Bulletin 364

Integrated Pest Management In Schools

IPM in Maryland Schools: Plant Selection and Care

University of Maryland, College Park | Maryland Department of Agriculture

MARYLAND COOPERATIVE EXTENSION
UNIVERSITY OF MARYLAND
COLLEGE PARK•EASTERN SHORE

ERRATA SHEET
AND
IMPORTANT NOTICE CONCERNING
IPM TRAINING MANUALS AND INFORMATION SHEETS

BACKGROUND

Legislation was enacted in 1997 mandating that Maryland Public Schools (Grades K-12) develop and implement Integrated Pest Management (IPM) plans for managing pests in public schools. The legislation also mandated schools to develop and implement methods for providing notification to parents and or guardians, as well as, school staff of pesticide use in school buildings. In 1999, this legislation was expanded to require public schools to develop and implement IPM plans and notification of pesticide use on school grounds.

In an effort to assist schools in the initial development and implementation of IPM plans and notification and posting formats, the Maryland Department of Agriculture (MDA) produced several manuals and contracted with the University of Maryland to write four additional manuals. These documents were intended for use by the schools for information and guidance. The documents were never intended to supplant the IPM and notification law and regulations but rather to facilitate implementation of the law. However, there are statements in these documents that incorrectly state the requirements of the law. The Department does not have the funds to republish the manuals and therefore has disseminated this errata sheet to all public school systems in Maryland to ensure that all schools are complying with the law.

Please note that the IPM in School manuals contain additional statements or information other than the examples listed below that do not uniformly incorporate and provide detail of the statutory mandate of Maryland's IPM and notification of pesticide use in public school buildings or on school grounds law and regulations. Therefore, if you are reading these manuals for training/guidance purposes or when performing pest control services, make sure you adhere to the definition of Integrated Pest Management found in Maryland's Integrated Pest Management and Notification of Pesticide Use in a Public School Building or on School Grounds law and regulations. For more information or questions, please contact the Maryland Department of Agriculture's Pesticide Regulation Section at 410-841-5710

ERRATA SHEET

PLEASE NOTE AND BE AWARE OF THE FOLLOWING:

1. The IPM in Schools manuals produced by MDA and the University of Maryland contain statements that incorrectly state that IPM is an alternative to pesticide application. An example of such a statement can be found in the Preface of the *Integrated Pest Management in Schools: IPM Training Manual,* where it states "Integrated Pest Management (IPM) is an alternative to pesticide use." This statement is incorrect. IPM **is not an alternative** in Maryland's Public Schools (Grades K-12); **it is the required method** of pest control under Maryland's IPM- in-Schools law and regulations."

2. The IPM in Schools manuals produced by MDA and the University of Maryland contain statements that fail to uniformly affirm the statutory mandate that pesticides be used only when "nontoxic options are unreasonable or have been exhausted." Examples of statements that fail to affirm the statutory mandate can be found 1) on page 6 of the manual entitled *Guidelines for Integrated Pest Management in Schools,* where it states "Pesticides are a component of an IPM program…" 2) on App. A, page 7 on the manual entitled *Contracting Guidelines for IPM Services in Maryland Public Schools* where it states "A broad definition of IPM is a pest control program that… incorporates different methods of pest control such as…and pesticides, when warranted…" and 3) in same manual on p. 17 where it states that "Pesticides play a limited, but important role in and IPM program." These statements do not reflect the statutory mandate that pesticides may be used only when nontoxic options are unreasonable or have been exhausted. In fact implementing an IPM program with a proper focus on pest prevention may result in a pest management program that does not include the use of any pesticides.

3. The IPM in Schools manuals produced by MDA and the University of Maryland contain some language that fails to provide the correct notice requirements mandated by the IPM-in-Schools law and regulations. An example of such a statement can be found on page 8 of the manuals entitled *Guideline for Integrated Pest Management (IPM) in Schools,* which states "A voluntary registry of individuals with medical problems or conditions who could be adversely affected by exposure to pesticides shall be maintained at the school health or administrative offices, as well as by the contact person." **Prior notification is not a voluntary option for schools, nor is it limited to individuals with medical problems or conditions.** Both the law and regulations regarding IPM and Notification in public schools buildings and on school grounds **mandate notification** to all parents, guardians and school staff for elementary schools. Middle and High schools may choose to either notify all parents, guardians and staff members or establish a list of parents, guardians and staff members who wish to be notified of pesticide use. The law requires that all parents, guardians and staff be informed of the notification list so they can opt-in.

4. The IPM in Schools manuals produced by MDA and the University of Maryland contain confusing statements regarding a school's legal obligations. An example of such a statement can be found on page 4 of the manual entitled *Contracting Guidelines for IPM Services in Maryland Public Schools.* The statement reads "In addition, the Governor's Pesticide Advisory Council has issued the following policy statement regarding IPM in schools…" This statement references a Council that no longer exists and a policy that is not in law or regulation

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What is IPM?

The Maryland Department of Agriculture regulation on Integrated Pest Management and Notification of Pesticide Use in a Public School Building or on School Grounds (Title 05, Chapter 02, Agriculture Article, Annotated Code of Maryland) defines Integrated F Management (IPM) as:

> *"a managed pest control program in which methods are integrated and used to keep pests from causing economic, health-related, or aesthetic injury through the utilization of site or pest inspections, pest population monitoring, evaluating the need for control, and the use of one. or more pest control methods including sanitation, structural repair, nonchemical methods, and, when nontoxic options are unreasonable or have been exhausted, pesticides, in order to minimize the use of pesticides, and minimize the risk to human health and the environment associated with pesticide applications."*

Managing pests through an IPM program requires a basic understanding of pest biology and behavior to select effective methods of control. The most basic aspect of any pest control program is understanding: "what is a pest." A pest is any living organism (animal, plant, or microorganism that interferes with or threatens humans or their property, or the environment. Pests have basic' needs for air, food, moisture, warmth, and harborage. Landscapes are commonly constructed and maintained in ways that provide these needs and create environments that encourage pests to stay and multiply.

Many individuals are under the false assumption that IPM represents a nonchemical pest management. In fact, IPM programs integrate both nonchemical and chemically based methods of pest control. In the long run, this integrated approach is more effective and less risky for school occupants than traditional pest management approaches that rely only on the use of chemicals. IPM employs a combination of tactics that include structural modifications, sanitation, inspections and monitoring, use of traps, and when nontoxic methods are unreasonable or have been exhausted, the judicious use of pesticides. Long-term control of pests is achieved by using the best available technical information about the interactions with its surroundings.

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Introduction

A traditional method of controlling pests on school grounds was to apply chemical pesticides as a general preventive treatment to turf and landscape plants, whether or not pests were present. New Maryland state regulations for integrated pest management in schools were created in response to public concerns about the routine use of pesticides in environments where our children learn and play. They require the Maryland Department of Agriculture to develop uniform standards and criteria for implementing IPM on school grounds (SB 149 Public Schools-Integrated Pest Management). Each county Board of Education is also required to develop and implement an IPM system for their school grounds.

To help guide schools with implementing their integrated pest management strategies, Maryland Cooperative Extension, of the University of Maryland, with funding and support from the Maryland Department of Agriculture, developed the *Integrated Pest Management in Schools: IPM Training Manual For School Grounds* in 1998 and *Integrated Pest Management in Schools: Contracting Guidelines for Integrated Pest Management Services in Maryland Public Schools* in 2001. The present document, *Plant Selection and Care* is the third in the *IPM in Schools* series. It will help you choose pest-resistant plants, create low-maintenance landscape designs, and install plants so they remain healthy and better able to resist pests.

IPM Begins with Healthy Plants

An IPM school grounds program is a long-term commitment that begins with landscape design, proper plant selection and installation, and grounds maintenance to discourage pest populations. In the long run, this strategy is often also the most economical. Landscapes are complex systems, composed of interacting populations of plants, animals and microorganisms. The living components of landscape ecosystems interact with the physical characteristics of the site, such as temperature, sunlight, rainfall, irrigation, soil and nutrients. Selecting plants that are adapted to the soil, light and drainage conditions of the site help ensure healthy plant growth. This, in turn, may encourage pest resistance or help plants recover from pest attack more readily. In addition, landscape plant designs that include many types of plants are more likely to support populations of natural enemies to insect pests than single-species designs. Large groups of a single plant variety encourage the persistence of specialist pests, such as some insect species, plant-parasitic nematodes and plant pathogens.

Not all landscape plantings require intervention. Using the concepts of **key pests, key plants,** and **key locations** will help you focus on and, hopefully, avoid those pests, plants and locations that require more frequent treatment. Observing current pest, plant and location problems and successes on school property will help you make plant choices and create landscape designs that are more pest-resistant in the future.

***Key pests** are those pests that meet at least one of the following criteria:*

They recur regularly in densities that warrant control.

They attack and damage very conspicuous or valuable plants.

At low densities, the pest is capable of killing or disfiguring a plant, or transmitting disease.

***Key plants** meet one of the following criteria:*

Plants are conspicuously located, or are unusual, unique, or historically significant. They may sustain infrequent damage, but because of their location in the landscape or their historical value, they need more attention.

Plants sustain damage from pests on a regular basis, or have a particular pest that can kill or disfigured them in low densities.

***Key locations** are identified by the following criteria:*

Areas that warrant frequent attention because they are frequently used or are significant in some way.

Areas where the plants have chronic problems with pests or have more severe problems with pests than plants of the same species in other locations. An example of a key location is plants in sunny, isolated sites. Many insect and mite problems are more severe on plants in these locations.

Unless you have reasons to create high-profile landscaping, such as showy entrance areas or historically significant landscapes that require specific plant species, it's a good idea to avoid key plants and key locations prone to key pests. Monitoring of school grounds is a good way to uncover key pests, key plants and key locations. However, even before you plant, this document will help you avoid some of these problems by providing guidance for selecting and maintaining pest-resistant and low-maintenance plants and landscapes.

Site Evaluation and Preparation

If a school district is building a new school, designing school property and landscaping may be a lengthy, collaborative process led by professional landscape architects. In most cases, however, school landscapes are created a little at a time. As the landscaping matures, plantings on school grounds may require improvement, enhancement, or even removal. Established groves of trees will need periodic pruning or tree replacement. School administrators or teachers may want to replace some of the lawns with educational gardens, ornamental plantings or natural areas. At many schools, students help with plantings, especially special gardens that may be used for educational purposes. Much of the time, though, maintenance staff or contractors tend school grounds.

A little homework before planting can save you work and the school district money. Integrated pest management (IPM) is a comprehensive strategy for pest control. It begins even before you plant. It's important to know your soils, understand the water movement on the property, and select plants best suited for your area. In many cases, landscaping already is established and is now in need of a facelift. It's worth the time upfront to walk the property, map what's there, and carefully look at current successes and failures.

Evaluating School Grounds

1: Determine goals

Work with school officials to determine goals for the school's property. These goals will influence plant choices, landscape design, and management practices. Features and questions worth considering may include the following. What are the school's IPM goals? Is it reduction or elimination of pesticide use? Is the goal a low-maintenance landscape that requires minimum input? Are safety issues, such as open lines of sight along roadways and parking areas, important? These issues will affect the economic resources (money and labor) needed to manage the landscape.

Should there be shade trees along walkways or around outdoor school lunch areas? Does the school want privacy buffers planted along the property edges? What type of entrance landscaping would be both pleasing and practical? Flowering plants will attract stinging insects that may be a nuisance or even a health hazard to children, so showy flowering trees and shrubs, as well as ornamental flowers, may need to be placed far from walkways, parking areas and lunch areas. Parking lots, walkways, athletic fields, and stormwater management areas have essential functions that require management for practicality and safety. Weed control and turf management (see the IPM in Maryland Schools document on Weed Control and Turf Management) may be the extent of needed management for most of these areas. Does the school system want to use the landscape for educational purposes?

Site Evaluation and Preparation

Landscape design can enhance educational opportunities. As mentioned above, stormwater management areas may offer unique educational opportunities to incorporate native plants and wetlands into the school's landscape design. Is there a bird feeder watch area where students observe birds from classrooms? This area may need berry-bearing shrubs and trees that provide food and cover for birds. Is the school interested in a butterfly garden, natural habitats, or a nature trail? Do school grounds already have unique areas worth conserving, like streams, wetlands or forests? New gardens or educational areas can be penciled into a master plan and created at a later date or over time. Keep in mind that even landscape plantings around the school building can offer lessons for students in beneficial plants, integrated pest management, ecology and agriculture.

2: Walk and map the property

Walk the school property and look carefully at its features. Consider bringing along a landscape designer, school official or teacher interested in the landscaping. Ask your local Cooperative Extension horticultural specialist to join you, or the school's pest management contractor and the IPM contact person. A second opinion or expert eye might save you work later.

Start with blueprints of school property or locate topographic or soils maps. You can find maps of local soils at county or regional Natural Resources and Conservation Service (NRCS) offices. The US Geological Survey (USGS) can provide typographic maps. Map the size, shape, borders (don't forget what's next to them) and contour of the property. Sketch the location of athletic fields, buildings, walkways and parking areas. Draw in landscaping features, such as location of trees and shrubs, and landscaping beds. Are special habitats on the property? Look for wetlands, forests, meadows and waterways. Are there special problems like slopes, erosion, or shade? Are there obvious problems like dead, diseased or insect-infested plants; poor turf condition; or poor growing conditions due to too much or too little water, inappropriate lighting, or crowding? Look at the "lay of the land." Where is high ground? Low ground? Is natural drainage present? Finally, note the wind direction. Usually, prevailing winds come from the west, but this may differ if your school was located near Chesapeake Bay or the Atlantic Ocean. A detailed map will help with designing future landscaping, as well as monitoring and maintenance later.

3: Look for insects, diseases, and plant stress

Regularly monitoring plants for pests and stress is an important part of an Integrated Pest Management (IPM) program. The first step is to create a baseline diagram of landscaped areas, healthy plants, and areas where plants may need attention, replacement or enhancement. Woody plants should be inventoried and an appraisal for large or valuable trees might be considered. When walking the property, look for insect damage, such as defoliation, nests of caterpillars, or colonies of aphids or other insects. Note plants with yellowing or spotted leaves, as well as plants that are dropping leaves during the growing season. Wilted and dying plants also should be recorded. (See *Integrated Pest Management in Schools: IPM Training Manual for Grounds Maintenance* for further information on pest "Identification, Monitoring, and Control Recommendations.")

4: Learn from the local ecology

Deciding what to plant might be as easy as observing what's already there and doing well. Observe what plants grow best in the nearby areas with similar growing conditions to those found on your school landscape. Many of these plants can be incorporated into your ornamental landscaping designs.

5: Evaluate growing conditions

Consider your local growing conditions, including climates, moisture, light, and soil type. Choose plants well-adapted for your local climate and soils that are insect- and disease-resistant. Plant survival depends on choosing the right plants for the conditions present on your site. Check the water drainage patterns on the property. What areas are well-drained and what areas are poorly drained? Are there areas where water pools seasonally or during heavy rainfall? (See the section on "Water and Drainage" later in this chapter.) Plants also vary with their tolerance to different soil types. For example, some plants, such as Japanese Black Pine, do better in sandy soils than other soil types. A soil test will tell you what type of soil you have. Like moisture conditions, plants also have different levels of light tolerance. Note what areas are shaded, receive partial shade throughout the day (note what time of day), and are sunny. Planting for the right growing conditions promotes plant health, pest-resistance, and survival.

6: Test the soil

A soil test to determine soil pH, nutrient levels, and soil type is strongly recommended before you start planting and a minimum of every 3 years thereafter. See Appendix A, "Fertilizer Recommendations for Landscape Trees and Shrubs for Professional Grounds Managers & Landscape Contractors" for Maryland's state requirements and University of Maryland Cooperative Extension recommendations. Contact your local Cooperative Extension office or the Maryland Extension Home & Garden Information Center for information on where to get your soil analyzed. (See the section below on "Why Test Your Soil" for where to get a soil test.) In addition to testing for nutrients, you may want to check for lead in areas near buildings or where you plan landscaped beds (see Appendix B, "Lead In Garden Soils"].

Proper soil pH is important for maintaining optimum growing conditions. Soil pH levels of 6.0–7.0 offer the best growing conditions for many plants. However, certain acid-loving plants, like azaleas, may require lower pH levels. A soil test will provide information on nutrients, including phosphorus and potassium, and some micronutrients. Knowing what baseline nutrients are present in soils will help guide fertilization in soil amendment choices. See the "Soils: Understanding the Basics" section below for details on soils and soil tests.

Soils: Understanding the Basics

Growing healthy, pest-resistant plants begins with healthy soil. Knowing your soil is more than sending a sample off to the lab or fertilizing with nitrogen. Soils are the base from which your plants will grow and home to soil structure-building earthworms and numerous beneficial insects and microorganisms. Soil is made up of minerals, organic matter, living organisms, water and air. Living organisms, like earthworms, insects and soil microorganisms, help create channels in soil that allow the flow of air and water. Soil creatures also contribute to soil fertility when they decompose organic matter.

Soils and their condition may vary throughout the school property. Because soils often are moved during construction, you will want to check soils in each area to be planted or already landscaped. As a result, plant selection and care may require site-specific approaches. Soil components are linked intricately with water and other factors that effect plant health. The more you understand your soil and how it interacts with water and nutrients the more likely you will be able to maintain a healthy landscape. Call the Maryland Cooperative Extension Home and Garden Information Center at 1-800-342-2507 or visit their website at www.agnr.umd.edu/users/hgic for helpful fact-

sheets on soil care. (See Appendix C, "Soil Amendments and Fertilizers," for more information.) Here are a few soil basics to get you started:

Soil texture results from the mixture of different sizes of soil particles. Soils are made up of some combination of sand, silt or clay. Texture combinations (your type of soil) can be estimated by rolling the soil between your thumb and forefinger. Sand particles are large and gritty. Clay particles are very small and slippery when wet. Silt particle size is between sand and clay, and feels dusty when dry. "Loamy" soil texture contains a fairly even ratio of two or three of the different particle types. The widest variety of plants will grow in loamy soils. Extra care must be taken with plant selection when working in soils heavy in any one texture—whether clay, silt, or sand.

Maryland soils vary across the state. Much of the Eastern Shore is sediments made up of gravel, sand, silt and clay. Wetland areas and Bay islands often have high ratios of silt and clay in their soils. Maryland' s Piedmont soils, located between Chesapeake Bay and the mountains, consist of weathered material from very old rock, including schist, gneiss, metabasalt and phyllite. In the Appalachian Province of Maryland, soils have formed from limestone, sandstone, shale and siltstone.

Texture can be assessed with some practice. Moisten a small amount of soil and rub it between your fingers and try and form a ribbon. It is impossible to produce a ribbon with very sandy soil. As the amount of clay increases in the soil texture, however, the length of ribbon you are able to produce also increases.

Soil structure is the arrangement of soil particles in soil. Soil aggregates (clumps) are held together by plant roots, microorganisms, and electrical and chemical bonds among the soil and water particles. The soil's structure allows movement of water and gases though soil. The ability of plant roots to penetrate soil is dependent on the soil's structure. Addition of **organic matter,** like grass clippings, manure or compost, can improve aggregation in soil structure.

Permeability is the ability of water, gases and roots to move through the soil. Soil texture, structure, and **pore space** (the openings between soil particles) affect permeability. Large pores, which are created by roots or soil-dwelling organisms, transmit water and gases more rapidly than small pores. **Compaction,** which can be caused by heavy vehicles driving on soil or long-term foot traffic, decreases and may even permanently damage soil permeability.

Aeration is the exchange of gases that occurs between the atmosphere and soil. When soil pores are filled with water, the soil is considered **saturated.** This leads to **anaerobic** or "no oxygen" conditions in which many plants cannot survive. **Aerobic conditions** exist when water is not fully occupying the pore spaces and atmospheric gases can exchange with soil gases. Plants stressed by anaerobic conditions may not be able to fend off certain pests and disease as well as healthy plants, so adequate aeration in soil is needed for plants to thrive and resist pests.

The **water-holding capacity** of the soil is related to soil texture and the size and number soil pores. The ability of soil to hold water affects how much water is available to plant roots. A fine-textured loam has the ability to hold more water than a course, sandy soil. Because water drains via gravity, highly porous or sandy soils may drain water before plants can absorb it, thus, they have

low water-holding capacity. Fine-textured clay particles hold water so tightly that they may leave little water available for plants. Therefore, a mixture of soil textures is best.

Soil nutrients are organic matter and the minerals needed for plant growth. **Organic matter** is usually present in only small amounts (1–6%), but is crucial for good soil structure. It is composed of living organisms, and fresh and decomposed plant and animal residues. Compost, manure, grass clippings, and dead leaves are examples of easily obtained organic matter. **Primary nutrients** are needed in the greatest amounts, including nitrogen (N), phosphorus (P) and potassium (K). Commercial fertilizers commonly list the N-P-K composition of their product. This describes the percentage of the net weight of each of the nutrients. For instance, a N-P-K listed as10-6-4 indicates the fertilizer contains by weight 10% nitrogen, 6% phosphorus, and 4% potassium. Only small amounts of **secondary nutrients** are required for plant growth. Secondary nutrients include calcium (Ca), magnesium (Mg), sulfur (S), boron (B), copper (Cu), chlorine (Cl), iron (Fe), manganese (Mn), molybdenum (Mo), and zinc (Zn).

Soil pH is a measure of the hydrogen ion concentration in soil. A pH value of 7.0 is neutral. Values below 7.0 are acidic and those above 7.0 are alkaline. pH widely varies in natural soils and can be even more variable and unpredictable in urban soils. Construction materials, wood ash, concrete, or chemicals can alter soil pH. Soil nutrients are most available to plants and microbial activity is greatest when soil pH is 6.0–7.0. However, acid-loving plants, like rhododendrons, azaleas, chamellias, mountain laurel, and hollies, prefer acidic soils with a pH of 4.5–6.0.

Soil pH problems can cause reduced plant health and increased vulnerability to diseases and other environmental stresses. Plants may show stunted growth, off-color leaves, reduced flowering and fruit production, or poor growth.

Why test your soil?

A soil test is critical to identifying the health and needs of your soil. Most soil test results will also make recommendations on how to amend (nutrients, pH, organic matter) your soil to optimize plant growth. To test soils, first request an information sheet and mailing container from either your County Extension Office or the Maryland Home and Garden Information Center (1-800-342-2507; or check the web site at www.agnr.umd.edu/users/hgic/ under "Publications"). A basic test package for lawn and gardens examines pH, texture, and levels of phosphorus, potassium and magnesium. A basic test package for agricultural field samples also includes examination of calcium levels and the percentage of organic matter. Follow the instructions for the proper method to collect the soil sample. Be sure to provide information on what you are growing, so recommendations can be made. Mail the sample to: Soil Testing Laboratory, University of Maryland, College Park, MD 20742.

Watch for toxic soils

You do not want students or staff working in contaminated soils and you certainly do not want to grow edible vegetables in those soils. If you are working in areas that contain or once contained old structures, you should check the soil for lead content. Chipping or peeling paint from old structures will raise the lead levels in nearby soils. Sites that may have been contaminated with leaded fuels, old lead plumbing pipes, or old orchard sites where lead arsenate pesticides may have been used should also be checked. High lead levels in soils are especially dangerous to the health of children under six-years-old and pregnant women. For more information on lead and where to get tests see Appendix B, "Lead In Garden Soils" or call your county Extension office.

If your site supported construction with treated lumber, you should check for arsenic contamination. Dust from the sawing of treated wood can raise arsenic levels to unacceptable levels in soil, posing possible health risks. The University of Maryland soil testing lab does not test for soil contaminants. You can contact the Home and Garden Information Center or your county Extension Office for information on private labs that test for arsenic. Also, several labs listed in Appendix B, "Lead in Garden Soils" test for arsenic.

Transplants may take longer to adjust and winter damage may be more severe if soil pH is not optimum for your particular plants. The most common pH adjuster is lime, which raises pH. Liming should be done during fall, because lime requires time to alter pH. Many types of lime products are available. Sulfur and iron sulfate will lower pH. Elemental sulfur is sold as "flowers of sulfur" or microfine sulfur. At pH levels above 6.0, iron sulfate lowers pH faster than elemental sulfur. For more information on pH adjusters and soil amendments see Appendix C, "Soil Amendments and Fertilizers."

Water and drainage

Water is often the limiting factor with plant growth. Some plants are stressed by lack of water and may be more vulnerable to disease and insects. The opposite is also true. Water-logged soils are stressful to most plants, except wetland plants, of course. Soil aeration and drainage can be assessed by observing soil color in the top 30–40 cm of the soil profile. Well-aerated, well-drained soils will often be yellow-brown or red-brown in color. When oxygen levels are low due to poor aeration, soils may appear gray or blue, and sometimes they may have bright yellow or red spots. You may want to ask your local Cooperative Extension specialist to help you assess school property soils, especially those that might seem troublesome.

When walking the school property, check for water-related problems like erosion and standing water. Signs of erosion include exposed tree roots or rocks, small gullies, build-up of soil in low-lying areas, splashed soil, and the widening and deepening of streams and drainage ditches. The key to preventing

erosion is to avoid having areas of bare soil. Sound turf management on athletic fields, mulched beds, and permanent walkways in high-traffic areas will help prevent many erosion problems. Extra care may be needed on slopes, where bare ground can erode dramatically in a single heavy rainfall.

Standing water may serve as a breeding site for insect pests, such as mosquitoes. Standing water can be eliminated with proper drainage. The drainage on school property should be part of a comprehensive stormwater management plan that routes water from school buildings, parking lots and athletic fields to safe storage and drainage areas. School property stormwater management is beyond the scope of this document, except to note that stormwater retention areas can be planted with water-loving wetland plants capable of surviving seasonal and long-term flooding. Mosquitoes that may breed in these sites can be controlled by the addition of fish that eat mosquito larvae. Planting wetland species in and around retention areas can be an educational environmental science exercise for students, with few to no maintenance responsibilities after the stand is established. If beneficial plants are included in wetland plantings, you will attract beneficial insects and birds to school property.

During most years, however, school grounds are more likely to suffer plant loss due to lack of water. Water-stressed plants are vulnerable to a variety of pests. **Xeriscaping** is water-efficient landscaping in areas prone to drought. Wise use of water in the landscape begins with choosing drought-tolerant plants, or at least plants with low water requirements, and learning the most efficient ways to apply water. You will want to work with school administrators to determine how much turf is really needed and how much area might be maintained as natural. Although the few years after planting may require extra watering, watering usually is not necessary after trees, shrubs and ground covers become established in natural areas. In addition, the use of pesticides and even mowing may be eliminated in natural areas. See the Maintenance chapter for more information on watering. Also, see Appendix D, "Xeriscaping and Conserving Water in the Landscape," and Appendix E, "Watering Tips for Drought Conditions."

MISS Utility
1-800-441-8355

Site preparation: when you dig . . .

First and foremost—tend the soil! A very important factor for growing pest-free plants is healthy soil that is compatible with your plant choices. Your local Cooperative Extension Office or the University of Maryland Home and Garden Information Center can supply you with the information on soil conditioning. Also, see Appendix C for information on soil amendments and fertilizers. Remember, a soil test will inform you of your soil needs. See the previous section, "Why Test for Soil," for soil test information.

Here are a few tips for prepping new landscape beds and sprucing up old ones.

- Contact utilities by calling the statewide organization called **"Miss Utility" at 1-800-441-8355.** All underground wires and lines must be marked. Utilities need at least three full business days to make arrangements to mark your wires and lines. The staff at Miss Utility will contact all pertinent utilities, including electric, gas, cable, telephone, water and sewer. A few counties charge for marking water and sewer lines, but other utilities normally do not charge for this service.
- Organic matter should be incorporated into new beds before planting begins and

older landscaping beds may require yearly top dressing. Compost, manures, grass clippings, or decaying leaves are organic materials that will help improve soil texture and structure, as well as moisture conditions.

