Florida Friendly Best Management Practices for Protection of Water Resources by the Green Industries

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
A Florida–Friendly Landscaping™ Publication

BEST MANAGEMENT PRACTICES FOR PROTECTION OF WATER RESOURCES BY THE GREEN INDUSTRIES

What, exactly, is meant by the phrase *by the Green Industries*? Simply put, only you, the people working every day, mowing, pruning, planting, weeding, fertilizing, watering, taking care of pest problems, and teaching your customers how to properly care for their lawn, can make a difference in the effects our landscapes have on our natural resources. Governments can regulate and educators can teach, but only the individual working in the yard can actually make a difference.

In the summer of 2000, a group of industry associations met with government and university representatives to discuss developing standards of environmental responsibility for their industry. In the summer of 2002, the first edition of this book was published. A Spanish edition soon followed. Many thousands of you have embraced these practices, and more will follow your lead. In 2009, the Florida legislature recognized the BMPs and made training mandatory for commercial fertilizer applicators. Whether you are affected by the new law or not, please use the practices discussed in this book, and remember…

HOW YOU DO YOUR JOB EVERY DAY MAKES A DIFFERENCE.

GOALS OF THE MANUAL

This manual provides information and guidance on turfgrass and landscape management practices to minimize Nonpoint Source Pollution in order to conserve and protect Florida's water resources. These practices cover both the establishment of new turf and landscapes and the care of existing turf and landscapes, including construction activities, irrigation, nutrient management, and pest management.

This manual is designed to be an educational guide for professional service providers and other interested parties. It does not substitute for the services of a landscape architect, engineer, or other design professional. Design issues are discussed as they apply to the service industry and their clients.

This document is intended to enhance the professional knowledge and judgment of turfgrass and landscape workers. Plants are living systems, and these practices should not be rigidly applied in all cases. Workers should use the guidance provided, but measures that are more restrictive may be required in specific situations to protect sites that are at particularly high risk for adverse effects on surface water and ground water. State laws and local ordinances always take precedence.

More information on Stormwater Management, Low Impact Development, and Florida Friendly Landscape Maintenance Practices is available from the Florida Department of Environmental Protection, the University of Florida Cooperative Extension Service, water management districts, universities and community colleges, and professional associations.

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Chapter 1: Introduction

USING BEST MANAGEMENT PRACTICES TO REDUCE POLLUTION AND CONSERVE WATER

The protection of water resources is enhanced through turf- and landscape-care practices that make the best use of technology and the practical experience of professionals. These practices address specific concerns, including the protection of water resources where pesticides and nutrients enter ground water and surface water as a result of nonpoint source pollution.

University studies throughout the country, including Florida, have shown that properly managed turfgrass and landscapes do not significantly contribute to nonpoint source pollution. Pollution occurs when less-than-adequate management techniques are used. Developing low-risk irrigation, fertilizer, and pesticide programs, and ensuring that these programs are properly administered and periodically reviewed, reduces the possibility of nutrient movement off-site. Whenever possible, professionals should educate their clients on landscape best management practices (BMPs) that encourage water conservation and pollution prevention.

The goals of the FDEP Green Industry BMPs are to reduce nonpoint source pollution and promote the efficient use of water, as follows:

- Reduce the off-site transport of sediment, nutrients, and pesticides through surface water or ground water.
- Use appropriate site design and plant selection.
- Use appropriate rates and methods of applying fertilizer and irrigation.
- Use integrated pest management (IPM) to minimize pests and apply chemicals only when appropriate.

BMPs should integrate selection, irrigation, fertilization, and pest management in a manner that minimizes environmental impacts, yet meets clients' and customers' expectations. Irrigation practices influence how often we need to fertilize and this can affect the occurrence of pest problems. Weigh these and other factors when making landscape management decisions.

The first edition of this manual was published in the summer of 2002. By the end of 2009, more than 100,000 manuals had been distributed, in both English and Spanish versions. More than 50,000 glove box sized summary booklets have also been distributed. In the last five years, more than 10,000 people have obtained formal certification through DEP or UF-IFAS sponsored training, and many of these people have taught others about the BMPs, but they did not obtain formal certification through the University.

Figure 1. With proper BMPs, our water resources can successfully coexist with residential landscapes.

Since the original publication of this BMP manual, several new laws have been passed, new research completed, and new products developed. Therefore, this 2010 printing contains new information in many areas, especially concerning irrigation systems and fertilizer use, along with many other suggestions received from dozens of landscapers and others seeking to improve this book. This revision would not be as good without their ideas and contributions.

This manual provides specific examples of how BMPs might work in typical situations. These examples are not meant to minimize concerns associated with other turfgrass or pest problems. Although certain rules are mentioned, this publication is an educational, not a regulatory, document. Always check with state and local authorities, because local ordinances may be more restrictive than federal or state regulations.

ENVIRONMENTAL ISSUES

Many areas of the state are running low on freshwater supplies. Water conservation is one of the most crucial issues facing Florida in the future, and applying the BMPs described in this manual will help to conserve our precious fresh water.

Since the passage of the Clean Water Act and the formation of the U.S. Environmental Protection Agency, tremendous strides have been made in cleaning up our air and water. Most of this cleanup has been accomplished through permitting and the regulation of point sources of pollution such as factory smokestacks and sewage discharges.

In contrast, nonpoint source pollution comes from diffuse sources and is associated with the long-term effects of everyday activities. It is carried primarily by rainfall and irrigation water, which cause pollutants that have accumulated on the land surface to run off into surface waters or to leach into ground water. Water is the primary mechanism for the transport of dissolved chemicals through the soil. Nonpoint source pollution may not be obvious until a rainfall event occurs, leading to stormwater runoff from roads, parking lots, suburban areas, and farms. As Florida's population has soared, this type of pollution has become an increasingly important issue in the state.

Many of Florida's water resources are particularly susceptible to pollution because of the state's unique geology and climate. Floridians obtain most of their drinking water from ground water via wells. Ground water supplies often lie near the surface and may be covered by nothing but sandy soil. Surface waters in Florida are very sensitive to even small additions of pollution, which have caused widespread ecosystem changes in our sensitive estuaries, lakes, rivers, and the Everglades.

In order to prevent potential leaching and runoff; users of fertilizers and pesticides need to consider the weather conditions, proper application rates of products and calibration of equipment, soil properties, the distance to the water table, the slope of the land, and the distance to surface waters and storm drains; all of this, in addition to plant nutrition, disease, and pest factors.

Remember, an ounce of prevention is worth many dollars of cure.

Figure 2. Grassy stormwater retention areas can add to a lawn and protect our environment.

IMPORTANCE OF MAINTAINING HEALTHY LANDSCAPES AND TURF

Well-planned, healthy landscapes designed with Florida-friendly landscape practices usually include trees, ornamentals, and a lawn of turfgrass or other ground cover. Native and well-adapted, noninvasive ornamentals contribute beauty and balance to a property, provide shade and wildlife habitat, and help to control erosion by diminishing the force of rainfall. Both the lawn and other landscape plantings reduce noise and glare, and modify temperatures.

A healthy and vigorous turf with good plant density provides many benefits. Healthy grass is viewed as an aesthetic asset, and a growing body of evidence points to the positive health and environmental contributions made by lawns and other turf areas. Turfgrass plays a significant role in reducing water runoff in urban and suburban environments that have significant areas of impervious surfaces such as parking lots, sidewalks, and driveways. Dense turf reduces the velocity of runoff and allows greater infiltration into both the thatch and root zone, where microbes can begin breaking down the water contaminants. The turfgrass root zone is a unique soil system. A healthy root zone does the following:

- Improves soil structure and reduces soil compaction, allowing greater infiltration of rain or irrigation water;
- Improves soil processes that facilitate the biodegradation (breakdown) of various types of organic pollutants, air contaminants, and pesticides used in lawn care;
- Encourages soil-building processes through the decomposition of organic matter and formation of humus, and contributes to easier lawn care with fewer weeds and insects and less disease.

CULTURAL PRACTICES FOR HEALTHY LANDSCAPES

Plant selection and location are the most important factors in planning a lawn and landscape. After weather, cultural practices are the biggest factors in determining how well an agronomic or horticultural program performs. The amount of pesticides, fertilizers, and water required often directly correlate with cultural practices and how well they are carried out.

Landscape professionals have a responsibility to supply their customers with educational material on their role in keeping turf and other landscape plants healthy. This includes (as appropriate) information on irrigation, mowing, plant selection, aeration, and traffic control. Few landscaping and lawn care companies have total control over all aspects of the properties they maintain. It is not uncommon for mowing, fertilization, pest management, and irrigation maintenance to be performed by two or more companies, or the homeowner may do one or more jobs themselves. It is of the utmost importance to educate customers about wise cultural practices so they can see that they are performed properly.

Cultural practices include irrigation, fertilization, mowing and pruning, aeration and dethatching. When each of

these is performed properly, the need for pesticides is reduced because plants and turfgrasses are healthier and more resistant to pest problems.

The concept of Integrated Pest Management (IPM) emphasizes proper cultural practices along with selecting plant species, varieties and cultivars that are less susceptible to insects, nematodes, and diseases, and best adapted to the environmental conditions of the site and geographic part of the state.

Mowing height has a tremendous impact on the severity of weed, insect, and disease pests. In general, lowering the height increases weed, insect, and disease pressure on turfgrasses by causing turf stress. There are exceptions: dwarf varieties, centipedegrass and improved bermudagrasses have lower mowing heights than the standard often used for lawn and commercial turfgrasses. Still, even these lower-growing varieties will suffer stress if mowed too short.

Pruning is an important task in maintaining a landscape. Through the selective removal of shoots and branches, pruning a plant can improve its health, control its growth, and enhance its fruiting, flowering, or appearance. Improper pruning, on the other hand, may weaken a plant, open it to invasion by disease or insect pests, or even lead to premature death of the plant. Incorrect disposal of material may lead to the spreading of diseases or pests, or of the spreading of invasive species.

Time fertilizer applications to maximize plant use and minimize adverse environmental impacts. Plants use the most nitrogen during periods of high growth, and less when dormant. However, it is important to avoid fertilizer applications if heavy rain is expected before the nutrients are immobilized. In theory, frequent, very light applications or "spoon feedings" of turf and landscapes are ideal to avoid leaching a large amount at one time due to a heavy rain event, but this is difficult to achieve safely without special management, such as for golf course greens. Slow release fertilizers attempt to match this ideal profile. Both quick- and slow-release fertilizers have a place in a sound management program.

Fertilization of plants can result in additional growth and production of leaves, stems, branches and roots. However, additional growth can result in more maintenance and yard trimming, so it is important to determine if heavy growth is the desired result. Fertilization is usually desirable when trying to establish newly installed landscape plants. In addition, adding fertilizer can help plants get off to a quick start so they fill the planted area.

Inadequate nutrition results in thin, weak plants that may be more susceptible to insects, weeds, and diseases. In addition, weakened plants do not hold the soil as well as healthy dense stands and can lead to soil erosion and water pollution. Certain diseases, such as rust and dollar spot, can occur in turf maintained under low-nutrient conditions. Under-fertilized landscape plants may require a higher than normal rate of nitrogen or other nutrients in order to return to a healthy condition.

Over-fertilization can also enhance plant susceptibility to pests and diseases. Several pesticide applications may be required to alleviate problems that would not have been as prevalent under a proper nutrition program.

Remember that plants don't waste water, people do. In a typical urban environment where soils and habitat have been modified, supplemental irrigation is necessary for the survival of many turf and ornamental plants during periods of severe moisture deficiency. However, overwatering may increase insect, weed, and disease pressures. For example, excessive moisture encourages the development of dollarweed and fungal pathogens. Conversely, some weeds such as spurge and Florida pusley thrive under dry conditions and can outcompete turfgrass suffering from drought stress. A balance is necessary to keep the landscape strong and healthy.

The average volume of rainfall in Florida ranges from 40 inches annually in Key West to about 53 inches in the central and northern peninsula and over 60 inches in the Panhandle west of Tallahassee and along the southeast coast below Lake Okeechobee. In parts of the central and southern peninsula, more than half of Florida's total annual rainfall is concentrated between June and September. During the winter and spring, or during

Figure 3. Poor fertilization technique wastes fertilizer, causes unsightly stains, and pollutes our waterbodies.

severe drought years, the lack of rainfall may seriously compromise plant health. Landscape plants, including turfgrass, that are growing in soils with a limited capacity to retain moisture can benefit from supplemental irrigation during periods of low rainfall. Even during the rainy season, evapotranspiration (water loss from plants and soil) occurs between showers and may necessitate supplemental watering while plants are becoming established.

Determining and controlling the rate, amount, and timing of irrigation can minimize soil erosion, runoff, and fertilizer and pesticide movement. The irrigation system should be designed to have an application rate that is less than the infiltration capacity of the soil so that no surface pooling occurs and water percolates with maximum efficiency. Rain sensors or soil moisture sensors eliminate irrigation when nature has supplied sufficient water. A correctly installed and operating rain sensor, which is required by law on all systems installed after 1991, can save up to 30% or more over a timer-only system. If you notice a defective rain sensor while performing other work on a property, try to notify the owner so they can get it repaired.

The use of pesticides for controlling pests remains an important part of landscape plant management in Florida. The key to reducing pesticide use is to combine genetic, cultural, and biological management practices into an IPM program that focuses on the prevention of pest problems. When suppression is necessary, it is easier to suppress a pest when conditions exist that do not favor its development. For example, diseases can be hard to manage during periods of heavy rains but if overwatering is promoting disease, cutting back irrigation will help suppress fungus much more effectively than fungicide applications alone.

BMPs to protect water quality can be affordable and easily implemented, and are effective in reducing the off-site transport of sediment, nutrients, and pesticides. Select pesticides that are the least toxic, least water soluble, least volatile, and most effective. The best defense against the movement of pesticides and fertilizer nutrients off-site or through the soil is a thick, vigorously growing stand of turf or other landscape plants.

Pesticides must be correctly applied. Spray when conditions for drift are minimal, avoid application when heavy rain is expected, and irrigate with appropriate volumes of water per label instructions. Granular applications should be targeted away from impervious surfaces and bodies of water. The landscape manager should check the proper calibration of equipment before every pesticide application.

Always follow the label directions for disposing of pesticide containers.

EMPLOYEE TRAINING

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

Employees should be given pertinent information relating to their job duties, especially job safety. The Green Industry is very diverse. Companies range in size from one or two individuals to very large corporations. Firms of any size may choose to avail themselves of horticultural and practical training available through professional associations, governments, or the county Cooperative Extension Service.

In addition to the BMPs, it is recommended that managers, salespeople, and supervisors take advantage of Florida Yards and Neighborhoods (FYN) training events where they are provided by their local IFAS Extension office. While consistent with the Green Industry BMPs, FYN training is geared to homeowners, and in some areas to retailers and homebuilders. While FYN is the "homeowner" BMP guide and applies to maintenance of all types of yards found in Florida, it also addresses design of diverse landscapes that minimize use of irrigation, supplemental fertilizers, and corrective pest control. FYN classes also focus considerable attention on specific plant selection, placement, and care. This information is tailored to local conditions and soils, topics beyond the scope of this manual. There is a growing demand for people to install and service these yards properly, and this may provide an opportunity to expand your client base.

If you are doing planting or irrigation work, or any other digging, find out where utility lines are buried before you dig in order to protect yourself and your crew from injury and prevent damage to underground utility lines. Train your employees that a call to 811 starts the process of getting underground utility lines marked for free. Calling 811 in Florida routes you to Sunshine State One Call. Utility companies then send a professional locator to the location to mark underground lines within two full business days. Once the lines are marked, you will know the approximate location of the utility lines and can dig more safely. However, One Call member utilities typically locate only those underground facilities they own. Customer wiring and piping within the lot are not marked by One Call.

Employees whose job duties include activities related to BMPs should be properly trained to perform those activities before going in the field. Applicable personnel at all levels of responsibility should receive refresher training annually on the general components and goals of the

BMPs, job safety, and the specific BMPs that apply to their jobs.

Documenting an employee's participation is an integral part of a successful training program. Employee training should be documented in an employee training log. This documentation provides the business with a tool to ensure the effective delivery of BMPs. It not only allows the company to track an employee's education and competence, but also provides a record in case of accident to show that the company provided the employee with the proper training to do his or her job. Records should have the name and signature of the employee, the provider or trainer, subject, date, and hours (time in/time out).

In 2009, the Florida Legislature enacted s.403.9335-9338, and s.482.1562 Florida Statutes, providing for fertilizer ordinances and requiring training and certification for commercial fertilizer applicators by 2014. Many local governments have ordinances that also regulate institutional and non-commercial fertilizer applicators and landscape workers. Many of these ordinances require education in these BMPs in order to obtain an occupational license or to provide services to the public. Maintaining training records shows that your business meets these requirements.

Remember . . .

- **Train employees about BMPs and job safety.**
- **Retrain annually and when changes are made.**
- **Train employees to document and retain records of activities.**

Finally, consider the real nature of your business. It is probably not the sale of pesticides, fertilizers, or gasoline. It is more likely that your real business is maintaining your customers' yards at a level that pleases them, at the lowest expense to you. Do not spend money applying materials that are not needed, or that are wasted by poor application practices or improper equipment calibration. Do not waste materials and time fighting the symptoms of problems you have no control over. Collaborate with other trades that have expertise you do not provide, such as an irrigation contractor. Then, if the irrigation system is causing fungal problems and dry spots, you can provide the customer with repairs; fix the real cause of the trouble; and save money on fungicide, insecticide, fertilizer and labor. Using Best Management Practices minimizes both the environmental and financial costs of maintaining a healthy and attractive landscape.

Chapter 2: Best Management Practices for Design and Installation of Landscapes

Bare soils and slopes without proper plant cover are highly susceptible to erosion. Sediment resulting from erosion is the leading cause of waterbody impairment and pollution. Sediment destroys fish-spawning beds, reduces useful storage volumes in reservoirs, and increases filtration costs for municipal water supplies. Pesticides and nutrients such as nitrogen and phosphorus can bind with sediments and be moved by running water. A healthy stand of turf and/or other landscape plants can help to control erosion and reduce runoff, but must be properly established and maintained to protect water quality.

It is important to design the landscape before installing the irrigation system. This allows the irrigation system to be designed to meet the needs of the plants instead of the other way around.

Florida Statutes 125.568(3), 166.048(3), 373.185(3) and 720.3075(4) provide that **a deed restriction or covenant or local government ordinance, may not prohibit, or be enforced to prohibit, any property owner from implementing Florida-friendly landscaping on his or her land.**

In many communities, construction and design documents and permits require the signature and seal of a design professional. To protect the public, landscape architects and professional engineers are licensed by the state. Contact your local authorities if you are not sure what is required. For more information on landscape architecture, see http://www.myfloridalicense.com/dbpr/pro/larch/, or to learn more about engineering services go to http://www.fbpe.org/.

SITE EVALUATION AND LANDSCAPE DESIGN

The long-term value of a landscape depends on how well it performs for its particular objectives. Performance is often directly related to matching a site's characteristics and a client's desires with plant requirements. Therefore, the first step in selecting plants for a landscape is to conduct a site evaluation, which may consist of studying planting site characteristics such as the amount of sun or shade, salt spray exposure, soil type, pH, soil compaction, slope and water drainage. These characteristics will most likely differ between areas on the same property. For example, the area on one side of a structure may have significantly different light conditions than an area on the other side. Construction activities may have produced severe compaction, and non-native soils may have been used as fill in some areas. Such soils may need aerification or amendment to be suitable for planting. The second step is to select plants with attributes that match the characteristics of the planting site. The design professional should always provide the owner with a record drawing identifying each plant or bed and the recommended irrigation requirements.

Figure 4. Narrow strips are difficult to maintain.

For more information, see IFAS Circular 536, *Basic Principles of Landscape Design*, at http://edis.ifas.ufl.edu/MG086.

FLORIDA FRIENDLY LANDSCAPE DESIGN STANDARDS

In 2004, the Florida legislature created section 373.228 Florida Statutes, directing the Department of Environmental Protection, the Water Management Districts, and several stakeholder groups to devise standards for Landscape Irrigation and Florida-Friendly landscape design. These standards were adopted in December 2006. Local governments must use these standards when adopting local ordinances after that date.

Florida law defines the nine principles of Florida-friendly landscaping to include planting the right plant in the right place, efficient watering, appropriate fertilization,

These landscape and irrigation design Standards shall be used by local governments when developing landscape irrigation and Florida-Friendly landscaping ordinances, pursuant to section 373.228, F.S.

I. Florida-Friendly Landscape Design Standards

A. Low impact site design practices, such as preserving existing native trees and vegetation, shall be used if feasible. Where established natural vegetation is incorporated into the landscape design, irrigation of those areas shall not be required.

B. The plant palette and irrigation system shall be appropriate for site conditions, taking into account that, in some cases, soil improvement can enhance water use efficiency.

C. Plants shall be grouped together by irrigation demand.

D. The percentage of landscaped area in irrigated high water use hydrozones should be minimized. Local government ordinances shall address the percentage of irrigated landscaped area that may be included in high water use hydrozones. These high water use limits should not apply to landscaped areas requiring large amounts of turf for their primary functions, e.g., ballfields and playgrounds.

mulching, attraction of wildlife, responsible management of yard pests, recycling yard waste, reduction of stormwater runoff, and waterfront protection. Additional components of Florida-friendly landscape include planning and design, soil analysis, the use of solid waste compost, practical use of turf, and proper maintenance.

This BMP manual for professionals and the Florida Yards and Neighborhoods (FYN) programs for homeowners, homebuilders and developers, and retailers are based on these nine principles, differing only in focusing on the needs of their target audience. All are part of the Florida Friendly Landscapes program, a partnership between the Florida Department of Environmental Protection, the UF-IFAS Environmental Horticulture Department and Center for Landscape Conservation and Ecology, and the five water management districts.

PLANT SELECTION

Because many of the plants used in Florida vary widely in their adaptation, consideration should be given to choosing grasses and other plants that are suited to their particular environment.

SELECTING A TURFGRASS FOR A FLORIDA LAWN

Selecting the correct grass is critical to maintaining a lawn successfully Table 1 can help you choose the grass that is best suited to a particular customer, location, and use.

To select the right grass, the following questions should be asked:

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

Table 1: Comparison of lawngrasses available for use in Florida
Common lawn grass species used in Florida. Some of the species may vary by cultivars for characteristics listed.

Environment	Bahiagrass	Bermudagrass	Centipedegrass	Seashore Paspalum	St. Augustinegrass	Zoysiagrass
Area Adapted To	Statewide	Statewide	N. Florida and Panhandle (one cultivar adapted to South Florida)	Statewide	Statewide	Statewide
Mowing Height	3"-4"	*Cultivar Dependent* 0.75"-1.5"	1.5"-2.5"	0.5"-2"	*Cultivar Dependent* 2-2.5"or 3.5-4"	*Cultivar Dependent* 1.5"-2.5"
Soil	Acid, sandy	Wide range	Acid, infertile	Wide range	Wide range	Wide range
Leaf Texture	Coarse-medium	*Cultivar Dependent* Fine-medium	Medium	Fine-medium	*Cultivar Dependent* Coarse-medium	*Cultivar Dependent* Fine-medium
Salt Tolerance	Poor	Good	Poor	Excellent	Good	Good
Shade Tolerance	Poor	Poor	Fair	Poor	Good	Good
Wear Tolerance	Poor	Good- excellent	Poor	Good-excellent	Poor	Good-excellent
Drought Tolerance	Excellent	Good	Medium	Good	Fair	Medium
Nematode Tolerance	Very good	Poor	Poor	Good	Good	Good
Maintenance Level	Low	*Cultivar Dependent* Medium-High	Low	High	Medium	Medium-High
Establishment Methods	Seed, sod	Sod, sprigs, plugs, seed	Seed, sod, sprigs, plugs	Sod, plugs, sprigs, seed	Sod, plugs, sprigs	Sod, plugs, sprigs, seed

- ***What are the environmental conditions at the planting site?*** Most importantly, what are the soil type, pH, drainage, and other soil characteristics? Has it been compacted by construction activity? Does the site contain low fertility subsoils brought in for fill? Is the site irrigated? Can it be easily mowed? Is it shaded or in full sun? Will it be shaded in a few years? What is the quality and the expected quantity of the water available for irrigation? What pests are prevalent in the area? Are pest-resistant cultivars available? Reclaimed water may contain high levels of chloride, leading to salt accumulation in the soil. When planning or renovating a landscape, check with the reclaimed water provider regarding chloride levels, and if necessary choose plants that are salt-tolerant.

