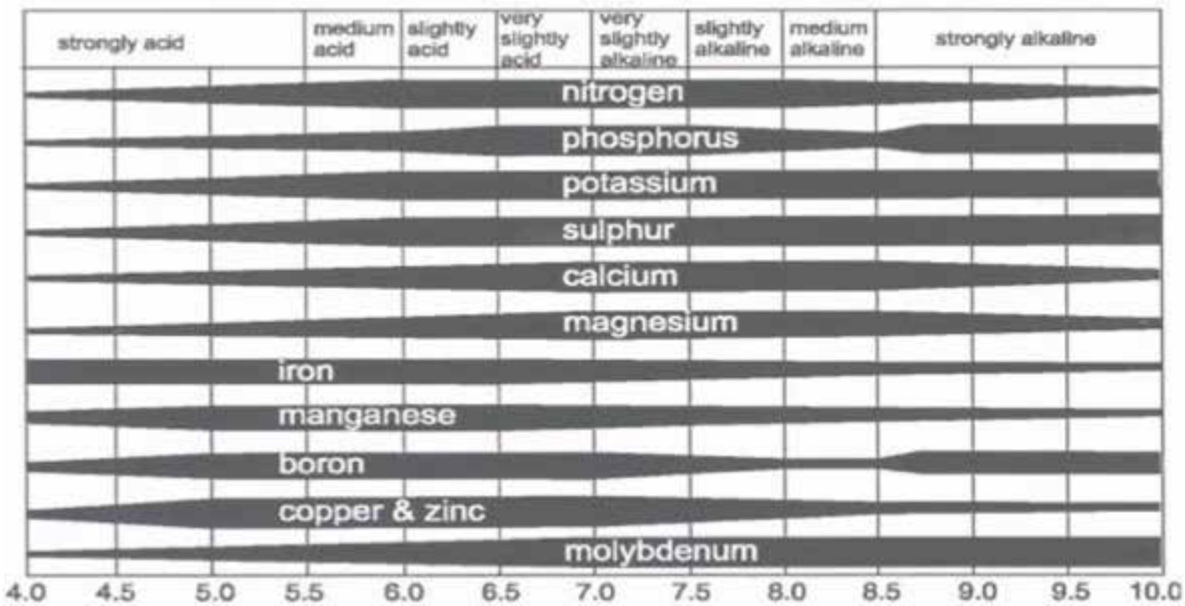


Figure 4: Nutrient uptake as a function of pH

EFFECTS OF SOIL pH ON NUTRIENT UPTAKE

The following sections provide information on the effects of soil pH on nutrient uptake. Nutrient uptake can be defined as the way plants absorb nutrients from the soil.

Potassium, Calcium, and Magnesium

The nutrients potassium (K), calcium (Ca), and magnesium (Mg) are available in soils with pH levels greater than 6.0. They are generally not as available for plant uptake in acidic soils since they may have partially leached out of the soil.

Phosphorus

Phosphorus (P) solubility and plant availability are controlled by complex soil chemical reactions that are pH-dependent. Plant availability of P is generally greatest in the pH range of 5.5 to 6.8. When soil pH falls below 5.8, P reacts with iron (Fe) and aluminum (Al) to produce insoluble iron and aluminum phosphates that are not readily available for plant uptake. At high pH values, P reacts with calcium to form calcium phosphates that are relatively insoluble and have low availability to plants.

Aluminum, Iron, and Manganese

At pH values less than 5.0, Al, Fe, and manganese (Mn) may become soluble at a level that is toxic to some plants.

Soil Organisms

Soil organisms grow best in soils with a neutral pH in the 7.0 range. In general, acidic soil inhibits the growth of most organisms, including many bacteria and earthworms. As a result, acidic soil slows many important activities carried on by soil microbes, including organic matter decay (Goatley, M. and Hensler, K., 2011; Bandel et al., 2002).

CATION EXCHANGE CAPACITY

Cation exchange capacity (CEC) is the ability of a particular soil to retain cations (the positively charged ions, i.e., K^+). Cations are the form of nutrients (largely calcium, magnesium, potassium, and sodium) that are easily available to plants. The CEC is related to the colloids in the soil, the clay content, and the organic matter content. This measurement will vary across Maryland soils.

The CEC can be compared to the size of a fuel tank on a car. The larger the tank, the more fuel it holds and the longer the car can run. For soils, the greater the CEC, the more nutrients the soil can supply (Bandel et al., 2002). A soil test will typically report CEC as milliequivalents per 100 grams (meq/100g) of air-dried soil. A low value for CEC may be 1 to 5 meq/100g. A higher CEC would be in the range of 15 to 25 meq/100g. Some clay soils (montmorillinite, for example) can be in the 70 to 100 meq/100g range. Clay and organic matter have negative charges that can hold and release positively charged nutrients. The charges keep nutrients from being washed away, so that they are available to plant roots and soil microorganisms. When the CEC is less than 10, adding organic matter is usually recommended.

URBAN SOILS

More often than not, the physical and chemical properties of the soils that we manage for turf growth in urban and suburban areas have been altered significantly from their natural state by excavating, grading, removing topsoil, or performing other operations. Simply put, urban soils do not contain the natural sequence of intact soil horizons normally found in a forest. Therefore, many of our underlying assumptions about soil testing results, plant growth response, and overall soil-plant relations may not apply.

The entire process of site development for housing, construction, or landscape development results in large amounts of soil disturbance, movement, and mixing. The degree of impact ranges from limited surface soil compaction to completely removing the native soil profile and replacing it with mixed and dissimilar fill materials. Thus, while predevelopment native soil properties will be fairly uniform and predictable on a given site, the postdevelopment site will be much more variable; and extreme short-range differences in important plant-growth-related properties such as compaction, texture, and soil pH will be common.

COMPACTION

Simple soil compaction (high-bulk density) is the most common limitation to plant growth and water movement in urban soils. Dense layers in soils are commonly called pans and may result from a variety of natural long-term soil processes; however, most are formed by grading machinery. Artificially induced pans may occur at the surface or deep in the subsoil and are often denser than natural pans or subsoil layers. They occur when several layers of soil have been disturbed, such as when topsoil is returned to a regraded lawn following new home construction or when cut-and-fill operations have reshaped an area for landscaping. Back blading is a common construction practice used to reshape the land to the final contours specified in a design. This practice involves driving a bulldozer in reverse with its blade on the ground to scrape and smooth the soil to the final desired shape. Back blading usually destroys soil structure, produces abnormally dense soils, and creates impermeable soil conditions. Additionally, back bladed soils no longer contain any natural channels or planes of weakness for roots, water, and air to penetrate.

In addition to construction compaction, normal foot traffic, game playing, or frequent tire traffic can cause compaction of the immediate surface soil, particularly when the soil is moist and readily compressible.

The ability of a growing root tip to penetrate soil directly depends upon soil strength. Soil's bulk density and moisture content are the primary controls for soil strength's ability to resist deformation or shearing. Workable, loose soils have bulk densities of 1.0 to 1.4 g/cm^3. In a clayey soil, root penetration is retarded greatly during dry conditions. However, the same soil when moist may not impede rooting because soil strength has been decreased. Sandy soils resist compaction because of their larger packing voids between particles. They can support adequate rooting at bulk densities approaching 1.8 g/cm^3 but will be limited at higher levels of compaction.

Soils that are compacted also resist water movement and gas exchange, which can seriously hinder plant growth. Compacted soils lack macropore space, which lessens water-holding capacity and rooting depth. Due to their lack of large pore spaces, water passes very slowly; therefore, dense soils often alternate between being very wet in the winter and very dry in the summer.

Compacted soils also can create wet spots in unexpected locations and can increase runoff. A compacted soil can severely limit plant growth, even if other physical and chemical characteristics, such as texture and pH, are optimal. For these reasons, soil compaction cannot be recognized by conventional soil testing and is often a hidden limitation.

Tillage (e.g., rototilling) or deep ripping (with a ripper or chisel plow) is the only practical way to improve soil porosity but may be too expensive or impractical for many home lawns or confined urban areas. Core aeration can be effective for surface compaction in home lawns. The addition of compost and/or other organic amendments into surface soil layers will promote aggregation and macroporosity, thereby decreasing bulk density over time. Grass will not grow out of compaction. Partsch et al., (1993) found that compaction below 2 inches does not recover, even after 12 years of turf growth. Similarly, certain plants (for example, switchgrass and alfalfa) are widely touted as having the ability to root deeply into compacted soils and loosen them. In summary, nutrient application cannot compensate for compaction problems.

SANDY SOILS

As more and more of Maryland's Eastern Shore is developed, more sandy urban soils with their own special management needs are appearing. Sandy soils occurring in developed areas are often low in organic matter, which results in low microbial activity and low CEC. Sandy soils usually have few drainage problems, but can have an impeding pan beneath the surface. Sandy soils can become acidic, so pH management is a concern. Adding organic matter to sandy soils improves water retention, increases the CEC, and moderates pH changes. Typically, adding organic matter will be a continual effort because organic matter can oxidize rapidly in sandy soils. Making smaller, more frequent nutrient treatments and including more slow-release nitrogen reduces nutrient losses. This strategy also is beneficial because it makes nutrients available continuously during plant growth.

Chapter 4: Soil Testing

INTRODUCTION

One of the most beneficial practices for lawn care professionals is to take soil tests for all turf properties that they manage or maintain. Soil testing provides an accurate determination of a lawn's nutrient and lime requirements. It is inefficient and potentially harmful to the environment to apply nutrients that may not be needed or that may not be adequately absorbed by turf because of high or low soil pH. Although nitrogen is the most significant nutrient governing turf growth, other factors that will not be apparent without a soil test may limit turf growth. The University of Maryland recommends that soil tests be performed for new customers and existing customers once every 3 years.

A separate soil test should be taken for each management unit. A management unit is an area of land with similar soil types and similar fertility levels (as determined by previous soil tests) that has been consistently managed in the same manner and will be managed in a similar fashion in the future.

HOW TO TAKE A SOIL SAMPLE

The reliability of a soil test largely depends upon the quality of the soil sample submitted. The small amount of soil submitted to the test laboratory must accurately represent the entire area to be fertilized. Take samples before lime, fertilizer, or organic nutrients are added. Use only clean equipment for collecting soil samples and carefully follow the directions detailed in this chapter.

Materials Needed

Use a clean plastic bucket and a soil probe or auger to take the soil sample. Do not use tools that are rusty, dirty, or made of galvanized metal. A soil probe or auger is strongly recommended for professionals, because these tools will expedite the soil sampling process. Use an auger if the soil is very stony or gravelly. If a soil probe or auger is not available, collect the sample using a garden trowel, shovel, or spade.

Taking the Sample

STEP 1:

Dig down 3 to 4 inches to the area of the soil that contains the bulk of the plant's roots. Remove a small, vertical slice of the soil profile from the soil's surface to a depth of 3 or 4 inches.

STEP 2:

To ensure that you have a composite sample, repeat the procedure in Step 1 at least 12 to 15 times in different spots of the lawn. Cover the sample area using a zigzag or W pattern. Do not collect samples from areas that are obviously or significantly different—such as a patch of dead grass or a low spot in the yard.

STEP 3:

Where poor growth exists, separate samples should be taken from both good and bad areas, if possible. Treat each area as a separate management unit.

STEP 4:

Mix the samples thoroughly in a clean bucket, removing roots, rocks, debris, and plant material.

STEP 5:

Fill the soil sample bag with approximately one cup of dry, mixed soil from the composite sample. Do not send wet soil. Allow samples to air dry, if necessary. Do not heat, as this may affect the accuracy of the test.

STEP 6:

Package the soil sample, identify management units, and include client information for each sample.

WHERE TO SEND THE SAMPLE

Send soil samples to a testing lab that uses methods and procedures approved by the University of Maryland. Submit each sample with its corresponding paperwork. Appendix C of this manual contains a list of these labs; additionally, the MDA website at **www.mda.maryland.gov** provides the list of laboratories. Laboratories use many different methods to test soil. Not all of these methods provide accurate results or are approved for Maryland soils. Maryland soils are substantially different from soils on the west coast. Generally, it is best to use a laboratory located in the same geographic region as the soil being tested.

INTERPRETING RESULTS

Soil testing laboratories will report levels of phosphorus, potassium, and other nutrients. Nitrogen usually is not reported because it readily converts to nitrate soon after application and is very mobile in the soil, making soil test results for nitrogen difficult to interpret. Nitrogen recommendations for grass depend on the type of grass grown and how the area is used.

Because labs use different methods and procedures to test for nutrients, a single soil sample sent to two different labs will yield different results. Moreover, laboratories differ in the units used to report; some report parts per million (ppm), others report pounds per acre (lbs/ac), and some could use an index.

Most laboratories will also provide fertilizer and lime recommendations. Maryland law, however, requires lawn care professionals to follow University of Maryland recommendations when applying nitrogen and phosphorus. **Therefore, do not follow the fertilizer recommendations provided by the lab for those nutrients**, as they may differ from Maryland's recommendations due to assumptions made by the lab, differences in soils, climate, and state water quality policies. Instead, follow the nitrogen and phosphorus recommendations included in University of Maryland Publication TT-115 (see Appendix A). To confirm that you have the latest update, always check the MDA Nutrient Management website.

Lime, potassium, and other nutrients included in the soil test results are not regulated under Maryland law.

Maryland recommendations for phosphorus are based on the soil test categories of low, medium, optimum, or excessive, as determined by the Maryland Fertility Index Value (FIV). The University of Maryland's former soil testing lab reported the results as FIV numbers. For quick reference in Maryland, an FIV with a range of 0 to 25 falls in the low category, 26 to 50 is medium, 51 to 100 is optimum, and anything over 100 is excessive.

Many laboratories categorize nutrient levels as low, medium or high. **Disregard the category provided by the lab for phosphorus**, because it may not be the same as Maryland's categorization.

The University of Maryland has developed formulas to convert nutrient levels reported by approved laboratories to the equivalent Maryland FIV. You must use the actual value reported by the lab for phosphorus or phosphate (P_2O_5) and use the chart in Appendix D to determine the Maryland soil test category. Follow the recommendation for the appropriate soil test category found in TT-115 for turf maintenance, TT-116 for seeding, or TT-118 for golf course maintenance.

Chapter 5: Interpreting Fertilizer Labels

INTRODUCTION

The State Chemist Section of the Maryland Department of Agriculture regulates the sale and distribution of fertilizer products sold in Maryland. Maryland law defines the term *specialty fertilizer* as a fertilizer distributed for nonfarm use. It includes turf fertilizer; all-purpose garden fertilizer; house-plant fertilizer; and numerous potting soils, soilless mixes, and soil substitutes that contain supplemental nutrients. Turfgrass fertilizer is a subset of general specialty fertilizers.

Proper fertilization is critical to healthy and vigorous turf growth. While general fertility guidelines can aid in maintaining high quality turfgrass, even the best recommendations provide little value if fertilizer is applied incorrectly. The ability to read and understand a fertilizer label is essential when purchasing and applying turfgrass fertilizers.

Many types of fertilizer are available for use on turfgrass. A fertilizer is referred to as complete when it contains nitrogen (N), phosphorus (P), and potassium (K)—three nutrients widely used for turfgrass fertilization. In certain situations, incomplete fertilizers containing some combination of N, P, and K (but not all three elements) may be the best choice. In response to the Fertilizer Use Act of 2011, maintenance turf fertilizer sold in Maryland no longer contains phosphorus.

THE THREE NUMBERS ON THE FERTILIZER LABEL

By convention, in the fertilizer industry, phosphorus and potassium contained in fertilizer are reported as phosphate (P_2O_5) and potash (K_2O). Most commercial fertilizer products have three numbers on the front label that are separated by dashes, for example, 32-0-10. This is the fertilizer analysis or grade and represents the percent, by weight, of the three most important plant nutrients: nitrogen, phosphate and potash, in that order.

A 32-0-10 fertilizer product contains 32 percent nitrogen by weight. For every pound of fertilizer applied, there is only 0.32 pound of nitrogen. The middle number on the fertilizer bag refers to the percent of phosphate. A 32-0-10 fertilizer contains 0 percent phosphate by weight. The final number on the fertilizer bag states the percent of potash. Again, a 32-0-10 fertilizer product contains 10 percent potash by weight. The remaining 58 percent of the product contains other nutrients and fillers.

To determine the weight of each nutrient in the bag of fertilizer, multiply the weight of the bag by the percent of the nutrient, expressed as a decimal. For example, a 12.5 pound bag of fertilizer labeled 32-0-10 contains 32 percent nitrogen. Multiply the weight of the bag (12.5 pounds) by the percent of nitrogen (0.32) to obtain the weight of nitrogen: 4 pounds.

Sometimes a fourth number is present (for example, 12-0-0-6). This indicates the percent by weight of a fourth nutrient. The fourth number represents any nutrient other than N, P, or K. Consult the label on the back of the package to determine the nutrient represented by the fourth number. For turf fertilizer, the fourth nutrient is often iron, calcium, or magnesium.

An easier way to compare the numbers on a fertilizer product is to break them down to the fertilizer ratio or the amounts of the three major nutrients in relation to each other. For example, a 32-0-10 fertilizer product has a ratio of 3-0-1. This becomes important when a fertilizer is sought for a specific need. A 1-2-1 ratio is often recommended for vegetables, which need plenty of phosphorus to set fruit. A 1-2-1 ratio could be 5-10-5, 10-20-10, or any similar extrapolation.

THE FERTILIZER LABEL

Every fertilizer material, whether complete or incomplete, must carry a label stating the guaranteed analysis of the material. The exact label information varies from state to state, as no national uniform standards exist. In Maryland, however, the manufacturer is required to include the following label information.

- Name, brand, or trademark.
- Guaranteed chemical analysis. This is the minimum percentage of plant nutrient claimed.
- Manufacturer's name and address.
- Net weight of fertilizer in the container.
- Grade.

Other nutrients, if claimed on the product label, are listed as a percentage by weight, on an elemental basis, as prescribed by regulation.

The label of a turf fertilizer product contains the following directions for use.

- Recommended application rate or rates in units of weight or volume per unit area of coverage.
- Effective October 1, 2011, turf fertilizer sold in Maryland must contain either an environmental hazard statement recommended by the U.S. Environmental Protection Agency, or the following statement:

  "Do not apply near water, storm drains or drainage ditches. Do not apply if heavy rain is expected. Apply this product only to your lawn and sweep any product that lands on the driveway, sidewalk, or street, back onto your lawn."

The Maryland State Chemist at the Maryland Department of Agriculture tests the product to guarantee the analyses.

NITROGEN

Nitrogen is the most important element in turfgrass management because it is present in larger percentages than other minerals in turf tissues. Turf uses this large quantity of nitrogen to form chlorophyll, a substance necessary for photosynthesis. Nitrogen also comprises portions of plant proteins, amino acids, enzymes, and vitamins. Obviously, nitrogen is important for turf development and health. Turf plants absorb nitrogen primarily in the nitrate (NO_3^-) form, although plants can take in the ammonium form (NH_4^+).

Nitrogen fertilization also is important for turfgrasses because it elicits the strongest growth response of any mineral element. Nitrogen mineral fertilization often is used to enhance green color and increase or maintain high density, both of which improve turf appearance. Response to nitrogen fertilization can be quick. Under good growing conditions, nitrogen can be translocated into leaf tissue within 15 to 24 hours following application. This quick response to fertilizer is often referred to as green up. Turf that receives proper nitrogen fertilization generally has good color and density.

It is difficult to conduct a nitrogen fertility program based upon soil test results. Typical soil tests do not report nitrogen. Soil nitrogen may exist in many different forms that can change quickly, becoming available or unavailable to plants. For this reason, most labs do not test or report nitrogen.

In addition to listing the percentage of nitrogen, phosphate, and potash by weight, a turf fertilizer product's label describes how much of the total N is water-insoluble nitrogen (WIN). The WIN component releases N slowly over a long period of time (several weeks, months, or years) as opposed to water-soluble nitrogen (WSN), which is quickly available. For lawn maintenance, a fertilizer containing both WSN and WIN is desirable. WSN is quickly available to turf and provides 4 to 6 weeks of improved color and growth very soon after application. However, WSN is more likely to cause foliar burn at rates exceeding 2 pounds of nitrogen per 1,000 square feet or during periods of hot, dry weather. If you want a longer period of response and fewer applications, consider using a fertilizer containing more slow-release nitrogen.