- Soil pH may need an adjustment, even on older beds. Most plants grow best with a soil pH between 6.0–7.0. In Maryland, acid rain may cause soils to become acidic (pH below 7.0) over time. Applying lime will raise soil pH. Products like iron sulfate and sulfur will lower pH.
- Fertilize if needed. If your soil test indicates nutrient deficiencies, fertilizing may be necessary, especially before you plant. Read the label! You don't want to over-fertilize, because excess fertilizer can runoff and pollute waterways, as well as increase pest problems. (See the Maintenance chapter for more information on fertilizing.)
- While you dig, look for the larvae of garden pests. Because larvae move slowly, you can pick them by hand and destroy them. Hand-picking can help you get a handle on the pest problem before plants go on the ground. For instance, picking out white grubs, which are the larvae of Japanese beetles, will decrease your local Japanese beetle populations before they emerge from the ground.

Plant Selection

Choosing the right plants is an essential part of IPM. Plants adapted to your growing conditions will be naturally healthier and better able to fend off insects and diseases. Some plants, or mixes of plants, will help repel unwanted insects or encourage beneficial insects. Even under the most difficult of growing conditions, there is usually a wide variety of native and sustainable plants, as well as numerous disease and insect resistant ornamentals available.

Sustainable plants are noninvasive and require minimum maintenance because they are well-adapted to local growing conditions. Sustainable plants require less trimming, watering, fertilizer, and pesticide applications than many other plants. In addition to identifying sustainable plants for landscapes, there has been a recent effort to identify plant species that attract good insects, like aphid-eating ladybugs or parasitic wasps. These plants are referred to as **beneficial insectary plants.** Beneficial insectary plants are attractive to **natural enemies** (insects or spiders that feed on insect or mite pests) because they provide them with refuges, favorable microclimates, and alternative food sources such as other insects and nectar and pollen. A few common beneficial insectary plants are listed in the table below.

A word of caution: because some beneficial plants produce nectar and pollen, bees and wasps will be attracted to them. Avoid planting these types of plants near sidewalks, entryways, or playgrounds were stinging insects may enter buildings or sting children.

Nectar-bearing species are considered beneficial, not only because they attract natural enemies, but because they also attract desirable animals such as hummingbirds and butterflies. Native cardinal flower, non-native butterfly bush, and water-loving native buttonbush are good nectar sources that bloom at different times of the year. Another beneficial plant, milkweed, is essential to the life cycle of migratory monarchs.

Native plants are considered sustainable. Native plants are trees, shrubs, vines, ground covers or herbaceous plants that would have been present before modern humans altered the landscape. Native plants often require less maintenance because they are adapted to the local climate and soils. For example, native warm season grasses will survive Maryland's hot summers without watering far better than ornamental ground covers. Placed in natural areas, warm season grasses will require next to no maintenance once established and provide important habitat for many species of birds. Although native plants have been difficult to find in the past, market demand is encouraging more Maryland nurseries to carry them. Native trees and flowers, in particular, are now easily found at prices comparable to common ornamental species. Because native species may vary dramatically from region to region in geographically diverse Maryland, it is important to ask about natives that are best adapted to your particular region. US Fish and Wildlife Service offers

Table 1. Beneficial Insectary Plants to Attract and Retain Natural Enemies

Family / Plant Group	Plants
Umbelliferae	anise, coriander, dill, fennel, parsley, Queen Anne's lace, yarrow
Compositae	asters, black-eyed susan, coneflower, coreopsis, daisies, marigolds, sunflowers, zinnias
Brassicaceae	flowering buckwheat
Polygonaceae	sweet alyssum
Perennial herbs	basil, bee balm, mints, oregano, sage, thyme
Other plants	nasturtiums, poppies, salvias, wallflowers

Native Plants for Wildlife Habitat and Conservation Landscaping for the three geophysical regions of Maryland: Coastal plain, Piedmont plateau, and Mountain zone. Call 410-573-4500 for lists and more information. Also, see Appendices F and G for native and beneficial plants lists.

Many **non-native or exotic plants** are also considered to be sustainable and beneficial. However, some have the potential to be extremely invasive. **Invasive exotics,** like purple loosestrife, bamboo and Japanese honeysuckle, can aggressively take over landscaped and natural areas, shutting out more beneficial species. Invasive species should be avoided at all costs. Many plant lists will identify invasive species, as will many nursery managers, if you ask. Table 1: Beneficial Insectary Plants to Attract and Retain Natural Enemies, also provides a list of beneficial plant families. **Ornamental plants** are cultivars developed for their aesthetic qualities, functionality, and/or disease and insect resistance. For years, ornamentals have been prime plant choices for landscaped areas. They are usually readily available and affordable from local nurseries. Ornamental plants with pest-resistance can be good choices for landscaped areas. Many disease-resistant crab apples, dogwoods and other trees are available. Many of these, however, were developed for average growing conditions (loamy soils and moderate water) and may not tolerate some of Maryland's more extreme soil and water conditions. Many ornamentals, especially annual flowering plants, are not drought-resistant and may require extensive watering to keep them flowering and even living. Although you may want to consider annual flowering ornamentals in high-profile landscape beds at building entrances, consider keeping them to a minimum and using better-adapted plants throughout the rest of the school property's landscape.

Woody Plants

Before you begin removing, pruning or planting trees, check for state and local laws that may affect trees in your community. Critical Area Laws, tree or forest preservation ordinances, county and community master plans, and school plans for landscaping may put limitations on removing trees or recommend species that can be planted. The next step, after examining any local restrictions, is examining the areas that may be affected by the canopy or roots of maturing trees. Roots will extend horizontally four to seven times the projected crown area. Projected crown size for different species is

available in published plant lists or books, from nursery managers, or from Maryland Extension Home & Garden Information Center. When deciding on tree-planting sites, be sure to consider what is below, above and around the proposed site.

Tree and shrub selection

After testing the soil, observing moisture conditions, and considering how roots and canopy will affect and be affected by existing and proposed buildings, paved areas, and other infrastructure, you're ready to choose specific plants for your landscape.

A few guidelines include:

- Define the purpose of the tree/shrub in the landscape's big picture and be sure it fits the goals of the school property's landscaping plans. You may want to consult with the school's IPM contact person, IPM contractor or school administrators. Do you need shade, a windbreak, or privacy border? Are entrance areas in need of specimen or compact trees and shrubs? Are tree or shrubs needed in natural areas or educational gardens? Will new trees and shrubs be planted in areas frequented by students, possibly making them vulnerable to vandalism?

Look for:

Overhead wires
Nearby trees and other vegetation
Existing and proposed buildings
Sidewalks, parking lots and roads
Traffic patterns (you don't want to block stop signs and red lights)
Athletic fields
Underground cables
Underground pipes and gas lines

- Plant diversity protects against catastrophic loss from disease and insects that may infest all individuals of a single species. Diverse plantings also may encourage the establishment and maintenance of diverse communities of beneficial insects. These can help reduce the frequency of pest outbreaks. Although uniform single-species plantings are attractive and acceptable in individual or isolated settings, consider a diversity of species for most of your plantings.
- Urban settings may require trees and shrubs that are pollution-tolerant, with compact canopies and minimum root spread. Recommendations for "street trees" are available from local nurseries, urban foresters, and County Extension Offices. Also, *Sustainable Trees and Shrubs,* by B.K. Maynard et al., from the University of Rhode Island Cooperative Extension, has a list of trees tolerant of urban conditions. See the References section for full bibliographic information.
- Match plants with the site. Choose plants that are suitable for the available soil, water and light conditions. Don't try to buck nature. Healthy trees and shrubs may be better able to withstand times of environmental stress and tolerate attacks by insects and diseases. Plus, they often require less maintenance.
- Check the wind. High winds can be extremely damaging to trees, breaking off limbs or even blowing trees down. On school grounds, this can be a safety issue

as well as an aesthetic one. It's good to know from which direction prevailing winds come. Trees used for windbreaks should be compact, sturdy and well-anchored by their roots. In addition, many city streets have long avenues lined with tall buildings, which create a wind-tunnel effect. Trees and shrubs planted along such avenues need to be compact and able to withstand strong winds.

- Know your hardiness zone. The US Department of Agriculture (USDA) has created hardiness zone maps that provide guidance for matching specific plants with specific geographic regions. The warmer the climate, the higher the hardiness zone number. In Maryland, the coastal plain and piedmont plateau are in Zone 7 and the mountains are in Zone 6. Use only plants suitable for your zone. When purchasing plants, look for the hardiness zone on the label or ask the supplier for information on hardiness zones for specific plants or cultivars. Keep in mind that you may be in a lower (cooler) hardiness zone if school property is located at a higher elevation, in a high-wind area, or on north-facing slopes. Most plant labels and many plant lists include the plant's hardiness zone.
- After you assess the environmental conditions and are clear on school goals for landscaping, consider aesthetics. Look at pictures and living examples of different tree and shrub species. Visit local nurseries to view samples and ask questions. Before you pick a tree or shrub, know how big it will get, what shape it will take, whether or not it will produce showy flowers or messy fruit, and what color leaves and stems will be during the growing season and winter.

Selecting healthy stock

To grow healthy trees and shrubs, it helps to start with healthy stock. Use the guidelines below to help choose strong trees and shrubs. If you don't get the chance to inspect plants at the nursery, be sure to inspect them immediately when they arrive on school grounds.

Check stock above-ground

Check that the ratio of height to caliper seems appropriate. **Caliper** is the diameter of the tree. Trees less than 4 inches in diameter are measured 6 inches above the ground. Trees 4 inches and larger are measured 12 inches above the ground. (Forest trees are measured at "diameter at breast height" (DBH), which is not an appropriate measure for nursery stock.) The ratio of height to caliper will vary among species, but in general, you do not want trees that are extremely tall for their caliper. Such trees may not survive transplanting or may be susceptible to blow down. Keep in mind that the larger the caliper, the longer the tree will take to become established in its new site. A general rule of thumb is one year for establishment and for each inch of caliper. Therefore, a one-inch caliper tree will take one year; whereas, a four-inch caliper tree will take four years to become established.

Inspect the form of the tree. The trunk, or leaders in multiple-trunk species, should be well-developed, strong and straight. Branches should be well-spaced and uniformly spaced around the trunk. Vertical spacing between branches of 10–18 inches is appropriate for most species. The crotches between branches and trunk should be wide-angled and U-shaped rather than narrow and V-shaped. Street trees planted along roads and sidewalks should be single-trunk trees, with bottom limbs removed so they don't interfere with pedestrian and vehicle traffic.

The bark should be bright and healthy. The tree should be free of insect or disease damage and mechanical injury. Foliage should be evenly distributed on the upper two-thirds of the tree. Denser

foliage is not always better. If the canopy is too dense, trees may look better at first, but will eventually develop problem-causing crossing and parallel branches, as well as inadequate lighting for leaves located inside the canopy. Both flower and leaf buds should look healthy.

Check stock below-ground

Bare-root stock usually comes as tiny trees with their roots packed in moisture-holding peat or moss. Look for abundant root growth, including numerous, small, light-colored roots. Roots should be moist when they arrive. Any injured roots should be removed. Larger trees may come **balled-and-burlapped.** The tree's roots are encased in a ball of soil with this type of nursery stock. The soil is usually wrapped in a fabric burlap, cloth, or wire. Specifically state that you will not accept trees wrapped with plastic burlap, since accidentally planting with this covering intact will result in tree failure. The soil ball should not be broken or dried out. When inspecting balled-and-burlapped stock, open the burlap up at the top and make sure the area where the roots begin to flare is at or near the surface of the soil ball. Trees grown as **container stock** are usually easy to handle and reasonably priced. Make sure the trees are not root-bound in the container and that roots are light-colored. Roots should not be encircling the perimeter of the container.

Selecting herbaceous plants

Selecting the right herbaceous plants requires some of the same steps used to select trees and shrubs. You need to match the plant with the site. Herbaceous plants can be as picky about their environmental conditions as trees and shrubs. Just like woody plants, healthy herbaceous plants may be able to fend off pests better than unhealthy plants. Be sure to consider the purpose of the plant. Do you need showy flowers at an entrance, nectar-bearing flowers for a butterfly garden, or low-maintenance ground covers? Perennial plants will come up every year if they are established properly and bloom for specific time periods within the season (for example, many bulbs will bloom during spring, different types of coreopsis and bee balm will bloom in summer, while most asters will bloom in fall). Annuals tend to be high-maintenance, requiring yearly replanting and regular watering throughout the growing season. The advantage of the annuals is that they flower most of the season. See Appendix H, "Introduction to Herbaceous Perennials" for more information and a list of plants by bloom time.

Here are a few tips for choosing the right herbaceous plants.

- Avoid invasive exotic plants! Consult your local Cooperative Extension specialist and the nursery where you are buying plants. They can guide you concerning what plants might be particularly troublesome in your area. (Also see the list below.)
- Check for persistent pest problems in existing landscaping. Avoid key problem plants or placing vulnerable plants in key problem locations.
- Get help with design. The Maryland Cooperative Extension Master Gardener program and US Fish and Wildlife Service Bayscapes program can provide technical assistance and, possibly, published materials for you, teachers and students. They have experience choosing plants for continual flowering throughout the growing season, combining colors and plant heights, and water conservation.
- Explore native and beneficial plants. Many of Maryland's native grasses, ground covers and flowers are now commercially available. When sited properly, perennial natives will require less watering and may be more resistant to pests. Non-

Table 2. Invasive Perennial Plants in Maryland

Common name	Scientific name	Type of plant	Notes
Bamboo	*Phylostachys aubea*	Small, leafy tree-like a plant	Grows in many habitats; spreads by rhizomes
Japanese honeysuckle	*Lonicera japonica*	Climbing vine	Grows in many habitats
Multiflora rose	*Rosa multiflora*	Vining shrub	Grows in upland habitats; spreads by route tips and seeds
Purple loosestrife	*Lythrum salicaria*	Flower	Grows in wetlands; spreads by seeds
Tree of Heaven	*Alanthus altissima*	Tree	Grows in upland habitats; spreads by cloning and seeds
Wisteria	*Wisteria sinensis*	Climbing vine	Grows in upland habitats; capable of climbing over trees
Mile-a-minute vine	*Polygomum perfoliatum*	Climbing vine	Grows in many edge habitats; spreads by seed
Phragmites	*Phragmites australis*	Wetland grass	Grows in wetland areas, retention ponds and drainage ditches

Adapted from *Using Beneficial Plants; A Homeowner's Guide,* Bayscapes factsheet by US Fish and Wildlife Service and Alliance for the Chesapeake Bay, Annapolis, Maryland.

native beneficial plants also will require less maintenance, while providing hardy, pest-resistant color, beauty and nectar for butterflies, hummingbirds, and natural enemies.

- In addition to using diversity to prevent catastrophic loss of a single species, many horticulturalists believe strategies like companion and repellent planting help protect plants from pests. **Companion planting** involves planting a diversity of plants that grow well together. The plants may give off substances that benefit other plants or fend off pests. For instance, flowers in the mustard family produce an oil that helps raise soil pH, benefiting surrounding plants that may not do well in acidic soil. **Repellent planting** makes use of plant chemicals that some believe keep insects and other pests away from surrounding plants. As an example, the herbs pennyroyal and spearmint may repel ants and aphids, and marigolds may repel nematodes. Greater detail about companion and repellent planting can be found in organic gardening references.
- The best displays select a limited number of plants for defined space. Consider texture, color (bloom time), vegetative spread, flower form and height.

Planting and Maintenance

Installation

Installing your plants begins with the map. Trees, shrubs and perennial plants are going to be around for a long time. You want to place them where they will be aesthetically pleasing, practical, and have room to grow to their full potential. On your map of the school grounds, you can sketch where trees and landscaped beds will go. Individual beds will require at least a little design work ahead of time. If you need it, ask for help from the Maryland Cooperative Extension Master Gardeners or the US Fish and Wildlife Service Bayscapes program.

When designing individual landscaped beds, consider the following:

- What are your goals? Do you have shady or sunny beds? Are you working on a showy entrance, creating educational gardens, or constructing demonstration areas for agriculture, natural habitat, or wildlife?
- What types of plants do you want in each individual area—woody trees and shrubs, perennial herbaceous plants, low-maintenance ground covers, or flashy annuals?
- Is safety an issue? How close will landscaped areas, trees and shrubs be to student activities? Do you need to worry about breaking branches or children picking poisonous plants? Are lines of sight near traffic areas in danger of being obstructed?
- Tend to problem spots. Be wary of replacing dying plants that may be suffering from a persistent pest problem or improper placement due to environmental conditions. Explore the use of different plants or placing plants in different areas.
- Is foot traffic an issue? Will students or staff be walking through, by or around gardens and plants? Do you need to construct footpaths?
- Ease of maintenance. How much time and help do you have to mow, prune, and water after plants are installed? By creating mulched beds with numerous plants instead of individual plants scattered around a property, you can reduce mowing and watering time substantially. Choosing perennials and beneficial plants also will require less maintenance in the long run.
- How much time and money do you want to spend watering? Water zoning is a strategy where you lay out your landscape, lawns and garden areas in zones according to their water needs. High water-use plants should be grouped close to buildings and water access. Medium water-use plants can be a bit further out, and you can safely place low water-use plants far from water access. (See the Maintenance chapter section on Watering for more information. Also, see Appendicies D and E, "Xeriscaping and Conserving Water in the Landscape" and "Watering Tips for Drought Conditions.")

- What about the wind? Know from which direction the wind comes. Incorporate windbreaks into your overall design, if needed, and avoid placing wind-intolerant or high water-use plants directly in a windy path.
- Cost. The amount of money available for landscaping school property is often relatively small. Be efficient when designing beds and choosing plants. Don't always go with the cheapest plants, because more sustainable plants that require less water and fertilization, experience fewer pest problems, and survive better will be less expensive in the long run.

Installing woody plants

Installation begins with soil preparation. After the soil has been tested, you may want to add amendments to improve fertility or soil structure. At the very least, adding organic matter, like peat, compost or dead leaves, will greatly enhance soil structure and encourage healthy plant growth. (See the section on Soil: Understanding the Basics in the Site Evaluation and Preparation chapter.)

When to plant. Trees and shrubs should be planted when the soil is "workable." That means the soil is not frozen or too wet. Transplanting time may be species-specific or based on the type of container in which are trees and shrubs are packaged. As a general rule, it's best to plant in early spring, when there is no longer danger of frost and soil temperatures are above 40_F, or late summer to fall, before soil temperatures drop. Tree roots will grow better in warmer soil, so when planting in fall, plants need to be placed in the ground early enough to allow some root growth before winter.

The hole. The size of the hole depends on the size of the root ball or root mass. The diameter of the hole should be two times the size of the root ball/root mass for small to medium-sized trees and shrubs, and three times the root ball/root mass for larger trees. The sides of the hole should be sloped, rather than vertical. The planting depth is determined by where the roots begin to flare from the trunk. The tree should be set in the hole so the trunk flare (beginning of the root mass) is just slightly above-grade. This will allow roots to procure oxygen after the hole is filled.

If your native soil has good characteristics of organic matter content, texture, nutrients and pH, then save the soil you remove from the hole. In the past, some experts recommended filling the hole after the plant is placed with a mixture of soil amendments such as topsoil, peat, compost and sand. Current research shows there is no benefit to adding such soil amendments and they may even reduce drainage or cause nitrogen deficiency. Instead, fill the whole with the original soil you removed. Another recent change to plant installation is the elimination of the practice of creating a depression around the base of the tree to capture water. This was done to help irrigate the newly planted tree, but evidence indicates that the root mass will grow beyond the depression quickly and benefits are lost after a week or two. Instead of making a depression, follow the instructions for mulching below.

Transplanting based on container. You may need to time your transplanting activities and strategies based on the "container" in which your trees and shrubs are packaged. **Bare-rooted plants** should be planted while dormant. In Maryland, that planting time may range from late autumn to early spring, depending on region and local climate. In the more mountainous regions, bare-rooted planting should be done during early spring. Roots should be kept moist during installation, so dig the hole ahead of time. If there is one exceptionally long root, prune it rather than bend it to fit in the hole. Place water in the hole when about one-third of the soil has been backfilled into the hole.

Balled-and-burlapped plants can be planted throughout the growing season. Time transplanting so the tree or shrub has a period of rapid root growth before winter. You can leave fabric burlap on the ball when transplanting. However, remove any twine, synthetic burlap or wire baskets that may surround the ball. Do this just before placing the balled plants in the hole. After the ball has been placed in the hole and before you begin filling in soil, pull the burlap back from the top of the ball. This will allow better water penetration. Remember, watering is critical, especially if planting is done during the summer months.

Container plants may be planted throughout the growing season, although summer through autumn is the best time. Containerized evergreens should be planted before mid-autumn to prevent winter injury. Of course, you should remove the container before planting. Encircling roots should be teased apart or pruned before placing the plant in the ground.

Tree spades are large blades attached to a vehicle that remove and transplant larger trees. They are often used to move trees within a property or from a nearby property. It's best to move and transplant spaded trees in spring. Excavate the hole with a backhoe or trencher, rather than the tree spade, because the sides of the hole dug with a spade may be less permeable to root penetration. To prevent air gaps and aid root penetration, the sides of the hole should be roughed up and a slurry of water and soil poured into the gap between the transplant and the hole sides as the spades are removed.

Pruning during installation. Before placing bare-rooted trees in the hole you will want to prune any torn or decaying roots. Dead and broken branches should also be removed from trees and shrubs before installation. In addition, you may want to prune back some of the branching. Inner branches may be removed to create better spacing of branches along the trunk. This additional pruning reduces the amount of leaves that are supported by the root mass, which may help plants survive the stressful transplantation stage.

Fertilizing and soil amendments. It's best to fertilize while planting. You can add decomposed organic matter to the backfill soil, but be sure it is well-decomposed. The addition of microrrhizal preparations in soil placed next to the root ball may help spur root growth. Granular fertilizers with at least 50% organic nitrogen or soluble tree fertilizers with nearly 100% organic nitrogen are slow-release fertilizers that can be used during planting. Slow-

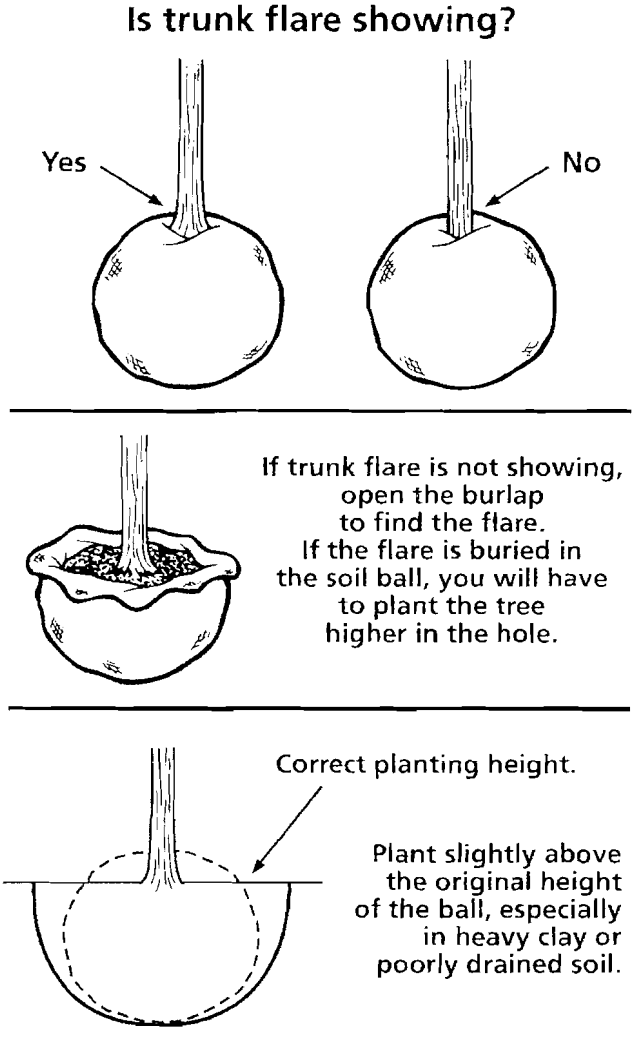

Figure 1: Location of the trunk flare on a balled-and-burlapped plant. *The trunk flare should be clearly visible at the top of the ball.*

Reprinted with permission from the International Society of Arboriculture and Caaperative Extension Service, University of Illiniois at Urbana-Champaigne, 1997. Plant Health Care for Woody Ornaments. *Printec Press, Champaigne, Illinois.*

release nitrogen is especially important when transplanting during fall, because increased vegetative growth late in fall can cause frost cracking in trunks and branches if there is a snowfall before leaf drop. Recent research shows that soil amendments containing biostimulants, such as mychorhizae and sugars, may enhance root growth and establishment at the time of transplanting. See Appendix A, "Fertilizer Recommendations for Landscape Trees and Shrubs," for a diagram of where to fertilize around the tree, as well as a rates of fertilization.

Mulching. Mulching helps conserve water and may increase water infiltration, as well as moderate soil temperatures. Mulches also help reduce weeds around your newly planted trees and shrubs. The key is to not overuse mulch. A thin layer, 2–3 inches deep, will provide moisture and weed-reduction benefits, without providing too much habitat for burrowing rodents. Certain shrubs, such as boxwood, may need even less mulch (as little as 1 inch.). Shredded hardwood mulches generally are considered superior. Avoid using recently chipped wood and green mulches that support high levels of soil microorganisms that may reduce availability of soil nutrients. Never mulch up to the base of the tree, because the upper root flare must be exposed to air. Experts recommend leaving a 6 to12-inch mulch-free zone around the trunk.

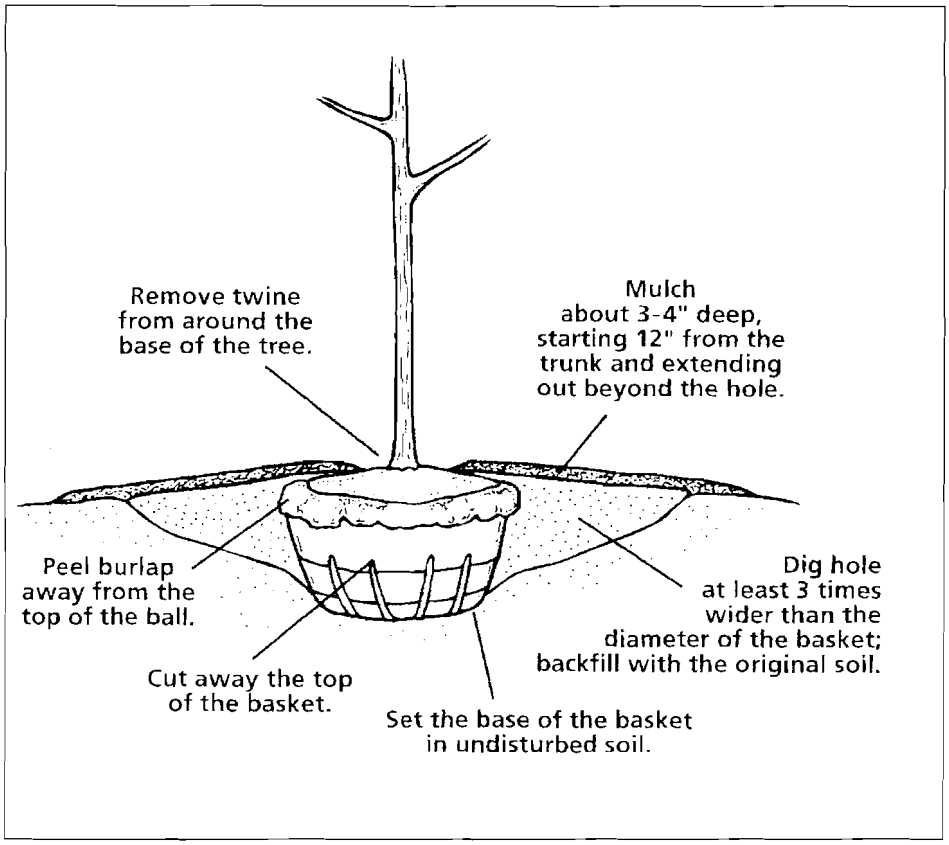

Figure 2. Planting a balled-and-burlapped tree. *The diagram also shows the area to be mulched.*

Reprinted with permission from the International Society of Arboriculture and Cooperative Extension Service, University of Illiniois at Urbana-Champaigne. 1997. Plant Health Care for Woody Ornaments. *Printec Press, Champaigne, Illinois.*

Staking and guying. Although newly planted trees will require staking initially, this should only be temporary. Staking should be removed within the first year, unless you need to support larger trees with guying. Improper staking may slow tree growth or girdle the stem. In general, trees with up to 3-inch caliper will require two stakes, unless they are located in sandy soils or windy sites, where they may require three stakes. Smaller trees should need only two stakes. Stakes should be attached to the tree between one-third and two-thirds the height of the trunk. Stakes placed higher than two-thirds the height may break off the upper stem. Wooden stakes are preferred over metal stakes simply because broken metal stakes may interfere with mowing or future landscaping around trees. Larger trees, of 3-inch caliper or greater, need at least three guy wires. Sixteen to 14-

gauge galvanized steel wire is usually adequate, but a 12-gauge wire may be needed for taller trees or those located on windy sites. Be sure to protect the trunk where wires are attached. Soft rubber hose, strips of cloth, burlap-wrapped blocks of wood and polypropylene chain are all suitable materials for protecting the trunk. Regular inspection is needed, however, to ensure no damage to the tree. Tree wrapping is not recommended for newly transplanted trees. An exception might be during the dormant winter season when the trunk may need protection from gnawing rodents. Paper or burlap is often used. It should be regularly checked for signs of girdling and removed after winter.

