FLORIDA GREEN INDUSTRIES

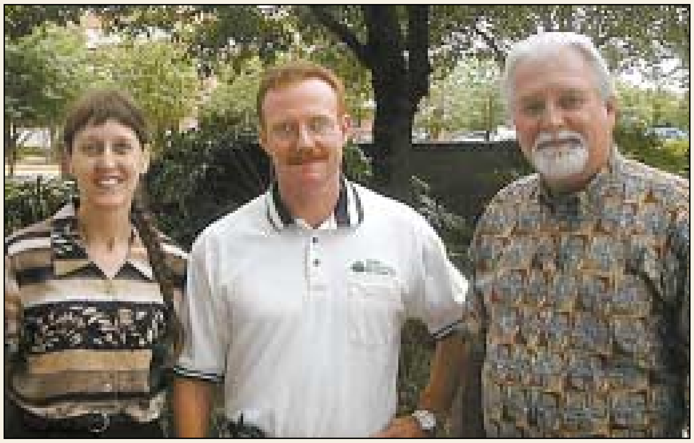
BEST MANAGEMENT PRACTICES FOR PROTECTION OF WATER RESOURCES IN FLORIDA

JUNE 2002

I am very pleased to support the distribution and implementation of this best management practices manual developed jointly by the Department of Environmental Protection, Department of Agriculture and Consumer Services, Department of Community Affairs, water management districts, the University of Florida, and many private industry partners. The manual is an excellent example of a collective commitment to assist the turf and landscape industry while also protecting the environment through the implementation of nonregulatory educational programs. I encourage you to follow the recommendations contained here. They will protect our fragile environment, minimize the need for future regulations, and continue to promote Florida's commitment to good environmental stewardship.

***David B. Struhs**, Secretary*
Department of Environmental Protection

The Green Industry is proud to have written our best management practices manual in partnership with the Department of Environmental Protection, Department of Agriculture and Consumer Services, the water management districts, and the University of Florida. We pledge to bring the information in this manual to our fellow industry members, and to continue our goal of protecting the environment. As technology improves, our best management practices will also advance as we strive for compliance-plus. Everyone shares the same earth, and everything we do matters to those around us. Taking care of a landscape is working with a slice of nature. We are committed to staying in harmony with our environment and making this a better world.



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GOALS FOR THE MANUAL

This manual provides information and guidance on turfgrass and landscape management practices 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.

The manual is designed as 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 should be used to enhance the professional knowledge and judgment of turfgrass and landscape managers, and should not be viewed as a regulatory standard to be rigidly applied in all cases. Turfgrass and landscape managers should use the information provided here as general guidance, but specific situations may require more restrictive measures to protect sites that are at particularly high risk for adverse effects on surface water and ground water.

LET ONLY RAIN
DOWN
THE STORM DRAIN
FOUNDRY & MFG. CORP

ACKNOWLEDGMENTS

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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 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 Green Industry's 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.

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 supply.

Since the passage of the Clean Water Act and the formation of the U.S. Environmental Protection

Figure 1. With proper BMP's, our water resources can successfully co-exist with residential landscapes.

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 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 almost all 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 cause widespread ecosystem changes in our sensitive estuaries, lakes, rivers, and the Everglades. Users of fertilizers and pesticides need to consider the soil's susceptibility to leaching and runoff, the distance to the water table, the slope of the land, and the distance to surface waters and storm drains in addition to plant nutrition, disease, and pest factors.

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

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

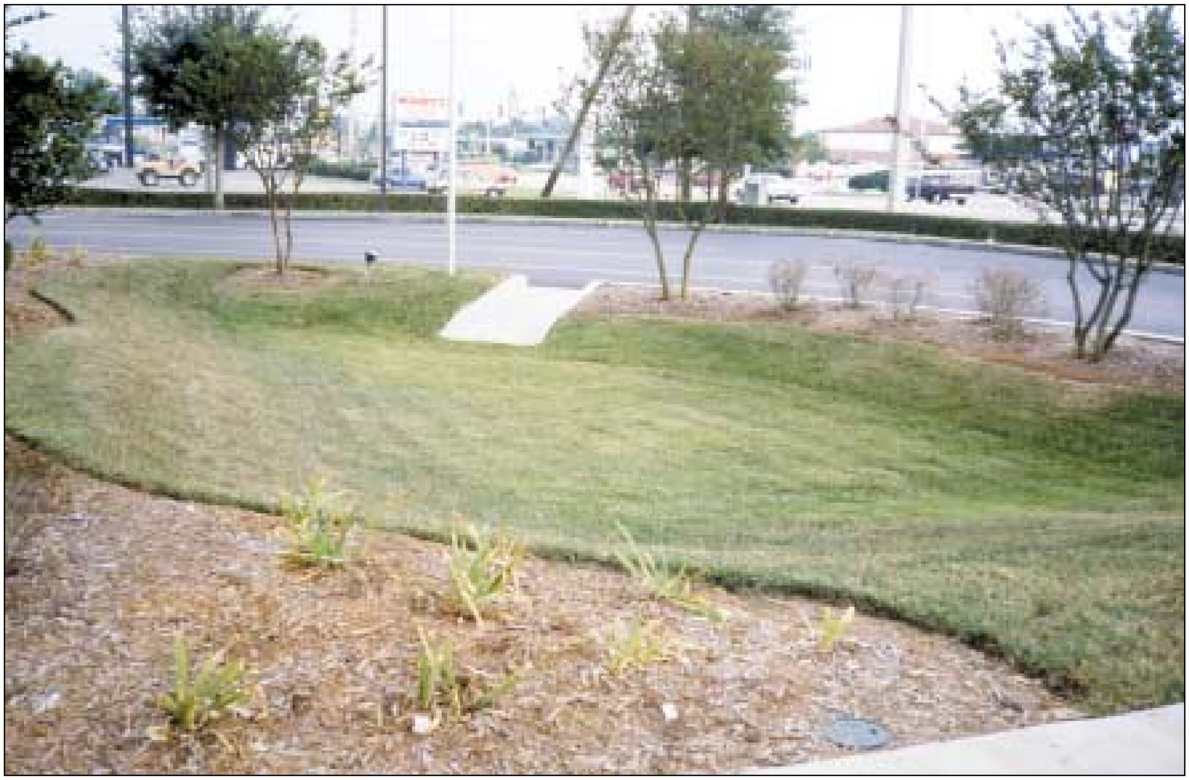

Figure 2. Grassy stormwater retention areas can add dimension to a lawn and protect our environment.

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 correlates 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. **Educating clients about wise cultural practices is of the utmost importance.**

Cultural practices are a management tool to reduce pesticide use. Use plant varieties that are less susceptible to insects, nematodes, and diseases in order to reduce pesticide use. Care should be taken to select turfgrass species and cultivars best adapted to the environmental conditions of the site and geographic part of the state.

Proper cultural practices include mowing, fertilization, irrigation, pruning, and supplemental cultural practices such as aerification and dethatching. These should be included in the management plan to take advantage of every aspect of the cultural control of pest problems. Cultural practices are a part of IPM and help to produce a healthy, vigorous stand of turf that is more resistant to pest problems.

Mowing height has a tremendous impact on the severity of weed, insect, and disease pests. Lowering the height increases weed, insect, and disease pressure on turfgrasses by causing turf stress. *There are exceptions: centipedegrass and improved bermudagrasses have lower mowing heights than the standard used for lawn and commercial turfgrasses.*

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.

Inadequate nutrition results in thin, weak plants that may be more susceptible to insects, weeds, and diseases. Certain diseases, such as rust and dollar spot, can occur in turf maintained under low-nutrient conditions. Overfertilization 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. Proper fertilization can alleviate these conditions.

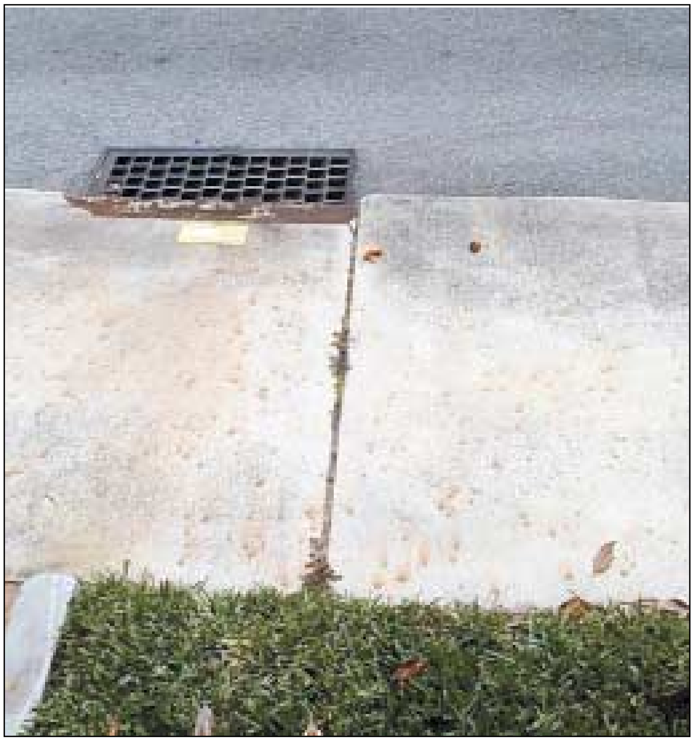

Figure 3. Poor fertilization technique wastes fertilizer, causes unsightly stains, and pollutes our waterbodies. Note the trail of stains on this sidewalk.

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

Time fertilizer applications to maximize plant use and minimize adverse environmental impacts. Frequent light applications or "spoon feedings" of turf and landscapes are ideal. Underfertilized landscape plants may require a higher than normal rate of nitrogen or other nutrients in order to return to a healthy condition. Both quick- and slow-release fertilizers have a place in a sound management program.

Remember that plants don't waste water, people do. Supplemental irrigation is necessary for the survival of some turf and ornamental plants during periods of severe moisture deficiency. Overwatering may increase insect, weed, and disease pressures. For example, overwatering during cooler months encourages dollarweed growth. Conversely, other pests thrive under extremely dry conditions and compete with desirable plants. Chinch bugs and spurge are examples of pests that attack turf when the soil is too dry. A proper balance is necessary to keep the landscape strong and healthy.

The average amount of rainfall in Florida ranges from nearly 52 inches annually in the central and northern peninsula to almost 65 inches in the Panhandle west of Tallahassee and along the southeast coast below Lake Okeechobee. More than half of Florida's total annual rainfall is concentrated in the central and southern peninsula between June and September. During the winter and spring, the lack of rainfall may seriously compromise plant health. Landscape plants 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 mandate supplemental watering while plants are becoming established.

Determining and controlling the rate, amount, and timing of irrigation can minimize soil erosion, runoff, and fertilizer and pesticide movement. The irrigation system should be designed to have an application rate that is less than the infiltration capacity of the soil so that no surface pooling occurs and water percolates with maximum efficiency. Rain sensors or soil moisture sensors eliminate irrigation when nature has supplied sufficient water.

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 discourage its development. One defense against the movement of pesticides and fertilizer nutrients off-site or through the soil is a thick, vigorously growing stand of turf or other landscape plants.

BMPs to protect water quality 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.

Pesticides must be correctly applied. Spray when conditions for drift are minimal, avoid application when heavy rain is imminent, and irrigate with appropriate volumes of water. Granular applications should be kept away from impervious surfaces and bodies of water. 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.

The Green Industry is very diverse. Companies range in size from one or two individuals to very large corporations. Large companies or corporations may choose to develop their own training programs

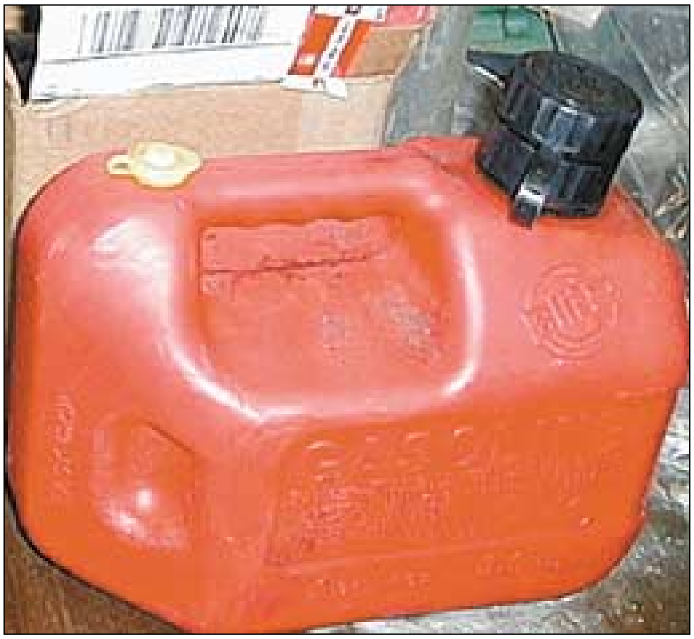

Figure 4. Plastic cans are not OSHA approved.

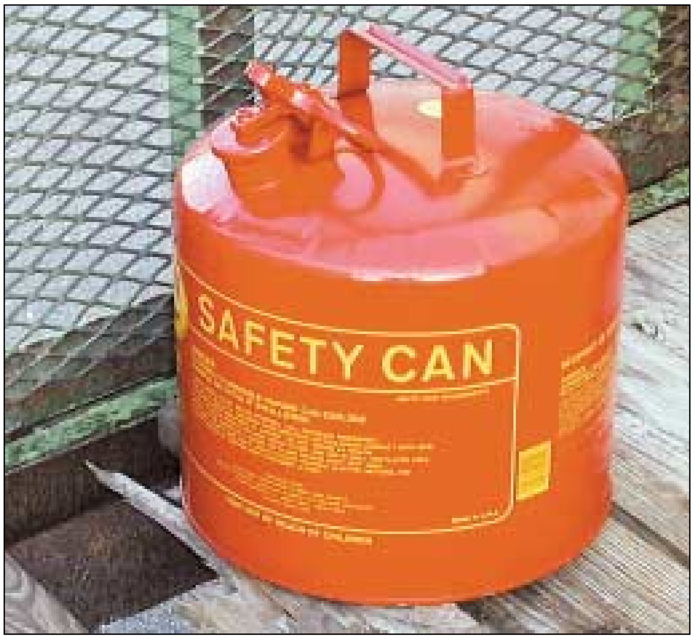

Figure 5. This can is approved but not properly secured.

administered by their own professional training staff. Smaller firms may choose to avail themselves of training available through professional associations or the county's IFAS Cooperative Extension Service.