WIN is slowly released by one of several mechanisms and is less likely to cause foliar burn. It provides a longer lasting response than quickly available WSN. It also is more expensive per pound of nitrogen applied, especially if the WIN was derived from natural organic sources such as sewage sludge, plant extracts, proteins, etc. The fertilizer also might contain slowly available water-soluble nitrogen. As the term suggests, this form of nitrogen is soluble in water; however, it dissolves so slowly that it should be considered a slow-release source of nitrogen along with the WIN.

The label will list total N as a percentage by weight. It also will list percentages of the following forms of nitrogen, if they are present in the product: ammoniacal nitrogen, nitrate nitrogen, urea nitrogen, WIN, and other recognized and determinable forms of N. These forms of nitrogen must equal the Total Nitrogen Guarantee.

No fertilizer label may contain a statement that connotes or implies that certain plant nutrients contained in a fertilizer are released slowly over a period of time, unless the slow release components are identified and guaranteed.

The terms, water insoluble, coated slow release, slow release, controlled release, slowly available water soluble, and occluded slow release all describe slow-release products. Manufacturers of these products must have a testing program to substantiate the claim. To determine the amount of soluble N, add the percentages of N forms that are not WIN and not guaranteed as slowly available N. Divide by the percentage of total N and multiply by 100. Table 1 shows common sources of nitrogen in fertilizer.

Table 1: Common sources of nitrogen in fertilizer

Inorganic Sources	Organic Sources
Ammonium nitrate	Alfalfa meal
Ammonium sulfate	Blood meal
Ammonium phosphate	Chilean nitrate
Diammonium phosphate (DAP)	Compost
Dimethylenetriurea (DMTU)	Cottonseed meal
Discyanodiamide (DCD)	Crab meal
Isobutylidene diurea (IBDU)	Gluten
Methylene Urea	Grass clippings
Methylenediurea (MDU)	Feather meal
Monoammonium phosphate (MAP)	Fish meal
Potassium nitrate	Manure
UAN (a solution of urea and ammonium nitrate)	Milorganite®
Urea	Soybean meal
Ureaform	
Urea-formaldehyde	

PHOSPHORUS

Physiologically, phosphorus helps hold and transfer energy required by turfgrass plants for metabolic processes. Phosphorous contributes to many fundamental plant processes, such as rooting and setting flower buds. However, it makes up only a small portion of dried turf tissues. The greatest growth response to phosphorus is usually observed with new turfgrass seedings. Phosphorus deficiencies are rarely observed in established turf, unless the phosphorus level in the soil is extremely low or an unfavorable soil pH exists. When a deficiency exists, turf plants may suffer from reduced growth, dark or reddish leaf color, or narrow leaf blades. The product label lists available phosphate as a percentage by weight.

Initially, the absence of phosphorus in lawn fertilizer products sounds like a serious lack of a critical nutrient. However, the phosphorus needs of healthy established turfgrass are very small compared with their nitrogen needs. Turf uses an estimated 0.10 to 0.25 pound of phosphate per 1,000 square feet per year. Simply returning clippings to the turf will meet a significant portion of turfgrass's phosphorus needs. Chopped leaves left on the turf also will provide phosphorus. Under Maryland law, fertilizer containing phosphorus may only be applied to established turf if soil test results indicate a deficiency.

POTASSIUM

Potassium plays a vital role in healthy turfgrass growth and development and is second to nitrogen in the amounts required for turf growth. Physiologically, potassium is involved in cellular metabolism, environmental stress resistance, disease incidence, internal water management, and wear tolerance.

As with phosphorus, potassium applications should be based upon soil tests. The principal factors affecting the potassium requirement for turf are clipping removal, irrigation, and soil texture. If clippings are removed, more potassium is generally required to maintain satisfactory growth. The specific requirement is usually about half the rate at which nitrogen is applied. When clippings are returned to the soil, the potassium requirement is 2 to 2.5 pounds less per 1,000 square feet per year. Very sandy soils tend to lose potassium more rapidly through leaching. Potassium reserves are more difficult to build up in sandy soils. Smaller and more frequent applications of potassium are recommended for coarse-textured soils.

High-potash fertilizers are often called winterizers. Manufacturers generally recommend that these fertilizers be used in autumn so that turf can derive the benefits of potash during the winter months. Potash certainly plays a role in turfgrass cold tolerance, but it also is important at other times of the year. The UMD recommendation is to maintain continuously adequate potash levels so that turf can derive potash benefits throughout the entire growing season. The product label will list soluble potash as a percentage by weight.

LIQUID FORMS OF FERTILIZER

Liquid forms of fertilizer usually are absorbed faster than dry formulations. These water-soluble or liquid fertilizer products are applied either to the soil or on the foliage. Many water-soluble fertilizer formulations are available. These range from high nitrogen plant starter formulations to minor element formulations. Iron chelate (pronounced KEY-late) is widely used to prevent and control iron deficiencies in azaleas, rhododendrons, and other popular ornamentals.

A quick solution to correct minor iron and manganese element deficiencies is to spray liquid or water-soluble fertilizer on the foliage. Absorption begins within minutes of application and is usually completed within 1 to 2 days. However, this method does not provide all the nutrients required by plants, and several applications may be necessary to correct nutrient deficiencies during the growing season.

The most popular forms of iron applied in turf applications are the chelates, which are applied as sprays over the top of the turf canopy. Liquid organic chelates are easy to handle, mix, and apply and can be tank-mixed with most pesticides. Chelated fertilizer products improve plant uptake by reducing the rate that iron changes into insoluble compounds in the soil. The benefit derived from foliar applications of iron is a rapid, deep-green color without a surge in shoot growth. Granular iron helps increase soil iron levels but does not provide rapid color response.

In determining how much nitrogen, phosphate, and potash are contained in a liquid fertilizer, it is important to remember that a liquid ounce generally does not weigh an ounce. The fertilizer analysis indicates the percent by weight of each element. For example, to determine how much nitrogen is contained in a 2.5-gallon jug of 6-0-0 fertilizer, you will need to know the weight per gallon of the fertilizer. The front of the package provides this information, as indicated in the following example.

Simply divide the weight in pounds by the volume in gallons. In this case $30 \div 2.5 = 12$ pounds per gallon. Each gallon of this fertilizer weighs 12 pounds. To determine the nutrient content, multiply the weight (12 pounds) by the percent of nitrogen (6%): $12 \times 0.06 = 0.72$ pound of nitrogen per gallon of liquid fertilizer.

If the information cannot be found on the label, pour a gallon of the fertilizer into a bucket and weigh it. Subtract the weight of the empty bucket to obtain the weight per gallon of the fertilizer. Most liquid fertilizers weigh between 10 to 12 pounds per gallon.

Chapter 6: University of Maryland Fertilizer Recommendations

INTRODUCTION

Turfgrasses require 16 chemical elements for growth and development. These elements can be divided into two main groups based upon how turf plants obtain them. The first group includes carbon (C), hydrogen (H), and oxygen (O) that are obtained from atmospheric carbon dioxide and water.

The second group includes minerals derived from the soil or fertilizer applications. This group can be divided further into three groups, based upon the quantity of the minerals that will be used.

- Turfgrasses use the macronutrients nitrogen (N), phosphorus (P), and potassium (K) in relatively large quantities.
- Turf plants use secondary nutrients sulfur (S), calcium (Ca), and magnesium (Mg) in somewhat smaller amounts.
- Plants use the micronutrients iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), molybdenum (Mo), boron (B), and chlorine (Cl) in the smallest amounts.

A deficiency in any one of these elements—even one that is needed only in minute quantities—will adversely affect the growth of the grass. However, most micronutrients are found in sufficient quantities in the soil and, generally, fertilizer is not required to add these micronutrients. Commercial fertilizer application mainly is focused upon N, P, and K and, to a lesser extent, S and Fe. These five nutrients are the focus of Table 2.

Table 2. Growth responses of major minerals used by turf

Mineral	Response
nitrogen (N)	green color; shoot growth and density; root growth; carbohydrate reserves; recuperative potential; heat, cold, drought hardiness; wear tolerance; disease susceptibility
phosphorus (P)	establishment rate; maturation; root growth; seed production
potassium (K)	root growth; heat, cold, and drought hardiness; wear tolerance; disease susceptibility
sulfur (S)	green color; shoot growth and density; root growth; carbohydrate reserves; disease susceptibility
iron (Fe)	green color; shoot growth and density; root growth; carbohydrate reserves; heat, cold, drought hardiness; wear tolerance

(Voigt et al., 1998)

Proper nitrogen fertilization is essential in maintaining quality turf that is resistant to pest problems, tolerant of stresses, and able to recover from damage. Current nitrogen recommendations are based upon extensive research and depend upon a variety of factors such as turfgrass species and cultivars; age of turf; soil type; management practices (irrigation, clipping removal, pest control programs); weather, how the area is used; length of growing season; and the need for recovery from pest damage, adverse environmental conditions, and traffic.

As a turfgrass professional, you must take into account all these factors in devising an appropriate nitrogen fertilization program. The program may vary from year to year as these conditions change.

When discussing rates of nitrogen fertilization, there are two primary issues: how much nitrogen may be applied in any one application and how much total nitrogen may be applied annually.

LIMITING RATE PER APPLICATION

The maximum amount of nitrogen that should be applied in one application primarily depends upon the amount of soluble nitrogen in the fertilizer. Research performed on many sites nationwide indicates that no more than 1.0 pound soluble nitrogen per 1,000 square feet should be made in a single application.

Maryland Law

Maryland law has simplified and modified the research findings. Applications are limited to no more than 0.9 pound total nitrogen per 1,000 square feet in any one application. Soluble nitrogen is limited to 0.7 pound per 1,000 square feet in any one application.

Annual Application Limits

As previously discussed, annual turfgrass requirements for nitrogen vary considerably depending upon a variety of conditions. However, the most critical is the turfgrass species. Annual nitrogen requirements for maintaining established stands of the most common turfgrass species grown in Maryland generally fall into the ranges listed in Table 3. Appendix A, *UMD Turfgrass Technical Update TT-115*, provides complete University of Maryland recommendations for commercially maintained lawns and turfgrass. Visit the MDA Nutrient Management website for the latest update.

Table 3. Annual nitrogen recommendation rates for commercially maintained turfgrass

Total Nitrogen Annually (pounds of N per 1,000 square feet)		
Cool-Season Grasses	**Years 1 Through 2**	**Subsequent Years**
Kentucky bluegrass	3.0 - 4.0	2.0 - 3.5
Turf-type tall fescue	2.5 - 3.5	2.0 - 3.0
Fine fescue	1.0 - 2.0	0.0 - 1.5
Perennial ryegrass	2.5 - 3.5	2.0 - 3.0
Warm Season Grasses	**Years 1-2**	**Subsequent Years**
Bermudagrass	2.0 - 4.0	2.0 - 3.0
Zoysiagrass	1.0 - 2.0	0.0 - 2.0

(Turner, 2013)

APPROPRIATE USE OF SOLUBLE AND SLOW-RELEASE NITROGEN

Numerous studies indicate that introducing slow-release fertilizer into the fertility program results in reduced nitrogen leaching. For the most part, slow-release formulations are beneficial. There are two considerations about slow-release nitrogen that should be taken into account. First, without approximately 0.5 pound soluble nitrogen per 1,000 square feet, the turf may not have a green-up response. This increases the likelihood that the homeowner may go out and purchase more fertilizer and end up over-fertilizing his or her lawn. Therefore, extensive use of slow-release fertilizer should be coupled with client education so that the client understands that an immediate response will not be forthcoming. Second, late applications of slow-release fertilizer may linger in the soil until after the turf has gone dormant. This may result in nitrogen release at a time when the turf is not taking up nutrients, increasing the potential for nitrogen leaching.

LIMING AND pH

Maryland soils are generally somewhat acidic. Application of lime on acidic or low pH soils will raise the pH, enhance the availability of essential plant nutrients, supply calcium and magnesium for plant use, reduce the toxicity of substances in soil that restrict root growth, improve soil structure, and promote the growth of beneficial soil microorganisms. A slightly acidic soil with a pH near 6.4 is optimum for most lawns and the soil microorganisms that recycle grass clippings. Raising the soil pH above 6.8 has no benefit and, in some instances, can be detrimental. Soils with different textures, but the same initial pH value, usually require different rates of lime applications. For example, a sandy loam soil with a pH of 5.5 may need 65 pounds of lime per 1,000 square feet, whereas a silt loam soil may need 150 pounds of lime. Soil pH will decrease (become more acidic) over time. Most nitrogen fertilizers used on lawns contribute to soil acidification. Applying the recommended rate of lime will maintain the soil pH within the desired range for 2 to 3 years on sandy soils and 3 to 4 years on finer-textured soils. Soils that test low in magnesium should receive dolomitic lime, which has a higher magnesium content than calcitic lime. Annual applications of lime may be excessive and can decrease the availability of soil nutrients and increase the severity of root-infecting turf diseases. Deficiencies of iron, manganese, and zinc may occur in turfgrasses with an excessively high soil pH. Soil test results will indicate how much lime is needed.

TIMING

The basic concept of timing is that fertilizer should not be applied unless either the shoots or the roots of the turf are actively growing. This means that fertilizer should not be applied in winter when the grass is dormant and in summer if heat and lack of precipitation have combined to make the cool-season turf go dormant. Appendix A contains UMD publication TT-115, which provides details. Check the publication date to ensure you have the latest version. The MDA Nutrient Management website contains up-to-date recommendations.

MOWING

There is often a disconnect between the turfgrass management professional and the client, especially regarding mowing. The client needs to be educated in how mowing affects the aesthetics and function of turf. For turf-type tall fescue, mowing below 3 inches has negative impacts upon turf performance, health, and appearance.

Low and infrequent mowing are perhaps the major causes of lawn deterioration. Mowing low forces the plant to put more energy into top growth. The result is shallow and less-dense roots, which allow more weeds to emerge.

When mowing, never remove more than 1/3 of the leaf surface at any time. For example, if the desired mowing height is 2.0 inches, do not allow turf to grow higher than 3.0 inches before mowing. By mowing to a height of 3.0 to 3.5 inches, broadleaf weeds can be reduced by 50 to 80 percent compared to turf mowed at a 2.0-inch height. Taller turf results in roots that are healthier and turf that is cooler. Finally, taller turf stays greener in the summer. It is best to maintain the mowing heights shown in Table 4. Mow as needed and return clippings to the lawn, but avoid mowing when turf is under heat and drought stress.

Table 4. Mowing height for Maryland turf

Turf Type	Spring and Summer (inches)	Autumn and Winter (inches)
Kentucky bluegrass	2.5 - 3.0	2.0
Perennial ryegrass	2.5 - 3.0	2.0
Tall fescue	2.5 - 3.0	3.0
Fine-leaf fescue	3.0 - 4.0	3.0
Zoysiagrass	0.5 - 1.0	0.5 - 1.5

(Dernoeden, 2003b)

GRASS CLIPPING MANAGEMENT

In a field plot study (Starr and DeRoo, 1981), impacts of clipping management were examined. Test plots with returned clippings had more vigorous growth. The average daily rate of growth was 60 percent greater for the plots with clippings returned. Soil nitrogen in the first 10 centimeters was greater for the plots with clippings returned. Another study (Kopp and Guillard, 2002) found that returning clippings to the lawn improved the growth and quality of turfgrass and reduced the need for nitrogen fertilization by as much as 50 percent.

DROUGHT TOLERANCE

Water conservation begins with proper species and cultivar selection at the time of turf establishment. Zoysiagrass and bermudagrass are the most heat- and drought-tolerant turfgrasses grown in Maryland. Zoysiagrass is preferred because it is winter-hardy, requires less care, and grows more slowly than bermudagrass. Both species are warm-season grasses that develop a brown color as they enter winter dormancy (Dernoeden, 2003a). However, most people prefer a cool-season turf because it stays green longer.

Turf-type tall fescue can become dormant when the weather is too dry and hot. When cooler, rainy weather returns, the turf will break dormancy and green up. The turf must be healthy for this to occur. Turf grown in a poor soil or with a poor root system will not fare well in drought.

Bluegrass has not fared as well in hot, dry weather; however, newer varieties promise better drought tolerance. In the past, bluegrass had to be irrigated to do well in drought conditions.

Warm season grasses do not have many problems in drought and, although they grow better when irrigated, they will survive without it. Bermudagrass used as athletic turf should be irrigated if it is expected to survive heavy traffic and use.

IRRIGATION

If the customer has good soil and healthy cool-season turf, the turf can be allowed to go into dormancy during the hot, dry summer months. The customer must understand that the turf will recover when rain returns. If necessary, the best time to irrigate is when the turf is just beginning to show signs of wilt. This, of course, is not always easy to determine. Turf exhibits two prominent symptoms as it begins to wilt: (1) foot printing, and (2) a blue-green or blue-gray leaf color. After walking across drought-stressed turf, the leaves will remain depressed for several minutes, providing the foot printing effect. When dormant turf exhibits foot printing or develops a blue-gray color under extreme drought conditions, it is very important to irrigate to avoid permanent leaf wilt.

If the lawn is under drought stress and the customer wants to irrigate, the soil should be wet to a depth of 4 to 6 inches. Frequent, shallow irrigation (for example ¼ inch of water) encourages shallow roots. This makes turf vulnerable to drought and heat damage. Deep watering encourages the roots of grass plants to grow deeper into the soil. This indirectly enhances the drought resistance of turfgrasses by providing a greater reservoir of soil water for plants to draw upon. The duration and quantity of water needed greatly depends upon soil texture, structure, and thickness of the thatch. In many housing developments, lawns are grown on heavy clay subsoils deposited when foundations and basements are excavated. This type of soil resists water penetration and the downward movement of water (percolation) through the soil. In many situations, it is extremely difficult to get water percolation to a 4 to 6-inch depth. For this reason, water must be applied slowly on heavy clay soils or where hard pans and dense layers of thatch exist (Dernoeden, 2003a).

Over-irrigating can cause nutrients to leach, nutrient-laden water to run off, or both. Turf root systems do not extend more than 6 inches in a density sufficient to utilize irrigation water. Irrigation that causes runoff is either being applied too heavily or allowed to run too long. Runoff from turf will contain both nitrogen and phosphorus in some amount. Irrigating to the point of runoff allows nutrient losses that are simply unnecessary. Proper irrigation should dampen the soil to a depth of 6 inches. Advise the homeowner to use a shovel to check how deep the irrigation water penetrated. A catch pan may be placed on the lawn to determine how much water is needed for a 6-inch penetration.

ENVIRONMENTAL AND MANAGEMENT CONDITIONS

Good turf managers understand that each growing season is different. Fertilization practices should be altered in response to environmental changes. Certain conditions, such as excessively cool and wet or hot and dry weather, require different fertilization practices. Cool, wet conditions are favorable to cool-season turf growth and nitrogen leaching. Under such conditions, turf may require additional fertilizer. Hot, dry weather is unfavorable for cool-season turf growth and less fertilizer may be required.

In addition, differences in soil, light, and shade can dictate different fertility regimes. Nitrogen leaching is more likely to occur on sandy soils. Increase the frequency of nitrogen applications, but at lower levels per application to help reduce nitrogen leaching while maintaining the health of the turf. Under shady conditions, the low end of the fertility range should be used since the nitrogen requirement of grasses is lower in shade than in full sun.

Heavily irrigated turfgrasses generally require additional fertilizer because of leaching and increased turf growth rate. To maintain turf quality, evaluate turf fertilization after making changes in other management practices.

REDUCING ANNUAL NITROGEN NEEDS

For tall fescue maintenance, the nominal annual nitrogen requirement is 2 to 3 pounds of nitrogen per 1,000 square feet. Cultural practices and good seedbed preparation can reduce this need. Turf planted on a clay subsoil will never have low nitrogen requirements unless the soil itself is altered. Tilling the soil and mixing in compost will allow the root system to grow and access more nutrients, which reduces annual nitrogen needs.