SELECTING TREES, SHRUBS, AND GROUND COVERS

The plants selected should be suited to the characteristics of the site that were determined during an earlier site analysis. Good landscape design requires that plants serve particular functions. They should reduce cooling and heating costs and improve the appearance or usefulness of the landscape. Plants should be selected and positioned to provide a transition between the structure and the landscape, a screen for privacy, shade for comfort, and wildlife habitat, or to direct traffic flow onto and within the property. Select plants that will not outgrow their allotted space. Even though smaller cultivars of landscape plants may take longer to reach the desirable size, they will not have to be pruned as frequently and are less likely to need replacing in a few years.

See http://hort.ifas.ufl.edu/woody/index.html for information on individual plants.

PLANTING

PREPARING TO PLANT A LAWN

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

- Call 811 before you dig (or 800-432-4770 or www.callsunshine.com)—before installing any and/or all plant material.
- Clean and rough grade—remove debris and level the area to make it suitable for mowing.
- Install irrigation—if you are including an irrigation system, install it prior to planting.
- Soil analysis—determine soil pH and phosphorus and potassium concentrations. Contact your county Cooperative Extension Service for information on how to do this.
- Soil amendments—add these prior to planting if you need to improve the soil's physical and chemical properties.
- Deep tillage—this loosens compacted soil and improves the establishment of turf. Tilling sand is unnecessary.
- Weed control—use a nonselective herbicide such as glyphosate to aid in weed control before planting. Several applications may be necessary.
- Final grading—a final leveling makes mowing easier and safer.

For more information, see *Preparing To Plant a Florida Lawn*, IFAS Publication ENH-02, at http://edis.ifas.ufl.edu/LH012.

LANDSCAPE PLANT INSTALLATION

Before digging the hole, 1) remove all soil from above the topmost root, and 2) measure the distance between the topmost root and the bottom of the root ball. Dig the hole about 10 percent shallower than this depth and as wide as possible (at least one and a half times the width of the ball and even wider in compacted soils). The root ball should be positioned in the hole shallowly enough so that the finished grade of the backfill soil and landscape soil is lower than the top of the root ball. In other words, leave the upper portion of the sides of the root ball exposed to the air. Then apply mulch so that it covers the sides of the root ball. Be sure that when you are finished planting, there is NO SOIL, and little or no mulch, over the top of the root ball. Soil (as well as thick mulch layers more than 3 or 4 inches deep) over the root ball can prevent water and air from entering the root ball.

When finished planting, you should be able to see the topmost root in the root ball originating from the trunk at the soil surface. In other words, the trunk flare (root flare) should be visible. Soil should be packed firmly between the root ball and existing soil to eliminate air pockets where roots can dry out. Air pockets can be removed when planting large specimens by inserting a running hose between the root ball-soil interface several times until all the soil settles around the root ball.

CARE DURING PLANT ESTABLISHMENT

Even the healthiest landscape plants installed in the most ideal circumstances may need a substantial amount of time, care, and proper irrigation to become established. During the establishment period, the roots are expanding out into the landscape soil, and the shoots and trunk grow more slowly than they did before transplanting. In most instances, established, drought-tolerant landscape plants have a root system substantial enough to keep them alive with little or no supplemental irrigation. Establishment occurs more rapidly when irrigation is supplied in the correct quantity and frequency.

In addition to requiring special attention to irrigation, during their establishment period trees benefit from mulching and may require staking or guying. Pruning and fertilizing may also benefit landscape plants while they are becoming established.

For more information, see the following:

IFAS Publication ENH 860, *Fertilization and Irrigation Needs for Florida Lawns and Landscapes*, at http://edis.ifas.ufl.edu/EP110.

IFAS Publication ENH 857, *Irrigating Landscape Plants During Establishment*, at http://edis.ifas.ufl.edu/EP113.

IFAS Circular 853, *Pruning Landscape Trees and Shrubs*, at http://edis.ifas.ufl.edu/MG087.

IFAS tree pruning website, *Pruning Shade Trees in the Landscape*, at http://hort.ifas.ufl.edu/woody/pruning/.

ENVIRONMENTAL STRESSES ON LAWNS

Florida lawn grasses are subjected to many environmental stresses as a result of prolonged exposure to shade, drought, nutrient deficiency, the effects of vehicle and foot traffic, salinity, and occasional cold temperatures. Biotic stresses result from living organisms such as insects, diseases, or nematodes.

Environmental stresses can be managed in two ways: 1) choosing the most stress-tolerant species or cultivar for a particular area, and 2) using proper cultural and management practices to alleviate the effects of the stress. Practices that reduce environmental stresses include the following:

- **Moderating nitrogen fertility.** Nitrogen encourages the plant to form new tissue and grow. When nitrogen is applied in excess, more energy reserves are used to form new tissue than can be replaced by photosynthesis, and the grass becomes more vulnerable to stresses. Less reserves are then available for recovery from, or avoidance of other problems.

- **Mowing at proper heights.** Mowing below recommended heights removes a large portion of the shoot tissue available for photosynthesis. This leaves the grass less able to support itself or recover from injury.

- **Irrigating when the grass needs water.** Over irrigating leads to the failure of many lawns by increasing fungal problems and limiting the root system to the top few inches of soil.

Many environmental stresses lead to increased disease or insect problems, which are often treated chemically without changing the cultural practices that initially caused the problem. **Chemical treatment in these cases will not take care of the problem until the cultural factors are handled correctly.**

SHADE CONSIDERATIONS FOR TURF

Most landscapes include shaded areas, with shade coming from either trees or buildings. This shade can drastically affect turfgrass growth, depending on the degree and duration of shade. In many landscape settings, grass receives a minimum amount of light for enough of the day to maintain adequate growth, even if an area is shaded for other portions of the day. In some situations, however, a grassed area may be shaded for most or all of the day, making it difficult for the grass to obtain either an adequate intensity or duration of light for growth.

Under shaded conditions, turfgrasses have elongated leaf blades and stems as they attempt to obtain sunlight by outgrowing their neighbors. This reduces their overall health and vigor. Coverage is also reduced, and the bare ground that results is conducive to weed growth. It is generally not advisable to grow turfgrass in heavy shade. Other ground covers or mulch should be used in these sites. For areas receiving moderate amounts of shade, however, certain species and cultivars are able to maintain suitable growth. Specific management practices also encourage better turfgrass health under shaded conditions.

Some species are particularly well suited for use in shaded areas. Within these species, certain cultivars sometimes maintain considerable advantages when grown in a shaded environment. These species and cultivars include the following:

St. Augustinegrass is somewhat better than others for growth in partial shade, although it also performs well in full sunlight. Cultivars that exhibit the most shade tolerance include 'Seville' and 'Delmar.' 'Floratam,' 'Floratine,' and 'Floralawn' exhibit somewhat less shade tolerance.

Zoysiagrass is another good choice for partially shaded areas. Like St. Augustinegrass, it also does well in full sunlight. Generally, any cultivar of zoysiagrass performs well in partial shade.

Bahiagrass is not recommended for use in shaded conditions, but centipedegrass tolerates some partial shade. **Seashore paspalum** and **bermudagrass** do not do well in shaded situations.

The following management practices produce better turfgrass growth in shaded situations:

- **Increase the mowing height** for grasses growing in the shade. For instance, if you normally cut St. Augustinegrass at a 3-inch height, increase the cutting height to 4 inches. This allows for more leaf area to intercept as much available light as possible. In addition, leaf blades

are longer and narrower in the shade, and a lower cutting height excessively reduces leaf length, which is not good for the grass. Increased mowing height also promotes deeper rooting, which is one of the key mechanisms of stress tolerance for turfgrasses.

- **Reduce fertilizer applications to turf growing in shade.** The grass grows more slowly in a shaded environment, which reduces fertility needs. Too much nitrogen fertilizer depletes carbohydrates and produces a weaker turf system. If you normally apply 4 pounds of nitrogen per 1,000 square feet yearly, apply 2.5 to 3 pounds to turf growing in the shade. Limit any single fertility application to no more than 0.5 pounds of nitrogen per 1,000 square feet at any one time.

- **Water use is substantially reduced under shaded conditions, so adjust irrigation accordingly.** If the irrigation system covers an area that is partially shaded and partially in sun, consider removing the sprinkler heads from the shaded areas and irrigate by hand when rainfall is inadequate.

- **Avoid the effects of vehicle and foot traffic.** The grass is more easily injured by traffic if growing in shade, and may not be able to recover adequately. Also, traffic in shady areas may damage a tree's roots, resulting in the decline or death of the tree.

- **Monitor for weed pressure.** Weeds are able to outcompete turf in certain situations, and will seek out those opportunities. In a shaded environment, lateral turfgrass growth and ground cover may be sparse, leaving bare ground suitable for certain weeds. Treatment with a pre- or post-emergence herbicide may be necessary. Use caution, however, when applying any chemical treatment to a shaded lawn, as there is a greater chance of phytotoxicity (toxicity to plants) when a grass is under stress. Also, many herbicides can damage landscape trees and shrubs.

- **Monitor for disease pressure.** In many shaded environments, there is less air movement and more humidity, which may increase the possibility of disease. Again, use caution if applying pesticides to a turf that is already under environmental stress.

In particularly troublesome areas, consider other ground covers besides turf. Examples include ivies *(Hedera spp.)*, liriope *(Liriope spp.)*, mondo grass *(Ophiopogon spp.)*, and Asiatic jasmine *(Trachelospermum asiaticum)*.

Remember, the key to a successful landscape is *"Right Plant, Right Place."*

Chapter 3: Irrigation Best Management Practices

Using proper irrigation system design, installation, management, and maintenance practices provides a multitude of benefits. These benefits include saving money, using irrigation efficiently, a healthy and more drought and pest-resistant landscape, and protecting the state's water resources. Green Industry workers need to be aware of the different irrigation processes and system components because irrigation is a major factor in the success of their industry. By understanding the irrigation system, they can save the company and the client money and help protect ground water supplies and water quality.

This section of the document includes background information and irrigation BMPs for the Green Industry. Some of the BMPs mentioned are not usually considered the responsibility of mowing and trimming services or route based service businesses. However, many Green Industry workers, who may be directly employed by property owners, associations or municipalities, are often responsible for operation and maintenance of an irrigation system. For complete BMPs specific to the Irrigation Industry please refer to:

- Florida Irrigation Association (www.fisstate.org)
- Irrigation Association (www.irrigation.org)
- The University of Florida's Institute of Food and Agricultural Sciences (IFAS) (http://edis.ifas.ufl.edu/)

Irrigation is an age-old art and is defined as the application of supplemental water to a soil for plant growth. It also provides a mechanism for nutrients to move from the soil into a plant. Other uses include salt leaching, chemigation, system flushing, seed germination, and climate modification.

On average, Florida receives more than 50 inches of rain per year. However, the distribution and amounts of this rainfall are not always adequate to meet a plant's water demands. Providing the amount of water that a plant needs at the correct time is the key to resource conservation, reduced pollutant loading, and optimum plant growth.

This chapter describes irrigation concepts to help explain the fundamentals of good irrigation. The green industry can use this information to assist them in their daily operations and to help their clients to save water, improve plant health and reduce the flushing of fertilizer nutrients from a plant's root zone. In addition, this chapter identifies specific irrigation BMPs for the Green Industry. Throughout the chapter, the term "plant" refers to both turf and landscape plants, including trees.

PERMITTING AND REGULATIONS

Many agencies have jurisdiction over an irrigation project before, during, and after construction. For example, Florida's five water management districts, Florida Department of Health, Florida Department of Environmental Protection, or local governments may require well permits. Typically, for large projects the water management districts issue water use permits, which are usually calculated for drought conditions rather than for normal irrigation. To prevent potential fines, it is important to identify and abide by all regulatory requirements.

Besides water use permits, some water management districts have special year-round water conservation measures and drought/water shortage restrictions that govern the amount and timing of irrigation. It is important to know the restrictions for a site and to set timers/controllers to those conditions. Since water shortage restrictions change with the severity of a drought, it is important to be aware of and to abide by current restrictions. If a site's irrigation system cannot be adjusted to meet the restrictions, the system should be upgraded as soon as possible, but in the interim, there are methods to obtain variances. These variances need to be obtained in writing, before irrigating.

Florida Law (373.62, see sidebar) requires an operating moisture cutoff device on all automatically controlled irrigation systems. In 2009 this was revised and mandates owners and contractors to maintain these systems. In 2004, the Florida legislature created section 373.228 Florida Statutes directing the Department of Environmental Protection, the Water Management Districts, and several stakeholder groups to devise standards for Landscape Irrigation and Florida-Friendly landscape design. These standards were adopted in December 2006. Local governments must use these standards when adopting local ordinances after that date. The irrigation standards are based on Appendix F of the Florida Building code. See the shadow box in the Irrigation Design section for more details.

373.62 Any person who purchases and installs an automatic landscape irrigation system must properly install, maintain, and operate technology that inhibits or interrupts operation of the system during periods of sufficient moisture. A licensed contractor who installs or performs work on an automatic landscape irrigation system must test for the correct operation of each inhibiting or interrupting device or switch on that system. If such devices or switches are not installed in the system or are not in proper operating condition, the contractor must install new ones or repair the existing ones and confirm that each device or switch is in proper operating condition before completing other work on the system.

The following permitting and regulatory guidelines should be followed for all irrigation projects:

- Contact local and state regulatory agencies (such as the county, city, Florida Department of Environmental Protection, water management districts, and health department) to determine current irrigation regulations and criteria.
- Obtain all permits before construction.
- Abide by all permit conditions and current water restrictions when operating the irrigation system.
- Obtain any desired regulatory variances before irrigating.

The use of irrigation BMPs promotes proper irrigation system design, construction, and management. This leads to reduced water use, the protection of aquatic resources, better plant development, economic savings to the end user, and efficient fertilizer use. Irrigation knowledge and education is a critical part of meeting the intent of the Green Industry's irrigation BMPs.

RECLAIMED WATER USE

Many urban areas use reclaimed wastewater for their irrigation water source. While this offers many benefits, it also can lead to landscaping and pollution problems if not properly managed. Nutrient levels in reclaimed water may vary by a factor of 10 or more, depending on the treatment plant supplying the water. Contact the supplier to get information on nutrient content. When applying fertilizers to a site that irrigates with reclaimed water, consider the amount of nutrients in the water, and reduce fertilization appropriately. Reclaimed water may contain high levels of chloride, leading to salt accumulation in the soil. Additional considerations, such as water for flushing salts, may be needed.

Nutrient pollution may occur if the user over-irrigates, because both reclaimed water that runs off on the surface, and the water and nutrients that move below the root zone, are lost. Maintenance of a high level of distribution uniformity is critical to prevent leaching of these nutrients. Irrigation managers should also pay close attention to all cross-connection controls and backflow prevention devices. **All reclaimed water piping, heads, valves, fixtures, etc. are required by law to be color-coded purple, and labeled "Do not drink this water."** As long as field capacity is not exceeded when irrigating, reclaimed water is a safe and reliable irrigation source.

IRRIGATION SYSTEM DESIGN

Irrigation system design is a complex issue and should be performed by trained professionals. These professionals should use existing standards and criteria, as well as the manufacturer's recommendations, to design the most appropriate system for a location. In addition to the *Landscape Irrigation and Florida-Friendly Design Standards*, a list of sources for current standards and criteria can be found at the end of this chapter. Many communities require construction and design documents and permits that require the signature and seal of a registered design professional. Members of the Green Industry should be able to visually identify system design problems to help their clients irrigate more efficiently, save water, reduce the need to add fertilizers or other chemical treatments, and improve plant health and water quality.

The irrigation design for a site depends on a number of factors including location, soils, landscape vegetation, water supply, and water quality. An irrigation system needs to be designed to meet a site's peak water requirements. In addition, to prevent irrigation runoff, a system's application rate must not exceed the ability of the soil to absorb and retain the water applied during any one application. The irrigation system should also have enough flexibility to adapt to various water demands and local restrictions.

Design operating pressure must not exceed the source pressure. The design operating pressure should account for low pressure during periods of high use (i.e., mornings) and for project buildout when all of a development's landscaping is in place. Plants should be grouped in irrigation zones based on similar water use requirements. Irrigation systems designed to service both turf and landscape areas should have enough zones to meet each area's individual water needs. In some regions, the irrigation design should account for the extra water required to periodically leach salt buildups that may accumulate due to high chloride levels in some sources of irrigation water.

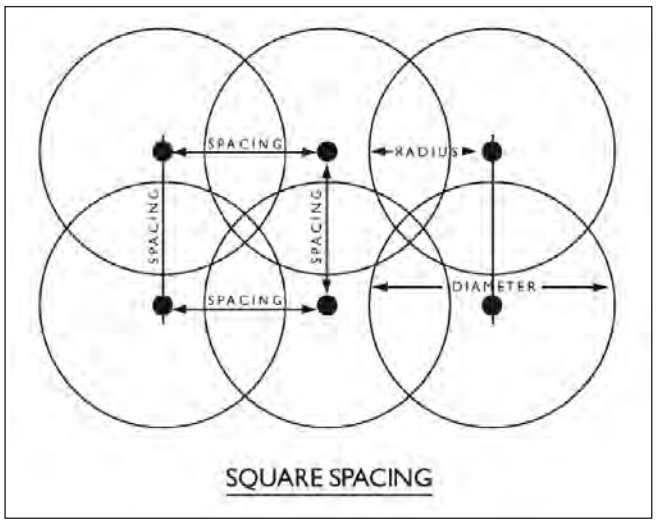
An irrigation system consists of three main components: water supply (consisting of a water source, pump, filters, and valves), water conveyance (made up of a mainline, manifold, lateral, and spaghetti tubes) and a distribution device (such as an impact sprinkler, oscillating sprinkler, rotary sprinkler, spray, or drip emitter). The proper design and installation of these components optimizes their use and decreases any off-site impacts. Irrigation design must also account for different site characteristics, such as soils and topography.

Hand-moved irrigation systems should have enough flexibility to provide sufficient coverage (see the manufacturer's recommendations) after each move. Microirrigation systems for shrubs and other landscape plants should be designed to cover at least 50 percent of the root systems. Microirrigation is rarely used for turf in Florida, and is prohibited in some places, but if used should be designed to cover 100 percent of the grass's root system.

To provide for peak water demands and have enough flexibility to reduce supply for different demand requirements, irrigation systems need to be designed with vari-

ous control devices, rain shut-off devices, and backflow prevention. Water conveyance systems should be designed with devices to protect against blowouts. The water conveyance pipelines should provide the system with the appropriate pressure required for maximum irrigation efficiency, uniformity, and the distribution devices should be designed for optimum uniform coverage. In addition, the distribution system should not include the irrigation of non-planted areas (such as driveways, parking lots, roads, sidewalks, underneath roof overhangs, and natural buffer zones).

To ensure optimum uniformity, permanent irrigation sprinklers, spray jets, and other distribution devices should be spaced according to the manufacturers' recommendations. Typically, this spacing is based on average wind conditions and operating pressures during irrigation.



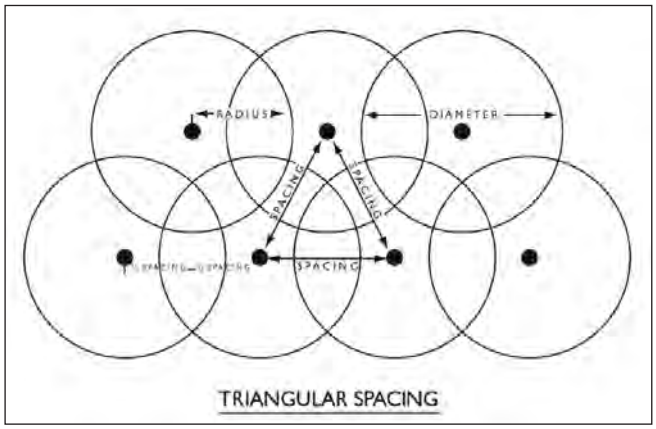


Figure 5. Sprinkler layouts.

If site-specific wind conditions are different than published averages, check with the local IFAS extension office, USDA NRCS or the Florida Irrigation Society for their recommendations. **Table 2** is provided as a general guideline. Spacing should not exceed the percentages in the table below. After the system is constructed and operating, periodic "catch can" uniformity tests should be performed (see the section on Irrigation Maintenance later in this chapter) to ensure that the system is continuing to function as designed.

Table 2. Irrigation Spacing

Wind	Square Coverage	Triangular Coverage
Miles Per Hour	Percentage of Diameter of Coverage	
0–5*	55%	60%
5–10	50%	55%
10+	45%	50%

* For many locations, the 0-5 mph wind condition occurs very infrequently and this spacing recommendation should only be used after careful consideration and site investigation.

MICROIRRIGATION FOR LANDSCAPE PLANTS

When designed and operated correctly, microirrigation, also known as drip or low-volume irrigation, is one of the most efficient methods of irrigation. It is highly manageable and provides small quantities of water directly to the plant's root zone. Low-pressure sprinklers, sprayers or drippers are also known as emitters, and they slowly release water into the soil around a plant. This saves water because only the main feeder roots receive water, and less water evaporates from the surface of the soil.

Typically, with drip irrigation in a sandy soil, water moves laterally only 10 to 12 inches. Drip irrigation is ideal when such precision is desirable or for narrow strip plantings, such as hedgerows. Because of the nature and location of drip irrigation it is difficult to determine if the emitters are providing enough water. Visual inspection of the landscape may identify clogging (dry spots, dead plants, and wilted plants) or excessive watering (soggy soil, weeds, excessive plant growth) problems from a drip irrigation system.

Overall, spray-jets (either microsprayers or microsprinklers) are more desirable than drip emitters for most landscape applications. This is because they cover larger areas and have fewer clogging problems. Clogging and excess water problems can be seen either by careful examination of the irrigation system or by looking at the landscape. Spray jets should not be designed or operated to irrigate non-planted areas

Regardless of the type of microirrigation system, clogging can be a problem if the water supply is not filtered before entering the irrigation system or if the filtration system is not cleaned. The safest and easiest way to maintain the emitters in a microirrigation system is to keep a small supply of clean backups on hand.

Clogged devices can be easily replaced with clean units, then placed in a small container of the cleaning fluid appropriate for the clogging material. Replacement emitters should always have the same operating characteristics (i.e., operating pressure and discharge rate) as the original emitters.

For more information, see the following:

IFAS Fact Sheet AE-254, *Microirrigation in the Landscape*, at http://edis.ifas.ufl.edu/AE076.

IFAS Bulletin 333, *Flushing Procedures for Microirrigation Systems*, at http://edis.ifas.ufl.edu/WI013.

Turf and Landscape Irrigation Best Management Practices, April 2005. The Irrigation Association, at http://www.irrigation.org.