Employees should also be given pertinent information relating to their job duties, especially job safety. For instance, do your employees know that if drivers carry less than 8 gallons of either diesel fuel or gasoline, they are exempt from Department of Transportation (DOT) or Occupational Safety and Health Administration (OSHA) regulations concerning fuel cans? If they carry over 8 gallons combined (exception: 9 one-gallon containers), they must use OSHA-approved fuel cans. Plastic cans are not in compliance with the regulations. Any petroleum product should be kept secured on the vehicle.

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 important to the success of a 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).

As time goes on, more and more local governments are passing ordinances to regulate the Green Industry. Many of these ordinances may require education 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.**

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.

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.state.fl.us/dbpr/pro/larch/lndsc_index.shtml, 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 appropriate 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, water drainage, soil type, and pH. 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. The second step is to select plants with attributes that match the characteristics of the planting site.

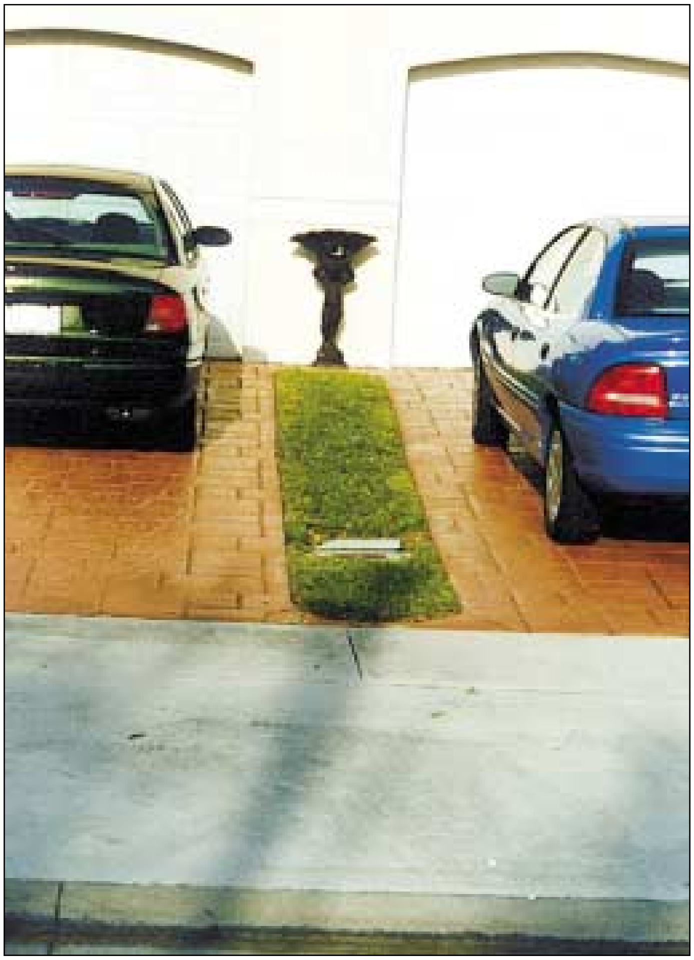

Figure 6. Narrow strips are difficult to maintain.

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

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.

Table 1. Comparison of lawngrasses available for use in Florida.

Environment	Species						
	Bahia Grass	**Bermuda Grass**	**Centipede Grass**	**Seashore Paspalum**	**St. Augustine Grass**	**St. Augustine Grass "dwarfs"**	**Zoysia Grass**
Area Adapted To	Statewide	Statewide	North Florida &Panhandle	Statewide	Statewide	Statewide	Statewide
Moving Height (inches)	3-4	0.5-1.5	1-2	1-2	3-4	1.5-2.5	1-3
Soil	Acid, Sandy	Wide Range	Acid-Infertile	Wide Range	Wide Range	Wide Range	Wide Range
Leaf Texture	Coarse-Medium	Fine-Medium	Medium	Fine-Medium	Course-Medium	Medium	Fine-Medium
Drought Tolerance	Good	Good	Medium	Good	Medium	Medium	Medium
Salt Tolerance	Very Poor	Good	Poor	Excellent	Good	Good	Good
Shade Tolerance	Poor	Poor	Fair	Poor	Fair-Good	Good	Good
Wear Tolerance	Poor	Good-Excellent	Poor	Good-Excellent	Poor	Poor	Good-Excellent
Nematode Tolerance	Very Good	Poor	Poor	Good	Good	Good	Poor
Maintenence Level	Low	Medium-High	Low	Medium	Medium	Medium	High
Uses	Lawns, Roadsides	Athletic Fields, Golf	Lawns	Lawns, Athletic Fields, Golf	Lawns	Lawns	Lawns
Establishment Methods	Seed, Sod	Sod, Sprigs, Plugs, Some Seed	Seed, Sod, Sprigs, Plugs	Sod, Plugs, Sprigs	Sod, Plugs, Sprigs	Sod, Plugs, Sprigs	Sod, Plugs, Sprigs

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

- *What type of lawn is desired or expected and what level of maintenance can be provided?* The level of maintenance required is closely related to cost and time, with high-maintenance turf costing the most and taking the most time. Homeowners should understand realistically what their options are and what each entails.
- *What are the environmental conditions at the planting site?* Most importantly, what are the soil type, pH, drainage, and other soil characteristics? Is the site irrigated? Can it be easily mowed? Is it shaded or in full sun? Will it be shaded in a few years? What is the quality of the water available for irrigation?

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, 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 IFAS Circular 858, *Selecting and Planting Trees and Shrubs*, at http://edis.ifas.ufl.edu/MG077. Also see http://hort.ifas.ufl.edu/woody/index.htm 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:

- 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 Roundup (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 shallow 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.

For more information, see IFAS Circular 858, *Selecting and Planting Trees and Shrubs*, at http://edis.ifas.ufl.edu/MG077.

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. Pruning and fertilizing may also benefit landscape plants while they are becoming established.

For more information, see the following:
IFAS Publication ENH 858, *Fertilization Recommendations for Landscape Plants*, at http://edis.ifas.ufl.edu/ENH858

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/home%20page.htm

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, the grass becomes more vulnerable to stresses. Less reserve material is 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 only when the grass needs water. Overirrigating 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 only addresses the symptoms, and will not solve the problem until the cultural factors are handled correctly.

SHADE CONSIDERATIONS FOR TURF

Most landscapes include shaded areas 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 sufficient 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.

Turfgrasses respond to shade by developing 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 partially 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.), lirope (Lirope 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

Plants don't waste water, people do. Using proper irrigation system design, installation, management, and maintenance practices provides a multitude of benefits. These benefits include saving money, using irrigation efficiently, and protecting the state's water resources. It is important for anyone involved with irrigation projects to be knowledgeable and adhere to all federal, state, and local irrigation rules.

This chapter documents and establishes irrigation BMPs that help individuals abide by existing regulations while protecting the state's resources. These practices are practical, easy to implement, cost-effective, and applicable to most turf and landscape plant varieties in Florida. Throughout the chapter, the term "plant" refers generally to both turf and landscape plants, including trees.

BACKGROUND

Irrigation is an age-old art and is defined as the application of supplemental water to a soil for the purpose of supplying the moisture for plant growth. It also provides a means for nutrients to move from the soil to a plant, and is used for salt leaching, chemigation, system flushing, seed germination, and climate modification.

On average, Florida receives more than 50 inches of rain per year. 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.

IRRIGATION SYSTEM DESIGN

Irrigation system design is a complex issue and should be handled by trained professionals. These professionals should use existing standards and criteria, as well as the manufacturer's recommendations, to design the most appropriate system for a location. A list of sources for current standards and criteria can be found at the end of this chapter. Remember that in many communities, construction and design documents and permits require the signature and seal of a licensed design professional.

The irrigation design for a site depends on a number of factors: location, soils, landscape vegetation, water supply, and water quality. An irrigation system needs to be designed to meet a site's peak water requirements. However, the system should also have enough flexibility to adapt to various water demands and local restrictions.

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 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 landscape is in place. Irrigation systems designed to service both turf and landscape areas should include enough zones to meet each area's individual water needs. The irrigation design should also account for the extra water needed periodically to leach salt buildups that accumulate due to poor irrigation water quality.

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, or spray or drip emitter). The proper design and installation of these components optimizes their use and decreases any off-site impacts. The design must also account for different site characteristics and topographies.

Hand-moved systems should be designed with 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 50 percent of the root systems. Microirrigation is rarely used for turf in Florida, but if used should be designed to cover 100 percent of the grass's root system.

To meet peak water use demands and have enough flexibility to supply different demand requirements, irrigation systems need to be designed with varying control devices, rain shut-off devices, and backflow prevention. Water conveyance systems should be designed with thrust blocks and air release valves to prevent system damage. The water conveyance pipelines should provide the system with the appropriate pressure required for maximum irrigation uniformity, and the distribution devices should be designed for optimum uniform coverage. In addition, the distribution system should not irrigate nonplanted 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 manufacturer's recommendations. Typically, this spacing is based on average wind conditions during irrigation. In the absence of this information, guidelines such as Table 2 can be used. For variable wind directions, the triangular spacing tends to be more uniform than the square spacing. Practical experience may suggest closer spacing than the guidelines. Spacing should not exceed the percentages in Table 2. After the system is constructed and operating, periodic "catch can" uniformity tests should be performed (see the section on Irrigation Management later in this chapter).

MICROIRRIGATION FOR LANDSCAPE PLANTS

Irrigation systems operate most efficiently if they don't wet the foliage of the plants. Plants do not use water applied to the foliage. The most efficient and effective watering method currently in use is microirrigation, which includes both drip and trickle irrigation. Microirrigation supplies small quantities of water directly to the mulch and soil through plastic tubing on or below the ground surface. Low-pressure emitters (that is, nozzles that drip, spray, or sprinkle) are attached to the plastic tubing and slowly release water into the soil around a plant. Wetting only the root zone saves water because less evaporates.

When microirrigating, you need to know which kind of emitter to install in a given location, a drip emitter or a spray-jet. With drip emitters, water moves laterally in sand only 10 to 12 inches from the emitter. Drip emitters are ideal when such precision is desirable or for narrow strip plantings, such as along hedgerows. Because drip emitters are sometimes placed under mulch or buried in the soil, clogging may occur that is difficult to detect. Because the action of drip emitters is not readily apparent, it is also hard to know whether the system is irrigating excessively due to a hole in the tubing or some other problem. Regular inspection is required to make sure that the drip emitters and the overall system are functioning as they should.

On the whole, spray-jets (either microsprayers or microsprinklers) are more desirable than drip emitters for most landscape applications. Because spray-jets can cover areas 3 to 20 feet in diameter, fewer emitters are needed. Not only is their action visible, but the greater flow rate of water through spray-jets (10 to 20 gallons per hour versus the drip emitter's 0.25 to 2 gallons per hour) also makes them less susceptible to clogging.

Microsprayers create a fan-shaped distribution of fine water droplets. These fan-jets perform well when used for directional spray and confined area applications. Shaping vanes, known as spokes, can be added to create streams of water called spoke-jets. A spoke-shaped application pattern works well for a single plant. A deflection cap will confine the application to areas 2 to 5 feet in diameter. Some manufacturers have added spinner devices to create a sprinkler effect. These microsprinklers have more uniform water distribution than the fan-jets or spoke-jets and can provide excellent coverage.

