Water Quality Best Management Practices: Nutrients, Irrigation and Pesticides for Golf Course, Athletic Turf, Lawn Care and Landscape Industries

Delaware Nutrient Management Commission

2006

Water Quality
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CHAPTER 1: INTRODUCTION

I. Purpose of booklet and nutrient management

This booklet is designed to provide information and guidance for the "green industry" on turfgrass and landscape plant production and maintenance practices to conserve and protect Delaware's water resources. These practices include the establishment of new turf and landscapes, and the care of existing turf and landscapes, including construction activities, irrigation, nutrient management and pest management.

This document should be used to enhance the professional knowledge and judgment of green industry professionals and should not be viewed as a regulatory standard to be rigidly applied in all cases. The information presented here should be used as general and educational guidance, but specific situations may require more restrictive measures to protect sites that are at particularly high risk for adverse effects on surface and ground water.

Throughout this document, watch for this symbol: BMP as it identifies a best management practice to protect water quality from nutrients and pesticides.

II. Delaware Nutrient Management Commission

The Delaware Nutrient Management Commission is charged to establish and encourage implementation of Best Management Practices (BMP) in generation, handling or land application of nutrients to protect water quality while maintaining agricultural profitability.

The responsibilities of the Delaware Nutrient Management Commission include:

- Consider establishing critical areas for the targeting of other voluntary losses to the environment.
- Establish best management practices to reduce nutrient losses to the environment.
- Develop educational and awareness programs.
- Consider a transportation and alternative use incentive program to redistribute nutrients.
- Establish the elements and general direction of the State Nutrient Management Program.

III. Laws & Regulations

A. Nutrient Management Act 1999

The Delaware Nutrient Management Act (Title 3, Chapter 22 of the Delaware Code) was enacted in June 1999 as part of an effort to address water quality concerns in Delaware. The purposes of Chapter 22 are:

- To regulate those activities involving the generation and application of nutrients in order to help improve and maintain the quality of Delaware's ground and surface waters, and to meet or exceed federally mandated water quality standards in the interest of the overall public welfare;
- To establish a certification program that encourages the implementation of best management practices in the generation, handling or land application of nutrients in Delaware;
- To establish a nutrient management planning program, and
- To formulate a systematic and economically viable nutrient management program which will both maintain agricultural profitability and improve water quality in Delaware.

B. Nutrient Management General Permit

A nutrient management general permit is designed to provide standards for certain farms, golf courses, operations, and situations relating to the handling and application of fertilizers. The general permit coverage is a substitute for a detailed nutrient management plan and is intended for low risk operations. An applicant of a general permit must apply for coverage with the commitment and intention to handle nutrients according to the general permit standards.

Eligibility:

- Land requiring nutrient management with perennial crops (non-tillage) or turf grass being grown for at least two years; and
- A nutrient management plan must have been implemented under mandatory nutrient planning for at least three years; and
- For animal feeding operations, the number of animals shall not exceed eight animal units (8,000 lbs).

- A Notice of Intent must be submitted for coverage; and
- Nutrient handling records must be maintained according to regulations; and
- Nutrient certification requirements must be met according to regulations; and
- Nutrient annual report must be submitted by March 1.

Limitations:

- No raw animal manure is to be applied; and
- Soil sampling of the area receiving nutrients must be conducted at least once every three years; and
- For high maintenance areas, no more than three pounds of nitrogen per year per 1,000 square feet (131 pounds per acre) maybe applied, of which no more than 1 pound of nitrogen per 1,000 square feet (44 pounds per acre) may be applied in a single application. For site-specific reasons, the annual total nitrogen application may exceed three pounds per 1,000 square feet per year with written justification by a certified consultant. The following recommendations are based on the maintenance degree and turf species. High and low maintenance must be determined by each area and should represent management intensity to include: mowing, travel, stress levels, compaction, pest pressure, irrigation and others.
- No more than two pounds of phosphorous as P_20_5 per 1,000 square feet (87 pounds per acre) per year may be applied unless justified by a certified nutrient consultant. For soil phosphorus levels greater than 150 fertility index value (or University of Delaware equivalent to P, to lbs. P/acres, by Mehlich 3 soil test), the application rates may not exceed 1 lb./1,000 square feet per year; and
- No fertilizer shall be applied within ten feet of the vegetative edge of any stream, pond, lake, river or any drainage conveyance or stormwater management facility.
- No nitrogen fertilizer may be applied on frozen ground, nor from December until February.

NOTE: There may be situations where the above standards are not practical for business operations. In these situations, a nutrient management plan approved by a certified consultant is recommended.

C. Total Maximum Daily Load

One of the factors that led to the drafting of nutrient management legislation is the 1972 Federal Clean Water Act (CWA), as amended. In particular, the CWA requires the establishment of Total Maximum Daily Loads (TMDL) for waters that have significant water quality "impairments."

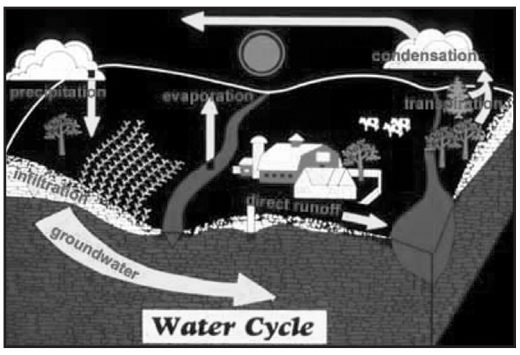
A TMDL is the maximum daily amount, or load, of a pollutant that can enter a body of water while still meeting water quality standards. Pollutants may be such things as nutrients, bacteria, sediments or even heat. The Delaware Nutrient Management Law specifically addresses nutrients, so implementation of the Law will help Delaware meet water quality goals for waters that are impaired by nutrients.

The CWA requires that a TMDL include, 1) a Wasteload Allocation (nutrients, or other pollutants, that can come from point sources such as wastewater treatment plant discharges); 2) a Load Allocation (such as nutrients from nonpoint sources like lawns, golf courses or agricultural fields); and, 3) a Margin of Safety.

The Delaware Nutrient Management Program will draw on the TMDL process in three main ways: 1) identifying nutrient load reduction goals; 2) targeting priority areas for nutrient management activities; and 3) tracking water quality improvements from those activities.

IV. Nutrient management and the environment

The overall goal of the Delaware Nutrient Management Act is to protect and improve water quality while maintaining profitable industries affected by nutrient management. Many areas of the state consist of relatively small lawns in urban and suburban areas, and fertilizing those lawns can have a significant cumulative impact.



Many of today's water-quality problems are caused by human activities on the land. By becoming aware of how our actions affect the environment, we can reduce pollution.

Think about water and how it cycles. All the water on earth exists in different forms and different places: in the atmosphere; in icebergs; in oceans, lakes and ponds; in plants and animals; and in soil. Water falls as precipitation, which either runs off hard surfaces or soaks into the porous soil. The water that runs off usually enters a body of water. The water

that soaks into the soil becomes ground water. Ground water feeds our lawns, crops and trees, and we can draw it up through wells for our personal use. It all gradually seeps into our bays, rivers and other waterways.

This water cycle will wash pollutants from our land into our waterways and water supply. Ground water and open waterways can be polluted by nutrients that come from excess lawn fertilizer. While nutrients are good for plants and grass in proper amounts, applying too much fertilizer will result in a surplus that inevitably follows the flow of ground water. The main nutrients that contribute to water pollution are nitrogen and phosphorus.

Nitrogen (usually in the form of nitrate) is the nutrient that produces the greatest growth response in plants. But if we put too much nitrate fertilizer on our lawns and landscaping, the excess nitrogen not taken up by plants will leach downward, entering the ground water supply that we use for drinking water. Nitrate contamination is most commonly caused by pet wastes, improperly designed or improperly installed septic tanks and overapplication of nitrogen fertilizers.

Phosphorus is an important nutrient necessary for plant growth, but when an excess washes into our lakes and ponds, it causes rampant algae and weed growth. The overabundance of decaying algae depletes the water's oxygen supply, which can kill fish and desirable vegetation.

Each of us contributes to this serious environmental impact. Although nature has the ability to reduce the effect of some of our activities, we have to do what we can to eliminate the pollution we cause.

V. Why be concerned about nutrient management & runoff?

A. Water resources

Nutrients entering the water system are of great concern in Delaware. The East Coast of the Mid-Atlantic region, including southern Delaware, falls into the highest risk category of water-quality impairment according to the United States Geological Survey. Their findings are based on the combination of well-drained soils, high nutrient input and high population density found in this region.

Whether excess nutrients are carried away in runoff through storm drains or percolate with water through the soil, they can end up in sensitive water bodies.

B. Urban turfgrass management

Nutrient losses occur from urban land uses as well as agricultural land uses. Turfgrass and agronomic crops are fertilized and managed differently. Nutrient losses are dependent on amount, type and timing of fertilization and irrigation. Agronomic crops are almost always fertilized and sometimes irrigated. Urban turfgrass is frequently unfertilized and unirrigated. Recreational turfgrass (greens, tees, athletic fields) is regularly irrigated and fertilized where it receives steady use; therefore, it presents greater potential nonpoint source pollution risk.

Turfgrass biology also affects nutrient losses. Both runoff and infiltration rates in turfgrass systems are markedly affected by the perennial nature of turfgrasses, which allows more prolonged uptake of nutrients, provides protection from sediment loss in runoff and promotes increased infiltration rates. In contrast, agricultural practices frequently allow soil to be exposed in late fall, winter and early spring. Many row crops do not cover the ground with canopy during the growing season until close to maturity. Pasture grasses, although perennial, are frequently of the clump-forming variety and leave thin areas between their crowns. Even with the use of agricultural best management practices (BMPs), row crops and pastures leave ground more vulnerable to runoff and transport of nutrients and sediments during the growing season than urban turf grass systems do.

C. Fate of Nitrogen

Five main categories of the nitrogen (N) cycle affect N loss: plant uptake, leaching, runoff, atmospheric loss and soil storage.

Plant uptake

Plant uptake, as measured by fertilizer recovery in clippings, varies from 5% to 74% of applied N. Increased plant uptake is favored by coarser soil texture, cooler temperatures and irrigation limited to moisture replacement.

Leaching

Leaching has the greatest potential to negatively impact water systems. Leaching can occur if N fertilizers are present in soluble form above a concentration useable by the turfgrasses, and if enough water is present to carry the nitrate-N through the soil to reach groundwater.

Nitrate leaching losses are increased by frequent and high application rates of soluble, quick-release fertilizer, coarser soil texture and increased irrigation. In most studies, excessive irrigation appears to be the primary cause of N leaching beyond the turfgrass root zone.

Regular, moderate applications of slow release N sources provides the minimum nitrate-N loss while still supplying adequate N to turf. The use of organic matter (peat or compost) as an amendment of the rooting medium has been shown to be the most important factor for limiting nitrate-N leaching on newly established turf. The amendments improved the water and nutrient-holding capacities of the soil until the grasses had developed thatch and substantial root systems. With organic matter amendments, nitrate-N leaching for newly established grasses was minimal to non-existent. When the turfgrass stands were mature and dense, and had developed thatch and soil organic matter levels of 2% to 2.5%, lower N fertilizer rates and the use of slow release N formulations have reduced nitrate leaching.

Surface runoff

Runoff from turfgrass systems is minimal, because turfgrass ecosystems usually have soils with high infiltration capacity. Experiments have found that grassed areas with well-established root systems did not experience much water runoff. Studies have shown that infiltration is reduced when soil is compacted due to heavy traffic on footpaths or stratified when subsoil material taken from basement or foundation construction is added to the areas surrounding a new house or office building.

Atmospheric losses

Atmospheric losses of N, or volatilization, can be significant when fertilizer is exposed to sunlight and air. Fertilizers such as urea are typically unstable and subject to volitalization.

Soil storage

Soil storage includes N stored in the soil and thatch pool. Nitrogen accumulation in the soil is rapid for the first 10 years, levels off slowly between 10 and 25 years and changes very little after 25 years. Turfgrass subjected to long-term, intensive fertilization rates may become “N saturated” and generate substantial N leaching.

Management options that can increase the efficiency of turfgrass N use include: frequent, light applications of liquid fertilizer; moderate irrigation immediately following application; use of slow-release fertilizers; and reduced fertilization rates for turfgrass stands over 25 years old. Amending soil with organic matter such as compost or peat moss at installation and avoiding compaction both at installation and afterwards, decreases leaching of nitrate-N and runoff of N.

D. Fate of Phosphorus

Phosphorus (P) exists in the soil in several forms: soluble, adsorbed, precipitated and organic. P can be transported in all these forms to surface water bodies.

The major route of P loss in general has been found to be erosion (particulate P) and runoff (dissolved P). Since very little runoff occurs from turfgrass systems due to their capacity to retard overland flow and allow high rates of infiltration, most losses occur in urban runoff when vegetative debris (leaves, grass clippings) or surface-applied fertilizer and composts are carried by large volumes of water over impermeable surfaces to storm drains and streams.

Surface water erosion/runoff transports P mostly in particulate form, with some P in soluble form. A significant portion of P that runs off from streets and lawns is derived from leaves or other vegetative sources.

Soils have considerable adsorbtion capacity for P but, under some circumstances, leaching can occur. Mature turfgrass ecosystems can develop macropores and preferential flow paths that can lead to reduced runoff, increased infiltration and leaching of nutrients.