Installing herbaceous plants

Soil prep for herbaceous plants is similar to that for trees and shrubs. Test your soil and incorporate fertilizer and amendments, if needed. Check for drainage by digging a hole about 10 inches deep and filling it with water. Fill the hole again the next day and see how long water remains. If your soil has good drainage, it should drain within 8 hours. You may need to add organic matter or amendments like sand to improve drainage. Prepare the bed by turning soil with a shovel or rototiller and then rake to break up any large clumps. Dig to a depth of 12–18 inches and incorporate about 4–6 inches of organic matter.

If the plants you receive are greenhouse-grown, you'll want to harden them by gradually exposing them to time outside. Plant herbaceous plants on a cloudy day or wait till later in the day, when the sun isn't so strong. The hole should be big enough to comfortably hold the root ball. Place herbaceous plants at a depth where roots are covered, but the upper roots are close to the surface. Be sure to leave enough space between plants for growth throughout the summer. Labels on plants will often list projected height and spread.

Water plants thoroughly. You may want to use a starter solution of water-soluble, high-phosphate fertilizer to stimulate root growth. Mulch with a layer of 2–4 inches of decomposed organic mulch, shredded bark chips, or a very thin layer of grass clippings. Leave a little mulch-free space around the base of plants. The safest way to remove weeds from landscaped beds is hand-pulling. Although mulch will keep the weeds down, some weeding will be necessary throughout the growing season. If you are growing tall flowers, like larkspur or cosmos, you may need to stake them for extra support. Begin staking when plants are about one-third their full size. Place stakes close to the plant and secure the stems of plants with paper-covered twist-ties, twine or other materials that won't damage the stem. Fragile plants, like cosmos, may be better supported with the framework of stakes and strings or a plastic mesh fence.

Maintenance

The use of low-maintenance plants means less work for you. But trees, shrubs and landscaped beds will require some work to keep them healthy and beautiful, while minimizing damage from pests. Soil testing may show that you need to fertilize and proper watering is crucial for plant health and survival. Although you want to conserve water as much as possible, strategically watering plants will help them become established and maintain them through dry seasons. If you choose your plants wisely and water in an efficient manner, you can keep water use to a minimum and still maintain beautiful landscaped areas. Pruning is an often-neglected maintenance practice that will help you maintain healthy trees and shrubs. The following sections provide tips on fertilization, watering and pruning that, if done correctly and regularly, will result in healthy, pest-resistant, and attractive landscaping.

Fertilizer basics

It's important to fertilize with care. Over-fertilization contributes to water pollution in the Chesapeake Bay region and throughout the United States. When water runs off the land it carries soil, nutrients and other pollutants with it. Nutrients, like nitrogen and phosphorus, fuel algae growth in the Chesapeake Bay and rivers, streams, and lakes. Excessive algae growth, along with sediments, clouds the water and prevents the growth of important underwater Bay grasses. In addition, when algae die they decay. Decaying plants use up oxygen that fish need to survive. Because warm water holds less oxygen than cold water, summer oxygen levels in the waterways, bays and lakes may drop so low that fish can't live. Furthermore, numerous studies show that many insect and mite pests perform better on fertilized plants.

Nutrient recommendations

Nutrient management recommendations recently developed by the State of Maryland will help guide school districts and other public facilities with fertilizing lawns, trees and shrubs. According to the Maryland Water Quality Improvement Act (WQIA) of 1998, grounds managers applying nutrients (fertilizer) to cumulatively 10 acres or more of land not used for agriculture or to any amount of state-owned land must follow University of Maryland Cooperative Extension recommendations, conduct soil tests, and keep records of fertilizer applications for three years.

Here are University of Maryland Cooperative Extension recommendations for trees and shrubs:

- At a minimum, soil tests should be conducted every three years. If you're growing horticultural plants, you should run foliar analysis also. Soil should be tested for obvious deficiencies, pH, phosphorus, potassium and micronutrients. At this time, it is not possible to easily analyze soil for nitrogen.
- Complete fertilizer for trees and shrubs usually comes with N:P:K ratios of either 3:1:1, 3:1:2, or 3:1:3. Secondary and microelements may be included also and will be listed under "guaranteed analysis."
- Slow-release nitrogen (**water insoluble nitrogen; WIN**) should be used instead of quick-release or water-soluble types. Slow-release nitrogen results in more uniform growth, is longer lasting, and has less impact on the environment. The technical data sheet or label on the fertilizer bag should indicate that a minimum of 50% of the nitrogen source is slow-release or WIN.
- The **salt index** of the fertilizer, which should be listed on the label, should be less than 50. Fertilizers with higher salt indexes may damage or even kill sensitive plants. The salt index is used to compare solubility of chemical compounds. Indexes are assigned relative to sodium nitrate, $NaNO_3$, which has a salt index of 100. Most nitrogen and potash compounds have high indices; whereas, phosphate compounds have low indices.
- Slow-release fertilizers should be applied at a rate of 1–4 lbs. of actual nitrogen per 1000 sq. ft. per application. No more than a total of 4 lbs. of actual nitrogen per 1000 sq. ft. should be applied annually.
- Fertilizer should be applied where shrub and tree roots are present. This is often within the drip line below the canopy of the tree. If one target area below a tree or shrub overlaps another, that area should be counted only once when calculat-

ing the total area to be fertilized.

- Small trees should be fertilized annually (3–4 lbs/yr). Split applications in spring and early summer will cause less nutrient runoff.
- Established trees should be fertilized every 3–4 years (3–4 lbs/yr), although low-level applications (1–2 lbs/yr) yearly may be acceptable.
- Slow-release fertilizer should be applied under shrubs at rates of 2–3 lbs. of actual nitrogen per 1000 sq. ft/yr.
- It is best to fertilize shade trees with slow-release fertilizer during fall through late winter, before growth appears in spring.
- Annual flowers may not require fertilization if beds are heavily amended with organic matter. If new gardens are low in organic matter, apply 2–4 lbs. of 5:10:10 (N:P:K) fertilizer per 100 sq. ft. Incorporate fertilizer into the top 6 inches of soil in early spring before planting. Older gardens may need 2 lbs. of 10:6:4 fertilizer per 100 sq. ft. for optimum flowering.
- Herbaceous perennials also may not require fertilization if beds are heavily amended with organic matter. New gardens low in organic matter may need 2–4 lbs. of 5:10:10 (N:P:K) fertilizer per 100 sq. ft. Older gardens may need 2 lbs. of 10:6:4 fertilizer per 100 sq. ft. for optimum flowering. Lightly broadcast fertilizer around plants in early spring.

Where to apply. Fertilizer can be applied on the surface, into the soil subsurface, or on leaves (foliar application). Surface application should be broadcast beginning at the trunk of the tree and extending out to the drip line. Surface application should not be made when or where runoff is likely to occur. If you choose subsurface application of either dry or liquid fertilizer, holes for dry fertilizer or injection sites for liquid fertilizer should be evenly distributed within the fertilizer area. Foliar application should only be used when soil application of fertilizer is not practical or effective. Be aware that excess fertilizer can burn the leaves.

Soil amendments. You may want to improve soil structure, fertilize with natural substances, or alter pH using soil conditioners like manure, iron sulfate, or compost. (For details see Appendix A, "Fertilizer Recommendations For Landscape Trees and Shrubs," and Appendix C, "Soil Amendments and Fertilizers.")

Watering basics

If you designed school ground landscaping with water conservation in mind and carefully chose drought-tolerant plants, your watering needs should be minimal. However, all newly planted trees and, shrubs, and perennial and annual plants need water, and drought-tolerant plants are no exception.

Here are a few tips for watering newly planted trees, shrubs and herbaceous plants. (For more details see Appendix D, "Xeriscaping and Conserving Water in the Landscape," and Appendix E, "Watering Tips for Drought Conditions.")

- Water plants prior to signs of wilting or check the soil. Soil that cannot be formed into a ball needs watering.
- Water in the morning. Watering during the heat of the day increases the amount of water lost to evaporation. Watering too late in the day or evening can promote fungal diseases.

- Water infrequently, but slowly and deeply. Frequent and light watering encourages shallow root growth and often only benefits weeds. Plan to water at least once each week during hot, dry weather. You will need to moisten the top 4–6 inches of soil.
- Soaker hoses or drip irrigation are most efficient for planted beds. Overhead sprinklers work well on lawns, trees and shrubs. You may need to individually water isolated trees or shrubs using a hose or container.
- Keep the water on-site. Proper design can prevent rainfall and irrigation water from running into streets and drainage ditches.
- In general, apply 1 gallon of water per sq. ft. of root zone once a week. The root zones of trees and shrubs extend out from the trunk a distance at least equal to the height of the plant.
- Sandy soil drains more quickly than other soils and will need to be re-watered sooner than soils with high clay content.
- Water will penetrate grass and mulch-covered soils quicker than bare soil. Consider using mulch cover 3–4 inches deep to reduce evaporation.

Watering during drought

It is not uncommon for Maryland to experience drought conditions during summer months. School ground landscapes and lawns may suffer temporary, or even possibly permanent damage if drought conditions are prolonged. Drought conditions that occur during June and July are more damaging than those in August and September, because of increased day length. Dry breezes can aggravate drought stress. Signs of drought stress include upward curling of leaves, yellowing and browning of leaves along the margins, and flower, fruit and leaf drop.

Here are tips to help plant survival during drought conditions.

- Prioritize your plants. Give priority to trees and shrubs, especially those that are newly planted or in areas exposed to wind and sun. Annual flowers and herbs, ornamental grasses and turf can be given low priority. They are relatively inexpensive to buy and easily replaced if they die.
- Mulch around trees, shrubs and flower beds to keep water-consuming weeds down, conserve soil moisture, and moderate soil temperatures.
- Control weeds. They compete with your cultivated plants for water and nutrients.
- Mist plant leaves with water during the day to reduce spider mite populations and help prevent flower and fruit drop.
- When possible, add organic matter to the soil, which will improve water-holding capacity during dry weather and promote good drainage during wet times.

Mulch

Mulching can provide dramatic water savings. Wood chips that have been aged, shredded hardwood or softwood bark, grass clippings and tree leaves are relatively inexpensive and highly effective mulch choices. Remember to keep grass at least 2 ft. away from the bases of trees and apply mulch instead. But, don't mulch right up to the tree base. Leave 6 inches of breathing room between mulch and tree base. Mulch should be applied 2–4 inches deep. When checking to determine water needs, pull back the mulch and check soil moisture below the mulch layer.

Pruning

Pruning is an essential part of maintaining beautiful and healthy landscapes. In nature, trees are trimmed by wind, ice, snow, drought, disease and insects. Leaving the pruning to nature, however, is not the best way to maintain landscapes on school grounds. Pruning may be necessary due to physical damage from ice or wind, insects and disease, the need for safety, and the desire for aesthetics. On school grounds, safety is especially important. You want to remove branches that might present a hazard to people or structures. For example, low-hanging branches over streets or walkways, and those near power lines, should be removed. Trees will be healthier if dead and diseased wood is removed. It is sometimes even possible to eliminate insect, fungal and bacteria infections by removing infected limbs. Branches that cross over and rub against each other can cause wounds that allow access for insects and disease. Potential problems can be eliminated by removing branches that touch each other.

Maintaining beautiful and healthy trees requires removal of undesirable plant parts, like **suckers** that grow out from the bottom or **watersprouts** that grow from the point where roots are grafted to the trunk. A common pruning mistake is trimming to produce a full canopy. This is especially a problem with urban street trees like Bradford pear or maple. A dense outer canopy fosters high humidity and low light conditions within the canopy. These conditions encourage fungal diseases and lead to less photosynthesis on inner leaves, resulting in leaf drop. Shade trees should be trimmed to produce less dense canopy and strong branching.

Here are a few tips:

- Encourage young trees to develop a strong framework from the start by pruning so primary branches are evenly spaced. Careful removal of interior branches will reduce crown density, allowing light to penetrate the canopy.
- You can improve the strength of the tree with selective pruning. When the angle between branches is V-shaped at the crotch, bark is pushed inside the crotch. This weakens the connection. Prune trees, leaving large branch angles that are U-shaped.
- New transplants that are dug and planted while dormant will probably require less pruning than trees transplanted after leaf out. Wait for leaf out to determine what might need pruning.
- Tree species with showy flowers or fruit require pruning that may delay flowering, but will also increase flower production. Call the Home & Garden Information Center or contact your local Maryland Cooperative Extension specialist for specific information if your school grounds have fruit trees.
- Evergreen trees should be pruned after new growth has stopped, but before new wood has lignified. This is usually late May–June in the Northeast.
- Deciduous trees should be pruned during the dormant season (winter). It's easier to see damage and disease without the leaves. Plus, during dormancy there should be less oozing sap. Heavy sap production can interfere with wound healing, as well as attract insects and other pests.
- Diseases such as fire blight, Dutch elm disease, and oak wilt can be initiated or spread by pruning. Cankers should be removed during dry weather to minimize the risk of spreading bacterium with pruning tools. Always sterilize pruning tools by dipping them in a 10% chlorine bleach solution between cuts. Pruning

deciduous trees during the dormant season also eliminates the possibility of attracting disease-carrying insects.

Pruning through the years

Prune only broken and damaged branches from new transplants. Don't trim the crown yet. During the first three years, continue to remove dead, broken and crossing branches. You may want to guide desired growth of the tree by removing some interior branches, but leave a few branches below the lowest permanent branch to serve as "temporary branches." They will help protect the tree from sun, storms and vandals during its early years. You can start removing those temporary branches when the tree is four to six years old. Prune mature trees for form by removing limbs that turn inward or those that extend beyond the desired crown. Continue to remove branches that may pose a safety risk or interfere with structural strength as suggested above.

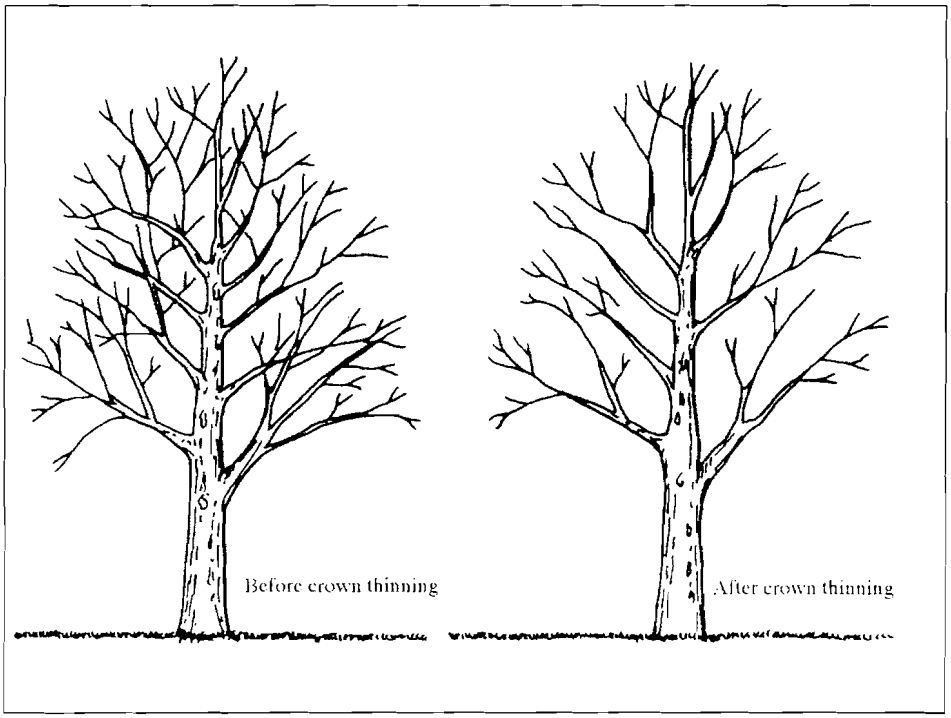

Figure 3. Crown Thinning. *When a mature tree becomes densely branched, it can cast too much shade and be succeptible to wind damage. Thinning the branches allows more light to filter to the ground and improves air flow through the foliage.*

Reprinted with permission from the International Society of Arboriculture and Cooperative Extension Service, University of Illiniois at Urbana-Champaigne. 1997. Plant Health Care for Woody Ornaments. *Printec Press, Champaigne, Illinois.*

Methods of pruning

Basal pruning is the removal of stems at ground level. Some shrubs, such as lilacs, often require basal pruning, as well as root suckers of trees. **Heading back** involves cutting a growing or one-year-old shoot back to the stub. Heading reduces the size of the crown initially, but it can release lateral buds, resulting in more lateral branching and a denser canopy in the future. **Topping** is an extreme version of heading, when stems, branches and sometimes the trunk of the tree are cut off without considering placement of cuts or the health of the plant. Topping is NOT recommended. **Thinning** is the removal of branches by cutting back to a crotch. Thinning can help reduce tree height or canopy density. Thinning is preferred to heading back.

Mature trees on the school grounds may require **maintenance pruning.** Older trees and trees that were not tended in earlier years will require periodic pruning. Maintenance pruning may involve removal of dead, diseased or weak branches from the crown; thinning the crown; removing lower branches to provide clearance under the crown; reducing the crown height or spread; or

removing branches to improve the structure or appearance of the tree. **Utility pruning** is really a maintenance pruning to provide space for utilities and structures.

The proper cut

Different types of pruning, of course, produce different results, so it's good to know how you want the tree to look before you trim. Never remove more than 1/4 of the foliage in a season. Branches should be cut outside the branch bark ridge and near the branch collar. This takes advantage of the tree's natural ability to seal off disease during the healing process. Wounds from pruning should be as small as possible. Don't leave a stub, which will begin to decay and attract insects and disease. Cuts flush to the trunk leave gaping wounds that will take a long time to heal and may allow entrance of disease or insects. Prune during a time of year when insects are not present. This will cut down substantially on the risk of insect-transmitted diseases, as well as insect damage.

Large limbs should be pruned using a three-cut procedure. The first cut should be on the underside of the limb approximately 1/4–1/3 through the branch. The second cut is made a short distance above the first cut, all the way through until the limb is removed. The third cut is made below the first cut, outside the branch bark ridge, thus removing the stub. All cuts should be clean, with no ragged are torn edges. Pruning paints on the wound are not recommended. Instead, trim during the dormant season when insects aren't out.

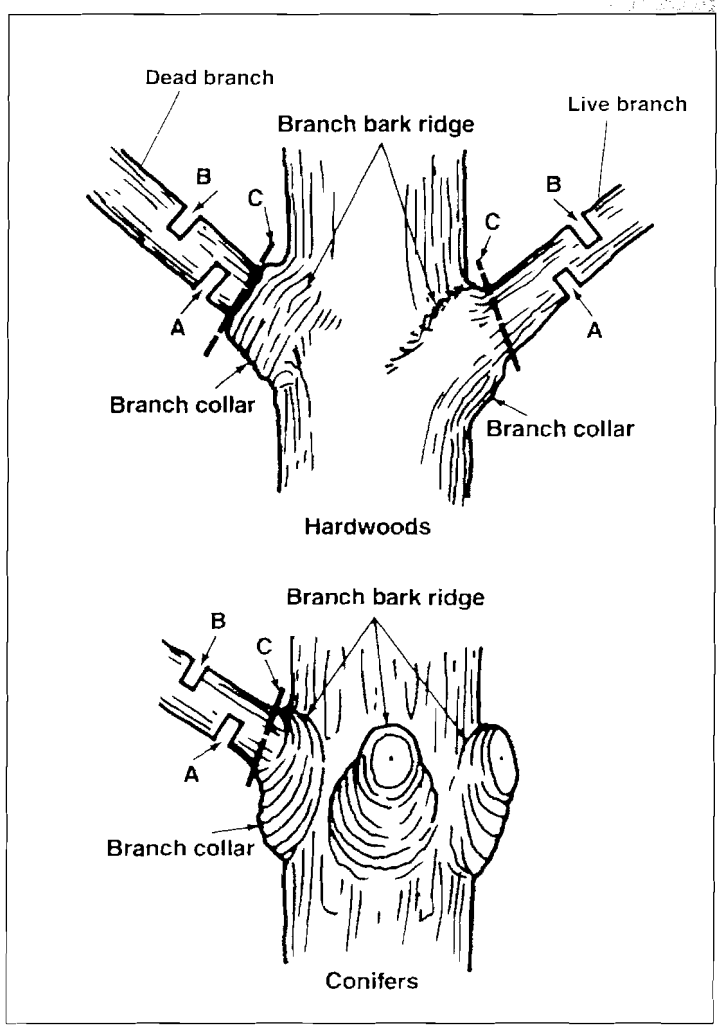

Figure 4. Pruning Principles. *The first cut (A) undercuts the limb. The second cut (B) removes the limb. The final cut (C) should be just outside the branch collar to remove the resulting stub.*

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The Extras

Landscape Management Practices to Prevent Structural Pest Problems on School Properties

Many structural pests of school properties can be prevented through sanitation and habitat modification. **Habitat modification** is the alteration of landscape design and management practices or structural changes that reduce or prevent pest problems. A habitat is the area where a pest lives. Habitats provide the pest with all its necessary resources such as food, moisture, harborage or shelter, and breeding sites. Habitats can maintain a specific number of pests depending on the abundance of resources available (carrying capacity). If there are abundant amounts of food, shelter and moisture, then pest populations can build up and result in problems. However, if any of these resources are limited, then the pest population will remain at a fixed level or they may not be able to exist. Even after using pest management measures and reducing pest populations, individuals are replaced rapidly through reproduction or movement back into the habitat unless you also alter the habitat to limit its resources. A combination of control tactics and an understanding of the biological requirements of various pest species are needed to successfully manage pests.

In school landscapes we often provide all the resources (food, moisture, shelter, and breeding sites) needed to attract and maintain pest populations. This, combined with structures that are not "pest proof, " result in pest problems or outbreaks that often fall under the purview of the structural pest control industry. By modifying the school landscape, in conjunction with improving structural defaults of the school buildings, you can limit one or more of these resources and make the school properties less attractive and favorable for pests. This requires effective communication between structural pest managers and the grounds or landscape pest managers. Depending upon how your school IPM program is run, communication might occur through the IPM coordinator for your school district or the IPM contact person at your individual school.

Habitat factors and modifications to reduce or prevent pest problems on school properties are listed below.

Moisture is a critical resource for all animals. Wet soils and mulches near buildings attract termites, earwigs, ants, and other pests. Water collecting in tree cavities and other "collecting sites" provide breeding sites for mosquitoes and attract rodents.

Habitat modifications to reduce moisture:

- Grade property so water drains away from buildings.
- Provide drainage for and/or regularly pour out standing water after rainfall.
- Maintain drains and gutters so mulch in foundation beds and soil near buildings do not stay wet.
- Extend eaves or overhangs at least 18" to prevent soil from remaining moist along the building foundations.

- Prune shrubs that touch walls of buildings and trees that shade buildings which contribute to moisture retention. This will increase air circulation and sunlight around buildings.

Exterior lighting near entrances attract many flying and crawling insects. This brings the insects closer to buildings where they can gain access to the inside through doors and windows. Evening school functions or large gaps under the doors increase the possibility that pests will enter at night.

Habitat modifications of exterior lighting:

- Locate light fixtures away from doors and direct their illumination towards the building.
- Change the type of lighting used. Use sodium vapor lights or yellow "bug" lights. These emit a spectrum of light less attractive to insects than mercury vapor or standard incandescent lights.

Several aspects of **landscape plantings** can influence pest problems. Dense plantings, especially those in close proximity to buildings can lead to problems. Shrubs, groundcovers, and bedding plants growing in dense monocultures can serve as rodent harborage and runways where they can live undetected and protected (problem plants may include ivy, yews, junipers, annual plants). Some plant species also attract insect pests. Installation of plants close to buildings can disturb termiticide treated soils making them ineffective (note – additions or construction to the building will do the same). Some trees produce blossoms, fruit, or support honeydew producing insects (ex. aphids) that can attract bees, wasps, ants, other insects and rodents. Some tree species attract "nuisance" insects or mass invaders that frequently enter buildings by the hundreds in the fall. For example, boxelder trees will support high populations of boxelder bugs that like to spend the winters inside buildings. Tree species should be carefully selected to avoid these problems, especially those to be planted near playground areas or near buildings. Tree branches touching buildings serve as "highways" for ants, spiders, and other potential pests. Older trees may harbor carpenter ants or mosquitoes in water collecting cavities.

Habitat modification of landscape plantings:

- Create a "protective zone" that surrounds buildings. Do not allow plants to become adjacent to the building foundation. Create a clean, dry border adjacent to the building foundation (18–24″ wide), line borders with landscape cloth and cover with pea gravel.
- Avoid dense monocultures and thin established plantings to reduce rodent activity.
- Select plant species that will not attract nuisance or "mass invader" pests or bees, wasps, and ants (refer to plant references or ask a nursery specialist). If rodents are a potential problem avoid planting trees and shrubs with edible fruits.
- Close mowing of lawns and weed control especially near buildings will reduce pest problems in buildings (ex. clover mites which are active in the spring and fall)
- Prune branches of trees and shrubs so they do not touch the buildings.
- Minimize moisture around the building foundation.

Mulches (leaf litter, bark mulches, gravel, landscape fabric and plastics) and **organic matter** (wood piles, compost piles, decaying vegetation) retain moisture and warmth, provide food for insects that feed on dead material, and provide harborage for "mass invaders." Mass invaders are insects and their relatives, such as millipedes, centipedes, pill bugs, crickets and earwigs that enter buildings after rain or with the onset of cold weather. Wood (or other cellulose materials) to soil contact, especially in moist areas, provide a perfect environment for subterranean termites populations to establish.

Habitat modification of mulches and organic matter:

- When mulching with hardwoods, use landscape cloth and do not add mulch more than 3–4″ deep. Remember to keep mulch at least 18–24″ away from the building foundation.
- Move harborage and breeding sites away from building (compost piles, leaf litter, wood piles).
- Minimize moisture around school building foundations.

In addition to these landscape habitat modifications, there are also many structural modifications to buildings and school properties that that can be implemented to reduce or prevent pest problems. These include caulking, screening, and weather stripping where needed to reduce pest access points. For more information contact the Maryland Department of Agriculture (410-841-5700) for IPM factsheet No. 3, *Structural Pest Control Using the IPM Approach.*

Preventing Deer and Rats

Rats

Rodents are also a major pest problem on many school properties. They can burrow, climb and swim. Rats tend to feed at night on a variety of foods, including meats and fruit. They may travel several hundred feet from their nests, preferring to move along the edges of buildings, pipes, roofs, or dense vegetation.