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%

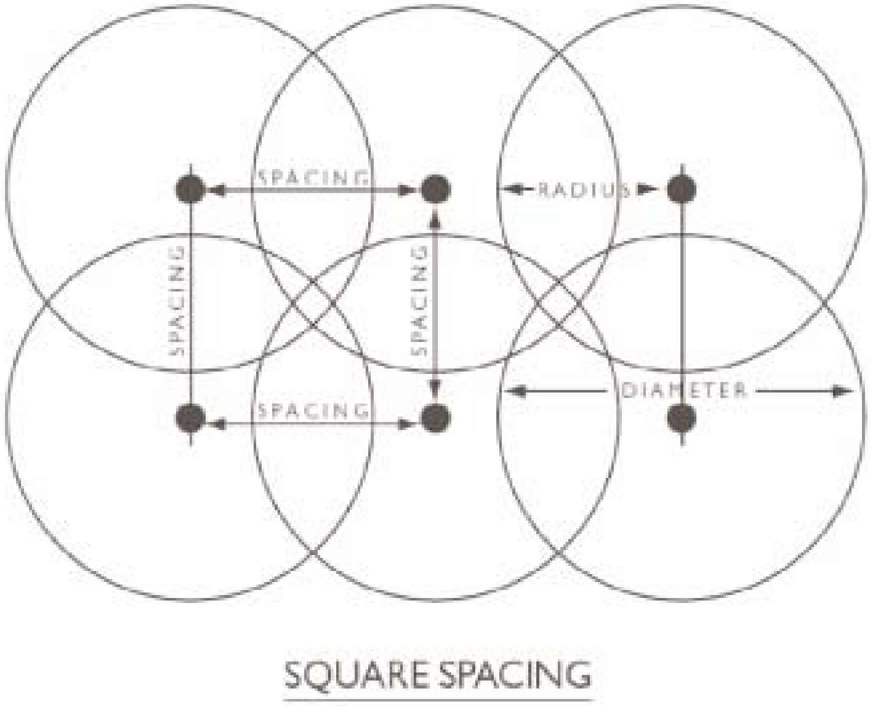
SPACING
RADIUS
SPACING
SPACING
DIAMETER
SPACING
SQUARE SPACING

Figure 7

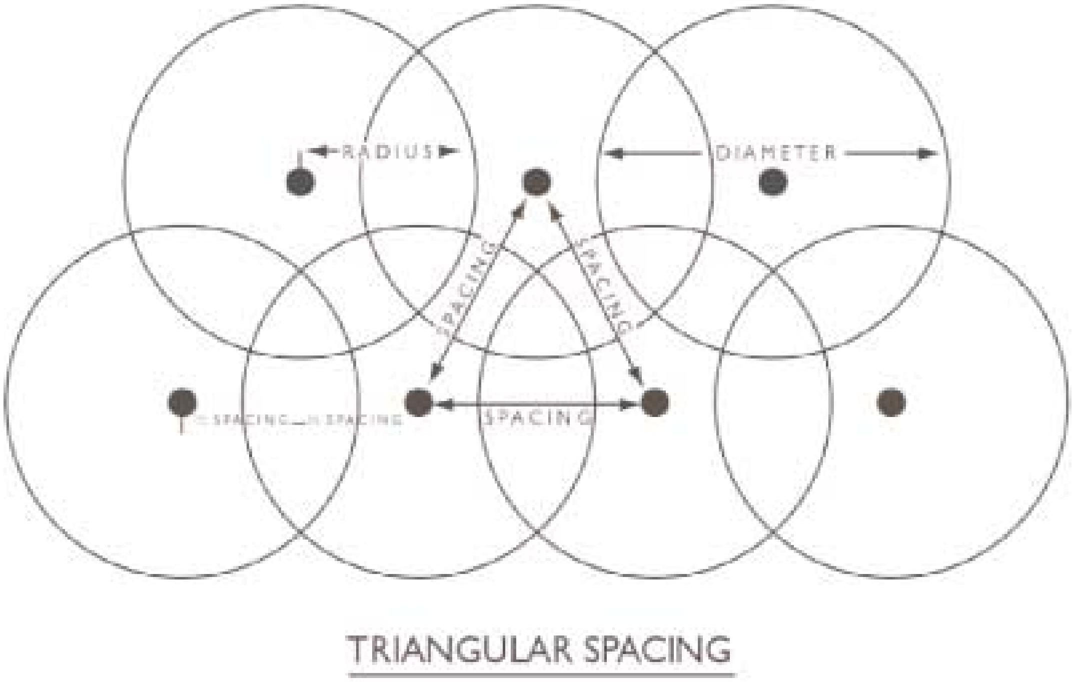
RADIUS
DIAMETER
SPACING
SPACING
½ SPACING ½ SPACING
SPACING
TRIANGULAR SPACING

Figure 8

Regardless of the emitter style, clogging can be a problem if the water supply is not filtered where it enters the irrigation system. Filters are easily installed in any system. Filtering well water is strongly recommended. The 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 and then placed in a small container of cleaning fluid that is appropriate for the clogging material.

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

IRRIGATION SYSTEM DESIGN BMPS

The principal BMPs for irrigation system design are as follows:

- The application rate must not exceed the ability of the soil to absorb and retain the water applied during any one application.
- The design operating pressure must not be greater than the available source pressure.
- The design operating pressure must account for peak use times and supply line pressures at final buildout for the entire system.
- Distribution devices and pipe sizes should be designed for optimum uniform coverage. The first and last distribution device should have no more than a 10 percent difference in flow rate. This usually corresponds to about a 20 percent difference in pressure.
- The system should be flexible enough to meet a site's peak water requirements and allow for operating modifications to meet seasonal irrigation changes or local restrictions.
- Distribution equipment (such as sprinklers, rotors, and microirrigation devices) in a given zone must have the same precipitation rate.
- Turf and landscape areas should be zoned separately based on plant water requirements.
- The design package should include a general irrigation schedule with recommendations and instructions on modifying the schedule for local climatic and growing conditions.
- If required by the plant species, design should account for the need to leach out salt buildup from poor-quality water. Otherwise, use species that are tolerant of these conditions.
- Water-supply systems (for example, wells and pipelines) should be designed for varying control devices, rain shut-off devices, and backflow prevention.
- Water conveyance systems should be designed with thrust blocks and air release valves, and flow velocity should be 5 feet per second or less.
- Pipelines should be designed to provide the system with the appropriate pressure required for maximum irrigation uniformity.
- Pressure regulating or compensating equipment must be used where the system pressure exceeds the manufacturer's recommendations.
- Equipment with check valves must be used in low areas to prevent low head drainage.
- Nonplanted areas, including impervious surfaces, should not be irrigated.

IRRIGATION SYSTEM INSTALLATION

Qualified, appropriately licensed, bonded, and insured professionals should handle irrigation installation. These individuals must follow the designer's plans and use existing standards and criteria (such as the American Society of Agricultural Engineers [ASAE], Florida Irrigation Society [FIS], Irrigation Association, 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 (such as ASAE, American Society of Civil Engineers [ASCE], or American Society of Testing Materials [ASTM]) standards. All construction practices should be planned according to standard safety practices. Before construction, the contractor should identify and flag all underground pipes, cables, and other elements. At the end of construction, the owner should receive a copy of the as-built plans, operating manuals, and warranties. The contractor should clean the site of any construction materials before the job is complete.

IRRIGATION SYSTEM INSTALLATION BMPS

The principal BMPs for irrigation system installation are as follows:

- Only qualified specialists should install the irrigation system.
- Construction must be consistent with the design.

- The designer must approve any design changes before construction.
- Construction and materials must meet existing standards and criteria.
- Acceptable safety practices must be followed during construction.
- All underground cables, pipes, and other obstacles must be identified and their locations flagged.
- The owner should receive a copy of the as-built plans, operating manuals, warranties, and written instructions on how to change the irrigation system's timers/clocks/controllers.
- At the end of construction, the site must be cleaned of all construction materials.

IRRIGATION MANAGEMENT

Irrigation management (knowing when and how much to irrigate) is the cornerstone of water conservation and reduced fertilizer and pesticide movement. It encompasses both the amount of water applied and the frequency of application. To prevent excess water use that could lead to leaching and runoff, irrigation scheduling should take into account plant water requirements, recent rainfall, recent temperature extremes, and soil moisture.

Under ideal conditions, the water required for a plant is equal to the water lost (excluding runoff or leaching) or used during plant growth. This is water that 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 for each month. Plants use more water during seed/flower/fruit production, and may not require irrigation in dormancy. During the colder months, most turfgrasses and landscape plants are not actively growing and thus use less soil moisture.

Although soil moisture levels are the preferred method to determine irrigation quantities, potential evapotranspiration (ETp) levels can be used. Current calculated Etp rates are available at http://fawn.ifas.ufl.edu. **Table 3** lists average turfgrass water requirements (using ETp from IFAS publications) for north and south Florida, where the southern part of the state is the area below a diagonal from north of Tampa to south of Daytona Beach.

These values should be used only as a general guideline for irrigation scheduling and for monthly timer/controller adjustments when local information is not available. In general, to prevent overirrigation and the leaching of fertilizers/pesticides, and to promote root development for drought conditions, no more than 1/2 to 3/4 inches of water should be applied for a single irrigation event.

An alternative method to Etp, 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. Because most roots grow in the topmost 6 inches of soil, 1/2 to 3/4 inch is needed for replenishment every 2 to 3 days during 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.

Many established, drought-tolerant landscape trees and shrubs require little or no irrigation, provided that

Table 3. Potential evaportranspiration (ETp) levels for two regions of Florida

Month	North Region ETp (inches/day)	South Region ETp (inches/day)
January	0.07	0.09
February	0.10	0.12
March	0.13	0.15
April	0.17	0.19
May	0.19	0.20
June	0.19	0.19
July	0.18	0.19
August	0.17	0.17
September	0.15	0.16
October	0.12	0.14
November	0.09	0.11
December	0.06	0.09

compacted soil, foundations, or other obstacles in the soil do not obstruct roots. Plants such as azaleas, copperleaf, impatiens, or other bedding plants that lack drought tolerance may require irrigation during extended drought periods.

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, *Drought Tolerant Plants for North and Central Florida*, at http://edis.ifas.ufl.edu/EP022

IFAS software publication, *Landscape Plant Selector*, at http://ifasbooks.ufl.edu

Irrigation requirements represent the amount of water an irrigation system must 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 Application Uniformity is a component of irrigation system efficiency and indicates how uniformly water is distributed over a wetted area. Higher application uniformities occur when spacing is adequate and sprinkler nozzles are matched. Poor application uniformity leads to localized overirrigation or underirrigation. This can cause brown spots in the grass, fertilizer or pesticide leaching or runoff, and the waste of irrigation water. These problems can be solved and the site's owner can reduce fuel and water costs by improving irrigation application uniformity.

Irrigation application uniformity is determined by a "catch can" test. Typically baby-food jars, tuna cans, or other containers are evenly placed around sprinklers to catch and measure irrigation. A system is turned on for a fixed amount of time, and the water collected in each container is measured and recorded. For sprinkler systems, 70 percent to 80 percent is considered good uniformity, and anything above 80 percent is excellent. For more information, see IFAS Publication AE 144, *Turf Irrigation for the Home*, at http://edis.ifas.ufl.edu/AE144.

Application Efficiency is another form of irrigation system efficiency. It indicates how much of the applied water is stored in a plant's root zone. For sprinkler systems, application efficiencies typically range between 70 and 85 percent.

Application Efficiency and **Emission Uniformity** measurements are used to determine microirrigation system efficiencies. In general, micro systems with emission uniformities of 90 percent or greater are considered excellent, 90 to 80 percent are good, 80 to 70 percent fair, and below 70 percent poor. For more information, see IFAS Publication AE094, *Field Evaluation of Microirrigation Water Application Uniformity*, at http://edis.ifas.ufl.edu/AE094.

The different system efficiencies determine how well a system can perform, but since they do not include irrigation management, they do not show how well the system is operating. To determine the overall irrigation efficiency, divide the total water used for reasonable and beneficial use (such as evapotranspiration, salt leaching, and establishment) by the total water provided and multiply by 100 to create a percentage. The higher the value, the more efficient the irrigation.

In some areas of the state, the water management districts or other local agencies may provide Mobile Irrigation Lab (MIL) services. These services will evaluate a system and make recommendations to improve system efficiency. Contact your local water management district for more information about these services in your area.

In humid regions such as Florida, irrigation is considered to be 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, tensiometers, soil moisture devices, and/or other irrigation management devices should be incorporated into the site's irrigation schedule.

Rain shut-off devices, which are required by law, and rain gauges should be placed in open areas to prevent incorrect readings. Flow meters should have a straight enough run of pipe both downstream and upstream to prevent turbulence and bad readings. Tensiometers and other irrigation management tools should be installed in representative locations and should be maintained to help make good irrigation management decisions. When mechanical/electronic devices are not available for irrigation management, the following visual indicators can 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.

Excess irrigation can waste our water supply, cause off-site damage, cause pollution, and have direct economic impacts. Overirrigation causes water to run off and possibly flood adjacent properties, or the water percolates below root systems and provides no benefits to the landscape or surrounding areas. Excess water can carry away nutrients or other chemicals that could damage nearby water resources. Wasteful use of water also increases both the user's water bill and fuel costs associated with pumping the water.

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 water requirements. Flow meters can be used to determine how much water is applied and when to turn off the irrigation system. A tensiometer or electronic moisture sensor can be placed below the root zone to determine the status of the wetted front 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.

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 water use and effective rainfall (rainfall stored in a plant's root zone, for plant use). Another way to determine irrigation requirements is to determine the amount of soil moisture deficit that needs to be replaced. When possible, the timing of an irrigation event should be planned in order 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 irrigation 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.

IRRIGATION MANAGEMENT BMPs

The principal BMPs for irrigation management are as follows:

- 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.
- Irrigation quantities should not be larger than the available moisture storage in the root zone.
- Never overirrigate.
- Use soil moisture sensing devices, rain gauges, and the visual observation of irrigation runoff or puddles to prevent overirrigation.
- When possible, the irrigation schedule should coincide with other cultural practices (such as the application of fertilizer, herbicides, or other chemicals).
- When fertilizing (other than when watering restrictions apply), irrigate with 1/4 inch following fertilization to avoid the loss of nitrogen and increase uptake efficiency. If water restrictions are in effect, you may irrigate as you are allowed, but more than 1/2 inch of water may cause some nitrogen to be leached past the root zone.
- Proper cultural practices (such as mowing) should be employed to promote healthy, deep root development and reduce irrigation requirements.

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 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.

Damaged/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.

Evaluating a system's application/distribution efficiency (an irrigation audit) and correcting problems can reduce water use and fertilizer/pesticide leaching. There are many procedures (from NRCS, IFAS, ASAE, and

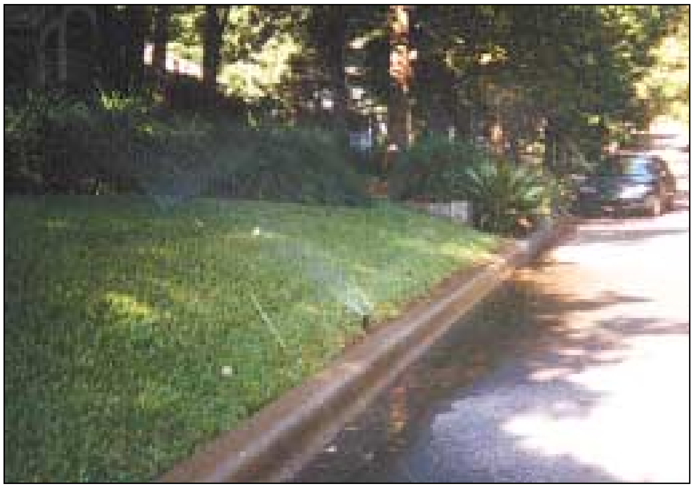

Figure 9. Poor Design – Turf and landscape plants should be separate zones and should not water the street.

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 application/distribution efficiency.