Best management practices recommended to reduce P losses include maintaining grass areas to minimize bare spots (sources of erosion), testing soils before adding fertilizer, following suggested P fertilizer application rates, and watering P-containing fertilizers into the turfgrass with light irrigation immediately after application. Homeowners should be encouraged to ask for fertilizers containing only N when soil testing indicates excess P in their soil. Homeowners should collect their own organic debris, make compost and use this compost to improve soil structure and provide nutrients. Recycling grass clippings is a best management practice as long as the grass is cut frequently enough to allow clippings to sift into the turfgrass and decompose, returning nutrients to the soil. When long clippings lie on the lawn surface, they have the potential to runoff in a hard rainfall and contribute to P pollution. The combined practices of regular street sweeping/cleaning (and careful disposal of the collected debris) and leaf removal can significantly reduce urban runoff.

CHAPTER 2: NUTRIENT MANAGEMENT CERTIFICATION

I. Who must be certified

No later than January 1, 2004, all persons who conduct the following activities shall be duly certified by the Nutrient Management Program or shall utilize a duly certified person or firm:

A. Operate any animal feeding operation in excess of eight animal units (8,000 pounds live animal weight);
B. Appy nutrients to 10 acres or greater of combined lands or water owned, leased or otherwise controlled by such handler; or
C. Advise and consult with persons as part of the development of a Nutrient Management Plan.

II. Levels of certification

A. Nutrient Generator – A person within the State who operates a facility that generates nutrients such as manure.
B. Private Nutrient Handler – A person within the State who applies organic or inorganic nutrients to lands he or she owns, leases, or otherwise controls.
C. Commercial Nutrient Handler - A person within the State who applies organic or inorganic nutrients to lands as a component of a commercial or agricultural business in exchange for a fee or service charge.
D. Nutrient Consultant - A person within the State who is engaged in the activities of advising or consulting regarding the formulation, application or scheduling of organic or inorganic nutrients as part of a Nutrient Management Plan.

III. Minimum requirements

A. Nutrient Generator – To obtain a nutrient generator certificate, the applicant must successfully complete at least six (6) credits of educational course work as approved by the Nutrient Management Program
B. Private nutrient handler – To obtain a private nutrient handler certificate, the applicant must successfully complete at least nine (9) credits of educational course work as approved by the Nutrient Management Program.
C. Commercial nutrient handler - To obtain a commercial nutrient handler certificate, the following criteria must be satisfied:
    1. The applicant must take and successfully complete at least twelve (12) credits of educational course work approved by the Nutrient Management Program. Proof of such completion of course work shall be submitted with the application.
    2. The applicant must pass a written test approved by the Commission.
    3. A fee is required (In 2006, $150 for the period of three years).
D. Nutrient consultant - To obtain a nutrient consultant certificate, the following criteria must be satisfied:
    1. The applicant must take and successfully complete at least twelve (12) credits of educational course work approved by the Nutrient Management Program. Proof of such completion of course work shall be submitted with the application.
    2. The applicant must pass a written test approved by the Commission.
    3. An annual fee is required ($100 in 2006).
    4. Reciprocity: The Commission has adopted a policy of accepting certification from certain other states and certification programs (e.g. CCA certification). A seminar covering the Delaware Law is still required.

IV. Continuing education

In order to maintain a certification, the certificate holder must successfully complete continuing education courses approved by the Nutrient Management Program in accordance with the following:

A. Nutrient generator – Six (6) credits prior to each 3-year anniversary date.
B. Private nutrient handler – Six (6) credits prior to each 3-year anniversary date.
C. Commercial nutrient handler – Six (6) credits prior to each 3-year anniversary date.
D. Nutrient consultant – Five (5) credits annually prior to the anniversary date.

V. Company and business personnel training

The effectiveness of any program is only as good as the understanding of the personnel responsible for final application. BMPs are no exception. For BMPs to be effective, the technicians in the field must understand their role in protecting our water resources. This understanding can only come from the development and implementation of employee training programs.

Large companies or corporations may choose to develop their own training programs administered by their own professional training staff. Smaller firms may choose to avail themselves of training available through professional associations. Training is also offered through the Department of Agriculture and Cooperative Extension.

Employees whose job duties include activities related to BMPs should be properly trained to perform those activities before going in to the field.

Your employees control the success or failure in your attempts to fertilize properly. Train your employees on the reasons for making proper applications and avoiding misapplications. Talk with them about the environmental impacts of improper fertilization.

Other nutrient management training topics follow:

- Train applicators on the proper calibration, use and application techniques for the equipment they will use.
- Train applicators how to make decisions regarding changing fertilizer application rates to meet changing conditions, both long-term and from one lawn to another.
- Train applicators how to keep fertilizers on the turf and off hard surfaces.
- Train applicators how to maintain their equipment to prevent leaks and spills. Make certain they know how to adjust spray equipment and how to fill spreaders and use protective devices such as spreader side shields and hopper caps to prevent spills and misapplications.
- Provide spill clean-up equipment such as absorbent materials, brooms, shovels, plastic bags and blowers, and demonstrate their use to your employees. Demand that they do everything possible to prevent spills and require them to clean up any spills.

All training programs may be eligible for certification continuing education credits, so it is important to contact the Nutrient Management Program at Delaware Department of Agriculture for these credits.

There are opportunities to earn continuing education credits, such as this program during Delaware Ag Week.

Chapter 3: NUTRIENT MANAGEMENT BMPs

BMP I. Conduct soil, nutrient and plant tissue tests

Soil tests are critical in determining soil productivity, acidity and nutrients present. All soils contain some plant nutrients, but usually more must be added for best plant growth. Information from a soil test will help you select the proper liming and fertilization program to obtain optimal growth of lawn, garden and ornamental plants.

Several types of tests are available for different clients, from those who want to know the fertility of their soil for the purpose of growing plants, to those who are having difficulty growing plants and want to determine whether pH or fertility problems are the cause.

A. Phosphorus and potassium

A soil test will tell you the levels of available phosphorus and potassium in the soil. Because nitrogen is so soluble, it is of no value to test for the level of nitrogen. For the effective management of nutrients, soil testing should be used in conjunction with tissue testing. Soil test recommendations are based on a correlation between the level of a given nutrient extracted from the soil and the anticipated plant response. The amounts of nutrients extracted are only an index relative to crop response. They are not a direct measure of actual plant nutrient availability.

B. Soil pH

Soil test results also indicate the soil pH, a measurement of acidity or alkalinity of the soil. The pH relates indirectly to the kinds of fertilizer elements present in the soil and their availability to plants. The ideal pH for turf is between 6.0 and 7.0. In this range, nutrients are most available and microorganism populations necessary for decay are active. Most trees and shrubs grow best in a pH range from 5.0 to 7.0. A good compromise for landscapes that include trees, shrubs and turf is to maintain the pH between 5.5 and 6.5. To increase the pH, add lime. To decrease the pH, add elemental sulfur, aluminum sulfate or an acidifying fertilizer. Certain acid-loving plants such as azaleas and rhododendrons can be grown in beds that are maintained between 4.5 and 5.0.

Delaware soils tend to be acid; therefore, lime may need to be applied yearly or every other year to raise the pH. For most situations, apply 50 lbs./1,000 sq. ft of limestone in the fall or winter. Limestone works very slowly and it may take over a year for soil pH to rise substantially.

The amount of liming material required to bring about a desired pH change is determined by several factors, including:

(1) the change in pH required,
(2) the buffer capacity of the soil,
(3) the chemical composition of the liming materials used, and
(4) the fineness of the liming materials.

The finer a liming material, the more rapidly it will react with the soil. The oxide and hydroxide of lime usually appear on the market as powders, so their fineness is always satisfactory, but different limestones may vary considerably in particle size as well as hardness. The inefficiency of coarser and harder limestones has necessitated legal requirements for a fineness guarantee.

Lime is usually available to the homeowner as ground lime, granular lime or pelletized lime. Ground lime has a powdery consistency with more surface area that reacts more quickly with the soil, although it can be a little difficult to spread. Granular lime is easy to spread, but has much less surface area and reacts so slowly with the soil that it is almost ineffective in modifying pH. Pelletized lime is ground lime that has reformed into easy-to-spread pellets. It is the most expensive lime product, but is easy to spread and once it dissolves, has sufficient surface area to react relatively quickly to change soil pH.

In the choice of liming materials, attention should be given to the need for magnesium. Everything else being equal, a magnesium-containing limestone (dolomitic lime) should be favored to help maintain appropriate nutritional balance.

C. Soluble salts

The soluble-salts test measures the amount of fertilizer present in soil. Too much fertilizer can be worse than not enough.

D. How to collect a soil sample:

Soil testing is a service provided by many private labs and the University of Delaware. Soil test bags can be purchased at Cooperative Extension offices or obtained from University of Delaware Soil Testing Program, 152 Townsend Hall, 531 S. College Avenue, Newark, DE 19717-1303, (302) 831-1392.

Soil test results can be no better than the sample submitted to the laboratory for analysis. A soil sample weighing about 1 pound is used to represent thousands of pounds of soil in the landscape or garden. Therefore, it is extremely important that soil samples be properly and carefully taken.

- Areas where plants grow differently and/or the soil appears different should be sampled separately. Maximum area should be 10 acres.
- Areas that have been treated differently should be sampled separately.
- Four samples should be taken: one each from the garden, the lawn, the ornamental shrubs in the landscape and the azaleas. If the front and back lawns have been treated differently or if they are seeded with different grasses, submit a separate sample from each.
- Take soil from a minimum of 10 random locations in each sample area and mix together in a clean bucket.
- Use clean sampling tools and containers. Never use tools or containers that have been used for mixing or applying fertilizer or limestone. A small amount of residue on containers can cause serious contamination of the sample.
- Remove any surface litter such as turf thatch or mulch.
- For lawns, sample to a minimum depth of 4 inches.
- Use a trowel or sample tube to collect soil samples. To use a trowel or spade, push the tool to the desired depth into the soil. Then push the handle forward, with the trowel or spade still in the soil, to make a wide opening. From the side of the opening, cut a thin slice of uniform thickness - about 1/4 inch thick and 2 inches wide, extending from the top of the ground to the depth of the cut. Scrape away any grass thatch or mulch, and place the slice of soil into a clean bucket or other container. All cores taken for a given sample should be carefully mixed and packaged.
- Fill the soil sample bag to the indicated line with the mixed soil.
- Supply all the information requested on the soil sample bag.

E. When should soils be tested?

Soils can be tested any time during the year; however, be sure to sample well before planting or spring green-up. This is particularly important in areas where it is likely that lime will be needed. Lime reacts slowly and should be mixed with the soil several weeks before planting. Generally, fall is the best time to sample soils, because landscapes and gardens are usually dry enough to till when sampling. If wet samples are collected, they should be air dried before being placed in the soil sample bag.

After initial soil testing, additional testing may only be required when fertility problems arise and the responses to fertilization are poor.

F. Tissue testing

Testing for nutrient levels in plants is another way of determining the rate and type of fertilizer to apply. High nutrient levels can be toxic and low nutrient levels can cause deficiencies.

Visual observation of foliate symptoms measures what damage has already occurred to the plant tissue. Nutrient deficiencies or toxicities often show distinct symptoms.

Most analytical labs test both soil and plant tissues and specific tissue sampling instructions are available by contacting the lab directly.

BMP II. Establish a healthy landscape and turf

Well-planned, healthy landscapes designed with eco-friendly landscape practices usually include trees, ornamentals and a lawn of turfgrass or other ground cover. Native and well-adapted, non-invasive ornamentals contribute beauty and balance to a property, provide shade and wildlife habitat, and help to control erosion by diminishing the force of rainfall. Both the lawn and other landscape plantings reduce noise and glare, and modify temperatures. A diverse, complex landscape has been shown to support a high population of beneficial insects, which

help control plant pests, keeping ecosystems in balance. By including a significant percentage of native plants in the landscape, home and commercial landscapes that now occupy a large portion of our developed land will support a population of native insects. Those native insects are required to support birds and the rest of the food web necessary for a healthy ecosystem.

A healthy and vigorous turf with good plant density provides many benefits. A growing body of evidence points to the positive health and environmental contributions made by lawns and other turf areas. Turfgrass plays a significant role in reducing water runoff in urban and suburban environments that have significant areas of impervious surfaces such as parking lots, sidewalks and driveways. Dense turf reduces the velocity of runoff and allows greater infiltration into both the thatch and root zone.

BMP III. Choose appropriate landscape plants

Selecting the ideal species is important to plant health. Plants recommended specifically for Delaware can be found in several brochures published by Delaware Cooperative Extension: **"Plants for a Livable Delaware," "Controlling Backyard Invaders," "Trees for Delaware," "Native Plants for Delaware Landscapes"** and **"Dealing with Dought in the Landscape."** These are available electronically at http://ag.udel.edu/extension/horticulture/ornamentals.htm.

Plant diversity, weather, soil conditions, drainage, light and many other factors should be considered when selecting a species.