From the December 2006 publication Landscape Irrigation and Florida-Friendly Design Standards:

Pursuant to section 373.228, F.S, these landscape and irrigation design Standards shall be used by local governments when developing landscape irrigation and xeriscape (Florida-Friendly) ordinances.

II. Irrigation System Design Standards

A. Irrigation systems shall be designed to meet the needs of the plants in the landscape (not the other way around).

B. When feasible, irrigation systems shall be designed to separately serve turf and non-turf areas.

C. The irrigation system plans and specifications shall identify the materials to be used and the construction methods.

D. The design shall consider soil, slope, and other site characteristics in order to minimize water waste, including overspray, the watering of impervious surfaces and other non-vegetated areas, and off-site runoff.

E. The system shall be designed to minimize free flow conditions in case of damage or other mechanical failure.

F. The system shall be designed to use the lowest quality water feasible.

G. Rain switches or other devices, such as soil moisture sensors, to prevent unnecessary irrigation, shall be incorporated. (Section 373.62, F.S.)

H. A recommended seasonal operating schedule and average precipitation rates for each irrigation zone for both establishment and maintenance conditions shall be provided.

I. Control systems shall provide the following minimum capabilities:
1) Ability to be programmed in minutes, by day of week, season and time of day,
2) Ability to accommodate multiple start times and programs,
3) Automatic shut off after adequate rainfall,
4) Ability to maintain time during power outages for a minimum of three days, and
5) Operational flexibility to meet applicable year-round water conservation requirements and temporary water shortage restrictions.

J. Recommended maintenance activities and schedules shall be included.

K. Precipitation rates for sprinklers and all other emitters in the same zone shall be matched, except that microirrigation emitters may be specified to meet the requirements of individual plants.

L. Irrigation systems shall be designed to maximize uniformity, considering factors such as:
1) Emitter types.
2) Head spacing.
3) Sprinkler pattern.
4) Water pressure at the emitter.

M. Irrigation systems with main lines larger than two inches or designed to supply more than seventy gallons per minute shall incorporate a means to measure irrigation water use, at a minimum of ninety-five percent accuracy across the flow range.

N. Irrigation system plans and specifications shall require the system installer to conduct final testing and adjustments to achieve design specifications prior to completion of the system and acceptance by the owner or owner's representative.

O Irrigation system plans and specifications shall require that the installer provide property owners and users with post-construction documentation, including as-constructed drawings, recommended maintenance activities and schedules, operational schedule, design precipitation rates, instructions on adjusting the system to apply less water after the landscape is established, maintenance schedule, water source, water shut-off method, and the manufacturer's operational guide for their irrigation controller. To the extent feasible, similar information should be made available for subsequent property transfers.

IRRIGATION SYSTEM INSTALLATION

Only professionals who are trained, certified, appropriately licensed for irrigation installation by the appropriate agency, bonded, and insured should handle irrigation installation. These individuals must follow the designer's plans and use recognized standards and criteria such as those promulgated by the American Society of Agricultural and Biological Engineers (ASABE, formerly ASAE), Florida Irrigation Society (FIS), Irrigation Association (IA), U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), or the manufacturer's recommendations. The designer must approve any changes to the design.

To prevent system failures, waste, and property damage, construction materials must meet appropriate standards, such as those from ASABE, the American Society of Civil Engineers (ASCE), or the American Society of Testing Materials (ASTM). Plan all construction practices according to standard safety practices. Before construction, the contractor should identify and flag all underground pipes, cables, and other elements. **Call before you dig.** Call 811 (or 800-432-4770 or www.callsunshine.com) for free Sunshine State One Call locator service. The contractor should clean the site of any construction materials before the job is complete and at the end of construction, provide the owner with a copy of the as-built plans, operating manuals, recommended operating schedules for both plant establishment and supplemental irrigation of mature plants, and warranties. For new construction, the job should include a follow-up site visit to reset the controller, rain shut off device, and soil moisture sensor (if installed) after the landscape is established.

IRRIGATION MANAGEMENT

Irrigation management (knowing when and how much to irrigate) is the cornerstone of water conservation and reducing nonpoint source pollution. It encompasses the amount of water applied and the frequency of application. To prevent excess water use that could lead to chemical leaching and runoff, fungal infestation, and disease; irrigation scheduling should take into account plant water requirements, recent rainfall, recent temperature extremes, and soil characteristics. In addition, the irrigation system must be properly designed and maintained, so that all of the plants in a given zone receive the same amount of water. See the Irrigation Maintenance section of this chapter for information about measuring distribution uniformity.

Under ideal conditions, the water required for a plant is equal to the water used during plant growth. This water goes to soil evaporation and plant transpiration. Typically, both processes are combined and called evapotranspiration (ET).

A plant's water requirements (ET) vary with its growth cycle and climatic conditions. The limiting ET factors are the amount of soil moisture to be transpired by the plant, solar energy reaching the plant (affected by latitude, season, cloud cover, and shade), the temperature and relative humidity of the air, and wind speed. If a soil is at field capacity, 100% canopy coverage is present to absorb radiation, and other factors are equal, the amount of water transpired varies little between plant types. Plant irrigation requirements will differ based on a plant's ability to extract soil moisture (i.e., root zone depth) and its physiological ability to deal with reduced availability of moisture.

Plants require more water during seed, flower, and fruit production, but will not require very much when they are dormant. During the colder months, or those with shorter periods of daylight, most turfgrasses and landscape plants are not actively growing, thus use less soil moisture and may not require irrigation.

Many established, drought-tolerant landscape trees and shrubs require little or no irrigation, provided the soils do not obstruct root development. Plants such as azaleas, copperleaf, impatiens, or other bedding plants that lack drought tolerance may require irrigation during extended drought periods.

In humid regions such as Florida, irrigation is considered supplemental because it supplements natural rainfall. Proper irrigation management must account for rainfall. Since rainfall varies from location to location, the proper use of rain gauges, rain shut-off devices, flow meters, soil moisture sensors, and/or other irrigation management devices should be incorporated into the site's irrigation schedule.

Using an irrigation schedule can help prevent wasteful over-irrigation, the leaching of fertilizers/pesticides, and promote root development for drought conditions. No more than 1/2 to 3/4 inch of water should be applied for a single irrigation event. The exact amount of irrigation needed for each event will depend on a plant's needs for growth, fruiting, dormancy for that time of year and soil characteristics (soil moisture, infiltration rates, soil root zone depth and water holding capacities). In addition, water management districts and local requirements should be considered before irrigating. A properly working, installed and calibrated rain shutoff device prevents the irrigation system from turning on if adequate rainfall has occurred. Rain shutoff devices are required by law on all automatic irrigation systems.

Irrigation management and control devices need to be installed correctly for proper irrigation management. Rain shut-off devices and rain gauges should be placed in open areas to prevent erroneous readings. Flow meters should have a straight enough run of pipe both downstream and upstream to prevent turbulence and bad readings. Soil moisture sensors and other irrigation management tools should be installed in representative locations and be maintained to help make good irrigation

management decisions. When mechanical/electronic devices are not available for irrigation management, the following visual indicators should be used as guidelines to determine the need for irrigation:

- The grass has a dull, bluish-gray coloring.
- Foot tracks remain in the grass.
- Leaf blades are folded in half on at least one-third of the site.
- Soil samples from the root zone are dry and crumbly.
- Indicator landscape plants (such as impatiens and azaleas) have drooping leaves.

There are several ways to prevent excess irrigation. Visual observations of runoff or puddles are simple indications. A system's timer/clock/controller can be adjusted to meet a plant's seasonal water requirements. Flow meters can be used to determine how much water is applied and when to turn off the irrigation system. Rain gauges, cans, or other containers can be used to measure how much water has been applied.

Rain shutoff devices, which, as mentioned earlier, are already required by law on all automatic systems installed since 1991, can save up to 30% or more over a timer-only system. However, many systems that should have sensors do not, either because they were not installed as required or because they have failed or been removed. Those who are responsible for overseeing an irrigation system should check the operation of the rain shutoff device at least once per year, and replace the unit if it is not operating correctly. Other workers who may notice a system irrigating shortly after a good rain event should attempt to notify their client of a possible problem with the rain shut off device so they can have it repaired.

One of the most effective and efficient methods of irrigation control is the use of properly installed and maintained soil moisture sensors with a specialized controller. There are two basic types of systems, direct control, where soil moisture sensors actually call for irrigation; and bypass control, where regularly scheduled irrigations are bypassed if sufficient moisture is present. Direct control systems are more expensive and require considerable management expertise, such as may be present at a golf course. Bypass systems are much less expensive and easier to install. Most bypass systems work with the existing controller.

Although soil moisture levels are the preferred method to determine irrigation quantities, in the absence of soil data, calculated ET methods may be used. Current calculated potential evapotranspiration (ETp) rates are available at http://fawn.ifas.ufl.edu. This site also includes a landscape irrigation scheduling tool and rainfall data. Rainfall can make up some or all of the ET, especially during the cooler months. Total rainfall is not the same as effective rainfall. Florida soils generally have low water holding capacity, so a two-inch rain may have little more effect on reducing landscape irrigation than a typical irrigation event in any given month.

An alternative irrigation scheduling method often used by homeowners and on some commercial landscapes is to assume that on average 1 inch of water wets the top 12 inches of a sandy soil. Typically most roots grow in the top 6-12 inches of soil, and 1/2 to 3/4 inch is needed for replenishment of moisture every 2 to 3 days during warm periods of active growth, and every 10 to 14 days during less active growth periods. This water can come from rainfall or be provided by the irrigation system. Again, soil characteristics (infiltration rates and water holding capacities) water management districts and local requirements should be considered before irrigating.

Another method of irrigation scheduling and timer or controller adjustments for sites without specific information is to use the weekly ET values in Figure 6 as a general guideline. The graph divides the state into northern and southern regions roughly around Interstate I-4.

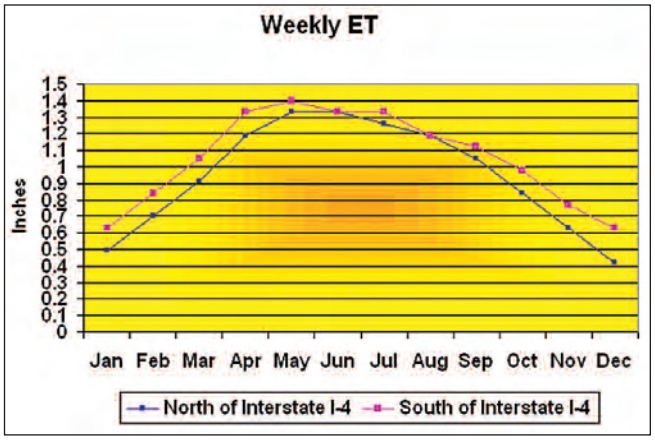


Figure 6. Approximate weekly evapotranspiration (ET).

Although irrigation management is a complex process, it can be boiled down to a simple checkbook (or water balance) process, where the irrigation amount consists of the difference between a plant's need for water and the effective rainfall (rainfall stored in a plant's root zone, for plant use). When possible, the timing of an irrigation event should be planned to increase irrigation efficiency, by reducing evaporative losses due to climatic conditions (for example, high temperature, low humidity, windy conditions) and by maintaining high irrigation uniformity.

Several irrigation management techniques help to improve a plant's health and reduce water use. Delayed irrigation and deficit irrigation promote root development and provide a level of drought tolerance. Delayed irriga-

tion promotes deeper root development by postponing irrigation until wilt is observed. Deficit irrigation calls for managing irrigation quantities so that there is always soil storage to take advantage of any possible rainfall.

When leaching salts, which is necessary in some soils due to poor water quality, always wait until the nutrient level in the soil is depleted to avoid leaching of fertilizer nutrients with the salt.

For more information, see the following:

IFAS Publication ENH 158, *Tips for Maintaining Landscapes During Drought*, at http://edis.ifas.ufl.edu/EP091.

IFAS Circular 807, *Managing Your Florida Lawn Under Drought Conditions*, at http://edis.ifas.ufl.edu/EP078.

Field Guide to Soil Moisture Sensor Use in Florida, at http://www.sjrwmd.com/floridawaterstar/pdfs/SMS_field_guide.pdf.

IRRIGATION SYSTEM MAINTENANCE

Proper maintenance extends the life of an irrigation system and helps it to perform optimally. Maintenance begins with a visual observation of the system and the plants. Check for proper functioning of rain sensors and controllers, leaks, broken/cracked lines, proper rotation, and damaged sprinkler heads. Also, check for obstacles that may interfere with irrigation uniformity. Brown spots, unnaturally green grass, certain types of weeds, and soggy spots are indicators of problems. Many types of businesses do not have control over the irrigation system, nor the expertise or contractual duty to address irrigation issues, but every effort should be made to inform the client when problems are noted and to explain the importance of proper operation and prompt repairs.

Damaged or defective systems should be repaired as soon as possible. Replacement parts should always have the same characteristics (that is, discharge-pressure relationship, jet size/colors) as the original components. Otherwise, the replacement might cause more harm than the bad component. Florida law requires licensed irrigation contractors to repair defective sensors, and there may be fines and penalties for failing to report a client that refuses repairs.

Evaluating a system's uniformity and efficiency (an irrigation audit) reduces water use and fertilizer/pesticide leaching. There are many procedures (such as NRCS, IFAS, ASABE, IA, and FIS) for irrigation system evaluation, all of which can be traced to a process published by Miriam and Keller. By following any of these methods, you can ensure that a system is operating at optimum levels.

Common irrigation efficiency problems include leaks, sprinkler head plugging, poor irrigation uniformity caused by nozzle wear, and poor system pressure. Some problems (such as repairing leaks and replacing nozzles) can be repaired at a minimal cost, while others (such as poor system design) might, at first glance, be very costly, but will pay off in the end. Problems need to be corrected as soon as possible to prevent wasted water and the leaching of fertilizers and other chemicals. In the long term, the investment made to improve the irrigation system pays off in reduced fertilizer, chemical and water bills.

Distribution Uniformity is a measurement of how evenly water is distributed over a given area, and should be considered when managing irrigation. This measurement is an indication of the system's hydraulic performance and can be used to identify deep percolation. Typically distribution uniformity is identified with the infiltration of the lowest 25% (low quarter) of irrigated area and can be determined by a "catch can" test. Baby-food jars, tuna cans, or other straight-sided containers are evenly placed around sprinklers. The system is turned on for a fixed amount of time, and the water collected in each container is measured and recorded.

The Distribution Uniformity, which is a percentage, is calculated by dividing the average depth of water collected in the lowest 25% of containers with the average depth of water in all the containers. This is multiplied by 100 to convert the value into a percentage. The Irrigation Association has published a range and rating of distribution uniformities for different irrigation methods. Recent work in Florida indicates that most landscape irrigation systems are below these published values.

Higher uniformities occur when spacing is adequate and sprinkler nozzles are matched. Poor application uniformity leads to localized over irrigation or under irrigation, brown spots in the grass, fertilizer or pesticide leaching

Table 3: Irrigation Association Distribution Uniformities

Rating of Lower Quarter Distribution Uniformity (DULQ) for Sprinkler Zones					
Type of Zone	Excellent	Very Good	Good	Fair	Poor
	(%)	(%)	(%)	(%)	(%)
Fixed Spray	75	65	55	50	40
Rotor	80	70	65	60	50
Impact	80	70	65	60	50
Predicting and Estimating Landscape Water Use. The Irrigation Association, Oct. 2001.					

or runoff, and the waste of irrigation water. Many of these problems can be solved and the site's owner can reduce water costs. Distribution uniformity is not a measurement of irrigation efficiency. For more information, see IFAS Publication AE 144, Turf Irrigation for the Home, at http://edis.ifas.ufl.edu/AE144.

For micro irrigation systems, Emission Uniformity is used instead of Distribution Uniformity to determine the uniformity of irrigation. Emission Uniformity is calculated by comparing the volume of water from the emitters to the statistical differences in the total volume. An Emission Uniformity of 90% or higher is considered excellent. For more information, see IFAS Publication AE094, Field Evaluation of Microirrigation Water Application Uniformity, at http://edis.ifas.ufl.edu/AE094.

Water Application Efficiency is a component of irrigation system efficiency and indicates how well a system is providing water to the plant's root system. Irrigation Application Efficiency is another form of irrigation system efficiency and it compares the amount of water delivered to an area by the amount of water beneficially used.

To help with irrigation efficiency, water management districts or other local agencies may provide mobile irrigation lab (MIL) services. MIL staff will evaluate an irrigation system and make recommendations to improve system efficiency and help with irrigation scheduling. Contact your local water management district for more information about these services in your area.

Irrigation requirements represent the amount of water an irrigation system needs to apply to meet a plant's water needs. This quantity is a function of the plant's water requirements, soil moisture, and the system's efficiency. For more information, see IFAS Publication AE110, *Efficiencies of Florida Agricultural Irrigation Systems*, at http://edis.ifas.ufl.edu/AE110.

IRRIGATION SYSTEM ERRORS

The following figures depict some examples of improper irrigation system design or installation.

Figure 7. Poor design; sprinkler does not match area.

Figure 8. Poor design; system does not match irrigation requirements. The area needs to be rezoned with landscape and turf separated.

Figure 9. Overirrigation, runoff. Small turf area should be irrigated with spray heads, not sprinklers.

Figure 10. Object is interfering with spray pattern, resulting in poor distribution uniformity

SOURCES FOR IRRIGATION STANDARDS

The following publications contain current irrigation standards:

- *Landscape Irrigation and Florida-Friendly Design Standards*, December 2006, Florida Department of Environmental Protection. http://www.dep.state.fl.us/water/waterpolicy/docs/LandscapeIrrigationFloridaFriendlyDesign.pdf.

Figure 11. Water gushing from broken head.

- *ASABE Standards*–2007. Standards, engineering practices, and data developed and adopted by the American Society of Agricultural and Biological Engineers. 2007. American Society of Agricultural and Biological Engineers, 2950 Niles Rd., St. Joseph, MO 49085. Telephone (269) 429-0300. http://www.asabe.org/standards/searchpur.html.

- *Florida Building Code—Plumbing, Appendix F*. International Code Council 900 Montclair Rd. Birmingham AL, 35213-1206 (205) 599-9871 http://www.floridabuilding.org/BCISOld/bc/default.asp or http://www.iccsafe.org.

- *National Engineering Handbook Series 210-VI*. November 1997. U.S. Department of Agriculture, Natural Resources Conservation Service, Washington D.C., 20013. http://directives.sc.egov.usda.gov/.

- *Standards and Specifications for Turf and Landscape Irrigation Systems, Fifth Edition*. December 2005. Florida Irrigation Society, (800) 441-5341, Address: 9340 56th Street N. Suite 105, Temple Terrace, FL 33617 , Florida. http://www.fisstate.org/standardsrevision3.pdf.

- *Turf and Landscape Irrigation Best Management Practices*, April 2005. The Irrigation Association. (703) 536-7080, 6540 Arlington Blvd., Falls Church, VA 22042-6638 http://www.irrigation.org.

GREEN INDUSTRY IRRIGATION BMPS

The principal BMPs for all of the Green Industry include:

- Call before you dig. Call 811 for free Sunshine State One Call locator service.
- When possible, the application of fertilizers, herbicides, or other chemicals that needed to be watered, should coincide with an irrigation event.
- Proper cultural practices (such as mowing) to promote healthy, deep root development and reduce irrigation requirements.
- Account for the nutrients in reclaimed water when making fertilizer calculations. Knowing the nitrate levels in reclaimed water can reduce your fertilizer purchases. The application of 1 inch of reclaimed water containing 20 ppm nitrate-Nitrogen adds about 4.5 pounds of nitrogen per acre (lb. N/acre) to the soil. If you irrigate 40 inches per year, that works out to a little over 4 lb. per 1,000 square feet.
- Repair any irrigation devices broken while servicing a site. Replacement parts should have the same characteristics as the original components.
- Visually observe site problems associated with irrigation (i.e., wet, dry spots, excessive weeds in specific location) or system components (leaks, broken equipment) and report problems to the client.
- When leaching salts, which is necessary in some soils due to poor water quality, always wait until the nutrient level in the soil is depleted to avoid leaching of fertilizer nutrients with the salt.

Additional BMPs for those with ownership/management responsibility:

- Group plants by similar water requirements (i.e., Hydrozones)
- Irrigation controllers/timers should be reset seasonally to account for plant growth requirements and local climatic conditions.
- Properly calibrated flow meters, soil moisture sensors, rain shut-off devices, and/or other automated methods should be used to manage irrigation.
- Irrigation rates should not exceed the maximum ability of the soil to absorb and hold the water applied in any one application.
- Implement a preventive maintenance program to replace worn components before they cause water, fertilizer and chemical waste.
- Perform weekly (or at each site visit) visual inspections to identify leaks, broken rain sensors or sprinkler heads, and other system malfunctions.
- Replace or repair all broken or worn components before the next scheduled irrigation.
- Distribution uniformity should be checked annually.

LANDSCAPE MULCHES

Mulch is any material applied to the soil surface to protect or improve the area covered. Mulches are frequently applied around plants to modify the soil environment and enhance plant growth. They may consist of organic material such as bark, wood chips, leaves, pine needles, or grass clippings; or they can be inorganic material such as gravel, pebbles, polyethylene film, or woven ground cloth. Mulch can be applied to the soil surface but should not rest against the stems of landscape plants.

BENEFITS OF MULCHING

Mulching has the following beneficial effects on the soil and plants:

- Mulches can prevent the loss of water from the soil by evaporation. Moisture moves by capillary action to the surface and evaporates if the soil is not covered by a mulch.

- Mulches suppress weeds when the mulch material itself is weed-free and applied deeply enough (2 to 3 inches after settling) to prevent weed germination or to smother existing small weeds.

Figure 12. Mulch, not grass, should be used here.

- A more uniform soil temperature can be maintained by mulching. The mulch acts as an insulator that keeps the soil cool under intense sunlight and warm during cold weather.

Figure 13. Never build volcanoes. This crown will rot and the roots are smothered.

- Most mulches prevent crusting of the soil surface, thus improving absorption and percolation of water into the soil and, at the same time, reducing erosion.

- Organic materials used as a mulch can improve soil structure and tilth. As mulch decays, the material becomes topsoil. Decaying mulch may also add nutrients to the soil.

- Mulches add to the beauty of the landscape by providing a cover of uniform color and an interesting surface texture.

- Mulched plants produce roots in and directly under the mulch that surrounds them. The plants produce these roots in addition to the roots in the soil. As a result, mulched plants have more roots than plants that are not mulched.

For more information, see IFAS Publication ENH 103, *Mulches for the Landscape*, at http://edis.ifas.ufl.edu/MG251.

MULCHING BMPS

- When feasible, use mulches made from environmentally friendly sources or recycled materials.

- Do not pile mulch against a tree or around the bases of shrubs. Burying the crowns can lead to crown and root rot. Leave a clear space for air to reach the trunk.

- Maintain a 2"-3" depth of mulch after settling.

MOWING THE FLORIDA LAWN

Mowing is an important maintenance operation. Mowing at the correct height increases turf density and root health and suppresses weeds. A dense turf impedes stormwater runoff. A healthy root system ensures that water and nutrients are absorbed and not wasted. Fewer weeds mean less need for herbicides.

Clippings contain nutrients and should be recycled on the lawn. The nutrients in clippings are pollutants when they end up in stormwater systems and waterbodies.

Figure 14. This is BAD! Never direct clippings into the street where they can enter the storm drain system.