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

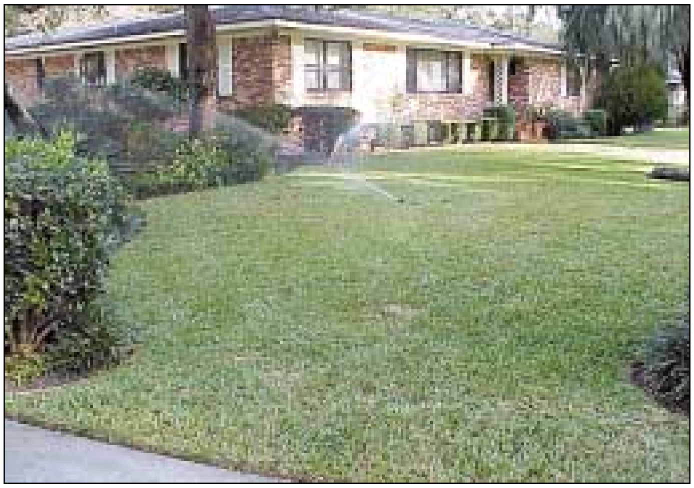

Figure 10. Poor design; system does not match irrigation requirements. The area needs to be rezoned with landscape and turf separated.

IRRIGATION SYSTEM MAINTENANCE BMPS

The principal BMPs for irrigation system maintenance are as follows:

- Perform visual weekly inspections to identify leaks, broken sprinkler heads, and other system malfunctions.
- Replace or repair all broken or worn components before the next scheduled irrigation.
- Ensure that replacement parts have the same characteristics as the original components.
- Check application/distribution efficiencies annually. Implement a preventive maintenance program to replace worn components before they cause fertilizer/chemical and water waste.

IRRIGATION SYSTEM ERRORS

Figures 9–15 depict some examples of improper irrigation system design or installation.

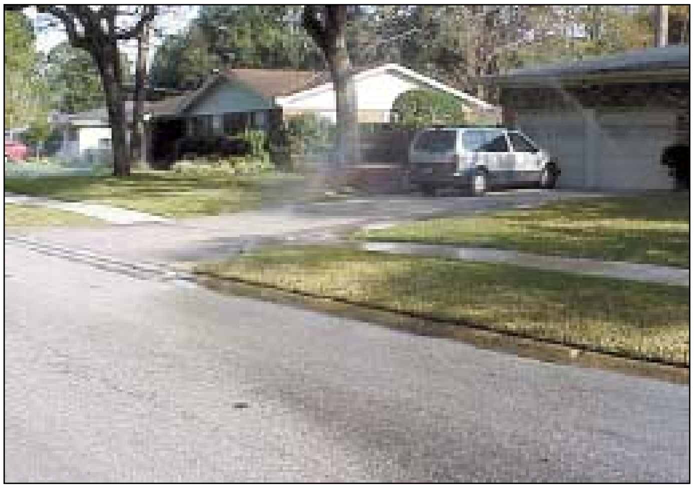

Figure 11. Overirrigation runoff. Small turf area should be irrigated with spray heads, not sprinklers.

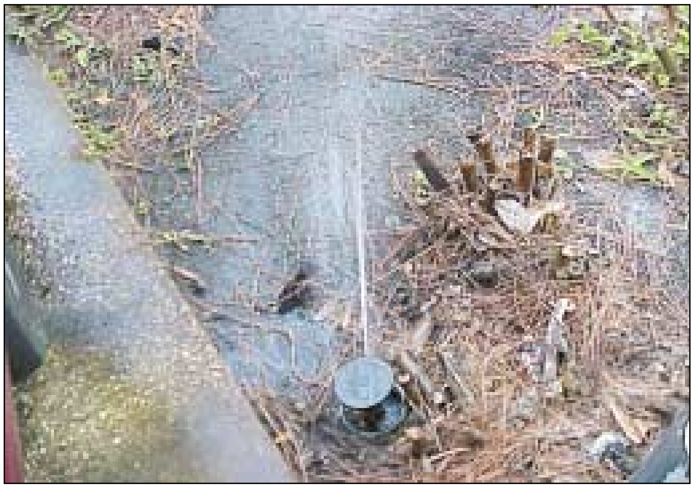

Figure 12. Object is interfering with spray pattern, resulting in poor distribution uniformity.

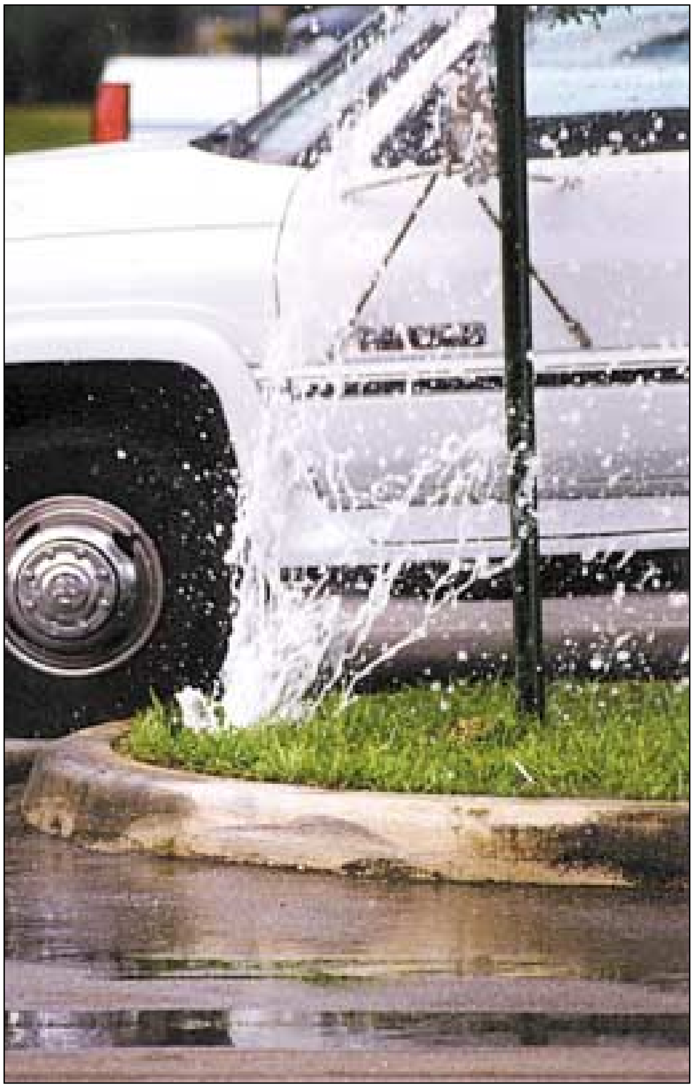

Figure 13. Water gushing from broken head.

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, and local governments might all 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, the water management districts have special 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.

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. Client education regarding the need for and benefits of BMPs is a critical part of meeting our goals.

SOURCES FOR IRRIGATION STANDARDS

The following publications contain current irrigation standards:

- *ASAE Standards–2002*. Standards, engineering practices, and data developed and adopted by the American Society of Agricultural Engineers. 2002. American Society of Agricultural Engineers, 2950 Niles Rd., St. Joseph, MO 49085. Telephone (616) 429-0300. http://www.asae.org/standards/searchpur.html
- *Florida Building Code–Plumbing Volume, Appendix F*. Southern Building Code Congress International, Inc., 900 Montclair Road, Birmingham, AL 35213-1206. Telephone (205) 591-1853. http://www.sbcci.org/floridacodes.htm
- *Standards and Specifications for Turf and Landscape Irrigation Systems, Fourth Edition*. January 2002. Florida Irrigation Society, Goldenrod, Florida. http://www.fisstate.org/
- *National Engineering Handbook Series 210-VI*. November 1997. U.S. Department of Agriculture, Natural Resources Conservation Service, Washington D.C., 20013. http://www.ftw.nrcs.usda.gov/tech_ref.htmls

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.
- 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.
- 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.

In using mulch, follow these tips:

- Use mulches made from recycled materials.
- Do not pile mulch against a tree. Leave a clear space for air to reach the trunk.

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

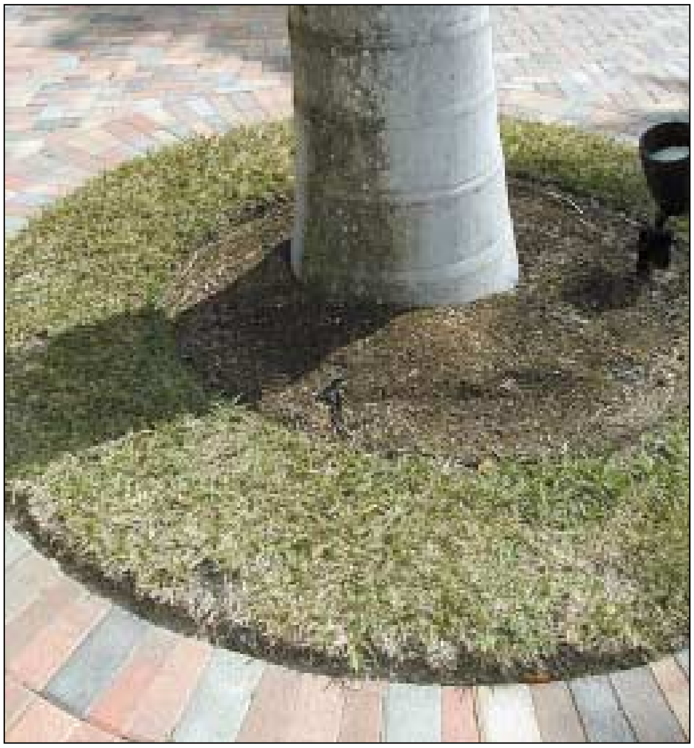

Figure 14. Mulch, not grass, should be used here.

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.

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 3 inches, it should be mowed when it grows to a height of 4 to 4.5 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.

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.

MOWING BMPS

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 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 best mowing results and 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.
- Do not mow wet turf with a rotary mower because 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.
- 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.

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	7-17	Rotary/Flail
Bermudagrass	0.5-1.5	3-5	Reel
Centipedegrass	1.0-2.0	10-14	Rotary
Seashore Paspalum	1.0-2.0	5-10	Rotary/Reel
St. Augustine “Dwarfs”*	3.0-4.0	5-14	Rotary
	1.5-2.5	5-14	Rotary
Zoysiagrass	1.0-3.0	10-14	Reel

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

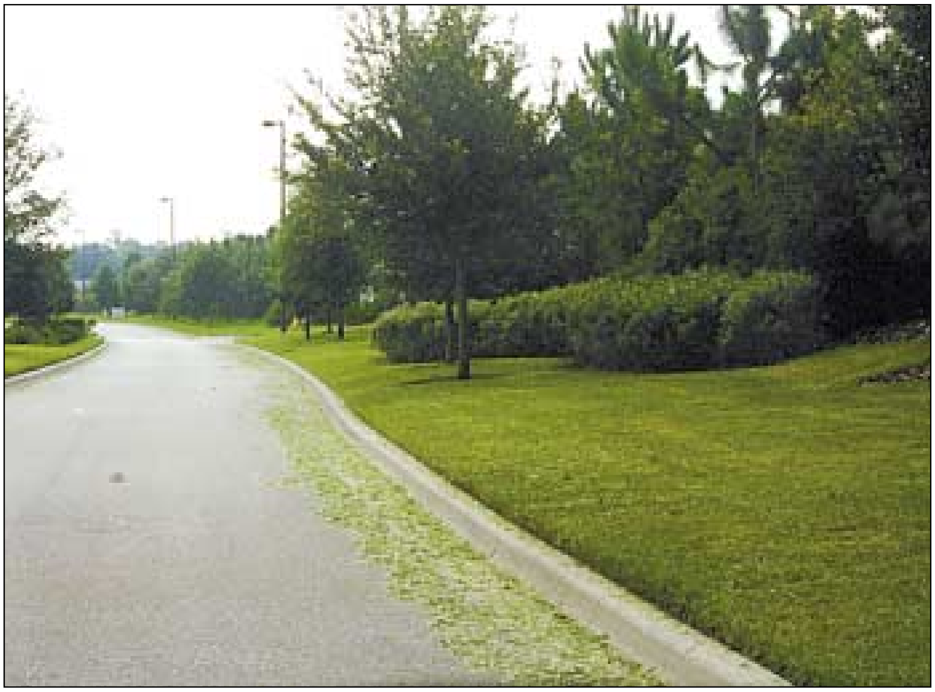

Figure 15. This is BAD! Never direct clippings into the street where they can enter the storm drain system.

- Check your mower every time it is used. Follow the manufacturer's recommendations for service and adjustments.
- 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.
- Never fill a hot mower with gasoline.
- Always wear heavy leather shoes when mowing the lawn.
- Wash the mower after use to reduce rusting and weed seed movement.
- Use the highest acceptable mowing height for the grasses being grown.
- Do not remove more than one-third of the foliage at one time.
- Practice grass recycling and return nutrients to the soil.
- Compost if you must collect clippings. Use the compost as a soil modifier or mulch.
- 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.
- Avoid mechanical damage to trees and shrubs from string trimmers, mowers, and other equipment.

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. Even with proper pruning cuts, if the wrong branches, or too many branches, are removed 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

Pruning Shade Trees in the Landscape, at http://hort.ifas.ufl.edu/woody/pruning/home%20page.htm

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/mangrove.htm.

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.

Sometimes landscape waste materials are disposed of in accessible locations on someone else's property, either public or private. Illegal dumping has allowed several non-native 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.