As turf ages, a layer of microbe-rich organic matter develops at the base of the root system. Growth of this layer requires nitrogen; but, at some point, nutrients are no longer necessary purely to develop microbial colonies. Although the time frame for this development has not been researched extensively, it appears to take approximately 10 years for this to occur in healthy turf. At 10 years, the annual nitrogen application can be cut back by approximately 1 pound of nitrogen per 1,000 square feet.

The grasscycling described in the *Grass Clipping Management* section should be credited in a fertility program as 1 pound of nitrogen per 1,000 square feet as soon as it has been started.

All of the nitrogen reductions described previously assume that the turf is healthy. A visual assessment is required to determine if the turf is healthy enough to cut back on the annual nitrogen application.

COMPOST AND SOIL AMENDMENTS

It is a common practice to use compost and other organic amendments to improve the soil. Used over time, they will increase soil tilth, water-holding capacity, and porosity, while providing a reservoir of nutrients. The analysis of many of these amendments is often very low (3-2-2, for example). When applied in large quantities, however, they can contribute a significant amount of nitrogen and phosphorus to the soil.

A soil test is required prior to the surface application of compost. The soil test must show that the phosphorus level is either low or medium. A compost analysis is also required. A single application of compost is limited to the lesser of 0.9 pound of nitrogen per 1,000 square feet or the P_20_5 application rate recommended by the University of Maryland according to soil test results.

Professional fertilizer applicators must reduce the annual amount of commercial fertilizer applied by the amount of nutrients contained in any compost or other organic nutrient source known to have been applied to the property. This includes materials applied by the homeowner, to the extent that this information is known by the professional.

Many products sold in Maryland as soil amendments contain a significant amount of nutrients. Regulations require professional fertilizer applicators to reduce the annual amount of commercial fertilizer applied to turf by the amount of nutrients contained in soil amendments.

Material in this chapter adapted from Goatley, M. and K. Hensler (eds.). (2011). Urban Nutrient Management Handbook. Publication 430-350. Virginia Cooperative Extension, Blacksburg, VA.

Chapter 7: Use and Calibration of Application Equipment

INTRODUCTION

There are several types of equipment that can be used to apply fertilizer. The equipment selected is usually determined by the type of fertilizer being used and the size of the area to be fertilized. Dry fertilizer is applied with either a drop spreader or a broadcast (rotary) spreader. Each type of equipment has its advantages and disadvantages.

DROP SPREADERS

Drop spreaders (Figure 5) allow granules to drop out of a hopper by gravity. These spreaders provide the most controlled product distribution method because the material falls directly below the release point. Wind is of minimal concern and distribution is uniform; however, applications take longer because a relatively small width is covered in a single pass. Drop spreaders are preferred when applying very fine material or a mix of nutrients of differing sizes. They are ideal for use near impervious surfaces and are particularly useful on small medians and narrow strips of turf planted between roads and sidewalks.

Figure 5. A typical gravity-fed, push-type drop spreader

BROADCAST/ ROTARY SPREADERS

Broadcast spreaders (Figure 6) deliver the fertilizer product by dropping a dry granule onto a spinning impeller. The spread pattern of a broadcast spreader is not as precise as a drop spreader, but usually it is the preferred means of rapidly delivering fertilizer to a large area. A consistent walking speed is important to optimize uniform delivery. In addition, wind affects distribution uniformity—especially when using a light-weight product.

The potential for the product to land on paved surfaces, or hardscapes, is much greater with broadcast spreaders because of the wide throw of the materials in the spread pattern. Take extra care when using these spreaders near sidewalks, driveways, and streets to ensure that the product does not land on hardscapes and potentially end up in a nearby water source.

Figure 6. Broadcast spreader

Spreading mixed materials of different sizes is problematic with broadcast spreaders because larger, heavier particles are thrown farther than smaller particles, thereby reducing the even distribution of nutrients.

Broadcast spreaders can hold large volumes of fertilizer and rapidly apply it with good uniformity.

Deflectors, when in good working order and used properly, exclude fertilizer from one side of a broadcast spreader, usually the right side. Many broadcast spreaders have deflector attachments (Figure 7) that minimize the potential for fertilizer ending up on nontarget areas such as hard surfaces. Fertilizer that makes it to a hardscape will end up in the nearest body of water and directly contribute to nutrient pollution. Even when deflectors are used, the site should be inspected after application and the product swept up or blown back onto the turf. Maryland law requires fertilizer that lands on hardscapes be swept back on to the turf. Using a deflector is easier than sweeping and the environmental benefits are a bonus.

Figure 7. Broadcast fertilizer spreader with deflector attachment

HOW TO MEASURE A LAWN

After determining the source and form of nutrients that best fit the situation and the type of spreader that will be used, an accurate estimate of the surface area that requires fertilization is needed. A few basic shapes (such as rectangles, triangles, and circles) can be used to calculate the square footage of an area. For information on using these basic shapes to calculate square footage, see *Home & Garden Mimeo # HG 306, How to Measure Your Yard*, in Appendix B. To get a reasonable estimate of the size of the area, it is an acceptable practice when measuring distances to pace the property, rather than using a tape measure. Additionally, there are commercial software products available such as Go iLawn, iSqFt, and Real Green Systems' Service Assistant that allow the lawncare professional to measure clients' properties quickly and easily using a satellite photo or aerial photography.

CALIBRATION AND MAINTENANCE ESSENTIALS

An effective fertilizer program requires proper calibration of the equipment on the truck and proper training of the technician in the field. The goal of calibrating fertilizer application equipment is to establish the rate of application that the equipment is applying per unit area. Proper calibration can mean the difference between a healthy, lush lawn and weak, brown turf. If an inexperienced technician applies fertilizer unevenly, it may result in unsightly striping of the turf (Figure 8). If poor equipment calibration causes the technician to apply too much fertilizer, lawn burn and nutrient runoff can result. This section discusses the importance of calibration in the fertilizer program and includes common methods used to calibrate equipment and train personnel in proper application techniques.

There are two guidelines for spreader calibration frequency. First, spreaders should be calibrated at least annually. Second, spreaders should be calibrated whenever something changes. If equipment or parts are replaced, the spreader should be calibrated. Calibration also should take place when you change products. For example, changing from fertilizer to lime; changing from a fertilizer with round pellets to a product with angular pellets; and changing from a large-particle product to small-particle product all require recalibration. Common sense and good judgment must be used in determining when to calibrate.

Equipment also must be inspected. Most inspections are visual. The technician must ask, "Does this equipment look right?" Inspect the impeller every day that the equipment is used. Clean the spinner plate at the end of the day to ensure that the wheels rotate freely. Check the deflector to ensure it moves into place properly, and check the pattern slide plate to ensure that it opens and closes correctly.

Equipment calibration is only part of the challenge of applying nutrients appropriately and uniformly. The worker who operates the

Figure 8. Example of striping

equipment also needs training or calibration. Constant speed is important because application rates change with ground speed. Spreader technicians need to maintain a constant, consistent walking speed of approximately 3.5 miles per hour when fertilizing turf. Practice by walking across slopes at a uniform speed using a stopwatch. Moving up and down hills does not work because a consistent or uniform pace is unlikely. Each person who operates the spreader must walk at the same pace, or the application rate will change.

DRY FERTILIZER AND APPLICATION METHODS

Fertilizers are available in either dry or liquid formulations. The Guaranteed Analysis section of the label indicates the percentage of each nutrient by weight. To determine the amount of fertilizer needed for a given area, use the following formula. Note that nitrogen is generally used because it is usually the most limiting nutrient. Also, the law restricts phosphorus in these formulations.

Lbs of N needed per 1,000 sq ft ÷ (N from label ÷ 100) = Lbs of fertilizer per 1,000 sq ft

Example*

How much 32-2-6 fertilizer is needed to supply 0.9 pound of nitrogen per 1,000 square feet?

0.9 ÷ (32/100) = 2.81 lbs of fertilizer per 1,000 sq ft

Because the numbers on the fertilizer label represent the percentage of nutrients by weight, the amounts of phosphate and potash delivered to the area are lbs of fertilizer per 1,000 sq ft x (nutrient from label ÷ 100) = lbs of nutrient applied per 1,000 sq ft.

Example

2.81 × 0.02 = 0.06 lb P_2O_5 /1,000 sq ft and
2.81 × 0.06 = 0.17 lb K_2O /1,000 sq ft

To determine the amount of fertilizer to apply, calculate the number of 1,000-square-foot units in the landscape area and multiply by pounds of fertilizer per 1,000 square feet. For example, if the client's landscape area is 4,500 square feet, multiply 2.81 × 4.5 to get 12.65 pounds of fertilizer for the 4,500-square-foot property.

HOW TO CALIBRATE A DROP SPREADER

Most professional-grade products come with suggested spreader settings that should be confirmed through calibration. Unlike rotary spreaders, drop spreaders provide a uniform distribution pattern of granules across the swath width of the spreader's hopper. Figure 9 illustrates a catch pan on a drop spreader. Take the following steps to ensure proper calibration of the drop spreader.

Figure 9. Drop spreader with catch pan

*Note that Maryland law prohibits applying phosphorus for routine maintenance of turf unless a soil test shows it to be necessary. This example uses phosphorus to show how the calculations work.

STEP 1:

Determine a known area for the calibration. Measure the drop width of the spreader (in feet) and the distance to be walked during the calibration process. Keep in mind that the drop width is not the total width of the spreader. To determine the drop width, measure the width between the outside edges of the two farthest (outside) holes. For this example, assume a 2-foot-wide spreader (again, drop width, not overall width of spreader) and plan on walking a 50-foot length for a calibration area of 2 ft × 50 ft = 100 sq ft.

STEP 2:

Prepare a collection device. A huge timesaver in calibrating a drop spreader is to hang a catch pan from the base of the spreader frame to collect the entire product as it falls through the hopper. To make a catch pan, cut a length of 4-inch diameter PVC pipe and fit it with end caps. Another method for collecting the product is to drop the material onto a piece of plastic or a clean, hard surface that can be swept. *(Note: For lengths longer than 10 feet, use a catch pan.)*

STEP 3:

Ensure normal spreader operation. Fill the hopper to a depth of about 3 inches. Make certain that the particle size is small enough and dry enough to readily flow through the spreader. Specialty turf fertilizers usually work well, but many agricultural-grade materials are too large to flow through a drop spreader.

STEP 4:

Make the calibration run. Select a low-to-medium setting on the spreader. Establish a consistent walking speed before you begin. Open the spreader as you reach the starting point and walk the desired known length. Collect the product in the catch pan, sweep it off the hard surface or collect it from the plastic, and place it in a container of a known weight.

STEP 5:

Weigh the product (Figure 10) and calculate the amount of product (total weight minus weight of the container) being delivered per unit area. If the amount of product delivered does not match the amount that you want to apply, adjust the spreader setting and repeat the calibration steps until the desired amount is collected. One of the biggest limitations when using a small area for calibration is accuracy of the scales. Accurate calibrations are possible in small areas with very precise scales that can measure ounces or grams, such as a scientific scale or a kitchen scale.

Figure 10. Measuring scale

Example

The fertilizer selected for application is a 3.6-3.9-2.3 processed poultry litter product that contains more than 20 percent slowly available nitrogen. The desired level of application is 0.9 pound of nitrogen per 1,000 square feet. Using the formula from earlier in this chapter:

Lbs of N needed per 1,000 sq ft ÷ (N from label ÷ 100) = Lbs of fertilizer per 1,000 sq ft

Therefore:
0.9 lb N per 1,000 sq ft ÷ (3.6/100) = 25 lbs of fertilizer per 1,000 sq ft

The spreader is 2-feet wide and is equipped with a catch pan. A length of 25 feet has been measured, resulting in a 50 square-foot calibration area (25 ft in length × 2 ft drop spreader width = 50 sq ft of area covered in a single pass). If we need to apply 25 pounds of fertilizer to 1,000 square feet, then how much fertilizer is needed to cover 50 square feet? The setup for the proportion is:

$$\frac{25 \text{ lbs fertilizer}}{1{,}000 \text{ sq ft}} = \frac{\boldsymbol{Y} \text{ lbs fertilizer}}{50 \text{ sq ft}}$$

Cross-multiply to solve the equation:

$$1{,}000 \times \boldsymbol{Y} = 25 \times 50$$

$$(25 \times 50) \div 1{,}000 = \boldsymbol{Y}$$

$$\boldsymbol{Y} = 1.25 \text{ lbs of fertilizer}$$

Continue to adjust the setting on the spreader until you collect 1.25 pounds of poultry litter product during the calibration run. (To work in ounces or grams, the calculations will be 1.25 lbs × 16 oz per lb = 20 oz of the product, or 1.25 lbs × 454 grams per lb = 567.5 grams.)

HOW TO CALIBRATE A BROADCAST SPREADER

Before calibrating a rotary spreader, determine its swath width. To determine the swath width, place shallow pans or boxes at regular intervals in a row that is wider than the anticipated spreader swath (Figures 11 and 12).

Figure 12. Fertilizer catch pans placed at regular intervals

Figure 11. Fertilizer catch pans placed at regular intervals

Part A: Determining the Effective Swath Width

The following steps provide detailed information on how to determine an effective swath width. To avoid over-fertilizing an area of turf, this procedure should be done on a plastic tarp or a hard surface where the fertilizer can be swept up.

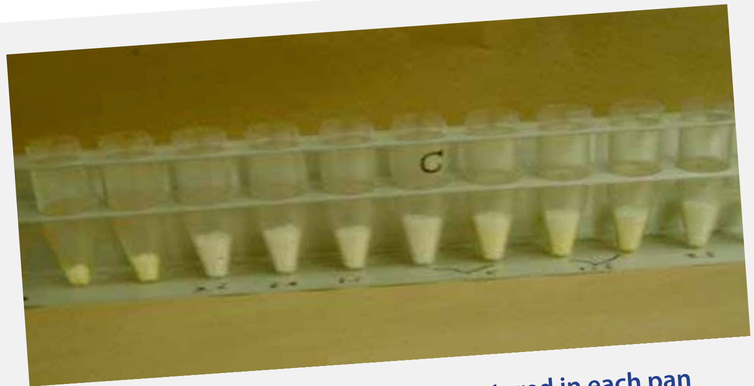


Figure 13. Display of fertilizer captured in each pan

STEP 1:

Ensure that the spreader is operating normally. Fill the hopper to a depth of about 3 inches with fertilizer.

STEP 2:

The product may be propelled 15 feet or more in a semicircle around the spreader. The amount of product delivered should decrease with distance from the spreader. It is important to know how the spreader distributes the product. Use catch trays spaced uniformly from the center of the spreader and perpendicular to its line of motion. Depending upon the size of the spreader, the fertilizer product may be thrown anywhere from 3 feet to 10 feet from the spreader. Therefore, more than 6 feet and probably less than 20 feet of catch pans will be required. To establish a constant walking speed before opening the hopper, begin walking a few paces behind the calibration starting point. Open the hopper when you are about 15 feet from the catch pans to ensure that the first pellets are captured and that you have created an accurate distribution pattern.

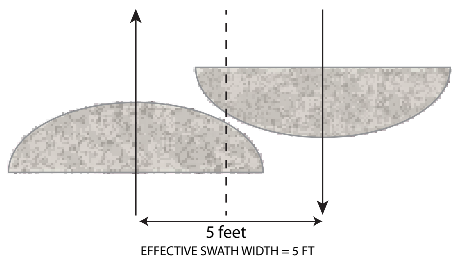
STEP 3:

Collect results. Collect the fertilizer that is captured in each pan and place it in small clear cups or tubes to make a visual evaluation of the spreader pattern (Figure 13). Be sure to keep the samples in the same order as the pans. The desired distribution for a standard application is a bell-shaped pattern, with the largest amount of product in the middle catch pan and decreasing amounts extending away from the center. If it is not desirable to use tubes or keep paper records, the results can be weighed and plotted. Weighing the samples will provide more accurate results with less product used.

STEP 4:

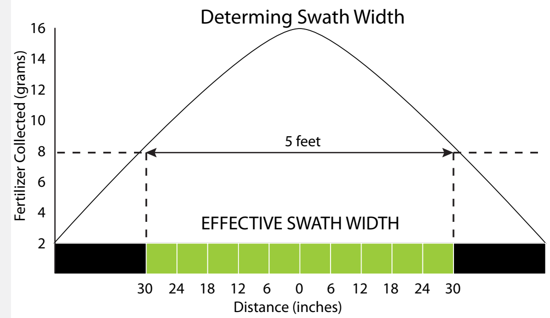
Evaluate the spread pattern to determine the effective swath width. This is the distance between the two pans that contain approximately half as much fertilizer as the center catch pan (Figure 15).

Ideally, the swath width will be centered around the middle of the spreader, but usually it is skewed to one side. Most professional broadcast spreaders have a mechanism to adjust the pattern so that it is more evenly centered. Ask the manufacturer for information on how to adjust the distribution pattern. Even if the distribution pattern is adjusted, it is not always perfect. Compensate for this lack of uniformity by overlapping your passes (Figure 14). If your effective swath width is 5 feet, you will make the next pass 5 feet over from the previous pass.



A 5 foot effective swath width as shown by parallel, adjacent passes of a rotary spreader.
Note the overlap of fertilizer into the adjacent swath.

Figure 14. An effective swath width



Fertilizer weights from pans set at regular intervals on both sides of a pass of a rotary spreader.

Figure 15. Determining swath width

Part B: Calibrating the Spreader

Now that the swath width of the spreader has been determined, it is time to calibrate the spreader to deliver the desired amount of fertilizer. There are several methods that can be used to calibrate the spreader. These are presented in order of preference. The method that is easiest and least likely to cause off-site movement of the fertilizer is presented first.

Collection Bag Method

The use of a collection bag—an attachment that encloses the impeller and captures the product as it is being delivered—greatly speeds the calibration process and prevents the product from repeatedly being delivered to the same area during the calibration run. In this example, the goal is to deliver a total of 0.9 pound of nitrogen per 1,000 square feet using sulfur-coated urea or SCU (28-0-5).

If possible, perform the calibration using a calibration run length that results in 1,000 square feet of coverage. If there is insufficient room to use 1,000 square feet, choose an area that can be easily multiplied to equal 1,000 square feet, such as 500 or 200 square feet. However, the accuracy of the calibration increases with the size of the calibration area.

If the swath width is 5 feet, then the desired calibration length is 200 feet (1,000 sq ft ÷ 5 ft effective swath width = 200 ft in length). Using the 28-0-5 fertilizer product described earlier, the following formula is used to determine how much product is needed to deliver 0.9 pound of nitrogen per 1,000 square feet:

0.9 ÷ (28 ÷ 100) = 3.2 lbs SCU per 1,000 sq ft

STEP 1:
Select a low-to-medium spreader setting.

STEP 2:
Establish a comfortable, constant walking speed that is initiated several feet before the beginning of the calibration course. Use the collection bag to collect fertilizer over the 200-foot distance.

STEP 3:
Weigh the material collected and adjust the spreader setting up or down depending upon the amount collected. Repeat the process until you collect 3.2 lbs of SCU.

Tarp Method

This method is effective at preventing off-site movement of the fertilizer; however, it is more expensive and labor intensive than using a collection bag. If you do not have a collection bag, cover the calibration area with a large tarp. Place a known weight of fertilizer in the hopper and apply the product to a length of at least 25 feet. Then, determine the level of nutrients applied by measuring the amount of fertilizer remaining in the hopper. In our example, 2 pounds of SCU is placed in the fertilizer hopper with a previously determined swath width of 5 feet and a calibration run length of 25 feet. The total area covered in a single pass is 5 ft x 25 ft = 125 sq ft. It was previously determined that 3.2 pounds of SCU per 1,000 square feet was required to deliver 0.9 pound of nitrogen per 1,000 square feet.