Growth rates and mowing height have the most influence on mowing frequency. As a rule of thumb, mowing should be done often enough so that no more than one-third of the leaf blade is removed at any one mowing. For example, if a St. Augustinegrass lawn is mowed at a height of 4 inches, it should be mowed when it grows to a height of 5.5 to 6 inches. Following this practice minimizes the effect of mowing on photosynthesis and helps to maintain the high percentage of leaf surface necessary for healthy root development. Research shows that returning grass clippings to the surface, sometimes referred to as grass recycling, does not increase thatch buildup on turf. Clippings have significant nutrient value and decompose rapidly, returning some fertilizer and organic matter to the soil.

Figure 15. Always remove clippings from impervious surfaces. These nutrients are going straight to a water body.

Mowing equipment and string trimmers can damage trees. Tree trunks that are bumped by mowers, or trees that are used as pivot points for turns, are injured via contact. Mechanical damage to trees can cause progressively bigger wounds, since the trees are hit in the same general area repeatedly over time. The damage eventually progresses through the phloem, cambium, and xylem of the tree. In a worst-case scenario, the tree is girdled and dies. Those trees not killed are stressed and the wounds end up as an entry point for disease and insect infestation. The whipping action of the nylon string on a trimmer can debark a young tree quickly, causing its demise.

The careful use of string trimmers and mowers in the landscape is imperative, and there is no reason to use them around trees. Replacing the grass around the base of trees with mulch provides a buffer zone. The larger the mulched area, the less the turf near the tree is stressed by shade, the more room the lawn mower has to maneuver with ease, and the less the string trimmer needs to be used. Mulch also confers other benefits, such as reduced competition from weeds and water conservation.

The growth habit and leaf width of a turfgrass species determines the optimum cutting height, frequency, and preferred mower type (Table 4). A grass that spreads

Table 4: Suggested mowing heights and mower types for Florida home lawns

Turfgrass Species	Optimal Mowing Height (inches)	Mowing Frequency (days)	Preferred Mower Type
Bahiagrass	3.0-4.0	7-14	Rotary/flail
Bermudagrass	0.75-1.5	5-7	Reel
Centipedegrass	1.5-2.5	7-14	Rotary
Seashore Paspalum	1.0-2.0	5-10	Rotary/reel
St. Augustinegrass, "Dwarfs"*	3.5-4.0 2.0-2.5	5-7 5-7	Rotary Rotary
Zoysiagrass	1.5-2.5	5-7	Reel

* Dwarf varieties of St. Augustinegrass ('Seville,' 'Jade,' 'Palmetto,' 'Delmar') are the only cultivars of this species that should be mowed at less than 3 inches.

MOWING BMPS

- Adjust the cutting height by setting the mower on a driveway or sidewalk and using a ruler to measure the distance between the ground and the blade.
- Do not mow wet turf because it can promote disease and fungus, and clippings can clog the machine. Mow only when the turf is dry.
- Sharpen the mower blade frequently enough to prevent a ragged appearance to the turf.
- Mow in a different direction every time the lawn is cut. This prevents wear patterns, reduces the grain (grass laying over in the same direction), and reduces the possibility of scalping.
- Use the highest acceptable mowing height for the grasses being grown.
- Do not remove more than one-third of the foliage at one time.
- Do not direct clippings into bodies of water or onto impervious surfaces. Remove any clippings that are blown onto sidewalks, driveways, and other impervious areas.
- Do not remove clippings. If clumping occurs, distribute the clippings by re-mowing or by lightly raking. You can also use a leaf blower to distribute clippings.
- Clean the mower after use to reduce rusting and weed seed movement.
- Practice grass recycling and return nutrients to the soil.
- If you must collect clippings, compost them. Use the compost as a soil modifier or mulch.
- Avoid mechanical damage to trees and shrubs from string trimmers, mowers, and other equipment.

horizontally can usually be mowed shorter than an upright-growing, bunching grass. Grasses with narrow blades can generally be mowed closer than grasses with wide blades. Bermudagrass is mowed at very low heights because of its numerous narrow leaf blades and low growth habit. On the other hand, bahiagrass needs to be mowed higher because of its open, upright growth habit.

Turfgrass undergoes physiological stress with each mowing, particularly if too much leaf tissue is removed. The effects of this "scalping" can produce long-term damage to the turf and leave it susceptible to numerous other stresses, such as insects, disease, drought, and sunscald. It is always important to leave as much leaf surface as possible for photosynthesis to provide food for regrowth.

For mowing safety, be sure to follow these tips:

- Pick up all stones, sticks, and other debris before mowing to avoid damaging the mower or injuring someone with flying objects.
- Never fill a hot mower with gasoline.
- Always wear heavy leather shoes when mowing the lawn.
- Check your mower every time it is used. Follow the manufacturer's recommendations for service and adjustments.

PRUNING OF LANDSCAPE PLANTS

Pruning is another important landscape maintenance task. Through the selective removal of shoots and branches, pruning a plant can improve its health, reduce the risk of failure, control growth, and enhance fruiting, flowering or appearance. Pruning should be a part of routine maintenance and should not be delayed until the landscape is overgrown. However, close attention should be paid to proper timing, depending on the needs of various plants. Proper plant selection can eliminate many pruning requirements, especially for shrubs.

Trees should not be pruned without a clearly defined objective. Objectives can include 1) reducing the risk of failure by improving structure and removing dead branches, 2) raising or reducing the crown to provide clearance, and 3) thinning the crown to increase air and light penetration. Removing the correct stems and branches to accomplish the specified objectives is as important as making the correct pruning cuts. If the wrong branches, or too many branches, are removed even with proper pruning cuts, nothing of merit has been accomplished.

For more information, see the following:

IFAS Circular 853, *Pruning Landscape Trees and Shrubs*, at http://edis.ifas.ufl.edu/MG087 or *Pruning Shade Trees in the Landscape*, at http://hort.ifas.ufl.edu/woody/pruning/.

MANGROVES

Three species of mangroves are native to Florida: red mangrove *(Rhizophora mangle)*, black mangrove *(Avicennia germinans)*, and white mangrove *(Laguncularia racemosa)*.

Red mangroves are easily identified by their "prop roots," which are tangled, reddish, aerial roots that originate from the trunk and branches. Their leaves are 1 to 5 inches long, broad and blunt on the tip, shiny deep green on top, and paler on the underside.

Black mangroves can be identified by numerous fingerlike projections, called pneumatophores, that protrude from the soil around the tree's trunk. Black mangrove leaves are oblong, shiny green on top, and very pale on the underside. Black mangroves are usually found at slightly higher elevations, upland from red mangroves.

White mangroves have no visible aerial root system, as do red and black mangroves. The easiest way to identify white mangroves is by their leaves. These are up to 3 inches long, elliptical (rounded at both ends, often with a notch at the tip), and yellowish in color, with two distinguishing glands at the base of each leaf blade where the stem begins. White mangroves are usually found at higher elevations and farther upland than either red or black mangroves.

The 1996 Mangrove Trimming and Preservation Act, Sections 403.9321-403.9333, Florida Statutes, governs the trimming and alteration of mangroves. The Florida Department of Environmental Protection (FDEP) and several delegated local governments implement the mangrove program. Mangrove trimming and alteration may be done by property owners under certain exemptions, as specified in Section 403.9326, Florida Statutes. Other trimming requires the services of a professional mangrove trimmer and may require an FDEP permit. Section 403.9329, Florida Statutes, governs who may be considered a professional mangrove trimmer.

The mangrove preservation act's major provisions include the following:

- The difference between "trimming" and "alteration" of mangroves is defined.
- Mangroves may not be reduced to a height below 6 feet from the substrate and often may not be legally trimmed down to 6 feet.
- Mangrove roots, including aerial and prop roots (red mangroves) and pneumatophores (black mangroves), may not be trimmed.
- Under certain conditions, a professional mangrove trimmer must conduct or supervise the trimming.
- **Dead mangrove trees are covered by the same regulations as living mangrove trees;** contact the closest Florida Department of Environmental Protection office for specific information on dealing with dead mangrove trees on your client's property.

It is especially important that Green Industry professionals understand that, under the act, **homeowners and the individuals they hire to trim their mangroves are jointly and severally responsible for the appropriate trimming of mangroves**.

All trimming should be done in a manner that does not result in the removal, defoliation, or death of the mangroves. Red mangroves are particularly sensitive to inappropriate trimming. In general, the canopy of red mangroves should not be trimmed, and no more than 25 percent of the canopy of black and white mangroves should be removed. Preferably, views should be obtained by thinning the canopy, creating "windows," and "uplifting," compared with hedging (which can be particularly damaging to red mangroves).

- The booklet *Mangrove Trimming Guidelines for Homeowners* is available at FDEP's district offices throughout the state. You may wish to obtain several copies to give your clients. Before trimming mangroves, homeowners and landscapers should read the publications cited in this section, or call the Environmental Resource Permitting staff at FDEP's district offices to avoid violating the mangrove preservation act.

For more information about the mangrove program, call (850) 245-8482 or go to http://www.dep.state.fl.us/water/wetlands/mangroves/.

DISPOSING OF LANDSCAPE MATERIAL

Never sweep grass clippings, leaves, or other debris into a storm sewer. This pollutes our waterbodies and may, in some cases, clog the system and contribute to flooding.

Be careful with yard waste! Careless disposal may spread invasive non-native plants to areas where they don't belong. Lawn and landscape maintenance involves the removal of leaves, clippings, whole landscape plants, and even unwanted houseplants. Given contact with soil and sufficient water, these materials may become established at the disposal site. Dispose of them carefully, so plants that are unwanted in one location don't unintentionally become established elsewhere. Contact your county waste management utility or Cooperative Extension Service agent for information about local disposal sites in your area that are designated for plant waste. Educate your customers about proper plant disposal and how it enhances the protection of natural areas.

Figure 16. Illegal dumping of plant material.

Sometimes landscape waste materials are disposed of in accessible locations on someone else's property, either public or private. Illegal dumping has allowed several species to become established in natural areas. Wax begonia, pothos, heavenly bamboo, ardisia, golden bamboo, and arrowhead vine are among the species that have moved into wild areas through this mechanism. This spread of non-native species into protected sites is threatening the plant and animal species those sites were purchased to conserve.

Awareness of how a species is likely to become established is important. A plant's relative ease of propagation may provide valuable insight into its potential to spread. Pruned material from a species that is quickly propagated from cuttings, such as wedelia or lantana, may take root without appropriate precautions. The timing of maintenance activities can reduce the potential for discarded plants to become established where they shouldn't.

Depending on the situation and local ordinances, several options are available to dispose of plant material. Living plant tissue can be destroyed on-site through burning, composting in bins, or putting it in or under heavy plastic. Material may also be dumped in designated disposal areas.

The following tips can reduce the accidental propagation of non-native species:

- Plants can be pruned before the fruit is mature, and leaf raking can be done before the seeds of surrounding plants have dropped.

- Whenever practical, and if the homeowner is amenable, yard wastes should be composted on-site and retained for use as mulch. This also avoids transportation and disposal costs and reduces the need for purchased materials.

FERTILIZER TERMS

"Fertilizer" means any substance that contains one or more recognized plant nutrients and promotes plant growth, or controls soil acidity or alkalinity, or provides other soil enrichment, or provides other corrective measures to the soil.

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

Many fertilizer terms are officially defined by the Association of American Plant Food Control Officials (AAPFCO), http://www.aapfco.org/.

FERTILIZER ANALYSIS

The Florida fertilizer label is detailed and intended to be highly informative. By law, the product's label is required to provide the following basic information: the brand and grade, manufacturer's name and address, guaranteed analysis, sources from which the guaranteed primary and secondary nutrients are derived, and net weight.
In addition to the grade of the fertilizer, the label also identifies the breakdown of Total N as either Nitrate-N, Ammoniacal-N, Water Soluble or Urea-N, and Water Insoluble-N. This N breakdown supplies information on the immediate availability and/or leachability of the N in the bag. Slow- or controlled-release fertilizer is defined by the Association of American Plant Food Control Officials (AAPFCO) as a fertilizer containing a plant nutrient in a form that delays its availability for plant uptake and use after application, or that extends its availability to the plant significantly longer than a reference "rapidly available nutrient fertilizer" such as ammonium nitrate or urea, ammonium phosphate, or potassium chloride.

Such delay of initial availability or extended time of continued availability may occur by a variety of mechanisms. These include the controlled water solubility of the material (by semipermeable coatings, occlusion, or the inherent water insolubility of polymers, natural nitrogenous organics, protein materials, or other chemical forms); by the slow hydrolysis of water-soluble, low molecular weight compounds; or by other unknown means.

In most cases, the higher the Water Insoluble-N percentage in the mix, the longer lasting the fertilizer. This is the portion where most of the N from natural organic and slow-release N sources appears. A fertilizer that contains all of its N as Nitrate-N, Ammoniacal-N, and/or Water Soluble N is referred to as a soluble N fertilizer, which has a high potential for leaching and should not be applied at rates greater than 0.5 lbs. N/1000 square feet.

A fertilizer label also contains a "derived from" section that identifies the materials from which the fertilizer was formulated.

For more information, see IFAS Circular CIR-1262, *Selected Fertilizers Used in Turfgrass Fertilization*, at http://edis.ifas.ufl.edu/SS318.

Secondary and micronutrients are identified in the lower portion of the label and are expressed in the elemental form. Sulfur (S) is expressed as "combined" (usually expressed as SO_4) and as "free" (elemental S form). The reason for this distinction is that "free" S is very acidifying when placed in the soil. Magnesium (Mg), Iron (Fe), Copper (Cu), Manganese (Mn), and Zinc (Zn) must be expressed as Total and/or Soluble or Water Soluble depending on the source materials formulated in the fertilizer. Chelated elements are guaranteed separately when a chelating agent is denoted in the derivation statement below the guaranteed analysis. For additional information, see IFAS Publication SL-3, *The Florida Fertilizer Label*, at http://edis.ifas.ufl.edu/SS170.

FERTILIZER APPLICATOR LICENSING

In 2009, new laws were passed that will require all commercial urban landscape fertilizer applicators to obtain and maintain a Limited Commercial Fertilizer Applicator Certificate (LCFAC) From the Department of Agriculture and Consumer Services by January 1, 2014. One requirement of obtaining this certificate is to complete an approved training program based on this book. Training is available throughout the state at County Extension service offices, online through UF Extension, and from industry associations and other trainers.
See http://fyn.ifas.ufl.edu or http://www.flaes.org/aes-ent/index.html.

URBAN TURF FERTILIZER RULE

In 2007, the Florida Department of Agriculture and Consumer Services adopted rule 5E-1.003(2), labeling requirements for urban turf fertilizers. The complete rule, as first adopted in 2007, is presented in the Appendix. The rule limits the amount of nitrogen and phosphorus that the manufacturer may recommend for application on urban turf and lawns in Florida. It also directs the manufacturer to recommend the use of BMPs for professional applicators and golf course or athletic field managers.

While this rule only applies to the manufacturer's label for fertilizer, many local government ordinances, and

future state requirements, may require that applicators abide by the recommendations on the label. In addition, weed and feed products are legally pesticides. **For pesticide – fertilizer combination products the label recommendation carries the full force of state and federal law**.

TURF FERTILIZATION MANAGEMENT

One of the first steps in developing a turfgrass fertilization management program involves a basic knowledge of the soils on which the turfgrasses are being grown. This knowledge can be acquired by observing and evaluating the soil's physical and chemical properties. Most Florida soils are sands and therefore retain limited quantities of water and nutrients. Individuals with only limited training in soils can discern whether a soil is mostly sand or predominately clay, and whether the soil contains flakes of free calcium carbonate or shell. These properties may significantly affect a turfgrass fertilization management program.

Figure 17. Streaking on a lawn caused by poor application technique.

Chemical properties such as soil pH, lime requirement, extractable levels of P, K, calcium (Ca), Mg, and selected micronutrients such as Mn, Cu, and Zn can be determined through soil testing. Florida soils are not analyzed for N because it is highly mobile in sandy soils. Since reliable correlations between turfgrass growth and soil test N have not been developed, turfgrass N fertilization is based on the requirements of the individual turfgrass being grown.

Additional information on soil testing for turfgrasses can be found later in this chapter or in IFAS Publication SL 181, *Soil Testing and Interpretation for Florida Turfgrasses*, at http://edis.ifas.ufl.edu/SS317.

NITROGEN MANAGEMENT

Fertilizer Sources

Matching the fertilizer source and rate with the growth phase of the turfgrass is one of the keys to nutrient management. For example, you may shift from 1 lb total N of 15-0-15 slow release to a 1/2 lb N of 5-0-20 for a fall fertilization as dormancy approaches. Leaching losses of nitrogen can be minimized by using controlled-release nitrogen sources, making frequent, low-rate applications of soluble fertilizers, or applying a combination of the two fertilizer materials. Low-rate applications are usually made using soluble fertilizers, whether applied as a liquid or granular product.

Quick Release Sources

One of the most common nitrogen fertilizers is urea (46 percent N), which is a water-soluble, synthetic organic nitrogen fertilizer with quick N-release characteristics. Urea can be applied as either liquid or granules, and is subject to volatilization, or loss of nitrogen to the atmosphere. If urea is applied to a turfgrass surface and not incorporated through proper irrigation, significant quantities of N can be lost through volatilization. Therefore, it is imperative that the proper quantity of water be applied following the application of urea fertilizer, unless rainfall is anticipated within 8 to 12 hours. Recall that one inch of applied water moves the water front 12 inches through a Florida sandy soil; therefore, do not apply excessive irrigation. Application of 1/4 inch of water should be sufficient to solubilize most of the urea and move it into the turfgrass root zone.

If urea is applied and followed by rainfall of an inch or greater within 8 to 12 hours after application, urea-N may move below the turfgrass root zone because of its nonionic nature and be lost through leaching. Although urea does not leach as rapidly or uniformly as nitrate-N significant loss of N can occur if excessive irrigation or rainfall occurs shortly after application. Once the urea has been exposed to soil or turfgrass thatch layer for a short time, it is converted by the enzyme urease to the ammonium-N form, which is more likely to be retained by the soil. This conversion of urea is usually complete within the first 24 hours after application. Thus, a heavy rainfall 2 to 3 days after an application of urea should not be as influential on N movement.

Figure 18. Weigh fertilizer to get accurate results.

Recently some new types of stabilized N fertilizer materials have been commercialized. These products contain urease inhibitors, which slow the conversion of urea to ammonium and reduce the volatilization loss of N. Therefore, these products can be left on the surface longer without significant loss of N through volatilization. This delay in urea conversion is usually 3 to 5 days, which means that the N remains in the urea form for a longer period of time and subjects the urea to leaching losses if heavy rainfall occurs during this period. In most cases, these stabilized N materials also contain nitrification inhibitors, which slow the nitrification process as well. Recent research suggests that these stabilized N materials extend the N availability to turfgrass for 10 to 14 days over that of quick release products.

Recent research has shown that some slow-release N materials may leach more urea than applications of quick release urea. This is thought to be due to the slow-release urea product leaching through the soil without being degraded by urease. Small quantities of urea (less than 10% of the total released N) have been detected in the leachate from some slow-release N sources during thefirst 7 to 10 days after application. However, by 14 days after application no urea was detected in the leachate regardless of the N source applied; only nitrate N remained after this period.

Ammonium Nitrate (AN) and Ammonium Sulfate (AS) are two other soluble, quick-release N sources commonly used by professional lawn-care services. These two materials are not as high in N as urea. AN (33.5 percent N) and AS (21 percent N), however, have a higher salt index and burn potential than urea on a per-pound-of-N basis. AS is also a very acidifying N source. For each pound of N applied as AS, 5.35 pounds of acidity are produced due to the ammonium-ion content. AS is often the preferred N source on high pH soils due to its acidifying properties.

Urea and AN are often formulated as liquid N sources for application in solution form through the irrigation system (fertigation) or direct application. Lawn-care professionals often use solution fertilizers because of application uniformity and efficiency. Solution fertilizers do not leach more readily than similar granular fertilizers once they have reacted with the soil components.

Slow Release Sources

There are many sources of slow release nitrogen. Several of the definitions provided by AAPFCO are listed below.

- *Slow or controlled release fertilizer* is a fertilizer containing a plant nutrient in a form which delays its availability for plant uptake and use after application, or which extends its availability to the plant significantly longer than a reference "rapidly available nutrient fertilizer" such as ammonium nitrate or urea, ammonium phosphate, or potassium chloride. Such delay of initial availability or extended time of continued availability may occur by a variety of mechanisms. These include controlled water solubility of the material (by semi-permeable coatings, occlusion, or by inherent water insolubility of polymers, natural nitrogenous organics, protein materials, or other chemical forms), by slow hydrolysis of water soluble low molecular weight compounds, or by other unknown means. (AAPFCO, Official 1985)

- *Enhanced Efficiency* is a term describing fertilizer products with characteristics that allow increased plant uptake and reduce the potential of nutrient losses to the environment such as gaseous losses, leaching or runoff, as compared to an appropriate reference product. (AAPFCO, Official 2008)

- *Ureaform Fertilizer Materials* (sparingly soluble) are reaction products of urea and formaldehyde which contain at least thirty-five percent (35%) nitrogen, largely in insoluble but slowly available form. The water insoluble content shall be at least sixty percent (60%) of the total nitrogen. The water insoluble nitrogen in these products shall have an activity index of not less than forty percent (40%) when determined by the appropriate AOAC International method. (AAPFCO, Official 1984)

- *Urea-Formaldehyde Products* (sparingly soluble) are reaction products of urea and formaldehyde which contain less than thirty-five percent (35%) nitrogen, largely in insoluble but slowly available form. They shall have the percentage of total nitrogen as part of the product name; for example: 20% N Urea-Formaldehyde. The water insoluble nitrogen (AOAC Int. Method 945.01) shall be at least sixty percent (60%) of the total nitrogen. The activity index of the water insoluble nitrogen shall be either (1) not less than forty percent (40%) by the AOAC International method for Urea-formaldehyde Products (#955.05) or (2) not less than fifty percent (50%) by the AOAC International alkaline permanganate method (#920.07) or eighty percent (80%) by the neutral permanganate method(#920.06). (AAPFCO, Official 1984)

- *Isobutylidene Diurea(IBDU)* is a condensation product of isobutyraldehyde and urea having a minimum total nitrogen content of thirty percent (30%). It is a source of slowly available nitrogen by virtue of particle size, solubility decreasing with increase in particle size. Material conforming to the description of a "granular fertilizer" will have ninety percent (90%) of its nitrogen content in the water insoluble form prior to grinding as tested by AOAC International Method 945.01 (15th Edition). (AAPFCO, Official 1986)

- *Sulfur Coated Urea (SCU)* is a coated slow release fertilizer consisting of urea particles coated with sulfur.