Here are a few tips for keeping rats away from school property, structures and playgrounds.

- Trim trees, vines, bushes, grass and weeds at least 12 –18″ from buildings and other structures.
- Thin shrubbery cover to reduce habitat.
- Avoid large plantings of a single groundcover. Dense groundcover provides cover for rats to move under.
- Break up dense plantings with pathways, stretches of lawn, or very low groundcovers. Avoid planting fruit-producing trees or promptly collect and remove fallen fruits.
- Playground equipment and other structures should be supported on piers or posts only. Slab, deck or platform-based structures can attract digging rats.
- Playground equipment should utilize synthetic, resilient play surfaces, such as preformed matting or rubberized surfaces. Sand, turf and mulch should be avoided, because they provide habitat for rat burrowing. In keeping with this recommendation, landscaped beds should not be planted near playground compounds.

- Playgrounds should be located as far away as possible from rat habitat or rat foraging areas, like loading docks and trash compactors.

Deer

School landscaping may be susceptible to damage from white-tailed deer, especially if the school is located in a rural or suburban area with patches of forest and agricultural fields nearby. A comprehensive IPM plan to control deer damage may include population management, vegetation management, fencing and repellents. Deer are creatures of habit, so monitoring of school grounds should tell you where and on what they prefer to feed. Damage from deer browsing is most severe when snow cover or extreme cold has reduced available food. New plant growth is also vulnerable during early spring. On many school properties, vegetation management may be all that is needed. Appendix I, *Resistance of Woody Ornamentals to Deer Damage,* provides lists of trees, shrubs, vines, annuals, perennials and bulbs that are rarely damaged, seldom damaged, occasionally damaged and frequently damaged by white-tailed deer.

Below are a few planting tips to keep the deer out of your landscaping.

- Leave as much open area as possible between field edges and landscaped areas.
- Plant trees and shrubs that are not preferred by deer (see Appendix I).
- Sometimes, planting a "nurse crop" of food deer prefer at the edge of school grounds may keep deer from moving further on school property. This can be expensive, however, and there is the risk of attracting even more deer to the area.
- If your area has high deer populations, be prepared to fence deer out of vegetable gardens or experimental agricultural plots.

School Gardens

School landscapes are a great place for educational gardens. Butterfly gardens, wetlands, nature trails, and horticultural gardens offer educational opportunities in a setting ripe with the student volunteers. Math, science, and even language lessons can be structured around gardens and natural areas. There are numerous resources available for teachers or groups interested in creating schoolyard habitat. The National Wildlife Federation offers a Schoolyard Habitats Program with tips on setting goals, involving the community, and incorporating habitat and across-curriculum learning. The American Community Gardening Association provides information for beginners and their From the Roots Up Program offers technical assistance and training. The National Park Service's Rivers, Trails and Conservation Assistance Program provides help for communities and schools working to revitalize natural areas. Project WILD is a national program designed to emphasize wildlife education. Contact the state Project WILD office for copy of Wild School Sites: A Guide to Preparing for Habitat Improvement Projects on School Grounds. Master Gardeners with Maryland Cooperative Extension as well as the US Fish and Wildlife Service's Chesapeake Bay Field Office and the Alliance for the Chesapeake Bay *Bayscapes* project can also help with information and technical assistance. The US Fish and Wildlife Service Chesapeake Bay Field Office also has a Schoolyard Habitat Program that provides information and technical assistance for schools interested in Bay-friendly landscaping and education.

Butterfly gardens

Butterfly gardens don't only benefit butterflies—hummingbirds, moths and other pollinators, like bees and flies also require nectar and pollen from blooming flowers. Carefully planned butterfly gardens can be educational, as well as attractive. The key to butterfly garden is diversity. You need flowers blooming throughout the growing season, even into mid-fall when late-migrating hummingbirds pass through Maryland. Adult butterflies and hummingbirds favor red flowers, but yellow, orange, pink or purple blossoms will also do. An essential and often forgotten element of butterfly gardens is food for caterpillars. Herbs like parsley and fennel, and native asters and milkweeds will attract butterflies and provide food for young caterpillars. This, of course, means tolerating caterpillars. Because butterfly gardens will attract bees and other stinging insects, gardens should not be placed near entrances or playgrounds, where children are regularly at risk of being stung.

Many agencies and organizations provide information on attracting wildlife, including butterflies, and natural landscaping. For more information contact the organizations listed below (see Additional Resources in the Reference Section).

- Maryland Department of Natural Resources. Wild Acres Program.
- Alliance for the Chesapeake Bay and the US Fish and Wildlife Service. *BayScapes* program.
- Maryland Cooperative Extension, Master Gardener Program, Howard County. Bay-Wise Landscape Management Demonstration Site Program.
- Chesapeake Wildlife Heritage. The Backyard Habitat Program.
- Smithsonian Institution. Butterfly Garden Website.
- American Horticultural Society. Fact sheets include Wildflower Meadow Gardening, Butterfly Gardening, and Gardening for Wildlife.

Glossary

A

Action Threshold (Action Level). The number of pests or level of pest damage that triggers a control action. For an explanation of action thresholds see Maryland Department of Agriculture, *Action Thresholds and School IPM Programs*. Pesticide Regulation Section, Annapolis, MD. 10 pp.

Active Ingredient. The chemical or chemicals in a pesticide responsible for killing or repelling a pest. Active ingredients are listed as part of the Ingredient Statement on all pesticide labels.

Aeration. The exchange of gases that occurs between the atmosphere and soil. Also, the process of amending soil to facilitate gas exchange.

Aerobic Conditions. The condition when water is not fully occupying the pore spaces and atmospheric gases can exchange with soil gases.

Anaerobic Conditions. No-oxygen conditions that occur when pore spaces are filled with water and no gas exchange occurs between soil and the atmosphere.

Anti-Microbial Pesticide. A pesticide used for control of microbial pests, including viruses, bacteria, algae, nematodes and protozoa, or for the purpose of disinfecting or sanitizing. Anti-microbials do not include fungicides used on plants.

B

Bait. A food or other substance used to attract a pest to a pesticide or trap.

Balled-and-burlapped Stock. Tree stock with roots encased in a ball of soil that is wrapped in a fabric burlap, cloth, or wire.

Bare-root Stock. Plant material with bare roots packed in moisture-holding peat or moss.

Basal Pruning. The removal of stems at ground level from shrubs.

Beneficial Insectary Plants. Plant species that attract beneficial insects, like the ladybugs or parasitic wasps.

Biological Control. Control of pests using predators, parasites, and disease-causing organisms. Biological controls may be naturally occurring or introduced.

Biostimulant. Commercially prepared formulation containing nutrients and/or biological products or organisms, usually added to soil at the time of transplanting to stimulate root growth and plant establishment.

Botanical Pesticide. A pesticide produced from plant-based chemicals. Examples include nicotine, pyrethrins, and strychnine.

Glossary

Brand Name. The name or designation of a specific pesticide product or device made by a manufacturer or formulator.

Broadcast. A pesticide application method of applying a pesticide over an entire area.

C

Caliper. The diameter of the tree, usually measured at 6 or 12 inches above the ground.

Certified Applicator. An individual that demonstrates a higher level of competence of pesticide use by meeting criteria established by the Maryland Department of Agriculture (MDA). A certified applicator must pass examinations administered by MDA.

Chemical Control. The use of a pesticide to reduce pest populations or activity.

Chemical Name. The scientific name of the active ingredient(s) found in a formulated product. The chemical name is derived from the chemical structure of the active ingredient.

Common Name. A name given to a pesticide active ingredient by a recognized committee on pesticide nomenclature. Many pesticides are known by a number of trade or brand names, but the active ingredient has only one recognized common name.

Companion Planting. Planting a diversity of plants that, when grown together, will reduce problems with the pests or environmental conditions.

Container Stock. Plant material that comes in a container with soil.

Crack and Crevice Treatment. A pesticide application method in which small quantities of pesticides are placed precisely into cracks, crevices, and other small openings where pests hide.

Cultural Control. A pest control method that involves changing human habits and practices such as sanitation, work practices, and garbage pickups schedules. This also includes altering landscape design, installation, and maintenance of grounds to reduce pest activity and damage.

D

DBH (diameter at breast height). Diameter of the tree at 4.5 feet. above the ground.

Degree-day Accumulations. Degree-days are the number of degrees above a threshold or base temperature that occur in a 24-hour period. Degree-day accumulations are the sum of these degree-days over a period of time, usually an entire season, beginning when temperatures first go above the threshold temperature.

E

Environmental Protection Agency (EPA). The federal agency responsible for ensuring the protection of humans and the environment from the potential adverse effects of pesticides.

EPA Registration Number. A number assigned to a pesticide product when the product is registered for use by the EPA. The number must appear on the all labels for a particular product.

Exotic Plants. Non-native plants introduced into an area. Invasive exotics can aggressively take over native plants, shutting out the more beneficial species.

F

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The federal law and its amendments that regulate pesticide registration and use.

Formulation. The pesticide product as purchased, containing a mixture of one or more active ingredients, carriers (inert ingredients), and other additivies that make it easy to store, dilute and apply.

H

Habitat Modification. The alteration of landscape design and management practices or structural modifications that reduce or prevent pest problems.

Harborage. The hiding places or protected areas where pests live, such as cracks and crevices.

Heading Back. Pruning that involves cutting a growing or one-year-old shoot back to the stub.

I

Inert Ingredients. Materials in a pesticide formulation that do not have anti-pest activity.

Ingredient Statement. The part of a pesticide label that provides the name and amount of each active ingredient and the total amount of inert ingredients in the formulation.

Integrated Pest Management (IPM). The Maryland Department of Agriculture has defined IPM as "a managed pest control program in which methods are integrated and used to keep pests from causing economic, health related, or aesthetic injury through the utilization of site or p'est inspections, pest population monitoring, evaluating the need for control, and use of one or more pest control methods including sanitation, structural repair, nonchemical methods, and , when nontoxic option are unreasonable or have been exhausted, pesticides, in order to minimize the use of pesticides and minimize the risk to human health and the environment associated with pesticide applications. "

Insect Growth Regulator (IGR). A pesticide that mimics insect hormones responsible for control ling molting and development of some insects systems. This disrupts the insect's ability to develop from the immature form to an adult.

K

Key Location. A site in a landscape or structure where pests occur more frequently or cause greater amounts of damage that requires intervention.

Key Pest. An insect, mite, disease, nematode or weed that frequently results in unacceptable damage and typically requires a control action. Key pests vary among geographic regions. Key pest status is dependent on action thresholds set for the pest and the status may differ among specific sites on school grounds and buildings. For example, cutworm may be a key pest on high-visibility athletic fields, but not on adjacent lawn areas. Routine or regularly scheduled pesticide applications may mask key pests.

Key Plant. A plant that frequently experiences unacceptable plant damage and typically requires treatment. Key plants vary among geographic regions. Improper site selection, plant selection, installation, and maintenance can result in a plant becoming a key plant by increasing its susceptibility to pests.

L

Label. The written material attached to or on all pesticide containers that provides the instructions users must legally follow.

Least Hazardous Materials. A control strategy that uses materials, practices and methods, including the use of chemicals, in a manner that causes the least exposure or harm to humans and the environment. The "least hazardous materials" strategy considers the pest control method, toxicity of the product, and exposure to occupants. For example, the use of a nonvolatile material formulation and/or application method is considered a "least hazardous materials" strategy, as opposed to a broadcast application and/or use of a volatile material.

M

Maintenance Pruning. Periodic pruning involving the removal of dead, diseased or weak branches from the crown; thinning of the crown; removing lower branches to provide clearance; reducing the crown height or spread; or removing branches to improve the structure or appearance of the tree.

Least-Impact Pest Control Options. Pest control actions that have very low mammalian toxicity, or ready-to-use, nonvolatile formulations of baits in tamper-resistant bait stations placed in areas inaccessible to children and staff. Nonchemical pest control options, such as cultural, mechanical, or physical controls, are considered least-impact options.

Maryland Department of Agriculture (MDA). The state agency responsible for administering the statutes contained in the Maryland Pesticide Applicators Law and Regulations. MDA is responsible for regulating the sale, use, and storage of pesticides.

Mechanical Control. The removal of pests by vacuuming, hand picking, pruning, crushing, dislodging by water or air, or disruption of pest activity and movement by impediments.

Monitoring. A systematic pest inspection conducted at regular intervals to determine the types of pests, their numbers, the amount of damage caused by pests, entry points, access to food, water, and harborage sites, and the effectiveness of treatment methods. Beneficial organisms are also observed during monitoring.

N

Native Plants. Trees, shrubs, vines, ground covers or herbaceous plants that would have been present before modern humans altered the landscape.

Natural Enemies. Predators, parasites, or pathogens that feed on insect or mite pests.

Nonchemical Controls. Pest control measures that do not use pesticides or other chemicals. Nonchemical controls include biological, physical, mechanical, and cultural tactics and strategies.

Nontarget. Any site or organism other than the site or pest toward which to control measures are directed.

O

Ornamental Plants. Cultivars developed for their aesthetic qualities, functionality, and/or disease and insect resistance.

Organic Matter. The organic part of the soil, including plant and animal residues, cells and tissues of soil organisms, and substances produced by soil organisms. Usually makes up less than 10% of soil matter.

P

Pathogen. A living microorganism, usually a bacterium, fungus, mycoplasm or virus, that can cause disease when a host is present under the right environmental conditions.

Permeability. The ability of water, gases and roots to move through the soil. Soil texture, structure, and pore space affect permeability.

Pest. Any living organism (animal, plant or microorganism) that interferes or threatens human, animal or plant health, property or the environment. A pest in one environment may be beneficial in another. For example, many plants that are considered weeds when found in lawns can be essential to the restoration of natural landscapes after a disturbance such as flood, fire, or human intervention.

Pesticide. A substance used to control, prevent, destroy, repel, or mitigate any pest.

Pest-proofing. A nonchemical, physical control measure to prevent the entry or movement of pests into or out of a structure or area. Pest-proofing might include sealing and caulking of crevices and holes, or installing screens and door sweeps.

Pesticide Applicator Law and Regulations. The Maryland statutes that outline the requirements concerning how pesticides are sold, used, stored, and disposed.

Pesticide Business License. The license issued by the Maryland Department of Agriculture that is required of any business offering pest control services or applying general or restricted-use pesticides for hire, or as part of a service or contract agreement.

Physical Control. Habitat alteration or changes in physical structure to reduce pest populations or their activity. Physical controls address problems such as caulking, holes, and cracks, sealingdoors and windows, reducing moisture , or improving ventilation.

Pore Space. The openings between soil particles.

Primary Nutrients. Nutrients most needed by plants, including nitrogen, phosphorus and potassium.

Q

Quality Control. An inspection and review of the pest control program to evaluate success and identify shortcomings of the program.

R

Reduced-impact Pest Control Options. Pest control options with low mammalian toxicity, formulations that do not present an obvious physical hazard, and with active ingredients that are not known to cause cancer or disrupt human hormones.

Re-entry Period. The time that must elapse from the completion of a pesticide application until the students and staff may re-enter the building.

Registered Pesticides. Pesticide products that have been registered by the Environmental Protection Agency (EPA) for the uses listed on the label.

Repellent Planting. Plants or plant combinations that give off chemicals that keep insects and other pests away from surrounding plants.

Residual Pesticide. A pesticide that continues to remain effective on a treated surface or area for an extended time period following application.

Routine Pesticide Application. A prescheduled pesticide application performed as a preventive measure without confirmation of pest presence or levels of infestation.

S

Salt Index. Used to compare solubility of chemical compounds. Indexes are assigned relative to sodium nitrate, $NaNO_3$, which has a salt index of 100. The salt index of fertilizer, which should be listed on the label, should be less than 50.

Sanitation. Measures that promote cleanliness and pest-free surroundings. Indoor pest control sanitation involves removing pest food sources and physically altering potential access and harborage sites. Outdoor removal of plants or plant parts that serve as harborage or a source of inoculum for pests.

Scouting (see also Monitoring). Planned, routine monitoring of a crop, ornamental planting, landscape, or structure for the purpose of detecting pests, pest damage, or conditions conducive to pests or pest damage. Beneficial insects and their activities are also observed.

Secondary Nutrients. Nutrients needed in small amounts for plant growth, including calcium, magnesium, sulfur, boron, copper, chlorine, iron, magnesium, molybdenum, and zinc.

Soil Amendments. Fertilizers or other materials added to soils to improve plant growth. Soil amendments can be organic or inorganic.

Soil Nutrients. The organic matter and minerals needed for plant growth that are present in soil. Nutrients needed in the greatest amounts include nitrogen, phosphorus and potassium. (See also primary nutrients and secondary nutrients.)

Soil pH. The measure of the hydrogen ion concentration in soil. A pH value of 7.0 is neutral; values below are acidic and those above are alkaline.

Soil Structure. The arrangement of the particles in soil.

Space Spray. A pesticide that is applied as a fine spray or mist to a confined area, usually used to kill flying or crawling insects.

Spot Treatment. A pesticide application restricted to specific areas or plants. For indoor pests areas do not exceed 2 sq.ft. Spot treatments are applied where pests are likely to occur, such as

portions of floors or walls, or the base or underside of equipment. In landscapes and on grounds, spot treatments include individual plants, parts of plants, sections of turgrass but never entire landscapes.

Sustainable Plants. Noninvasive plants that require minimum maintenance because they are well-adapted to local growing conditions.

T

Tamper-resistant Bait Station. A container for toxic bait that is used for rodent and insect control. Tamper-resistant bait stations provide the least risk to children, pets, and other animals. As defined by the US Environmental Protection Agency (EPA), the bait stations must be durable, lockable, have warning labels, and be anchored to keep them in place.

Thinning. Removal of tree branches by cutting back to a crotch.

Threshold (see also Action Threshold). The level of pest density (based on number of pests observed, trapped, counted, etc.) that requires some action. Pest thresholds in urban pest management may be site-specific. For example, different numbers of cockroaches may be tolerated in different sites (such as the kitchen vs. garbage rooms). In some situations pests cannot be tolerated and the threshold may be set at zero.

Topping. An extreme version of pruning, when stems, branches and sometimes the trunk of the tree are cut off the tree top without considering placement of cuts or the health of the plant. Topping is not recommended.

Toxicity. The ability of a pesticide to cause harmful, acute, delayed, or allergic effects.

Tree Spades. Large blades attached to a vehicle used to remove and transplant larger trees.

U

Utility Pruning. Maintenance pruning to provide space for utilities and structures.

V

Void Treatment. A pesticide application method in which a spray or dust is injected or blown into the empty spaces inside walls, false ceilings, or other enclosed areas.

W

Water-holding Capacity. The ability of soil to hold water. The water-holding capacity of the soil is related to soil texture and the size and number of soil pores.

WIN (Water Insoluble Nitrogen). Slow-release nitrogen that does not dissolve in water.

Watersprouts. Suckers that grow out from the bottom of grafted trees where roots are grafted to the trunk.

X

Xeriscaping. Water-efficient landscaping.

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Additional Resources

Alliance for the Chesapeake Bay
6600 York Road, Suite 100
Baltimore, MD 21212
410-377-6270

Alliance for the Chesapeake Bay, Chesapeake Regional Information Service (CRIS)
800-662-CRIS
www.acb-online.org

American Community Gardening Association
100 N. 20th St., 5th Floor
Philadelphia, PA 19103-1495
215-988-8785
www.communitygarden/org

American Horticultural Society
7931 East Boulevard Drive
Alexandria, VA 22308
703-768-5700
https://wwwnt4.clark.net/ahss/

Chesapeake Bay Program Office
US Environmental Protection Agency
410 Several Avenue, Suite 109
Annapolis, MD 21403
800-YOUR BAY
www.chespeakebay.net/bayprogram

Chesapeake Wildlife Heritage
PO Box 1745
Easton, MD 21601
410-822-5100
www.cheswildlife.org

Home and Garden Information Center
Maryland Cooperative Extension
12005 Homewood Rd.
Ellicott City, MD 21042
800-342-2507
www.agnr.umd.edu/users/hgic

Howard County Master Gardener Program Office
3525-L Ellicott Mills drive
Ellicott City, MD 21043
410-313-2707

Maryland Department of Agriculture
50 Harry S. Truman Parkway
Annapolis, MD 21401
410-841-5700
www.mda.state.md.us

For information on MDA's IPM program, pest control and pesticide use contact the Pesticide Regulation Section. For information on fertilizer recommendations contacted the Nutrient Management Section.

Maryland Department of Natural Resources
Tawes State Office Building
580 Taylor Avenue
Annapolis, MD 21401
410-260-8367
www.dnr.state.md.us

Maryland Native Plant Society
PO Box 4877
Silver Spring, MD 20914
www.geocities.com/RainForest/Vines/2996

Additional Resources

National Park Service
Project WILD
5430 Grosvenor Lane, Suite 230
Bethesda, MD 20814-2142
301-493-5447
http://eelink.umich.edu/wild/

National Wildlife Federation
8925 Leesburg Pike
Vienna, VA 22184-0001
703-790-4434
www.nwf.org

Smithsonian Institution
Butterfly Habitat Garden Website
http://web3.si.edu/resource/tours/gardens/butterfly/

US Fish and Wildlife Service
Chesapeake Bay Field Office
177 Admiral Cochran Dr.
Annapolis, MD 21401
410-573-4500
www.fws.gov/r5cbfo

Maryland State Cooperative Extension County Offices

Allegheny County
701 Kelly Road, Suite 101
Cumberland, MD 21502
301-724-3320

Anne Arundel County
101 Crain Highway, NW, Suite 307
Glenn burning, MD 21061
410-222-6758

Arundel Center North
Metro: 301-970-8250 x 6757

Baltimore City
17 S. Gay Street
Baltimore, MD 21202
410-396-1753

Baltimore County
9811 Van Buren Lane
Cockeysville, MD 21030
410-666-1022

Calvert County
PO Box 486
150 Main Street, Suite 300
County Services Plaza
Prince Frederick, MD 20678
410-535-3662
Metro: 301-855-1500

Caroline County
207 S. Third St.
Denton, MD 21629
410-479-4030

Carroll County
700 Agriculture Center
Westminster, MD 21157
410-848-4611

Baltimore Metro: 410-875-2801
Cecil County
Cecil County Courthouse
129 East Main Street, Room 7
Elton, MD 21921
410-996-5280

Charles County
9375 Chesapeake Street, Suite 119
LaPlata, MD 20646
301-934-5403
Metro: 301-753-8195

Dorchester County
County Office Building
PO Box 299
501 Court Lane, Room 208
Cambridge, MD 21613
410-228-8800

Frederick County
330 Montevue Lane
Frederick, MD 21702
301-694-1594

Garrett County
1916 Maryland Highway, Suite A
Mt. Lake Park, MD 21550
301-334-6960

Harford County
PO Box 663
2335 Rock Spring Road
Forest Hill, MD 21050
410-638-3255

Howard County
3525-L Ellicott Mills Drive
Ellicott City, MD 21043
410-313-2707
Metro: 301-621-4300

Kent County
203 Calvert Street
Chestertown, MD 21620
410-778-1661

Montgomery County
18410 Muncaster Road
Derwood, MD 20855
301-590-9638

Prince George's County
6707 Groveton Dr.
Clinton, MD 20735
301-868-9366

Queen Anne's County
505 Railroad Avenue, Suite 4
Centreville, MD 21617
410-758-0166

St. Mary's County
21580 Peabody Street
PO Box 663
Leonardtown, MD 20650
301-475-4482

Somerset County
30730 Park Dr.
Princess Anne, MD 21853
410-651-1350

Talbot County
PO Box 519
125 Bay Street
Easton, Maryland's 21601
401-822-1244

Washington County
1260 Maryland Avenue
Hagerstown, MD 21740
301-791-1304

Wicomico County
PO Box 1836
Salisbury, MD 21802
410-749-6141

Worcester County
PO Box 219
Snow Hill, MD 21863
410-632-1972

List of Appendices*

Appendix A.

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Appendix F.

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Appendix H.

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Appendix I.

Kays, J.S., M.V. Bartlett, and L. Curtis. 1997. *Resistance of Woody Ornamentals to Deer Damage.* Factsheet 655. Maryland Cooperative Extension, University of Maryland, College Park, Maryland. 8 pp.

*Appendices were reprinted from a variety of sources some of which were internet based. Therefore, consistent print quality could not be maintained. Original, high quality copies can be obtained by contacting the appropriate Maryland Cooperative Extension Office (see Additional Resources) or visiting the Home and Garden Information Center website at www.agnr.umd.edu/users/hgic.

MARYLAND COOPERATIVE EXTENSION
UNIVERSITY OF MARYLAND
COLLEGE PARK•EASTERN SHORE

Fact Sheet

Fact Sheet 789

Fertilizer Recommendations

for Landscape Trees and Shrubs

(For Professional Grounds Managers and Landscape Contractors)

Background Information

Grounds managers play an important role in creating and maintaining a healthy environment in Maryland. Studies reported by the Chesapeake Bay Program indicate that nutrients, sediments, and toxic substances are polluting Maryland's ground and surface water. Grounds managers can help reduce their contribution of nutrients, sediments, and toxins by using environmentally sound practices while still making a profit.

Events in the late 1990s led Maryland officials to take an even closer look at our state's water quality. As a result, the Maryland General Assembly passed the Water Quality Improvement Act (WQIA) of 1998. The WQIA specifies that all agricultural operations with annual incomes above $2,500, that apply nutrients, whether in the form of commercial or organic fertilizers and/or manure, must comply with this legislation. Farmers must now have a nitrogen- and phosphorus-based plan, which must be implemented by December 31, 2002, or July 15, 2005, depending on the type of nutrients applied. In addition, grounds managers and persons hired to apply nutrients (fertilizer) to land not used for agricultural purposes that is cumulatively 10 or more acres, or land that is state-owned and of any size, are also included in the WQIA. The 10 acres "cumulative" should be interpreted as including several small lots (each lot under 10 acres) that together add up to 10 acres or more. Although grounds managers are not required to have nutrient management plans, they are required to apply fertilizer according to University of Maryland Cooperative Extension recommendations, take soil tests, and keep records of those applications for 3 years.

Records must include

- soil test results,
- management objectives,
- total nutrients applied to the whole landscape,
- date applied and rate of each application(s),
- location of application(s), and
- the nutrient content of any fertilizer applied.

Record keeping requirements and the regulations regarding them became effective May 30, 2000. See the Maryland Department of Agriculture COMAR (Code of Maryland) recommendations for a summary of penalties.

University of Maryland Fertilizer Recommendations

Following the practices suggested in this publication should assure compliance with the nutrient management law and prevention of nutrient runoff.

The University of Maryland Cooperative Extension (MCE) recommends analyzing the soil prior to any fertilizer application. Analysis reveals any nutrient deficiencies. Once nutrient deficiencies are determined, apply a fertilizer high in water insoluble nitrogen (WIN).

Test Soil

The goals of tree and shrub fertilization include overcoming obvious visual deficiencies that are confirmed by soil tests, increasing resistance to specific diseases and maintaining tree health. Before fertilizing, conduct a soil test to determine if any nutrients are deficient. With many horticultural plants MCE suggests that a foliar analysis be run in combination with a soil test to help determine which nutrients are deficient and the degree of deficiency. Currently, there is little published data on the ideal foliar nutrient levels for all of the species of shade trees and landscape plants. Soil test results should be used to determine the fertilizer needs of landscape woody plants until further data is available on foliar analysis. Soil tests should be run a minimum of every 3 years to determine the nutrient needs of the landscape plants.

Secondary and micronutrient deficiencies are closely related to soil pH. The pH should be corrected, if necessary, before the deficient nutrient is applied to the soil. Correcting the pH will make nutrient availability optimal. Recent findings suggest that the optimum pH for turf in Maryland is between 5.8 and 6.2. Most trees will perform well in this pH range.