If 3.2 pounds of SCU are applied to 1,000 square feet, how much SCU should be applied to 125 feet?

$$\frac{3.2 \text{ lbs fertilizer}}{1{,}000 \text{ sq ft}} = \frac{\mathbf{Y} \text{ lb fertilizer}}{125 \text{ sq ft}}$$

*Cross-multiply to solve for **Y***

$$3.2 \times 125 = 1{,}000 \times \mathbf{Y}$$

$$\mathbf{Y} = 0.40 \text{ lb of 28-0-5 fertilizer}$$

STEP 1:
Select a low spreader setting.

STEP 2:
Apply the fertilizer over the 25-foot calibration run length; then, collect and weigh the remaining fertilizer in the hopper. If 2 pounds of SCU was placed in the hopper before the application, then the desired amount remaining in the hopper is 2 lbs - 0.40 lb = 1.60 lbs of SCU.

STEP 3:
Adjust the spreader setting and repeat the process until the desired application rate has been achieved. The fertilizer on the tarp can be collected and reused.

Broom Method

Another method used to calibrate spreaders is to apply the dry product to a clean, paved area. The product can then be collected and measured using a broom and dustpan. This method is the least preferred because it is labor intensive and has the greatest potential for off-site movement of the fertilizer. Furthermore, you will likely collect pebbles and debris when you sweep up the fertilizer.

STEP 1:
Determine a suitable length based upon the swath width. Of course, sweeping up a product that has been dispersed over a 200-foot distance is quite labor-intensive; therefore, a shorter length is typical but some precision in calibration may be sacrificed.

STEP 2:
Apply the product, collect it with a broom and dust pan, and weigh it to determine the rate of product per unit area covered in the calibration run. Because the entire product used in the calibration run will be collected, it is unnecessary to start with a known quantity.

STEP 3:
Adjust the spreader settings until the appropriate amount of product has been delivered per unit area.

APPLICATION TECHNIQUES

To apply fertilizer, begin by making a trim pass along the perimeter of the yard with the deflector down. Keep the deflector on the side where the fertilizer is not to be delivered (Figure 16). This will help to keep fertilizer off hardscapes and provide an area to turn around. When making a trim pass, speed up the pace.

Figure 16. A deflector shield is used along a curb

Next, move half a swath width from the side of the yard and begin making parallel passes at swath width intervals. Always start walking before opening the operating lever. Close the operating lever when the trim pass and turn around have been reached. Keep the impeller as level as possible. Travel across hills, not up and down them. Be sure to maintain a constant speed. Sweep or blow any fertilizer that lands on impervious surfaces back onto the lawn.

When the day is half over, estimate how much fertilizer you have applied. Compare this amount to how much fertilizer should have been applied based upon the size of the customers' lawns. If there is a substantial difference, first determine whether the correct speed was maintained. If the pace is acceptable, the spreader setting may need to be adjusted.

LIQUID FERTILIZER CALIBRATION AND APPLICATION METHODS

Many specialty products are marketed as liquid formulations that quickly dissolve or are easily suspended in water. Several micronutrient formulations are sold as chelates—organic forms of the nutrient that are in a liquid formulation. Also, several common granular forms of fertilizers are highly water-soluble and can be quickly dissolved in water to make their own spray solution, while others are quite insoluble and unsuitable for liquid feeding (Table 5).

Before adding different fertilizers and/or pesticides to a tank, check the label carefully for specific information regarding tank mixing and/or conduct a test to determine product compatibility. To do this, add small, proportional amounts of the products into a sufficient amount of water to simulate what will be added to the spray tank. If the product blends into a uniform solution, mixing in the tank is acceptable. If the combination takes on a sludge-like consistency, avoid tank-mixing.

Table 5. Fertilizer water solubility

Fertilizer	Formulation	Cold-Water Solubility (pounds/gallon*)
Ammonium nitrate	34-0-0	15.0
Ammonium sulfate	21-0-0	5.9
Potassium nitrate	13-0-44	1.1
Monoammonium phosphate	11-48-0	1.9
Diammonium phosphate	20-50-0	3.6
Urea	45-0-0	6.5
Superphosphate	0-20-0	0.16
Triplesuper phosphate	0-45-0	0.32
Rock phosphate	0-30-0	NA
Bone meal	4-12-0	NA
Potassium chloride	0-0-60	2.8
Potassium sulfate	0-0-50	1.0

** The maximum number of pounds that can be dissolved in 1 gallon of cold water.*

(Source: Virginia Polytechnic Institute and State University)

HOW TO CALIBRATE A SERVICE-VEHICLE-MOUNTED HOSE REEL AND GUN SPRAYER

Many lawn care professionals apply liquid fertilizer using a vehicle-mounted spray delivery system that consists of a tank attached to a spray hose—usually 3/8 inch to ½ inch in diameter and 200 to 300 feet in length (Figure 17)—and a trigger-actuated spray gun. Hose reels and gun sprayers are very effective at delivering fertilizer and other compatible components.

Figure 17. Examples of vehicle-mounted reel-and-tank liquid spray delivery systems

Spray guns usually come in two designs (Figure 18). The spray gun on the right has colored nozzles that provide different delivery rates. For example, the yellow nozzle attached to the gun is designed to deliver 2 gallons of spray solution in 1 minute (2 gpm).

The spray solution in the tank is pumped through a strainer to remove particles that are too large to pass through the nozzle orifice. A pressure regulator provides constant delivery volume to the spray gun.

Figure 18. Liquid spray guns

Calibrating the Spray Gun

The spray gun is calibrated to deliver a given amount of liquid while the technician walks at an appropriate rate of speed.

STEP 1:
Choose the correct spray tip. This will depend upon how much water is to be applied. A typical rate for a fertilizer application is 2 gallons per minute (gpm).

STEP 2:
Perform a bucket check. This is a simple calibration verification process that requires a 5-gallon bucket marked in quarts and either a watch with a second hand or a stopwatch. A properly calibrated spray system should deliver 1 gallon of spray solution in 30 seconds (2 gpm).

STEP 3:
Spray the solution into the bucket. After 30 seconds, 1 gallon should be collected. If more or less than the 1-gallon target rate has been collected, adjust the pressure regulator up or down.

STEP 4:
Return the contents of the bucket to the tank and repeat the process. Continue to measure and adjust the output of the sprayer until a rate of 2 gpm has been achieved.

STEP 5:
After the correct delivery rate has been established, tighten the locking nut on the pressure regulator.

STEP 6:
Repeat a bucket check at the beginning of each day to verify that the delivery rate has not fluctuated. If variations are noted, check for any of the following.

- a blocked strainer
- worn or kinked hoses
- a partially blocked or damaged nozzle
- pump malfunction
- pressure regulator malfunction or wear

Note: Since most spray solutions applied to turf are highly diluted, viscosity (thickness or gooeyness) is not a concern when choosing the proper delivery rate or nozzle.

STEP 7:
Determine the swath width. The nozzle on most turf spray guns produces a cone pattern comprised of large, rain-drop-sized droplets. The correct method is to create a pattern of spray solution in front of the body that is perpendicular to the direction of travel. Determine the swath width by spraying water on asphalt or concrete

where the pattern can be easily observed. Hold the spray gun at a 45 degree angle to your body about waist high. Lock your elbow to your body and swing your arm from side to side several times without moving the elbow or the wrist. Observe and note the width of the spray pattern. It is important that the spray width remain uniform. Most hose and gun sprayers will cover a swath of 8 to 10 feet.

Calibrating Pace

Achieving uniform coverage with a spray gun and hose reel is almost entirely dependent upon the technician at the end of the hose. It is critical for the technician to maintain a consistent pace throughout the day.

STEP 1:
Mark off an area of 1,000 square feet. If the desired rate of application is 2 gallons per 1,000 square feet, the measured area will need to be covered completely in 1 minute. Remember, the gun was calibrated at the rate of 2 gpm.

STEP 2:
Practice with water on concrete or asphalt where the spray pattern can be clearly seen. To improve visibility, add a colorant to the water.

STEP 3:
Starting at the most distant location, spray the water in parallel passes while moving backwards. This method prevents the hose from moving across the applied material and prevents you from tracking through the product.

STEP 4:
Repeat the process until you are proficient in covering the area in 1 minute.

Spray Gun Placement

After the pace has been mastered, focus upon spray gun placement and arm movement (Figure 19).

Figure 19. Appropriate arm and spray gun placement

STEP 1:
Hold the spray gun at a 45 degree angle to the body, about waist-high. New technicians have a tendency to drop their arm, which causes the spray to land at their feet.

STEP 2:
Lock your elbow at the hip. With each step, your arm should consistently move back and forth in front of your body two or three times, depending upon the velocity of the spray solution. The slower the spray solution velocity, the faster the arm movement.

STEP 3:
As with dry fertilizer applications, overlap passes to obtain uniform coverage. If the swath width is 8 feet, make a pass every 4 feet so that half of the previous pass is being overlapped with each subsequent pass. Remember, to achieve the proper rate and a consistent fertilizer response,

everything must be overlapped. The combination of walking at the correct pace, proper arm placement, and spray gun movement (two to three times in front of the body per step using an 8-foot-wide spray swath) will produce an even application on open ground.

TREATING PROPERTY LINES AND HARD EDGES

To treat turf along property lines or hard edges, use the method called a trim pass. To apply a trim pass properly, move your arm in a half-swing so that an edge is created with the outermost portion of the spray pattern. Speed up the pace and arm swing accordingly. When executing a trim pass, remember to apply the same amount of spray solution on half the area. Assuming the swath width is 8 feet, move in 4 feet from the edge, complete the trim pass, then move in another 4 feet to make the first full pass.

CLEANUP

The equipment must be kept clean and functioning to ensure that it remains properly calibrated.

Maintenance

Perform required or needed maintenance. This may include replacing o-rings, the strainer, or pump parts. Proper calibration is difficult to maintain on poorly maintained equipment. Check the owner's manual for recommended procedures, time frames, and tips.

CALIBRATING THE BOOM SPRAYER

The following sections describe boom sprayers and how to calibrate them.

Introduction

Boom sprayers are used on large expanses of relatively flat turf such as athletic fields and golf courses. These spray systems have a tank, pump, boom, nozzles, and sprayer tips. The following information should help to achieve accurate calibration of these spray systems. More detailed information is available in *Fine Tuning a Sprayer with Ounce Calibration Method*, Virginia Cooperative Extension Publication 442-453 (Grisso et al., 2009).

The boom sprayer's pump is used to create pressure (whether the pump is powered by hand or by an engine). It is important that the pressure be optimal, consistent, and repeatable. Most products will have pressure and spray volume recommendations on their labels.

Choose the appropriate nozzle and tips for the system and the application. Again, this information is usually provided on the product label or as a recommendation provided by the sprayer system and/or the nozzle and tip supplier. True foliar feeding of nutrients (feeding a plant through its leaves) is accomplished with spray volumes of 45 gallons per acre (gpa) or less. If the solution is meant to be absorbed through the plant roots, the volume of water will be much higher.

Other factors to consider when selecting a nozzle and tips for multinozzle booms (often used in golf course turf and athletic field management) are spacing and height off the ground. Some tips require up to a 33 percent spray pattern overlap to ensure 100 percent coverage. Again, product manufacturers often provide helpful charts containing this information. The Internet also is a valuable resource.

Figure 20. Evaluating nozzle and tip performance before calibration

The system and its components should be checked regularly to ensure that they are in good working condition. Make sure that hoses and fittings are securely attached, nozzles and tips are not clogged, and spray pressure generated by the pump is constant. A driveway or parking lot is a great place to run a preliminary inspection of the system. Applying water to a hard surface makes it easy to confirm that boom height, nozzle selection, and nozzle spacing will provide a uniform application (Figure 20). The next step is to move on to the calibration process.

The **Ounce** ***Calibration Method***

This method of calibration is popular because it reduces the need for math calculations. A gallon equals 128 ounces, so if a sprayer is calibrated for an area of 1/128th of an acre (1 acre = 43,560 sq ft ÷ 128 = 340 sq ft), then the ounces collected during calibration equate to gallons per acre. Materials needed include a stopwatch, measuring tape or wheel, flags to mark the course (Figure 21), and containers to collect and measure the liquid discharge.

STEP 1:

Begin by measuring the nozzle spacing on the boom to determine the course length required to cover 1/128th of an acre with the spray from one nozzle (1/128th of an acre = 340 sq ft). Convert the nozzle spacing in inches to feet. For example, using a 20-inch nozzle spacing (20 ÷ 12 in/ft =1.67 ft), each nozzle sprays a width of 1.67 feet. Divide 340 square feet by the nozzle spacing in feet to determine the length of the calibration area required (340 sq feet ÷ 1.67 ft nozzle spacing = approximately 204 lin ft). (See Table 6 for course lengths based upon standard nozzle spacing).

STEP 2:

When calibrating a single nozzle such as those used for a hose-end or backpack sprayer, determine the spray width in feet for the single nozzle. Divide 340 square feet by the spray width (in feet) to determine the course length for calibration.

Figure 21. The basic equipment needed for sprayer calibration

STEP 3:

As Table 6 indicates, a boom with 20-inch nozzle spacings requires a course length of 204 feet to cover 1/128th of an acre.

- Fill at least half the tank with water.
- Determine an optimum speed for the terrain and product delivery (usually 3 to 4 mph).
- Set the power takeoff at an appropriate rate of RPMs for the pump to deliver the desired pressure and volume of spray solution.
- Operate the sprayer system as if the product were being applied. To ensure accuracy, the test course terrain should be comparable to the area that will be treated. For example, if you will be treating a hilly area, calibrate on a hilly area.

Table 6. Course length required to calibrate 1/128th of an acre, 340 square feet

Boom Nozzle Spacing (inches)	Course Length (feet)
12	340
16	255
20	204
24	170
28	146
32	127
36	113
40	102

(Source: Virginia Polytechnic Institute and State University

STEP 4:

Time how long it takes to travel the 204-foot test course length for this spray system setup. Next, operate the sprayer in a stationary position, capturing the discharge from a single nozzle for the time period it took to drive 204 feet. Use a measuring cup marked in ounces to measure the amount of fluid collected. This amount (collected in ounces) equals gallons per acre (Figure 22).

Figure 22. Example of sprayer calibration

In the example, the 40 ounces of discharge collected for the known time period equates to a sprayer calibrated to deliver 40 gpa. Catch the output (Figure 23) from at least three nozzles for the required duration to ensure that all nozzles are performing comparably. If a nozzle does not deliver an output that is within 5 percent (plus or minus) of the average nozzle output, check the filter and tip for clogs or damage. Replace any suspect nozzle or tip.

Figure 23. Capturing nozzle discharge

DETERMINING HOW MUCH PRODUCT TO ADD

The following sections provide examples of how to determine the amount of product to add under specific circumstances.

Example A:

The label of a popular 15-0-0 liquid fertilizer that is 4 percent sulfur and 6 percent iron by weight recommends an application rate of 2 to 8 fluid ounces per 1,000 square feet. If 4 ounces per 1,000 square feet is selected, how much fertilizer should be added to the sprayer system that was just calibrated using the ounce calibration method? If relatively large areas are being treated, it is logical to prepare full tanks of spray solution. Assume the system has a 100-gallon tank. Calibrated at 40 gpa, a full tank can cover 2.5 acres (100 gallons ÷ 40 gpa = 2.5 acres).

How many square feet are in 2.5 acres? One acre is 43,560 square feet; therefore, 2.5 × 43,560 = 108,900 square feet. The following formula shows the setup using a basic proportion.

$$\frac{\text{4 fluid oz of product}}{\text{1,000 sq ft}} = \frac{\textbf{Y}\text{ fluid oz of product}}{\text{108,900 sq ft}}$$

$$435{,}600 = 1{,}000\,\mathbf{Y}$$

$$\mathbf{Y} = \text{approximately 436 fluid oz of product}$$

$$\text{Divide 436 by 128 oz per gal}$$

According to the calculations, 3.4 gallons of 15-0-0 liquid fertilizer should be added to the tank of a sprayer calibrated to deliver 40 gpa. To prepare a full tank, fill the tank partially with water, add the fertilizer, then add more water to bring the tank to the 100-gallon level.

Example B:

What if the goal is to cover only 20,000 square feet of area? The previous calculation proved that a full sprayer tank holding 100 gallons will cover 108,900 square feet. There is no point in using a full tank of solution. Instead, mix just enough product to cover 20,000 square feet. The following equation illustrates a simple proportion.

$$\frac{\text{100 gal}}{\text{108,900 sq ft}} = \frac{\textbf{Y}\text{ gal}}{\text{20,000 sq ft}}$$

$$2{,}000{,}000 = 108{,}900\,\mathbf{Y}$$

$$\mathbf{Y} = \text{approx. 18.4 gal of water}$$

How much fertilizer is needed to treat the 20,000-square-foot area using a rate of 4 fluid ounces per 1,000 square feet?

$$\frac{\text{4 fluid oz of product}}{\text{1,000 sq ft}} = \frac{\textbf{Y}\text{ fluid oz of product}}{\text{20,000 sq ft}}$$

$$80{,}000 = 1{,}000\,\mathbf{Y}$$

$$\mathbf{Y} = \text{80 fluid ounces of product}$$

According to the calculations, 80 fluid ounces of product are needed to treat a 20,000-square-foot area. First, add a few gallons of water to the tank; next, add the 80 fluid ounces of fertilizer; and, last, fill the tank to a final volume of approximately 18.4 gallons.

Example C: Adding Products and Powders

Many commercially available powdered fertilizers are highly water-soluble and some bulk fertilizer materials may be sufficiently soluble to deliver in liquid form. As shown previously in Table 5, up to 6.5 pounds of urea is soluble in a gallon of water. (Note that rapid mixing and even heat may be required to speed dissolution of some materials) If the goal is to use a calibrated sprayer to provide a nitrogen level of 0.25 pound per 1,000 square feet of urea to 20,000 square feet of turf, use the desired application rate (in this case 0.25 pound of nitrogen) divided by the percent of nitrogen in the product (in this case 0.45) to arrive at 0.56 pound of urea per 1,000 square feet to deliver the desired level of nitrogen. To calculate the total amount of product for the area to be covered (20,000 square feet), use the following equation.

$$\frac{0.56 \text{ lbs of urea}}{1{,}000 \text{ sq ft}} = \frac{\mathbf{Y}}{20{,}000 \text{ sq ft}}$$

$$11{,}200 = 1{,}000\ Y$$

$$\mathbf{Y} = 11.20 \text{ lbs of } (45\text{-}0\text{-}0)$$

According to the calculations, 11.20 pounds of product will be required to treat a 20,000 square-foot area. It was previously determined that a sprayer calibrated to deliver 40 gpa would need approximately 18.4 gallons of total spray volume to treat 20,000 square feet. Fill the tank with approximately 9 gallons of water, add the 11.20 pounds of urea (stirring or agitating to ensure that the product fully dissolves), and raise the final tank volume to approximately 18.4 gallons. The sprayer is calibrated to deliver 0.25 pound of nitrogen per 1,000 square feet.

OTHER CONSIDERATIONS WITH SPRAYABLE FERTILIZERS

Because of the high volumes applied and the relatively dilute concentration of nutrients, liquid fertilizer applications often are uniform and precise. However, it is important to pay close attention to the label recommendations regarding spray volume, nozzles, and tips and the requirements for sprayer agitation. Also, record any observations regarding sprayer performance and plant response for future reference. Watering in of many liquid fertilizers may be recommended after application to reduce leaf-burn potential or to improve uptake efficiency. Be very careful regarding the compatibility of tank mixtures of fertilizers, pesticides, and other spray additives because they can cause undesired changes in the physical or chemical properties of the materials.

Chapter 8: Requirements for Professional Fertilizer Applicators

INTRODUCTION

The Fertilizer Use Act of 2011 is intended to reduce the amount of nutrients washing into the Chesapeake Bay from nonagricultural sources such as lawns, golf courses, parks, recreation areas, and business properties. The law limits the amount of phosphorus contained in lawn fertilizer products sold to the public; requires both homeowners and lawn care professionals to obey fertilizer application restrictions; and establishes a training, certification, and licensing program for people who are hired to apply fertilizer to nonagricultural landscapes. In addition, the law addresses the improper use of fertilizer as an ice melt.