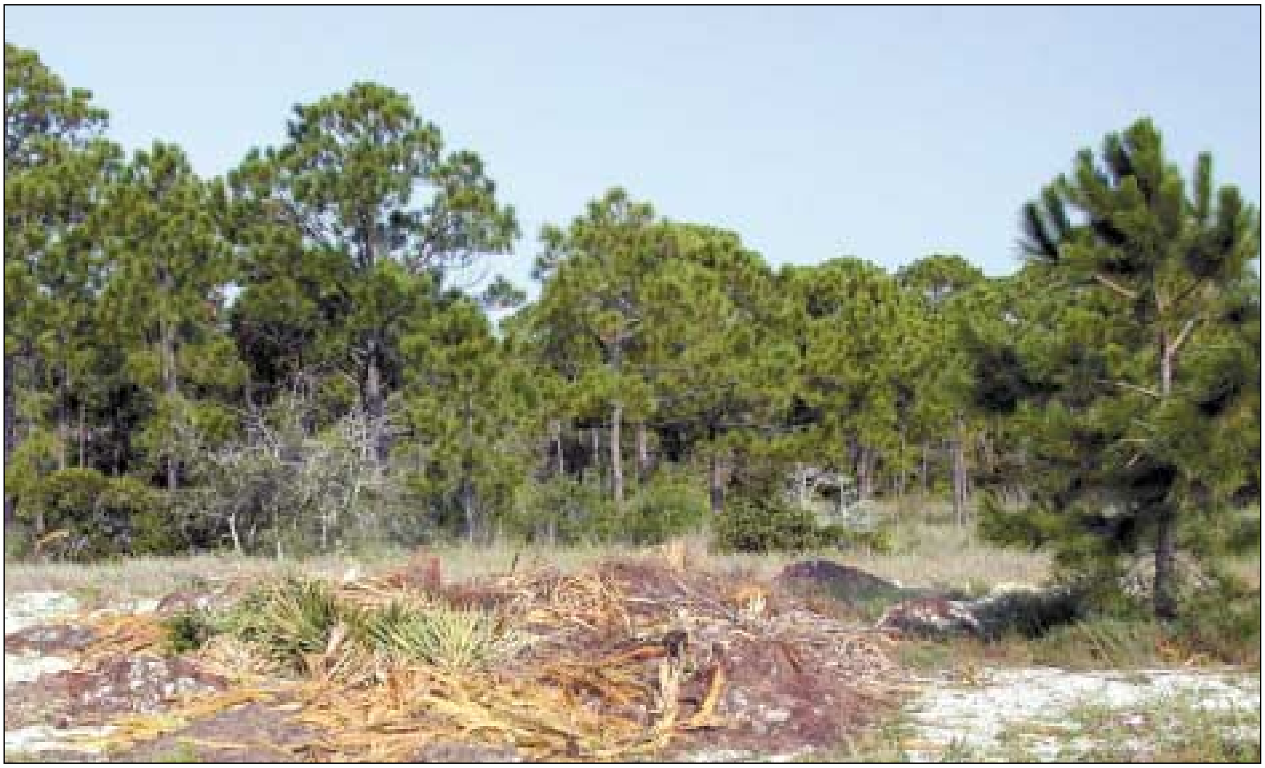

Figure 16. Illegal dumping of plant material.

CHAPTER 5: FERTILIZATION

FERTILIZER TERMS

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

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

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 noncontrolled release N as Nitrate-N, Ammoniacal-N, and/or Water Soluble N is referred to as a soluble N fertilizer that has a high potential for leaching and should not be applied at rates greater than 0.5 lbs. N/1000 square feet.

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

For additional information, see IFAS Publication SL-3, *The Florida Fertilizer Label*, at http://edis.ifas.ufl.edu/SS170.

FERTILIZING LANDSCAPE PLANTS

WHY FERTILIZE?

Clearly, plants grow in the wild without any help from humans. However, 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 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, as well as the timing, method, and location of application. Slow-release fertilizers are often preferred, but similar or better results can be obtained using small amounts of soluble fertilizers applied frequently.

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.

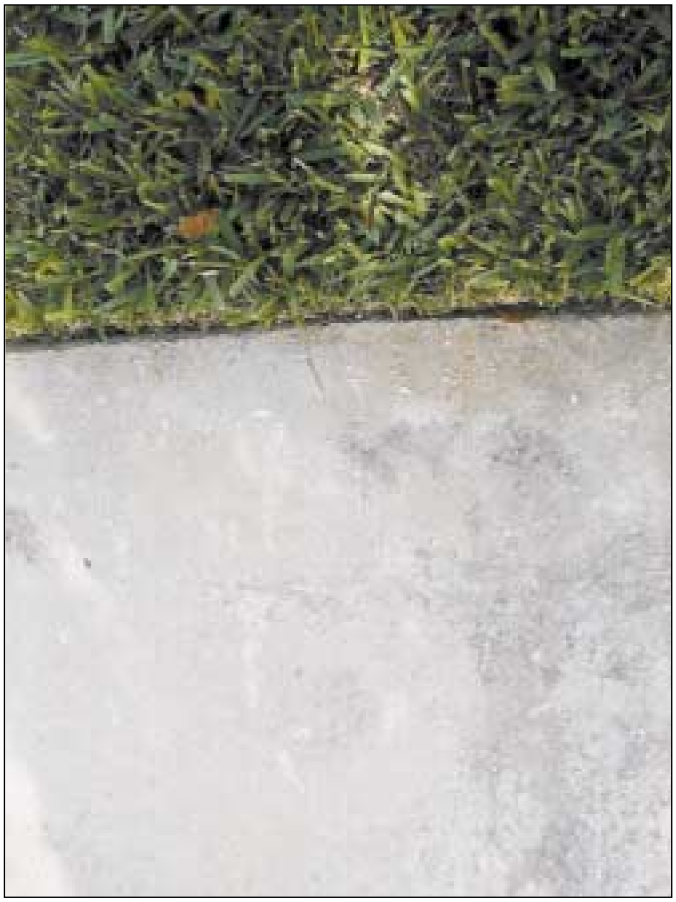

Figure 17. Fertilizers off target grow algae in lakes, not grass on lawns

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.

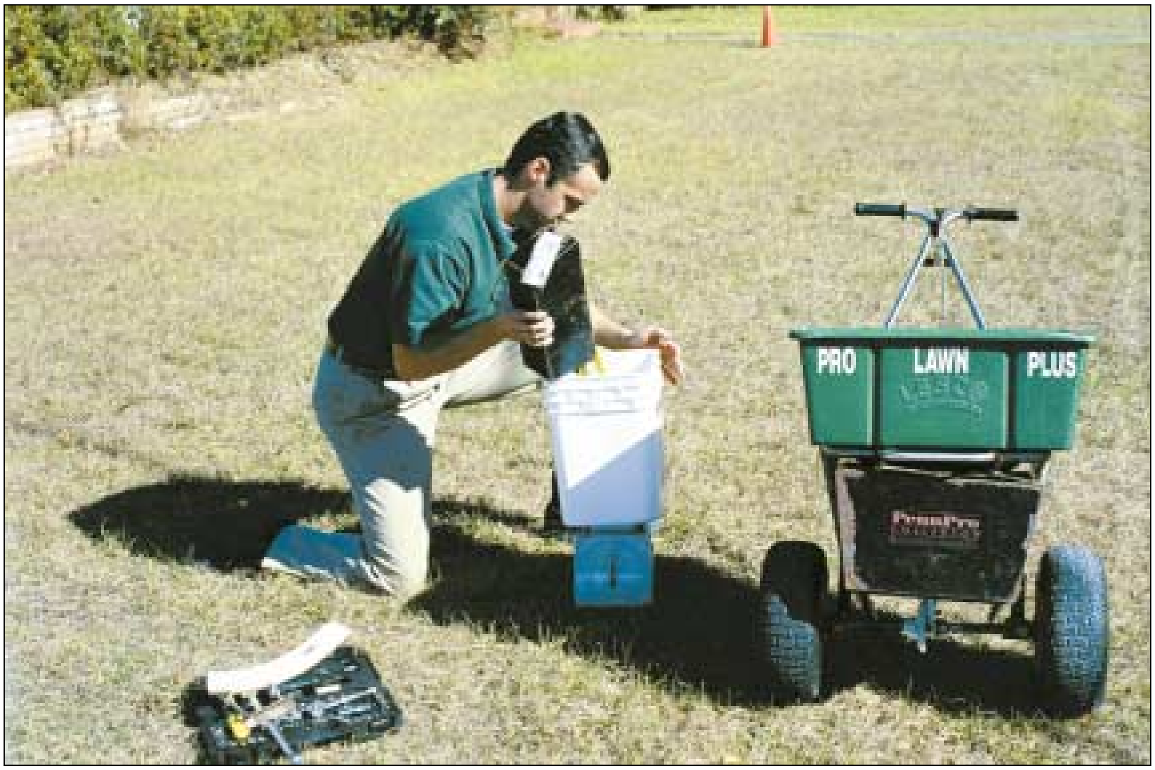

Figure 18. Weigh fertilizer to get accurate results.

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 5**.

The P content of the fertilizer should be 0 to 2 percent unless a soil 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.

Water-soluble fertilizers should be applied at a rate of no more than 0.5 pounds N/1000 ft^2 per application. The application rates for controlled-release fertilizers depend on the release rates of the product.

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

Table 5. Nitrogen fertilization rates

Level of Maintenance	**Amount of Nitrogen Fertilizer**
Basic	0-2 pounds N/1000 ft^2/year
Moderate	2-4 pounds N/1000 ft^2/year
High	4-6 pounds N/1000 ft^2/year

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 8:1:12:4 ratio. The 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 IFAS Publication SSORH02, *Palm Nutrition Guide*, at http://edis.ifas.ufl.edu/EP052.

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. 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.

For more information, see the following:

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

IFAS Publication SL-60, *Plant Nutrients and Fertilizers for the Non-Farmer*, at http://edis.ifas.ufl.edu/MG090

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.

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, it is logical to modify the source and rate for dormant turf. Losses of nitrogen through leaching can be minimized by making frequent, low-rate applications of soluble fertilizers, using controlled-release nitrogen sources, 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.

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 air. If urea is applied to the turfgrass surface and not incorporated through proper watering, significant quantities of N can be lost through volatilization.

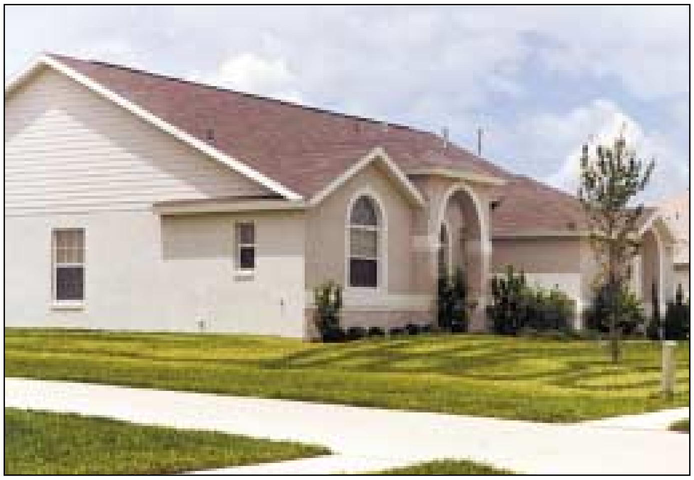

Figure 19. Streaking on a lawn caused by poor application techniques.

Therefore, it is imperative that the proper quantity of water be applied following the application of urea fertilizer, if rainfall is not anticipated in 8 to 12 hours.

If urea is applied and followed by rainfall of an inch or greater in 8 to 12 hours after application, urea-N may be lost through leaching because urea is highly soluble (more than 1000 g/100ml) and moves through the soil rapidly. Once the urea has been exposed to soil or turfgrass for a short time, however, 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 nearly as influential on N movement.

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 granular fertilizers once they have reacted with the soil components. **Solution fertilizers are often used in lawn fertigation programs in which small amounts of nutrients are frequently applied. When used in this manner, solution fertilizer programs may actually result in fewer environmental impacts due to fewer losses from runoff or leaching.**

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 resin-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.

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 most effective materials in the cool season.

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.**

Resin- and/or polymer-coated urea products release N through a diffusion process. Since diffusion is affected by temperature, these products tend to release N at a slower rate during the cool season. They have been shown to be very effective and long lasting during the high-rainfall warm season.

In conclusion, slow-release N sources leach less than soluble N sources under the same conditions. A mixture of soluble and slow-release N sources is recommended, especially in environmentally sensitive areas.

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 soluble N per 1,000 square feet be applied in a normal application.

For a detailed fertilization guide for Florida turfgrasses, see IFAS Publication SL-21, *General Recommendations 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 nongrowing turfgrass. During dormancy, turfgrasses take up very small quantities of nutrients, and applied nutrients are more likely to leach. Slow-release sources also influence the timing of fertilization, in that fertilization is required less frequently. **Do not apply fertilizer when heavy rains are imminent.**

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 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 will be in the forthcoming Golf Course BMP manual by the Florida Golf Course Superintendents Association.

Seashore paspalum produces a high quality turfgrass with minimal fertility requirements. This is a relatively new grass in Florida. For up-to-date information, contact your cooperative extension service or go to http://turf.ufl.edu/residential/seashorepaspalum.htm.

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 amount based on soil test recommendations. 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. Responses to P fertilization are most typically observed during establishment, in rooting enhancement and seedhead production, and where soils have a P deficiency. More direct effects of P fertilization have been observed on cool-season, overseeded grasses. This occurs mainly due to positional availability and the effects of temperature on P diffusion. Some Florida soils are high in native P, and turfgrasses grown on these soils require only limited P fertilization.

The off-site transport of P is 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 as N management.

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

- P fertilization should be based on reliable soil test recommendations. Many Florida soils are high in extractable P and may never require P fertilization for optimum turfgrass growth.
- Since unvegetated 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 maintain your turfgrass optimally.

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 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 should be considered when fertilizing grass for establishment or recovery:

- N rates should be adjusted to meet the needs of the turf.
- Weakened turf can be stimulated back to health by N fertilization.
- Newly established turf often requires a different fertility schedule to grow and develop a dense stand. Both rates and timing may be different.
- 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 can be used to supplement lower rates of soluble fertilizer. Micronutrients provide an initial color response, while soluble N thickens the turf and improves root development.
- Slow-release fertilizer may be an advantage when nutrients cannot be applied 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 generally more important than the type of product.
- New sod typically does not require fertilizer until it has firmly rooted into soil. This usually occurs in about one month. Plugs can be fertilized at the time of installation to encourage the runners to spread. A quick, complete ground cover is the ultimate goal.