BMP *A. Maintain diversity in plant species*

A wide diversity of trees in an urban forest is essential to give scenic beauty and variety, to provide food and habitat for wildlife, and to protect against exotic pest disasters. To avoid disasters caused by introduced pests such as the Dutch elm disease:

- Never use a single species in mass plantings in a park or neighborhood.
- Never allow one species to dominate a shopping mall or corporate campus.
- Never line a long street on both sides with one species.
- Group species in multiples of three, five or seven. Urban wildlife health and diversity depend on a variety of tree species.
- A good guideline is to plant no more than 20 percent of a single species.

Use a variety of species in landscape plantings.

To create and maintain a healthy landscape, choose plants that are suited to the conditions in your yard. Plants placed in a location that meets their requirements usually thrive without requiring a lot of attention. Plants in a location that does not suit them will be stressed, vulnerable to attack from pests and diseases, and may require more care. For example, rhododendrons are popular landscape plants because they are evergreen and offer a spectacular display of flowers in the spring. Most rhododendrons require good soil drainage, some shade and acid soil conditions. If planted in a poorly drained area, they are likely to develop root rot diseases. In full sun, they often become infested with lace bugs and other insects. If they are planted in an alkaline soil, they are likely to weaken and die. If the conditions in your yard are not right for rhododendrons, you should consider choosing another plant. Follow the steps below in selecting new plants for your yard. When you have gathered the information described in these steps, you also will be able to evaluate problems of existing plants in your landscape.

BMP *B. Know the conditions in your landscape*

Climate

It is important to select species that will survive in your USDA Cold Hardiness Zone. Southern Delaware is in cold hardiness zone 7, while northern Delaware is right at the border between zones 6 and 7. Deodar cedars grow well in southern Delaware but are considered borderline in the northern part of the state. Cold hardiness is not the only important climatic factor.

You must also consider warm hardiness, or the southern-most range of a species. European white birch is a fantastic tree in New England, but is below its southern climatic range in Delaware and suffers many disease and insect problems. Warm hardiness is harder to quantify than cold hardiness because it is a chronic problem, weakening trees rather than killing them immediately during a low-temperature event. Plants that are grown at the southern end of their range become weak and gradually succumb to disease or insect problems.

Native trees have evolved with an adaptation to the climate of Delaware, so they will be both cold- and warm-hardy. However, many non-native trees and shrubs are also well adapted to Delaware's climate.

Follow USDA Cold Hardiness Zone guidelines when selecting plants.

Microhabitats

Many microhabitats exist within a climatic region. While the overall temperature range fits the hardiness zone, the microhabitat may provide extra warmth, moisture, wind, salt or a host of additional characteristics. Some microhabitats are by human creation such as buildings and walls in the form of angles, edges, hot reflective surfaces, cool shadows and wind tunnel effects. Select trees for their ability to withstand conditions of the individual planting site.

Look for the following possible microhabitat extremes:

- Very wet or very dry conditions
- Unusually high soil temperatures
- Soil compaction and lack of oxygen availability
- Deep or day-long shade from structures or other trees
- Heat reflected from glass, light-colored walls, concrete or other structures
- Ocean salt spray or heavy salt from ice and snow treatments
- High winds tunneled between buildings
- Possibility of damage from car doors, bumpers, mowers and string trimmers
- Likelihood of vandalism
- High probability of buried construction materials or other rubble
- Natural gas, water, sewer or buried electrical and communication lines
- Likelihood of consistently high auto exhaust and smog levels

Choose shade-loving species to plant under trees.

BMP *C. Know the requirements of landscape plants*

Learn the specific needs of a new plant before you buy it. Will the plant be able to survive the winter at your location, or will it need protection? Does it require more rainfall than occurs in your area? Does this plant require soils to have a pH within a narrow range? How much space will this plant require at maturity? Does it have a shallow root system that will interfere with your sidewalks or lawn? Does it shed pollen or fruit, or does it have thorns that will be a nuisance in the location where you plan to place it?

Some insect pests and diseases occur when certain plants are grown near each other. One common example happens when eastern red cedar (*Juniperus spp.*) is grown near apple or crabapple trees. Cedar-apple rust is a disease caused by a fungus that requires two different host plants to complete its life cycle. It overwinters on the red cedar and releases spores in the spring that infect apple leaves. In the fall, it produces spores that infect cedar. When either host plant is absent, the fungus cannot complete its life cycle. A similar disease problem occurs when junipers are planted near quince, hawthorne or serviceberry. Thorough research and questioning will enable you to avoid such troublesome plant combinations.

Identify existing plants in your landscape. If any are not doing well, find out what their preferences are. You may discover that they need to be moved to a more compatible site or removed altogether.

BMP *D. Choose plants that are well adapted to your site*

Of all the choices you make in selecting plants, this is the most important. Create a landscape that does not depend on irrigation, special seasonal protection and constant artificial control of diseases and pests.

Native plants occur naturally in a region without being introduced or planted there by humans. Trees, shrubs and other plants native to a particular locality usually can be relied upon for their cold tolerance and longevity in the area. Even though a plant is native, however, it still may have problems, especially if it is placed in a location that does not meet its requirements. For example, white pine is a beautiful native pine, but if it is planted in an area with poor drainage, it probably will not thrive in that site. Also, white pine is very susceptible to injury by salt, so it should not be planted along a highway that is treated with de-icing salt in the winter.

Exotic plants are those introduced from another area; however, the growing conditions of that area might be very similar to those of your location. Before choosing an exotic plant, make sure your growing conditions will meet the plant's requirements. Sometimes, exotic plants are more resistant to pests than are their native relatives. For example, *Cornus kousa*, an exotic dogwood that was introduced from the Far East, is less susceptible to infestation by the dogwood borer than is *Cornus florida*, the flowering dogwood, one of our native species.

Your local Cooperative Extension office can provide lists of plants recommended for a specific area and advise you if plants you are considering have problems.

BMP *E. Select resistant varieties*

If a plant is highly susceptible to a certain disease, plant breeders work to develop varieties with built-in resistance. Many disease-resistant varieties, or cultivars, are available at your local nursery. Even if you have to search farther to find them, you will be rewarded in the long run because resistant varieties, when managed properly, will thrive where susceptible ones will not.

Flowering crabapple (*Malus spp.*) is a popular small tree for residential landscapes, mainly because few other trees or shrubs approach its beauty when in full flower. The species is plagued with disease problems such as scab, fireblight, cedar-apple rust and powdery mildew. Disease-resistant flowering crabapples have been developed; a list is available from your local Cooperative Extension office.

You may have a favorite shrub or tree that is susceptible to problems, but for which no resistant variety has been developed. In this case, you usually can find a more rugged substitute with a similar bloom color, bloom time, fall foliage, bark or whatever characteristic attracts you to the plant.

When selecting trees, match mature size and shape to the site.

BMP *F. Start with an appropriate size*

Little trees can grow into very big trees. Never plant medium-height (30 to 50 feet tall at maturity) or tall (60 to 100 feet at maturity) trees under power

lines. If a tree must be planted near power lines, choose one that grows no higher than 15 to 25 feet.

Smaller transplanted trees establish and resume growing more quickly than larger (and often more expensive) trees. A larger-caliper (trunk diameter) tree (such as 3- to 4-inch caliper) takes several years to recover from transplant shock. A 1.5- to 2-inch caliper-tree establishes and grows more quickly and often catches up to the 4-inch-caliper tree before the larger tree recovers from shock.

BMP *G. Plan design and function*

Before selecting a tree, consider the function you wish the tree to provide. Will it be viewed as a single specimen, or is it part of a cluster of trees and plants that create a grove or mass? How is the site used? Do people want shade, a screen from traffic or the enclosure provided by a canopy of trees? Should the tree be green all year (evergreen), or should it allow sun to warm the area in the winter (deciduous)? What special features, such as bright fall color, winter bark interest, colorful fruit or showy flowers are desired?

If the effect of an individual species is desired, allow the following distances between trees so each tree has room to develop as it matures:

- Large trees (60-100 feet tall) 40-75 feet
- Medium trees (30-50 feet tall) 30-50 feet
- Small trees (less than 30 feet tall) 20-40 feet

Try planting some trees together in a cluster. The shared root space will improve tree survival and the effect will be more natural. Select trees whose mature size and shape is in the proper scale to fit the site and surrounding buildings.

- Select trees that perform the desired function
- Look for special ornamental attribute (i.e., flower, fruit, bark and fall color)
- Space trees properly as individuals or in natural-looking clusters
- Select trees with the proper scale for the site

BMP *H. Select high-quality plant material*

Once you have become familiar with your landscape's conditions and have learned about the plants that you plan to install, the next step is to purchase them. Buy healthy, robust, thriving plants. They will become established more easily and will be less likely to introduce a pest or disease problem into your landscape. Remember that "bargain" plants may have a lower rate of survival. These plants usually have been sitting around for months and may have been neglected.

Choose healthy plants that have no signs of harmful insects or their damage. The bark should be free of defects, splits or soft areas. The soil surrounding the roots should be moist but well drained, and the roots should not be growing in circles around the root ball or protruding from the drainage holes. The root ball should be big enough to support the plant.

Before you buy new plants, make sure you are ready to plant them as soon as they arrive. Use proper planting methods for your new plants and water them regularly until the plants become established, at least through their first season. For current planting recommendations, see fact sheet #3, "Plant With Care." (Available on line at http://sepaipm.cas.psu.edu/facts.html).

BMP IV. Select the right turf species

Selecting the correct grass is critical to maintaining a lawn successfully. To select the right grass, the following questions should be asked:

What type of lawn is desired or expected and what level of maintenance can be provided? The level of maintenance required is closely related to cost and time, with high-maintenance turf costing the most and taking the most time. Homeowners should understand realistically what their options are and what each entails.

What are the environmental conditions at the planting site? Most importantly, what are the soil type, pH, drainage and other soil characteristics? Is the site irrigated? Can it be easily mowed? Is it shaded or in full sun? Will it be shaded in a few years? What is the quality of the water available for irrigation?

Choose or recommend the best suited turf species (new, emerging, native cultivars) based on the best available technologies, preferably those that have minimal nutrient needs, minimal maintenance requirements and tolerance to

drought conditions. Certified seed is recommended which will identify the percentage of germination and purity.

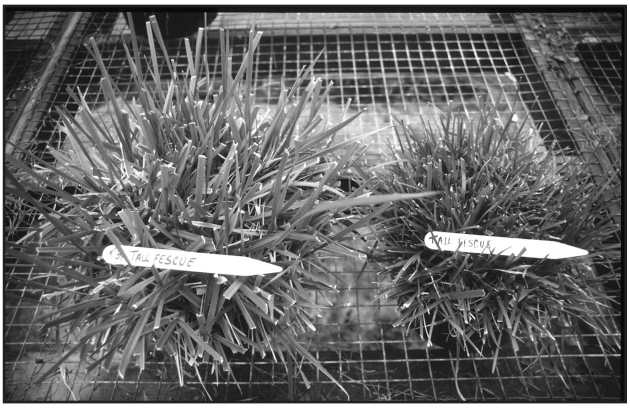
Turfgrasses are divided into two categories based on their climate adaptation. Cool-season grasses grow best in the spring and fall, with optimum growth when the temperature is between 60 and 75 degrees Fahrenheit. Warm-season grasses grow best in the summer, with optimum growth at 80-90 degrees F. Delaware is in the transition zone. Our winters are too cold for warm-season grasses and our summers are too hot for cool-season grasses. Since we are in the northern part of the transition zone, we often see the following grasses:

A. Cool-season grasses:

Kentucky bluegrass — This high-quality turf has a nice green color and good recuperative ability. However, it damages easily, suffers from heat and drought, requires moderately high maintenance, has a tendency to thatch, is susceptible to many diseases and is intolerant of shade or salt.

Perennial ryegrass — This turfgrass establishes very rapidly and is often included in grass mixtures to provide a quick cover. It does not wear or recuperate well and is intolerant of heat, drought, shade, and salt. Perennial ryegrass is susceptible to a moderate number of fungal diseases.

Tall fescue — The new turf-type tall fescues are excellent for Delaware. While they take a little while to establish or recuperate since they are a clump-type grass, they are extremely wear-resistant; drought-, heat- and salt-tolerant; and moderately shade-tolerant. Tall fescues have few disease problems and require less maintenance that other grasses. Kentucky bluegrass is the first grass to brown out in the summer and tall fescue is the last.



Tall fescue

Fine-leaf fescues — Fine fescues such as red fescues have an extremely narrow, almost needle-like leaf blade. They are included in turfgrass mixtures for their excellent shade tolerance. Fine-leaf fescue often appears in neglected lawns because it withstands a high pH. Due to its fine texture, fine-leaf fescue is often difficult to mow.

Hard fescues — Intended for minimal mowing, hard fescues are used along roadsides and as other utility or ornamental turf.

Bentgrass — This fine-textured grass is unique among cool-season grasses in its ability to be cut at heights of 1/2 inch or less. It has a high disease potential, poor drought tolerance and requires extremely high levels of maintenance. Bentgrass is a grass used on golf courses.

Pencross bentgrass

Annual bluegrass —Annual bluegrass, *Poa annua*, is a widely distributed winter annual turfgrass that is found on every continent in the world including Antarctica. Annual bluegrass is usually considered a weed due to its invasive and persistent traits in both cool-season and warm-season turf stands. It is a tufted bunch type and weakly stoloniferous annual turfgrass that becomes rapidly established through its prolific seed production traits even at extremely low cutting heights. Annual Bluegrass is a very weak turfgrass in terms of disease, drought, height and wear tolerances. This makes it very unsuitable for premium turf usage. It is one of the greatest challenges for turfgrass managers to eradicate and manage.

B. Warm-season grasses:

Bermudagrass and Zoysiagrass are the two most widely used warm-season grasses in the Mid-Atlantic region. Both Bermudagrass and Zoysiagrass thrive when the air temperatures are between 85-95 degrees F. Both exhibit stoloniferous and rhizomenous growth habits and form a thick high density sod. Both of these turfgrass cultivars discolor to a light tan/brown when the soil temperatures drop below 50 degrees F. and when frequent frost occurs. This action is better known as dormancy. Zoysiagrass, a more coarse-textured plant, is most commonly used in residential lawns and on some golf courses. Bermudagrass, a more fine textured plant, is used more on golf

courses and athletic fields. Zoysiagrass and Bermudagrass are usually established by way of vegetative planting or "sprigging." There are newer bermudagrass varieties that can be established by way of seeding and some of the newer varieties are very cold-tolerant.

C. Lists of cultivars

Lists of cultivars recommended based on results from the National Turfgrass Evaluation Program and suitable for Delaware sites are available from: National Director, National Turfgrass Evaluation Program, Beltsville Agricultural Research Center - West, Building 001, Room 333, Beltsville, MD 20705.

BMP V. Follow recommended turf planting practices

A. Soil preparation

Proper soil preparation before grass planting is critical to ensure the establishment of quality turf. Preparation determines how quickly the lawn becomes established and its long-term maintenance requirements. The general guidelines for preparing to plant a lawn are as follows:

- **Clean and rough grade**: Remove debris and existing plants. Level the area to make it suitable for mowing.
- **Deep tillage**: Tillage loosens compacted soil and improves the establishment of turf. Tilling sand is unnecessary.
- **Soil amendments**: Add these prior to planting if you need to improve the soil's physical and chemical properties. By adding 2 to 4 inches of organic matter such as composted sewage sludge, yard compost, mushroom soil or manure), you can greatly improve the soil structure and increase the chance for success.
- **Soil analysis**: Till in organic matter and take a soil sample to determine base fertility and soil pH.
- **Weed control**: Use a nonselective herbicide such as Roundup (glyphosate) to aid in weed control before planting. Several applications may be necessary.
- **Install irrigation**: If you are including an irrigation system, install it prior to planting.
- **Final grading**: A final leveling makes mowing easier and safer.
- **Fertilize**: Use a starter fertilizer just before planting based on a recent soil test. (No more than 1/2 lb. N per 1,000 sq. ft.) Soil test the area again later to check nutrient availability.

Whether in preparation for a vegetable garden such as this plot at Laurel High School or before planting a new lawn, adding organic matter such as composted horse manure can greatly improve the soil structure and increase the chance for success.

B. Stabilization Practices

For turf construction, ensure compliance with stormwater law, regulations and standards outlined in the 689-page *Delaware Erosion & Sediment Control Handbook* (1989 or as amended) available from Delaware Natural Resources and Environmental Control, Division of Soil and Water Conservation, telephone (302) 739-9921. It is also downloadable from the Internet.

- Design active areas to minimize disruption of natural waterways and native sites;
- Develop and implement strategies to stabilize soil and control sediment runoff from areas of disturbed soils;
- During the grow-in period, stabilize soil with straw, spray tack, sod, etc.;
- Irrigate seeded soil lightly to prevent soil runoff.

C. Planting procedures

The best time to seed a lawn in Delaware is from August 15 to October 15. Grass seed germinates quickly with warm soil temperatures, and cool temperatures provide optimum growing conditions for newly established seedlings. Additionally, frosts in the fall eliminate competition from summer annual weeds.

Spring is a poor second choice for beginning or reseeding a lawn. Soil temperatures are cool, air temperatures are becoming warmer, and weed competition is severe. If spring seeding is unavoidable, seed between March 1 and April 15.

Spread seed uniformly over the soil surface. Seed the lawn in at least two different directions to ensure full, uniform coverage. If you are seeding into an existing lawn, remember that each seed must have soil contact to germinate. Slit seeders can be used to place the seed in a shallow slit ensuring good seed/soil contact. Cover seed by raking lightly or adding a thin layer of topsoil. Optimum seed/soil contact is critical for successful germination.

Add a mulch or salt hay to maintain moisture, control weeds and reduce potential for erosion and seed loss. Use one to two bales of salt hay per 1,000 square feet.

Sodding (transplanting large pieces of established turf) can be done any time of year as long as soil can be prepared and water is available. Note that soil preparation for laying sod must be as thorough as that for seeding. Soil should be lightly moistened before sod is laid. Stagger the ends of each sod piece to minimize cracks and push pieces together for a firm fit. Lightly tamp the soil and sprinkle topsoil on the seams for rapid rooting.

Stabilize newly planted areas with mulch or salt hay and irrigate lightly.

Hydro-seeding is the method of seeding using water as a carrier. Seed is added to a tank of agitated water and then distributed or sprayed onto the soil surface. Various pressures and nozzles are used to gain greater distance or "throw" of the material. Amendments and fertilizers can also be added to this slurry. Paper mulch, fiber mulch and a tack material can be added to the slurry to enhance material stabilization and seed germination and establishment. Hydro-seeding is used extensively in roadside, large area and construction seeding and erosion control. This method is also being used in residential construction and for golf course and athletic field establishment.

D. Post-planting care

Water either newly establishing seed or sod daily (or more frequently) to keep the soil evenly moist until seeded areas have reached 1.5 inches in height (about three weeks after emergence) or sod is well-rooted (when sod cannot be lifted easily). Irrigate seeded soil lightly to prevent soil runoff.

Mow newly seeded turf when leaves reach 2.5 to 3 inches. Be sure to use a mower with a sharp blade. Mow sod at the desired height, but avoid heavy mowing equipment for several weeks to prevent rutting.

Three to four weeks after germination or sodding, apply a light rate of fertilizer such as 1 pound of nitrogen per 1,000 square feet.

BMP VI. Mow properly and recycle clippings

Many people believe that fertilizer is plant food. In fact, plants make their own food through the process of photosynthesis. Fertilizers provide nutrients that help plants process that "food" into useful substances. This affects mowing practices. The longer the blade, the more leaf surface for photosynthesis, the more food made, the longer the root system, the greater the ability to reach water and nutrients, and the healthier the plant.

When grass is cut too low, photosynthesis is decreased and the crown (or growing point) may be injured. When grass is cut too high, long blades shade each other and reduce photosynthesis. Uncut grass has an unattractive, shaggy, open, coarse texture.

The following mowing heights are recommended for lawns:

Kentucky bluegrass	1.5-2.5 inches
Perennial ryegrass	2-3 inches
Tall fescue	2.5-3.5 inches
Fine fescue	1.5-2.5 inches

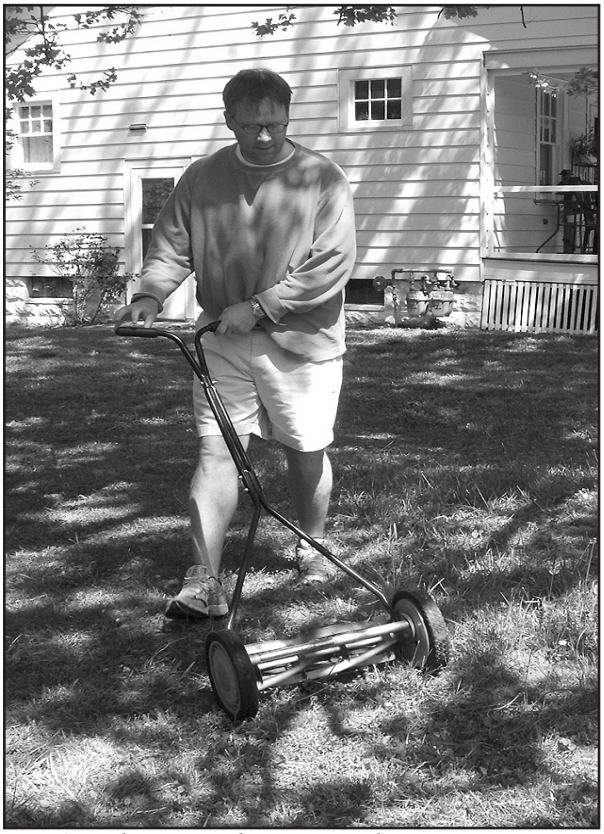
Recommended mowing height varies seasonally. In the spring and late fall, cut at the shortest recommended height. Cut higher in summer and if grass is grown in the shade.

To determine when to cut the lawn, follow the rule of one-third. Never remove more than one-third of the leaf area at any time. When the grass reaches 4.5 inches, remove 1.5 inches to maintain a 3-inch lawn. To maintain a lawn at 3 inches, you must remove 1 inch when the grass reaches 3 inches.

Other practices relating to turf mowing include:

- Cut the grass only when it is dry.
- Keep the mower blade sharp.
- Keep the discharge chute clear and mow in alternate patterns.
- Avoid mowing turf during times of plant stress or high disease pressure.
- Mowing frequency should increase during intense plant growth and lessen during dry and stressed periods.
- In most circumstances, let clippings remain or, if removed, compost them. Clippings can contain up to 30 percent of the nitrogen required by a lawn. If the lawn is cut by following the rule of one-third, clippings can be left on the lawn to provide organic matter and recycled nitrogen. Clippings decompose quickly and do not contribute to thatch. If the lawn is mowed infrequently, clippings are too long, become matted on the lawn, exclude light and can damage patches of turf. In that case, they should be raked up or caught in a lawn mower bag and recycled in a compost pile.

If the lawn is cut by following the rule of one-third, clippings can be left on the lawn to provide organic matter and recycled nitrogen.



A push-type reel mower is the most environmentally friendly way to cut grass.

If lawn is cut by the rule of one-third, clippings left on the lawn decompose quickly and do not contribute to thatch.

CHAPTER 4: FERTILIZER

The goal of a fertilizer program is to apply the least amount of fertilizer for the desired growth.

To get the most value out of your lawn fertilizer, understanding what your lawn needs and what a particular fertilizer can supply is essential. If you understand what is on the label, you can make the right selection, save money and help protect the environment.

There are hundreds of fertilizer formulations available, each with different analysis, which means they contain different amounts of nutrients. A complete fertilizer is one that contains the primary nutrients nitrogen (N), phosphorus (P) and potassium (K).

Depending on your soil nutrient status, you may not need all the nutrients in a complete fertilizer. Phosphorus may run off into surface water areas and degrade water quality. A lawn needs phosphorus for good health, but if the soil has a sufficient amount as determined by a soil test, it does not need to be applied every year. There are formulations of fertilizer that contain only nitrogen or only potash if those are the elements you need.

BMP I. Learn fertilizer terms

• **"Fertilizer"** means any substance that contains one or more recognized plant nutrients and promotes plant growth.

• **"Fertilizer grade or analysis"** is the percent nitrogen, phosphorus and potassium guaranteed by the manufacturer to be in the fertilizer. For historical reasons, nitrogen is expressed as N, available phosphorus as P_2O_5, and soluble potassium as K_2O. The percent sign is not used, but instead the numbers are separated by dashes, and the order is always N, P_2O_5, and K_2O (for example, 15-0-15). In this book, the abbreviations N, P and K, respectively, are used for nitrogen, phosphorus and potassium.

• **"Secondary elements"** include calcium (Ca), magnesium (Mg) and sulfur (S), nutrients which are also essential to plant growth and are secondary only by reference to the amounts of these elements needed by the plant. Calcium is part of a compound in the cell wall. Calcium is supplied primarily in the form of limestone. Magnesium, which is present in chlorophyll, can be supplied as dolomitic limestone or magnesium sulfate. Sulfur is present in certain plant proteins. It affects cell division and formation. Sulfur can be supplied as elemental sulfur, gypsum (calcium sulfate) or sulfuric acid. Sulfur is present in adequate quantities in many fertilizers

• **"Micronutrients,"** or "**trace elements,"** are elemental minerals that are needed by plants in minute amounts but are still essential for healthy growth and development. Micronutrients include: manganese (Mn), zinc (Zn), boron (B), copper (Cu), iron (Fe), molybdenum (Mo) and chlorine (Cl). Too little of one or more of these produces deficiencies resulting in plant disease. Iron and possibly manganese can supplement lower rates of soluble fertilizer. Micronutrients can help provide an initial color response while soluble nitrogen will help thicken turf density and improve root development.

• **"Water insoluble nitrogen" (WIN**) is a form of fertilizer that is not available to your turf right away, so it can release the nitrogen to your lawn over a period of months or longer. WIN will stretch out the time between applications and give greater environmental protection since the WIN sources will not leach as rapidly into groundwater. This is especially important on sandy soils.

• **"Water soluble nitrogen" (WSN)** is a form of fertilizer that is available rapidly and gives quick results. A high percentage WSN can "burn" the lawn if spilled or over applied. It can also move into the groundwater if there are heavy rains following the application. Both WIN and WSN sources can be good choices for managing your lawn. However, the higher the percentage of WIN in a fertilizer, the higher the cost as WIN sources are more costly to include than WSN sources.

• **"Slow- or controlled-release fertilizer"** is fertilizer containing a plant nutrient in a form that delays its availability for plant uptake and use after application, or that extends its availability to the plant significantly longer than a reference "rapidly available nutrient fertilizer" such as ammonium nitrate or urea, ammonium phosphate or potassium chloride. Slow-release fertilizers are designed to release at a rate more consistent with plant needs. The fertilizer in the slow-release formulations is released by water penetration, weathering or microbial action, depending on the type of slow-release fertilizer. Slow-release fertilizers are usually more expensive than soluble fertilizers.

• **"Quick-release fertilizers"** are soluble fertilizers that release their nutrients rapidly, whereas organic and slow-release fertilizers release nutrients over time. Quick-release fertilizer used at lower rates can produce desired turf

improvements when applied on a frequent basis. With a single application of a soluble fertilizer, plants may not be able to take up all the available fertilizer and some nitrogen may leach below the plant rooting depth with percolating water.

The choice of soluble or slow-release nitrogen depends on the reason for fertilization. Soluble fertilizer may be required when a quick response is desired, as when turf is being established or renovated, and slow-release fertilizers are excellent for regular maintenance. A mixture of soluble and slow-release nitrogen sources is recommended, especially in environmentally sensitive areas.

• **"Liquid fertilizer"** is a fluid in which fertilizer nutrients are in true solution. However, this term is applied also to suspension and slurry fertilizers, which are fluid mixtures containing dissolved and undissolved plant nutrients. Unlike true liquid fertilizers, they require continuous mechanical agitation during application. The value of these materials is based on the grade and weight of the liquid rather than on the fluid content.

• **"Flowable fertilizer"** contains fertilizer nutrients of extemely small particle size carried in liquid suspension. Because of the particle size and added suspension agents, flowable fertilizers do not require constant mechanical agitation during application.

• **"Natural organic fertilizers,"** as opposed to synthetic fertilizers, are derived from animal or vegetable waste, or minerals occurring in nature. Many organic materials provide excellent sources of nutrients. Release of nutrients from organic materials, applied in proper quantities, is usually slow, so that little of the nutrients are leached from the soil (although some "raw manure" sources such as poultry manure can be "fast release.") Composted sewage sludge, composted manures, composted leaves and other vegetation, peat moss, sea weed and fish emulsion are all organic sources of nutrients. Prepared organic fertilizers include leather dust (10-0-0) and cotton seed meal (7-2-1).

When organic materials are used as sources of nutrients, the content of available nitrogen and other nutrients should be known. If you purchase packaged manure or composted sewage sludge at a garden supply store, the "total" fertilizer analysis should be on the package. This does not mean that all those nutrients will be "available" to the plants. The level of nutrients in unprocessed organic materials, bulk sources or organic material produced at home is sometimes unknown; however, Table 1 shows the approximate percentage (by weight) of N, P and K in several common organic fertilizer substances. You may not apply enough fertilizer to get the desired result or you may over-fertilize and nitrate leaching, salt toxicities or excessive vegetative growth will

Dry or Liquid — Water It In!

There is no difference in uptake from dry or liquid forms. Both require irrigation or rainfall to distribute nutrients in the soil-water solution so they are available for uptake. To protect the environment, the proper application of fertilizer is more important than the type of product.

Solution fertilizers do not leach more readily than granular fertilizers once they have reacted with the soil components. Solution fertilizers are often used in lawn fertigation programs in which small amounts of nutrients are frequently applied. When used in this manner, solution fertilizer programs may actually reduce environmental impacts because fewer losses occur from runoff or leaching.

It is imperative that the proper quantity of water be applied following the application of soluble fertilizer, if rainfall is not anticipated in 8 to 12 hours. You should not apply fertilizer when heavy rains are imminent. The surface application of ammonium-N and/or urea-containing fertilizers to high-pH soils without watering in (with 1/4 inch of irrigation) is not recommended.

Table 1. PERCENTAGE OF NUTRIENTS (BY WEIGHT) IN ORGANIC FERTILIZER SUBSTANCES

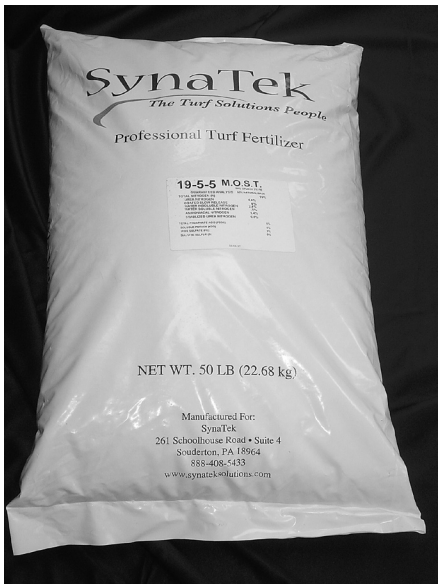
Material	N%	P%	K%
blood meal	15.0	1.3	0.7
bone meal	4.0	21.0	0.2
cocoa shell meal	2.5	1.5	2.5
composted horse manure	0.7	0.3	0.6
composted leaf mould	0.6	0.2	0.4
corn stalks	0.8	0.4	0.9
cottonseed meal	7.0	2.5	1.5
dried blood	13.5	3.0	0.0
dried cattle manure	2.0	1.8	2.2
dried coffee grounds	2.0	0.4	0.7
fish emulsion	5.0	2.0	2.0
fresh cattle manure	0.3	0.2	0.4
fresh horse manure	0.4	0.2	0.4
maple leaves	0.5	0.1	0.5
oak leaves	0.8	0.4	0.2
seaweed	1.7	0.8	5.0
soybean meal	6.0	1.2	1.5
wood ash	0.0	1.5	7.0

(SOURCE: Mel Bartholomew's Square Foot Gardening)

Note: Poultry litter analysis averages 65-45-45 in lbs./ton

occur. It is a common misconception that using organic fertilizers is beneficial to the environment and "safe." Organic fertilizers are beneficial if used properly but over-application can be just as detrimental to groundwater as over-application of inorganic fertilizers.

BMP II. Understand fertilizer labels



Labels include:

- The name brand or trademark.
- Guaranteed chemical analysis which may include % water insoluble nitrogen.
- Nutrient sources.
- Manufacturer's name and address.
- Net weight of the fertilizer in the container.

Two very important features on the label are the guaranteed analysis and the net weight.

The guaranteed analysis is always given in a specific order and is given as the percent of nitrogen for the first number, the percent of phosphate for the second number and percent potash for the third number.

In our example (see Fig. 1 below), there is 12% nitrogen, 4% phosphate and 8% potash. Nitrogen is the first number, phosphate (P_2O_5) is the second number, and potash (K_2O) is the third number. Only nitrogen is given as the actual percentage of the nutrient. The actual amount of phosphorus (phosphate) and potassium (potash) are given as percents of their oxide forms. This is not a problem because soil tests are usually reported in these same oxide forms, as are the recommendations for fertilizer application.

Figure 1. HYPOTHETICAL EXAMPLE OF INFORMATION PRESENTED ON A LAWN FERTILIZER BAG

LAWN FERTILIZER
12-4-8

GUARANTEED ANALYSIS:
Total Nitrogen (N) 12%
6.5% Ammoniacal Nitrogen
1.0% Nitrate Nitrogen
0.9% Other Water Soluble Nitrogen (WSN)
3.6% Water Insoluble Nitrogen (WIN)
Available Phosphate Acid (P_2O_5) 4%
Available Potash (K_2O) 8%
Total Available Plant Food,
Not less than 24%

Easy Green Company
Greenlawn, DE
Net Weight 50 lbs.

This hypothetical bag contains 50 pounds of fertilizer. Since we know the percent of nitrogen, phosphate and potash, we can calculate how many pounds of each element using the following formula:

(% nutrient in decimals) x total lbs. of fertilizer = lbs. of nutrient in the bag

In our example the calculations would be as follows:

Nitrogen: 12% x 50 lbs. = 6 lbs. nitrogen.
Phosphate: 4% x 50 lbs. = 2 lbs. phosphate.
Potash: 8% x 50 lbs. = 4 lbs. potash.

If you add up the total pounds of nutrients, you may wonder why it does not equal 50. Have they added filler? Not

necessarily. The nutrients you are applying may have other molecules (such as chloride or sulfate), attached as part of their naturally occurring form. These additional molecules may be a source of nutrients valuable to your lawn. For example, sulfate will provide sulfur that is beneficial to plants.

Secondary and micronutrients are identified in the lower portion of the label and are expressed in the elemental form. Sulfur (S) is expressed as "combined" (usually expressed as SO_4) and as "free" (elemental S form). The reason for this distinction is that "free" S is very acidifying when placed in the soil. Magnesium (Mg), Iron (Fe), Copper (Cu), Manganese (Mn) and Zinc (Zn) must be expressed as Total and/or Soluble or Water Soluble depending on the source materials formulated in the fertilizer. Chelated elements are guaranteed separately when a chelating agent is denoted in the derivation statement below the guaranteed analysis. A fertilizer label also contains a "derived from" section that identifies the materials from which the fertilizer was formulated.

BMP III. Follow fertilizer recommendations for lawn and landscape

Chart 1 gives general recommendations for fertilization required for different plants under different circumstances.

Chart 1: FERTILIZER RECOMMENDATION FOR LAWN AND LANDSCAPE

Plant	Fertilizer recommendation lb. N/1000 ft^2	Example
*Shade trees**		
Promote active growth	3	15 lbs. 18-6-12/1000ft^2
Maintain mature tree	1	5 lbs. 18-6-12/1000 ft^2
Rescue declining tree	3	15 lbs. 18-6-12/1000ft^2
Conifers	2	10 lbs. 18-6-12/1000 ft^2
*Shrubs**		
Deciduous shrubs	3	1/2 cup (4 oz) 10-6-4/yd^2
Evergreens	1.5	1/4 cup (2 oz) 10-6-4/yd^2
Groundcovers	1.5	3 lbs. 5-10-10/100 ft^2
Perennials		
Early spring	1.5	1/2 cup (4oz) 5-10-10/yd^2
June	3/4	1/4 cup (2oz) 5-10-10/yd^2
Annuals		
Before planting	3	1 cup (8 oz) 5-10-10/yd^2
After first flowering		1-2 Tablespoons/plant
Vegetables		
Before planting	2	2 lbs. 10-10-10/100 ft^2
At transplanting		1/4 cup 10-10-10/plant
Sidedressing		1/4 cup 10-10-10/plant
Lawns		
Before planting	0.5	5 lbs. 12-4-8/1000 ft^2
March-April	05.-1	5-10 lbs. 12-4-8/1000 ft^2
September-October	1.5-2	15-20 lbs. 12-4-8/1000 ft^2

*Annual rates

Source: Delaware Cooperative Extension "Fertilizer Basics," NPS-2.

BMP IV. Manage high maintenance turf areas with care

The recommendations in Chart 2, Page 25, give the total annual amount of nitrogen for various turfgrasses by species. These numbers are provided to assist turf managers in evaluating nutrient needs for optimum plant growth while maintaining healthy turf growth.

Turf grass care professionals, Certified Nutrient Consultants and property managers will need to evaluate the use of the site and determine whether the site, as an entirety or in segments, is "standard" or "high" maintenance. A site map should illustrate these areas.

Chart 2: TOTAL NITROGEN RATES FOR TURFGRASSES PER YEAR

Species	Standard Maintenance* (rates in lbs. per 1,000 ft^2)	High Maintenance* (rates in lbs. per 1,000 ft^2)
Creeping Bentgrass	3 lbs.	4-5 lbs.
Perennial Ryegrass	2 lbs.	4-5 lbs.
Kentucky Bluegrass	2 lbs.	4-5 lbs..
Poa Annua	3-4 lbs.	5-6 lbs.
Tall Fescue	2 lbs.	3-4 lbs.
Fine Fescue (K-31)	2 1bs.	3-4 lbs.
Bermudagrass	3-4 lbs.	4-6 lbs..
Zoysiagrass	2-3 lbs.	4-5 lbs.

*See site considerations below for determining standard or high maintenance.
Source: Delaware Nutrient Management BMPs for Commercial and Residential Turf Management 2-12-03 Policy

The above rates are annual recommendations. Single applications should not exceed one lb. per 1,000 square feet, unless the fertilizer consists of at least 30% controlled release fertilizer, in which a single application should not exceed two lbs. per 1,000 square feet. In high maintenance situations, the split application, or "spoon feeding," of nitrogen is necessary. The maintenance level of a turf area is dependent on several factors that demand more nutrients, namely nitrogen. The following examples differentiate high and standard maintenance turf areas:

High maintenance:

- Irrigated and grass clippings removed
- Vehicle or personnel traffic that creates visual damage to the turf area
- Insect pest pressure or disease pressure that demonstrates visual damage and stress to the plant
- The introduction of a sandy growth medium for improved drainage such as California greens

Standard maintenance:

- Little traffic on turf area or minimal response to plant growth as a result of traffic
- Grass clippings recycled into the soil surface of the turf area
- Native healthy soil structure

Areas of high maintenance include those with a regular mowing schedule where grass clippings are collected.

In situations where nitrogen applications may exceed the above rates, a specific recommendation should be documented by a certified nutrient consultant.

Residential and commercial lawns comprised of cool-season turfgrasses should receive the bulk of their yearly fertilization (75-100%) in the fall (between September and November). Fall fertilization promotes root and tiller growth rather than excessive topgrowth. An early spring fertilization of no more than 1/2 lb. N per 1000 square feet can be used to promote spring green up. Late spring and summer fertilization should be avoided because it promotes excessive topgrowth, which is susceptible to drought and disease injury in the summer, the most stressful period for cool season turf lawns. In situations where summer applications are needed, a certified nutrient contsultant should be involved.

Warm season turfgrasses such as zoysiagrass and bermudagrass, should be fertilized in late May or June.

BMP V. Follow proper timing and methods for ornamental landscaping

Fertilization of plants can result in additional growth and production of leaves, stems, branches and roots. In turn, additional growth can result in more maintenance and yard trimming, so it is important to determine if growth is the desired result.

Fertilization is usually desirable when trying to promote growth of young landscape plants. Fertilizer is not

recommended at planting because it may burn tender roots and promote top growth before the root system becomes well established; however, fertilizer can be applied in subsequent growing seasons.

Time fertilizer applications to maximize plant use and minimize adverse environmental impacts.

Frequent light applications for turf and landscapes are ideal.

A. Trees

Trees may be fertilized any time in late fall or early spring (November until April). The important consideration is to make sure nutrients are available during growth. This can be accomplished by applying slow-release materials in late fall (after the trees have dropped their leaves), winter or early spring (before leaves come out). Soluble fertilizers, which are more quickly available, can be applied in spring. Newly planted trees should not be given mineral fertilizer at planting. Do not apply fertilizer during drought conditions or when the soil is frozen.

Nitrogen is the most important element for tree response. Most garden soils contain sufficient phosphorus and potassium for normal tree growth. Ammonium nitrate (33-0-0) or a fertilizer high in nitrogen (ratio: 3-1-1) can be used. It is important to maintain the proper ratio of nitrogen, phosphorus and potassium in the soil. When you push growth by applying a lot of nitrogen, trees may require more phosphorus and potassium than can be obtained from the soil. A fertilizer with a 3-1-1 ratio will supply enough phosphorus and potassium to support accelerated growth from nitrogen application. It may be necessary to add phosphorus to the root zone of trees growing in soil that tests deficient in phosphorus.

Surface broadcasting fertilizers over the entire area of the root system is an effective and efficient method of application. The complicated procedures of liquid deep feeding, dry fertilizer in holes, foliar feeding, injection feeding or placement of pills, packets or spikes in root zones are no better than a simple broadcast application of high-nitrogen fertilizer. About 80 percent of all fibrous roots are found in the upper 12 inches of soil, and many are found in the upper 6 inches. Therefore, fertilizer applied with a surface broadcast application can easily reach a majority of the root system. The root system of an established tree extends beyond the drip line. For maximum uptake, broadcast fertilizer over the entire root zone. If the root zone area is planted with groundcovers, grass or other plants sensitive to high nitrogen levels, watering-in of fertilizer may be necessary to prevent fertilizer burn. Apply fertilizer to trees in lawn areas before March 1 or use split applications to prevent burn.

Fertilizer recommendations should be based on the spread of the tree's root system and not on the diameter of the trunk (as was thought in the past). To get the most from the fertilizer applied, it is important to distribute the recommended amount over the entire root zone. The fibrous root systems of most shade trees extend far beyond the tree's crown or dripline. Soil sampling should be used to map the extent of the root zone.

A mature tree growing in a lawn that is fertilized regularly does not need extra fertilizer. Trees confined to small planting areas usually have a greater need for fertilizer.

B. Shrubs

Deciduous shrubs have similar nutrient requirements to trees but in lesser amounts. A ratio such as 10-6-4, applied at a rate of 1/4 to 1/2 cup per square yard of ground underneath the shrub, should provide adequate nutrition. Because nitrogen stimulates growth of foliage, a fertilizer with less nitrogen (5-10-5) may be used with plants grown for their flowers. Shrubs may be fertilized in early spring before plants leaf out (February or March) or in late fall after plants become dormant. Late summer applications of fertilizer stimulate succulent growth, which is often killed during the winter and should be avoided.

C. Evergreens

Since it is easy to over-fertilize evergreens and cause injury, a low-analysis fertilizer is recommended. The following ratios and rates are common:

3-2-1 at 1/2 cup per sq. yd.

10-6-4 at 1/4 cup per sq. yd.

The higher nitrogen ratios are useful for broadleaf evergreens. Organic fertilizers are especially good for use on evergreens. Their slow release eliminates problems with fertilizer burn. All evergreens should be fertilized in the spring. To improve color of broadleaf evergreens, additional nitrogen can be applied in a soluble form in June or July. Many broadleaf evergreens such as hollies, rhododendron, mountain laurel and Japanese andromeda, require an acid

soil. The use of a specifically formulated organic fertilizer for acid-loving plants will help to keep the soil at the proper pH. The pH may also be lowered by adding ground sulfur.

D. Ground covers

Ground covers are attractive, low-growing plants that spread quickly to form a living carpet. Ground covers planted on a slope help to prevent soil erosion. Their fibrous root system stabilizes the soil and their branch structure and foliage cover the soil to decrease runoff. Ground covers can be planted where it is difficult to grow turf, such as in the shade or on a steep slope.

Once established, ground covers need little maintenance except weeding, fertilizing and watering during very dry periods. Fertilize ground covers with organic fertilizer, since mineral fertilizer causes burning when it comes in contact with foliage. Broadcast 2 to 3 pounds of organic fertilizer per 100 square feet each spring.

E. Perennials

Herbaceous perennials have a life span of several seasons to many years. Their roots live from year to year and their leaves and stems usually die back to the ground each fall.

Fertilize perennials in the early spring before growth starts and again in June. Use a complete fertilizer such as 5-10-10, 5-10-5 or 10-10-10. In early spring, spread 1/2 cup fertilizer over each square yard of surface and work in, being careful not to get any into crowns of plants. Repeat in June, using 1/4 cup per square yard. For chrysanthemums, repeat the June amount in July and August or use monthly applications of a soluble fertilizer.

F. Annuals

Annuals live for one growing season. Many began blooming in the spring and don't stop until frost. Annuals require heavy fertilization. The objective is to keep annuals growing rapidly throughout the season. Apply 1 cup of 5-10-10 per square yard of bed as the ground is being worked before planting in the spring. Six weeks later, or when the first flowering cycle is over, sprinkle 1 to 2 tablespoons around each plant.

G. Bulbs

Bulbs, or more correctly, geophytes, are self-contained, highly developed, food storage mechanisms adapted to live underground. The storage structure contains food to nourish the plant through the blooming season. After blooming, a geophyte must produce and store next year's food by photosynthesis in the foliage. Therefore, the foliage of a geophyte must not be removed until it begins to brown and shrivel.

BMP *Follow these general tips to prevent overapplication of nutrients*

- Apply smaller amounts of nutrients more often as opposed to large amounts only a few times/year.
- Never apply more fertilizer than is recommended. Just because a little is good, more is not better.
- Use slow release fertilizer during slow plant growth to provide nitrogen more gradually.
- Avoid late spring and summer fertilization except for application schedules that provide small quantities of nutrients throughout the growth season, as with golf courses and athletic fields. Excess nutrients promote lush growth that makes it susceptible to disease, insects and drought.
- Limit nutrient application prior to a storm event, heavy rainfall or when the turf or soil is saturated by evidence of standing water.
- Calibrate fertilizer spreaders for accurate application amount and placement. Use the right kind of spreader and spreading techniques.
- Establish buffers in sensitive areas (waterways, wells, impervious surfaces, pond/stream edges) for the purpose of restricting or limiting fertilizer application. Do not fertilize within 10 feet of shoreline
- Optimize turfgrass cultural practices such as aeration, topdressing and vertical mowing to maximize effectiveness of nutrients.
- Avoid fertilizing on non-target areas such as impervious surfaces and around bodies of water. All fertilizer spills must be cleaned immediately and any fertilizer that has been incidentally applied to any impervious surface such as driveways, streets, parking areas and sidewalks, must be redirected (swept/blown) immediately after application.
- Never apply fertilizer to frozen ground.
- Remove plant debris, which contains phosphorus, from streets, gutters, sidewalks and driveways as quickly as possible so it does not run off with surface water. Use the debris as compost or mulch.
- Control weeds in your lawn. Weeds reduce the quality of the turf and compete with desirable turf species for precious water.
- Clean up after pets.
- Do not feed ducks and geese.

In general, bulbs require fewer nutrients than most other garden flowers. Where mature bulbs are planted, over-fertilization encourages splitting. For bulbs that are left in the ground year round (which includes most spring-flowering and some summer-flowering bulbs), bone meal provides a slow-acting, long-lasting source of phsophorus. At planting, bone meal can be applied at a rate of 5 to 6 pounds per 100 square feet, 1 cup per square yard, or 1 teaspoon per planting hole. On established bulbs that are not replanted, sprinkle 1/3 cup over each square yard in early spring.

Summer-flowering bulbs (which are dug each fall and replanted in the spring) can be fertilized with a general purpose fertilizer such as 5-10-5 at the rate of 1/2 cup per square foot.

BMP VI. Utilize and calibrate application equipment

A. Spinner vs. drop spreaders

All users of lawn spreaders should carefully read the operator's manual. Then, the entire product label must be read and the rate and pattern settings modified if necessary for specific conditions. Misapplication of fertilizer can result in inadequate fertility, striping of the lawn and waste of fertilizer. The excessive application of weed killer may result in injury or death to valued trees and/or shrubs. Proper calibration is also necessary when preparing to apply granular insecticides. Remember that improperly applying any pesticide is both dangerous and illegal.

There are two types of commonly used lawn spreaders – drop and rotary (spinner). Drop spreaders provide an even, more precise distribution of granules while rotary spreaders cover a wider swath but less uniformly.

Maintain a uniform walking speed while using a spreader, as changes in speed do not result in a corresponding increase or decrease in application rate.

It is best to begin spreading a lawn by covering a swath around the perimeter. This provides an area in which to turn around and realign the spreader as well as uniform coverage of border areas. When spreading the lawn, develop normal operating speed in the border strip with the spreader closed. Open it when you reach the edge of the border area. At the other end, close the spreader as you enter the border strip still at operating speed. Avoid leaving the spreader open when making turns or when it is stationary. When coverage problems occur (usually with rotary spreaders), reduce the setting to a half rate and cut the swath in half. Continue to walk in parallel swaths. Avoid operating the spreader backwards because most spreaders will dispense a different rate and provide less uniform coverage when pulled rather than pushed. Maintain a uniform walking speed as changes in speed do not result in a corresponding increase or decrease in application rate.

B. Equipment management & calibration

Since the amount of nitrogen in fertilizers varies, remember that you should figure application rates from pounds of nitrogen needed, not just pounds of product. Using the percentage of nitrogen from the fertilizer analysis on the bag, you can accurately figure how much to apply by using the following formula:

(Desired lbs. of N per 1,000 sq. ft x 100) ÷ (%N in fertilizer) =
lbs. of fertilizer needed to apply desired lbs. of N to 1,000 sq. ft

For example, if you want to apply 1 lb. of nitrogen per 1,000 sq. ft. using a 29-4-8 fertilizer you would set up the formula as shown here:

(1.0 x 100) ÷ 29 = 3.44 lb. of 29-4-8 required to apply 1.0 lb. N to 1,000 sq. ft.

Before calibrating your spreader, walk off or measure the length and width of your lawn. Multiply length x width to get area in square feet. If you have several smaller areas, simply add them up to get your total lawn area. Record this number for future reference.

If you know how much lawn area you have and how much fertilizer to apply per 1,000 sq. ft., you can then determine the total amount of fertilizer to purchase and apply.

For example, if your lawn area is 5,000 sq. ft. and you want to apply 1 lb. of nitrogen per 1,000 sq. ft. using 29-4-8. Applying the calculation above, for five times the area you will need:

5 x 3.44 lbs. = 17.20 lbs./5,0000 sq. ft.

It is advisable to calibrate the spreader for each product to be used as well as each operator. Every fertilizer product has a different spreader setting to provide the target rate of fertilizer. Spreader setting information on the bag should be used only as the initial setting subject to verification prior to use.

During calibration, observe the lateral distribution of fertilizer by placing a row of boxes across the area to be spread, and then weigh the amount of fertilizer in each box. Lateral calibration will show you if the spreader and fertilizer carrier are producing a lopsided spread distribution. If you see that more material is being spread to one side of the spreader or the pattern is uneven, you can adjust your spreading passes to accommodate for such differences and provide a uniform application.

C. Calibrating drop spreaders

Instructions for calibrating spreaders are available from Cooperative Extension and on the Internet. One method to determine the rate of application for drop spreaders follows:

Measure the width of the opening along the bottom of the spreader hopper to determine the swath width.

Lay out a 50-foot long strip of polyethylene. The width of the plastic should be at least one foot wider than the spreader.

Fill the hopper about half full and adjust the spreader setting to the appropriate one indicated by the manufacturer, product label or one that you feel will deliver the amount specified on the product label.

While walking at normal speed, push the spreader along the full length of the strip. This should be repeated three to five times.

Collect the product in a container for weighing. Be sure to account for the weight of the container.

Determining the amount of product delivered per 1,000 square feet is a two-step procedure:

1) Calculate area covered by the amount of product collected and weighed:
   Swath width in inches ÷12 x the number of passes x 50 feet
2) Adjust this to the amount of product that would have been delivered to a 1,000 square foot area =
   Weight (lbs.) of product collected ÷ area covered x 1000

EXAMPLE: Swath width = 26 inches
Number of passes = 3
Amount collected = 11 oz. = 0.69 lbs.
Area covered = 26 inches ÷ 12 x 3 passes x 50 ft = 325 sq. ft
Product per 1,000 sq. ft. = (1000 x 0.69 lbs.) ÷ 325 sq. ft. = 2.12 lbs.

This calculation indicates that the product is being applied at the rate of 2.12 lbs. per 1,000 sq. ft. To determine the amount of each nutrient (N, P and K) being applied, multiply the rate times the percentage of nutrient in the fertilizer, divided by 100. If the product is a 12-4-8 fertilizer blend, the nutrient rate applied would be 0.25 lbs. of total nitrogen, 0.1 lb.of P_2O_5 and 0.17 lbs. of K_2O per 1,000 square feet

While properly calibrating a spreader is the best method of applying the proper quantity of fertilizer to the lawn, it is also somewhat time consuming and this step is often skipped by busy homeowners. If you do not calibrate your spreader, be very careful when applying fertilizer. Calculate the quantity of fertilizer you intend to spread on your entire lawn and divide that quantity in half. Set the spreader to the proper setting based on the manufacturer's instructions. Begin applying half of the total fertilizer you intend to apply to the lawn. Check the quantity of fertilizer

you've used after you've covered about 1/4 of the area. Do you still have 3/4 of the quantity of fertilizer left? If not, adjust your spreader settings accordingly. When you apply the second half of the fertilizer, walk in the opposite direction to get more even coverage. This method will insure that you don't apply all the recommended fertilizer to only half your lawn.

BMP VII. Handle fertilizer carefully

If not handled properly, fertilizers can alter or degrade the environment. Nutrients such as N and P in fertilizers can lead to the excessive growth of algae and noxious plants in estuaries, ponds and streams.

Mishandling of fertilizers containing nitrates may result in excessively high levels of nitrate in drinking water supplies.

A. Loading

Load fertilizer into application equipment away from wells or surface waterbodies. A concrete or asphalt pad with rainfall protection is ideal, as it permits the easy recovery of spilled material. If this is not feasible, loading at random locations in the field can prevent a build-up of nutrients in one location. Avoid contamination. Fertilizers contaminated with pesticides may damage plants or generate hazardous waste.

B. Spill avoidance and clean up

By using Best Management Practices (BMPs) and administering lawn care products as precisely as possible, most spills can be eliminated. Any fertilizer spill, whether liquid or granular, needs to be taken extremely seriously because it could easily be washed into a waterway.

Wash water generated should be collected and applied to the target crop. Discharge of this wash water to waterbodies, wetlands, storm drains or septic systems is illegal.

In case of a spill, the first priority should be containing the material and not allowing it to escape. Ideally, granular products should be swept up immediately and used appropriately. Collected material may be applied as a fertilizer.

At fixed sites, the area can be cleaned by sweeping or vacuuming (or with a shovel or loader, if large spill) or by washing down the loading area to a containment basin specifically designed to permit the recovery and reuse of the wash water.

Liquid products are more difficult to handle when they are spilled. Professional landscape companies should use absorbent materials designed to soak up liquids. These absorbent products are then disposed of properly. Homeowners should prevent liquid spills from going into a storm drain. Whenever possible, employ professionals who are trained to apply fertilizer and other chemicals to lawns and landscapes.

BMP VIII. Store fertilizer in a dry, protected area

Store fertilizer in an area that is not exposed to rainfall and is protected from the general public and animals.

Storing dry bulk materials on a concrete or asphalt pad may be acceptable if the pad is adequately protected from rainfall and from water flowing across the pad.

Always store nitrate-based fertilizers separately from solvents, fuels and pesticides since nitrate fertilizers are oxidants and can accelerate a fire. Ideally, fertilizer should be stored in a concrete building with a metal or other flame-resistant roof.

CHAPTER 5: IRRIGATION & FERTIGATION MANAGEMENT

BMP Use proper irrigation management for conservation

Is a green lawn really necessary all summer long? Most lawns in Delaware go dormant during the summer in response to drought stress. These lawns are not dead and will green up and continue to grow vigorously as soon as fall rains arrive. In a few cases, turf that is already stressed may die. This should serve as an opportunity to correct the problem and reseed those areas in the fall. Newly seeded or sodded lawns need water until the new turf is well established.

The best way to reduce lawn watering needs is to maintain a healthy, vigorous lawn. Landscape plants growing in soils with a limited capacity to

Determining and controlling the rate, amount and timing of irrigation can minimize soil erosion, runoff, and fertilizer and pesticide movement.

General tips for irrigation management

The principal BMPs for irrigation management are as follows:

- Have irrigation water tested to determine what plant nutrients and potential problems are present in the water.
- Irrigate lightly after application to wash fertilizer into turf;
- Irrigation timing should allow proper infiltration and mitigate evapo-transpiration.
- Irrigate turf on an as-needed basis and not on a planned schedule, optimizing irrigation controller technology to ensure efficient irrigation patterns;
- As much as possible, direct surface water runoff to catch basins or ponds that recycle back to irrigation holding ponds;
- Avoid irrigation during times of high humidity to discourage the spread of turf disease;
- Avoid irrigation in dry, windy conditions to avoid high evaporation and non-point coverage.
- Irrigation controllers/timers should be reset seasonally to account for plant growth requirements and local climatic conditions.
- Use properly calibrated flow meters, soil moisture sensors, rain shut-off devices and/or other automated methods to manage irrigation.
- Irrigation rates should not exceed the maximum ability of the soil to absorb and hold the water applied in any one application.
- Irrigation quantities should not be larger than the available moisture storage in the root zone.
- Use soil moisture sensing devices, rain gauges and the visual observation of irrigation runoff or puddles to prevent overirrigation.
- When possible, the irrigation schedule should coincide with other cultural practices (such as the application of fertilizer, herbicides or other chemicals).
- When fertilizing (other than when watering restrictions apply), irrigate with 1/4 inch following fertilization to avoid the loss of nitrogen and increase uptake efficiency. If water restrictions are in effect, you may irrigate as you are allowed, but more than 1/2 inch of water may cause some nitrogen to be leached past the root zone.
- Proper cultural practices (such as mowing) should be employed to promote healthy, deep root development and reduce irrigation requirements.
- Avoid overwatering. This will prevent water and nutrients from seeping below the root zone, and it will keep excess water from running off the surface into drains, gutters and streams. Overwatering may increase insect, weed, and disease pressures. Conversely, other pests thrive under extremely dry conditions and compete with desireable plants. A proper balance is necessary to keep the landscape strong and healthy.

retain moisture can benefit from supplemental irrigation during periods of low rainfall. Even during the rainy season, evapotranspiration (water loss from plants and soil) occurs between showers and may mandate supplemental watering while plants are becoming established.

Determining and controlling the rate, amount and timing of irrigation can minimize soil erosion, runoff and fertilizer and pesticide movement. The irrigation system should be designed to have an application rate that is less than the infiltration capacity of the soil so that no surface pooling occurs and water percolates with maximum efficiency. Rain sensors or soil moisture sensors eliminate irrigation when nature has supplied sufficient water. When watering the lawn, use a slow watering technique such as trickle irrigation or soaker hoses. Trickle irrigation is 90 percent efficient compared to sprinklers which are only 70 percent efficient.

Irrigation system design

Irrigation system design is a complex issue and should be handled by trained professionals. These professionals should use existing standards and criteria, as well as the manufacturer's recommendations, to design the most appropriate system for a location. A list of sources for current standards and criteria can be found at www.icid.org/onfarm_iso.pdf.

Irrigation design professionals use existing standards and criteria to design the most appropriate system for a location.

As much as possible, direct surface runoff to catch basins or ponds that recycle back to irrigation holding ponds.

The irrigation system should be designed to have an application rate that is less than the infiltration capacity of the soil so that no surface pooling occurs and water percolates with maximum efficiency.

Sprinklers are only 70 percent efficient compared to trickle irrigation which is 90 percent efficient.

CHAPTER 6: PESTICIDE HANDLING

The use of pesticides for controlling pests remains an important part of landscape plant management. The key to reducing pesticide use is to combine genetic, cultural, and biological management practices into an Integrated Pest Management (IPM) program that focuses on the prevention of pest problems. When suppression is necessary, it is easier to suppress a pest when conditions exist that discourage its development. One defense against the movement of pesticides and fertilizer nutrients off-site or through the soil is a thick, vigorously growing stand of turf or other landscape plants.

BMPs to protect water quality are affordable, easily implemented and effective in reducing the off-site transport of sediment, nutrients and pesticides.

Wear the personal protective equipment the label recommends.

BMP I. Select pesticides appropriate to the pest

Select pesticides that are the least toxic, least water soluble, least volatile and most effective.

Once you have decided that a pesticide is needed, you must decide which chemical is right for your situation. No insecticide, fungicide or herbicide will kill all insects, diseases or weeds. The pesticide label will provide information on which pests are controlled by the chemical selected.

In general, most homeowners only need to purchase small quantities of pesticides. However, if you need to make multiple applications to control the pest problem, be sure to buy a large enough quantity so you can mix the necessary amount of material. If it is a one-time application, a smaller quantity will be more cost-efficient and reduce the problems of storage and disposal.

BMP II. Mix pesticides according to label directions

Some pesticides are packaged specifically for homeowner use. These products can be safely and accurately mixed with few problems. The following pointers should be considered before you mix any pesticide:

- Do not mix more spray than you need and then spray everything. Treating plants that don't need it may kill beneficial insects that generally keep pest species under control.
- Always dilute pesticide concentrates according to label directions. Only use full strength if specified on the label.
- Keep special tools for measuring and mixing pesticides outside of the house. Keep them under lock and key.
- Protect yourself by wearing rubber gloves, long-sleeve shirt, long pants and goggles. Never eat, drink or smoke while mixing chemicals, and be sure to wash up after you are done. Never mix pesticides with anything unless the label directs you to do so.

BMP *Take safety precautions*

Pesticides can be important tools in your pest management program around the home. They can also cause severe problems if misused. The following guidelines will help to ensure that you use pesticides safely:

- Read the label before you buy. Make sure the pest you want to control is on the label as well as the plant and place you intend to use it.
- Follow the instructions exactly. Pay special attention to precautions and information about what to do in case of an accident.
- Know the following symptoms of accidental poisoning: headache, dizziness, weakness, shaking, nausea, stomach cramps, diarrhea, sweating and muscle twitching.
- Post the telephone number for Poison Control: 800-222-1222.
- Wear the personal protective equipment the label recommends.
- To prevent spillage of chemicals, always check equipment for leaking hoses and connections and for plugged, worn or dripping nozzles.
- Before spraying, be sure to clear all people, pets, toys, food or dishes from the area to be sprayed. Keep everyone out of the treated area until the spray has dried or for as long as the label directs.
- Use only the prescribed amount. Twice as much is not twice as good.
- Have one sprayer for insecticides and fungicides and another for herbicides.
- Store flammable pesticides away from flames and hot places. The label will tell you if a pesticide is flammable.

BMP III. Apply pesticides according to label directions

Pesticides must be correctly applied. Spray when conditions for drift are minimal, generally in early morning or late evening. You can also avoid drift by using low-pressure nozzles and nozzles with large openings. If a moderate wind comes up while you are working, stop immediately

Avoid application when heavy rain is imminent and irrigate with appropriate volumes of water. Granular applications should be kept away from impervious surfaces and bodies of water.

Check the proper calibration of equipment before every pesticide application.

Timing is often essential if you want to achieve good control. Insects and weeds are easier to kill when they are young rather than older and larger. Fungicides usually should be applied as a protectant before the disease occurs.

Good plant coverage is also important for effective control. If a pest occurs on a particular part of the plant, be sure the spray reaches that area of the plant.

BMP IV. Use appropriate pesticide application equipment, correctly calibrated

Selecting the appropriate application equipment and calibrating the amount of pesticide to be used is a key component of proper pesticide use.

A. Application equipment

Pesticide application equipment comes in all shapes, sizes and prices. Select equipment according to common sense.

- **Proportioner on hose-end sprayer**: These inexpensive sprayers are designed to be attached to the end of a garden hose. They operate by metering out a desired amount of chemical into a stream of water. You may encounter problems with pool spray distribution and clogged nozzles. All hose-end sprayers should have an antisiphon device to prevent backsiphoning of chemicals into the water system.
- **Compressed air sprayer**: The spray is generally mixed in a small tank, which is carried in your hand or over the shoulder. A uniform concentration spray can be maintained since the pesticide is mixed with a known quantity of water. You can get excellent coverage of plants with this type of sprayer, and it is a good choice for treating small fruit trees, vegetables and ornamentals.
- **Small power sprayers**: These have the advantage of being motor-driven, so the operator does not have to pump up the tank. They also provide excellent coverage but are generally too expensive for home use.
- **Hand duster**: The duster may consist of a squeeze tube or shaker, a plunger that slides through a tube or a fan powered by a hand crank. Uniform coverage is difficult to get with any duster. In addition, materials applied with dusters are more susceptible to drift because of their light weight and poor sticking qualities.