The goal of Maryland's Professional Fertilizer Applicator Certification Program is to ensure that commercial fertilizer applicators and turf managers have an adequate knowledge of fertilizer products and proper application techniques. By establishing uniform standards for applying fertilizers, the law aims to foster overall improved nutrient management in the urban and suburban landscape. The following sections provide a brief description of the new requirements for lawn care professionals.

CERTIFICATION

Beginning October 1, 2013, all lawn care professionals hired to apply fertilizers to nonagricultural land must be certified by MDA or work under the direct supervision of an individual who is certified. The rules apply to professionals for hire as well as individuals responsible for turf management at golf courses, public parks, airports, athletic fields, businesses, cemeteries, and other nonagricultural properties.

LICENSING

Licenses will be required for all businesses engaged in commercial fertilizer applications. Each business will be required to employ at least one certified fertilizer applicator. Licenses to qualifying firms will be issued beginning in fall 2013.

SOIL TESTING

Soil tests must be taken for each new customer and once every 3 years thereafter if phosphorus will be applied to the property. An approved lab must be used to test the samples.

Follow University of Maryland recommendations included in the following fact sheets: TT-115 (turf maintenance), TT-116 (seeding) and TT-118 (golf courses), which can be found on MDA's Nutrient Management website.

RECORD KEEPING

Keep the following records of fertilizer applications.

- Name of the fertilizer applicator
- Size of the area fertilized
- Date of nutrient application
- Address/location of client
- Rate of application (for example 4 pounds of fertilizer per 1,000 square feet)
- Total amount of fertilizer used per application
- Analysis of the fertilizer product used
- An original or legible copy of the fertilizer label

NITROGEN LIMITS

A single application may not exceed 0.9 pound total nitrogen per 1,000 square feet and 0.7 pound of soluble nitrogen per 1,000 square feet, except when using enhanced efficiency fertilizer. Annual limits may not exceed UMD recommendations as shown in Table 3.

Enhanced efficiency fertilizer

- Enhanced-efficiency, controlled-release products may be applied at no more than 2.5 pounds of nitrogen per year.
- No more than 80 percent of the annual recommended rate for nitrogen may be applied. The maximum monthly release rate may not exceed 0.7 pound of nitrogen per 1,000 square feet.
- These products may not be applied after November 15.
- Professionals must maintain records of the release rate documented by the manufacturer.

PHOSPHORUS LIMITS

Organic or natural organic turf fertilizer

- P_2O_5 may be applied in accordance with soil test results and the University of Maryland Fertility Index Value Soil Test Category (Appendix D.)
- Organic or natural organic turf fertilizer may not be applied when soils test at "optimum" to "excessive" for phosphorus levels.
- If P_20_5 is recommended for seeding or sod installation (TT-116) when the soil test phosphorus level is in the "optimum" range, only synthetic fertilizer may be used.

Synthetic turf fertilizer

- Except for starter fertilizer, fertilizer labeled for use on turf may not contain phosphorus.
- P_2O_5 may be applied in accordance with soil test results and the University of Maryland Fertility Index Value Soil Test Category (Appendix D).

FERTILIZER SETBACKS

- Nitrogen or phosphorus may not be applied to turf within 15 feet of streams, creeks, ponds, or other waterways.
- If using a drop spreader, rotary spreader with deflector shield, or targeted spray, the setback may be reduced to 10 feet.
- Do not apply fertilizer to driveways, sidewalks, or other impervious surfaces. Any product that lands on these surfaces must be swept back onto lawns or cleaned up.

FERTILIZER TIMING RESTRICTIONS

- No nitrogen or phosphorus fertilizer may be applied to turf between December 1 and March 1.
- From November 16 through December 1, lawn care professionals (not homeowners) may apply nitrogen to lawns at a maximum rate of 0.5 pound per 1,000 square feet, if agronomically appropriate.
- The law prohibits anyone from applying lawn fertilizer containing nitrogen and phosphorus to impervious surfaces or frozen ground.
- Lime, potassium, and other nutrients are not regulated under the law.

NEWLY ESTABLISHED LAWNS

Turf fertilizer used for routine maintenance applications may not contain phosphorus unless a soil test that is less than three-years old indicates the need. When establishing turf after a tillage operation or more drastic disturbance, such as construction, phosphorus may be applied without a soil test following University of Maryland Extension recommendations for seeding. See UMD publication TT-116 on MDA's Nutrient Management website.

PENALTIES

Violators are subject to civil penalties of up to $1,000 for the first violation and $2,000 for each subsequent violation.

MORE INFORMATION

Visit **www.mda.maryland.gov/fertilizer** for additional information.

Chapter 9: Other Environmental Laws and Regulations

CLEAN WATER ACT

The Federal Clean Water Act is the primary law governing water pollution in the United States. Passed in 1972, it established the basic structure for regulating discharges of pollutants into U.S. waters and setting quality standards for surface waters. The Clean Water Act made it unlawful to discharge any pollutant from a point source (such as a pipe) into navigable waters, unless a permit was obtained first.

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT PROGRAM

The Environmental Protection Agency's (EPA) National Pollutant Discharge Elimination System (NPDES) permit program regulates sources that discharge pollutants. Point sources may be pipes or man-made ditches. Individual homes that are connected to a municipal system, use a septic system, or do not have a surface discharge do not need an NPDES permit; however, industrial, municipal, and other types of facilities must obtain permits if they discharge directly to surface waters.

STORMWATER DISCHARGES FROM MUNICIPAL SEPARATE STORM SEWER SYSTEMS

Stormwater runoff is generated when precipitation from rain and snowmelt events flows over land or impervious surfaces (paved streets, parking lots, and building rooftops) and does not percolate into the ground. As the runoff flows over the land or impervious surfaces, it accumulates debris, chemicals, sediment, or other pollutants that could adversely affect water quality if the runoff is not treated. The primary method to control stormwater discharges is the use of best management practices (BMPs). It is through the inclusion of stormwater management and permits to municipalities that the authority to make laws addressing turf management exists.

Polluted stormwater runoff is commonly transported through Municipal Separate Storm Sewer Systems (MS4s), from which it is often discharged untreated into local water bodies. To prevent harmful pollutants from being washed or dumped into an MS4, operators must obtain an NPDES permit and develop a stormwater management program.

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION REQUIREMENTS

The Occupational Safety and Health Administration (OSHA) requires employers to provide a safe and healthful workplace. Many of its requirements deal with the safe operation of equipment. Spreaders and other equipment used to apply nutrients are subject to OSHA regulations. However, the safety of workers who use equipment to apply fertilizer does not fall within the scope of this manual.

MARYLAND WATER QUALITY IMPROVEMENT ACT OF 1998

Individuals and companies that apply fertilizer to 10 or more acres of nonagricultural land are required to take soil tests for each client or management area; follow University of Maryland fertilizer and timing recommendations; keep records of fertilizer applications; and make those records available for inspection by MDA.

CHESAPEAKE BAY PHOSPHORUS REDUCTION ACT OF 2009

Maryland's Chesapeake Bay Phosphorus Reduction Act of 2009 mandated that only low phosphorus fertilizer may be labeled and sold for use on established turf. Low phosphorus is defined as having 5 percent or less P_2O_5. The legislation also established labeling and reporting requirements. High phosphorus fertilizer is prohibited from being labeled for use on turf. For example, 10-10-10, and spreader settings are prohibited from appearing on the fertilizer bag. In addition, high phosphorus fertilizer is required to contain the following statement in ¾-inch letters on the front of the product bag: "NOT FOR USE ON ESTABLISHED LAWNS OR GRASS." Manufacturers are required to report to MDA the pounds of phosphorus sold in the state.

FERTILIZER USE ACT OF 2011

Maryland's Fertilizer Use Act of 2011 was a game changer for lawn care professionals and homeowners alike. The law expands MDA's regulatory authority to include more than 1,500 urban land management companies statewide. Beginning October 1, 2013, urban land managers will need to be certified and licensed by MDA before they can apply nutrients to nonagricultural properties. The law also limits the amount of nutrients in fertilizer products sold to the public, imposes new labeling requirements, establishes blackout dates for lawn fertilizer applications, and requires lawn care professionals and homeowners to follow University of Maryland fertilizer recommendations. The law requires MDA to publish a list of certified professional fertilizer applicators on its website. This law supercedes the Water Quality Improvement Act of 1998.

MARYLAND STATE PESTICIDE LAW

Maryland's pesticide regulations specify that any person who performs pest control services (which includes the application of a pesticide to someone else's property) must be certified by MDA as a Pest Control Applicator. Lawn care professionals who apply any pesticide to someone else's property, must obtain a Pest Control Applicator Certificate and a Pesticide Business License from MDA. Therefore, professionals who apply weed-and-feed products must be certified by MDA as ***both*** a Pest Control Applicator ***and*** a Fertilizer Applicator.

References

Astera, M. 2007. Cation exchange capacity in soils, simplified (so that even I can understand it). In: www.soilminerals.com/Cation_Exchange_Simplified.htm. Accessed November 30, 2012.

Bandel, V.A., B.R. James, and J.J. Meisinger. 2002. Basic principles of soil fertility II: Soil properties. Fact Sheet 640, University of Maryland Extension, College Park, MD. pp 8.

Brady, N. C., and R. R. Weil. 2008. The nature and properties of soils. 14th ed. Upper Saddle River, N.J. Pearson Prentice Hall.

Dernoeden, P.H. 2003a. Irrigation and water conservation on home lawns. University of Maryland Turfgrass Technical Update TT-62. University of Maryland Extension, College Park, MD. pp 3.

Dernoeden, P.H. 2003b. General guidelines for lawn maintenance in Maryland. University of Maryland Turfgrass Technical Update TT-63. University of Maryland Extension, College Park, MD. pp 3.

Goatley, M. and K. Hensler. 2011. Urban nutrient management handbook. Publication 430-350. Virginia Cooperative Extension, Blacksburg, VA.

Grisso, R., M. Weaver, K. Bradley, S. Hagood, Jr., and H. Wilson. 2009. Fine tuning a sprayer with "ounce" calibration method." Virginia Cooperative Extension Publication 442-453. http://pubs.ext.vt.edu/442/442-453/442-453.html. Accessed May 8, 2013.

Harper, J.C., C.A. Morehouse, D.V. Waddington, and W.E. Buckley. 1984. Turf management, athletic-field conditions, and injuries in high school football. Pennsylvania State University, College of Agriculture, University Park, PA. pp 10.

Kopp, K.L. and K. Guillard. 2002. Clipping management and nitrogen fertilization of turfgrass: Growth, nitrogen utilization, and quality. Crop Science 42. Crop Science Society of America, Madison, WI. pp 1225–1231.

Partsch, C. M., A. R. Jarrett, and T. L. Watschke. November-December 1993. Infiltration characteristics of residential lawns. Transactions of the ASAE Vol. 36(6): 1695-1701. Journal of the American Society of Agricultural Engineers, St. Joseph, MI.

Starr, J.L. and H.C. DeRoo. 1981. The fate of nitrogen applied to turfgrass. Crop Science 21. Crop Science Society of America, Madison, WI. pp 531–536.

Turner, T.H. 2013. Fertilizer recommendations for commercially maintained lawns and turfgrass in Maryland. University of Maryland Turfgrass Technical Update TT-115. University of Maryland Extension, College Park, MD. pp 5.

USDA National Agricultural Statistics Service (NASS). 2007. The Maryland turfgrass industry: A statistical profile and economic survey. Maryland Turfgrass Council, Churchville, MD. pp 20.

Voigt, T., T. Fermanian, and D. Wehner. 1998. Turfgrass fertilization. Extension Turfgrass Publication, University of Illinois, Urbana-Champaign, IL. http://www.turf.uiuc.edu/extension/ext-fert.html. Accessed May 8, 2013.

Williams, C.F. and G.E. Pulley. 2002. Synthetic surface heat studies. Brigham Young University. In: Sherratt, P. 2011. The benefits of turf. BuckeyeTurf, Department of Horticulture and Crop Science, The Ohio State University, Columbus, OH http://buckeyeturf.osu.edu. Accessed November 30, 2012.

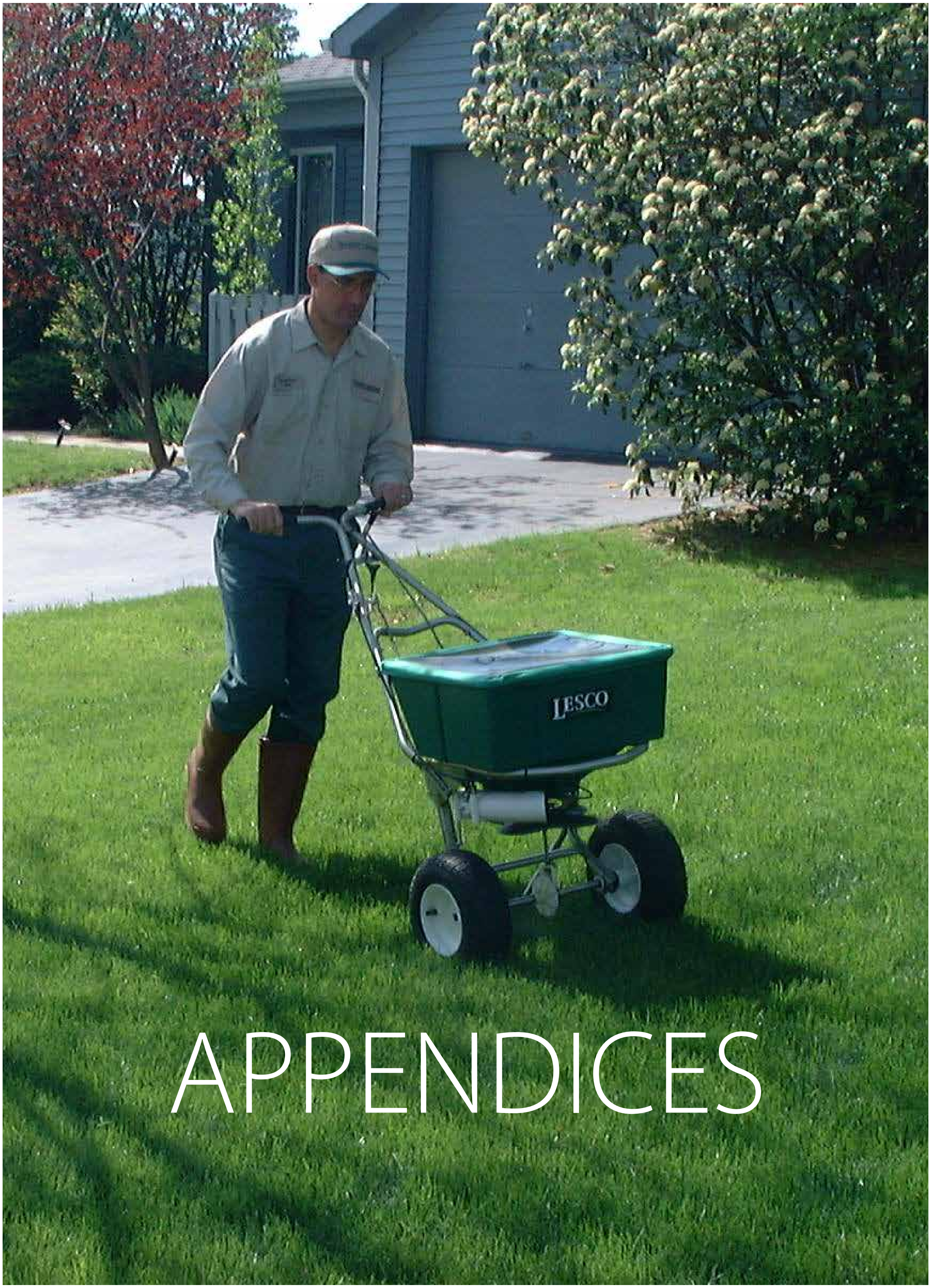
Acknowledgements

The Fertilizer Use Act of 2011 states: "The Department (MDA) shall, in consultation with the University of Maryland, establish a program to certify professional fertilizer applicators." That requirement resulted in the development of this manual.

The Maryland Professional Fertilizer Applicator Certification Program Training Manual was developed through the cooperation of many individuals, including numerous members of lawn care industry. I have received help from Chris Forth of TruGreen, Mark Schlossberg of Pro-Lawn-Plus, Inc.; Rick LaNore of MRW Lawns, Inc.; and Chris Wible of Scott's MiracleGro Inc. among other industry professionals. Additionally, Dr. Mike Goatly and many of his colleagues at Virginia Polytechnic Institute and State University (Virginia Tech) produced an *Urban Nutrient Management Handbook* that laid the foundation from which sections of this manual were developed. Their work greatly eased the burden of development for me.

My colleague, Dr. Tom Turner here at the University of Maryland, provided review and text that helped flesh out parts of the manuscript. He also provided humor and perspective that is greatly appreciated.

The Maryland Department of Agriculture provided a venue for the Urban Nutrient Management Work Group to evaluate and critique the manual as it was developed. I am grateful to the members of the work group for their input. Special thanks to Judy McGowan (MDA) who coordinated this group, and Louise Lawrence (MDA) and Rona Flagle (MDA) for developing the final product.


LESCO
APPENDICES

Appendix A: UMD Turfgrass Technical Update TT-115

Please note that this technical update is revised periodically. For the most current version, visit www.mdturfcouncil.org.

Fertilizer Recommendations for Commercially Maintained Lawns and Turfgrass in Maryland

University of Maryland Turfgrass Technical Update TT115–April 2013

Dr. Thomas Turner, Turfgrass Specialist;
University of Maryland Department of Plant Science & Landscape Architecture

Nutrient management laws passed by the Maryland Legislature in 1998 require that University of Maryland nutrient management guidelines be followed on state property and commercially managed turfgrass sites. These laws affecting turfgrass fertilization were part of an overall effort to regulate the impact of the agricultural industry on the water quality of the Chesapeake Bay. In 2011, additional regulations were enacted that further specify how nitrogen (N) and phosphorus (P) may be applied to turfgrass in Maryland, and what fertilizer formulations may be sold at the retail level. These new laws regarding turf fertilizer application become effective in 2013. The following information is intended to serve as a nutrient management guideline for the maintenance of commercially maintained turfgrass sites in an efficient, effective, and environmentally sound manner, and to meet state regulatory requirements. Nutrient management recommendations for the establishment of turf, and for sod production, golf courses, and athletic fields are addressed in separate publications.

Turf-type tall fescue fertilized and maintained following Uninversity of Maryland recommendations. Following fertilizer recommendations helps maintain high turf density that reduces soil erosion, improves water infiltration, reduces water runoff, prevents nutrient movement, and greatly reduces weed encroachment.

TURFGRASS AND WATER QUALITY

Properly managed turfgrass has been shown to be an environmental asset. Turfgrass has significant cooling effects during the summer and traps significant amounts of the dust and dirt that is released each year into the atmosphere. Turfgrass absorbs carbon dioxide, ozone, sulfur dioxide, and other gases while releasing oxygen. Turfgrass intercepts nutrient pollutants running off of the vast amount of impervious surfaces found in urban and suburban areas.

Water runoff from properly managed turfgrass areas is greatly reduced and water infiltration increased compared to most other agriculture and plant systems. Once turfgrass is established, soil loss from erosion is negligible. Also, turfgrass is an efficient organic matter producing system. Thus, little N or P is lost from turfgrass sites if sound nutrient management and cultural practices are followed.

Nitrogen - Onsite monitoring and numerous research studies have shown that N loss from turfgrass sites is minimal if current recommendations are followed. However, research has also shown that improper N applications on specific types of sites can result in excessive nitrate (NO_3) leaching. This problem is very specific and has occurred as follows:

1. Very high rates of N were applied using soluble NO_3-N containing fertilizers (e.g. ammonium nitrate [NH_4NO_3]),
2. The fertilizer was applied to dormant turf, such as bermudagrass during the winter,
3. Soils were predominantly sand or were disturbed soils, and
4. The sites had high water tables or movement of N was measured over a short distance in the soil profile.