The product is usually further coated with a sealant (2% to 3% of total weight) and a conditioner (2% to 3% of total weight). It typically contains about thirty percent (30%) to forty percent (40%) nitrogen and about ten percent (10%) to thirty percent (30%) sulfur. (AAPFCO, Official 1980)

- *Urea-Formaldehyde Products* (water soluble) are reaction products of urea and formaldehyde which contain at least thirty percent (30%) nitrogen, largely in water soluble form. Some slowly available nitrogen products are present. Stable aqueous solutions may be prepared from these materials. The reaction products shall contain a maximum of fifty-five percent (55%) free urea, with the remainder of the urea being chemically combined as methylolureas, methylolurea ethers, and/or methylenediurea (MDU) and dimethylenetriurea (DMTU). (AAPFCO, Official 1984)

- *Methylenediurea (MDU)* is a water soluble condensation product resulting from the reaction of one molecule of formaldehyde with two molecules of urea, with the elimination of one molecule of water. It has a minimum total nitrogen content of forty-two percent (42%) and is a source of slowly available nitrogen. (AAPFCO, Official 1984)

- *Dimethylenetriurea (DMTU)* is a water soluble condensation product resulting from the reaction of two molecules of formaldehyde with three molecules of urea, with the elimination of two molecules of water, and having a minimum total nitrogen content of forty-one percent (41%). It is a source of slowly available nitrogen. (AAPFCO, Official 1984)

- *Dicyandiamide (cyanoguanidine)* is a water soluble organic compound of formula $C_2H_4N_4$ which contains at least sixty-five percent (65%) nitrogen. It is a source of slowly available nitrogen. It is a nitrification inhibitor.(AAPFCO, Official 2000)

- *Polymer Coated Urea (PCU)* is a coated slow release fertilizer consisting of urea particles coated with a polymer (plastic) resin. It typically contains about forty percent (40%) nitrogen. It is a source of slowly available nitrogen. (AAPFCO, Official 1990)

- *Triazone* is a water soluble compound of formula $C_5H_{11}N_5O_2$ [5-(N-methyl)-urea-1,3,5-triazin-2-one or 5-methyleneureido-2-oxohexahydro-s-triazine] which contains at least forty percent (40%) total nitrogen. (AAPFCO, Official 1989)

- *Urea-Triazone Solution* is a stable solution resulting from controlled reaction in aqueous medium of urea, formaldehyde, and ammonia which contains at least twenty-five percent (25%) total nitrogen. The solution shall contain no more than forty percent (40%) nor less than five percent (5%) of total nitrogen from unreacted urea and not less than forty percent (40%) from triazone. All other nitrogen shall be derived from water soluble, dissolved reaction products of the above reactants. It is a source of slowly available nitrogen. (AAPFCO, Official 1990)

- *Methylene Urea(s)* (MU, polymethylene urea(s)) is a product obtained by the reaction of urea with formaldehyde and contains oligomers of urea bonded together by methylene ($-CH_2-$) linkages. It is chiefly composed of cold-water soluble fractions from methylenediurea (MDU) and dimethylenetriurea (DMTU), hot water soluble fractions from trimethylenetetraurea (TMTU) and tetramethylenepentaurea (TMPU) and hot-water insoluble fractions from longer chain oligomers. It is generally free of methylolureas and methyol ethers. It is a source of slowly available nitrogen. (AAPFCO, Official 2001)

Urea is often formulated using a chemical reaction or coating to produce fertilizers with slow-release characteristics, such as ureaformaldehyde (UF or Nitroform), isobutylidene diurea (IBDU), and sulfur- or polymer-coated urea. These fertilizers depend on microbial action, soil moisture, and/or a chemical reaction for the release of N for use by turfgrass. It is important to know when to use a given slow-release N source in order to obtain maximum effectiveness from the material. This is due to environmental influences on the N-release mechanisms of slow-release N sources.

Figure 19. Slow or quick release, this fertilizer is going to a water body. Keep fertilizer away from impervious surfaces and water bodies.

The N-release mechanism for methylene urea–type products (Ureaformaldehyde, UF, Nitroform, Nutralene, Methex, or CoRon) is microbial. Because temperature influences the activity of the soil microbial population, these materials release N more slowly and are less effective during the cool season.

Particle size and rate of hydrolysis control the N release from IBDU; thus, this product should not be used during periods of heavy rainfall. However, it is one of the more effective materials in the cool season when precipitation levels decrease.

N release from sulfur-coated urea (SCU) products is controlled by the coating thickness and the degree of imperfection in the coating. SCU products typically induce a somewhat mottled appearance when used during the cool season, but are generally very effective during the high-rainfall, warm-season growth period. **Because of the fragile nature of the sulfur coating on most SCU materials, they should not be applied using a drop-type spreader.**

Other products include polymer-coated, controlled-release fertilizers that use a polymer coating to encapsulate nutrient granules. A polymer membrane is chemically bonded to the substrate resulting in a fertilizer with release governed largely by soil temperature, provided adequate moisture is present. The release mechanism is osmotic diffusion. Some systems consist of multiple layers of polymer, and may include other intermediate coatings. Product longevity may be controlled by coating thickness and blending ratios.

Organic fertilizers are another source of nitrogen that is slowly made available through microbial degradation. In this case, the release rates depend on nature of the product and the prior treatment that it has received as well as temperature and moisture. Organic fertilizers, including biosolids from wastewater treatment plants, generally have low N:P_2O_5 ratios, which means that it is difficult or impossible to meet the nitrogen needs of the turf without exceeding the annual maximum allowable P_2O_5, unless other nitrogen sources are added. Some manufacturers do blend in other N sources to overcome this and provide a more balanced product that preserves the benefits of nutrient recycling.

In conclusion, a wide variety of slow-release materials is available. Under typical Florida conditions, slow-release N sources are likely to leach less than an equal amount of soluble N sources. However, leaching can still take place and some slow-release products may be subject to runoff of the nutrient-containing slow release particles. Judicious use of professional judgment and a mixture of soluble and slow-release N sources are recommended.

For more information on N sources for lawn fertilization, see IFAS Publication CIR-1262, *Selected Fertilizers Used in Turfgrass Fertilization*, at http://edis.ifas.ufl.edu/SS318, or Publication SP141, *Florida Lawn Handbook: An Environmental Approach to Care and Maintenance of Your Lawn*, Second Edition.

Nitrogen Rate and Frequency

The rate of nutrient application, particularly N, depends on a number of factors: turfgrass species, turfgrass maintenance level goals, the location in the state where the turfgrass is being grown, time of year, and type of fertilizer source being used (soluble or slow release). Thus, a single rate of application cannot be recommended. The frequency of fertilization also depends on all the factors listed above for N rate. To limit the environmental impact of your fertilization program, **it is recommended that no more than 0.5 pounds of water-soluble N per 1,000 square feet be applied in a normal application.** Total N should be limited to 1 lb./1000 ft^2, per the Urban Turf Rule. **Table 5** is from the Florida Fertilizer Rule, 5E-1.003(2). In areas irrigated with reclaimed water, check with the reclaimed water supplier for estimates of the N applied per year in the reclaimed water, and recommendations to adjust the fertilization. A study for the Tampa Bay Estuary program (April 2008) estimated 0.6 to 5.3 lb N/1000ft^2 was applied annually to lawns from several different wastewater treatment systems.

For a detailed fertilization guide for Florida turfgrasses, see IFAS Publication SL-21, *General Recommendations*

Table 5: Fertilization guidelines for established turfgrass lawns in three regions of Florida

Nitrogen recommendations (lbs N / 1000 ft^2 / year)*			
Species	**North**	**Central**	**South**
Bahia	2-3	2-4	2-4
Bermuda	3-5	4-6	5-7
Centipede	1-2	2-3	2-3
St. Augustine	2-4	2-5	4-6
Zoysia	3-5	3-6	4-6

* North Florida is north of Ocala. Central Florida is defined as south of Ocala to a line extending from Vero Beach to Tampa. South Florida includes the remaining southern portion of the state.

for Fertilization of Turfgrasses on Florida Soils, at http://edis.ifas.ufl.edu/LH014.

Timing and Season

The timing of fertilization is tied to the turfgrass species, maintenance level goal, season of the year, the location in the state where the turfgrass is being grown, and the fertilizer source being used. One of the most important principles of fertilization timing is avoiding fertilizer application to dormant or non-growing turfgrass. During dormancy, turfgrasses take up very small quantities of nutrients, and applied nutrients are more likely to leach or run off site in the next thunderstorm. Slow-release sources also influence the timing of fertilization, in that fertilization is required less frequently.

Rainfall that exceeds the ability of the soil to retain moisture in the root zone may lead to runoff into surface waters or leaching through the soil to ground water. **Do not apply fertilizer when the National Weather Service has issued a flood, tropical storm, or hurricane watch or warning, or if heavy rains[1] are likely**. While only about 3 to 5% of Florida rain events exceed two inches,[2] caution should always be used to avoid runoff or leaching from saturated or compacted soils or in other high-risk situations. Additional information on storms and weather may be found at http://severe.worldweather.org/rain/, http://www.wrh.noaa.gov/sew/MediaGuide/TermsOutlooks_Watches_Warnings.pdf, and http://www.dep.state.fl.us/water/nonpoint/docs/nonpoint/SW_TreatmentReportFinal_71907.pdf.

Location in the State

Based on seasonal differences, changes in soil types, and the predominant turfgrass species used on lawns, the state is divided into three regions: south, central, and north. The dividing line between north and central Florida is a straight east-west line from coast to coast through Ocala, and the dividing line between central Florida and south Florida is a line from coast to coast through Tampa and Vero Beach.

For tables providing fertilization guidelines for the various turfgrass species by maintenance level in a given region of the state, see IFAS Publication SL-21, *General Recommendations for Fertilization of Turfgrasses on Florida Soils*, at http://edis.ifas.ufl.edu/LH014.

Soil Types and Turfgrass Species

Most of the soils in Florida are classified as sands (96 percent), but within these soil types the chemical properties of the soils vary according to the region of the state in which they occur.

Soils in south Florida tend to contain higher levels of free calcium carbonate (lime or shell) and have a higher pH than the rest of the state. Generally speaking, St. Augustinegrass grows better on high pH soils than do bahiagrass or centipedegrass; thus, one finds more lawns with St. Augustinegrass in south Florida. In fact, approximately 85 percent of the residential and commercial lawns in Florida use one of the several cultivars of St. Augustinegrass. For the recommended soil pH for the various turfgrasses used in Florida, see IFAS Publication SL-181, *Soil Testing and Interpretation for Florida Turfgrasses*, at http://edis.ifas.ufl.edu/SS317.

Due to the potential for ammonia volatilization, **the surface application of ammonium-N and/or urea-containing fertilizers to these high pH soils without watering in (with 0.25 inch of irrigation) is not recommended. Central Florida soils** contain less calcium carbonate and tend to be more acidic, with a pH of between 5.5 and 7.5. Except for areas where limestone outcroppings occur, most of the turfgrass species can be grown. Since bahiagrass and centipedegrass do not grow well on high pH soils, their establishment on soils with a pH of greater than 7.0 should be avoided. Soils in north Florida tend to contain higher quantities of clay and to be more acidic than soils in the rest of the state. Therefore, bahiagrass and centipedegrass are used more commonly for lawns in this part of the state.

Zoysiagrass is not used extensively as a lawn grass in Florida, but when used it grows best under the same soil and fertilization conditions as St. Augustinegrass. Bermudagrasses require high maintenance and specialized equipment, but can be grown under a broad array of soil conditions. They are typically grown under intensively managed golf course conditions. Bermudagrass maintenance is not covered in this manual but is included in *Best Management Practices for Enhancement of Environmental Quality on Florida Golf Courses*, published by FDEP in 2007. Available: http://www.dep.state.fl.us/water/nonpoint/docs/nonpoint/glfbmp07.pdf. Seashore paspalum produces a high quality turfgrass with minimal fertility requirements and a high tolerance for salinity. This is a relatively new grass in Florida and may be very sensitive to cultural practices. For up-to-date information, contact your cooperative extension service or see *Seashore Paspalum for Florida Lawns* at: http://edis.ifas.ufl.edu/ EP059.

PHOSPHORUS FERTILIZATION

Because P has been implicated as a cause of increased algae growth in surface water impoundments, proper P fertilization management is imperative. Therefore, the goal in P management should be to apply the correct

[1] World Meteorological Organization definition of heavy rain: Rainfall greater than or equal to 50 mm (2 inches) in a 24 hour period.
[2] Data from "Evaluation of Current Stormwater Design Criteria within the State of Florida" (Harper and Baker, 2007, FDEP Contract S0108).

amount based on soil test recommendations. Since the first publication of this manual, the Urban Turf Fertilizer Rule, 5E-1.003(2) has been enacted. In addition to the nitrogen restrictions discussed earlier, there are changes to phosphorus application limits. The rule limits phosphate application to no more than 0.25 lb. P_2O_5 /1000ft^2 per application, not to exceed 0.5 lb. P_2O_5 /1000ft^2 per year, without a soil test. A one-time only application of up to 1.0 lb. P_2O_5 /1000ft^2 is permitted for establishment of new turf. This BMP manual strongly recommends soil testing before any initial P_2O_5 application and annually if applications are being made based on previous testing. Where subdivisions have been determined to have relatively similar soils, this may be reduced to testing 1/2 to 1/3 of the customers each year, rotating the testing so all are tested every 2 or 3 years. For more information, see IFAS Publication SL-181, *Soil Testing and Interpretation for Florida Turfgrasses*, at http://edis.ifas.ufl.edu/SS317.

Turfgrasses use significantly less P than N and/or K. Some Florida soils are high in native P, and turfgrasses grown on these soils require only limited P fertilization or none at all. Soil or tissue testing should always be used in these situations. Responses to P fertilization are most typically observed for rooting enhancement during establishment and where soils have a P deficiency.

The off-site transport of P is often associated with soil erosion from unvegetated and thin turfgrass areas. Research shows that runoff from a healthy turfgrass area is minimal, but thin and/or poor quality turfgrass has much a higher erosion and runoff potential. Because P can be a significant contributor to eutrophication, the proper management of P on turfgrass is just as important to the environment as N management.

Another source of P is in reclaimed water. Turf irrigated with reclaimed water may receive an excess of P, compared to the maximum amounts recommended in the Urban Turf Rule. Do not add phosphorus to a site irrigated with reclaimed water without a soil test recommendation to do so.

By using the following simple measures, you can properly manage the P fertilization of your turfgrasses:

- P fertilization should always be based on reliable soil or tissue test recommendations. Many Florida soils are high in extractable P and may never require P fertilization for optimum turfgrass growth. Never exceed the amounts allowed by the Florida Fertilizer Label without a soil or tissue test recommendation.

- Since unvegetated slopes or thin, low-quality turfgrass areas are more likely to produce runoff and off-site P contamination than healthy, well-maintained turfgrass areas, it is important to properly maintain your turfgrass.

POTASSIUM FERTILIZATION

Of the three primary nutrients (N, P, and K), K is second only to N in utilization by turfgrasses. Large responses in turfgrass growth are not typically observed in response to K fertilization, but K has been linked to reduced disease incidence, drought and cold tolerance, and enhanced root growth. The K fertilization rate is often tied to the N fertilization level, generally in a 3:1, 2:1, or 1:1 ratio. Recent research on Bermudagrasses suggests that optimum growth and tissue K levels can be attained at a 3:1 or 2:1 ratio.

Ideally, turfgrass K fertilization should be based on soil test recommendations. Because of high mobility in sandy soils, K fertilization should be made as soon after soil testing as possible. However, K is often applied without a prior soil test, based on the requirements of the turfgrass. Fortunately, K is not considered a pollutant, but prudence in K fertilization is essential for economic and resource conservation reasons. Excessive K fertilization can contribute to high soil electroconductivity (EC) levels that may limit root growth and turfgrass tolerance to drought.

SECONDARY NUTRIENT FERTILIZATION

Ca, Mg, and S are referred to as secondary plant nutrients, not because they are of secondary importance, but because they are typically used in smaller quantities than the primary nutrients. Of these three, the Extension Soil Testing Laboratory (ESTL) makes recommendations only for Mg. Mehlich-1 extractable Mg levels are typically low, and responses have been observed when the soil Mg status drops below 40 pounds per acre. For more information, see IFAS Publication SL-181, *Soil Testing and Interpretation for Florida Turfgrasses*,at http://edis.ifas.ufl.edu/SS317.

Due to the presence of apatite and/or residuals from previous P fertilizations, the Mehlich-1 extractant may dissolve higher levels of Ca than are plant available; therefore, no interpretation is made for the extracted soil Ca. Generally, plant-available Ca levels of Florida soils are high and no responses to applied Ca have been observed. You may increase Ca levels by applying irrigation water containing high levels of Ca.

Consistent and reliable correlation data do not exist for soil test S levels and turfgrass growth; thus, the ESTL does not analyze or make recommendations for S. Fortunately, S is often an accompanying anion in N, K, Mg, and micronutrient sources and is not often deficient for turfgrass growth.

MICRONUTRIENTS

The ESTL analyzes and makes recommendations for Cu, Mn, and Zn. Of these three micronutrients, turfgrass responses have only been observed for Mn. In most Florida soils, extractable Cu and Zn levels are adequate for optimum turfgrass growth, except for Cu on organic soils under sod production. No analysis or recommendation is made for Fe in Florida soils due to limited information on

the correlation between soil and tissue levels, and turfgrass growth response. A greening in response to the application of Fe and/or Mn will most likely be obtained on turfgrasses grown on soils having a pH of 7.0 or greater or irrigated with alkaline water. The application of 2 ounces of iron sulfate per 1,000 square feet as a foliar spray usually produces the desired response. This response is generally short-lived, however, and reapplication may be required. For additional information, see IFAS Publication SL-181, *Soil Testing and Interpretation for Florida Turfgrasses*,at http://edis.ifas.ufl.edu/SS317.

FERTILIZING GRASS FOR ESTABLISHMENT OR RECOVERY

Establishment and recovery are special situations. The goal is to get the environmental benefits of a solid cover of turfgrass as quickly as possible and this may require fertilization above what established turf requires. N and K are used to promote a thick, vigorous stand of turf. Use P only when a soil test indicates there is a need. The BMP for retaining nutrients on the lawn is a dense stand of turf.

The following measures can be used to fertilize grass for establishment or recovery:

- New sod should not be fertilized with nitrogen for the first 30 days, until it has firmly rooted into soil. Plugs can be fertilized at the time of installation to encourage the runners to spread. A quick, complete ground cover is the ultimate goal.
- Newly seeded areas should not receive nitrogen fertilization until a cover has been established and roots have pegged down, usually about 30 days.
- For new turf establishment only, soil test results may indicate a one time application of up to 1 lb. P_2O_5 /1000ft^2 is needed to encourage root growth. This should not be applied until 30 days after planting.
- Newly established turf often requires a different fertility schedule to grow and develop a dense stand. Both rates and timing may be different.
- Weakened turf may be stimulated back to health by N fertilization.
- N rates should be adjusted to meet the needs of the turf.
- Soluble fertilizer may be necessary to provide a rapid response on weakened turf.
- Lower total rates of soluble fertilizer can produce desired turf improvement when applied frequently.
- Fe and Mn may be useful to improve color, especially in neutral or alkaline soils. Micronutrients may provide an initial color response, while N thickens the turf and improves root development.
- Slow-release fertilizer may be an advantage when nutrients cannot be applied as frequently.

There is no significant difference between liquid or dry applications. Turfgrasses take up N in the form of nitrate and ammonium, and all dry fertilizers have to be dissolved by water before they benefit the turf. In terms of BMPs for environmental protection, the proper application of fertilizer is more important than the type of product.

UNTREATED BUFFERS NEAR BODIES OF WATER

Except when adjacent to a protective seawall, always leave a "**Ring of Responsibility**" around or along the shoreline of canals, lakes, or waterways, so that you do not get fertilizer into a body of water. When fertilizing, it is important to **ensure that fertilizers and other lawn chemicals do not come into direct contact with the water or with any structure bordering the water or a storm drain such as a sidewalk, brick border, driveway, or street. If any materials do get onto these impervious surfaces, sweep them into the vegetated landscape or otherwise clean them up.**

Figure 20. Leave a "Ring of Responsibility" to prevent pollution. Also note the swale and berm.

This untreated buffer protects the water quality of the waterway by ensuring no prills or droplets enter the water. When applying liquid fertilizers, the Ring of Responsibility should be at least 3 feet from the edge of the water.

The same is true for applying granular fertilizers with a broadcast fertilizer spreader that features a deflector shield. A deflector shield only allows fertilizer to be distributed on one side. This half-circle application (instead of the typical full-circle application of most fertilizer spreaders) allows for a more accurate fertilizer application.

If you are broadcasting fertilizer without a deflector shield, the Ring of Responsibility should extend at least

10 feet from the edge of the water, since the prills may be thrown up to 7 feet.

Figure 21. Spreaders with deflector shields.

The "Ring of Responsibility," is a preventative buffer, which protects against accidental direct contamination when fertilizing, and is the responsibility of the applicator. Some communities may require larger treatment buffers, which are intended to absorb pollutants from stormwater flowing across the land. Land development codes in these communities require developers and builders to leave native vegetation or other riparian buffers or filter strips to protect the water from the broader effects of upland development. These areas usually do not require fertilization, or need it only during an initial establishment period. The applicator should understand and respect the nature of these areas.

IMPERVIOUS SURFACES

Most urban landscapes are surrounded by impervious surfaces such as sidewalks, driveway and streets. An impervious surface that drains to a water body or the stormwater system is called a Directly Connected Impervious Area (DCIA). Fertilizer inadvertently applied on these surfaces has ready access to our water resources through storm drains. This is why it is so important to keep fertilizer off impervious surfaces and to remove any that is spilled on them and deposit it back into the landscape.

Figure 22. Fertilizer on sidewalks runs off into storm drains. Sweep it into the grass.

If using a broadcast spreader, deflector shields should always be used when applying fertilizer adjacent to these surfaces.

FERTIGATION

Fertigation is the application of liquid fertilizer thorough irrigation systems. While fertigation is not widely practiced in residential or commercial lawn and landscape care, some systems are available. For effective nutrient management to be achieved, a fertigation system should be designed, installed, and maintained by a qualified irrigation specialist. Proper and legal backflow prevention devices must be used so that fertilizer does not back-siphon into the water supply. Apply minimum quantities of fertilizer. Due to the hazards of direct deposition on streets, driveways, and sidewalks; and potential over-application by misadjusted irrigation systems; FDEP does not recommend use of fertigation for residential use unless the entire system is under an operation and maintenance contract with a reputable contractor who is fully responsible for any pollution due to improper operation of the fertigation equipment or the associated irrigation system.

FERTILIZING LANDSCAPE PLANTS

WHY FERTILIZE?

Clearly, plants grow in the wild without any help from humans. However, our modern urban landscape is not the same as the one where our native plants evolved. Subdivisions filled with subsoils, forests cut down, and drainage modifications all combine to make an urban landscape a very different environment. In addition, we have learned that some plants respond to fertilizers in ways that we may consider desirable, such as faster growth or improved appearance. The value of these outcomes is subjective. For example, faster growth may be desired in one circumstance but may lead to unwanted pruning in another. Improved appearance is important to some and unimportant to others.

Thus, the reason for fertilizing plants should be to supply nutrients to achieve a clearly defined objective, such as the following:

- Increasing shoot growth, root growth, flowering, or fruiting;
- Establishing newly planted trees and shrubs;

- Enhancing foliage color and plant appearance;
- Correcting or preventing nutrient deficiencies.

RECOMMENDATIONS AND BASIC PRINCIPLES FOR FERTILIZING LANDSCAPE PLANTS

The recommendations in this section do not pertain to products containing insecticides, herbicides, or other pesticides. By law, such products are considered pesticides. For-hire applicators must be licensed and the label instructions must be followed (see Chapter 6 on pest control for more information).

Important recommendations and principles for fertilizing landscape plants are as follows:

- Prior to fertilizing, a soil and/or foliar nutrient analysis should be used to determine whether any need exists for phosphorus fertilizer.
- Before fertilizing, pests may need to be controlled and/or soil modified to improve nutrient uptake or plant responses to fertilizer.
- Plants with pests or other problems that could increase to damaging levels with fertilization should be fertilized only in conjunction with a treatment program. Without a treatment program, fertilizer may increase the severity of the damage.
- Soil pH should be considered when selecting a fertilizer.
- The amount of fertilizer applied should be the minimal amount needed to achieve the defined objective.
- Read and follow **all** label instructions and safety precautions.
- The types and rate of fertilizer should be specified, aswell as the timing, method, and location of application. Slow-release fertilizers are often preferred. High levels of nitrogen fertilizer may reduce flowering in some plants.

WHEN TO FERTILIZE

Fertilization MAY be justified in the following situations:

- If trees and shrubs are newly planted (thus justifying fertilization until established);
- If homeowners or clients desire more or faster growth;
- If landscape beds have been leached of nutrients by flooding or overirrigation;
- If trees and shrubs are NOT near fertilized turfgrass;
- If established plants are lacking in foliage color or density for the homeowners' or clients' purposes;
- If plants exhibiting nutrient deficiencies are in situations where they cannot be replaced with better-adapted species.

Fertilization may NOT be required in the following situations:

- If homeowners or clients are pleased with the appearance of their landscape plants;
- If plants are established;
- If plants are flowering or fruiting, since exposure to high nitrogen at this stage may impede development;
- For trees, unless nutrient deficiencies exist.

If landscape plants exhibit nutrient deficiency symptoms, they may not be suited to the site due to soil pH, soil drainage, soil salts, limited soil volume, irrigation water quality, or mineral content of the soil. Consider replacing such plants with others adapted to the site's conditions.

HOW MUCH TO FERTILIZE

General Recommendations

When it has been determined that fertilization is necessary, most established landscape plants should be fertilized at rates within the ranges shown in **Table 6**.

Table 6: Landscape plant nitrogen fertilization rates.

Level of Maintenance	**Amount of Nitrogen Fertilizer**		
	pounds N/1000 ft^2/year	per 3' diameter plant/yr*	
		Oz.**	Tablespoons**
Basic	0 – 2	0 – 3	0 – 6
Moderate	2 – 4	3 – 6	6 – 12
High	4 – 6	6 – 9	12 – 18

* Typical, assumes 15% N 50% slow release, Approx 7 sq. ft. root zone.
** 1 lb. N rate is about 1.5 oz. or 3 Tablespoons per 10 ft^2 per application.

The P content of the fertilizer should be zero unless a soil or tissue test indicates a need for additional phosphorus. Historically, the ratio of N to K for landscape plants has been in the range of 1:1 to 2:1. Since magnesium (Mg) deficiency occurs in certain landscape plants in many parts of the state, up to 2.5 pounds Mg/1000 ft^2/year may be applied to address this problem. Micronutrients can be applied at specified rates and timing to achieve fertilization objectives.

In general, slow release fertilizers are horticulturally and environmentally preferable for landscape plantings. Water-soluble fertilizers should be applied at a rate of no more than 0.5 pounds N/1000 ft^2 per application. The maximum application rates for controlled-release fertilizers depend on the percent that is water soluble and the release rates of the product. Never broadcast fertilizers on newly bedded plants. Apply the appropriate amounts to the individual plant within the area under the plant canopy, which usually indicates the major root area.

For additional information on landscape plants grown in soil, see IFAS Publication SL-141, IFAS *Standardized Fertilization Recommendations for Environmental Horticulture Crops*, at http://edis.ifas.ufl.edu/CN011.

Palms

Palms have different nutritional requirements than most other landscape plants. In Florida's rock, muck, and sandy soils, palms may be especially prone to K, Mg, Mn, Fe, and B deficiencies. If you suspect deficiencies in a palm tree, take a leaf to your Cooperative Extension Service agent for assistance. In general, fertilizers or supplements should be applied to supply N, P, K, and Mg at about an 8:2:12:4 ratio. The N, K and Mg should be in a slow-release form. In addition, 1 to 2 percent Fe and Mn, and trace amounts of Zn, Cu, and B, may be needed.

For more information on palms and palm deficiencies, see *Fertilization of Field-grown and Landscape Palms in Florida*, http://edis.ifas.ufl.edu/EP261 or *Nutrient Deficiencies of Landscape and Field-grown Palms in Florida*, http://edis.ifas.ufl.edu/EP273.

WHERE AND HOW TO FERTILIZE

Fertilizer should be broadcast uniformly over the desired areas of the landscape. Root location, fertilization objectives, and plant species should be considered. Areas where tree or shrub fertilization zones overlap with lawn fertilization zones should receive one, not two, fertilizations. Start with the lowest recommended rate and slowly increase to amount up to the maximum recommendation only if the plant requires it. Foliar applications, injections, or implants should only be used when the soil application of fertilizer is impractical or ineffective in achieving fertilization objectives. When applying foliar fertilizer, the fertilizer solution should be thoroughly sprayed to cover the affected foliage at the proper stage of growth to achieve objectives.

Make sure your fertilizer spreader is properly calibrated and on the correct setting to deliver the desired amount of fertilizer for the area being treated. This is discussed in more detail in the section on calibrating pesticide spreaders in the next chapter and in the publication below. For more information, see the following:

IFAS Publication *How to Calibrate Your Fertilizer Spreader*, IFAS Publication ENH 62, 2003. Available at: http://edis.ifas.ufl.edu/LH024.

IFAS Publication *Fertilization Recommendations for Landscape Plants*, G.W. Knox, T. Broschat, and R.J. Black, IFAS Publication ENH 858, 2002. http://edis.ifas.ufl.edu/EP114.

FERTILIZER STORAGE AND LOADING

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

Mishandling of fertilizers containing nitrates may result in excessively high levels of nitrate in drinking-water supplies (greater than 10 parts per million [ppm]of NO_3-N). This has been linked to health problems such as blue baby syndrome (methemoglobinemia) in infants. Because the state's aquifers and surface waters are extensively interconnected, Florida requires all potentially potable ground water to meet drinking-water standards. For nitrate, federal and state regulations set the drinking-water standard at 10 ppm NO_3-N. Shallow wells (less than 50 feet in depth) and old wells with faulty casings are at the highest risk for nitrate contamination.

STORAGE

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

Take care when storing fertilizer to prevent the contamination of nearby ground water and surface water. Always store fertilizer in an area that is protected from rainfall. Storing dry bulk materials on a concrete or asphalt pad may be acceptable if the pad is adequately protected from rainfall and from water flowing across the pad. The secondary containment of stationary liquid fertilizer tanks is addressed in Florida Department of Environmental Protection Rules 62-761 and 62-762, Florida Administrative Code (F.A.C.). Even where not required, the use of secondary containment is sound practice.

LOADING

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

Clean up spilled fertilizer materials immediately. Collected material may be applied as a fertilizer. At fixed sites, the area can be cleaned by sweeping or vacuuming (or with a shovel or loader, if a large spill), or by washing down the loading area to a containment basin specifically designed to permit the recovery and reuse of the wash water. Wash water generated should be collected and applied to the target crop. Discharging this wash water to waterbodies, wetlands, storm drains, or septic systems is illegal.

For more information, see *Best Management Practices for Agrichemical Handling and Farm Equipment Maintenance*, published by the Florida Department of Agriculture and Consumer Services and the Florida Department of Environmental Protection, May 1998.

SOIL TESTING

Although it may not be an essential practice for the everyday maintenance of a healthy landscape, testing to determine the soil's chemical properties before installing turfgrass or landscape plants is a recommended practice. Through soil testing, the initial soil pH and P level can be determined. Soil pH is important in determining which turfgrass is most adapted to initial soil conditions (bahiagrass and centipedegrass are not well adapted to soil with a pH greater than 7.0). Since it is not easy to reduce the pH of soil on a long-term basis, you should use St. Augustinegrass or bermudagrass on high-pH soils.

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

Soil testing is an applied science and can be used as one of the tools in the maintenance of healthy turfgrass and landscapes. For the effective management of nutrients, soil testing should be used in conjunction with tissue testing. Soil test recommendations are based on a correlation between the level of a given nutrient extracted from the soil and the anticipated plant response. The amount of nutrients extracted by a particular extractant is only an index relative to crop response. It is not a direct measure of actual plant nutrient availability.

The levels of extracted P, K, and Mg are divided into five categories: very low, low, medium, high, and very high.

Figure 23. Taking a soil sample.

For more information, see your county Cooperative Extension Service agent or IFAS Publication SL-181, *Soil Testing and Interpretation for Florida Turfgrasses*, at http://edis.ifas.ufl.edu/SS317.

SOIL SAMPLING METHODOLOGY

The soil test and resulting recommendations are only as representative as the sample itself. Therefore, it is imperative that the soil sample be taken and handled properly. The sample should be obtained by taking 15 to 20 small plugs at random over the entire area where information is desired. Avoid any unusual areas or areas with a specific identifying appearance. Areas with identifying characteristics should be sampled separately. For turfgrass, since most of the roots are in the top 4 inches of soil, limit the sampling depth to 4 inches. For landscape plants, the sampling depth should be no more than 6 inches.

Figure 24. Soil Core.

Place the plugs that have been collected into a

plastic container, mix them thoroughly, and send approximately 1 pint of the mixed sample to the Extension Soil Testing Laboratory (ESTL) for chemical analysis. Several commercial laboratories also offer the same service in Florida. You should use the same laboratory on a continued basis to establish a historical log of your soil properties. Laboratories across the state do not use the same extractant, so if you change labs often you may be comparing results obtained by different methods.

SOIL TEST INTERPRETATION

A soil analysis supplies a wealth of information on the nutritional status of a soil and can detect potential problems that limit plant growth. A routine soil analysis supplies information on soil pH and the extractable P, K, Ca, and Mg status of the soil. The ESTL currently uses Mehlich-1 as an extractant on all the acidic mineral soils in the state and AB-DTPA (Ammonium Bicarbonate-DTPA) extractant on soils with pH above 7.3 (calcareous soils).

The IFAS Everglades Extension Soils Laboratory currently uses acetic acid to extract nutrients from all organic soils. Therefore, the extractants are calibrated to different soil types. These extraction procedures must be ascertained when approaching any laboratory for a soil analysis. The routine analysis includes a lime requirement determination if the soil pH is below 6.0. N is not determined, because in most soils it is highly mobile and its soil status varies greatly with rainfall and irrigation events.

Table 7 presents interpretation ranges for soil test levels of P, K, Mg, Mn, Zn, and Cu. For detailed explanations of soil tests and interpretation, see IFAS Publication SL-181, *Soil Testing and Interpretation for Florida Turfgrasses*,at http://edis.ifas.ufl.edu/SS317.

Note that there is no interpretation made for soil test Ca or Fe. No interpretation is made for Mehlich-1 extractable Ca levels because the extractant dissolves Ca compounds, which may not be readily plant available. Thus, the amount of plant-available Ca can be erroneously interpreted. In most cases, Ca levels are adequate for turfgrass growth because Florida soils are inherently high in Ca, have a history of Ca fertilization, or receive Ca regularly through irrigation with high-Ca water. The soil test level for Mehlich-1 extractable Ca is used only to determine the type of limestone needed when lime is recommended. For most soils and turfgrasses, liming to ensure an adequate soil pH ensures more-than-adequate Ca. Research has shown no turfgrass response to added Ca, from either liming materials or gypsum, when the Mehlich-1 extractable Ca level is above 250 ppm.

The ESTL does not analyze for extractable Fe because definitive interpretation data are lacking. Significant correlation of soil test Fe levels with plant tissue levels is also lacking. The testing procedures tend to produce highly variable results. Most soils, except those having a pH greater than 7.0, generally contain adequate levels of Fe for optimum growth. Turfgrasses grown on soils with pH greater than 6.5 exhibit a greening response to Fe applied as a foliar spray. Unfortunately, reapplication may be required on a frequent basis to sustain the desired color.

For more information on fertilizing landscape plants, see IFAS publication SL-141, *Standardized Fertilization Recommendations for Environmental Horticulture Crops*, at http://edis.ifas.ufl.edu/CN011.

TISSUE TESTING

Because of the mobility of most essential nutrients for landscape plant and turfgrass growth in Florida soils, one of the best indicators of appropriate fertilization and plant health is tissue analysis. Since turfgrass is a perennial crop, historical logs of tissue composition can be used to fine-tune a turfgrass fertilization program for optimum plant growth and minimum environmental impact. Leaf analysis, along with appearance and soil analysis, can be used to diagnose the problems and the effectiveness of a fertilization program, especially for micronutrient deficiencies. Soil analysis for some nutrients, because it is a snapshot of what is present at the time of sampling, does not always indicate their availability to plants. Potential nutrient deficiencies can be detected with leaf analysis before visual symptoms

Table 7: Suggested ranges for Mehlich-1 extractable soil nutrient levels for Florida turfgrasses.

Macronutrients*			**Micronutrients****		
P	K	Mg	Mn	Zn	Cu
Parts per million (ppm)					
16–30	36–60	20–30	3–9	0.5–3	0.1–0.5

* Medium ranges of Mehlich-1 extractable P, K, and Mg when in 25 percent of the cases a response to applied fertilization would be expected.

** Soils testing below these levels of micronutrients are expected to respond to applied micronutrients. The interpretation of soil test micronutrient levels is based on soil pH. The smaller number is for soils with a pH of less than 6.0, and the larger number is for soils with a pH of 7.0 or greater. Mehlich-1 extractable micronutrient levels are only determined when requested and require an additional charge.

appear. Leaf analysis may provide information on induced deficiencies and inferences on plant uptake.

TISSUE SAMPLING METHODOLOGY

Clippings can be collected during regular mowing practices for tissue analysis. It is essential that the clippings are free of sand and fertilizer contamination. Do not harvest clippings immediately after fertilization, top-dressing, or any other cultural practice that results in significant mower pickup. Place approximately a handful of well-mixed clippings in a paper bag. Do not place the clippings in a plastic bag because the clippings may begin fermenting prior to drying.

If facilities exist at your location, dry the collected clippings at approximately 70°C (158°F) for 24 hours and then mail them to your favorite analytical laboratory for analysis. If you do not have dry facilities, ship them, preferably overnight, to the analytical laboratory. Even if placed in a paper bag, if the sample is allowed to sit for more than a couple of days the tissue will begin to ferment and the value of the sample for analytical purposes will be lost.

SAMPLE CONTAMINATION

Turfgrass clippings that have been recently sprayed with micronutrients for fungicidal or nutritional purposes should not be used for micronutrient analysis. Washing recently unsprayed clippings to remove soil and dust particles is recommended prior to sending the samples to the lab for analysis. If you wash one collection of clippings and not all, the nutritional analyses may not be comparable because the concentration of some nutrients in tissue, such as K, is highly mobile and a portion of the K may be removed during washing. Unwashed samples may appear to have a much higher concentration than the washed samples, and you may suspect a deficiency in the washed samples when in fact an adequate supply of K exists.

INTERPRETATION OF RESULTS

Sufficiency levels of essential nutrients in the various turfgrass species do not vary much among the various species, except for N. The sufficiency tissue N concentration can vary from a low of 1.5 percent for centipedegrass or bahiagrass to a high of 3.5 percent in cool-season, overseeded ryegrass. **Table 8** lists the sufficiency ranges for tissue N concentration for the various turfgrasses used in lawns. In most cases, tissue N concentrations below the minimum of the range would be deficient and above the range would be excessive.

The concentration of other macro and micronutrients in the tissue does not vary greatly among the various species of turfgrasses. The sufficiency ranges in **Table 9** are applicable to most of Florida's turfgrass species. All of these values are on a dry weight basis.

These values represent the range over which a particular nutrient might vary across the various species of turfgrasses. They represent sufficiency ranges, which suggests that levels below the range may indicate a deficiency or above the range may represent excessive fertilization or toxicity.

The sufficiency ranges in the tables show the most current interpretation for nutrient concentrations in turfgrass tissue. If analytical test results are in the deficiency range or below the sufficiency range, an increase in fertilization for that nutrient is recommended. Alternatively, if test results fall above the sufficiency range, the fertilization program should be adjusted downward. If a change in fertilization is indicated, the adjustment should be reasonable. The intent is to find the correct nutrient management level that maintains turfgrass tissue nutrient concentration within the optimum range, but does not lead to over-fertilization and possible adverse environmental and economic results.

SUMMARY

Fertilization is one of the key management practices in establishing and maintaining healthy, actively growing turfgrass. The desires of the individual lawn owner or turfgrass manager often dictate the level of fertility management. Due to environmental concerns, some

Table 8: Sufficiency ranges of tissue N concentration for selected lawn turfgrasses.

	St. Augustine	Zoysia	Bermuda	Centipede	Bahia	Rye
N (%)	2.0 - 3.0	2.0 - 3.0	2.5 - 3.5	1.5 - 2.5	1.5 - 2.5	3.5 - 5.5

Table 9: Sufficiency concentration ranges for selected macro and micronutrients in turfgrass tissue

P	K	Ca	Mg	Fe	Cu	Mn	Zn	B
Percent (%)				ppm				
0.15 - 0.50	1.00 - 3.00	0.5 - 1.0	0.20 - 0.50	50 - 250	5 - 30	25 - 100	20 - 250	5 - 20

think that less fertilization is always best, but research shows that fewer nutrients are lost from the surface or leached through a healthy, well-maintained turfgrass than an unhealthy, sparsely established turfgrass.

The importance of proper irrigation during fertilization cannot be overemphasized. Excessive irrigation after fertilization may cause leaching or runoff, and a lack of irrigation may result in volatilization and inefficient use of fertilizer.

Due to the prevalence of streets, driveways, and other impervious areas, it is very important to ensure no fertilizers are left where they can run off into stormwater systems or water bodies. Deflector shields should always be used near boundaries with water or impervious areas.

BMPS FOR TURFGRASS AND LANDSCAPE FERTILIZATION

- Do not fertilize if a heavy rainfall is expected, especially tropical or frontal weather systems.
- Avoid both leaching and surface runoff. Match the product to the situation. Remember that all fertilizers, even slow release products, contain nutrients and can cause pollution if allowed to escape the root zone.
- Correct other deficiencies first. Be aware of the effects soil pH, shade, overwatering, or other stresses may have on the plants. Be sure fertilizer is the correct response to the problem.
- Remember that rate and timing of N fertilization depends on the turfgrass species, season of the year, level of maintenance desired, source of N applied, and location in the state.
- Limit water-soluble (quick release) Nitrogen applications to 0.5 lb./1000 ft^2. This includes the water soluble part of slow-release blends. Limit total N to 1 lb./1000ft^2 per the Urban Turf Rule.
- P application should be limited to soils that require additional P based on soil or tissue testing.
- Limit N and P fertilization at establishment to one time 30 days after seeding/sodding. Do not add N or P before installation, but amend the soil as needed with lime or organic matter.
- Always leave a Ring of Responsibility near water bodies or impervious surfaces. Always use deflector shields on broadcast or rotary spreaders when applying fertilizer near water or sidewalks, driveways and streets.
- Sweep any fertilizer left on impervious areas back into the vegetated area.
- Become proficient in reading and understanding the fertilizer label.
- Know the exact square footage of the area where fertilizer is being applied and make sure the spreader/application equipment is properly calibrated and set to deliver the correct amount of fertilizer to that area.
- Become knowledgeable in soil sampling procedures and soil test interpretation.
- When fertilizing (other than when watering restrictions apply), irrigate with 1/4 inch of water following fertilization to avoid the loss of nitrogen and increase uptake efficiency. If water restrictions apply, you may irrigate as you are allowed, but more than 1/2 inch may cause some nitrogen to be leached past the root zone.
- Use Fe and/or Mn instead of N to enhance turfgrass color on soils having a pH greater than 7.0, especially during times of enhanced rainfall.
- Maintain a healthy, actively growing turfgrass to minimize the environmental impact of fertilizer and pesticide application, erosion, and stormwater runoff.
- There is no significant difference between liquid or dry applications of similar products. In terms of BMPs for environmental protection, *the proper application of fertilizer is more important than the type of product.*

LEGAL ISSUES

DEFINITIONS

A pest is anything that competes with humans, domestic animals, or desirable plants for food or water; injures humans, animals, desirable plants, structures, or possessions; spreads disease to humans, domestic animals, wildlife, or desirable plants; or annoys humans or domestic animals.

Types of pests include the following:

- Arthropods such as insects and arachnids;
- Microbial organisms such as bacteria, fungi, viruses, and Mycoplasma;
- Weeds, which are plants growing in an area where they are not wanted;
- Nematodes;
- Mollusks such as snails and slugs; and
- Vertebrate pests.

Under Florida law (Chapter 482 Florida Statutes), integrated pest management (IPM) is defined as the following:

> *. . . the selection, integration, and implementation of multiple pest control techniques based on predictable economic, ecological, and sociological consequences, making maximum use of naturally occurring pest controls, such as weather, disease agents, and parasitoids, using various biological, physical, chemical, and habitat modification methods of control, and using artificial controls only as required to keep particular pests from surpassing intolerable population levels predetermined from an accurate assessment of the pest damage potential and the ecological, sociological, and economic cost of other control measures.*

LICENSING REQUIREMENTS FOR PESTICIDE USE IN LAWN AND LANDSCAPE MAINTENANCE

Not only should pesticides be used carefully, existing laws regarding pesticide applications and licensing requirements for conducting a business should also be complied with. There are three categories of licenses, (local occupational license, limited certification for commercial landscape maintenance license, or a pest control business license and a certified operators certificate) that could apply to persons who practice landscape maintenance as a business.

In most cases, if a person or company is providing services that only include mowing, edging, landscaping, and fertilizing, only a county or municipal occupational license is needed. (**This does not apply to "weed and feed" or "insect control" applications.**)

- If a person or company also applies any herbicide (even a granular product of a pesticide coated onto fertilizer), fungicide, or insecticide, to residential lawns or plant beds, a license for pesticide application is required from the Florida Department of Agriculture and Consumer Services (FDACS) Bureau of Entomology and Pest Control. Failure to obtain a license can result in fines up to $5,000. **This includes the application of "weed and feed" or "insect control" pesticide/fertilizer mixtures to lawns**.
- If the only pesticides applied by a person or business are herbicides and "caution"-labeled insecticides applied to plant beds or along the edges of pavement, then a limited certification for commercial landscape maintenance license is needed from the Bureau of Entomology and Pest Control. For this category, each applicator must have a license. **This does NOT allow the application of pesticides to turf or the use of insecticides labeled "Warning" or "Danger," or the application of "weed and feed" or "insect control" pesticide/fertilizer mixtures to lawns**.
- If any application of any pesticide is made to a lawn as part of a service provided by a person or business, then a pest control business license and a certified operators certificate are needed from the Bureau of Entomology and Pest Control. **This includes the application of "weed and feed" or "insect control" pesticide/fertilizer mixtures to lawns**.
- Government employees and private business employees who are applicators also need a pesticide license to make any applications to lawns or ornamental plants. **This includes the application of "weed and feed" or "insect control" pesticide/fertilizer mixtures to lawns.**
- Information on how to obtain these licenses can be obtained from FDACS Bureau of Entomology and Pest Control at (850) 617-7997 or at http://www.flaes.org/aes-ent/.
- Applications of restricted use pesticides made to parks, cemeteries, and golf courses require a license obtained through FDACS Bureau of Compliance Monitoring at (850) 488-3314 or at http://www.flaes.org/complimonitoring/index.html.

PESTICIDE RECORD KEEPING

Proper records of all pesticide applications should be kept according to state or federal requirements. These records

help to establish proof of proper use, facilitate the comparison of results of different applications, or find the cause of an error. Records that provide this information may include the following:

- The date and time of application;
- Name of applicator;
- Person directing or authorizing the application;
- Weather conditions at the time of application;
- Target pest;
- Pesticide used (trade name, active ingredient, amount of formulation, amount of water);
- Adjuvant/surfactant and amount applied, if used;
- The area treated (acres or square feet) and location;
- Total amount of pesticide used;
- Application equipment;
- Additional remarks, such as the severity of the infestation or life stage of the pest; and
- Follow-up to check the effectiveness of the application.

RESTRICTED USE PESTICIDES

Certain pesticides are classified as restricted use pesticides (RUPs). Very few pesticides in this category are routinely used in turf maintenance, but if you happen to use one of them, certain record-keeping requirements apply. The Florida pesticide law requires certified applicators to keep records of all restricted use pesticides. To meet your legal responsibility and to document your treatment methods, you need to maintain accurate pesticide records.

Florida regulations require that information on RUPs be recorded within 2 working days of the application and maintained for 2 years from the application date. Federal worker protection standards (WPSs) only apply to pesticide applications made by producers of agricultural products and do not affect Green Industry pesticide applicators.

NOTE: Florida law requires RUP record keeping. See FDACS Bureau of Entomology and Pest Control regulations for specifics on the regulation. In addition, record keeping is required to comply with the federal Superfund Amendments and Reauthorization Act (SARA, Title III), which contains emergency planning and community right-to-know legislation.

INTEGRATED PEST MANAGEMENT

The philosophy of IPM was developed in the 1950s because of concerns over increased pesticide use, environmental contamination, and the development of pesticide resistance. The objectives of IPM include reducing pest management expenses, conserving energy, and reducing the risk of exposure to people, animals, and the environment. Its main goal, however, is to reduce pesticide use by using a combination of tactics to control pests, including cultural, biological, genetic, and chemical controls.

The **cultural component** consists of the proper selection, establishment, and maintenance (such as mowing/pruning, fertilization, and irrigation) of turf and landscape plants. Keeping lawns and landscapes healthy reduces their susceptibility to diseases, nematodes, and insects, thereby reducing the need for chemical treatment. In the service industry, unfortunately, many of the cultural components of IPM are not under the control of the pesticide application professional. It is essential that customers be made aware of their responsibility for cultural factors, whether in doing their own work or in selecting qualified professionals for third-party activities such as irrigation and mowing.

The **biological component** involves the release and/or conservation of natural enemies (such as parasites, predators, and pathogens) and other beneficial organisms (such as pollinators). Natural enemies (including

Florida law requires that you record the following items to comply with the restricted use pesticide record-keeping requirement.

- Brand or product name.
- U.S. Environmental Protection Agency registration number.
- Total amount applied.
- Location of application site.
- Size of area treated.
- Crop/variety/target site.
- Month/day/year/time of application.
- Name and license number of applicator (if applicator is not licensed, record his or her name and supervisor's name and license number).
- Method of application.
- Name of person authorizing the application, if the licensed applicator does not own or lease the property.

ladybird beetles, green lacewings, and mantids) may be purchased and released near pest infestations. However, the landscape can also be modified to attract natural enemies, provide habitat for them, and protect them from pesticide applications. For example, flowering plants may provide parasitoids with nectar, or sucking insects (aphids, mealybugs, or soft scales) may provide a honeydew source when growing on less-valuable plants.

The **genetic component** relies on the breeding or genetic engineering of turfgrasses and landscape plants that are resistant to key pests. Such resistance could increase a plant's tolerance to damage and weaken or kill the pests. Pests may also develop more slowly on partially resistant plants, thereby increasing their susceptibility to natural enemies or "softer" pesticides. Selecting resistant cultivars or plant species when designing a landscape is a very important part of IPM. Although turfgrass and landscape managers often work with established plant material, they can still recommend changes. Every opportunity should be taken to educate builders, developers, landscape architects, sod producers, and others on which plants are best suited to their areas.

Chemical controls include a wide assortment of conventional, broad-spectrum pesticides and more selective, newer chemicals, such as microbial insecticides and insect growth regulators. IPM is not antipesticide, but it does promote the use of the least-toxic and most selective alternatives when chemicals are necessary. Pesticides are only one weapon against pests and should be used responsibly and in combination with other, less-toxic control tactics.

To determine which pesticides are most appropriate for use, and when and how to use them, consult the appropriate pesticide selection guides produced by IFAS. Whenever practical, limit treatment to infected areas. Spot spraying lessens pesticide use, saving the application service money and lowering risk to beneficial organisms, pets, homeowners, and the environment. Consult with county Cooperative Extension Service agents, chemical distributors, product manufacturers, or independent turf or landscape maintenance consultants.

IPM is commonly used in agricultural crop production, where the economic thresholds for key pests have been determined. Using IPM in the urban environment, however, has been more challenging. The Green Industry is sensitive to aesthetic damage, and customers are often intolerant of anything that could affect the appearance of ornamental plants. Increased education of growers, consumers, and maintenance personnel could raise the aesthetic threshold and allow for minor damage without compromising plant health and beauty.

Another important aspect of a successful IPM program is pest monitoring. This includes understanding the life cycle of a pest and knowing which plants and conditions it may prefer. Monitoring populations, understanding historical trends, and knowing where a pest is most likely to occur can target control practices to a specific pest in a specific location. Maintaining records and histories of pest populations can help a manager forecast pest occurrence and apply pesticides wisely.

The monitoring of pest populations presents special difficulties for the service industry, because the service professional may only be on-site one day per month or less. While spot applications are generally preferable, in certain situations preventative measures may be necessary. This is particularly true where experience has determined that less pesticide, or a less toxic pesticide, may be needed when a preventative control is used.

The basic steps for IPM programs are as follows:

- Identify key pests on key plants.
- Determine the pest's life cycle, and know which life stage to target (for an insect pest, whether it is an egg, larva/nymph, pupa, or adult).
- Use cultural, mechanical, or physical methods to prevent problems from occurring (for example, prepare the site, select resistant cultivars), reduce pest habitat (for example, practice good sanitation, carry out pruning and dethatching), or promote biological control (for example, provide nectar or honeydew sources).
- Decide which pest management practice is appropriate and carry out corrective actions. Direct control where the pest lives or feeds. Use preventative chemical applications only when your professional judgment indicates that properly timed preventative applications are likely to control the target pest effectively while minimizing the economic and environmental costs.
- Determine if the "corrective actions" actually reduced or prevented pest populations, were economical, and minimized risks. Record and use this information when making similar decisions in the future.

For more information on IPM, see IFAS Publication ENY-336, *Integrated Pest Management in the Commercial Ornamental Nursery*, at http://edis.ifas.ufl.edu/IG144.

PESTICIDE USE

Pesticides are designed to kill or alter the behavior of pests. When, where, and how they can be used safely and effectively is a matter of considerable public interest. If they are not used wisely, pesticides may pose risks to pesticide applicators and other exposed people, and may create long-term environmental problems.

The best way to manage pesticide storage and disposal is to reduce the amount of pesticide left over after applications through proper planning and equipment calibration. Faulty or improperly managed storage facilities may result in direct runoff or leaching of pesticides into surface water and ground water. Users may be held liable for damage caused by improperly stored or disposed pesticides.

Pesticide spills can be especially problematic. Even pesticides designed for rapid breakdown in the environment can persist for years if present in high concentrations. The results can be the contamination of drinking water, fish kills and other impacts to nontargeted organisms, and administrative fines and legal remedies. It is important that pesticide users protect themselves from all of these hazards.

The most obvious method to reduce the risk from pesticides is to use them only when necessary. Determine which pesticides are the most useful and least environmentally harmful for a given situation. Apply them properly and effectively to minimize costs and the effects on public health and the environment while maximizing plant response. Give particular attention to the vulnerability of the site to ground water or surface water contamination from leaching or runoff.

A pest-control strategy should be used only when the pest is causing or is expected to cause more damage than what can be reasonably and economically tolerated. A control strategy should be implemented that reduces the pest numbers to an acceptable level while minimizing harm to nontargeted organisms. The strategy of IPM is as follows

- Prevention—keeping a pest from becoming a problem, and then, if needed,
- Suppression—reducing pest numbers or damage to an acceptable level.

Always follow the directions on the label. These directions have been developed after extensive research and field studies on the chemistry, biological effects, and environmental fate of the pesticide. The label is the single most important document in the use of a pesticide. **State and federal pesticide laws require following label directions!**

GENERAL PESTICIDE BMPS

The following general BMPs should always be used for pesticides:

- **Develop** – and implement a quality IPM program.
- **Labels** – Observe all directions, restrictions, and precautions on pesticide labels. It is dangerous, wasteful, and illegal to do otherwise.
- **Storage** – Store pesticides behind locked doors in original containers with label intact, separate from seed and fertilizer.
- **Rate** – Use pesticides at the correct application rate and recommended intervals between applications to avoid injury to plants and animals.
- **Handling** – Never eat, drink, or smoke when handling pesticides, and always wash with soap and water after use.
- **Rinsing** – Triple-rinse containers into the spray tank. Never pour pesticides down a drain or into an area exposed to humans, animals, or water.
- **Disposal** – Dispose of used containers in compliance with label directions so that water contamination and other hazards will not result.
- **Clothing** – Always wear protective clothing when applying pesticides. At a minimum, wear a long-sleeved shirt, long-legged pants, rubber gloves, boots (never go barefoot or wear sandals), eye protection, and a wide-brimmed hat. Additional protective gear may be listed on the pesticide label.

PESTICIDE SELECTION

Identifying or recognizing pests is essential to proper pesticide application and selection. Once the pest has been identified, the best control method must be chosen. If a pesticide is to be used, the applicator must know the proper application technique and read the label thoroughly. Pesticides should be evaluated on effectiveness against the pest, mode of action, life stage of the pest, personnel hazards, non-target effects, leaching or runoff potential, and cost.

PESTICIDE SELECTION BMPS

- Develop and implement a quality IPM program.
- Train employees in proper pest identification and pesticide selection techniques.
- Choose the product most appropriate for the problem or pest.
- Mix only the quantity of pesticide needed in order to avoid disposal problems, protect non-targeted organisms, and save money.
- Spot treat pests whenever appropriate.
- Read and follow all label directions. The label is a legal document.
- Make note of any ground water advisories on the label.

PESTICIDE STORAGE

If you store pesticides for your operation, this storage must be properly constructed and maintained to prevent problems or an expensive cleanup in the event of an accident. **The best way to minimize storage problems is to minimize the amount you store.** Purchasing only small amounts that you can use quickly is the best approach for many turf management professionals. If you have to store pesticides, follow these guidelines:

- Design and build pesticide storage structures to keep pesticides secure and isolated from the surrounding environment.
- Store pesticides in a roofed concrete or metal structure with a lockable door.
- Keep pesticides in a separate facility, or at least in a locked area separate from areas used to store other materials, especially fertilizers, feed, and seed.
- Do not store pesticides near flammable materials, hot work (welding, grinding), or in shop areas.
- Do not allow smoking in pesticide storage areas.

Figure 25. Pesticide storage areas should be locked.

Store personal protective equipment (PPE) where it is easily accessible in an emergency, but not in the pesticide storage area (since that may make it unavailable during an emergency). Check the label and the Material Safety Data Sheet (MSDS) to determine the required safety equipment for each chemical used in the operation. Keep a written pesticide inventory and the MSDS file for the chemicals on site. Do not store this information in the pesticide storage room itself. Remember that PPE is specified for normal application and handling activities. Regular PPE may not be protective in emergency situations, such as fires or reactions with other spilled chemicals.

Depending on the products stored and the quantity, you may need to register the facility with the Florida Department of Community Affairs and your local emergency response agency. Check with your pesticide dealer about community right-to-know laws for the materials that you purchase. An emergency response plan should be in place and familiar to personnel before an emergency occurs, such as a lightning strike, fire, or hurricane. Individuals conducting emergency pesticide cleanups should be properly trained under the requirements of the federal Occupational Safety and Health Administration (OSHA). For reporting chemical spills, see the section on spill reporting requirements later in this chapter.

Do not store large quantities of pesticides for long periods. Adopt the "first in–first out" principle, using the oldest products first to ensure that the product shelf life does not expire.

Store pesticides in their original containers. Do not put pesticides in containers that might cause children and others to mistake them for food or drink. Keep the containers securely closed and inspect them regularly for splits, tears, breaks, or leaks. All pesticide containers should be labeled. Arrange pesticide containers so that the labels are clearly visible, and make sure that the labels are legible. Refasten all loose labeling using non-water soluble glue or sturdy, transparent packaging tape. Do not refasten labels with rubber bands (which quickly rot and easily break) or nontransparent tapes such as duct tape or masking tape (which may obscure important product caution statements or label directions for product use). If a label is damaged, immediately request a replacement from the pesticide dealer or formulator. As a temporary supplement to disfigured or badly damaged labels, fasten a baggage tag to the container handle. On the tag write the product name, formulation, concentration of active ingredient(s), "signal word," the statement "Keep Out of Reach of Children," and the date of purchase. If there is any question about the contents of the container, set it aside for proper disposal.

Dry bags should be raised on pallets to ensure that they do not get wet. Do not store liquid materials above dry materials. Store flammable pesticides separately from nonflammable pesticides.

Segregate herbicides, insecticides, and fungicides to prevent cross-contamination and minimize the potential for misapplication. Cross-contaminated pesticides often cannot be applied in accordance with the labels of each of the products. This may make it necessary to dispose of the cross-contaminated materials as wastes and could require the services of a consultant and hazardous waste contractor.

Use shelving made of plastic or reinforced metal. Keep metal shelving painted (unless made of stainless steel) to avoid corrosion. If you use wood shelving, paint it with an enamel or waterproof paint to minimize any absorption of spilled pesticide materials. It is best to replace wood shelving with metal or plastic.

Construct floors of seamless metal or concrete sealed with a chemical-resistant paint. For concrete, use a water-cement ratio no higher than 0.45:1 by weight, and leave a rough finish to provide adhesion for the sealant. Equip the floor with a continuous curb to retain spilled materials. While a properly sealed sump may be included to help recover spilled materials, do not install a drain, as it can release spilled material into the environment. If you have a drain in a storage area, seal it as soon as possible to prevent uncontrolled releases. Provide sloped ramps at the entrance to allow handcarts to safely move material in and out of the storage area.

When designing the facility, keep in mind that temperature extremes during storage may reduce safety and affect pesticide efficacy. Provide automatic exhaust fans and an emergency wash area. The emergency wash area should be outside the storage building. Local fire and electrical codes may require explosion-proof lighting and fans. The light/fan switches should be outside the building, and both switches should be turned on before people enter and should remain on until after they have left the building.

The BMPs discussed in the next section often address the ideal situation of newly constructed, permanent facilities. However, you are encouraged to apply these principles and ideas to existing facilities.

Plans and specifications for pesticide storage buildings are available from several sources, including the the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), the Midwest Plan Service, and the IFAS Publications Office. These organizations' publications also contain recommended management practices for pesticide storage facilities.

Note that cancelled, suspended, or unusable pesticides must be disposed of properly. Storage for long periods can lead to leaking containers or other costly problems. The Florida Department of Environmental Protection and the Florida Department of Agriculture and Consumer Services (FDACS) operate a program for the free disposal of these materials (Operation Cleansweep, ph. 877-851-5285 toll-free, or 386-418-5525). For more information, go to www.dep.state.fl.us/waste/categories/cleansweep-pesticides. If this program is not available, a licensed waste disposal contractor should do the disposal.

A good storage facility should have the following features:

- A secure area where unauthorized persons are restricted from entering.
- Proper labeling on exterior doors, such as signs that say "NO SMOKING" and "WARNING: PESTICIDE STORAGE." No-smoking regulations need to be enforced.
- No opportunity for water to enter.
- Temperature control to avoid excessive cold or heat.

BMPS FOR PESTICIDE STORAGE AND DISPOSAL

The following BMPs should be used for storing and disposing of pesticides:

- Maintain and follow labels on all pesticide containers.
- Store pesticides only in their original containers or make sure the new containers are properly labeled.
- Store similar pesticides together; for example, store herbicides with herbicides, and insecticides with insecticides.
- Store dry pesticides above liquids.
- Keep containers closed tightly.
- Inspect inventory frequently and watch for damaged containers.
- Store separately any pesticides that may be flammable.
- Limit the amount of inventory, and purchase only the amounts needed.
- Triple-rinse, puncture, and crush empty containers. Clean all visible chemical from the container, including the container cap and cap threads. Follow the label directions for container disposal.
- Apply unused chemical mixtures or rinsate to a legal target at or below the label rate, or save it to use as make-up water for later applications of compatible materials.
- For cancelled, suspended, or unusable pesticides, contact the FDACS Bureau of Compliance Monitoring at (850) 488-3314 or go to http://www.flaes.org/complimonitoring/index.html for guidance.

- Nonporous floors.
- Not located close to a body of water, sinkhole, or wellhead.
- Adequate lighting and ventilation.
- The ability to contain runoff from spills.
- A source of clean water with prevention of backflow of chemicals into the water supply.
- Freedom from combustible materials or debris.
- Storage shelves and cabinets of nonporous material that will not absorb pesticides.
- Shelves or other means of keeping chemicals off wet floors.
- Materials and equipment to contain and clean up pesticide spills.
- Clean, readily available personal protective equipment and emergency telephone numbers or other means of securing assistance in an emergency.
- Appropriate fire extinguishers.

MIXING AND LOADING ACTIVITIES

In most cases, the mixing and loading of pesticides into application equipment should be done adjacent to the application site. If chemicals are routinely mixed and loaded at a shop or storage site, spilled material can accumulate and expensive cleanup procedures may be required.

Use extreme caution when handling concentrated chemicals. Spills could result in an expensive hazardous waste cleanup. It is important to understand how mixing and loading operations can pollute vulnerable ground water and surface water supplies if conducted improperly and at the wrong site. Locate operations well away from ground water wells and areas where runoff may carry spilled pesticides into surface waterbodies. Areas around public water supply wells should receive special consideration and may be designated as wellhead protection areas. Before mixing or loading pesticides in such areas, consult with state and local government officials to determine if special restrictions apply.

To prevent problems when mixing chemicals on-site, use a mixing tray or portable pad to avoid spillage that could be transported to non-targeted areas. Should a chemical spill onto the mixing tray, the material should then be rinsed into the applicator equipment and used according to the product label.

For your own safety, always use all personal protective equipment required by the label.

PESTICIDE EQUIPMENT CALIBRATION AND LOADING

Keep application equipment properly calibrated and in good repair. Correct measurement keeps you in compliance with the label; reduces the risks to applicators, workers, and the environment; and saves you money.

Figure 26. Calibrate spreaders frequently.

Calibrate using clean water and do not calibrate equipment near wells, sinkholes, or surface waterbodies. Measure pesticides and diluents accurately to avoid improper dosing, the preparation of excess or insufficient mixture, or the preparation of a tankload of mixture at the wrong strength.

The proper application of pesticides helps to reduce costs and increase profits. Improper application can result in wasted chemicals, marginal pest control, excessive carryover, or damage to turf or landscape ornamentals. As a result, inaccurate application is usually very expensive.

Be aware of the proper application methods, chemical effects on equipment, equipment calibration, and correct cleaning methods. **Sprayers should be calibrated when new or when nozzles are replaced** and recalibrated after a few hours of use, as new nozzles may wear and the rate of flow may increase rapidly. For example, wettable powders may erode nozzle tips, causing an increase in application rates after spraying as few as 50 acres. Recalibrate equipment periodically to compensate for wear in pumps, nozzles, and metering systems.

The amount of chemical solution applied per unit of surface area depends on the forward speed, system

pressure, size of nozzle, and spacing of nozzles on the boom. A change in any one of these will change the rate of application. Consult the operator's manual for detailed information on a particular sprayer. Backpack sprayers and hand sprayers also can and should be calibrated, and applicators should be "calibrated" to determine how much chemical is being applied during a broadcast application while walking across a lawn.

Calibration should be performed by measuring the amount of pesticide applied to a small area (for example, 1,000 square feet) and calculating how much would be applied to a large area. For equipment with more than one nozzle, be sure to check the flow rates of all nozzles on the sprayer so they are similar. Equipment suppliers and pesticide suppliers often supply calibration equipment or assistance at low or no cost. If you calculate the return on investment for time spent calibrating equipment, you will see that even a small improvement in calibration accuracy can save a significant amount of money spent on pesticide that was wasted because it was over applied.

BMPS FOR LOADING AND CALIBRATING PESTICIDE EQUIPMENT

- Mix the pesticide and load the spreader or sprayer carefully to avoid spills.
- Mix and load pesticides on an impervious mix/load pad with provisions for collecting and reusing spilled or waste material.
- Use excess pesticide mixtures on a site that is specified on the label.
- Consider closed systems for loading and mixing.
- Triple-rinse containers, pour the rinsate into the spray tank, and use the excess according to the product label.
- Calibrate your spreader or sprayers.

Florida law requires an air gap or back-siphoning device between the water supply and the application equipment to prevent backflow into the water supply. **Never submerge the end of a water supply hose in a tank.** This can lead to the costly contamination of a water supply.

PESTICIDE APPLICATION EQUIPMENT WASH WATER

Wash water from pesticide application equipment must be managed properly, since it could contain pesticide residues. Ensuring that no pesticide spills occur on the vehicle by mixing all pesticides over mixing trays eliminates potential pesticide hazards. Sweep any granular products that have spilled onto the vehicle or non-targeted areas into labeled bags for later use. Wash the vehicle in a designated wash area. The water hose should have an on/off valve and a water-reducing nozzle. Use the least amount of water possible to wash the equipment adequately. Motorized spray equipment can be rinsed of pesticides residues over turf areas at the job site where the rinsate will be used according to the product label. These practices prevent unwanted pesticide residues from being washed onto non-targeted areas. **Avoid conducting such washing in the vicinity of wells or surface waterbodies.**

For most turf application equipment, the inside of the application tank should be rinsed. This is done by filling it with water and then applying the rinse water in the same manner and at the same site as the original pesticide. For larger equipment that is loaded at a central facility, the inside of the application equipment should be washed on the mix/load pad. This rinsate may be applied as a pesticide (preferred) or stored for use as make-up water for the next compatible application. Otherwise it must be treated as a (potentially hazardous) waste. After washing the equipment and before an incompatible product is handled, the sump should be cleaned of any liquid and sediment.

PESTICIDE SPILL MANAGEMENT

Clean up spills as soon as possible. Unmanaged spills may quickly move into surface waters and injure plants and animals. It is essential to be prepared for major or minor spills. The sooner you can contain, absorb, and dispose of a spill, the less chance there is that it will cause harm. Always use the appropriate personal protective equipment as indicated on the MSDS and the label for a chemical. In addition, follow the following four steps:

- **CONTROL actively spilling or leaking materials** by setting the container upright, plugging leak(s), or shutting the valve.
- **CONTAIN the spilled material** using barriers and absorbent material. For small spills, use kitty litter, vermiculite, shredded newspaper, absorbent pillows, clean sand, or pads. Use dikes to direct large spills away from ditches, storm drains, ponds, sinkholes, or woods. You can also use products such as "Soak Up" to absorb spilled materials. These types of products allow the absorbed material to be diluted into the spray mixture and applied as usable pesticide.
- **COLLECT spilled material**, absorbents, and leaking containers and place them in a secure, properly labeled container. Some contaminated materials could require disposal as hazardous waste.
- **STORE the containers of spilled material until they can be applied as a pesticide** or appropriately disposed of.

Small liquid spills may be cleaned up by using an absorbent such as cat litter, diluting it with soil, and then applying the absorbent to the target site as a pesticide in accordance with the label instructions.

SPILL REPORTING REQUIREMENTS

Comply with all applicable federal, state, and local regulations regarding spill response training for employees, spill reporting requirements, spill containment, and cleanup. **Keep spill cleanup equipment available when handling pesticides or their containers.**

If a spill occurs for a pesticide covered by certain state and federal laws, you may need to report any accidental-release if the spill quantity exceeds the "reportable quantity" of active ingredient specified in the law. See **Appendix A** for important telephone numbers for reporting pesticide spills. Very few of the pesticides routinely used in turf management are covered under these requirements. A complete list of pesticides and reportable quantities is available at http://www.floridadisaster.org/cps/SERC/htc1.htm.

Table 10 provides reportable quantities for some common pesticides, but it is your responsibility to determine if a pesticide you use has a reportable quantity. The list in the table should not be used as a substitute for a review of the official Section 304 list provided at the website above.

Table 10: Reportable quantities for certain pesticides

Chemical Name	Brand Name	CAS Number	EHS RQ	CERCLA RQ
Atrazine	AAtrex	1912249	N/A	N/A
Fenoxycarb	Logic	74490-01-8	N/A	N/A
Hydramethylnon	Maxforce	67485-29-4	N/A	N/A
Malathion	Cythion	121-75-5	N/A	100
Methiocarb	Mesurol	2032-65-7	10	10
Simazine	Princep	122-34-9	N/A	N/A
Trifluralin	Treflan	1582098	N/A	10

(For a complete list call (850) 413-9970, or go to http://www.floridadisaster.org/cps/SERC/htc1.htm). Reportable quantities are given in pounds of active ingredient.

Public Law 96-510 and Public Law 92-5000 (CERCLA) require immediate notification of the appropriate U.S. governmental agency when oil or hazardous substances are discharged. The law states, "Any such person who fails to notify immediately such agency of such discharge shall, upon conviction, be fined not more than $10,000 or imprisoned for not more than one year, or both."

Under Chapters 376 and 403, Florida Statutes:

- Any owner or operator of a facility who has knowledge of any release of a hazardous substance from a facility in a quantity equal to or exceeding the reportable quantity (see the MSDS sheet) in a 24-hour period shall immediately notify the State Warning Point.
- The owner or operator having a discharge of petroleum products exceeding 25 gallons on a pervious surface (or any amount in a waterbody) must report such discharge to the Florida Department of Environmental Protection or the State Warning Point.

The penalty is not in reporting a spill; it is in failing to report a spill.

REPORT THE FOLLOWING INFORMATION

- Name, address, and telephone number of person reporting.
- Name, address, and telephone number of person responsible for the discharge or release, if known.
- Date and time of the discharge or release.
- Type or name of the substance discharged or released.
- Estimated amount of the discharge or release.
- Location or address of the discharge or release.
- Source and cause of the discharge or release.
- Size and characteristics of the area affected by the discharge or release.
- Containment and cleanup actions taken to date.
- Other persons or agencies contacted.

MANAGEMENT OF PESTS IN THE LANDSCAPE

WEED MANAGEMENT

Florida law defines a weed as a plant growing where it is not wanted. Plants often earn their reputations as weeds if they grow without care or cultivation and despite efforts to get rid of them. Weeds compete with desired plants for space, water, light, and nutrients and can harbor insect pests and diseases. The predominant weed species change from season to season in Florida. Because weed populations can explode if not kept in check, the amount of pressure from these pest plants remains consistently high.

Weeds reproduce from seed, root pieces, and special vegetative reproductive organs such as tubers, corms, rhizomes, stolons, or bulbs. People, animals, birds, wind, and water can distribute seeds. Many of the weeds that show up in landscape beds come from seeds. Weeds also arrive in landscape beds when their reproductive tissues and organs are in the soil of transplants. Weed rhizomes or stolons can also creep into a landscape bed from an adjacent infested area. Plastic or metal edging that penetrates several inches into the ground around the perimeter of the bed reduces the likelihood of weed infestations from rhizomes or stolons.

Preventative weed control is important. Removing established weeds from landscape beds can be time consuming and/or expensive. Weed infestations will probably have to be removed by hand, as there are a limited number of herbicides available that can be safely applied over the top of and around most landscape plants. For Green Industry service personnel, the application of most herbicides must be done by licensed pest-control professionals. For more information, see the IFAS website: http://edis.ifas.ufl.edu/TOPIC_Ornamental_Pests.

INSECTS AND OTHER ORGANISMS

Fewer than 1 percent of all insects are harmful to plants and many are actually beneficial, acting as predators or parasites of harmful insects and assisting in the cross-pollination of certain plants. Remember that disease, nutritional deficiencies, cultural treatments, and environmental conditions can cause a plant to appear unhealthy or discolored, so it is important to diagnose a problem correctly before remedial measures are taken. Some plants in the urban landscape are oversprayed, resulting in unnecessary environmental contamination and often upsetting the natural predator/parasite–pest balance.

Think about all of the control options available under IPM. Before using a chemical control method for an active pest infestation, look around the landscape to see if predatory or parasitic insects are present to control your pest problem. If you must spray, use the least-toxic remedy possible and exercise great care to avoid contaminating yourself and other living creatures.

In general, IPM calls for pesticides to be applied as needed when plants have an active infestation and significant damage is likely. However, some pest problems may be best handled with preventative measures, such as the use of residual Imidacloprid to target chinch bug nymphs as they emerge from their eggs. Preventative application measures should not be routine but should be based on your professional knowledge of the control agent or method, the pest's life cycle, environmental conditions, and historical data. Use preventative chemical applications only when your professional judgment indicates that properly timed, preventative applications are likely to control the target pest effectively while minimizing economic and environmental costs.

In addition to Florida's abundance of native pests, landscape workers need to be aware of imported plant pests, their identification and control. In the last several years, these pests have caused substantial economic damage and an increase in the use of pesticides. The effects caused by citrus canker and greening are just two examples of diseases that have devastated a sector of Florida's economy. Insect examples in the landscape include the Asian cycad scale, pink hibiscus mealybug, Chilli Thrips, Lobate Lac Scale, Ficus whitefly, and many others.

Florida's tropical climate and international status predisposes us to imported plant pests. We have a history of the rapid spread of these imported pests to landscape plants. The normal problems of pest control are made worse by:

- No populations of beneficial predators,
- Poor or slow problem identifications,
- No basis for control product selection
- It requires the constant awareness that new pest problems are likely.

Employers and employees must be vigilant and seek additional training from IFAS, which is the key source of diagnostic and control information for these exotic pests.

For more information on IPM and insect pests, see the following:

- IFAS Publication ENY-337, *Commercial Applications of Insecticides and Miticides in the Green Industry*, at http://edis.ifas.ufl.edu/IG145.
- IFAS Publication ENY-338, *Insect Management on Landscape Plants*, at http://edis.ifas.ufl.edu/IG013.
- IFAS Publication ENH-300, *Insect Pest Management on Turfgrass*, at http://edis.ifas.ufl.edu/IG001.
- Featured Creatures at http://creatures.ifas.ufl.edu.

PLANT NEMATODES

Nematodes are small, unsegmented roundworms, generally transparent and colorless; most are slender, with bodies from 1/100 to 1/8 inch long. Only about 10 percent of nematodes are estimated to be plant parasites. Nematodes affect plants by damaging the roots, reducing their ability to function. For more information, see:

- *Nematode Management in Residential Lawns*, IFAS Publication ENY-006, http://edis.ifas.ufl.edu/NG039.
- *Nematode Management for Perennial Landscape Plants*, IFAS Publication ENY-051, http://edis.ifas.ufl.edu/IN469.
- The IFAS website: http://edis.ifas.ufl.edu/TOPIC_Ornamental_Pests.

PLANT DISEASES

Plant pathology is the study of plant diseases. Diseases are caused by microorganisms such as fungi, bacteria, and viruses. Some disease symptoms, such as leaf spots and wilting, are easily seen or measured. Others are difficult to observe (for example, root decay) or are very subtle (for example, shorter growth flushes). Detecting the less-obvious symptoms is more difficult when the diseased plant is the only specimen of its kind in the landscape and cannot be compared with a healthy one.

Normally, nonparasitic plant disorders are not included in the study of diseases, but it is still important to recognize them. These disorders include improper planting depth, nutrient imbalances, temperature extremes, toxic chemicals, mechanical injury, water imbalances, and air pollution. Most environmentally induced problems tend to be uniform, whereas disease may show up in spots throughout a field.

For more information on plant disease, see the following:

- IFAS Publication LH064, *Key for Identification of Landscape Turfgrass Diseases*, at http://edis.ifas.ufl.edu/LH064.
- IFAS Publication LH040, *Turfgrass Disease Management*, at http://edis.ifas.ufl.edu/LH040.

DIAGNOSTIC ASSISTANCE

The primary role of the Florida Extension Plant Diagnostic Clinics (FEPDC) is to determine whether symptoms in submitted plant samples involve an infectious causal agent, e.g. fungus, bacterium or virus, or other cultural or environmental factor that causes similar symptoms. The goal of the FEPDC system is to educate clientele by providing plant disease and disorder diagnoses and recommendations for preventative and therapeutic measures. The FEPDC is a fee-based service provided to any Florida resident by the Plant Pathology Department of the Institute of Food and Agricultural Sciences (IFAS), University of Florida, in conjunction with the Cooperative Extension Service. For more information, the nearest laboratory, and fees, see *Sample Submission Guide for Plant Diagnostic Clinics of the Florida Plant Diagnostic Network*. Available at: http://edis.ifas.ufl.edu/SR007.

The UF-IFAS Rapid Turfgrass Diagnostic Service was designed and implemented for managers of high quality turfgrass in Florida. The biggest distinction between this and the standard services provided by the Plant Disease Clinic is the turn-around time for sample results, the direct involvement of the UF Extension Turfgrass Pathologist, and the price charged for the service. The price is $75 (in 2008) and reflects the added costs associated with a full time student dedicated to turfgrass diagnostics with rapid turn-around time. http://turfpath.ifas.ufl.edu/turfgrass/rapiddiag.shtml.

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APPENDIX A: IMPORTANT TELEPHONE NUMBERS

REPORT THE FOLLOWING INFORMATION

- Name, address, and telephone number of person reporting.
- Name, address, and telephone number of person responsible for the discharge or release, if known.
- Date and time of the discharge or release.
- Type or name of the substance discharged or released.
- Estimated amount of the discharge or release.
- Location or address of the discharge or release.
- Source and cause of the discharge or release.
- Size and characteristics of the area affected by the discharge or release.
- Containment and cleanup actions taken to date.
- Other persons or agencies contacted.

EMERGENCY REPORTING TELEPHONE NUMBERS

For Ambulance, Fire, or Police
Dial 911

State Warning Point
24 hours Toll-Free • 1 (800) 320-0519

Department of Community Affairs, Division of Emergency Management
(850) 413-9911

National Response Center
24 hours Toll-Free • 1 (800) 424-8802

(Federal law requires that anyone who releases into the environment a reportable quantity of a hazardous substance [including oil when water is or may be affected], or a material identified as a marine pollutant, must immediately notify the NRC).

FDEP Emergency Response

Jacksonville
(904) 807-3246

Orlando
(407) 893-3337

Ft. Lauderdale
(954) 958-5575

Ft. Myers
(239) 332-6975

Tampa
(813) 744-6462

Panama City
(850) 872-7650

Pensacola
(850) 595-8300

Tallahassee
(850) 245-2010

HELP LINE TELEPHONE NUMBERS

(For chemical hazard information)
CHEMTREC HOTLINE (Emergency only)
24 hours Toll-Free • 1 (800) 424-9300

NON-EMERGENCY TELEPHONE NUMBERS

State Emergency Response Commission

(NOT a 24-hour number) 1 (800) 635-7179

(This telephone number is for follow-up reporting under state spill reporting requirements. In an emergency, call the State Warning Point [see Emergency Reporting Telephone Numbers on the preceding page]. If federal reporting is required, also call the National Response Center [see Emergency Reporting Telephone Numbers on the preceding page.)

Florida Friendly Landscapes Program

University of Florida (352) 273-4520

Florida Department of Agriculture and Consumer Services

Bureau of Entomology and Pest Control (850) 617-7997

Bureau of Pesticides (850) 487-0532

Bureau of Compliance Monitoring (850) 488-8731

Florida Department of Environmental Protection

Stormwater/Nonpoint Source Management Section (Tallahassee) (850) 245-7508

Hazardous Waste Management Section (850) 245-8707

Mangrove Trimming Section (850) 245-8482

Florida Department of Environmental Protection District Offices

Northwest (Pensacola) (850) 595-8300

Northeast (Jacksonville) (904) 807-3300

Central (Orlando) (407) 894-7555

Southeast (West Palm Beach) (561) 681-6600

Southwest (Tampa) (813) 632-7600

South (Ft. Myers) (239) 332-6975

Water Management Districts

	Local	Toll-free
Northwest Florida (Tallahassee)	(850) 539-5999	
Suwannee River (Live Oak)	(386) 362-1001	1-800-226-1066
St. Johns River (Palatka)	(386) 329-4500	1-800-451-7106
Southwest Florida (Brooksville)	(352) 796-7211	1-800-423-1476
South Florida (West Palm Beach)	(561) 686-8800	1-800-432-2045

Sunshine State One Call (locator service)

811 or 800-432-4770 www.callsunshine.com

APPENDIX B: FLORIDA COOPERATIVE EXTENSION SERVICE TELEPHONE NUMBERS

County	City	Telephone
Alachua	Gainesville	(352) 955-2402
Baker	Macclenny	(904) 259-3520
Bay	Panama City	(850) 784-6105
Bradford	Starke	(904) 966-6224
Brevard	Cocoa	(321) 633-1702
Broward	Davie	(954) 370-3725
Calhoun	Blountstown	(850) 674-8323
Charlotte	Punta Gorda	(941) 764-4340
Citrus	Inverness	(352) 527-5700
Clay	Green Cove Springs	(904) 284-6355
Collier	Naples	(239) 353-4244
Columbia	Lake City	(386) 752-5384
Dade	Homestead	(305) 248-3311
Desoto	Arcadia	(863) 993-4846
Dixie	Cross City	(352) 498-1237
Duval	Jacksonville	(904) 387-8850
Escambia	Pensacola	(850) 475-5230
Flagler	Bunnell	(386) 437-7464
Franklin	Apalachicola	(850) 653-9447
Gadsden	Quincy	(850) 875-7255
Gilchrist	Trenton	(352) 463-3174
Glades	Moore Haven	(863) 946-0244
Gulf	Wewahitchka	(850) 639-3200
Hamilton	Jasper	(386) 792-1276
Hardee	Wauchula	(863) 773-2164
Hendry	LaBelle	(863) 674-4092
Hernando	Brooksville	(352) 754-4433
Highlands	Sebring	(863) 386-6540
Hillsborough	Seffner	(813) 744-5519
Holmes	Bonifay	(850) 547-1108
Indian River	Vero Beach	(772) 770-5030
Jackson	Marianna	(850) 482-9620
Jefferson	Monticello	(850) 342-0187
Lafayette	Mayo	(386) 294-1279
Lake	Tavares	(352) 343-4101
Lee	Ft. Myers	(239) 533-4327

Leon	Tallahassee	(850) 606-5200
Levy	Bronson	(352) 486-5131
Liberty	Bristol	(850) 643-2229
Madison	Madison	(850) 973-4138
Manatee	Palmetto	(941) 722-4524
Marion	Ocala	(352) 671-8400
Martin	Stuart	(772) 288-5654
Monroe	Key West	(305) 292-4501
Nassau	Callahan	(904) 879-1019
“	Yulee	(904) 548-1116
Okaloosa	Crestview	(850) 689-5850
“	(alt- phone)	(850) 729-1400 x5850
Okeechobee	Okeechobee	(863) 763-6469
Orange	Orlando	(407) 254-9200
Osceola	Kissimmee	(321) 697-3000
Palm Beach	West Palm Beach	(561) 233-1700
Pasco	Dade City	(352) 521-4288
“	New Port Richey	(727) 847-8177
Pinellas	Largo	(727) 582-2100
Polk	Bartow	(863) 519-8677
Putnam	East Palatka	(386) 329-0318
St. Johns	St. Augustine	(904) 209-0430
St. Lucie	Fort Pierce	(772) 462-1660
“	Port St. Lucie	(772) 337-5684
Santa Rosa	Milton	(850) 623-3868
Sarasota	Sarasota	(941) 861-5000
Seminole	Sanford	(407) 665-0311
Sumter	Bushnell	(352) 793-2728
Suwannee	Live Oak	(386) 362-2771
Taylor	Perry	(850) 838-3508
Union	Lake Butler	(386) 496-2321
Volusia	DeLand	(386) 822-5778
“	Daytona Beach	(386) 257-6012
“	New Smyrna Beach	(386) 423-3368
Wakulla	Crawfordville	(850) 926-3931
Walton	DeFuniak Springs	(850) 892-8172
Washington	Chipley	(850) 638-6180

APPENDIX C: RULE 5E-1.003(2) LABELING REQUIREMENTS FOR URBAN TURF FERTILIZERS

Effective Dec. 31, 2007

(2) FERTILIZER LABEL REQUIREMENTS FOR URBAN TURF, SPORTS TURF OR LAWNS.

(a) Definitions

1. "Urban Turf" or "Lawns" means non agricultural land planted in closely mowed, managed grasses except golf courses, parks and athletic fields.

2. "Sports Turf" means non agricultural land planted exclusively for golf courses, parks and athletic fields.

3. "No Phosphate Fertilizer" means fertilizer products with phosphate levels below 0.5% intended for established urban turf or lawns.

4. "Low Phosphate Fertilizer" means fertilizer products intended for new or established urban turf or lawns, with phosphate levels equal to or above 0.5% or as provided in paragraph (2)(b).

5. "Starter Fertilizer" means a fertilizer formulated for a one-time application at planting or near that time to encourage root growth and enhance the initial establishment.

6. "Established Urban Turf" means urban turf older than 12 months.

7. "New Urban Turf" means urban turf established less than 12 months.

(b) Fertilizer products labeled for use on sports turf, urban turf or lawns shall be no phosphate or low phosphate and have labeling that meets the restrictions set forth in this rule for the application of nitrogen.

1. No phosphate fertilizers shall not contain more than 0.5% of available phosphate expressed as P_2O_5. The "grade" shall indicate a zero guarantee.

2. Fertilizers labeled as Low phosphate shall have use directions that do not exceed an application rate of 0.25 lbs P_2O_5/1000ft^2 per application and not to exceed 0.50 lbs P_2O_5/1000ft^2 per year. Label use directions may be included that allow higher rates if an annual soil sample representative for the site shows the need for a higher application rate.

3. Fertilizers labeled as, or formulated for use as, starter fertilizer shall have use directions that do not exceed an application rate of 1.0 lb of P_2O_5/1,000 ft$_2$ and that subsequent applications shall be made with products meeting the definition of Low or No Phosphate fertilizers. The term "Starter Fertilizer" shall be part of the brand name.

4. Fertilizers labeled as urban turf, sports turf, or lawn fertilizer shall have directions for use for nitrogen that:

a. Are consistent with the recommendations in the following table:

Fertilization Guidelines for Established Turfgrass Lawns in Three Regions of Florida

	Nitrogen recommendations (lbs N / 1000 ft^2 / year)*		
Species	North	Central	South
Bahia grass	2-3	2-4	2-4
Bermuda grass	3-5	4-6	5-7
Centipede grass	1-2	2-3	2-3
St. Augustine grass	2-4	2-5	4-6
Zoysiagrass	3-5	3-6	4-6

North Florida is north of Ocala. Central Florida is defined as south of Ocala to a line extending from Vero Beach to Tampa. South Florida includes the remaining southern portion of the state.

b. Nitrogen shall not be applied at an application rate greater than 0.7 lbs of readily available nitrogen per 1000 ft^2 at any one time based on the soluble fraction of formulated fertilizer, with no more that 1 lb total N per 1000 ft^2 to be applied at any one time and not to exceed the annual nitrogen recommendations in the Fertilization Guidelines for Established Turfgrass Lawns in Three Regions of Florida, set forth herein. Use directions for nitrogen may be included that allow higher rates if an annual tissue sample representative of the site shows the need for a higher application rate.

5. The following language shall appear conspicuously on bags of fertilizer sold at retail: "Do not apply near water, storm drains or drainage ditches. Do not apply if heavy rain is expected. Apply this product only to your lawn/ garden, and sweep any product that lands on the

driveway, sidewalk, or street, back onto your lawn/garden."

(c) Specialty fertilizers labeled for urban turf or lawns shall have directions for use that include:

1. Application rates for phosphorous shall not exceed 0.25 lbs. P_2O_5/1000 ft^2 per application and not exceed 0.50 lbs. P_2O_5/1000 ft^2 per year. Label use directions may be included that allow higher rates if an annual soil sample representative for the site shows the need for a higher application rate.

2. Application rates for nitrogen shall not exceed 0.7 lbs of readily available nitrogen per 1000 ft^2 at any one time based on the soluble fraction of formulated fertilizer, with no more that 1 lb total N per 1000 ft^2 to be applied at any one time and not to exceed the annual nitrogen recommendations in the Fertilization Guidelines for Established Turfgrass Lawns in Three Regions of Florida. Use directions for nitrogen may be included that allow higher rates if an annual tissue sample representative of the site shows the need for a higher application rate.

3. Rates shall be expressed in units of weight or volume per unit of area coverage (where application rates are given in volume, the label shall provide sufficient information to calculate the application rates by weight).

4. Rates shall be expressed per 1000 square feet.

5. Maximum coverage area per container or bag shall be displayed prominently on the front of the container or bag. (i.e. This product covers 5000 square feet; This bag feeds 4000 square feet).

(d) Fertilizers labeled for sports turf at golf courses, parks and athletic fields shall:

1. Have directions for use not to exceed rates recommended in the document titled SL191 "Recommendations for N, P, K and Mg for Golf Course and Athletic Field Fertilization Based on Mehlich I Extractant", dated March 2007, which is hereby adopted and incorporated by reference into this rule. Copies may be obtained from the Soil and Water Science Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, FL 32611 or the following website: http://edis.ifas.ufl.edu/SS404.

2. Have directions for use in accordance with the recommendations in "BMP's for the Enhancement of Environmental Quality on Florida Golf Courses", published by the Florida Department of Environmental Protection, dated January 2007. Copies may be downloaded from http://www.dep.state.fl.us/water/nonpoint/pubs.htm.

(e) Fertilizers other than specialty fertilizers labeled for urban turf shall:

1. Have directions for use not to exceed rates recommended in the document titled Best Management Practices for Protection of Water Resources in Florida, June 2002, Florida Green Industries., which is hereby adopted and incorporated by reference into this rule. Copies may be obtained from http://www.dep.state.fl.us/water/nonpoint/docs/nonpoint/BMP_Book.

(f) Existing Stock – Licensees are permitted to sell or distribute products that do not meet the label requirements of the rule for one and one-half years after the effective date of the rule. Products at the retail level on or after the effective date of the rule are permitted to be offered for sale.

EMERGENCY REPORTING TELEPHONE NUMBERS

For Ambulance, Fire, or Police		**Dial 911**
State Warning Point	24 hours Toll-Free	1-800-320-0519
Department of Community Affairs, Division of Emergency Management		(850) 413-9911
National Response Center	24 hours Toll-Free	1-800-424-8802

(Federal law requires that anyone who releases into the environment a reportable quantity of a hazardous substance [including oil when water is or may be affected], or a material identified as a marine pollutant, must immediately notify the NRC).

FDEP Emergency Response

Jacksonville	(904) 807-3246
Orlando	(407) 893-3337
Ft. Lauderdale	(954) 958-5575
Ft. Myers	(239) 332-6975
Tampa	(813) 744-6462
Panama City	(850) 872-7650
Pensacola	(850) 595-8300
Tallahassee	(850) 245-2010

HELP LINE TELEPHONE NUMBERS
(for chemical hazard information)

CHEMTREC HOTLINE (Emergency only) 24 hours Toll-Free	1-800-424-9300

DEPARTMENT OF ENVIRONMENTAL PROTECTION

FLORIDA

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