B. Calibrating sprayers and spray patterns

An important step in calibrating any sprayer is determining the area to be treated. The following formulas can help you determine the area of regularly and irregularly shaped areas:

RECTANGLES - Area = length x width

CIRCLES - Area = 3.14 x radius squared

TRIANGLES - Area = 1/2 x base x height

The following procedures can be used to calibrate a sprayer:

Fully pressurize the sprayer and determine the delivery time. This can be done by spraying water through the sprayer into a pint jar for 30 seconds. If after 30 seconds there is 1/2 cup in the jar, mark this delivery time on the sprayer for future reference.

Spray an area with water at a normal speed for 30 seconds. Measure the area sprayed. This tells you how much area you can treat in 30 seconds.

Example: If the label calls for 3 tablespoons of pesticide per 1000 square feet and your sprayer covers 100 sq. ft. in 30 seconds, how much water should you mix with the 3 tablespoons to get proper spray coverage?

Amount of Water Delivered in 30 Seconds = 1/2 cup

Amount of Area Covered in 30 Seconds = 100 sq ft

Amount of Water Needed to Cover 1000 sq ft =?

1/2 cup covers 100 sq ft

1000 sq ft ÷ 100 sq ft = 10

1/2 cup x 10 = 5 cups or 40 oz.

So 3 tablespoons of pesticides must be mixed in 40 ounces of water to achieve proper spray coverage.

The best spray pattern used to cover an area of ground is one that gives uniform coverage with little overlap. The spray pattern should be continuous and uninterrupted. Sometimes overlap may be useful. If good coverage is questionable, such as with hose-end sprayers, cut the application rate in half and apply the pesticide first in an east-west pattern, then in a north/south pattern. The spray pattern should form an arc no more than 3 to 4 feet on either side of the applicator.

BMP V. Clean up thoroughly

Always follow the label directions for disposing of pesticide containers.

When you are finished applying the pesticide, clean all equipment immaculately. The best way to dispose of a small quantity is to apply it according to label instructions. Always check the label to avoid exceeding specific application rate. Make sure the site is listed on the label.

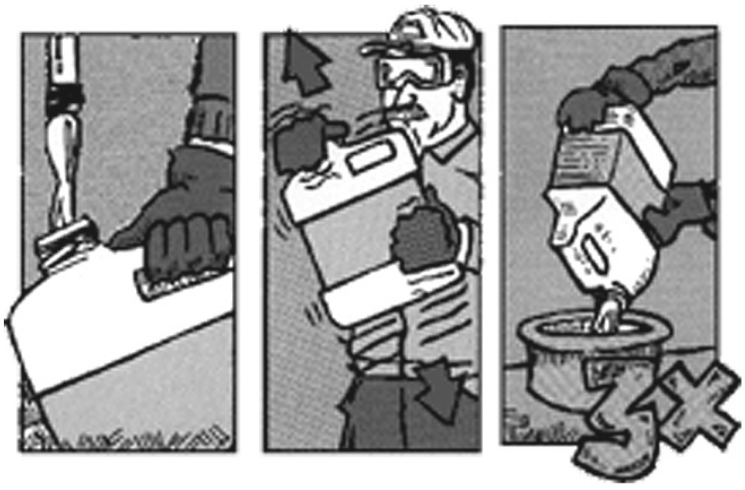
If excess pesticide is left that cannot be used, spray it over an area that you know it will not harm. The addition of chlorine bleach or lime to the surplus solution will help to break it down. Equipment should be cleaned inside and out with clean water. Don't forget to flush out hoses and nozzles.

Proper disposal of pesticides and empty containers is as important as proper application. Since pesticides are expensive, the prudent user will mix only the amount needed for immediate application. However, there may be an occasion when you must dispose of excess pesticides. Check with the Delaware Solid Waste Authority to find out the times and places for disposing of unwanted pesticides (1-800-404-7080).

Never pour a pesticide down the drain.

Empty paper pesticide containers should be flattened and rolled for disposal. Then wrap the containers in heavy paper and tie securely with a cord. Plastic, metal and glass containers must be triple rinsed first, according to the following instructions:

- Empty container into the mix or spray tank. Allow it to drain for 30 seconds.
- Fill the container one-fourth full of water.
- Replace the lid and agitate the container so that the water contacts all interior surfaces.
- Pour the contaminated rinse water into a sprayer, allowing the container to drain for 30 seconds after emptying. Do not pour the rinse water onto the ground or street. Repeat the procedure at least two more times. Spray rinse water on a site listed on the label.
- Lastly, puncture cans so they cannot be reused, and place them in the garbage for disposal. Plastic containers can be recycled.



BMP VI. Recycle empty pesticide containers

In cooperation with the Agricultural Container Research Council, the DDA Pesticides Section provides an empty pesticide container recycling program in the State of Delaware. For more information, visit the following web site: http://www.acrecycle.org/. Containers are collected at the Sussex Conservation District Maintenance Yard on Shortly Road in Georgetown and at the large commercial applicator sites. To arrange a pickup or drop-off, contact the pesticide section at 302-698-4572.

Each container is closely inspected for cleanliness, chipped and bagged for storage and transport. Container chips are processed into pallets, park benches, new pesticide containers, or converted into fuel.

To be acceptable for recycling, containers must be empty, clean, uncapped and dry. Follow this checklist to make sure your containers are acceptable:

• Empty: Plastic containers must be empty to be recycled.

• Clean: Pressure or triple-rinse the container as soon as it is emptied. Containers must be cleaned or they will not be accepted into the recycling program.

• Inspect: Immediately after rinsing the container, look inside and make sure that all the formulation has been

rinsed out. Also inspect the outside of the container; particularly check that the pour spout, the spout threads and the container wall surrounding the spout are free of formulation residues that flake, smear or come off on a glove when touched. Containers that have dried formulation in or on them cannot be processed.

• Discard cap: Caps are usually made of a different kind of plastic and cannot be recycled. Be sure to clean the cap at the time the container is rinsed. Never put a cap back on a cleaned container. Dispose of the cleaned caps as normal solid waste.

• Keep containers dry: Cleaned containers must be kept out of the rain and away from rain water. Store cleaned containers in a roofed building, an enclosed trailer or in plastic bags.

• Labels: Remove the instruction booklets.

• Stains: Containers that originally held products known to stain plastic are acceptable for recycling if the plastic is stained but otherwise clean.

BMP VII. Store pesticides in a safe manner

Pesticides come in many types and formulations. The most common types are herbicides, insecticides, fungicides, rodenticides and fumigants but there are many more. Pesticides can be formulated as concentrates; liquids that are ready to use; solids such as dusts, wettable powders or granules; or gases such as in pressurized cylinders. Packaging materials for pesticides include metal, glass, plastic and paper.

A. General precautions

Always store pesticides:

1. In their original, labeled containers and never in beverage, food, open or other containers that could be mistaken for something else.
2. Out of reach of children, pets and livestock. A well ventilated, dry, locked and labeled cabinet or storage room is recommended.
3. Separate from foods, feeds, drugs or other edible products including their packaging materials.
4. Separate from protective clothing, respirators, gas masks or goggles.
5. Away from sources of flame or ignition and away from sources of water. Consider the potential for flooding, fire or other disaster.
6. With lids tightened. Periodically check for leaks or other problems.
7. With the labeling intact and legible. The label is a legal document and if it becomes illegible, you may have compromised your legal use of the product.

Store chemicals within a secure, properly designed facility adequately posted with warning signs.

B. Inventory

Recommended storage procedures include keeping an accurate and current inventory record that indicates product storage information such as special storage and handling needs and dates of arrival.

Placing dates on product packaging or labels can be useful but don't obscure label information.

With the inventory, you should keep any applicable emergency response information in case of poisoning, fire or spill. Keep a copy located in an area separate from the storage facility. Pay special attention to volatile agricultural chemicals both for their shelf life and for possible contamination of other products stored in the same area. Send a copy to your local fire control agency with a map showing locations of storage areas. Rotate your inventory to insure maximum shelf life.

C. Shelf life

The shelf life of a pesticide is the storage time over which the product remains useful. To remain useful, the product must still be effective for its intended purpose and still be in a condition that allows it to be applied as directed. Shelf life is a function of several variables such as time, sensitivity (temperature, moisture, light), formulation stability (dry, liquid, concentrated, ready to use) and container integrity (metal, glass, plastic, paper).

Shelf life protection for pesticides includes: 1) storage in the original container tightly sealed, 2) storage in a cool, dry and ventilated area, 3) keeping liquids above their recommended minimum temperatures, and 4) keeping solids from becoming damp.

As a general rule of thumb, two years is considered the maximum storage life for most pesticides, although there are many exceptions to this.

D. Cold weather precautions

Pesticide labels have a section on "Storage and Disposal." Products that are frozen should be warmed gradually to the indicated temperature and then rolled or shaken to re-dissolve crystals and achieve proper mixing. All products that have been in prolonged storage should be rolled or shaken to obtain uniform mixing. A simple test of liquid pesticides can help determine if they were frozen and may have reduced efficacy. Two tablespoons of the liquid concentrate should be added to a quart jar that is about three-fourths full of water, the mixture shaken thoroughly and allowed to sit for an hour. If the mixture remains uniformly milky, the pesticide is probably still good. If it separates to show a layered effect, it may have reduced efficacy. Contact the manufacturer.

Store chemicals in their original containers with labeling intact and legible.

E. Pesticide storage facility

Safety is the number one reason for a well-managed pesticide storage facility — safety for both the workers and the environment. Protecting against spills protects the health of your family and your employees, as well as your family's water quality. Furthermore, insurance carriers are limiting policies on environmental damage caused by a fire or spill involving agrichemicals and may require certain practices be put in place prior to writing the policy.

A properly designed and managed pesticide facility promotes storage, handling and disposal practices that enhance worker safety and minimize the risk of point source contamination.

Suggestions are presented here for storage building design, management and disposal of pesticides. Additional information is available from your County Extension Agent.

Electrical

All electrical service must comply with the National Electric Code (NEC) and any applicable state codes. Electrical design for a storage/handling building is covered under the NEC, also referred to as NFPA 70. Use plastic, dust-proof, water-proof electrical boxes and switches. Plastic is not subject to deterioration like metal and can be exposed to limited amounts of water without posing a safety threat. It is important to install ground fault circuit interrupters (GFCI) protection when electricity is in close proximity to water and on all exterior applications.

Use vapor proof fluorescent or incandescent lighting fixtures. On small buildings, provide an exterior switch to control both the ventilation fan and the lights. An exterior operation light that indicates when the lights and fan are on is a convenient feature. Choose electrical equipment and wiring designed to prevent a spark from igniting a flammable vapor. Avoid sources of high temperature and sparks in storage areas.

Duplex outlets, switches, fan blades and motors are all potential sources of sparks. Use U.L. and National Electric Manufacturers Association (NEMA) listed anti-spark equipment if available.

Fire

To reduce the hazards associated with pesticide fires, consider storing pesticides in a separate, locked building. Mount an ABC fire extinguisher near the door. Never permit smoking, fires or welding within the immediate area. Avoid excessive heat, flame or ignition sources.

Treat a fire in a pesticide storage facility as though it was a flammable liquid or oil fire. Explosions of containerized pesticides are possible during fires. The smoke, fumes, vapors, dusts and/or liquids produced by all burning pesticides are toxic. Do not extinguish burning pesticides without proper protective clothing and a supplied air device or self-contained breathing apparatus!

Mixing areas

Consider mixing all pesticide formulations outside. If it is too windy to mix the chemicals safely, then it is too windy to apply the chemical. If it is too wet to mix the chemicals, then it is too wet to apply the chemical. Always wear a respirator when mixing chemicals as per manufacturer's instructions. If mixing indoors, a down-draft ventilation hood at the back of the mixing table can be used to remove dust and vapors. Down-draft hoods are superior to updraft hoods because the chemical is not taken up past the user's face.

Rinse pad & collection tank

- Slope the rinse pad 2% to the center of the pad or far enough away from any side/end that the rinsate will not wash off the pad.
- Use berms or curbs whenever possible to contain the rinsate. The pad should have a sealed surface to provide chemical-resistant.
- No pipe or plumbing may pass through the concrete of the rinse pad.
- The water supply must have backflow prevention installed.
- Catch both rinsate and precipitation from the rinse pad. The collection system must be designed to contain at least 125 % of the volume of the largest chemical tank that will be placed on the structure.
- Use steel-grated floor drains to shallow concrete collection sumps. A sump is used to collect rinsate and wash water from the pad and allow reuse as makeup water for subsequent sprayer fillings. Prevent tracking of mud or chemicals off the pad by wheel traffic by properly washing down the equipment and pad.

Catch both rinsate and precipitation from the rinse pad.

To use the rinse pad, drive the sprayer onto the concrete pad and make sure that the sump drain valve is locked in the closed position. Any leftover field-strength chemical and rinse water from the sprayer drain valve is pumped into a marked rinsate tank. Any spills can be washed into the sump for later recovery. Wash water is collected from the exterior wash down of spray equipment and tank and plumbing cleanout.

The pad should be washed down and then rinsate collected and transferred to storage or nurse tanks located on pad before a change in pesticide or after field operations on a daily basis. Sediment that collects in the sump should be removed prior to switching from one chemical to another. The sludge contains pesticides and must be disposed of properly.

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