Phosphorus - Loss of P from turfgrass sites is also minimal if current recommendations are followed. Phosphorus movement is 1) generally due to soil erosion, which is greatly minimized by properly fertilized turfgrass, and 2) by over application of P fertilizers on soils already high in P. Phosphorus should only be applied as recommended by soil tests.

SOME KEY POINTS of 2011 TURFGRASS FERTILIZER REGULATIONS REGARDING NITROGEN APPLICATIONS

Do not apply more than 0.7 lb. of soluble N per 1000 ft^2 in any one application.

If fertilizer contains 20% or more slow release N, do not apply more than 0.9 lb. of total N per 1000 ft^2 in any one application.

Do not apply N after December 1. Between November 15 & December 1, use only a soluble N source and don't apply more than 0.5 lb. N/1000 ft^2.

Do not apply N before March 1.

SOME KEY POINTS of 2011 TURFGRASS FERTILIZER REGULATIONS REGARDING PHOSPHORUS APPLICATIONS

Phosphorus cannot be applied for maintenance unless a soil test indicates a need.

Beginning October 1, 2013, natural organic fertilizers or products containing P can only be used if not exceeding .25 lbs. P_2O_5/1000 ft^2 per application, and not exceeding .50 lbs. P_2O_5/1000 ft^2 annually.

Products containing P, including natural organics, cannot be used on established turf where soils test have determined that soil has "optimum to excessive" levels of P.

NITROGEN FERTILIZER RECOMMENDATIONS

Proper nitrogen fertilization is essential in maintaining dense turf that prevents soil erosion, increases water infiltration, and reduces water runoff. Proper nitrogen fertilization is also essential in maintaining turf that is resistant to weed encroachment, has reduced disease problems, is tolerant of stresses, and is able to recover from traffic damage. It should be stressed that the recommendations for N applications are not made to promote a dark green turf. They are made to maximize density, root growth, and the overall health of the turfgrass stand.

Current N recommendations are based on extensive research and are dependent on a variety of factors such as turfgrass species and cultivars, age of turf, soil type, management practices being used (irrigation, clipping removal, pest control programs), weather conditions, use of area, length of growing season, and the need for recovery from pest damage, adverse environmental conditions, and traffic.

The professional turfgrass manager must take into account all these factors in devising an appropriate N fertilization program. The program may vary from year to year as these conditions change. Three major factors must be considered in developing an N application plan: 1) what types of N-fertilizer are applied, 2) how much N should be applied per application and annually, and 3) when should N be applied?

Inadequate attention to each of these factors increases the potential for thin turf that is more prone to pest and stress problems. Thin turf also results in sites which are more prone to soil erosion. Additionally, the potential for leaching and/or runoff of N increases if guidelines are not followed.

Sources of Nitrogen

A wide range of N-containing fertilizers are available to the turfgrass manager. These fertilizers generally fall into one of two broad categories: 1) fertilizers that contain only soluble, quickly available N, or 2) fertilizers that contain some N in a slowly available form, which is not immediately available for plant use. The amount of N fertilizer that can be applied in any single application is dependent on the type of N fertilizer. Following are the main categories of N fertilizers as defined by the Maryland regulations:

Water Soluble Nitrogen - Fertilizers that contain N that can immediately go into solution, and thus have N that is rapidly available for turf uptake, are categorized as water soluble N fertilizers. These fertilizers, while quickly available for turf use, have the most potential for leaching if used improperly.

The most common water soluble forms used for lawn fertilization contain N in the ammonium form (NH^{+4}). Soluble N fertilizers that contain ammonium N include urea, ammonium sulfate and ammonium chloride. These fertilizers can produce excellent quality turf without leaching or runoff problems if used properly. The ammonium N can be adsorbed by soil, reducing the potential for N movement.

Some water soluble N fertilizers contain N in the nitrate (NO^{-3}) form. Leaching and runoff potential is much higher for NO_3-N. Thus, where conditions exist that are conducive to leaching or runoff, fertilizers that contain significant amounts of NO_3-N should not be used. These conditions include sandy sites (sands and loamy sands) with high water tables when turf is not actively growing, and sites that are highly sloped. Fertilizers high in NO_3-N include ammonium nitrate, potassium nitrate, and calcium nitrate. Fertilizers that contain predominantly NO_3-N should only be used on sites not prone to runoff or leaching, where very rapid response is essential, and on turf that is actively growing. Turfgrass uptake may occur within a few days with NO_3-N containing fertilizers compared to 7-10 days with NH_4-N fertilizers. Generally, fertilizers containing significant amounts of NO_3-N are not recommended for home lawn fertilization.

Excessive rates of soluble N per application can result in excessive growth of turf (which can eventually affect tolerance to environmental stress and pest resistance) and can increase the potential for N loss on some sites. **The 2011 Maryland lawn fertilization regulations limit the application of water soluble N fertilizers to 0.7 pounds actual N per 1000 square feet per application.**

Slow Release Nitrogen – Slow release N fertilizers contain N in a form that delays its availability for plant uptake and use after application. It extends N availability significantly longer than a reference rapidly available nutrient such as urea. Slow release N fertilizers include sources such as sulfur coated urea (SCU), polymer coated ureas, ureaformaldehyde (UF), methylene ureas, isobutlyidene diurea (IBDU), and natural organics. To be considered a slow release N fertilizer, the fertilizer must contain at least 20% water insoluble or controlled release N. The N in all slow release fertilizers used for turfgrass maintenance, including natural organics, is ultimately converted to NH_4-N.

Slow release fertilizers are less prone to N leaching and runoff as compared to applications of soluble N fertilizers applied in excess of recommended rates. While varying considerably in individual characteristics and release patterns, slow release N fertilizers typically provide more even turfgrass response and provide N for turfgrass uptake over a longer period of time. The use of slow release fertilizers should particularly be considered on sites that are prone to leaching or runoff, and when an N application needs to be made to turfgrass during non-optimum growing conditions.

The 2011 Maryland lawn fertilization regulations limit the application of slow release N fertilizers to 0.9 pounds actual N per 1000 square feet per application.

Natural Organic Nitrogen – Natural organic fertilizers are a type of slow release N fertilizer that is derived from either a plant or animal product and do not contain synthetic materials. They have not been altered from their original state except by physical manipulation (drying, cooking, chopping, grinding, shredding, or pelleting). Most natural organic fertilizers contain P, and thus have additional regulations imposed on their application. Natural organic fertilizers for lawn fertilization cannot contain more than 5% P. Also, natural organic fertilizers that contain P cannot be applied to lawns that have soil test P levels measuring optimum or excessive. On lawns that have low or medium soil P levels, natural organic fertilizers cannot be applied in excess of the amount of P recommended by the soil test, cannot apply more than 0.25 lbs. of P_20_5 per 1000 square feet per application, and cannot exceed 0.50 lbs. of P_20_5 per 1000 square feet annually.

Enhanced Efficiency Nitrogen – Enhanced efficiency N fertilizers are a type of slow release N fertilizer that further decrease the potential of nutrient loss to the environment and release less than 0.7 lb. N/1000 ft^2 per month. If a turfgrass fertilizer is classified as an enhanced efficiency N fertilizer, **Maryland regulations allow up to 2.5 pounds of actual N per 1000 square feet be applied in one application, as long as 80% of the annual rate for a given turfgrass species is not exceeded.**

Rates of Nitrogen

There are two primary issues regarding rates of N fertilization: how much N can be applied in any one application, and how much total N can be applied annually. As previously described, the maximum amount of N that can be applied in one application is dependent on the amount of soluble N in the fertilizer. The 2011 Maryland turfgrass fertilizer regulations stipulate that no more than 0.7 lb. soluble N/1000 ft^2 can be made in any single application. If the fertilizer contains slow release N, up to 0.9 lb. total N/1000 ft^2 may be applied in any single application, as long as no more than 0.7 lb. soluble N/1000 ft^2 is applied. In addition, if an enhanced controlled release fertilizer is used, up to 2.5 lb. N/1000 ft^2 can be applied in a single application. However, the application of an enhanced controlled release fertilizer cannot exceed the 80% of the total annual N recommendation for a given species listed in Table 1.

As previously discussed, the total annual turfgrass requirements for N vary considerably depending on a variety of conditions. The first factor to consider, however, is turfgrass species. The annual N requirements for maintaining established stands of the most common turfgrass species grown in Maryland generally fall into the ranges listed in Table 1.

Table 1. Standard Total Annual Nitrogen Rate Recommendations for Commercially Maintained Turfgrass

	Years 1-2 after establishment	Subsequent Years
Cool Season Grasses	Pounds actual N/1000 square feet	
Fine Fescue	1.0 - 2.0	0.0 – 1.5
Turf-type tall fescue	2.5 – 3.5	2.0 – 3.0
Kentucky bluegrass	3.0 – 4.0	2.0 – 3.5
Perennial ryegrass	2.5 – 3.5	2.0 – 3.0
Warm Season Grasses		
Zoysiagrass	1.0 – 2.0	0.0 – 2.0
Bermudagrass	2.0 – 4.0	2.0 – 3.0

Numerous factors influence whether moderate adjustments to these rates may be warranted. For example, if clippings are returned to the site when it is mowed, reductions in the annual N rates (as well as P and K) may be possible as the lawn matures. Maintaining a healthy root system through good cultural practices is not only important for overall turfgrass quality, but can help reduce the need for fertilizer. Also, if the site receives little traffic and thus does not need higher growth rates to recover from wear, lower N rates may be adequate. Other means of possible reductions in the total N requirements include the use of iron (if turfgrass color is an issue), increasing the height of mowing, and careful selection of cultivars when seeding, overseeding or sodding. Additionally, a turf stand that has been maintained for approximately 10 years or longer may require less N due organic matter buildup.

Conversely, several factors may warrant a moderate increase in annual rates to tall fescue, Kentucky bluegrass, and bermudagrass. These include 1) heavily used sites that need high recuperative rates and/or that are mowed lower than recommended due to use requirements, and 2) sites that have been damaged from adverse environmental conditions or pests. Also, on sites where pesticide use is not economically feasible or is not permitted (such as some school systems in Maryland), somewhat higher N rates can be important in minimizing many pest problems, particularly weeds and diseases. For these aforementioned conditions, moderately higher rates than the standard rates in Table 1 will help maintain turfgrass density and thus help minimize water runoff, soil erosion, and weed encroachment. Rates much higher than those recommended, however, can have the opposite effect and would not be warranted either agronomically or environmentally. If moderately higher rates than those typically recommended are used, they should be reviewed on an annual basis to determine if they can be reduced in subsequent seasons.

Key Points For Long-term Reductions in Total Annual N Applications

- **Correct soil pH, P, and K according to soil tests**
- **When establishing turf, improve soil conditions with the incorporation of organic matter**
- **Use recommended turfgrass species and cultivars**
- **Don't mow turfgrass too short**
- **Return clippings when mowing**
- **Don't try to grow turfgrass where it is not adapted, such as heavy shade or where there is severe tree root competition. Applying N will not help turf on these locations.**
- **Promote healthy root system through proper cultural practices.**
- **Established turf that is older than 10 years may require 30 to 50% less N fertilizer than younger turf.**

Timing of Nitrogen Applications

The primary potential for N loss from turfgrass sites is when excessive rates of N, particularly NO_3-N, are applied to turf that is not actively growing. Thus, most or all of the annual fertilizer requirement should be applied during periods of active shoot (leaf blades, rhizomes, stolons) and/or root growth.

Warm Season Grasses

The primary period for growth of warm season grass species (zoysiagrass and bermudagrass) is from mid-spring, after dormancy has broken, through mid-fall, when the first killing frost is experienced. Thus, N applications to warm season grasses should generally be restricted to these periods. However, fertilizer that contains primarily NH_4-N can be applied up to a month before dormancy is typically broken in the spring so that N is available for plant uptake at this time. Applications after September 1 are not generally recommended due to the possible enhancement of winterkill, particularly with bermudagrass. However, if bermudagrass has been overseeded with a cool season species such as perennial ryegrass, up to 0.9 lb. N/1000 ft^2 may be applied in September to enhance its performance.

Cool Season Grasses

Cool season grasses (tall fescue, Kentucky bluegrass, perennial ryegrass, and fine fescues) have a longer seasonal growth period in Maryland than the warm season species. They can exhibit growth at virtually any time during the year if moisture and temperature conditions are conducive. The prime periods for growth are typically from late winter through early summer and from late summer through late fall. Research would indicate that 2/3 to 3/4 of the total annual N should be applied during the latter period to maximize cool season turfgrass performance and quality.

Although research has shown some benefits to late fall fertilization, **the 2011 Maryland turfgrass fertilizer law prohibits homeowners from applying N fertilizers between November 15 and March 1. Professional applicators may apply 0.5 lb. N/1000 ft^2 (using soluble N fertilizers only) between November 15 and December 1, but may not apply N fertilizers between December 1 and March 1.**

Under extended hot and dry periods during mid-summer, cool season grasses may experience a period of dormancy until rainfall occurs. Nitrogen fertilizer should not be applied at this time. If irrigation is available or if rainfall is adequate throughout the summer, little dormancy will occur and N uptake of cool season grasses may continue. Although not generally needed, applications of $^1/_4$ to $^1/_2$ lb. N/1000 ft^2 can be made to these sites during this period if growth is not adequate to meet the demands of the use of the site.

Phosphorus and Potassium

Phosphorus (P) is critical in the establishment of turfgrass. Inadequate soil P will result in very poor seedling vigor, slow establishment of grass, and a stand with very poor density and root growth. Thus, soil will be much more susceptible to erosion. Weed encroachment will also be much more severe due to the lack of competition from the thin turfgrass stand. Thus, it is essential that sufficient P be added to the soil at the time of seeding if soil levels are inadequate (*refer to University of Maryland Turfgrass Technical Update TT-116 – "Nutrient Management Guidelines for Commercial Turfgrass Seeding" for current recommendations*). Although not as critical as during establishment of turfgrass, soil deficiencies of P in mature turf can result in poor spring greenup, reduced vigor, reduced density, and reduced drought tolerance. Light applications of P are generally sufficient to overcome soil P deficiencies in mature lawns.

Potassium (K) is not as critical as N or P during the initial establishment phase of turf. However, K can have an impact in mature turf regarding rhizome production and tolerances to heat, drought, and cold. Thus, sufficient K needs to be available for turfgrass to ensure that quality turf will be obtained during and after summer and/or winter stresses. Severe deficiencies of K will result in thin, chlorotic turf that may also exhibit a lack of vigor.

Soil Testing

Whereas N fertilizer application recommendations cannot currently be obtained from soil tests, applications of P and K and adjustment to soil pH must be based on recommendations obtained from soil tests from a laboratory approved by the Maryland Department of Agriculture. **Phosphorus may not be applied for maintenance of turfgrass unless recommended by a soil test. In addition, P may not be applied between November 15 and March 1.** While K has not been identified as a problem regarding water quality, it is recommended that not more not more than 2.0 lb. K_2O per 1000 ft^2 be applied for maintenance of turf if a soil test has not yet been taken.

Sites having different soil types, sites with different use or management histories, and/or sites having substantially different fertility levels as determined by previous soil tests should be sampled separately. Conversely, sites having similar soil types, having similar use and management histories, and having similar fertility levels as determined by past soil tests may be lumped together into one sample. For example, a single sample may be sufficient for a town house development that has had similar management over a period of time and has a relatively uniform soil type. After the initial soil test at a specific site, subsequent sampling every 3 years is generally sufficient to monitor soil P and K levels.

Table 2. P and K Recommendations for Commercially Maintained Turf

Soil Test Category

	low	medium	optimum---excessive
	Lbs. P_2O_5 or $K_2O/1000\ ft^2$		
Phosphorus	2.0	1.0	0
Potassium	2.0 - 4.0	1.0 - 2.0	0 - 1.0

Soil Reaction

Maintaining soil pH in an optimum range is important for maximizing the efficiency of nutrient use, and can be important in reducing weed and disease problems. Turfgrass can withstand a rather broad range of soil pH, but a soil pH 5.8 to 6.4 is generally considered ideal. Wide deviations from this range can result in reduced P and micronutrient availability, and can interfere with soil N metabolism and availability. Depending on turfgrass species, problems in turf may start to occur at soil pH above 7.8 and below 5.6. Thus, to maximize the efficiency of nutrient availability and use, soil tests should be taken as previously recommended to determine soil pH. Recommended limestone applications to achieve a soil pH of about 6.4 will be obtained from the soil test.

If the disease spring dead spot of bermudagrass is of concern or is a problem, maintaining lower soil pH (5.6-5.9) may be desirable, and either no or reduced rates of limestone should be applied to achieve this level. If an existing lawn is to be overseeded, it is recommended that limestone be applied approximately one month or more before overseeding to minimize potential P availability problems and the potential for volatilization loss of applied N.

Additional Fertilizer Application Recommendations and Requirements

- Fertilizer cannot be applied to impervious surfaces such as walkways, driveways, and roadways. If fertilizer does land on impervious surfaces, it must be removed or returned to the turf (such as by sweeping or blowing).
- Fertilizer containing N or P cannot be applied to frozen ground, even if the date is before December 1 or after March 1.
- Delay scheduled fertilizer applications if heavy rain is forecast.
- Do not use fertilizers as a de-icer.
- No fertilizer can be applied with 15 feet of waterways. If a drop spreader, a rotary spreader with a deflector, or a targeted liquid spray is used for applications, then fertilizer can be applied no closer than 10 feet of waterways. Waterways include:
  1. surface water subject to the jurisdiction of the State,
  2. the Chesapeake Bay and its tributaries,
  3. a pond, lake, river, stream, public ditch, or tax ditch within the State
  4. a public drainage system within the State other than those designed and used to collect, convey, or dispose of sanitary sewage.

It should be emphasized that the information presented within this publication for N, P, K, and limestone applications is meant only as a guideline. If the proper species and cultivars for a specific site are selected, and sound management practices such as recommended mowing heights are implemented, these fertilizer recommendations should result in satisfactory turfgrass quality in most situations. However, there are many factors that could impact whether moderate modifications of these recommendations are warranted for a specific site.

Related Publications:

University of Maryland Turfgrass Technical Update TT-116 – "Nutrient Management Guidelines for Commercial Turfgrass Seeding"

University of Maryland Turfgrass Technical Update TT-118 – "Nutrient Management Guidelines for Maryland Golf Courses"

University of Maryland Turfgrass Technical Update TT-77 – "Recommended Turfgrass Cultivars for Certified Sod Production and Seed Mixtures in Maryland"

UNIVERSITY OF MARYLAND EXTENSION
Solutions in your community

HOME AND GARDEN INFORMATION CENTER
University of Maryland Extension

HG 306
2006

How to Measure Your Yard

To apply the correct amount of fertilizer on your lawn, you need to know its surface area.

First, determine the total area of your property. Second, subtract the areas not to be fertilized. The remaining square footage is the number needed to determine how much fertilizer is needed. (See Figure 1)

Total lot:	Lot, 125' x 100'	= 12,500 sq. ft.
Subtract:	House, 44' x 26'	= 1,144 sq. ft.
	Deck, 12' x 12'	= 144 sq. ft.
	Drive, 40' x 10'	= 400 sq. ft.
	Garden, 25' x 15'	= 375 sq. ft.
	Walk, 4' x 20'	= 80 sq. ft.
Total to subtract		= 2,143 sq. ft.
Remainder: Yard		= 10,357 sq. ft.

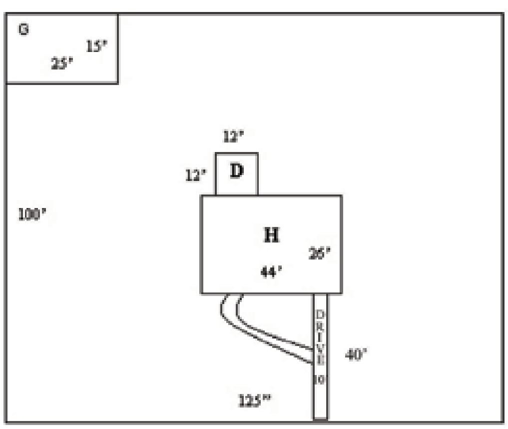


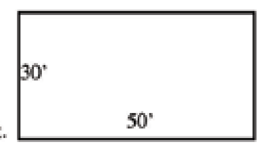
Figure 1.

How to determine the square footage of some familiar shapes

Squares, rectangles

Area = Length x width

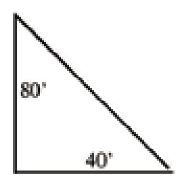
Length = 50'
Width = 30'
Area: 50' x 30' = 1,500 sq. ft.



Triangles

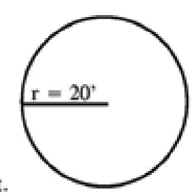
Area = .5 x base x height

Base = 40'
Height = 80'
Area: .5 x 40' x 80' = 1,600 sq. ft.



Circles
Area = D x r²
(D = 3.14)

r (radius) = 20'
Area; 3.14 x (20' x 20') = 1,256 sq. ft.

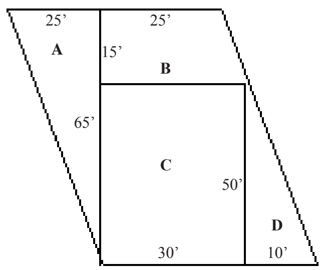


For more information on this and other topics visit the University of Maryland Extension website at www.extension.umd.edu

Irregular shapes

Divide area into smaller sections having familiar shapes (e.g. triangles A and D; rectangles B and C), then:

Area = Area A + Area B + Area C + Area D



A: .5 x 25’ x 65’ = 813 sq. ft.
B: 15’ x 25’ = 375 sq. ft.
C: 50’ x 30’ = 1,500 sq. ft.
D: .5 x 10’ x 50 = 250 sq. ft.

Area: 813 + 375 + 1,500 + 250 = 2,938 sq. ft.

Use the space below to draw your yard. Record the area in the box below.

Total lot: ____________________________

Subtract: House ______________
Deck ______________
Drive ______________
Garden ______________
Walk ______________
Other ______________

Total to subtract ______________
Remainder: Yard ______________

Have a home pest or garden question?
Call the Home and Garden Information Center
1-800-342-2507
http://extension.umd.edu/hgic

Author: University of Maryland Extension, Home and Garden Information Center

This publication is a series of publications of the University of Maryland Extension and The Home and Garden Information Center. For more information on related publications and programs, http://extension.umd.edu/hgic. Please visit http://extension.umd.edu/ to find out more about Extension programs in Maryland.

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, University of Maryland, College Park, and local governments. Cheng-i Wei, Director of University of Maryland Extension. The University of Maryland is equal opportunity. The University’s policies, programs, and activities are in conformance with pertinent Federal and State laws and regulations on nondiscrimination regarding race, color, religion, age, national origin, gender, sexual orientation, marital or parental status, or disability. Inquiries regarding compliance with Title VI of the Civil Rights Act of 1964, as amended; Title IX of the Educational Amendments; Section 504 of the Rehabilitation Act of 1973; and the Americans With Disabilities Act of 1990; or related legal requirements should be directed to the Director of Human Resources Management, Office of the Dean, College of Agriculture and Natural Resources, Symons Hall, College Park, MD 20742.

Appendix C: Soil Test Labs

Laboratory Name	Telephone	Web Address
A&L Eastern *(now Waypoint Analytical)*	804.743.9401	waypointanalytical.com
Agri Analysis, Inc.	800.464.6019 717.656.9326	www.agrianalysis.com
AgroLab, Inc.	302.265.2734	www.agrolab.us
Brookside Laboratories, Inc.	419.977.2766	www.blinc.com
Harris Laboratories*	402.476.0300	agsource.crinet.com/page 3036/turf
Logan Laboratories*	888.494.SOIL	www.loganlabs.com
Pennsylvania Agricultural Analytical Services	814.863.0841	www.aasl.psu.edu
Spectrum Analytic Inc.	800.321.1562	www.spectrumanalytic.com
University of Delaware Soil Testing Program	302.831.1392	http://ag.udel.edu/DSTP/
Waters Agricultural Laboratories, Inc.	229.336.7216	www.watersag.com
VA Tech*	540.231.6893	www.soiltest.vt.edu
**Soil test conversions are available for these labs.*		

Appendix D: Maryland Fertility Index Value Soil Test Category

Table D-1. Determining University of Maryland Soil Test Category

Laboratory	Units Reported	Extraction Method	Lab P Result	MD Soil Test Category
A & L Eastern (now Waypoint Analytical)	ppm	Mehlich-3	0-21	low
			22-44	medium
			45-90	optimum
			91+	excessive
Agri Analysis: Use P_2O_5 value	lb P_2O_5/ac	Mehlich-3	0-81	low
			82-193	medium
			194-415	optimum
			416+	excessive
AgroLab	ppm	Mehlich-3	0-21	low
			22-44	medium
			45-90	optimum
			91+	excessive
Brookside: Use easily extractable P, ppm P	ppm	Mehlich-3	0-18	low
			19-39	medium
			40-81	optimum
			82+	excessive
Brookside: Use easily extractable P, lb/ac P as P_2O_5	lb/ac	Mehlich-3	0-84	low
			85-181	medium
			182-373	optimum
			374+	excessive
CLC	lb P/ac	Bray 1	0-22	low
			23-52	medium
			53-111	optimum
			112+	excessive
Harris: Make sure lab knows sample is from MD	ppm	Bray 1	0-10	low
			11-27	medium
			28-60	optimum
			61+	excessive
Logan	lb P_2O_5/ac	Mehlich-3	0-84	low
			85-181	medium
			182-373	optimum
			374+	excessive
Penn State	ppm P	Mehlich-3	0-16	low
			17-39	medium
			40-84	optimum
			85+	excessive
Spectrum Analytic	ppm	Mehlich-3	0-15	low
			16-39	medium
			40-86	optimum
			87+	excessive

Appendix D: Maryland Fertility Index Value Soil Test Category (continued)

Table D-1. Determining University of Maryland Soil Test Category (continued)				
Laboratory	**Units Reported**	**Extraction Method**	**Lab P Result**	**MD Soil Test Category**
Spectrum Analytic	lb/ac	Mechlich-3	0-21	low
			22-54	medium
			55-121	optimum
			122+	excessive
University of Delaware	P Index	Mehlich-3	0-18	low
			19-43	medium
			44-92	optimum
			93+	excessive
VA Tech	lbs P/ac	Mehlich-1	0-18	low
			19-39	medium
			40-81	optimum
			82+	excessive
Waters	lbs P/ac	Mehlich-1	0-18	low
			19-39	medium
			40-81	optimum
			82+	excessive

Use the following steps to determine the University of Maryland's soil test category.

1. Find the phosphorus value reported by the lab (column one).
2. If more than one result is reported for phosphorus, use the value reported in the units listed in column two, Units Reported, for the lab used.
3. If an extraction method is reported, it should match the method listed in column 3, Extraction Method, for the lab used.
4. Find the range of numbers in column four, Lab P Result, that includes the phosphorus value reported.
5. Follow that line over to the right. The final column, MD Soil Test Category, will tell you the corresponding University of Maryland soil test category.
6. Phosphorus recommendations are based upon UMD's soil test category.

This document has been adapted from the University of Maryland Extension publication SFM 4, *Converting Among Soil Test Analyses Frequently Used in Maryland*, revised August 2006.

Appendix E: Measurement Conversion Chart

1 acre = 43,560 square feet
1 pound (lb.) = 16 oz (this is a weight measurement)
1 gallon = 4 quarts = 128 fluid ounces
1 cubic foot = 7.48 gallons
1 mile = 5,280 feet
1 minute = 60 seconds
1 mm = 0.039 inches
1 gallon of water = 8.337 pounds of water

Appendix F: Maryland Commercial Fertilizer Law

MARYLAND COMMERCIAL FERTILIZER LAW

§§ 6-201 — 6-224, of the Agriculture Article, Annotated Code of Maryland
Downloaded from Legislative Reference 10/7/11, Updated 5/9/12

§ 6-201. Definitions

(a) In general. In this subtitle the following words have the meanings indicated.

(b) Adulterated. A commercial fertilizer is "adulterated" if:

(1) Any poisonous, deleterious, or nonnutritive ingredient is added in sufficient amount to render it injurious to the health of plants, humans, or animal life or injurious to the environment;
(2) A valuable constituent is omitted or abstracted wholly or partially from it or any less valuable substance is substituted for it; or
(3) Its composition or quality falls below or differs from that which it is purported or is represented to contain by its labeling.

(c) Brand. "Brand" means the term, design, trademark, or other specific designation under which a commercial fertilizer or soil conditioner is distributed in the State.

(d) Bulk fertilizer. "Bulk fertilizer" means any commercial fertilizer distributed in a nonpackaged form.

(e) Buyer's mixture. "Buyer's mixture" means commercial fertilizer mixed on specific request of a purchaser according to a formula furnished by him.

(f) Commercial fertilizer. "Commercial fertilizer" means any substance containing a recognized plant nutrient used for its plant nutrient content and designed for use or claimed to have value in promoting plant growth, except unmanipulated animal and vegetable manure, marl, lime, wood ashes, and gypsum.

(g) Custom-mix. "Custom-mix" means commercial fertilizer mixed on specific request of a purchaser according to a formula furnished by him.

(h) Distribute. "Distribute" means to import, manufacture, produce, compound, mix, blend, barter, sell, offer for sale, consign, furnish, provide, or otherwise supply commercial fertilizer or soil conditioners as part of a commercial enterprise.

(i) Enhanced efficiency fertilizer. "Enhanced efficiency fertilizer" means a fertilizer product that increases plant uptake and decreases the potential of nutrient loss to the environment, including gaseous loss, leaching, or runoff, when compared to an appropriate reference fertilizer product.

(j) Fertilizer material. "Fertilizer material" means a commercial fertilizer containing a recognized plant nutrient, which is used primarily for its plant nutrient content.

(k) Grade. "Grade" means the percentage of total nitrogen (N), available phosphate (P2O5), and soluble potash (K2O) stated in whole numbers in the same terms, order, and percentages as in the "guaranteed analysis". In the case of any "specialty fertilizer" or "mixed-to-order fertilizer" guarantees may be stated in decimal fractions of whole numbers.

(l) Guaranteed analysis. "Guaranteed analysis" means the minimum percentage of plant nutrient claimed as follows:

(1) Total nitrogen (N), available phosphate (P2O5), soluble potash (K2O);
(2) For unacidulated mineral phosphatic materials and basic slag, both total and available phosphate and the degree of fineness;
(3) For bone, tankage, and other organic phosphatic materials, total phosphate;
(4) Additional plant nutrients, when claimed, shall be expressed in elemental form; and
(5) Potential basicity or acidity may be expressed in terms of calcium carbonate equivalent in multiples of 100 pounds per ton.

(m) Gypsum. "Gypsum" means any product that consists chiefly of calcium sulfate intended for use for agricultural purposes.

(n) Label. "Label" means the display of all written, printed, or graphic matter on the immediate container or a statement accompanying a commercial fertilizer or soil conditioner.

(o) Labeling. "Labeling" means all written, printed, or graphic matter on or accompanying any commercial fertilizer or soil conditioner, or the contents of any advertisement, brochure, poster or television or radio announcement used in promoting the sale of a commercial fertilizer or soil conditioner.

(p) Lot. "Lot" means a definite quantity of commercial fertilizer or soil conditioner, identified by name, grade, or code designation as certified by the Secretary.

(q) Low phosphorous fertilizer. "Low phosphorous fertilizer" means fertilizer:

(1) Containing not more than 5% of available phosphate (P2O5); and
(2) That has an application rate not to exceed 0.25 pound of available phosphate (P2O5)/1,000 square feet/application and 0.5 pound of available phosphate (P2O5)/1,000 square feet/year.

(r) Misbranded. A commercial fertilizer or soil conditioner is "misbranded", if:

(1) Its labeling is false or misleading in any particular;
(2) It is distributed under the name of another product;
(3) It is not labeled as required in § 6-210 of this subtitle and in rules and regulations prescribed under this subtitle;
(4) A fertilizer purports to be or is represented as a commercial fertilizer or if it purports to contain or is represented as containing a fertilizer material, unless the fertilizer material conforms to any definition of identity, prescribed by departmental rules and regulations which give due regard to commonly accepted definitions, such as those issued by the Association of American Plant Food Control Officials, Inc.; or
(5) Any word, statement, or other information, required to appear on the label or labeling, is not placed on it prominently and conspicuously as compared with other words, statements, designs, or devices in the labeling, and it is not in terms that render it likely to be read and understood by the ordinary individual under customary conditions of purchase and use.

(s) Mixed fertilizer. -- "Mixed fertilizer" means a commercial fertilizer containing any combination, blend, or mixture of fertilizer materials designed for use or claimed to have value in promoting plant growth.

(t) Mixed-to-order. -- "Mixed-to-order" means commercial fertilizer mixed on a specific request of a purchaser according to a formula furnished by him.

(u) Natural organic fertilizer.

(1) "Natural organic fertilizer" means a fertilizer product that is derived from either a plant or animal product containing carbon, and one or more elements, other than hydrogen or oxygen that are essential for plant growth.
(2) "Natural organic fertilizer" does not include a fertilizer product that contains:

(i) Synthetic materials; or
(ii) Materials that are changed in any physical or chemical manner from their initial state, except by physical manipulation, including drying, cooking, chopping, grinding, shredding, or pelleting.

(v) Official sample. "Official sample" means any sample of fertilizer or soil conditioner taken and designated as "official" by the Secretary.

(w) Organic fertilizer.

(1) "Organic fertilizer" means a fertilizer product that is derived from either a plant or animal product containing carbon and one or more elements, other than hydrogen or oxygen that are essential for plant growth.

(2) "Organic fertilizer" includes a fertilizer product that contains:
(i) Synthetic materials; or

(ii) Materials that are changed in a physical or chemical manner from their initial state.

(x) Percent; percentage. "Percent" or "percentage" means percentage by weight.

(y) Professional fertilizer applicator. "Professional fertilizer applicator" has the meaning stated in § 8-801 of this article.

(z) Registrant. "Registrant" means any person who registers a commercial fertilizer or soil conditioner pursuant to the provisions of this subtitle.

(aa) Retail establishment. "Retail establishment" has the meaning stated in § 5-401 of the Economic Development Article.

(bb) Slow release nitrogen. "Slow release nitrogen" means nitrogen in a form that:

(1) Delays its availability for plant uptake and use after application; or

(2) Extends its availability to the plant significantly longer than a reference "rapidly available nutrient" such as ammonium nitrate or urea, ammonium phosphate, or potassium chloride.

(cc) Soil conditioner.

(1) "Soil conditioner" means any substance or mixture of substances intended for sale, offered for sale, or sold for:

(i) Manurial, soil enriching, or soil corrective purposes;

(ii) Promoting or stimulating the growth of plants;

(iii) Increasing the productivity of plants;

(iv) Improving the quality of crops; or

(v) Producing any chemical or physical change in the soil, except a commercial fertilizer, unmanipulated animal and vegetable manures, agricultural liming material, and gypsum.

(2) "Soil conditioner" includes but is not limited to materials such as compost, peat, vermiculite, or perlite, that are incorporated into the soil.

(dd) Soil test. "Soil test" means a technical analysis of soil conducted by a laboratory using standards recommended by the University of Maryland.

(ee) Specialty fertilizer. "Specialty fertilizer" means a commercial fertilizer distributed primarily for nonfarm use, such as home gardens, lawns, shrubbery, flowers, golf courses, municipal parks, cemeteries, greenhouses, and nurseries, and may include commercial fertilizers used for any research or experimental purpose.

(ff) Ton. "Ton" means a net weight of two thousand pounds avoirdupois.

(gg) Turf. "Turf" means land, including residential property and publicly owned land that is planted in mowed, managed grass, except land that is used in the sale and production of sod, as defined in § 9-101 of this article.

(hh) Water-soluble nitrogen. "Water-soluble nitrogen" means nitrogen that is readily soluble in water.

§ 6-202. Administration

This subtitle shall be administered by the State Chemist subject to the supervision of the Secretary.

§ 6-203. Enforcement; rules and regulations

The Secretary shall enforce this subtitle. After notice and public hearing he may adopt reasonable rules and regulations necessary to secure the efficient administration of this subtitle.

§ 6-204. Fund for payment of administration expenses

Any registration or inspection fee, and penalty shall constitute a special fund to be used only to defray partially the cost of inspection, sampling, analysis, and other expenses necessary for administering this subtitle. Notwithstanding any other provisions of this Code, any unexpended funds up to a maximum of $ 100,000 may not revert to the General Fund of the State at the end of the fiscal year.

§ 6-205. Publication of information concerning fertilizers and soil conditioners

The Secretary shall publish at least annually, in any form he deems proper, (1) information concerning the distribution of commercial fertilizers and soil conditioners; (2) data on their production and use as he considers advisable; and (3) a report of the results of the analysis of official samples of these products distributed in the State as compared with the analyses guaranteed in the registration and the label. The published information concerning production and use of commercial fertilizers and soil conditioners may not disclose the operation of any person.

§ 6-206. Inspection, sampling, testing, and analyses of commercial fertilizer

(a) Inspection, sampling, testing, and analysis required. The Secretary shall sample, inspect, test, and make analyses of any commercial fertilizer and soil conditioner distributed in the State at any time and place and to an extent the Secretary considers necessary to assure compliance with the provisions of this subtitle.

(b) Methods of sampling and analysis. The Secretary shall adopt the methods of sampling and analysis from sources, such as the journal of the Association of Official Analytical Chemists, or methods that insure representative sampling and accurate examination.

(c) Secretary to be guided solely by official sample. In determining for administrative purposes whether a commercial fertilizer or soil conditioner is deficient in any component, the Secretary shall be guided solely by the official sample obtained and analyzed as provided by this subtitle.

(d) Right of entry. The Secretary may enter any public or private premises, including any transportation vehicle, during regular business hours, to obtain access to commercial fertilizer or soil conditioners or to records relating to their distribution.

§ 6-207. Registration

(a) Registration of commercial fertilizer and soil conditioner required. Except as provided in subsection (d) of this section, a distributor shall register each brand and grade of commercial fertilizer and each product name of soil conditioner before distributing it in the State and shall pay the registration fee.

(b) Registration application; copy to be furnished. The registration application shall be accompanied by a label or other printed matter describing the product, if requested by the Secretary. The application shall be submitted on forms furnished by the Secretary. Upon the Secretary's approval, a copy of the registration shall be furnished to the applicant.

(c) Expiration date. Each registration expires January 31 each year.

(d) Exemptions.

(1) Provided the product label has not been altered or changed, a distributor shall not be required to register any brand and grade of commercial fertilizer or product name of soil conditioner which has been registered under this subtitle by another person.

(2) A distributor shall not be required to register a commercial fertilizer mixed or blended according to a formula furnished by a consumer, but he shall label the fertilizer in the order and form provided in § 6-210(c) of this subtitle. However, any fertilizer mixed in advance of receipt of the customer's specific order shall be registered.

§ 6-208. Registration and inspection fees

(a) Amount of fees. For each brand and grade of commercial fertilizer and for each soil conditioner distributed in the State, the annual registration fee is $ 15 and the annual inspection fee is 25 cents per ton except:

(1) For each brand and grade of commercial fertilizer and each soil conditioner distributed in packages of 10 pounds or less, the annual registration fee is $ 30, notwithstanding any other registration or inspection fee; and

(2) For each brand and grade of commercial fertilizer and each soil conditioner distributed in packages of 10 pounds or less and in packages over 10 pounds, the annual $ 30 registration fee applies, and only the portion distributed in packages over 10 pounds is subject to the inspection fee of 25 cents per ton.

(b) Exemptions.

(1) Mixed-to-order, buyer's mixture, or custom-mix fertilizer is exempted from the registration fee, but the inspection fee shall be paid.

(2) Distribution of fertilizer materials to manufacturers or exchange between them is exempted.

§ 6-209. Semiannual statement of tonnage sold; report of sales to nonregistrant

(a) Statement required. Each person who registers any commercial fertilizer or soil conditioner in the State shall furnish the Secretary with a semiannual written statement of the tonnage of each grade of commercial fertilizer or each soil conditioner distributed in the State. This statement shall include every sale for the periods of January 1 through June

30 and July 1 through December 31 of each year.

(b) Failure to file statement or pay fee. If the tonnage report is not filed and the inspection fee is not paid within 31 days after the end of the semiannual period, a collection fee amounting to 10 percent of the amount, or a minimum of $ 10, shall be assessed against the registrant. The amount of fees due constitute a debt and may become the basis of a judgment against the registrant.

(c) Distributor to keep records. Any person who distributes any commercial fertilizer or soil conditioner shall keep records necessary or required by the Secretary to indicate accurately the tonnage of commercial fertilizer and soil conditioner distributed in the State. The Secretary has the right to examine the records to verify any statement of tonnage.

(d) Monthly report of sales and distribution to nonregistrant. Each registrant distributing or selling commercial fertilizer to a nonregistrant shall mail to the Secretary within ten days, excluding legal holidays and Sundays, after the last day of each month a statement showing the following information for that month: (1) the total tons of commercial fertilizer distributed by grades and analyses, (2) the counties to which it was distributed, and (3) the form in which the commercial fertilizer was shipped, such as, bags, bulk, or liquid. If more than one person is involved in the distribution of commercial fertilizer, the last registrant who distributes to a nonregistrant, whether a dealer or consumer, is responsible for reporting tonnage, unless a prior distributor has reported.

(e) Section does not require disclosure. This section does not require the disclosure of the name of the consignee or the sale price of the commercial fertilizer or any aspect of the operations of any person other than as specifically required. No information furnished pursuant to this section shall be disclosed in a way so as to divulge the operation of any person.

§ 6-209.1. Records of sale or distribution of ammonium nitrate fertilizer

(a) Maintenance of records. A distributor shall maintain, for at least 2 years, a record of all sales or distributions of ammonium nitrate fertilizer including:

(1) The date of sale or delivery of the fertilizer;
(2) The name, address, and copy of the driver's license or picture identification card of the buyer or recipient;
(3) The quantity of fertilizer sold or delivered; and
(4) Any other information required by the Secretary.

(b) Records available on request of Secretary. Records maintained pursuant to subsection (a) of this section shall be made available to the Secretary upon request.

(c) Confidentiality; exceptions.

(1) Except as provided in paragraph (2) of this subsection, the Secretary shall maintain all records or reports requested under subsection (b) of this section in a manner that protects the identity and location of the distributor and buyer or recipient.

(2) If the Secretary determines that the disclosure is necessary to protect the public, the Secretary may disclose the identity and location of the distributor and buyer or recipient to a federal, State, or local government or unit of government that requests the information in the course of performing its duties related to public safety.

(d) Regulations. In consultation with the Office of Homeland Security, the Secretary shall adopt regulations to carry out the provisions of this section.

§ 6-210. Labeling

(a) Commercial fertilizer. Each brand and grade of commercial fertilizer distributed in the State shall be accompanied by a legible label bearing the following information:

(1) The net weight;
(2) The brand and grade under which the commercial fertilizer is distributed;
(3) The guaranteed analysis giving the minimum percentage of every plant nutrient claimed to be contained in the fertilizer; and
(4) Name and address of manufacturer.

(b) Statement to accompany delivery in bulk. If distributed in bulk, a written or printed statement of the information required by subsection (a) of this section shall accompany delivery and be supplied to the purchaser at the time of delivery.

(c) Mixed-to-order fertilizer. Any fertilizer mixed or blended according to a formula furnished by a purchaser shall be marked plainly or tagged with the words "buyer's mixture", or "mixed-to-order", or "custom-mix" together with a statement containing the following information:

(1) Net weight;
(2) The guaranteed analysis giving the minimum percentage of every plant nutrient claimed to be contained in the fertilizer; and
(3) Name and address of the manufacturer. In addition, the amounts or kinds of materials used in the formulation may be shown.

(d) Specialty fertilizer.

(1) Except as provided in paragraph (2) of this subsection, a specialty fertilizer shall be labeled to contain all information required by subsection (a) of this section.
(2) A specialty fertilizer used on turf shall be labeled to contain:

(i) All of the information required by subsection (a) of this section;
(ii) The percentage of total nitrogen, including the percentage of other water soluble nitrogen and water insoluble nitrogen;
(iii) The percentage of available phosphate;
(iv) The percentage of soluble potash; and
(v) 1. The following statement: "Do not apply near water, storm drains or drainage ditches. Do not apply if heavy rain is expected. Apply this product only to your lawn, and sweep any product that lands on the driveway, sidewalk, or street back onto your lawn."; or
2. The environmental hazard statement recommended by the U.S. Environmental Protection Agency for that product.

(3) The information required under paragraphs (1) and (2) of this subsection shall be printed in a legible and conspicuous manner on at least one side of the container, or if it does not appear on the face or display side of the container, it shall appear on the upper third of the side used.

(e) Lawn fertilizer with acid content greater than 5%.

(1) Except as provided in paragraph (2) of this subsection, on or after April 1, 2011, a lawn fertilizer with an available phosphate (P2O5) content greater than 5%:

(i) May not be labeled for use on established lawns or grass;
(ii) May not be labeled with spreader settings; and
(iii) Shall be marked with the words "NOT FOR USE ON ESTABLISHED LAWNS OR GRASS" in at least a three-quarter inch font and in a legible and conspicuous manner on the front side of the container.

(2) This subsection does not apply to seed starter fertilizer for use on newly established lawns or turf.

(f) Soil conditioner. Each brand of soil conditioner distributed in the State shall be accompanied by a legible label bearing the following information:
(1) Net weight or other measure prescribed as satisfactory by the Secretary;
(2) The brand under which the soil conditioner is distributed;
(3) An accurate statement of composition and purpose; and
(4) Name and address of the registrant.

§ 6-210.1. Commercial fertilizer. Required signage at retail outlets.

(a) In general. Any retail outlet distributing commercial fertilizer in bags weighing 50 pounds or more shall display prominently a sign advising customers that:

(1) Overuse of commercial fertilizer damages State waters, including the Chesapeake Bay; and
(2) Customers concerned with protecting and restoring the health of the Chesapeake Bay and other State waters should, before using a commercial fertilizer, receive a chemical analysis of the soil to be fertilized from a soil-testing laboratory.

(b) Development of signs by Department. The Department shall develop and make available at no cost to an affected retailer a sign that meets the requirements of subsection (a) of this section.

§ 6-211. Distribution of adulterated or misbranded fertilizer or soil conditioner

A person may not distribute an adulterated or misbranded fertilizer or a misbranded soil conditioner.

§ 6-212. Short weight

If the Secretary finds that a consumer possesses any commercial fertilizer or soil conditioner short in weight, the registrant of the product shall pay the consumer a penalty equal to two times the value of the actual shortage within 30 days after official notice of the Secretary.

§ 6-213. Change in plant nutrient content

The plant nutrient content of each commercial fertilizer shall remain uniform for the period of registration. No percentage of any guaranteed plant nutrient element may be changed in a manner that lowers the crop-producing quality of the commercial fertilizer, even if the fertilizer is registered subsequently.

§ 6-214. Disposition of fertilizer or soil conditioner found in violation of subtitle

(a) Stop-sale order. In general. The Secretary may issue and enforce a written stop-sale order to the registrant, owner, custodian, or distributor of any fertilizer or soil conditioner that the Secretary finds is in violation of any provision of this subtitle or regulation under this subtitle, or has been found by federal or State authorities to cause unreasonable adverse effects to humans, animals, plants, or the environment.

(b) Stop-sale order. Duration. The order prohibits sale or distribution of the fertilizer or soil conditioner until the Secretary:

(1) Has evidence that the product is in compliance with the law; and
(2) Provides a written release from the stop-sale order.

(c) Condemnation and confiscation. The Secretary may petition the circuit court of the county in which the commercial fertilizer or soil conditioner is located, if the fertilizer is located there, to seize any lot of commercial fertilizer or soil conditioner not in compliance with this subtitle. If the court finds the material to be in violation of the provisions of this subtitle and orders condemnation of the commercial fertilizer or soil conditioner, the material shall be disposed of in any manner consistent with the quality of the commercial fertilizer or soil conditioner and the laws of the State. The court may not dispose of the material without first giving the claimant an opportunity to apply to the court for release of it or for permission to process or relabel it so that it complies with the provisions of this subtitle.

§ 6-215. Official analysis prima facie evidence of composition

In any prosecution under this subtitle relating to the composition of a lot of commercial fertilizer or soil conditioner, a certified copy of the official analysis signed by the Secretary or the State Chemist is prima facie evidence of the composition.

§ 6-216. Report of violations for criminal prosecution; minor violations

(a) Report of violations for criminal prosecution. The State's Attorney to whom any violation is reported shall institute appropriate judicial proceedings without delay. Before the Secretary reports a violation for prosecution, the person against whom the proceeding is contemplated shall be given reasonable notice of the alleged violation and an opportunity to present his view, orally or in writing, with regard to the contemplated proceeding.

(b) Minor violations. This subtitle does not require the Secretary to report for prosecution or for institution of condemnation proceedings any minor violation of the subtitle when he believes the public interests will be served best by a suitable written warning notice.

§ 6-217. Injunctions

The Secretary may petition the court to grant a temporary or permanent injunction restraining any person from violating or continuing to violate any provision of this subtitle or any rule or regulation adopted under it, notwithstanding the existence of any other remedy at law. The injunction shall be issued without bond.

§ 6-218. Refusal or cancellation of registration

The Secretary may refuse to register or cancel the registration of any brand of commercial fertilizer or soil conditioner upon satisfactory evidence that the registrant has used fraudulent or deceptive practices in evasions or attempted evasions of the provisions of this subtitle or any rules and regulations adopted under it. However, no registration may be refused or revoked until the registrant has been given the opportunity to appear for a hearing by the Secretary.

§ 6-219. Deficiencies or excesses in plant nutrients

(a) Determination and publication of nutrient values. To determine the commercial value to be applied in subsection (b) of this section, the Secretary shall determine and publish annually the values per pound of nitrogen, available phosphate, soluble potash and other plant nutrients in commercial fertilizers in the State as determined by the Secretary.

(b) Penalty for deficiency in guaranteed primary plant nutrient. If an official analysis of a lot shows that a commercial fertilizer is deficient in a guaranteed primary plant nutrient, that is nitrogen, available phosphate, and soluble potash, beyond the investigational allowance as established by rule or regulation, the Secretary shall assess against the registrant a penalty of three times the commercial value of the deficiency in the lot analyzed if the deficiency is confirmed in a hearing before him.

(c) Other deficiencies or excesses. The Secretary shall evaluate other deficiencies or excesses beyond the investigational allowance established by rule or regulation in any other constituent covered under § 6-201(l) of this subtitle which the registrant is required to or may guarantee, and he shall prescribe the penalty for any deficiency or excess.

§ 6-220. Short title

This subtitle may be cited as the "Maryland Commercial Fertilizer Law".

§ 6-221. Regulations regarding product standards

(a) Adoption. The Secretary shall adopt regulations in consultation with the State Department of the Environment to establish product standards for compost intended for commercial use and distribution.

(b) Contents. The regulations adopted under subsection (a) of this section shall include:
(1) Certification requirements for operators of composting facilities; and
(2) A classification scheme for compost.

(c) Consistency with national and other standards. -- To the greatest extent practicable, the regulations adopted under subsection (a) of this section shall be consistent with applicable national standards and with relevant standards which may have been developed in neighboring states.

§ 6-222. Low phosphorous fertilizer

(a) Prohibitions.
(1) Except as provided in paragraph (2) of this subsection, on or after April 1, 2011, a person may not sell or distribute for use or sale any fertilizer intended for use on established lawns or grass unless it is low phosphorous fertilizer.
(2) This subsection does not apply to organic or natural organic fertilizer that is sold to a professional fertilizer applicator.

(b) Reduction levels.

(1) On or before April 1, 2011, a manufacturer of lawn fertilizer whose products are sold in the State shall reduce by 50% from 2006 levels the amount of available phosphate (P2O5) resulting from the application of its lawn care products within the State.
(2) The amount of available phosphate (P2O5) resulting from the application within the State of lawn care

products sold or distributed by a manufacturer may not exceed an average of 1.5% available phosphate (P2O5) if, prior to April 1, 2010, the manufacturer did not sell or distribute fertilizer in the State intended for use on established lawns or grass.

(3) Beginning in 2011, a manufacturer of fertilizer whose products are sold in the State shall report the pounds of phosphorus in its lawn care products sold at retail locations in the State to the Department at the end of each calendar year.

(c) Regulations. -- The Department may adopt regulations to implement this section.

§ 6-223. Regulation of fertilizer and its application (Section effective October 1, 2012.)

(a) Department has exclusive authority. -- Except for enforcement provided under § 8-803.5(g) of this article, the Department has the exclusive authority to establish standards regulating fertilizer and its application to turf.

(b) Local laws prohibited. -- A local government entity may not adopt laws, regulations, rules, ordinances, or standards regulating fertilizer and its application to turf.

(c) Compliance with provisions of Environment Article. -- Subsections (a) and (b) of this section do not exempt a person from complying with any provision of, or any regulation adopted in accordance with, the Environment Article.

§ 6-224. Restrictions on use and sale of fertilizer (Section effective October 1, 2013.)

(a) Specialty fertilizer. Except as provided in subsection (b) of this section, any specialty fertilizer labeled for use on turf may not:

(1) Result in an application of more than 0.7 pounds per 1,000 square feet of water-soluble nitrogen and no more than 0.9 pounds per 1,000 square feet of total nitrogen, at least 20% of which shall consist of slow-release nitrogen, when applied in accordance with the instructions on the container;

(2) Contain phosphorus, except:

(i) For organic and natural organic fertilizer sold to a professional fertilizer applicator; or

(ii) When specifically labeled for the following purposes:

1. Providing nutrients to specific soils and target vegetation as determined to be necessary in accordance with a soil test that was:

A. Conducted by a laboratory identified under § 8-803.7 of this article; and

B. Performed no more than 3 years before the application;

2. Establishing vegetation for the first time, such as after land disturbance, provided the application is conducted in accordance with the recommended application rates established by the State; or

3. Reestablishing or repairing a turf area; and

(3) Be labeled for use as a de-icer.

(b) Enhanced-efficiency fertilizer. An enhanced-efficiency fertilizer labeled for use on turf may not:

(1) Result in an annual application of more than 2.5 pounds per 1,000 square feet of total nitrogen;

(2) Result in an application of more than 80% of the annual recommended rate for total nitrogen established by the University of Maryland; or

(3) Have a release rate of more than 0.7 pounds per 1,000 square feet of total nitrogen per month.

(c) Sale of specialty fertilizer. Except as provided in subsections (d) and (e) of this section, a person may not offer to sell specialty fertilizer for use on turf that:

(1) Results in an application of more than 0.7 pounds per 1,000 square feet of water-soluble nitrogen and no more than 0.9 pounds per 1,000 square feet of total nitrogen, at least 20% of which shall consist of slow-release nitrogen, when applied in accordance with the instructions on the container; and

(2) Contains phosphorus and is intended for use on turf unless the intended use of the fertilizer is:

(i) For application to specific soils and turf as determined to be necessary pursuant to a soil test conducted by a laboratory identified in § 8-803.7 of this article and performed no more than 3 years before the application, provided the application complies with recommended application rates established by the University of Maryland;

(ii) For the establishment of turf for the first time, such as after land disturbance, provided the application complies with recommended application rates established by the University of Maryland; or

(iii) For the reestablishment or repair of a turf area.

(d) Sale of organic or natural organic fertilizer. A person may offer to sell an organic or natural organic fertilizer containing phosphorus to a professional fertilizer applicator.

(e) Sale of enhanced-efficiency fertilizer. A person may not offer to sell enhanced-efficiency fertilizer for use on turf that:

(1) Results in an annual application of more than 2.5 pounds per 1,000 square feet of total nitrogen;

(2) Results in an application of more than 80% of the annual recommended rate for total nitrogen established by the University of Maryland; or

(3) Has a release rate of more than 0.7 pounds per 1,000 square feet of total nitrogen per month.

(f) Use as de-icer. A person may not offer to sell a commercial or specialty fertilizer product for use as a de-icer.

Appendix G: Acronyms and Abbreviations

Acronym/Abbreviations	Meaning
CEC	cation exchange capacity
FIV	Fertility Index Value (Maryland)
g/cm^3	grams per cubic centimeter
gpa	gallons per acre
gpm	gallons per minute
lbs/ac	pounds per acre
lin ft	linear foot OR linear feet
MDA	Maryland Department of Agriculture
meq/100g	milliequivalents per 100 grams
mm	millimeters
mph	miles per hour
ppm	parts per million
SAV	submerged aquatic vegetation
UMD	University of Maryland
USDA	United States Department of Agriculture
WIN	water-insoluble nitrogen
WIP	Watershed Implementation Plan
WSN	water-soluble nitrogen

Appendix H: Terms and Definitions

Term	Definition
acidic	with a pH less than 7
aggregation	a group of soil particles stuck together
ammoniacal nitrogen	nitrogen that comes from ammonia NH_4
anoxia	without oxygen
bulk density	the dry mass of solids per unit volume of soils
calcitic lime	crystalline calcium carbonate ($CaCo_3$) used to raise the pH of soil
chelated iron	iron that is attached to a molecule at two or more points
chelates	a metal attached to a molecule at two or more points, thus forming a circle
colloides	very small (<.001mm) soil particles—usually clay or organic matter that carry a charge (usually negative)
compaction	closely packed
core aeration	removal of many cylindrical plugs of soil from the soil surface
dimethylenetriurea	a type of nitrogen fertilzer
discyanodiamide	a type of nitrogen fertilizer
dolomitic lime	a liming material high in magnesium carbonate
hypoxia	a deficiency of oxygen
isobutylidene diurea	a type of nitrogen fertilizer; also called IBDU
leaching	downward movement of nutrients through the soil
lime	a material used to raise the pH of soil
macropores	soil pores that are larger than 0.05 mm
methlenediurea	a type of nitrogen fertilizer
microorganism	a living thing that is too small to be seen without a microscope
micropores	soil pores that are smaller than 0.05 mm
nitrate nitrogen	nitrogen found in the NO_3- form
perennial ryegrass	a cool-season grass species commonly used for lawns
pH	a symbol used to express the acidity or alkalinity on a scale of 0 to 14. It is the natural logarithm of the reciprocal of the hydrogen ion concentration in a solution.
photosynthesis	the process by which green plants turn energy from sunlight into sugars
porosity (soil)	the open pore space between the soil particles that is filled by water and air
soil horizons	distinct layers of soil or its underlying material in a vertical section of land
tillage	the process of disturbing and mixing the top three or more inches of soil in preparation for planting seed
tilth	the soil's physical condition as it relates to plant growth
urea nitrogen	nitrogen that comes from the breakdown of urea
ureaform	a type of fertilizer that is manufactured by reacting urea with formaldehyde
ureaformaldehyde	a group of fertilizers made by reacting urea with formaldehyde in various ratios

Prepared by:

Dr. Gary K. Felton
Environmental Science and Technology
University of Maryland
1426 Animal Science/Agricultural Engineering Building
University of Maryland
College Park, MD 20742-2315

UNIVERSITY OF MARYLAND
EXTENSION
Solutions in your community

301.405.8039
extension.umd.edu/hgic

Maryland
Department of Agriculture
Office of Resource Conservation

Nutrient Management Program
50 Harry S. Truman Parkway
Annapolis, MD 21401
410.841.5959
www.mda.maryland.gov

Photos courtesy of Gandy.com; Maryland Department of Agriculture; Mark Schlossberg, ProLawnPlus; Chris Wible, The ScottsMiracle-Gro Company; Shutterstock.com; Chris Forth, TruGreen; and University of Maryland.

MDA PUBLICATION 15.01.19