UNTREATED BUFFER ZONES NEAR BODIES OF WATER

Except when adjacent to a protective seawall, always leave a "**Ring of Responsibility**" around or along the shoreways of canals, lakes, or waterways. This avoids fertilizing too close to a body of water. **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, such as a sidewalk, brick border, driveway, or street.**

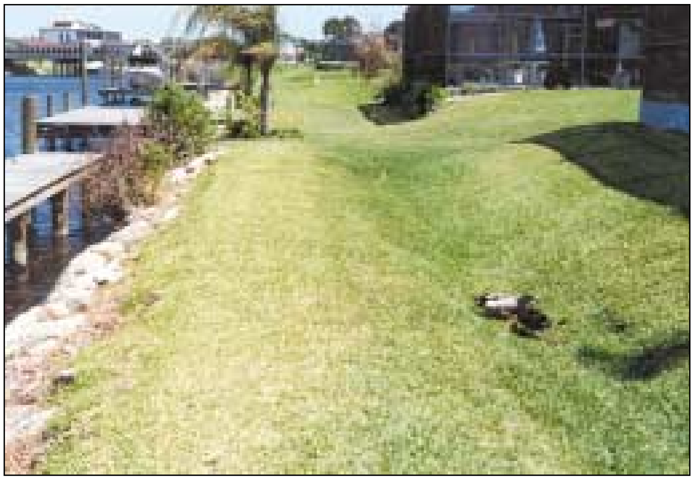

Figure 20. Leave a "Ring of Responsibility" as shown by the lighter green area, to prevent pollution.

This untreated buffer zone protects the water quality of the waterway. 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 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 applying fertilizer without a deflector shield, the Ring of Responsibility should extend at least 10 feet from the edge of the water.

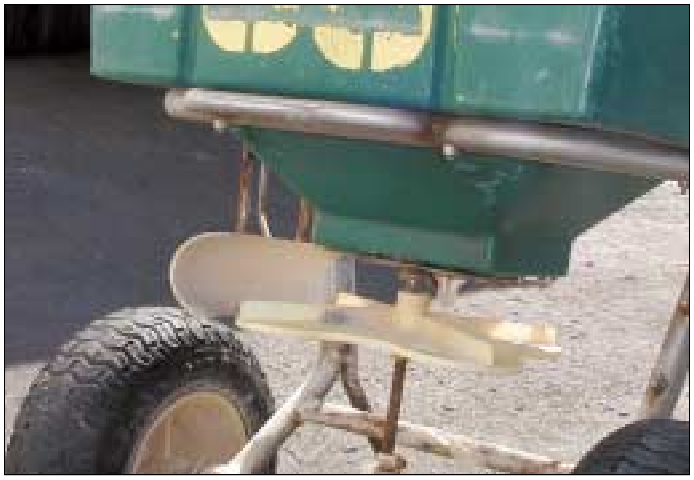

Figure 21. Spreader with deflector shield installed.

FERTIGATION

Fertigation is the application of liquid fertilizer through irrigation systems. While fertigation is not widely practiced in commercial lawn and landscape care, a number of 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.

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. 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 larger than 550 gallons is addressed in Florida Department of Environmental Protection Rule 62-761, 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. Avoid contamination. 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.

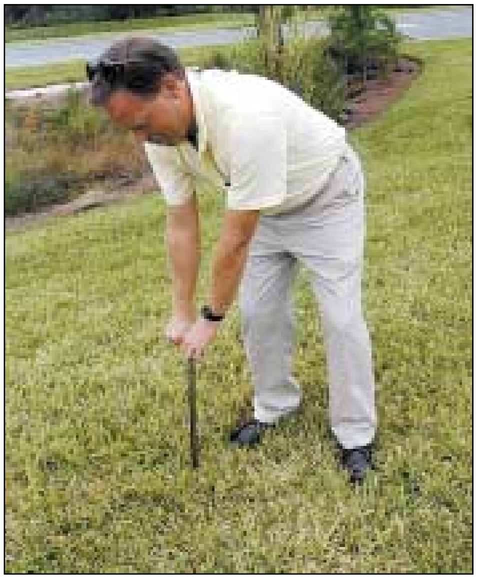

Figure 22. Taking a soil sample.

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 amounts of nutrients extracted are only an index relative to crop response. They are 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. 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. These areas 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.

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 Service 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 your results may not be directly comparable.

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).

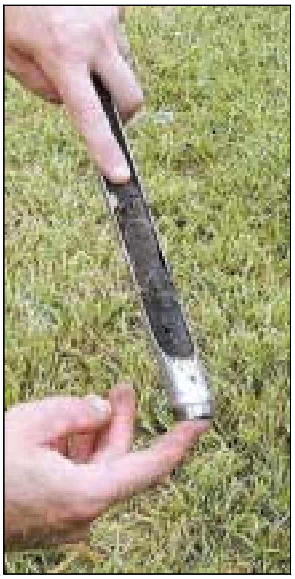

Figure 23. Soil Core

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 6 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.

Table 6. 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.

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 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 analysis 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 7** 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.

Table 7. 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

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 8** are applicable to most of Florida's turfgrass species. All of these values are on a dry weight basis.

Table 8. 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

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.

FERTILIZATION 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 think that less fertilization is always best, but research shows that fewer nutrients are lost from the surface and 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, and a lack of irrigation **may result in fertilization inefficiency. Don't fertilize during a heavy rainfall.**

Some of the most important BMPs for turfgrass fertilization are as follows:

- The maintenance of healthy, actively growing turfgrass minimizes the environmental impact of fertilizer and pesticide application.
- It is important to become proficient in reading and understanding the fertilizer label.
- It is also important to become knowledgeable in soil sampling procedures and soil test interpretation.
- The 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.
- When fertilizing (other than when watering restrictions apply), you should 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.
- In most cases, greater attention to P fertilization should be directed to the establishment phase of the turfgrass than the routine maintenance phase.
- P application should be limited to soils that require additional P based on soil testing.
- In most cases, Fe and/or Mn can be used to enhance turfgrass color on soils having a pH greater than 7.0.

CHAPTER 6: PEST CONTROL

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" 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" herbicide/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" herbicide/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" herbicide/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" herbicide/fertilizer mixtures to lawns.
- Information on how to obtain these licenses can be obtained from FDACS Bureau of Entomology and Pest Control at (850) 921-4177 or at http://doacs.state.fl.us/~aes-ent/pestcntrl/pcpage1.html.
- 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://doacs.state.fl.us/~aes/compli.htm.

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; 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 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

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 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. 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 enable control practices to be targeted 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. In certain situations, preventative measures may be necessary where experience has determined that less pesticide is needed when 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.

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!**

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. The following guidelines are important in selecting pesticides:

- 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 nontargeted 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.

GENERAL PESTICIDE BMPS

The following BMPs should generally be used for pesticides:

- **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.
- **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.
- **Handling–**Never eat, drink, or smoke when handling pesticides, and always wash with soap and water after use.

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.

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.

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 nonwater-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.

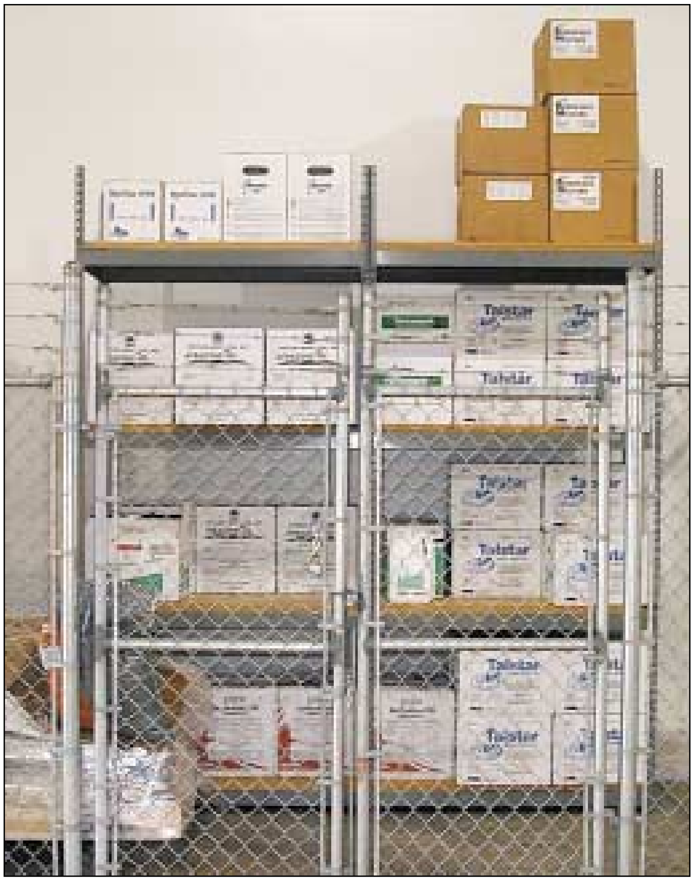

Figure 24. Pesticide storage areas should be locked.

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. Currently (2002), 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). For more information, contact the FDACS Bureau of Compliance Monitoring at (850) 488-3314 or go to http://doacs.state.fl.us/~aes/compli.htm. If this program is not available, a licensed waste disposal contractor should be contracted to perform the disposal.

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://doacs.state.fl.us/~aes/compli.htm for guidance.

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.
- 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 far 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 nontargeted 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.

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.

Figure 25. Calibrate spreaders frequently.

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 would otherwise be wasted because it was overapplied.

Several different calibration methods can be found in IFAS Circular SM38, *Spray Equipment and Calibration*. It is available from the IFAS bookstore pesticide training section at http://ifasbooks.ufl.edu/merchant2/merchant.mv.

The following BMPs should be used for loading and calibrating 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 the label specifies for their use.
- 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 nontargeted 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 nontargeted 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 9 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.

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.

Table 9. Reportable quantities for certain pesticides.

(For a complete list call (850) 413-9921
or go to http://www.floridadisaster.org/cps/SERC/htc1.htm)
Reportable quantities are given in pounds of active ingredient.

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
Hydramethlynon	Maxforce	67485-29-4	N/A	N/A
Lindane	Lintox	58-89-9	1	1
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

- 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 IFAS Publication ENH-93, *Weed Management in Ornamentals*, at http://edis.ifas.ufl.edu/wg057

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.

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

- IFAS Circular 1149, *Integrated Pest Management Strategies*, at http://edis.ifas.ufl.edu/LH080
- 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 on nematodes, see the following:

- IFAS Publication ENY013, *Nematode Management for Landscape Ornamentals*, at http://edis.ifas.ufl.edu/ng013
- IFAS Fact Sheet RF-LH053, *Nematodes: What They Are, How They Live, What They Do to Turf*, at http://edis.ifas.ufl.edu/LH053

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
- IFAS publication PDMG-VG-01 *Characteristics of Plant Disease*, at http://edis.ifas.ufl.edu/PG001

REFERENCES

Unless otherwise mentioned, references are available from the Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, FL 32611, or your county Cooperative Extension Service agent.

- Florida Lawn Handbook. 1998. K.C. Ruppert and R.J. Black. SP-45, Second Edition. http://ifasbooks.ufl.edu/

CULTURAL REFERENCES

PREPARATION

- *Basic Principles of Landscape Design*, D.L. Ingram, IFAS Circular 536. http://edis.ifas.ufl.edu/MG086

- *Preparing To Plant a Florida Lawn*, L.E. Trenholm, IFAS Publication ENH-02. http://edis.ifas.ufl.edu/LH012

- *Establishing Your Florida Lawn*, L.E. Trenholm, IFAS Publication ENH-03. http://edis.ifas.ufl.edu/LH013

- *Planting Specifications for Landscape Plants*, E.F. Gilman, IFAS Publication ENH 856. http://edis.ifas.ufl.edu/EP112

SELECTION

- *Atlas of Florida Vascular Plants*. R.P. Wunderlin and B.F. Hansen. 2000. (S.M. Landry and K.N. Campbell [application development], Florida Center for Community Design and Research). Tampa, Florida: Institute for Systematic Botany, University of South Florida. http://www.plantatlas.usf.edu/default.asp.

- *Guide to the Vascular Plants of Florida*. R.P. Wunderlin. 1998. Gainesville, Florida: University Press of Florida.

- *Selecting and Planting Trees and Shrubs*, D.L. Ingram, R.J. Black, and E.F. Gilman, IFAS Circular 858. http://edis.ifas.ufl.edu/MG077

- *Woody Ornamentals-Selecting Trees and Shrubs*, E.F. Gilman. http://hort.ifas.ufl.edu/woody/index.htm

- *Selecting a Turfgrass for Florida Lawns*, L.E. Trenholm, J.B. Unruh, and J.L. Cisar, IFAS Publication ENH-04. http://edis.ifas.ufl.edu/LH005

- *St. Augustinegrass for Florida Lawns*, L.E. Trenholm, J.L. Cisar, and J. B. Unruh, IFAS Publication ENH-5. http://edis.ifas.ufl.edu/LH010

- *Yearly Calendar for St. Augustinegrass Care and Culture*, L.E. Trenholm, J.B. Unruh, and J.L. Cisar, IFAS Publication ENH-73. http://edis.ifas.ufl.edu/LH021

- *Bahiagrass for Florida Lawns*, L.E. Trenholm, J.L. Cisar, and J.B. Unruh, IFAS Publication ENH-6. http://edis.ifas.ufl.edu/LH006

- *Centipedegrass for Florida Lawns*, L.E. Trenholm, J.L. Cisar, and J.B. Unruh, IFAS Publication ENH-8. http://edis.ifas.ufl.edu/LH009

- *Drought Tolerant Plants for North and Central Florida*, G.W. Knox, IFAS Circular 807. http://edis.ifas.ufl.edu/EP022

- *Landscape Plant Selector*, IFAS software publication at http://ifasbooks.ufl.edu

ENVIRONMENTAL STRESSES

- *Environmental Stresses and Your Florida Lawn*, L.E. Trenholm, IFAS Publication ENH-153. http://edis.ifas.ufl.edu/EP070

- *Growing Turfgrass in the Shade*, L.E. Trenholm, IFAS Publication ENH-151. http://edis.ifas.ufl.edu/EP072

- *Minimizing Traffic Damage to Your Florida Lawn*, L.E. Trenholm, IFAS Publication ENH-152. http://edis.ifas.ufl.edu/EP071

- *Low Temperature Damage to Turf*, L.E. Trenholm, IFAS Publication ENH-80. http://edis.ifas.ufl.edu/LH067

- *Improving Drought Tolerance in Your Florida Lawn*, L.E. Trenholm , IFAS Publication ENH-57. http://edis.ifas.ufl.edu/LH027

- *Managing Your Florida Lawn under Drought Conditions*, H.C. Jones, C.S. Lippi, and L.E. Trenholm, IFAS Publication ENH-157. http://edis.ifas.ufl.edu/EP078