In general, young trees in good condition produce approximately 8 to 12 inches of growth on the main branches yearly. A soil test will indicate whether elements are in short supply. Fertilizer applications should be based on the results of this test. If the soil test shows optimum or excessive levels of phosphorus or potassium, no additional phosphorus or potassium needs to be applied. Keep in mind that the yearly rate of new twig growth for a tree varies depending on the species, soil conditions, rainfall, and general environment. However, as trees mature, the growth may be only half as much and yet they are still healthy.

Select the Proper Fertilizer

There are many types of fertilizers available for use. Each one has specific properties that make it different from another. A complete fertilizer contains nitrogen, phosphorus and potassium, major nutrients required for plant growth. A commonly used complete fertilizer for trees and shrubs has a ratio of 3:1:1, 3:1:2, or 3:1:3. An incomplete fertilizer lacks at least one of the three elements, N, P or K. These incomplete fertilizers are sometimes used to supply exact amounts of a specific element when necessary. Secondary and microelements may also be included in some fertilizers. These elements will be listed under "guaranteed analysis."

Slow-release fertilizers are preferred over quick-release or water-soluble types for nutrient management purposes. Another term for 'slow release' is water-insoluble nitrogen (WIN). Slow-release fertilizers provide nitrogen more slowly than water-soluble sources. The result is more uniform growth. Slow-release fertilizers are longer lasting and have a lower impact on the environment. Quick-release fertilizers, or water-soluble nitrogen, are good for restoring leaf nitrogen content with resulting green-up and should be used in moderation. The technical data sheet or label on the fertilizer bag should show that a minimum of 50 percent of the nitrogen source is water insoluble (WIN) and the salt index is less than 50. (Note: Salt index is relative to sodium nitrate, $NaNO_3$, which has a salt index of 100.)

Slow-release fertilizers should be applied at a rate of between 1 to 4 pounds of actual

nitrogen per 1,000 square feet per application. Apply no more than a total of 4 pounds of actual nitrogen per 1,000 square feet annually. Quick release fertilizers should only be used when the objectives of fertilization cannot be met with a slow-release fertilizer. When using quick-release fertilizers, rates should be between 1 to 3 pounds of actual nitrogen per 1,000 square feet per application and shall not exceed 3 pounds of actual nitrogen per 1,000 square feet annually. The combination of slow and quick release fertilizers should not exceed the maximum recommendation of 4 pounds of actual nitrogen per year. All of the fertilizer does not need to be applied at one time. Split applications of two more applications, at lower rates, may be more beneficial and reduce the chance of runoff. Terms such as IBDU, sulfur-coated urea, resin-coated urea, and nitroform indicate slow-release fertilizers.

In order to avoid movement into streams or groundwater, it is usually best to choose a slow-release form of nitrogen. Fertilizers, with at least 50 percent of their N as WIN are considered slow-release.

Calculate Fertilization Area and Application Rate

Fertilizer should be applied where shrub and tree roots are present. The root spread varies with plant species and with several species the roots extend beyond the dripline of the plant. Knowledge of the plant species and its root growth habits will help in directing the fertilizer application. In the absence of information on the root habits, direct fertilizer applications within the dripline area of the plant. The dripline is defined as the area directly below the canopy of the tree.

Define the area to be fertilized prior to application. Consider root accessibility and location, fertilization objectives (rate of growth desired), and plant species (e.g., ericaceous, broadleaf, or deciduous) when determining the target area to be fertilized.

The target fertilization area for trees and shrubs is generally the area within the dripline of the plant. For some aggressively rooting plants such as Norway maple and pin oak, an area 1.5 times the dripline area can be considered the target area to be fertilized. Inaccessible and paved surfaces should not be included in the target area. If one target area overlaps a second target area, use the shared area only once when calculating the total area to be fertilized.

The area, or square footage, of some common shapes is listed in the chart below. The area is always written as square feet (ft^2).

Shape	Area	Formula
Square or Rectangle	Length X Width	A = L x W
Triangle	½ Base X Height	A = ½ B x H
Circle	3.14 X Radius Squared	$A = \pi r^2$ (π=3.14)

Fertilizer Application Rates

Status	Rate/Year
Newly planted (1-2 years)	0-1 lb. N/1,000 ft^2/year
(New transplants in poor soil, as is common at construction sites, may respond to slightly higher rates of N.)	
Established plants	2-4 lb. N/1,000 ft^2/year
(Trees that have not yet reached full potential size)	
Maturing trees	1-3 lb. N/1,000 ft^2/year
(Trees that have generally reached full size for the species)	

Calculation of area for fertilizer application

Example:

How much 36-12-12 fertilizer is needed to fertilize a 20-foot diameter spread, established red maple? See Figure 1.

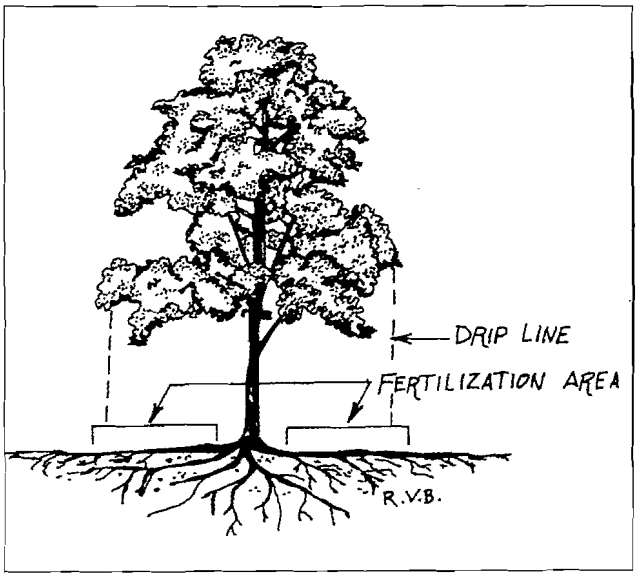

Figure 1. Example of dripline and fertilization area.

Solution:

This is a three-step problem. The first step is to determine the area to be fertilized. The second step is to calculate the amount of actual nitrogen needed. The third step is to convert the amount of actual nitrogen needed into the amount of fertilizer needed.

Step 1.

Since the diameter of the tree is 20 feet wide, the radius is one half the diameter (r =½ D)

$$r = \tfrac{1}{2} \times 20 \text{ feet} = 10 \text{ feet}$$

Now that the radius is known, it is possible to calculate the area.

$A = \pi r^2$ (π=3.14)

$A = \pi r^2$

$A = 3.14 \times 10 \text{ ft}^2 =$
$3.14 \times 10 \text{ feet} \times 10 \text{ feet} = 314 \text{ sq. ft.}$

Step 2.

Since this tree is established, we are using the lower fertilization rate of 2 pounds of nitrogen per 1,000 sq. ft. per year.

$$\frac{X \text{ lbs. of actual N}}{314 \text{ ft}^2} = \frac{2 \text{ lbs. of actual N}}{1{,}000 \text{ ft}^2}$$

$$X = \frac{314 \text{ ft}^2 \times 2 \text{ lbs. of N}}{1{,}000 \text{ ft}^2}$$

$$X = \frac{628 \text{ lbs. of N}}{1{,}000}$$

$X =$ 0.628 lbs. of actual N

Therefore, .628 lbs. of actual nitrogen is needed to fertilize a 20-foot diameter established tree.

Step 3.

To determine how much *fertilizer* is needed to deliver the 0.628 lbs. of actual nitrogen per sq. ft., use the following formula.

$$\text{Total Product Needed} = \frac{\text{Application Rate (lbs. of N)}}{\text{\% N in Product (expressed as a decimal)}}$$

$$\text{Total Amount of 36-12-12 Needed} = \frac{0.628 \text{ lbs. of N}}{.36}$$

Total Amount of 36-12-12 Needed = 1.74 lbs.

Therefore, it takes 1.74 pounds of a 36-12-12 fertilizer to fertilize a 20-foot-wide established red maple.

How often to fertilize

How much and how often to fertilize shade trees depends on your landscape goals and the current nutrient status of the soil. Small trees, where rapid growth is desired, should be fertilized annually. Split applications (spring, early summer) may have less chance of causing runoff.

Established trees typically are fertilized once every 3 to 4 years, although most arborists prefer an annual application of a low level (1-2 lbs N/1,000 sq. ft./year) of nutrients because infrequent, high rates (3-4 lbs N/1,000 sq. ft./year) tend to contribute more to environmental contamination.

Technically, fertilizer can be applied and is absorbed by plants any time during the year as long as the soil is not frozen or too dry. The best time of the year to fertilize shade trees with slow-release fertilizer runs from the fall through the late winter, before growth appears in the spring. If you are using quick-release nitrogen sources, then spring to early summer is the best time for applications of fertilizer. Avoid applications during the period between late summer and when deciduous trees drop their leaves. Roots absorb fertilizer during the winter months as long as soil temperatures are above 40°F. Most N uptake is driven by leaf growth active flushes. The nitrogen that is fall applied in slow-release form will be available for root uptake with the spring flush of growth. If turfgrass growing in the root zone of the tree is receiving regular fertilization, then in many cases no additional nutrients may be required.

Fertilizer application methods

For surface application all fertilizer should be uniformly distributed within the defined area of fertilization. Broadcast the fertilizer in the area under the tree, beginning near the trunk to the dripline. Broadcasting on slopes greater than 5-8 percent should be avoided. **Surface application should not be made where surface runoff is likely to occur.** Where runoff is likely or turf or ground cover exists, subsurface fertilization should be the preferred method of fertilization.

For subsurface liquid fertilizer injection, the injection sites should be evenly distributed within the fertilization area. For liquid injection systems, the pressure should not exceed 200 pounds per square inch. Fertilizer should be evenly distributed between holes. See Figure 2.

For subsurface dry fertilization, holes should be evenly spaced within the defined fertilization area. Holes should be 2 to 4 inches in diameter, spaced 12 to 36 inches apart, and 4 to 10 inches deep. See Figure 3. The fertilizer should be evenly distributed among the holes. The fertilizer should not be closer than 2 inches to the soil surface.

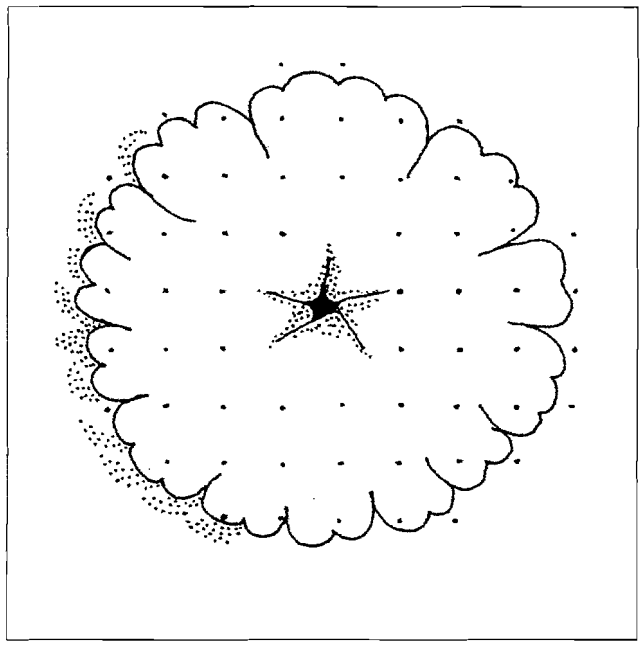

Figure 2. Example of guide to positioning fertilizer application holes beneath the tree canopy.

Foliar applications, injections, or fertilizer implants should only be used when soil application of fertilizer is impractical or ineffective in achieving fertilization objectives.

An excessive concentration of fertilizer can burn the foliage. This damage is usually caused by ammoniacal N or urea N. Foliar fertilization is a common way to apply

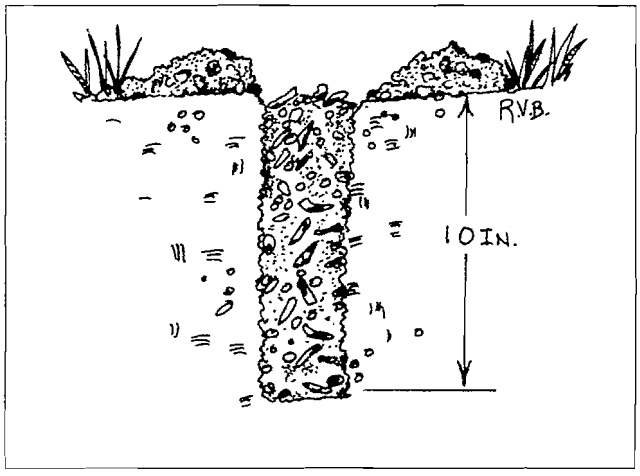

Figure 3. Example of subsurface fertilization holes.

chelated iron to plants suffering from iron chlorosis. The benefits of foliar application of nutrients are often only seen for one season for many of the micronutrients.

Fertilizing Evergreen and Deciduous Shrubs

Broadcast a granular fertilizer (slow-release is preferable) uniformly on the soil under the shrub and a little beyond its dripline. Use an application rate of 2 to 3 pounds of actual nitrogen per 1,000 square feet. A lower rate of nitrogen fertilizer is used around foundation plantings to reduce excessive growth and the resultant need for pruning and trimming.

Ericaceous evergreens such as rhododendrons, azaleas, camellias, mountain laurel, pieris, and leucothoes perform best in an acidic soil. They require a soil pH range of 4.5 to 6.0. Fortunately, many undisturbed Maryland soils are already acidic enough to grow these plants well. Soils in regions of the state with a limestone base are not suitable for these plants unless special procedures are used to lower the soil pH.

Two Prevalent Nutrient Problems in Landscape Plantings

Iron chlorosis:

A symptom of a soil with a high pH problem is iron chlorosis. Chlorosis is an interveinal yellowing of new leaves. This deficiency can be temporarily corrected by applications of chelated iron to the foliage or the soil. The soil pH should be corrected or the symptoms will gradually recur. If the pH is too high (alkaline), sulfur and/or iron sulfate are applied to the soil to lower the pH. Follow the directions based on the results of a soil pH analysis. If chlorosis persists, have the soil tested for manganese (Mn). Always test first to avoid misapplications. Keep in mind, chlorosis is also a secondary symptom of root rot or death of roots. Some conditions that can cause root death and chlorosis include poor soil drainage, over-watering, over-mulching, planting too deeply, magnesium deficiency, root nematodes, or a root injury.

Magnesium deficiency:

In very sandy soils, magnesium deficiency can also be a serious problem with acid-loving plants. These symptoms generally appear as chlorosis of older leaves and short, unhealthy new growth. Soil, or foliar, testing is the only accurate method to determine this deficiency. The deficiency can easily be corrected by applying 4 to 16 ounces of magnesium sulfate (Epsom salts) per 100 square feet and irrigating thoroughly.

Problems Caused by Excessive Fertilizer

Fertilization can be beneficial to plants with a deficiency. However, very high fertilizer concentrations can cause root damage to the plant.

"Burn" is a term describing visual symptoms of salinity due to over-application of fertilizer. Symptoms resemble those of drought damage because plants are injured by lack of water, even though sufficient water may be present in the soil. Fertilization in droughty times of the season is more likely to burn roots.

Excessive use of fertilizer in the landscape can contribute to the nitrogen and phosphorus contamination of groundwater, streams, and ultimately the Chesapeake Bay. Most runoff problems are due to surface applications on slopes and paved surfaces. Groundwater problems may result from fast-release fertilizers on sandy soils. It is very important to select the correct analysis fertilizer, use slow-release whenever possible, and always read the label instructions.

Summary

University of Maryland Cooperative Extension Recommendations

1. Test soil to determine nutrient deficiencies, then fertilize accordingly.
2. Use a fertilizer containing at least 50 percent WIN.
3. Apply no more than 4 pounds of nitrogen per 1,000 square feet per year to trees and shrubs.
4. Remove granular fertilizer from paved surfaces.

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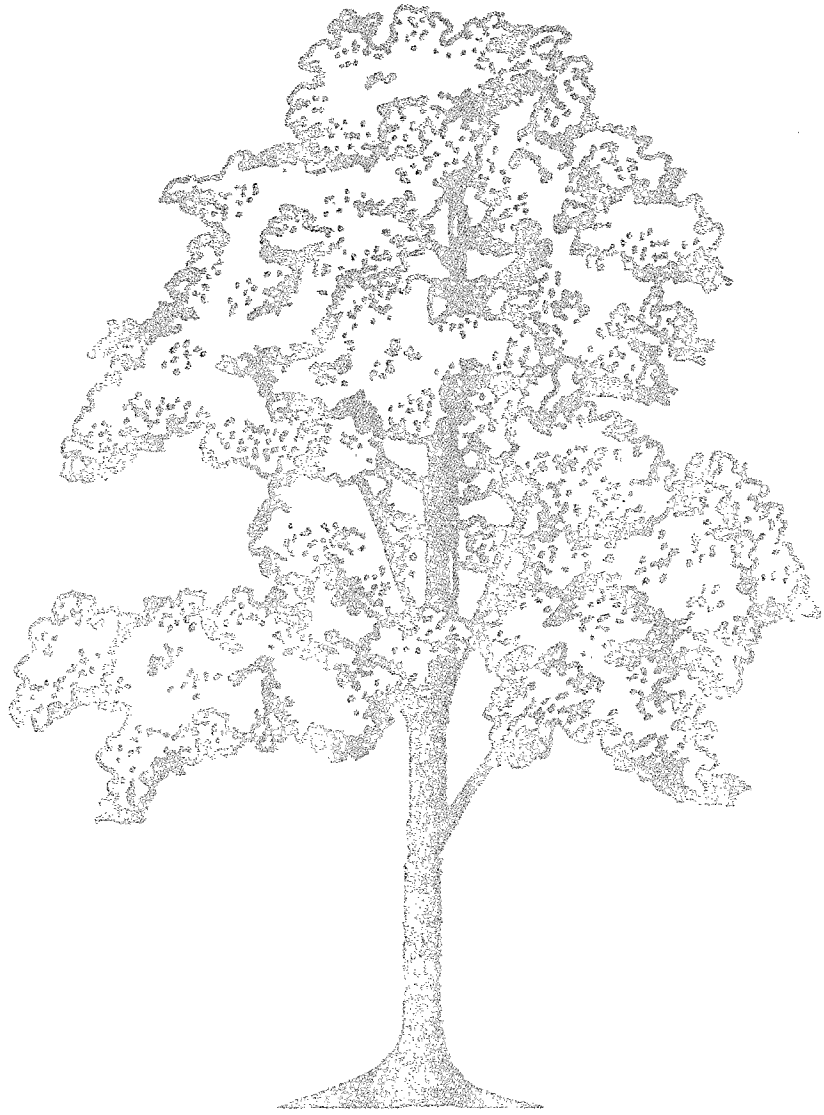

Fertilizer Recommendations for Landscape Trees and Shrubs

(For Professional Grounds Managers and Landscape Contractors)

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Lead in Garden Soils

INTRODUCTION

We don't usually think of our gardens as dangerous or toxic, but unfortunately, some garden soils do contain moderate to very high levels of lead. Garden soils contaminated with lead pose a serious health risk. The risk is primarily from contaminated soil brought into the home on clothing, shoes and tools. The soil becomes mixed with housedust that is inhaled or ingested. This can result in dangerous increases in blood lead levels, particularly in infants and toddlers. Lead may also be ingested from contaminated soil clinging to vegetable crops. However, lead uptake by plant roots and deposition in edible plant parts is very low, even when soils have a very high lead content.

SOURCES OF LEAD

Chipping or peeling paint around older structures will raise the lead level in the soils directly adjacent to the building. Even today, when an old building is demolished, the soil can become contaminated with lead from old lead paint. In the 1950's, cheaper titanium pigments largely replaced lead pigments. Federal restrictions were not imposed until the late 1970's. Today paint companies are allowed to mix up to 0.05% lead in paints. However, the lead content of commercial and artist's paints is not restricted.

Soil can be contaminated with lead from several other sources - industrial sites, from leaded fuels, old lead plumbing pipes or even old orchard sites in production where lead arsenate was used. Lead accumulates in the upper 8 inches of the soil and is highly immobile. Contamination is long-term. Without remedial action, high soil lead levels will never return to normal.

HEALTH RISKS

We do not require lead in our diet or environment. At very low levels that naturally occur in soils (15-40ppm), no detrimental health effects have been noted. But higher soil lead levels can raise the body's lead level without producing any obvious physical symptoms. Young children under the age of 6 and pregnant women are at the greatest risk. As a group, children exposed to lead have lower IQs and may experience permanent learning disabilities and behavioral disorders when compared to children not exposed to lead.

SOIL TESTING

Testing for lead will help to evaluate the potential risk to health. The risk is based on exposure. Both private and university soil test labs can determine lead levels in soils. However, no legal regulations for soil lead levels are in effect.

Soil laboratory results will be returned listing the parts per million (ppm) of lead from either an extracted or total lead test, or both. Pay careful attention to the total lead values. The values in Table 1 will help you understand your test results.

Table 1.
Soil Lead Levels

Relative Soil Lead Levels	Total Lead (ppm)
Low	0 - 499
Medium	500 - 999
High	1000 - 3000
Very High	above 3000

Soil samples should be taken from several areas to determine the location of the contamination. The greatest lead concentration is in the top 1 to 2 inches of soil. Children's play areas or vegetable gardens should be sampled separately. Avoid mixing several sites into one sample.

REDUCING HEALTH RISKS

Gardeners can reduce the risk of lead poisoning from lead contaminated soils by following the methods listed below:

- Locate fruit and vegetable gardens away from old painted buildings, heavily traveled roads.

- Contaminated soil particles are more likely to cling to or become imbedded in leafy greens and root crops than on fruiting vegetables like tomatoes and cucumbers. Always wash all vegetables and peel all root crops before they are cooked and eaten. Remove the outer wrapper leaves of cabbage. Wash off excess soil from root and leaf crops outside the house, preferably at an outside hose bib, to prevent bringing contaminated soil into the home.

- Rinse and launder gardening clothing promptly. If possible, don't allow young children to play in contaminated soils. Frequent hand washing and rinsing outside toys will reduce the amount of soil ingested. Always wash hands before eating meals or snacks. Have family members leave outdoor shoes in a cardboard box at the door, to avoid spreading lead contaminated dust through the home. Mulch play areas with wood chips or other soft materials to reduce soil dust. Build a plastic lined sand box for a clean area to play.

- Parents of children under age 6 living in areas with contaminated soils should consult their physician. A blood test to monitor lead levels may be recommended.

- The amount of lead absorbed by plants is affected by the pH, organic matter and the phosphorus content of the soil. To reduce lead uptake by plants, adjust the pH of the soil with lime to a level of 6.5 to 7.0. Add organic matter such as compost, manure, leaf mold, or grass clippings to the gardening site. Add phosphorus to the soil as recommended by a soil test.

- In heavily contaminated soils adjacent to a residence, plant trees, shrubs or perennials and mulch the area to minimize annual tilling and cultivation operations. When the soil lead level is over 5000 ppm total lead, the garden soil should be removed and replaced with clean topsoil. Test the new topsoil for soluble salts, pH, and the standard nutrients (phosphorus, potassium and magnesium), before making a purchase. Testing for lead and other heavy metals is recommended especially if the topsoil is from an urban area.

- No food crops should be grown in a soil that is heavily contaminated. In these cases, container gardening or construction of raised beds filled with purchased soil is recommended.

We are increasingly concerned with environmental quality and the need to protect ourselves from toxins. Lead is another unwelcome environmental concern. For further information on lead in Maryland contact the Department of the Environment at 410-631-3820 or your local health department.

Soil Testing Labs

The following list of laboratories is by no means complete and is intended for reference only. Mention of businesses in this publication does not constitute an endorsement by the Cooperative Extension Service.

University of the District of Columbia
Cooperative Extension Service
901 Newton St. N.E.
Washington, DC 20017
Phone 202-274-6907

Soil and Plant Tissue Testing
West Experiment Station
University of Massachusetts Amherst, MA 01003
Phone 413-545-2311

Martel
1025 Cromwell Bridge Road
Baltimore, MD 21286
Phone 410-825-7790

A and L Eastern Agricultural Testing Laboratory
7621 White Pine Rd.
Richmond, VA 23237
Phone 804-743-9401

American Environmental Network
9151 Rumsey Road
Columbia, MD 21045
Phone 410-730-8525

Fredericktown Lab
Myersville, MD 21773
Phone 301-694-7133

American Medical Labs
14225 Newbrook Dr.
Chantilly, VA 22021
703-802-6900

Fees and soil preparation procedures vary. Contact the individual lab for their procedures and charges before sending the sample.

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Soil Amendments and Fertilizers

Fertilizing Guidelines Included by Plant Group

Fertilizers and soil amendments are a wide array of materials added to soils to improve plant growth. They can be organic, such as bone meal, or inorganic, such as 10-10-10 fertilizer. Some must be purchased, while others are free for the taking from your landscape. Many are dual purpose—they serve as both fertilizers and soil amendments.

Fertilizers are primarily valued for their ability to supply nutrients. Plants use these nutrients to make components for plant growth such as proteins and carbohydrates.

Soil amendments are mixed into topsoil to promote healthy plant growth in a number of ways. For example, they may moderate the pH of soil or supply nutrients.

In addition to nutrition, fertile soils must provide a conducive structure for root growth, water retention, and air exchange. **Soil conditioners**, like composted horse manure, improve **soil structure** by binding soil particles into larger aggregates. This increases the amount of pore space and enhances air exchange, water movement, and root growth.

Feed The Soil First!

The surest way to improve plant growth is the regular incorporation of organic matter such as composted yard waste. Organic matter improves soil structure, slowly releases nutrients, and increases beneficial microbial activity.

From the many "homegrown" and retail products available, the wise gardener selects those that most closely address a need while providing the best value for the money.

Caution!! *Wear gloves and a dust mask or respirator when handling caustic or finely powdered materials. These include hydrated and burnt lime, perlite, vermiculite, and peat moss. Take similar precautions with bonemeal, fresh manure, mulch and peat moss.*

FERTILIZERS

The main chemicals that must be supplied to plants are called **primary nutrients**. Those required in the greatest amounts are nitrogen (N), phosphorus (P), and potassium (K). Most retail fertilizers are labeled with a three number analysis corresponding to N, P, and K. It tells what percentage of the net weight is actually composed of these three nutrients. A fertilizer containing all three nutrients is a **balanced fertilizer.** Some common N-P-K analyses of inorganic, granular fertilizers are 10-6-4, 5-10-5, and 10-10-10. A 50-lb. bag of 10-6-4 fertilizer will contain 5 lb. of nitrogen (N), 3 lb. of phosphate (P_2O_4), and 2 lb. of potash (K_2O). (Phosphate and potash are merely the available forms of phosphorus and potassium respectively.)

Plants also require the **secondary nutrients,** calcium, magnesium, and sulfur, plus very small amounts of the **micronutrients** boron, copper, chlorine, iron, manganese, molybdenum, and zinc. These latter, plus a few others, are referred to as **trace elements**.

Contributions of primary nutrients to plant health:

- *Nitrogen (N)- strong leaf growth, dark green color.*
- *Phosphorous (P)- roots, early plant growth, seed formation.*
- *Potassium (K)- plant vigor, disease and stress resistance, flavor and color enhancement.*

Inorganic or **"chemical" fertilizers** are typically less expensive (per pound of nutrient) and more readily available for plant growth than **organic fertilizers**. However, the latter have the advantage of supplying other nutrients in addition to N-P-K, and often double as soil conditioners.

Some fertilizers can be absorbed immediately upon application. These are known as **quick release** or **highly soluble fertilizers**. They are useful when rapid results are required. They come in liquid or powder form and are applied to root zones or sprayed directly on foliage.

To reduce maintenance and cut down on laborious re-applications of fertilizer, **slow release fertilizers**, such as Osmocote and sulfur-coated urea, make nutrients available in small amounts over an extended period. Fertilizer stakes or tablets placed in root zone soil are also slow release formulations. However, salt accumulation resulting in root burn, can occur immediately adjacent to these products.

Fertilizers often target specific plant needs. For instance, **starter fertilizers** specially formulated for seedlings and transplants are high in phosphorus to foster root establishment.

Available Fertilizer Products:
(Italics are trade names)

Read All Product Label Instructions before You Open the Bag!

***Materials with an (*) are considered acceptable by organic gardeners and farmers.**

Alfalfa meal*: typically 3-5% organic nitrogen (3-1-2). May contain ethoxyquin, a preservative, to keep it green.

Ammonium nitrate: good general fertilizer with 33% N, half ammonium nitrogen and half nitrate nitrogen. Mix into soil to prevent nitrogen dissipation into air. Will absorb moisture and harden if the bag is left open. (If this happens, break up the hardened pieces with a hammer. It doesn't "go bad.")

Ammonium sulfate: a dry fertilizer which is 21% N, plus sulfur. Very acidic, especially suitable for blueberries, azaleas, etc.. Mix into soil to prevent loss of nitrogen to atmosphere.

Blood meal*: readily available nitrogen, typically 10-12%. Lasts about 2 months. May help repel deer and rabbits when top-dressed around plants.

Bone meal*: steamed ground bone high in phosphate. Sample analysis (1-11-0) or (5-12-0). Especially good for bulbs and root crops. Contains calcium 15-22%, plus trace elements. Lasts 6 to 12 months.

Boron*: micronutrient. Can be toxic to plants if applied in excess. Often applied by fruit growers to prevent fruit pitting and rot disorders. Deficiencies are most likely to occur on sandy soils. Incorporate 6-7 tablespoons of Borax per 1,000 sq. ft. of vegetable garden area each spring where soils are sandy.

Chelated iron*: Chelated iron is applied to plants suffering from iron chlorosis. Chelate means "claw" in Greek. Chelated elements are combined with compounds that hold them in solution, making them available for plant uptake through roots or leaves.

> ***Foliar fertilizers*** *are applied directly to the upper and lower leaf surfaces. Plants take up nutrients more efficiently through leaves than through roots. Foliar feeding is recommended to aid in the root growth and establishment of seedlings and transplants.*

Corn gluten*: a natural pre-emergent herbicide. Apply in spring as a top-dressing to control crabgrass and some weed species. It adds some organic matter and nutrients to the soil (a 10-1-1 analysis).

Cottonseed meal*: a slow release fertilizer for acid-loving plants. Sample analyses are (6-0.4-1.5) and (6-2-1). Lasts 6 months to 1 year.

Epsom salts*: magnesium sulfate, a highly soluble form of magnesium and sulfur. Can be used as a foliar spray for speedier results. Makes melons sweeter. When adding to a planting hole you should counter-balance the magnesium by adding an equal amount of calcitic lime.

Feathermeal*: a high nitrogen byproduct of the poultry industry. Sample analysis (12-0-0). Usually encountered as a component of an organic mix.

Fish products*: formulations range from fish powder (usual analysis 9-1-1), emulsion, and foliar sprays, to fishmeal with a slow 6-9 month release. Many valuable micronutrients. May have strong fishy smell.

Greensand*: a naturally occurring iron-potassium silicate (also called glauconite) with the ability to absorb 10 times more moisture than ordinary sand. It contains marine potash, silica, iron, magnesium, and lime, plus up to 30 other trace minerals. Dual ability to bind sandy soils and loosen clay soils. Potassium (5-7 %) released very slowly over 4 to 5 years. Slightly acidic.

Guano*: decomposed manure, usually of bat or seabird origin. Was the first commercial fertilizer sold in the U.S. Desert bat guano escaped leaching in caves, preserving its nutrients. Seabird guano recycles marine trace elements. Valued for fast release and high N analysis (10-3-1). Suggested use is as a potting soil additive.

Holly-Tone, Bulb-Tone, etc.: mixtures of organics (animal tankage, crabmeal, kelp, and greensand) and inorganics (sulfate of potash, ammonium sulfate) that target specific plant groups. All contain 11-12 micronutrients.

Mix granular fertilizers into the top 4-6 inches of soil, then water the area well.

Humates*: a mined ancient organic soil. Unlike peat, humates are thoroughly decayed or mineralized, so nutrients are available to plants. Contains up to 35% humic acids that dissolve other nutrients for plant utilization. Manures and yard waste compost also contain humic acids.

Kelp products*: made from seaweed; contains dissolved ocean minerals. Dried kelp will usually contain 1.6- 3.3% nitrogen, 1 to 2 % $P_2 0_5$ and 15% to 20% $K_2 0$. Also valued as a growth stimulant because of rich concentrations of trace minerals (over 60), amino acids, vitamins, and growth hormones, including cytokinins, auxins and gibberellins. Available in meal, powder, and liquid forms.

Miracid: very high-solubility fertilizer (30-10-10) with chelated iron to combat chlorosis in acid-loving plants. Over-use may drop the pH too low.

Miracle-Gro: very highly soluble fertilizer (15-30-15). Dissolved in water and used as a foliar spray or applied directly to soil. Ammonium phosphate and urea sources of N. Contains six important micronutrients.

Osmocote: resin coated, slow release fertilizer (up to 4 month release outdoors). Many different analyses are available. Popular in the nursery and greenhouse industries.

Rock products: a wide variety. Be aware that touted "immediately available" nutrients may refer to only a small percentage of the whole, while the rest will be released slowly. Not considered organic if treated with a chemical to increase nutrient solubility. A selection of those available follows:

- **Azomite or rock dust***— an aluminum silicate clay mixed with over 50 minerals, from marine deposits (2.5% potassium).
- **Black rock phosphate***— about 30% phosphate rock with calcium oxide, silicas, and trace minerals. Only 3% of phosphate immediately available. Slow release builds longer reserve than colloidal phosphate. Best in slightly acid soils.
- **Soft rock or colloidal phosphate***— phosphate clay with 18-22% phosphate, 27% calcium oxide, silicas, and 14 trace minerals. 2% phosphate immediately available, the rest slow-release over 3-5 years. Half the liming value of ground lime.
- **Superphosphate** (0-20-0) **and triple superphosphate** (0-45-0)—Phosphate rock treated with acid to make the phosphorous more soluble.

Seaweed products: See Kelp products

Shellfish compost*: a crab and/or shrimp shell meal. Slow release source of nutrients, especially calcium. Do not apply to acid-loving plants.

Chesapeake Blue* is a local shellfish product of composted crab "chum" (waste from packinghouses) and wood chips. Resembling soil, it retains moisture and nutrients in sandy soils and improves aeration in clay soils. High salt content may burn seedlings unless well incorporated into soil.
Clandosan* is another shellfish compost.

Stop Rot*: a liquid formulation of calcium carbonate ($CaCO_2$) used to prevent blossom-end rot in vegetable crops. Plants take up foliar sprays very efficiently.

***Blossom-end rot** of tomatoes is caused by a lack of calcium in the developing fruit. Prevent it by adding a small handful of finely ground limestone to each planting hole prior to transplanting. Water plants regularly and deeply and keep them mulched. Be aware that excessive N levels block Ca uptake.*

Sul-Po-Mag*: sulfate of potash magnesia from the mineral langbeinite, with about 22% sulfur, 22% potash and 18% magnesium oxide. Readily soluble.

Urea: rapid nitrogen release (46-0-0) with a high "burn potential" which should be handled and used with care. Must be mixed into the soil to prevent conversion to ammonia and subsequent escape into the air. **Sulfur-coated urea** is a slow release formulation.

Wood ashes*: analyses runs from 1 to 2% P and from 4 to 10% K. Hardwood ashes are 45% carbonate equivalent and are half as effective as lime for raising soil pH. Softwood ashes are less effective than hardwood. Ashes are too fine to improve soil structure. The recommended yearly application rate is 25-50 lbs./1,000 sq. ft. At higher rates, test soil pH yearly.

SOIL CONDITIONERS

Most garden and landscape plants perform best in soils high in organic matter (greater than 3% organic matter (by weight) in the topsoil). These soils are loose, easy to work and have a large number of earthworms. Organic matter is continuously used up through oxidation, downward movement through the soil profile and plant growth and must be replenished on a yearly basis.

Compost (commercial or "home-grown"): made from decayed organic materials such as straw, corn cobs, cocoa bean hulls, poultry litter, grass clippings, leaves, manure. Composts improve soil structure and slowly release nutrients to plant roots.

Coverage

3 cubic feet of organic matter will cover 36 sq. ft. to a depth of 1 inch.

Useful conversions: *7.5 gallons = 1 cu. ft.*
1 cu. ft. = 1.25 bushels
27 cu. ft. = 1 cu. yd.

Composted sewage sludge: available in Maryland as ***Compro*** or ***Milorganite***. ***Compro*** (1-2-0) has a relatively high pH (7.8). ***Milorganite*** has been heat dried and therefore has a higher N-P-K (5-2-5). Labeled for use in vegetable gardens in Maryland. Anecdotal evidence suggests composted sewer sludge repels rabbits, deer, voles, and squirrels when used as a top-dressing.

Gypsum*: calcium sulfate, a mined product also called "land plaster." Can be used on very heavy, clay soils to improve soil structure without raising soil pH. About 20-23% calcium and 15-18% sulfur, two secondary nutrients usually fairly well supplied in Maryland soils. Also recommended to tie-up excess magnesium. Will leach sodium from soils with high salt concentrations caused by de-icing materials or ocean spray.

Humus*: the stable, end product of the composting process. It holds water and nutrients, aids soil aggregation, is a source of humic acid and chelates, and contains huge microbial populations. May be purchased.

Humic acid*: an important component of organic matter. It's a very mild acid released in the decay process. Dissolves soil minerals, especially phosphorus, for plant use.

LeafGro*: composted leaves and yard debris. Approximate analysis, 1.0-.05-1.0, with a pH range of 6.8-7.2. Holds 225% of its weight in water and does not repel water when dry as peat moss does. Use as a soil amendment, potting mix component, or top-dressing when seeding turf. Good peat moss substitute.

Manure (purchased):

- **Cow or Steer (dehydrated)***— manure exposed to 180°F, dried to 17% moisture, and ground into a fine, soil-like texture. Nutrients are more concentrated and the soluble salt level is probably higher in dehydrated manure than in locally available farm manure.
- **Chicken***— poultry manure composted with wood chips and other materials (1.5-4-2). May contain gypsum.
- **Cricket***— manure of crickets raised for bait (4-3-2). Because high salts may burn roots, add sparingly to potted plants.

Manure (local)*: sheep, cattle, horse and chicken manure are widely available from nearby farms. Ask for manure that has been mixed with bedding material and allowed to compost for at least 2 months. Farm manures usually contain 1% or less each of N, P, and K. Rabbit, sheep and chicken manure are higher in these nutrients. Manure mixed with urine-soaked bedding will be higher in N. Approximately 20-40% of the nitrogen is available to plants the first summer after application. (Some weed problems may occur if soil is not mulched).

Manure tea*: ordinarily homemade from "steeping" manure in a bucket of water, then draining and applying the brew to plants (after further dilution with water). Handy for getting the soluble components of manure directly to foliage or roots during the growing season.

Mushroom compost*: used or "spent" compost from mushroom farming. It is some combination of manures, wheat straw, corn cobs, feathermeal, peanut meal, peat moss, lime, etc. Growing mushrooms use only a small portion of the many nutrients. Nutrient analysis: (2.75-1.5-1.5) Can have high soluble salt levels and should be fully incorporated and watered prior to planting

Use Manures Wisely

All animal manure should be composted before it is applied to vegetable gardens. Turn composted manure into your soil; don't leave it on top of the ground. Never use pet manure in the vegetable garden.

Peat moss*: partially composted moss mined from prehistoric non-renewable bogs. Light and porous, it absorbs 10-20 times its weight in water, but its high surface tension causes it to repel water when it's dry; so do not use as mulch or top-dressing. May not improve the *available* water-holding capacity of soils. Contains little nutrient value, but has a high nutrient-holding capacity. Acidic (as low as 3.0 pH); good for working into azalea and blueberry beds.

Pine bark fines*: a finely shredded pine bark product that retains moisture. Sometimes a composted component of potting mediums. OK to incorporate into annual beds. Very acidic, so watch soil pH levels if large quantities are used. Good for lowering pH. A peat moss alternative.

Sand*: to improve water drainage and aeration of clay soils a minimum of 50% by volume is necessary. Can worsen the situation by causing clay to "set up" like concrete. Use only coarse builder's sand, not play sand. Often impractical to use because of the large volume needed.

Sawdust*: only well-decayed sawdust should be incorporated into the soil. Fresh sawdust can burn plant roots and "tie up" nitrogen as it decomposes. (Soil microbes that break down the high-carbon sawdust need nitrogen.) Good for mulching blueberry beds.

Topsoil*: no state or federal standards. Quality will vary. Inspect topsoil, ask for references. Inquire where it came from and whether any testing for pH, soluble salts, heavy metals, etc. has been done. Avoid very sticky, grayish, mottled, or foul-smelling soils.

Blended **topsoil (70%) and leaf compost (30%) mixes** are excellent for an instant raised bed garden. Can be purchased by the cubic yard.

Water-absorbing polymers: super-absorbent polymer granules that can absorb 300-400 times their weight in water. As soil dries, stored water is released slowly back into soil. Also absorbs and releases fertilizer. The cost-effectiveness of these materials has not been demonstrated for outdoor garden use.

Worm castings*: the rich digested "soil" produced by redworm farming. No guaranteed, listed analysis due to the great variability in feedstock, storage, and handling. Concentrated source of Ca, Mg, N, P and K, in readily available form. Used for container culture, indoors and out. Use 1 to 2 cubic feet per 100 square feet of garden area. Castings can be purchased through catalogs or produced at home in redworm bins.

GROWTH STIMULANTS

See also: Humus, Kelp products

Bioactivators*: various commercial products containing one or more of the following: beneficial bacteria, growth hormones and stimulants, nutrients, and vitamins. Can be very useful as a "tonic" for the lawn, seedlings, transplants and plants languishing in cool soils in the spring. These are unnecessary for backyard compost piles.

Microp*: soil innoculant. When sprayed on the soil these nitrogen-fixing algae grow rapidly and can supply 30 to 60 lbs. of nitrogen per acre, plus producing polysaccharides (the soil aggregating product in humus) which combat soil compaction.

Maxicrop*: See (Kelp products). A kelp extract, containing growth regulators, that stimulates root development and plant growth (1-0-3).

Nitrogen-fixing bacteria innoculant*: a powder used to coat legume (pea, bean, and clover) seed to increase the growth of nitrogen-fixing nodules on their future roots.

Roots*: a soil treatment composed of peat humic substances, kelp extract, and vitamin B-1. Probably no different than using seaweed (kelp) extracts by themselves.

Transplant Insurance*: composed of polymer crystals and mycorrhizae. Mycorrhizae are beneficial fungi which grow symbiotically on or in roots and extend the root structure by sending out tiny filaments to forage for nutrients.

pH ADJUSTORS

See also: Ammonium sulfate, Cottonseed meal, Gypsum, *Miracid*, Shellfish products, and Wood ashes

Aluminum sulfate*: *not* recommended as a soil acidifier because it can cause a toxic aluminum build-up (Maryland soils have adequate aluminum levels). Iron sulfate is preferred.

Iron sulfate*: lowers pH. Turns hydrangea flowers blue. It contains 20% iron. Use 3-4 times the recommended amount of sulfur. (In a medium texture soil, lower the pH by ½ unit by applying 12-14 lbs./1000 sq. ft. of area.)

Soil pH

Soil pH is a measure of the hydrogen ion concentration of soil. A pH value of 7.0 is neutral. Readings below 7.0 are acidic (sour soil), and those above 7.0 are alkaline (sweet soil). Soil nutrients are most available to plant roots and microbial activity is greatest when soil pH is in the 6.0 to 7.0 range. Plants may show symptoms of nutrient deficiency or toxicity at very high or low soil pH. For example, azaleas grown in high pH soil may have yellow leaves due to a deficiency of iron (iron chlorosis). Acid rain adds 15-25 lbs. of sulfur/acre, so Maryland soils become acidic over time. Liming is best accomplished in the fall, because lime requires time to change pH.

Lime*: raises pH. There are two kinds of naturally occurring mined limestone: calcitic (calcium carbonate) and dolomitic (calcium carbonate and magnesium carbonate). Dolomitic is recommended when magnesium levels are low.

- **Aragonite***- or oyster shell lime, is 96% calcium carbonate mined off the coast of Bermuda. Less quickly available than ground ag lime, but it lasts 4-5 years.

- **Agricultural limestone***- a finely granulated calcitic limestone. The finer the grind or mesh size, the more readily it will act to raise soil pH. **Powdered lime** is faster acting.
- **Hydrated lime***- calcium hydroxide, produced by adding water to burnt lime. Quick acting. Need apply only 75% of calcitic recommendation.
- **Burnt lime***- calcium oxide, very caustic. (Also known as "quick lime".) Produced by heating limestone to very high temperature. Apply only 50% of calcitic recommendation. Will burn plant roots upon direct contact.
- **Pelletized lime***- very similar to ground ag lime, but easier to apply.

Sulfur*: elemental sulfur, sold as "flowers of sulfur" or micro-fine sulfur, is used to lower soil pH. At pH above 6.0, iron sulfate lowers pH more quickly than sulfur.

POTTING MIXES

See also: Peat moss

Perlite*: a very lightweight heat-expanded volcanic mineral which provides drainage and oxygen space in soils. Does not hold nutrients or water but is especially effective for loosening heavy and clay soils. Commonly used in potting mediums.

Potting soil*: varies widely. Often contains topsoil. Tends to be heavy and drain poorly. Should be mixed with peat moss and perlite before using.

Soil-less mix*: a sterile mix of peat moss, perlite and vermiculite. Recommended for growing seedlings. Also fine for indoor and outdoor container gardening. Soil-less mixes, like *Pro-Mix, Reddi Earth,* and *Sunshine Mix,* have a small amount of added fertilizer, so they can sustain a crop of flower and vegetable seedlings for 4-5 weeks without the need for additional fertilizer. Work water into these mixes by hand, prior to use.

Vermiculite*: mica-type mineral heated in high temperature furnaces to form sterile, expanded, fan-like particles with many air spaces which promote aeration and water movement. Absorbs and holds nutrients and water (unlike perlite). Also rich in trace elements.

10 Ways to Conserve Nutrients, Prevent Pollution and Preserve Soil

1. Take a soil test every 3 to 4 years. Fertilize according to soil test recommendations. Do not exceed label directions.
2. Keep fertilizers off hard surfaces. Rain water will carry fertilizer salts into storm drains and surface waters and contribute to nutrient pollution of our waterways.
3. Keep bare soil covered with a mulch or plant a cover crop or ground cover. Over time, rainfall causes bare soil to erode and become compacted. Grow ground covers in place of turf in deep shade.
4. Leave grass clippings on your lawn (grasscycling.) They are a source of nitrogen for your lawn and will not contribute to thatch build-up in fescue or bluegrass lawns.
5. Keep stored manures and compost covered to prevent leaching of nutrients.
6. Incorporate or compost plant residues. However, discard plants with serious disease problems.
7. When appropriate, substitute slow-release fertilizers for those that are highly soluble and substitute locally available organic fertilizers like farmyard manure, backyard compost and municipal leaf compost for manufactured chemical fertilizers.
8. Keep soil in raised beds framed with solid sides. Avoid excessive foot or equipment traffic to prevent soil compaction, especially when the soil is wet.
9. Avoid cultivating soils on steep slopes. Construct terraces where appropriate.
10. To melt winter ice, use calcium magnesium acetate (CMA), potassium chloride (KCl), sodium chloride (NaCl) or calcium chloride ($CaCl_2$). Do not use urea, potassium nitrate, or other chemical fertilizers containing nitrogen or phosphorous. The salts in these fertilizers may burn the foliage and roots of adjacent plants and wash into and pollute waterways.

FERTILIZER GUIDELINES BY PLANT GROUP

Good health in plants depends on a continuous supply of available nutrients from the soil or, in the case of container plants, the growing media. Nutrient needs vary from plant to plant and the ability of the soil to supply those nutrients varies from site to site.

Take a soil test of major areas of your landscape -front and back lawn, vegetable garden, large flower beds- every 3-4 years to determine nutrient levels. The basic University of Maryland soil test will measure the levels of calcium, magnesium, phosphorous and potassium and soil pH. The levels of these nutrients are often in the "excessive" range in older and well-tended landscapes. This is not a problem for plants. It simply means you don't need to add these nutrients for some time.

Most garden and landscape plants grow best in a soil pH range of 6.0-7.0. Many nutrients become either unavailable or overly-abundant outside this range. Pay close attention to your soil pH readings and be prepared to adjust them according to your soil test recommendations.

Applying fertilizers won't necessarily help sick plants, if the cause of poor growth is related to insect, disease or environmental problems and not to a lack of nutrients. And overuse of fertilizers can lead to weak, succulent growth, encourage insect pests and disease problems and contribute to water pollution.

Home gardeners tend to over-fertilize flower and vegetable beds. Plan to reduce or eliminate fertilizer applications in these areas if an inch or more of organic matter is incorporated into the soil at least once a year.

Use the information below as a starting point for planning how to fertilize your plants. More specific information can be found in the Maryland Cooperative Extension fact sheets and publications listed on page 8.

Trees:

- Mature trees do not usually benefit from fertilization. Trees in the landscape receive nutrients from turf fertilization, grass clippings, fallen leaves and natural soil fertility.
- When required, trees are fertilized in the fall (after leaf drop) or early winter. Use 10-15 lbs. of 10-6-4 per 1,000 sq. ft. of area.
- Tree spikes are not recommended. When fertilizer is warranted, it should be broadcast evenly over an area that extends beyond the tree's dripline (canopy).

Shrubs:

- Shrubs that are surrounded by fertilized turf receive adequate nutrients and don't require additional fertilizer. The breakdown of organic mulches also contributes nutrients.
- Where growth is lagging, top-dress shrub beds with well-decomposed compost or apply a balanced fertilizer (e.g. 5-10-5, 10-6-4) in the late fall or early spring at the rate of 1 lb. per 100 sq. ft. of area.

Annual flowers:

- No fertilizer may be necessary if beds are heavily amended with organic matter. However, flower size and overall production can be increased with a supplemental fertilizer applied to the foliage or soil.
- In new gardens low in organic matter, apply 2-4 lbs. of 5-10-10 per 100 sq. ft. of area. In older gardens, apply 2 lbs. of 10-6-4 per 100 sq. ft. of garden area. Incorporate fertilizer into the top 6 inches of soil in early spring before planting.

Sweep or wash granular fertilizers off foliage to prevent leaf burn.

Herbaceous perennials:

- No fertilizer may be necessary if beds are heavily amended with organic matter.
- In new gardens low in organic matter, apply 2-4 lbs. of 5-10-10 per 100 sq. ft. of area. In older gardens, apply 2 lbs. of 10-6-4 per 100 sq. ft. of garden area. Broadcast the fertilizer lightly around plants in early spring.

Vegetables:

- No fertilizer may be necessary if beds are heavily amended with organic matter.
- In new gardens low in organic matter, apply 2-4 lbs. of 5-10-10 per 100 sq. ft. of area. In older gardens, apply 2 lbs. of 10-6-4 per 100 sq. ft. of garden area. Fertilizer should be applied and incorporated into the top 6 inches of soil in early spring.
- Early season crops benefit from foliar or liquid fertilizers, especially starter fertilizers (high in phosphorous), and kelp (seaweed products.)
- Perennial crops, like asparagus and rhubarb, are fertilized in early spring and after harvest.

Fruit:

- Most fruit plants are fertilized in early spring when buds swell. Strawberries are fertilized in July after harvest.
- Peaches require heavier fertilization than other fruit trees. Apple and pear trees should not be fertilized if the trees are healthy and productive (making 18-24 inches of new shoot growth each year.)

- Blueberry plants require a soil pH in the 4.3-5.2 range and should be fertilized each spring with ammonium sulfate.

Houseplants:

- Micronutrients are deficient in many houseplants, so replace them once a year. Fertilizing with a commercial fertilizer containing micronutrients or adding a small amount of well-composted, screened leaf mold or other compost will fill this need.
- Because magnesium leaches from the soil at each watering, replace it with a solution of 1 teaspoon Epsom salts per gallon of water. Water with this solution two times each year or use the solution as a leaf spray.
- During the winter months, houseplants don't need fertilizer because reduced light and temperature result in reduced growth. Fertilizing at this time could harm some plants, unless they are actively growing.
- Monthly applications of a dilute liquid fertilizer in the summer months will keep most plants healthy.
- Excessive fertilizer results in the buildup of salts, as evidenced by a white coating on the inside of pots, leafburn, and excessive, leggy growth. Flush out excessive salts by pouring a large amount of water through the growing media.

Herbs:

- Apply fertilizers sparingly. Many herbs, especially the "Mediterranean" herbs, such as basil, thyme, rosemary, oregano and lavender, grow best on sunny, dry sites with light (sandy) soil. Heavy applications of fertilizers or organic matter may lower the plants' essential oil content and encourage root and stem rot diseases.

Turf:

- Established, cool-season grasses (bluegrass and fescues) should be fertilized in the fall with two lbs. of nitrogen per 1,000 sq. ft. of area. One lb. should be applied in September and the second lb. in October. If you select a slow release fertilizer, a single fall appliction can be made. Do not exceed 2 lbs. of N per 1,000 sq. ft. of area. Ten lbs. of 10-6-4 fertilizer will supply one pound of nitrogen. If you miss the fall application or if your turf is weak or thin, apply ½ lb. of nitrogen per 1,000 sq. ft. of area in May.
- Warm season grasses (zoysia and bermuda) are fertilized in July with ½ -1 lb. of nitrogen per 1,000 sq. ft. of area.

MCE Publications containing fertilization guidelines:

- Home Fruit Production Guide EB125
- Lawns and the Chesapeake Bay. Fact Sheet 702
- Fertilizing Ornamental Trees and Shrubs. HGIC Mimeo #23
- Basic Principles of Soil Fertility I: Plant Nutrients. Fact Sheet 639
- Saving Your Soil and the Chesapeake Bay. Fact Sheet 704
- Fertilize Your Lawn, Not the Bay. HGIC Mimeo #305
- Indoor Redworm Composting. HGIC Mimeo #40
- Home Composting. Leaflet 245
- Soil Test Basics. HGIC Mimeo #11
- Lead in Garden Soils. HGIC Mimeo #18
- Melting Ice Safely. Fact Sheet 70
- The Maryland Master Gardener Handbook

Order these from your county/city MCE office, the toll free HGIC phone number or web site listed below.

Mention of specific commercial products and trade names does not constitute an endorsement by the University of Maryland.

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Xeriscaping and Conserving Water in the Landscape

True, Xerophytes are plants adapted to withstand long periods of drought, like a cactus or other succulent desert plants. But xeriscaping is not only desert plantings with succulents, yuccas and gravel. It is a technique of planning a landscape that conserves water by using plants that are tolerant of heat and dryness. Many of the same types of plants can also tolerate wet conditions as well. A water-conserving landscape requires little or no additional water during the periods of extended dryness. It is a landscape that is simple and beautiful with color, form and texture using a variety of plants. Many may be native species.

It has been reported that people in the U.S. use approximately 200 gallons of water each day in doing necessary daily activities. About half of the water used in households may be used for landscape and gardening purposes. People living in the Southwest U.S. are familiar with drought and have learned which plants tolerate dryness better if they are to have any success landscaping without using a lot of water. In Maryland we are fortunate to have a fairly plentiful supply of rain during the spring and fall months, but usually by mid-summer our weather rivals that of the Southwest. Gardeners learn from these experiences and learn which plants require less water and still remain healthy-looking under drought and heat stress.

How Plants Cope with Drought

Plants have a remarkable ability to adapt and have evolved over time to grow successfully in their environment. Some of these adaptations for heat and dryness are not only practical, but also give many plants a special beauty and appeal for use in the landscape. For example, many xeriphytic plants have silvery or gray foliage. This color is created by a coating of fine hairs that shades the leaf's surface, reducing moisture loss by the sun and wind. Another means of protection is a thick wax layer called cutin that gives the leaf a dull bluish color.

Most plants that have evolved for survival under arid conditions also have reduced leaf sizes. When there is less leaf surface area, the moisture loss is reduced. Some types of plants have developed large, fleshy, deep roots (such as a tap root). These enable the plant to reach deep into the soil for moisture that in unavailable to shallower rooted plants. Lastly, many xeriphytic plants have succulent stems that serve as reservoirs of water for use at a later time. The typical example is the cacti although many other types possess these features.

Common Misconceptions about Xeriscaping

- *Lawn grass in the least expensive landscape planting and the easiest to care for.* Yes, a lawn may be the lowest cost to put in initially. Thereafter, however, it requires more frequent maintenance, such as mowing, and other chores than any other landscape feature. If irrigated, lawns require five times more water than other landscape plants.

- *Water-conserving landscapes are dull and lack color.* Contrary to what xeriscaping brings to mind, it is not only cacti and rock gardens. Many woody and herbaceous plants already in popular use in Maryland qualify for xeriscaping. A well-planned water-conserving landscape will have a mixture of carefully selected trees, shrubs, ground covers, annuals and perennials.

- *Drought-tolerant plants don't require any water or maintenance.* Not quite true. All plants need water to become established and drought-tolerant plants are no different in this respect. However, they require a lot less supplemental water and tolerate extended periods of little or no rainfall better than other plants. Drought tolerant plants can easily reduce water use by as much as 50% or more. Like any type of landscape they still need occasional weeding, pruning and pest monitoring.

Water Saving Tips for Homeowners

- Always use water sparingly, irrigating the landscape only when absolutely necessary. Lawns consume the greatest share of water used and many times it is not even required. Lawns in our region normally go into a summer dormancy

when regular rainfall decreases and the temperatures increase. They stop growing and often turn brown. This is a normal process and does not mean the lawn will die. Water established landscape plantings only when the soil is dry to a depth of six inches. Drought tolerant landscapes will be able to withstand these dryer conditions longer without additional water.

- Water in the morning. Watering during the heat of the day increases the amount of water lost to evaporation by as much as 40%. On the other hand, avoid late day or evening overhead watering if possible. Overhead watering at that time promotes fungal diseases because the foliage will not have time to dry before darkness when fungi spores are released.

- Water infrequently, slowly and deeply. Frequent light watering actually does more harm than good because it encourages shallow root growth. The only plants that seem to benefit from frequent shallow watering are weeds.

- Prevent water from running off the landscape. Often sprinklers and other water devices throw water on paved surfaces. This water goes directly into storm drains and is wasted. Use soaker hoses and low-output sprinklers to reduce this type of water waste.

- Repair leaking hose connections and sprinkler parts. It has been estimated that leaking connections waste 50% or more of the water flowing through a hose.

- Turn off automatic sprinkler systems when it is raining. Obviously this makes sense, but many times automatic sprinkler systems are set on a timer and continue to operate even during rain.

- Mow the lawn high. Cool season grass species such as bluegrass, red fescue and tall fescues grow best at a higher mowing height. The recommended height is 2 to 3 inches. This height is not only better for the health of the grass and reduces weed invasion, but also shades the soil, reducing evaporation of moisture.

- Mulching planting beds. Organic mulches, such as bark, not only add an aesthetic touch to the landscape and reduce weeds, but they also reduce evaporation from the soil and keep the soil cooler during the summer. The porous texture of mulch also traps water allowing it to percolate slowly into the soil instead of running off the site. The recommended depth for mulch is about 2 inches. Remove old mulch or incorporate it into the soil before applying fresh material. Too often people over apply mulches, causing them to be several inches over the recommended depth. This is damaging because it starves the surface roots of oxygen. Also be careful not to pile mulch against the stems and trunks of woody plants. This can cause cankers and other rots to occur.

- Plant trees and shrubs in mass plantings. Most residential landscapes have only a few shade trees scattered individually. Shrubs are also often planted individually. Trees and shrubs actually look best when planted in groups. Planting in this manner will reduce the lawn area and therefore reduce maintenance time and watering.

- Rethink the lawn. So many homeowners try to maintain grass in places where it simply does not grow well. It becomes thin and the exposed soil dries, becomes compacted and erodes during storms. Grass is not the best choice under the dense shade of trees, on steep slopes, narrow strips between buildings and walkways or areas of heavy foot traffic. Use ground covers or other suitable plants or durable materials instead.

- Plant in the spring or fall when temperatures are lower and water loss from the soil is reduced. This is an easier time for new plantings to get established with less water needed.

- Make small earthen basins around newly planted trees and shrubs to catch water and hold it for the roots to absorb.

- Remove or kill weeds before they grow large. Weeds compete heavily with landscape plants for soil moisture and usually they win.

- Antidesiccant sprays may or may not be helpful in reducing moisture loss from leaves. There is no research that proves these materials perform as advertised.

- Keep the water on the site. Prevent rainfall and irrigation water from running into streets. Design features that direct runoff from down spouts, driveways and patios into lawn and garden areas where it can be absorbed. Be careful not to divert this water into planting areas that drain poorly, or plants may be damaged or killed.

A Selection of Drought-Tolerant Landscape Plants

The plants listed below are some that generally survive well under dry, hot conditions that would normally harm most other plants. It must be kept in mind that even these plants will require regular watering during the first season they are planted. The frequency of watering of established landscapes will vary based on the plant species, its conditions and maturity and soil conditions of the site.

Shade Trees

Red Maple	(*Acer rubrum*) (wet or dry situations, and depends on seed source)
Green Ash	(*Fraxinus pennsylvanica*)
Ginkgo	(*Ginkgo biloba*)
Tupelo	(*Nyssa sylvatica*)
Red Oak	(*Quercus rubra*)
Pin Oak	(*Quercus palustris*)
Zelkova	(*Zelkova serrata*)
Japanese Pagodatree	(*Sophora japonica*)
Golden Raintree	(*Kolreuteria paniculata*)
Japanese Tree Lilac	(*Syringa reticulata*)
Crapemyrtle	(*Lagerstroemia indica*)
Tulip Poplar	(*Liriodendron tulipfera*)

Evergreen Trees

Atlas Cedar	(*Cedrus atlantica*)
Colorado Blue Spruce	(*Picea pungens glauca*)
American Holly	(*Ilex opaca*)
Red Cedar	(*Juniperus virginiana*)

Deciduous Shrubs

Red Chokeberry	(*Aronia arbutifolia*)
Smoketree	(*Cotinus coggyria*)
Pinxterbloom Azalea	(*Rhododendron nudiflorum*)
Flameleaf Sumac	(*Rhus copallina*)
Burning Bush	(*Euonymus alatus*)
Fragrant Wintersweet	(*Chimonanthus praecox*)
Japanese Barberry	(*Berberis thunbergii*)

Evergreen Shrubs

Heavenly Bamboo	(*Nandina domestica*)
False-Holly	(*Osmanthus heterophyllus*)
Mugo Pine	(*Pinus mugo*)
Pyracantha	(*Pyracantha coccinea*)
Glossy Abelia	(*Abelia x grandiflora*)
Junipers	(*Juniperus species*)

Herbaceous Plants:

May-June Blooming:

Cushion Spurge	(*Euphorbia sp*)
Candy tuft	(*Iberis sempervirens*)
Dwarf Crested Iris	(*Iris cristata*)
Sea Pink	(*Armeria maritima*)
Perennial Bachelor's Button	(*Centaurea montana*)
Gas Plant	(*Dictamnus albus*)
Day Lily	(*Hemerocallis*)
Beaded Iris	(*Iris spp*)
Iceland Poppy	(*Papaver nudicaule*)

June-Sept Blooming:

Black Eyed Susan	(*Rudbeckia hirta*)
Yarrow	(*Achillea filipendulina*)
Coreopsis	(*Coreopsis lanceolata*)
Coreopsis	(*Coreopsis verticillata*)
Foxtail Lily	(*Eremurus x isabellinus*)
Blanket Flower	(*Gaillardia x grandiflora*)
Perennial Baby's Breath	(*Gypsophila paniculata*)
Red-Hot Poker	(*Kniphofia uvaria*)
Moneywort	(*Lysimachia nummularia*)
Perennial Salvia	(*Salvia x superba*)
Yucca	(*Yucca filamentosa*)
Blue Fescue	(*Festuca glauca*)
Hens and Chicks	(*Sempervivum tectorum*)
Goldenrod	*spp.*(*Solidago*)
Lamb's Ear	(*Stachys byzantina*)
Pearly Everlasting	(*Anaphalis margaritacea*
Silvermound	(*Artemesia schmidtiana*)
Liatris	(*Liatris spicata*)
Sedum	(*Sedum spectabile*)

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Watering Tips for Drought Conditions

Maryland frequently experiences hot, dry conditions during the summer months. When drought conditions are prolonged, landscape plants, trees and lawns may suffer temporary or permanent damage. This fact sheet will help you make the right decisions for watering and managing your landscape when Mother Nature turns the spigot off.

Plants are like water pumps, drawing in moisture from the soil that is used for plant growth and then releasing water from stems and leaves through a process called transpiration. Plants begin to wilt and suffer drought stress when the transpiration rate exceeds water uptake. Drought periods that occur during the long-day months of June and July are more damaging than those in August and September because of increased day length. Dry breezes also contribute significantly to drought stress.

Signs of Drought Stress

In addition to wilting, plants will exhibit some or all of the following symptoms during a prolonged drought:

- Upward curling or rolling of leaves
- Yellowing and browning of leaves, particularly along leaf margins and tips
- Under-sized and off-flavored fruits, vegetables and nuts
- Under-sized leaves; twig and branch dieback
- Blossom and fruit drop
- Interior needle and leaf drop on conifers and evergreens
- Iron chlorosis symptoms on foliage (leaf yellowing between veins)

Secondary problems associated with drought:

- Spider mite infestations
- Blossom-end rot of tomatoes, peppers, squash and melons
- Increased wildlife feeding on fruits and vegetables
- Increased damage by insects (e.g. grasshoppers) driven into home landscapes by a lack of food and water

Long-term consequences of drought:

- Increased susceptibility to attack by insect borers
- Increased susceptibility to certain plant diseases
- Root death
- Diminished winter hardiness
- Terminal dieback; dead twigs and branches
- Eventual plant death

Prioritize Your Plants

First, determine which plants are most susceptible to water stress. High on your watering list should be plants that are valuable in terms of replacement cost, prominence in the landscape and enjoyment. Below is a rating system for prioritizing the water needs of typical landscape plants:

High Priority- trees and shrubs (especially those that are young and planted in an exposed site). Large, mature shade trees and shrubs can be left alone unless the drought is severe and the trees begin to wilt, or the root systems have been recently disturbed.

Medium to high priority- perennials, fruit and nut trees, small fruits and vegetables; turf that is less than one-year old.

Low priority- annual flower and herb plants, ornamental grasses, established turf. These are relatively inexpensive and easily replaced. It may be difficult to keep large beds of annuals adequately watered during a drought. (See HGIC Fact Sheet: Irrigation and Water Conservation on Home Lawns.)

Lawns

Lawns composed mostly of turf-type tall fescue will withstand drought conditions unless they are newly seeded or sodded. Established fescue and bluegrass lawns should not be irrigated. Light, frequent watering can be harmful because it encourages shallow rooting. Fescue lawns turn brown and become dormant during a drought, but green-up and grow with a return to cooler, wetter weather. Like fescue, bluegrass is a cool-season grass that will become dormant during droughty weather. Bermudagrass and zoysiagrass are warm-season grasses that cope well with hot, dry weather and require no irrigation. Increasing the mowing height to 2.5 to 3" for cool-season turf grasses will also help them withstand drought conditions.

Cultural Tips

- ☐ Mulch around plants to keep weeds down, conserve soil moisture and moderate soil temperatures. Organic mulches, such as bark, shredded leaves, grass clippings and straw are preferred because they improve soil structure and return nutrients to the soil upon decomposition. Apply mulches no deeper than 2-3 inches.
- ☐ Avoid using fertilizers or pesticides. Fertilizers can damage root systems under droughty conditions and pesticides may burn plant foliage.
- ☐ Resist the temptation to prune "dead wood" from your woody ornamentals. Wood that is obviously dead may be removed at any time. However, drought-stressed plants become dormant and may appear dead. Dead wood is brittle and brown under the bark and dormant wood is green under the bark.
- ☐ Keep foot and equipment traffic to a minimum on dormant turf. Turfgrass crowns become brittle during a drought and are more easily damaged by compaction.
- ☐ Keep turf at least 2 feet from the trunks of young or newly planted trees because it competes with the trees for water. Apply a mulch in this area.
- ☐ Control weeds around shrubs, vegetables and flowers. Weeds can out-compete cultivated garden plants for water and nutrients.
- ☐ Spray plant foliage with water during the day to reduce spider mite populations. Spraying water on vegetable plants will help prevent blossom and fruit drop. (Watering plants on a hot day will **not** burn the foliage).
- ☐ Replace declining or dead plants with those that are hardy and more drought tolerant. (See HGIC Fact Sheet #25- eriscaping and Conserving Water in the Landscape)
- ☐ Leave shallow pans of fresh water out for wildlife and beneficial insects. Keep birdbaths filled with fresh, clean water.

When possible, add organic matter to the soil on your property. This will improve the water-holding capacity during dry weather and promote good drainage during wet weather.

Watering Tips

When:

When the soil is dry. Soil that cannot be formed into a ball is too dry to supply water to plant roots.

Water when plants first begin to wilt. The needles of evergreen shrubs and trees will become dull-colored when water-stressed. Leaf browning (scorch) is a sign that drought damage has already occurred.

Water in early morning, if possible. Evening watering is fine although it may contribute to disease problems.

How much:

A good rule of thumb is to apply 1 gallon of water per square foot of root zone once a week. This will vary depending on the type of plant and its growth stage. For example, large vegetable plants, like tomato, squash and cucumber, that are fruit-laden require large amounts of water and may need to be irrigated 2-3 times each week. If you water with a garden hose without a nozzle, simply make note of how much time it takes to fill a 5-gallon bucket. You can then calculate how much time it will take to deliver a given amount of water.

Sandy soils need to be re-watered sooner than soils high in clay.

Water will penetrate grass and mulch-covered soils more quickly than bare soil. Bare soils high in clay often form a crust that limits water infiltration.

Pull back your mulch to be sure the water is getting past it to the root-zone. Check the soil wetting depth with a screwdriver or stake. To adequately wet the root system you need to thoroughly moisten the top 4-6 inches of soil.

Application Methods:

It is very important to apply enough water to thoroughly wet the root zone. The larger the plant the larger the root zone. The root zones of trees and shrubs extend out from the trunk in an area at least equal to the height of the plant.

Water plants slowly and deeply at least once each week during very hot and dry weather. Apply water around the base of herbaceous plants (vegetables, flowers and herbs) so that it percolates down through the soil to the root zone.

Invest in soaker hoses and drip irrigation systems for vegetable, fruit, and flower gardens. These operate at low pressure and deliver water slowly and efficiently to the root zone.

Water sprinklers should be moved back and forth to prevent soil erosion and run-off onto driveways and sidewalks.

Gray water (from washing dishes and clothes) can be used around outdoor plants. Avoid using water that has been through a water-softening device.

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Fact Sheet

Fact Sheet 726

RIPARIAN BUFFER MANAGEMENT

TREES FOR RIPARIAN FOREST BUFFERS

Tree selection for a riparian forest buffer requires consideration of several factors:

- region,
- wildlife value,
- light preference,
- flood tolerance,
- growth rate,
- height, and
- rooting.

Trees closest to the waterway are most likely to be flooded, and need a greater tolerance to high water tables. If the area has recently been disturbed, trees with a fast growth rate will quickly establish root systems to hold the soil. Fast-growing trees are not necessarily long-lived, therefore interplanting fast- and slow-growing trees is a wise practice.

Eventual tree height is an important factor to consider. Ask the following questions when you choose your buffer:

1. At its maximum height, will the tree provide adequate shade for the stream?

2. Are there any aesthetic considerations (the trees will screen or frame a view or provide a windbreak)?

3. Are there any safety considerations (avoiding power and telephone lines or ensuring that the view of vehicles on a road is not obstructed)?

Trees with shallow rooting systems hold surface soils well, but do not provide as much stability to high banks and steep slopes as trees with deeper root systems. Also, deeper root systems anchor trees better where there are repeated flooding/drying cycles.

Below is a table of trees recommended for Maryland riparian forest buffers, compiled from several references. Information on the trees' ecological and growing characteristics should help the landowner determine suitable species for a specific riparian forest buffer site.

REFERENCES

Brown, R.G. and M.L. Brown. 1972. *Woody Plants of Maryland.*

Collingwood, G.H. and W.D. Brush. 1984. *Knowing Your Trees.*

U.S. Department of Agriculture Forest Service. 1997. *Chesapeake Bay Riparian Handbook.*

Riparian Buffer Management: Trees for Riparian Forest Buffers
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Trees for Riparian Forest Buffers

	Region	Wildlife Value	Light Preference	Flood Tolerance	Growth Rate	Height (feet)	Rooting
	Coastal plain (CP) Piedmont (P) Mountains (M)	V. high High Medium Low	○ ◗ ●	High Medium Low	V. fast Fast Medium Slow	>75' 50-75' <50'	
American basswood	P, M	Low	◗	Low	Medium	>75'	Deep lateral
American beech	CP, P	High	◗/●	Low	Slow	>75'	Shallow
American holly	CP, P	High	◗	Medium-Low	Slow	30-40'	Taproot
American hornbeam	P, M	Medium-High	◗/●	Medium-Low	Slow	30-40'	Deep lateral
Bald cypress	CP, P	Low	○/◗	High	Medium	>75'	Shallow
Bitternut hickory	CP, P	Medium	○/◗	Medium	Medium-Slow	>75'	Deep taproot
Black cherry	P, M	High	◗/●	Low	Medium	40-60'	Deep taproot
Blackgum	CP, P, M	Medium	○/◗	Medium-High	Slow	<50'	Taproot
Black locust	P, M	Low	○	Low	Medium-Fast	40-60'	Shallow
Black walnut	P, M	Medium-Low	○/◗	Medium	Medium	>75'	Taproot
Black willow	P, M	High	○	High	Very fast	50-75'	Shallow
Boxelder	P, M	Medium	○	High	Very fast	>50'	Deep lateral
Cherrybark oak	CP	High	◗	Low	Medium	>75'	Taproot
Chestnut oak	P, M	High	◗/●	Low	Slow	50-75'	Taproot Deep lateral
Choke cherry	CP, P, M	High	○/◗	Low	Fast	<50'	Deep taproot
Crabapple	CP, P, M	High	○/◗	Low	Medium	<30'	Shallow
Dogwood	CP, P, M	Medium	○/◗/●	Low	Slow	30-40'	Shallow
Eastern cottonwood	CP, P, M	Low	○	High	Fast	>75'	Shallow

Wildlife Value = food source for wildlife

Light Preference: ○ = full sunlight
◗ = partial shade
● = shade

Flood Tolerance: High = tolerates flooding/high water
Low = does not tolerate flooding/high water

	Region	Wildlife Value	Light Preference	Flood Tolerance	Growth Rate	Height (feet)	Rooting
	Coastal plain (CP) Piedmont (P) Mountains (M)	V. high High Medium Low	○ ◗ ●	High Medium Low	V. fast Fast Medium Slow	>75' 50-75' <50'	
Eastern red cedar	CP, P	Medium	○/◗	Low	Slow	<50'	Shallow
Green ash	CP, P, M	Low-Medium	○	Medium-High	V. fast	50-75'	Shallow
Grey birch	CP, P, M	Medium	○/◗	Low-Medium	Medium-Slow	60-70'	Shallow
Hackberry	CP, P, M	High-V. high	○/◗	Medium	Fast-Medium	>75'	Deep lateral
Hawthorn	CP, P, M	High	○	Low-Medium	Medium	<30'	Shallow
Hemlock	P, M	Medium	◗/●	High-Medium	Slow-Medium	>60'	Shallow lateral
Hophornbeam	CP, P, M	Medium	○/◗/●	Low	Slow	<30'	Shallow
Loblolly pine	CP, P	Low-Medium	○	Low	Fast	>75'	Shallow
Mulberry	CP, P	High-Medium	◗/●	Medium	Fast	30-40'	Taproot
Northern red oak	CP, P, M	Medium-High	◗	Low	Medium-Fast	>75'	Deep lateral
Overcup oak	CP	High	◗/●	Medium	Slow	50-75'	Deep taproot
Pawpaw	P	V. high	◗/●	Low-Med.	Slow	30-40'	Deep lateral
Persimmon	CP, P	V. high-High	○	Medium	Slow	<50'	Deep taproot
Pin oak	CP, P	High	○/◗	Medium-High	Fast-Medium	>75'	Shallow
Pitch pine	CP	Low	○	Medium	Medium-Slow	<50'	Shallow
Redbud	CP	Medium	◗	High	Slow	<50'	Shallow

	Region	Wildlife Value	Light Preference	Flood Tolerance	Growth Rate	Height (feet)	Rooting
	Coastal plain (CP) Piedmont (P) Mountains (M)	V. high High Medium Low	○ ◗ ●	High Medium Low	V. fast Fast Medium Slow	>75' 50-75' <50'	
Red maple	CP, P, M	Medium-High	○/◗	High	Fast Medium	50-75'	-Very shallow
River birch	CP, P, M	Medium-High	○/◗	High	Fast	50'+	Shallow
Sassafras	CP, P, M	High	○	Low	Fast	<50'	Shallow
Scarlet oak	CP, P, M	Medium-High	◗	Low	Medium	50-75'	Deep lateral
Shagbark hickory	CP, P, M	Medium	◗	Med.-Low	Medium	50-75'	Deep taproot
Silver maple	CP, P, M	Low-Medium	○/◗	High	Medium	>75'	V. shallow
Southern red oak	CP, P	Medium	◗	Medium	Medium	50-75'	Deep lateral
Sugar maple	M	Medium	●/◗	Med.-Low	Slow	<75'	Shallow
Swamp chestnut oak	CP, P	High	○/◗	High	Medium	50-75'	Shallow
Swamp white cedar	CP	Medium	○	Medium-High	Medium Slow	50-75'	Shallow
Swamp white oak	CP, P	High	○/◗	High	Fast-Medium	>75'	Shallow
Sweet bay magnolia	CP, P	V. low-Low	◗	Medium	Medium	<30'	Deep lateral
Sweet birch	M	Medium	◗/●	Medium	Slow	50-75'	Shallow
Sweetgum	CP, P	Medium-Low	○/◗	Medium-High	Medium	50-75'	Deep taproot
Sycamore	CP, P	Low	○/◗	Medium	V. fast	50-75'	Shallow
Water oak	CP	Medium	◗	Medium-High	Fast	50-75'	Deep lateral
White ash	P, M	Medium-Low	○/◗	Medium	Medium	>75'	Shallow
White oak	CP, P, M	V. high	○/◗	Low-Medium	Slow	>75'	Deep taproot
Willow oak	CP, P	High	○/◗	Medium-High	Fast-Medium	>75'	Shallow
Yellow poplar	CP, P, M	Low	○/◗	Low	Fast	>75'	Shallow/deep

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Fact Sheet

Fact Sheet 727

RIPARIAN BUFFER MANAGEMENT

UNDERSTORY PLANTS FOR RIPARIAN FOREST BUFFERS

The following tables list understory trees and shrubs appropriate for riparian forest buffers. Understory trees and shrubs are tolerant to shade and are an important structural component of any forest. Some shrubs, such as rhododendron and some blueberries are also adapted to the low-light conditions of the forest understory, but more are adapted to the buffer's edge. The edge might be next to the water or next to an upland area. Most of the shrubs listed prefer moist growing conditions and are good choices for areas that filter water flow. Shrubs that prefer drier sites include witch hazel, grey dogwood, and rosebay rhododendron.

Including understory trees and shrubs in a riparian forest buffer planting increases the structural diversity of the buffer by providing layers of vegetation. This increases biodiversity and enhances both the water quality and wildlife habitat attractiveness of the buffer.

REFERENCES

U.S. Department of Agriculture Forest Service. 1997. *Chesapeake Bay Riparian Handbook.*

Other Fact Sheets in the Riparian Buffer Series:

FS 724	An Introduction to the Riparian Forest Buffer
FS 725	Buffer Design, Establishment, and Maintenance
FS 726	Trees for Riparian Forest Buffers
FS 728	Grasses for Riparian Buffers and Wildlife Habitat Improvement
FS 729	Soil Bioengineering or Streambank Restoration for Riparian Forest Buffers
FS 733	Riparian Buffer Systems

Riparian Buffer Management: Trees for Riparian Forest Buffers
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Riparian Understory Shrubs

	Region	Wildlife Value	Light Preference	Flood Tolerance	Growth Rate	Deciduous/ Evergreen	Rooting
	Coastal plain (CP) Piedmont (P) Mountains (M)	V. high High Medium Low	○ ◗ ●	High Medium Low	V. fast Fast Medium Slow		
Arrowwood viburnum	CP, P, M	Medium	○/◗	Medium	Medium	Deciduous	Shallow
Bayberry	CP	High	○	High	Medium	Deciduous/ Evergreen	Shallow
Blackhaw	P, M	High	○/◗	High	Medium	Deciduous	Shallow
Buttonbush	CP, P, M	Medium-High	○/◗	High	Medium	Deciduous	Shallow
Common ninebark	CP, P	Medium	○	High	Fast	Deciduous	Shallow
Elderberry	CP, P, M	V. high	○/◗	High	Fast	Deciduous	Shallow
Grey dogwood	P, M	V. high	○/◗	Low	Medium	Deciduous	Shallow
Highbush blueberry	CP, P	V. high	○/◗	High	Slow	Deciduous	Shallow
Inkberry	CP	High	○/◗	High	Slow	Evergreen	Shallow
Maple-leaf viburnum	P, M	High	◗/●	Low	Medium-Slow	Deciduous	Shallow
Pinxterbloom azalea	CP, P	Low	◗/●	High	Slow	Deciduous	Shallow
Possumhaw	P, M	High	○/◗	High	Medium	Deciduous	Shallow
Pussy willow	P, M	Medium	○	Medium	Fast	Deciduous	Shallow
Red chokeberry	CP	Medium	○/◗	High	Slow	Deciduous	Shallow
Red osier dogwood	CP, P, M	High	○/◗	High	Fast	Deciduous	Shallow
Rosebay rhododendron	CP, P, M	Low	◗/●	Low	Slow	Evergreen	Shallow
Silky dogwood	P, M	High	○/◗	Medium	Fast	Deciduous	Shallow (good bank stabilizer)

Wildlife Value = food source for wildlife

Light Preference: ○ = full sunlight
◗ = partial shade
●= shade

Flood Tolerance: High = tolerates flooding/high water
Low = does not tolerate flooding/high water

Riparian Understory Shrubs (continued)

	Region	Wildlife Value	Light Preference	Flood Tolerance	Growth Rate	Deciduous/ Evergreen	Rooting
	Coastal plain (CP) Piedmont (P) Mountains (M)	V. high High Medium Low	○ ◗ ●	High Medium Low	V. fast Fast Medium Slow		
Smooth alder	P, M	Medium	○/◗	High	Medium-Fast	Deciduous	Shallow
Speckled alder	M	Medium	○	High	Fast	Deciduous	Shallow
Spicebush	CP, P, M	V. high	●/◗	Medium	Fast	Deciduous	Deep lateral
Swamp azalea	CP, P	Low	○/◗	High	Medium	Deciduous	Shallow
Swamp leucothoe	CP, P	Low	◗/●	Medium	Slow	Evergreen	Shallow
Sweet pepperbush	CP, P, M	High	○/◗	High	Medium	Deciduous	Shallow
Virginia sweetspire	P, M	Low	○/◗	High	Medium-Slow	Deciduous	Shallow
Winterberry	CP, P	High	○/◗	High	Slow	Deciduous	Shallow (seasonally flooded areas)
Witch-hazel	P, M	Low	○/◗	Low	Medium	Deciduous	Deep lateral

Wildlife Value = food source for wildlife

Light Preference: ○ = full sunlight
◗ = partial shade
● = shade

Flood Tolerance: High = tolerates flooding/high water
Low = does not tolerate flooding/high water

Riparian Understory Trees

	Region	Wildlife Value	Light Preference	Flood Tolerance	Growth Rate	Height (feet)	Rooting
	Coastal plain (CP) Piedmont (P) Mountains (M)	V. high High Medium Low	○ ◗ ●	High Medium Low	V. fast Fast Medium Slow	>75' 50-75' <50'	
American holly	CP, P	High	◗	Medium-Low	Slow	30-40'	Taproot
American hornbeam	P, M	Medium-High	◗/●	Medium-Low	Slow	30-40'	Deep lateral
Boxelder	P, M	Medium	○	High	V. fast	>50'	Deep lateral
Flowering Dogwood	CP, P, M	Medium	○/◗/●	Low	Slow	30-40'	Shallow
Hawthorn	CP, P, M	High	○	Low-Medium	Medium	<30'	Shallow
Hophornbeam	CP, P, M	Medium	○/◗/●	Low	Slow	<30'	Shallow
Pawpaw	P	V. high	◗/●	Low-Medium	Slow	30-40'	Deep lateral
Persimmon	CP, P	V. high-High	○	Medium	Slow	<50'	Deep taproot
Redbud	P, M	Medium	◗	High	Slow	<50'	Shallow
Sassafras	CP, P, M	High	○	Low	Fast	<50'	Shallow
Shad-bush	P, M	High	◗/●	High	Slow	30-40'	Shallow
Sweet bay magnolia	CP, P	V. low-Low	◗	Medium	Medium	<30'	Deep lateral

Wildlife Value = food source for wildlife

Light Preference: ○ = full sunlight
◗ = partial shade
●= shade

Flood Tolerance: High = tolerates flooding/high water
Low = does not tolerate flooding/high water

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Introduction to Herbaceous Perennials

Using Perennials

Enthusiasm for perennials has been on the increase in this country since the late seventies. This is due in part to the wide selection of herbaceous perennials available today, their ornamental appeal and their ability to thrive with minimal care. Fortunately, there are many perennials that are not susceptible to insects and diseases which is another advantage in their favor. Many perennials offer a wide range of color, texture and form, all of which contribute to the beauty of a landscape. Many are also ideal for fresh cut or dried flowers. Perennials are indeed very appealing. They are best utilized as part of a total design incorporating trees and shrubs. A well-planned perennial border will provide that special seasonal interest that so many landscapes need.

To begin, follow a few basic design principles and add your imagination to create a visually rewarding garden. The following is a description of some basic principles used by professional designers that will help in the creation of a perennial garden with long-lasting seasonal interest. Don't be afraid to copy successful ideas that you like in other people's gardens.

Seasonal Display and Color

The primary reason people grow flowering plants is for the color and beauty of their flowers. Next is for the form and texture of the foliage. Some perennial plants may be selected exclusively for their unique foliage interest. When it comes to color there are different aspects to consider when planning a perennial garden. Consider not only the blossoms but also the color of surrounding features such as the background, other plants, fences, etc. Color can also set moods for the observer. Consider a garden backed by evergreens or woodlands which would lose blue and purple colors in the foreground, but would look very striking with yellows, white or silver. For example, red, yellow and orange are bright, warm and cheering while blue and white are calming and cooling. A romantic old fashioned look is achieved with pastels. If uncertain about choice of a color, use a color wheel. There are basically three successful combinations.

A Selection of Perennials for a Succession of Bloom

Early Spring (February - March)

Lenten Rose	*Helleborus*

Late Spring (April-May)

Bergenia	*Bergenia*	Globeflower	*Trollius*
Barrenwort	*Epimedium*	Iris	*Iris*
Bleeding Heart	*Dicentra*	Lady's Mantle	*Polygonum*
Creeping Buttercup	*Ranunculus*	Lungwort	*Pulmonaria*
Candytuft	*Iberis*	Peony	*Paeonia*
Columbine	*Aquilegia*	Pinks	*Dianthus*
Coralbell	*Heuchera*	Poppy	*Papaver*
Gas Plant	*Dictamnus*	Sea Pink	*Dianthus*

Summer (June-August)

Japanese Anemone	*Anemone*	Coralbell	*Heuchera*
Stoke's Aster	*Stokesia*	Coreoposis	*Coreoposis*
Astilbe	*Astilbe*	Gas Plant	*Dictamnus*
Baby's Breath	*Gypsophila*	Goldenrod	*Solidago*
Balloon Flower	*Platycodon*	Ligularia	*Ligularia*
Butterfly Weed	*Asclepias*	Lupine	*Lupinus*
Cardinal Flower	*Lobelia*	Garden Phlox	*Phlox*
Black-eyed Susan	*Rudbeckia*	Perennial Sunflower	*Helianthus*
Shasta Daisy	*Chrysanthemum*	Yarrow	*Achillea*
Daylily	*Hemerocallis*		

Fall (September-Frost)

Hardy Ageratum	*Eupatorium*	Coralbell	*Heuchera*
Japanese Anemone	*Anemone*	Big Blue Lily Turf	*Liriope*
Aster	*Aster*	Mallow	*Malva*
Chrysanthemum	*Chrysanthemum*	Stonecrop	*Sedum*

Monochromatic - combines all shades of the same color.
Complementary - Includes colors that are exactly opposite such as blue with orange.
Analogous - colors that are next to each other on the color wheel such as all the shades of blue plus all the shades of violet, etc.

Two additional hints are helpful: white flowers and grey foliage are considered neutral and always blend easily with any other color; secondly, varying the intensity of different colors will also provide additional vitality. The nice thing about perennials is that even if the finished planting does not turn out exactly as you like, it is usually easy to transplant them to a new spot. Try to select plants that, when combined, will provide a succession of bloom throughout the season. This takes some thought because most perennials have a limited season of bloom. Also, annuals can be successfully integrated into the garden to provide bloom between the times when perennials are not in full bloom.

When developing the garden, avoid putting all of the plants that bloom at the same time in the same place. Instead, spread them out in groups to achieve balance in the garden. Intermixing plants according to their time of bloom may seem complicated, but the job is actually fairly simple if you draw the plan out on paper first. Of course changes can be made from year to year as you see any problems or you find new plants that you want to add.

Form and Texture

Form and texture are characteristics of plants that many gardeners overlook when considering a perennial garden design. In reality, some plants are included in the garden solely for the texture of their foliage. Many of these types of plants include ferns, hostas, sedums and ornamental grasses.

Even blossoms will vary in form and texture, ranging from the delicate blossoms of baby's breath to the heavy coarse blossom of the foxtail lily. By choosing perennials with different forms and texture, the garden can become more interesting. Examples of different plant forms include: low ground hugging forms, tall spike types, arching types and rounded types. Some examples of texture include feathery leaved plants and coarse types with large bold foliage. It is best to contrast foliage forms next to each other for textural interest.

Some plants can provide interest with their uniquely patterned foliage or blossoms. These include spots, stripes or splotches of color on leaves or blossoms. Be careful not to overuse them because too much becomes distracting rather than complimentary to the design.

Maintenance

Most perennials are tolerant of a range of soil types as long as they drain. Some perennials will even tolerate wet soils. Unlike annuals or vegetable gardens, perennial gardens are not tilled each year. Once planted they usually are not disturbed except for some routine care. Therefore, the initial work of incorporating liberal amounts of organic matter when the garden is planted will certainly pay off in the long run. Once the garden is established it requires minimal seasonal care. However, it is an important point that all gardens need some maintenance.

Basically, there are four tasks that should be performed on a regular basis throughout the growing season. These are: watering, weeding, fertilizing and removing spent blossoms. Occasionally insect control is needed to protect the aesthetic quality of a plant, although insect pests seldom destroy the entire plant. Every 3 to 8 years most perennials will need dividing because they will have grown too crowded. Perennials that are too crowded have greatly reduced vigor and bloom. Division of perennials is usually done in early spring or fall. Some perennials need to be divided during a specific season. If uncertain about dividing then check one of the suggested references.

Watering

In the absence of regular rainfall, irrigation will be very important during the first year the garden is established. Infrequent, deep irrigation is better than frequent shallow irrigation which only encourages shallow roots and will encourage weed growth. To avoid wasting water and spreading foliar diseases, apply the water with a hose or soaker hose directly to the soil in the early morning hours of the day. Dig into the soil to make sure that the soil is wet to a depth of six inches. Mulching will help to conserve soil moisture as well as reduce weed growth.

Weeding

The best method for weed control is the use of an organic mulch, periodic hand pulling and to have the desirable plants shade as much of the ground (soil) as possible. Lay the mulch to a depth of 2 inches soon after planting. Cultivation is not desirable because it cuts many roots and brings dormant weed seeds to the surface. Another alternative for weed control is to apply a pre-emergent herbicide to kill the weeds as they germinate. You can select from different brands on the market. Follow the label instructions for rates of application. This technique should not be used in areas where seeds or very young transplants are grown. Wait until the plants are 4 to 6 inches tall before applying these chemicals.

Fertilization

General purpose fertilizers are formulated in a combination of three primary nutrients: N, P, K. N represents the percentage of nitrogen, P is the phosphorus and K is the potassium. Fertilizers are helpful to correct nutrient deficiencies in the soil. Always start with a soil test to determine the soil's nutritional and liming needs. Plants consume soil nutrients as they grow and rainfall can deplete nutrients by leaching. To help monitor the changing nutrient levels in a perennial garden a soil test should be performed once every three years. Many perennials are very easy to grow on any average, well-drained soil without additional fertilization. However, additional feeding will yield much better results. Since perennials are flowering plants, a good source of phosphorus (ie 5-10-5) is beneficial for quality color and abundant blossoms.

Ordinary granular types of fertilizer should also be applied once a month throughout the growing season unless specified otherwise by the fertilizer's manufacturer. Another choice is a slow-release fertilizer which will provide a time-release feeding over a longer period of time. Powdered fertilizers, which are diluted in water, may be chosen. These are applied as a foliar treatment.

Some perennials actually produce better flowers under lower soil fertility and should not be fertilized regularly.

Suggested References:

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MARYLAND COOPERATIVE EXTENSION

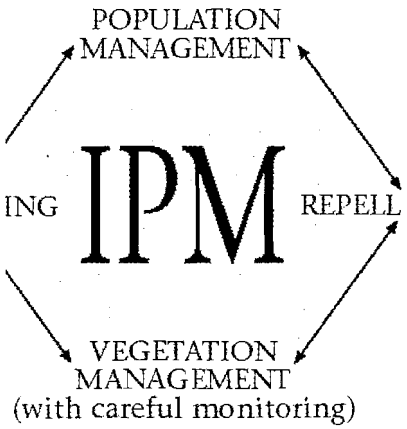
Fact Sheet

Fact Sheet 655

Damage to ornamental plants by white-tailed deer (*Odocoileus virginianus*) has increased during the past decade. This increase is attributed to: 1) rising deer populations; 2) human populations shifting to rural and suburban homesites; 3) loss of deer habitat to development; and 4) landowner decisions to prevent deer hunting.

The best approach to control deer damage is an integrated pest management (IPM) plan, which includes careful monitoring of any one, or a combination of the following strategies: population management, fencing, repellents, or vegetation management. An in-depth description of all options is found in Extension bulletin 354, "Controlling Deer Damage in Maryland," available at your local Maryland Cooperative Extension office. This fact sheet will deal with aspects of vegetation management in residential applications.

In the short run, damage to ornamental plants is largely irreversible. Damage, particularly in suburban areas with good-quality deer habitat, probably will increase. However, by planting ornamentals not favored by deer, landscapers and homeowners can attempt to preserve vulnerable landscapes.



Deer Feeding Habits

Deer feed selectively on fertilized and unfertilized landscape plantings and managed croplands. Costly browsing damage may be reduced or eliminated by planting less-preferred species or by establishing susceptible plants only in protected areas. A few strategies to consider include planting susceptible plants close to the house or in a fenced yard, or planting preferred species inside a protective ring of less-preferred species. Under most circumstances, landscaping based on a knowledge of deer feeding preferences provides an alternative to expensive chemical repellents and unsightly physical barriers.

Whether deer will target a particular plant species or variety depends on their previous habits and nutritional needs, plant palatability, seasonal factors, weather conditions, geographic area, and availability of alternative foods. Deer are creatures of habit, and previous movement patterns or foraging experiences can determine where damage will occur. Also, one plant species may be rarely damaged in one region of the country, but highly preferred in another due to differences in deer pressure and other factors. Examples of species with noted regional differences include holly, white pine, and deciduous magnolias. Therefore, caution must be taken when using plant preference lists from areas outside your own.

In general, damage from browsing is most severe when snow cover or extreme cold has reduced food availability. Another problem

magnolias. Therefore, caution must be taken when using plant preference lists from areas outside your own.

In general, damage from browsing is most severe when snow cover or extreme cold has reduced food availability. Another problem time is early spring when young succulent growth of ornamentals provides attractive browse before other spring growth is available. When food is in short supply, deer will browse even the most undesirable plants. Under such conditions, landscapers should combine other damage control measures with careful plant selection. Information on repellents, physical barriers (fencing), and deer population control are available from the Maryland Cooperative Extension Service and the Maryland Department of Natural Resources Wildlife Division. Ultimately, reducing the deer herd size is the most effective solution.

Plant Damage List

The following list contains many ornamental plants adaptable to Maryland landscapes and notes their susceptibility to deer damage. This information is useful both to select plants that are unlikely to be damaged by deer and to identify those ornamentals that frequently require protection. Four categories were created: *Rarely Damaged*, *Seldom Damaged*, *Occasionally Damaged*, and *Frequently Damaged*. The placement of plants in these categories is based on the experiences of nursery operators, landscape contractors and designers, Maryland Cooperative Extension Service personnel, research staff, and professional horticulturists. The information derives from personal communications, published articles, and unpublished reports. Please note that deer-browsing resistance of a plant species changes according to fluctuations in deer populations, alternative food availability, and environmental factors. No plant is safe under all conditions.

This is an evolving list and any suggestion for additions and changes can be sent to the following address: Fact Sheet 655, Maryland Cooperative Extension Service, 18330 Keedysville Road, Keedysville, MD 21756-1104.

Plants listed in the *Rarely Damaged* category are eaten infrequently by deer and are the best candidates for damage-prone landscapes. Deer sometimes feed on ornamentals listed as *Seldom Damaged*, but the browsing is usually minor and generally does not detract from the shape or attractiveness of the plant. The category *Occasionally Damaged* includes plants that can be severely damaged by deer. Finally, deer prefer ornamentals in the category *Frequently Damaged*. These plants often require physical or chemical protection. Before planting any of the species listed, check to ensure that they suit local climatic and soil conditions.

Rarely Damaged

Botanical Name	Common Name
Trees	
Aesculus parviflora	Bottlebrush Buckeye
Amelanchier arborea	Downy Serviceberry
Amelanchier canadensis	Shadbush
Amelanchier laevis	Allegheny Serviceberry
Betula albo-sinensis	Chinese Paper Birch
Betula nigra 'Heritage'	Heritage Birch
Betula papyrifera	Paper Birch
Chamaecyparis pisifera	Japanese Falsecypress
Cryptomeria japonica	Japanese Cedar
Ilex x *aquipernyi* 'Dragon Lady'	Dragon Lady Holly
Ilex x *aquipernyi* 'San Jose'	San Jose Holly
Picea pungens glauca	Colorado Blue Spruce
Pinus sylvestris	Scotch Pine
Pseudotsuga menziesii	Douglas Fir

Shrubs and Climbers

Arctostaphylos uva-ursi	Bearberry
Asimina triloba	Pawpaw
Berberis spp.	Barberry
Buxus spp.	Boxwood
Caryopteris x *clandonensis*	Caryopteris
Calastrus scandens	American Bittersweet
Cornus sericea	Red Osier Dogwood
Cephalotaxus harringtonia var. *koreana*	Japanese Plum-Yew
Elaeagnus angustifolia	Russian Olive
Gaultheria procumbens	Creeping Wintergreen
Gaultheria shallon	Shallon
Hibiscus syriacus	Rose of Sharon
Ilex x *'John T. Morris'*	John T. Morris Holly
Ilex x *'Lydia Morris'*	Lydia Morris Hollies
Leucothoe spp.	Leucothoe
Ligustrum vulgare	European Privet
Pieris japonica	Japanese Andromeda
Rhamnus cathartica	Common Buckthorn
Sambucus canadensis	Blueberry Elder
Sarcoccoca hookeriana var. *humilis*	Dwarf Sweet Christmas Box

Annuals, Perennials, and Bulbs

Achillea spp.	Yarrow
Aconitum spp.	Monkshood
Ageratum houstonianum	Ageratum
Allium christophii	Star of Persia
Allium neapolitanum	Daffodil Garlic
Allium ostrowskianum	Lily Leek
Anemone x *hybrida*	Japanese Anemone
Anemonella thalictroides	Rue Anemone
Anethum graveolens	Common Dill
Aquilegia spp.	Columbine
Aurinia saxatilis	Basket-of-Gold
Antirrhinum majus	Snapdragon
Arabis spp.	Rock-cress
Arisaema triphylum	Jack-in-the-Pulpit
Aubrietia deltoidea	Rock Cress
Bergenia spp.	Berginia
Ceratostigma plumbaginoides	Plumbago
Cimicifuga racemosa	Snakeroot
Colchicum autumnale	Colchicum
Colchicum speciosum	Colchicum
Consolida ambigua	Larkspur
Convallaria majalis	Lily-of-the-valley
Coreopsis verticillata 'Moonbeam'	Threadleaf Coreopsis
Cyclamen hederifolium	Neopolitan Cyclamen
Dicentra spectabilis	Bleeding Heart
Digitalis spp.	Foxglove
Dryopteris marginalis	Wood Fern
Ecinacea purpurea	Purple Coneflower
Epimedium spp.	Barrenwort
Euphorbia spp.	Euphorbia
Fritillaria spp.	Fritillary
Galium odoratuim	Sweet Woodruff
Gloriosa superba	Glory Lily
Hemmerocallis 'Stella de Oro'	Stella de Oro Daylily

Hesperis matronalis	Dame's Rocket
Hyacinthus orientalis	Hyacinth
Lamium maculatum	Deadnettle
Lavandula spp.	Lavender
Linaria vulgaris	Toadflax
Lobularia maritima	Sweet Alyssum
Lychnis coronaria	Rose Champion
Matteuccia struthiopteris	Ostrich Fern
Narcissus spp.	Daffodil
Nicotiana spp.	Flowering Tobacco
Onoclea sensibilis	Sensitive Fern
Osmunda regalis var. *spectabilis*	Royal Fern
Pachysandra procumbens	Allegheny Spurge
Pachysandra terminalis	Japanese Spurge
Papaver orientale	Oriental Poppy
Pelargonium spp.	Scented Geranium
Pervoskia atriplicifolia	Russian Sage
Ranunculus spp.	Buttercup
Rheum rhabarbarum	Rhubarb
Rudbeckia spp.	Coneflower
Salvia spp.	Sage
Santolina chamaecyparissus	Lavender Cotton
Scilla spp.	Squill
Stachys byzantina	Lamb's Ears
Tagetes spp.	Marigold
Tanacetum vulgare	Common Tansy
Thymus spp.	Thyme
Tiarella cordifolia	Foam Flower
Tropaeolum majus	Nasturtium
Yucca spp.	Yucca

Seldom Damaged

Botanical Name	Common Name
Trees	
Ammelanchier canadensis	Shadbush
Betula pendula	European White Birch
Cornus florida	Flowering Dogwood
Cornus kousa	Korean Dogwood
Crataegus laevigata	English Hawthorn
Fagus sylvatica	European Birch
Gleditsia triacanthos	Honey Locust
Ilex opaca	American Holly
Lindera benzoin	Spicebush
Picea abies	Norway Spruce
Picea glauca	White Spruce
Pinus nigra	Austrian Pine
Pinus mugo	Mugo Pine
Pinus resinosa	Red Pine
Pinus rigida	Pitch Pine
Prunus serrulata	Japanese Flowering Cherry
Salix matsudana 'Tortuosa'	Corkscrew Willow
Sassafras albidum	Common Sassafras

Shrubs and Climbers

Buddleia spp.	Butterfly Bush
Calycanthus occidentalis	California Sweetshrub
Ceanothus spp.	Cheonothus
Choisya ternata	Mexican Orange
Cistus spp.	Rock Rose
Cornus sanguinea	Bloodtwig Dogwood
Daphne spp.	Daphne
Enkianthus campanulatus	Redvein Enkianthus
Forsythia spp.	Forsythia
Hippophae rhamnoides	Sea Buckthorn
Ilex glabra	Inkberry
Jasminum nudiflorum	Winter Jasmine
Juniperus chinensis	Chinese Juniper
Kerria japonica	Japanese Kerria
Kolwitzia amabilis	Beauty Bush
Laurus nobilis	Laurel
Lonicera spp.	Honeysuckle
Mahonia spp.	Grape Holly
Myrica pensylvanica	Bayberry
Nandina spp.	Heavenly bamboo
Osmanthus heterophyllus	Holly Osmanthus
Philadelphus spp.	Mock Orange
Prunus laurocerasus	Cherry Laurel
Ribes spp.	Currant
Spirea spp.	Spirea
Syringa villosa	Late Lilac
Syringa vulgaris	Common Lilac
Viburnum juddii	Judd Viburnum
Viburnum rhytidophyllum	Leatherleaf Viburnum
Viburnum carlesii	Koreanspice Viburnum
Viburnum plicatum	Doublefile Viburnum
Weigela florida	Old Fashion Weigela

Annuals, Perennials, and Bulbs

Agapanthus spp.	Lily-of-the-Nile
Alcea spp.	Hollyhock
Artemisia spp.	Wormwood
Aruncus dioicus	Goat's Beard
Asarum spp.	Ginger
Aster spp.	Aster
Astilbe spp.	Astilbe
Begonia spp.	Begonia
Chrysanthemum spp.	Chrysanthemum
Coreopsis spp.	Tickweed
Crocosmia hybrids	Montbretia
Delphinium spp.	Delphinium
Helleborus niger	Christmas Rose
Helleborus orientalis	Lenten Rose
Hypericum spp.	St. John's-wort
Iris spp.	Iris
Kniphofia spp.	Red Hot Poker
Lantana spp.	Lantana
Lilium tigrinum	Tiger Lily
Lobelia spp.	Lobelia
Lupinus spp.	Lupine
Mentha spp.	Mint

Nepeta spp.	Catmint
Ophiopogon japonicus	Dwarf Mondo Grass
Oxalis spp.	Sorrel
Potentilla spp.	Potentilla
Romneya coulteri	California Tree Poppy
Tiarella spp.	Foamflower
Umbellularia californica	California Laurel
Veronica spp.	Veronica
Zinnia spp.	Zinnia

Occasionally Damaged

Botanical Name	Common Name
Trees	
Abies concolor	White Fir
Abies fraseri	Fraser Fir
Acer griseum	Paperbark Maple
Acer palmatum/green-leaved only	Japanese Maple
Acer rubrum	Red Maple
Acer saccharinum	Silver Maple
Acer saccharum	Sugar Maple
Aesculus hippocastanum	Horse Chestnut
Chamaecyparis thyoides	Atlantic White Cedar
Juniperus virginiana	Eastern Red Cedar
Larix decidua	Larch
Liquidambar styraciflua	Sweet Gum
Michelia figo	Banana Shrub
Metasequoia glyptrostroboides	Dawn Redwood
Pseudolarix kaempferi	Golden Larch
Pyrus calleryana	Callery Pear
Quercus alba	White Oak
Quercus prinus	Chestnut Oak
Quercus rubra	Red Oak
Rhus typhina	Staghorn sumac
Robinia spp.	Locust
Salix spp.	Willow
Syringa reticulata	Japanese Tree Lilac
Tilia americana	American Linden
Tilia cordata	Littleleaf Linden
Shrubs and Climbers	
Bambusa spp.	Bamboo
Campsis radicans	Trumpet Vine
Chaenomeles speciosa	Japanese Flowering Quince
Comus racemosa	Panicled Dogwood
Cotinus coggygria/not purple-leaved	Smoke Bush
Cottoneaster spp.	Cottoneaster
Hamamelis spp.	Witch Hazel
Hydrangea arborescens	Smooth Hydrangea
Hydrangea anomala petiolaris	Climbing Hydrangea
Hydrangea paniculata	Panicle Hydrangea
Ilex crenata	Japanese Holly
Lonicera x *heckrottii*	Goldflame Honeysuckle
Parthenocissus quinquefolia	Virginia Creeper
Pyracantha coccinea	Firethorn

Rhododendron spp./deciduous tree forms	Rhododendron
Rosa multiflora	Multiflora Rose
Rosa rugosa	Rugosa Rose
Spirea x *bulmada* 'Anthony Waterer'	Bumald Spirea
Spirea prunifolia	Bridalwreath Spirea
Syringa x *persica*	Persian Lilac
Wisteria floribunda	Japanese Wisteria
Viburnum opulus	European Cranberry Bush

Frequently Damaged

Botanical Name	Common Name
Trees	
Abies balsamea	Balsam Fir
Acer palmatum/red-leaved varieties	Japanese Maple
Acer platanoides	Norway Maple
Cedrus atlantica	Atlas Cedar
Cercis canadensis	Redbud
Chionanthus virginicus	Fringe Tree
x *Cupressocyparis leylandii*	Leyland Cypress
Fraxinus excelsior	European Ash
Ilex 'Nellie Stevens'	Nellie Stevens Holly
Kuelreutaria paniculata	Goldenrain Tree
Magnolia soulangeana	Saucer Magnolia
Malus spp.	Apple and Crabapple
Prunus spp.	Cherry and Plum
Pinus strobus	White Pine
Pyrus spp.	Pear
Thuja occidentalis	Arborvitae
Tsuga spp.	Hemlock
Shrubs and Climbers	
Chaenomeles japonica	Quince
Clematis spp.	Clematis
Cornus mas	Cornelian Cherry Dogwood
Euonymus alatus	Winged Euonymus
Euonymus fortunei	Wintercreeper
Hydrangea macrophylla	Bigleaf Hydrangea
Hydrangea quercifolia	Oakleaf Hydrangea
Ilex cornuta	Chinese Holly
Ilex x *merserveae*	Merserve Holly
Ilex verticillata	Common Winterberry
Kalmia latifolia	Mountain Laurel
Rhododendron austrinum	Florida Azalea
Rhododeneron nudiflorum (periclymenoides)	Pinksterbloom Azalea
Rhododendron vaseyl	Pink Shell Azalea
Rhododendron hybrids	Evergreen Azaleas & Rhododendron
Rosa hybrids	Hybrid Roses
Rubus spp.	Blackberry & Raspberry
Sorbus aucupatia	European Mountain Ash
Syringa patula	Manchurian Lilac
Taxus spp.	Yew
Vaccinium corymbosum	Highbush Blueberry

Annuals, Perennials, and Bulbs

Aegopodium podagaria	Bishop's Weed
Aquilegia spp.	Columbine
Athyrium niponicum var. *pictum*	Japanese Painted Fern
Cherianthus spp.	Wallflower
Hedera helix	English Ivy
Helianthus spp.	Sunflower
Hosta spp.	Hosta
Hemerocallis spp. & hybrids	Daylily
Iberis sempervirens	Candytuft
Lilium spp.	Lily
Matthiola incarna	Stock
Pelargonium spp.	Geranium
Polygonatum biflorum	Solomon's Seal
Ranunculus asiaticus	Buttercup
Trillium spp.	Trillium
Vinca minor	Periwinkle
Viola spp.	Pansies & Violas

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Acknowledgement

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