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

FERTILITY

- *General Recommendations for Fertilization of Turfgrasses on Florida Soils*, J.B. Sartain, IFAS Publication SL-21. http://edis.ifas.ufl.edu/LH014

- *Soil Testing and Interpretation for Florida Turfgrasses*, J.B. Sartain, IFAS Publication SL-181. http://edis.ifas.ufl.edu/SS317

IRRIGATION REFERENCES

STANDARDS

- *ASAE Standards-2002*. Standards, engineering practices, and data developed and adopted by the American Society of Agricultural Engineers. 2002. American Society of Agricultural Engineers, 2950 Niles Rd., St. Joseph, MO 49085. Telephone (616) 429-0300. http://www.asae.org/standards/searchpur.html

- *Florida Building Code-Plumbing Volume, Appendix F*. Southern Building Code Congress International, Inc., 900 Montclair Road, Birmingham, AL 35213-1206. Telephone (205) 591-1853. http://www.sbcci.org/floridacodes.htm

- *Standards and Specifications for Turf and Landscape Irrigation Systems, Fourth Edition*. January 2002. Florida Irrigation Society, Goldenrod, Florida. http://www.fisstate.org/

- *National Engineering Handbook Series 210-VI*. November 1997. U.S. Department of Agriculture, Natural Resources Conservation Service, Washington D.C., 20013. http://www.ftw.nrcs.usda.gov/tech_ref.html

GUIDANCE

- *Water Requirements of Florida Turfgrasses*, B.J. Augustine, IFAS Bulletin 200, July 1983. http://edis.ifas.ufl.edu/EP024

- *Irrigation of Lawns and Gardens*, D.Z. Haman, G.A. Clark, and A.G. Smajstrla, IFAS Circular 825, May 1989. http://edis.ifas.ufl.edu/WI003

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

- *Field Evaluation of Microirrigation Water Application Uniformity*, A.G. Smajstrla, B.J. Boman, D.Z. Haman, D.J. Pitts, and F.S. Zazueta, IFAS Publication AE094, 1997. http://edis.ifas.ufl.edu/AE094

- *Efficiencies of Florida Agricultural Irrigation Systems*, A.G. Smajstrla, B.J. Boman, G.A. Clark, D.Z. Haman, D.S. Harrison, F.T. Izuno, D.J. Pitts, and F.S. Zazueta, 1991. http://edis.ifas.ufl.edu/AE110

- *Flushing Procedures for Microirrigation Systems*, A.G. Smajstrla and B.J. Boman, IFAS Bulletin 333. http://edis.ifas.ufl.edu/WI013

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

- *Annual Maintenance and Evaluation of Overhead Irrigation Systems*, G.W. Knox, IFAS Publication ENH 142, March 2000. http://edis.ifas.ufl.edu/WO007

- *Design of Agricultural Irrigation Systems in Florida*, A.G. Smajstrla, IFAS Bulletin 294, March 1994. http://edis.ifas.ufl.edu/AE064

- *Lawn Sprinkler Selection and Layout for Uniform Water Application*, A.G. Smajstrla, G.A. Clark, and F.S. Zazueta, IFAS Bulletin 230, 1997. http://edis.ifas.ufl.edu/AE084

- *Basic Irrigation Scheduling in Florida*, A.G. Smajstrla, B.J. Boman, G.A. Clark, D.Z. Haman, F.T. Izuno, and F.S. Zazueta, IFAS Bulletin 249, 1988. http://edis.ifas.ufl.edu/AE111

- *Potential Impacts of Improper Irrigation System Design*, A.G. Smajstrla, F.S. Zazueta, and D.Z. Haman, IFAS Publication SS-AGE-807, November 1988. http://edis.ifas.ufl.edu/AE027

- *How To Calibrate Your Sprinkler System*, L.E. Trenholm, J.B. Unruh, and J.L. Cisar, IFAS Publication ENH 61, January 2001. http://edis.ifas.ufl.edu/LH026

- *Watering Your Florida Lawn*, L.E. Trenholm, J.B. Unruh, and J.L. Cisar, IFAS Publication ENH 9, February 2001. http://edis.ifas.ufl.edu/LH025

- *Florida Irrigation Guide*. Gainesville, Florida: U.S. Department of Agriculture, Natural Resources and Conservation Service, 1982. http://www.fl.nrcs.usda.gov/

- *Turf Irrigation for the Home*, F.S. Zazueta, A. Brockway, L. Landrum, and B. McCarty, IFAS Circular 829, April 1995. http://edis.ifas.ufl.edu/AE144

- *Turf Irrigation with a Hose and Sprinkler*, F.S. Zazueta and G. Miller, IFAS Fact Sheet AE265, March 2000. http://edis.ifas.ufl.edu/WI015

- *Irrigation System Controllers*, F.S. Zazueta, A.G. Smajstrla, and G.A. Clark, IFAS Publication AGE-32, Bulletin 294, July 1994. http://edis.ifas.ufl.edu/AE077

- *Soil Moisture Sensors*, F.S. Zazueta and X. Jiannong, IFAS Bulletin 292, April 1994. http://edis.ifas.ufl.edu/EH226

Mulching, Mowing, and Pruning References

- *Mulches for the Landscape*, R.J. Black, E.F. Gilman, G.W. Knox, and K.C. Ruppert, IFAS Publication ENH 103. http://edis.ifas.ufl.edu/MG251

- *Mowing Your Florida Lawn*, L.E. Trenholm, J.B. Unruh, and J.L. Cisar, IFAS Fact Sheet ENH10, January 2001. http://edis.ifas.ufl.edu/LH028

- *Pruning Landscape Trees and Shrubs*, E.F. Gilman and R.J. Black, IFAS Circular 853. http://edis.ifas.ufl.edu/MG087

- *Pruning Shade Trees in the Landscape* at http://hort.ifas.ufl.edu/woody/pruning/home%20page.htm

- *Mangrove Trimming Guidelines for Homeowners*. Tallahassee, Florida: Florida Department of Environmental Protection.

FERTILIZATION REFERENCES

- *Fertilization and Irrigation Needs for Florida Lawns and Landscapes*, L.E. Trenholm, E.F. Gilman, G.W. Knox, and R.J. Black, IFAS Publication ENH 860 2002. http://edis.ifas.ufl.edu/EP110

- *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

- *General Recommendations for Fertilization of Turfgrasses on Florida Soils*, J.B. Sartain, IFAS Publication SL-21, 2000. http://edis.ifas.ufl.edu/LH014

- *Palm Nutrition Guide*, T.K. Broschat, IFAS Publication SSORH02. http://edis.ifas.ufl.edu/EP052

- *Plant Nutrients and Fertilizers for the Non-Farmer*, G. Kidder, IFAS Publication SL-60, 2001. http://edis.ifas.ufl.edu/MG090

- *Selected Fertilizers Used in Turfgrass Fertilization*, J. Sartain, IFAS Circular CIR-1262, 2001. http://edis.ifas.ufl.edu/SS318

- *Soil Testing and Interpretation for Florida Turfgrasses*, J.B. Sartain, IFAS Publication SL-181, 2001. http://edis.ifas.ufl.edu/SS317

- *Standardized Fertilization Recommendations for Environmental Horticulture Crops*, G. Kidder, E.A. Hanlon, T.H. Yeager, and G.L. Miller, IFAS Publication SL141, 1998. http://edis.ifas.ufl.edu/CN011

- *The Florida Fertilizer Label*, J.B. Sartain and W.R. Cox, 1998. http://edis.ifas.ufl.edu/SS170

PESTICIDE REFERENCES

- Many documents are available on the Florida Department of Environmental Protection's Nonpoint Source Management Publications web page at http://www.dep.state.fl.us/water/nonpoint/pubs.htm.

- *Best Management Practices for Agrichemical Handling and Farm Equipment Maintenance*, Florida Department of Agriculture and Consumer Services and Florida Department of Environmental Protection, 1998. http://www.dep.state.fl.us/water/nonpoint/docs/nonpoint/agbmp3p.pdf

- *Agrichemical Handling Facility, Code 702*. 1997. U.S. Department of Agriculture, Natural Resources Conservation Service, P. O. Box 141510, Gainesville, FL 32605. Telephone (352) 338-9555. http://www.fl.nrcs.usda.gov/flstandards/fl702.pdf

- *Broadcast Boom Sprayer Calibration*, T.W. Dean, IFAS Pesticide Information Sheet PI-24. http://edis.ifas.ufl.edu/PI016

- *Broadcast Boom Sprayer Nozzle Uniformity Check*, T.W. Dean, IFAS Pesticide Information Sheet PI-23. http://edis.ifas.ufl.edu/PI015

- *Characteristics of Plant Disease*, T. Kucharek, IFAS Publication PDMG-VG-01, 1997. http://edis.ifas.ufl.edu/PG001

- *Designing Facilities for Pesticide and Fertilizer Containment*. MWPS-37. Revised 1995. Midwest Plan Service, 122 Davidson Hall, Iowa State University, Ames, IA 50011-3080. Telephone (515) 294-4337. http://www.mwpshq.org/

- *Diseases of Landscape Woody Ornamentals*, G. W. Simone, PP/PPP 57, http://edis.ifas.ufl.edu/PP108

- *Key for Identification of Landscape Turfgrass Diseases*, M.L. Elliott and G.W. Simone. http://edis.ifas.ufl.edu/LH064

- *Insect Management on Landscape Plants*, E.A. Buss and D.E. Short, IFAS Publication ENY-338. http://edis.ifas.ufl.edu//pdffiles/IG/IG01300.pdf

- *Insect Pest Management on Turfgrass*, E.A. Buss. http://edis.ifas.ufl.edu/IG001

- *Integrated Pest Management Strategies*, L.B. McCarty, IFAS Circular 1149, 1995. http://edis.ifas.ufl.edu/LH080

- *Nematode Management for Landscape Ornamentals*. W.T. Crow and R.A. Dunn. http://edis.ifas.ufl.edu/NG013

- *Nematodes: What They Are, How They Live, What They Do to Turf*, R.A. Dunn, IFAS Fact Sheet RF-LH053. http://edis.ifas.ufl.edu/LH053

- *Pesticide Container Rinsing*, T.W. Dean and O.N. Nesheim. http://edis.ifas.ufl.edu/PI003

- *Turfgrass Disease Management*, M.L. Elliott and G.W. Simone. http://edis.ifas.ufl.edu/LH040

- *Weed Management in Ornamentals*, J.G. Norcini, IFAS Publication ENH 93. http://edis.ifas.ufl.edu/WG057

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, or 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).

HELP LINE TELEPHONE NUMBERS

(For chemical hazard information and regulatory questions)

CHEMTREC HOTLINE (Emergency only) 24 hours Toll-Free	1-800-424-9300
SARA Title III Help Line Toll-Free	1-800-535-0202
CERCLA/RCRA Help Line Toll-Free	1-800-424-9346

NONEMERGENCY 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 Department of Agriculture and Consumer Services

Bureau of Entomology and Pest Control	(850) 921-4177
Bureau of Pesticides	(850) 487-0532
Bureau of Compliance Monitoring	(850) 488-3314

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) 807-4300
Central (Orlando)	(407) 894-7555
Southeast (West Palm Beach)	(561) 681-6800
Southwest (Tampa)	(813) 744-6100
South (Ft. Myers)	(239) 332-6975

Water Management Districts

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

Florida Marine Patrol, district offices:

Jacksonville	(904) 448-4320
Orlando	(407) 893-3337
Ft. Lauderdale	(954) 467-5966
Ft. Myers	(239) 332-6975
Tampa	(813) 744-6462
Panama City	(850) 872-7650
Pensacola	(850) 595-8300

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) 966-6299
Brevard	Cocoa	(321) 633-1702
Broward	Davie	(954) 370-3725
Calhoun	Blountstown	(850) 674-8323
Charlotte	Punta Gorda	(941) 639-6255
Citrus	Inverness	(352) 726-2141
Clay	Green Cove Springs	(904) 284-6355
Collier	Naples	(239) 353-4244
Columbia	Lake City	(386) 758-1030
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) 653-9337
Gadsden	Quincy	(850) 627-6317
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) 675-5261
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) 997-2986
Lafayette	Mayo	(386) 294-1279
Lake	Tavares	(352) 343-4101
Lee	Ft. Myers	(239) 338-3247
Leon	Tallahassee	(850) 487-3004
Levy	Bronson	(352) 486-2165
Liberty	Bristol	(850) 643-2229
Madison	Madison	(850) 973-4138
Manatee	Palmetto	(941) 722-4524
Marion	Ocala	(352) 620-3440
Martin	Stuart	(772) 288-5654
Monroe	Key West	(305) 292-4501
Nassau	Callahan	(904) 879-1019
Okaloosa	Crestview	(850) 689-5850
Okeechobee	Okeechobee	(863) 763-6469
Orange	Orlando	(407) 836-7570
Osceola	Kissimmee	(407) 846-4181
Palm Beach	West Palm Beach	(561) 233-1712
Pasco	Dade City	(352) 521-4288
Pinellas	Largo	(727) 582-2100
Polk	Bartow	(863) 533-0765
Putnam	East Palatka	(386) 329-0318
Santa Rosa	Milton	(850) 623-3868
Sarasota	Sarasota	(941) 793-2728
Seminole	Sanford	(407) 323-2500
St. Johns	St. Augustine	(904) 824-4564
St. Lucie	Fort Pierce	(772) 462-1660
Sumter	Bushnell	(352) 793-2728
Suwannee	Live Oak	(386) 362-2771
Taylor	Perry	(850) 584-4345
Union	Lake Butler	(386) 496-2321
Volusia	DeLand	(386) 822-5778
Wakulla	Crawfordville	(850) 926-3931
Walton	DeFuniak Springs	(850) 892-8172
Washington	Chipley	(850) 638-6180

APPENDIX C: SUMMARY OF GREEN INDUSTRY BMPS

GENERAL

- Reduce 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.

EDUCATIONAL

- Inform employees of pertinent information on their job duties, especially job safety and DOT/OSHA regulations.
- Train employees about BMPs and job safety.
- Retrain employees annually and when changes are made.
- Train employees to document and retain records of activities.

LANDSCAPE INSTALLATION

- Design the landscape before installing the irrigation system.
- Conduct a site evaluation.
- Select plants with attributes that match the characteristics of the planting site. Ask what type of lawn is desired or expected, what level of maintenance can be provided, and what are the environmental conditions at the planting site.
- Select and position plants for specific functions.
- Select plants that will not outgrow their allotted space.
- Prepare the soil properly before planting grass to ensure establishment.
- Till the soil deeply if it is compacted. Tillage of sand is unnecessary.

Planting Trees and Shrubs

Before digging the hole:

- Inspect the root ball and remove all soil from above the topmost root.
- 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).
- Apply mulch.

Lawns

Practices that reduce environmental stresses include the following:

- Moderating nitrogen fertility.
- Mowing at proper heights.
- Irrigating when the grass needs water.
- In shaded situations, doing as follows:
- Increase the mowing height;
- Reduce fertilizer applications;
- Reduce water use substantially;
- Avoid the effects of foot traffic;
- Monitor for weed pressure;
- Monitor for disease pressure;
- Consider other ground covers.

IRRIGATION

Need for Irrigation

The following visual indicators are guidelines to determine the need for irrigation:

- Grass has a dull bluish-gray coloring.
- Foot tracks remain in the grass.
- Leaf blades are folded in half on at least a 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.

Irrigation System Design

- The application rate must not exceed the ability of the soil to absorb and retain the water applied during any one application.

- The design operating pressure must not be greater than the available source pressure.
- The design operating pressure must account for peak use times and supply line pressures at final buildout for the entire system.
- Distribution devices and pipes should be designed for optimum uniform coverage. The first and last distribution device should have no more than a 10 percent difference in flow rate. This usually corresponds to about a 20 percent difference in pressure.
- Flexibility must exist to meet a site's peak water requirements and allow for the modification of the system's operation to meet seasonal irrigation changes or local restrictions.
- Distribution equipment (such as sprinklers, rotors, and microirrigation devices) in a given zone must have the same precipitation rate.
- Turf and landscape areas should be zoned separately based on plant water requirements.
- The design package should include a general irrigation schedule with recommendations and instructions on modifying the schedule for local climatic and growing conditions.
- If required by the plant species, the design should account for the need to leach out salt buildup from poor-quality water. Otherwise, use species that are tolerant of these conditions.
- Water supply systems (such as wells and pipelines) should be designed for varying control devices, rain shut-off devices, and backflow prevention.
- Water conveyance systems should be designed with thrust blocks and air release valves, such that flow velocity is 5 feet per second or less.
- Pipelines should be designed to provide the system with the appropriate pressure required for maximum irrigation uniformity.
- Pressure regulating or compensating equipment must be used where the system pressure exceeds the manufacturer's recommendations.
- Equipment with check valves must be used in low areas to prevent low head drainage.
- Nonplanted areas, including impervious surfaces and underneath roof overhangs, should not be irrigated.

IRRIGATION SYSTEM INSTALLATION

- Only qualified specialists should install the irrigation system.
- The construction must be consistent with the design.
- The designer must approve any design changes before construction.
- Construction and materials should meet existing standards and criteria.
- Acceptable safety practices must be followed during construction.
- All underground cables, pipes, and other obstacles should be identified and their locations flagged.
- Obtain all permits before construction.
- Always give the owner a copy of the as-built plans, operating manuals, warranties, and written instructions on how to change the irrigation system's timers/clocks/controllers.
- At the end of construction, the site must be cleaned of all construction materials.

IRRIGATION MANAGEMENT

- 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.
- Irrigation quantities should not be larger than the available moisture storage in the root zone.
- Never overirrigate.
- Use soil moisture sensing devices, rain gauges, and the visual observation of irrigation runoff or puddles to prevent overirrigation.
- When possible the irrigation schedule should coincide with other cultural practices (such as the use of fertilizer, herbicides, or other chemical applications).
- When fertilizing (other than when watering restrictions apply), irrigate with 1/4 inch following fertilization to avoid the loss of nitrogen and increase uptake efficiency. If water restrictions 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.
- Proper cultural practices (such as mowing) should be employed to promote healthy, deep root development and reduce irrigation requirements.

- 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.
- Abide by all permit conditions and current water restrictions when operating the irrigation system.
- If necessary, obtain any desired regulation variances before irrigating.

IRRIGATION SYSTEM MAINTENANCE

- Perform visual weekly inspections to identify leaks, broken sprinkler heads, and other system malfunctions.
- Replace or repair all broken and worn components before the next scheduled irrigation.
- Replacement parts should have the same characteristics as the original components.
- Application/distribution efficiencies should be checked annually. Implement a preventive maintenance program to replace worn components before they cause fertilizer/chemical and water waste.

MULCHING

- Apply mulch deeply enough (2 to 3 inches after settling) to suppress weeds.
- Use mulches made from recycled materials (sustainable sources).
- Do not pile mulch against a tree. Leave a clear space for air to reach the trunk.

MOWING

- Pick up all stones, sticks, and other debris before mowing to avoid damaging the mower or injuring someone with flying objects.
- Avoid mowing wet turf with a rotary mower because 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.
- Use the highest acceptable mowing height for the grasses being grown.
- Avoid removing more than a third of the foliage at one time.
- Mow in a different direction every time the lawn is cut.
- 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.
- Check your mower every time it is used. Follow the manufacturer's recommendations for service and adjustments.
- 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.
- Never fill a hot mower with gasoline.
- Always wear heavy leather shoes when mowing the lawn.
- Wash the mower after use to reduce rusting and weed seed movement.
- Practice grass recycling, and return nutrients to the soil.
- Compost if you must collect clippings. Use the compost as a soil modifier or mulch.
- Do not direct clippings into bodies of water or onto impervious surfaces. Sweep or blow back onto the lawn any clippings that are blown onto sidewalks and driveways.
- When using mowers, string trimmers, edgers, and other equipment, avoid mechanical damage to trees and shrubs.

PLANT DISPOSAL

- Never sweep or blow debris into a storm drain.
- Be careful with yard waste! Careless disposal may spread invasive non-native plants.
- To minimize the chance of accidental propagation, plants can be pruned before 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 onsite and retained for use as mulch. This avoids transportation and disposal costs and reduces the need for purchased materials.

FERTILIZATION

- Water-soluble fertilizers should be applied at no more than 0.5 pound N/1000 ft^2 per application. The application rates of controlled-release fertilizers depend on the release rates of the product.

- Remember that **the application of "weed and feed" herbicide/fertilizer mixtures to lawns for hire requires a pest control business license and a certified operators certificate** from the Florida Department of Agriculture and Consumer Services.
- There is no significant difference between liquid or dry applications of fertilizer. Turfgrasses take up nitrogen in the form of nitrate and ammonium, and all dry fertilizers have to be dissolved by water before they benefit the turf. To protect the environment, the proper application of fertilizer is more important than the type of product.
- Solution fertilizers do not leach more readily than granular fertilizers once they have reacted with the soil components. Solution fertilizers are often used in lawn fertigation programs in which small amounts of nutrients are frequently applied. When used in this manner, solution fertilizer programs may actually reduce environmental impacts because fewer losses occur from runoff or leaching.
- It is imperative that the proper quantity of water be applied following the application of soluble fertilizer, if rainfall is not anticipated in 8 to 12 hours.
- A mixture of soluble and slow-release nitrogen sources is recommended, especially in environmentally sensitive areas.
- You should not apply fertilizer when heavy rains are imminent.
- The surface application of ammonium-N and/or urea-containing fertilizers to high-pH soils without watering in (with 1/4 inch of irrigation) is not recommended.
- 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.
- If landscape plants exhibit nutrient deficiency symptoms, they may not be suited to that site. Consider replacing such plants with others adapted to the site's conditions.
- If you suspect deficiencies in a palm tree, take a leaf to the Cooperative Extension Service for assistance. Palms have different nutritional requirements than most other landscape plants. In general, fertilizers or supplements should be applied to supply nitrogen-phosphorus-potassium-magnesium (N-P-K-Mg) at about an 8:1:12:4 ratio.
- Fertilization may NOT be required:
  - 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.
- Before fertilizing, soil and/or foliar nutrient analysis should be used to determine whether any need exists for phosphorus fertilizer.
- Prior to fertilizing, pests may 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 the fertilizer.
- The amount of fertilizer applied should be the minimal amount needed to achieve the defined objective.
- Phosphorus fertilization should be based on reliable soil test recommendations. Many Florida soils are high in extractable phosphorus and may never require phosphorus fertilization for optimum turfgrass growth.
- Unvegetated or thin, low-quality turfgrass areas are more likely to produce runoff and off-site contamination than healthy, well-maintained turfgrass areas; therefore, maintain turfgrass optimally.
- Adequate potassium levels can usually be maintained at a 3:1 or 2:1 ratio. Ideally, turfgrass potassium fertilization should be based on soil test recommendations.
- Read and follow all label instructions and safety precautions.

Establishment and Recovery

Establishment and recovery are special situations:

- Newly established turf often requires different rates and timing of fertilization to grow and develop a dense stand.

- Underfertilized turf may be stimulated back to health by nitrogen fertilization.
- 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.
- Use iron and manganese to supplement lower rates of soluble fertilizer. Micronutrients provide an initial color response, while soluble nitrogen thickens turf density and improves root development.
- Slow-release fertilizer may be an advantage when nutrients cannot be applied as frequently.
- New sod typically does not require fertilizer until it has firmly rooted into soil. This usually takes about one month. Plugs can be fertilized at the time of installation to encourage spreading of the runners. A quick, complete ground cover is the ultimate goal.

SHORELINE FRONTAGE

- Make sure that fertilizers and other lawn chemicals do not come into direct contact with the water or with any structure bordering the water such as a sidewalk, brick border, driveway, or street.
- Leave a "Ring of Responsibility" around or along canal, lake, or waterway shorelines by not fertilizing close to the body of water.
- When applying liquid fertilizers or granular fertilizers with a fertilizer spreader that features a deflector shield, the Ring of Responsibility should be at least 3 feet from the edge of the water.
- Without a deflector shield, the Ring of Responsibility should extend at least 10 feet from the edge of the water.

FERTILIZER STORAGE AND HANDLING

- Always store nitrate-based fertilizers separately from solvents, fuels, and pesticides, since nitrate fertilizers are oxidants and can accelerate a fire.
- Prevent contamination of nearby ground water and surface water by storing fertilizer in an area that is protected from rainfall.
- Load fertilizer into application equipment away from wells or surface waterbodies.
- Clean up spilled fertilizer materials immediately.
- Wash water generated should be collected and applied to the target crop. Discharge of this wash water to waterbodies, wetlands, storm drains, or septic systems is illegal.

PESTICIDES

- 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. This includes the application of "weed and feed" herbicide/fertilizer mixtures to lawns. Failure to obtain a license for pesticide application can result in fines up to $5,000.
- Proper records of all pesticide applications should be kept
- USE integrated pest management (IPM).
- The basic steps for IPM programs are as follows:
  - Identify key pests on key plants.
  - Determine the pest's life cycle.
  - Use cultural, mechanical, or physical methods to prevent problems.
  - Decide which pest management practice is appropriate.
  - Determine if the "corrective actions" worked. Record and use this information when making similar decisions in the future.
- Read and follow all label directions. The label is a legal document.

PESTICIDE SELECTION

- The identification or recognition of 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.
- 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 nontargeted organisms, and save money.
- Spot treat pests whenever appropriate.
- Make note of any ground water advisories on the label.

GENERAL PESTICIDE USE

- **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 their labels intact.
- **Rate**–Use pesticides at the correct application rate and recommended intervals between applications to avoid injury to plants and animals.
- **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 the label directions so that the contamination of water 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.
- **Handling**–Never eat, drink, or smoke when handling pesticides, and always wash with soap and water after use.

PESTICIDE STORAGE

- The best way to minimize storage problems is to minimize the amount you store. Limit inventory, and purchase only the amounts needed.
- 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.
- Store personal protective equipment (PPE) where it is easily accessible in an emergency, but not in the pesticide storage area.
- Do not put pesticides in containers that children and others might mistake for food or drink.
- Dry bags should be raised on pallets to ensure that they do not get wet.
- Do not store liquid materials above dry materials.
- Keep containers closed tightly.
- Inspect inventory frequently and watch for damaged containers.
- Store flammable pesticides separately from non-flammable pesticides.
- Segregate herbicides, insecticides, and fungicides to prevent cross-contamination and minimize the potential for misapplication.

PESTICIDE HANDLING

- Use extreme caution when handling concentrated chemicals.
- Locate operations well away from ground water wells and areas where runoff may carry spilled pesticides into surface waterbodies.
- Keep application equipment properly calibrated and in good repair.
- Do not calibrate equipment near wells, sinkholes, or surface waterbodies.
- 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 the label specifies for their use.
- Consider closed systems for loading and mixing.
- Calibrate your spreader or sprayers.
- Triple-rinse containers, pour the rinsate into the spray tank, and use according to the product label.

PESTICIDE DISPOSAL

- Maintain and follow labels on all pesticide containers.
- Triple-rinse, puncture, and crush empty containers. Clean all visible chemical from the containers, including the cap and cap threads. Follow the label directions for container disposal.
- Use dilute rinsates or excess mixture as a pesticide. Apply at or below the manufacturer's recommended (label) rates. 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.
- For cancelled, suspended, or unusable pesticides, contact the Florida Department of Agriculture and

Consumer Services, Bureau of Compliance Monitoring, at (850) 488-3314 or go to http://doacs.state.fl.us/~aes/compli.htm for guidance.

PESTICIDE SPILL MANAGEMENT

- Keep spill cleanup equipment available when handling pesticides or their containers.
- Clean up spills as soon as possible.
- Control actively spilling or leaking materials.
- Contain the spilled material.
- Collect spilled material.
- Store the containers of spilled material until they can be applied as a pesticide or appropriately disposed of.

Remember!
The penalty is not in reporting a spill, it is in failing to report a spill.

State Warning Point 24 hours Toll-Free	1-800-320-0519
National Response Center 24 hours Toll-Free	1-800-424-8802
CHEMTREC (Emergency only) 24 hours Toll-Free	1-800-424-9300

NOTES: