

Carolina Lawns

A Guide to Maintaining Quality Turf in the Landscape

Lawns are smooth, living carpets that add beauty and recreational space to your home. The benefits of a healthy lawn go beyond the obvious. As your grass grows, it helps the environment by stabilizing soil and reducing air pollution, noise, heat, dust, and glare. Surveys show that an attractive, well-landscaped lawn can even add to the value of your home.

To reap the rewards of a handsome lawn, take great care in the selection, establishment, maintenance, and renovation of your lawn grass. By making the proper choices, you can create a durable lawn that will grow with minimal maintenance and pesticide use.



Recommendations for the use of agricultural chemicals are included in this publication as a convenience to the reader. The use of brand names and any mention or listing of commercial products or services in this publication does not imply endorsement by the North Carolina Cooperative Extension Service nor discrimination against similar products or services not mentioned. Individuals who use agricultural chemicals are responsible for ensuring that the intended use complies with current regulations and conforms to the product label. Be sure to obtain current information about usage regulations and examine a current product label before applying any chemical. For assistance, contact your county Cooperative Extension agent.

Professional lawn care companies may use a maintenance schedule that differs from what is described in this publication, and it may be equally effective.

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What To Plant

Whether you are establishing a new lawn or renovating an existing one, deciding which type of grass to plant will be the first step. No one type of grass is best suited to all situations. A number of factors should be considered before deciding which lawn grass to plant. Your decision should be based on region, climate, intended use or wear at the site, and desired appearance.

Find your region in the map in Figure 1. Both cool-season (northern) and warm-season (southern) grasses are grown in North Carolina. Cool-season grasses grow best in the spring and fall and less actively in the summer. They stay reasonably green in the winter. Tall fescue, Kentucky bluegrass, fine fescue, and perennial ryegrass are common types of cool-season grasses. Table 3 rates the performance of various cultivars of these grasses in North Carolina. Warm-season grasses are slow to green up in the spring, grow best in the summer, and go dormant after the first heavy frost. Table 4 lists many warm-season cultivars.

Also consider the characteristics of each site and your goals to determine which types of grass are appropriate. Choose the grass that best meets your preference for color, density, and texture. Choose a tough, aggressive, wear-tolerant grass where heavy traffic is expected. And consider the amount of time, effort, and money you are willing to spend for turf-grass maintenance.

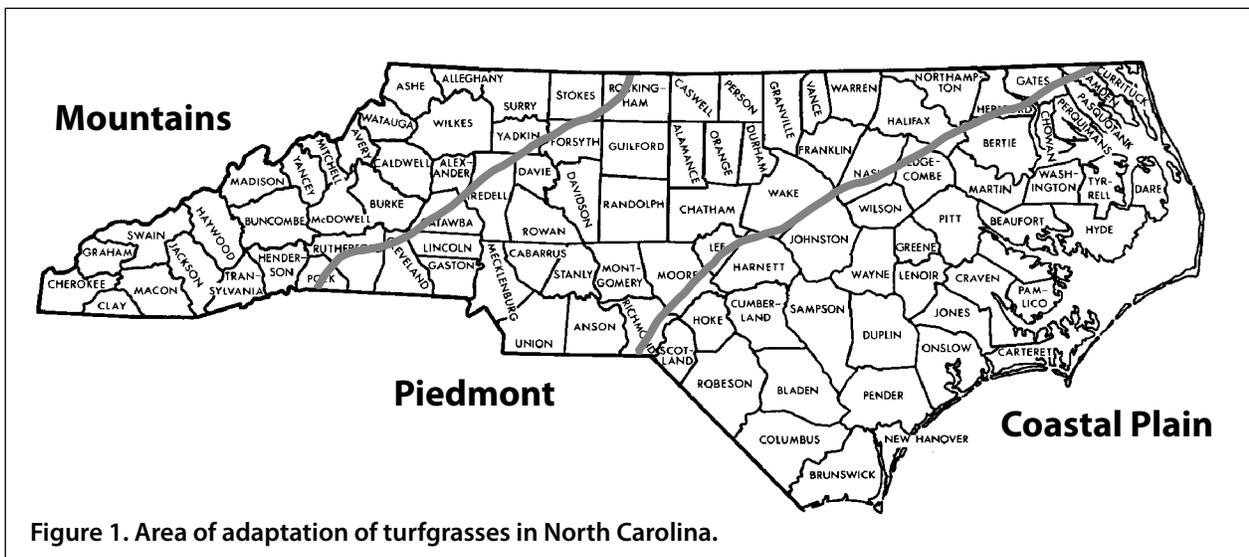
Cool-season Grasses

Tall fescue, Kentucky bluegrass, and fine fescues—such as creeping red, chewings, and ryegrass—are cool-season perennial grasses used for lawns, mostly in the mountain and piedmont regions of North Carolina. Unlike warm-season grasses, cool-season grasses remain green throughout most of the winter. They

are better adapted to the mountains and piedmont. These grasses perform best in spring and fall and have a tendency to show signs of stress in the summer. This is especially true as you move toward the coastal plain. Cool-season grasses are best seeded in early fall, but fair results may be obtained from seeding in early spring (mid-February to late March in the piedmont). Generally, late winter or spring seeding of these grasses is not recommended.

Tall fescue is best adapted to the mountains and piedmont but can be successfully maintained on the heavy silt loams in the coastal plain. It is a reliable performer and easily started from seed. It is the best grass to plant if you want a year-round green lawn. Tall fescue thrives in sun or medium shade. It will not perform well in full sun in the coastal plain, especially if the soil is sandy. It can be seeded by itself or mixed with Kentucky bluegrass, fine fescue, or both, particularly where shade is a concern. Tall fescue is a bunch-type grass, so damaged or bare areas will need to be re-seeded. It exhibits good disease resistance, drought tolerance, and cold tolerance; tolerates moderate traffic; and persists with minimum care. Several improved tall fescue cultivars have been developed that are more shade tolerant, denser, and finer textured than Kentucky 31, a commonly used older cultivar. These characteristics become more evident as the turf matures and the maintenance level increases. Research has shown that some of these improved cultivars also have darker green color, improved disease tolerance, lower growth habit, better wear tolerance, and drought tolerance.

Experts recommend that a blend of two or three cultivars be planted rather than seeding just a single cultivar. This broadens the genetic base and gives the turf a better chance of withstanding a variety of challenges. Use a seeding rate of 6 pounds per 1,000



square feet (sq ft). Don't assume more is better. Higher seeding rates can result in weak, thin stands that are more susceptible to disease and high temperature stress.

The improved tall fescues should be mowed at a height of 3 inches, and never shorter than 2.5 inches. Kentucky 31 should be mowed at 3 to 3.5 inches. Tall fescue may turn brown, yet can often survive short periods of drought. Under certain circumstances, some tall fescue may be lost if a drought exceeds three weeks. To maintain a green lawn, it is best to irrigate, if possible, during periods of drought.

Kentucky bluegrass produces a high-quality, medium- to fine-textured turf, at least when grown in the right climate. In North Carolina, it is well suited for the mountains and can be grown in combination with tall fescue in the piedmont. It is not suitable for use in the coastal plain. Kentucky bluegrass prefers fertile, limed, well-drained soils in sun or light shade. Excellent sod results from rhizomes (underground stems) that spread, with most cultivars recuperating from and tolerating pest control measures and moderate levels of traffic. Many new cultivars with improved color, texture, and pest resistance are now commercially available.

As with most cool-season grasses, it is best to broaden the genetic base by planting a blend of two to three cultivars rather than seeding a single cultivar. It is also common for Kentucky bluegrass to be seeded in combination with tall fescue. The tall fescue enhances drought and heat tolerance whereas the Kentucky bluegrass provides finer texture and greater recuperative potential. Generally, Kentucky bluegrass grows better than tall fescue in moderate shade. When mixed with tall fescue, Kentucky bluegrass tends to dominate where the soil is limed and the turf is adequately fertilized and mowed fairly short.

Kentucky bluegrass should be mowed at a height of 1.5 to 2.5 inches when planted alone. It should be mowed at 2.5 inches or higher when mixed with tall fescue. Seeding rates range from 1 to 2 pounds per 1,000 sq ft. Higher rates can result in weak, thin stands that are more susceptible to disease and high temperature stress.

Even though Kentucky bluegrass may turn brown during a two- to four-week summer drought, it is not necessary to irrigate. Kentucky bluegrass recovers well from most droughts, and watering will often increase disease problems.

Fine fescues include creeping red, chewings, and hard fescue. The name is derived from the very finely textured leaves, which are almost as fine as pine needles. Noted for tolerance to shade, drought, and poor soil

conditions compared to other cool-season grasses, fine fescues are often included with tall fescue or Kentucky bluegrass when planted in the shade or subject to low maintenance. They are best adapted to the mountains but can be grown in the piedmont. They should not be used in the coastal plain. They may not persist in sunny locations exposed to high temperature extremes, excessive soil moisture or humidity, or heavy traffic.

Fine fescue seed should be mixed with Kentucky bluegrass because most of the fine fescues are bunch type and do not have the ability to spread. New seedlings establish quickly due to excellent seedling vigor. Seed fine fescue at 1.5 pounds per 1,000 sq ft when mixed with either tall fescue or Kentucky bluegrass.

Fine fescue should be mowed at 1.5 to 2.5 inches when mixed with Kentucky bluegrass but at 2.5 inches or higher when mixed with tall fescue.

Perennial ryegrass is similar in appearance to Kentucky bluegrass, but is only adapted to the mountains. In North Carolina it is never seeded alone but always mixed with Kentucky bluegrass. These grasses complement each other because perennial ryegrass establishes faster than Kentucky bluegrass, and Kentucky bluegrass has the ability to spread and fill in damaged areas.

A mix of Kentucky bluegrass and perennial ryegrass should be seeded at the rate of 2.5 pounds per 1,000 sq ft, with Kentucky bluegrass making up 60 percent of the mix by weight.

Perennial ryegrass should be mowed at 1.5 to 2.5 inches when mixed with Kentucky bluegrass.

Annual (Italian) ryegrass is used only when a temporary turf cover is needed. It is *never* recommended for permanent lawn mixtures because it dies in late spring, when temperatures approach 80°F or higher. It is sometimes found in inexpensive commercial seed mixtures but should be avoided. Because annual (Italian) ryegrass is an annual, it must be re-seeded each fall. Annual ryegrass has been used by some homeowners to provide winter color for bermudagrass lawns. It is never recommended for overseeding other warm-season grasses. Refer to *Overseeding Bermudagrass Turf* (AG-352).

Warm-season Grasses

Bermudagrass, zoysia, centipedegrass, St. Augustine, carpetgrass, and bahia are classified as warm-season perennial grasses. All except bahia are mostly recommended for lawns in the piedmont and coastal plain of North Carolina. They grow best in the summer, go dormant in the fall at the first heavy frost, turn brown, and then green up slowly the following spring. For this reason, they usually perform better the farther

east and south you go in those regions. Warm-season grasses are best planted in late spring and early summer. Unlike cool-season grasses, some warm-season grasses must be planted either by sod or other vegetative means because seeds either are not available or do not result in uniform stands. Warm-season grasses are usually seeded or planted as a single variety (monoculture) rather than in blends and mixtures.

Bermudagrass spreads by stolons and rhizomes, and it can invade flowerbeds and other areas because it has runners that spread rapidly both above and below ground. But Bermudagrass is extremely drought tolerant, grows rapidly on any type of soil except where drainage is poor, and makes a good turf if fertilized and mowed low and often. Cultivar texture ranges from coarse to fine, and it forms a dense, durable surface when grown in full sunlight. The majority of cultivars will not tolerate shade. Bermudagrass is well adapted to sandy soils. Bermudagrass establishes quickly, withstands wear and traffic, and recovers rapidly from injury.

Most finely textured, high-quality turf-type bermudagrasses are planted using sod, sprigs, or plugs. Common bermudagrass, which is the most coarsely textured, can be seeded. Several newer cultivars, however, can also be seeded that have a medium texture. Bermudagrass should be seeded at 1 to 2 pounds per 1,000 sq ft. Best results are obtained by planting dormant sprigs in March.

Bermudagrass lawns perform best when mowed at 0.75 to 1 inch using a reel mower. However, good performance can be achieved with a rotary mower with sharp blades set as low as possible without scalping. Uneven ground can make mowing this low difficult. For best results, bermudagrass should be mowed often (at least twice per week), especially at the lower mowing heights.

Zoysiagrass spreads by stolons and rhizomes, but it is easier to keep out of flowerbeds than bermudagrass. Zoysiagrass produces a very dense, wear-tolerant lawn that grows well in full sun and light shade. It has stiff leaves that produce a very dense turf, which people often describe as feeling like “walking on a cushion.” Zoysiagrass grows more slowly than bermudagrass, and thus requires less frequent mowing. But because the leaves are stiff, mowing can be difficult unless the mower blades are sharp. To look its best, zoysiagrass requires approximately the same amount of fertilizer as bermudagrass; it will rapidly thin out if underfertilized. Zoysiagrass is very drought resistant. It rarely needs irrigation to survive in North Carolina.

Zoysiagrass cultivars were once limited to two cultivars: Meyer and the finer textured Emerald. These cultivars must be planted vegetatively, and are low- and slow-growing. They are very slow to establish from plugs, often taking three years for total coverage when planted on 12-inch centers. These older cultivars can become thatchy—puffy due to an accumulation of dead, dying, decaying plant residue at the soil surface. This is especially so when these grasses are mowed high and infrequently or heavily fertilized. Thatch may need to be removed every two to three years, but care should be taken because the recovery rate of these cultivars is very slow.

Some of the newer vegetative cultivars, such as El Toro and Crowne, are coarser in texture (similar to newer tall fescues), are quicker to establish and recover from injury, and can be mowed with a rotary mower. They are not as cold tolerant as Meyer and should not be mowed as short as Emerald and Meyer. Cavalier is a quick-establishing new zoysiagrass cultivar with a fine texture similar to Emerald. Cold tolerance of zoysia is not a problem in North Carolina’s piedmont and coastal plain.

A few cultivars of zoysiagrass, such as Zenith and Companion, can be seeded. Both grasses can be mowed with a rotary mower.

Centipedegrass spreads by stolons. Centipedegrass is a slow growing, apple-green, coarsely leaved turfgrass that is best used as a low maintenance, general purpose turf. It requires little fertilizer once established (0.5 to 1 pound of nitrogen per 1,000 sq ft per year) and infrequent mowing, and it grows well on acidic soils in full sun to partial shade. It does not tolerate traffic, compaction, high soil pH, high soil phosphorus, excessive thatch, drought, or heavy shade.

Centipedegrass is slow to establish and may take two to three years when seeded. It should be mowed when it attains 1 inch in height and no higher than 1.5 inches. Centipedegrass can become thatchy, especially when mowed high and infrequently or when heavily fertilized. Thatch may need to be removed every two to three years, but care should be taken because the stems can easily be torn from the ground, leaving bare spots.

Tifblair, an improved cultivar from the University of Georgia, is quicker to establish and more cold tolerant than common centipedegrass. It also retains its green color later in the fall.

St. Augustinegrass spreads by stolons. St. Augustinegrass is a fast-growing turfgrass best adapted to the coastal plain. It has a medium- to dark-green

color and very coarsely textured leaves. With proper maintenance, it will provide a dense, lush lawn. St. Augustinegrass is very shade and salt tolerant but is considered the least cold tolerant lawn grass. The cultivar Raleigh has the best cold tolerance and is well adapted for the eastern side of the piedmont and the western side of the coastal plain.

Seed is unavailable, so cultivars must be vegetatively planted. St. Augustinegrass grows best in fertile, well-drained soils.

Because St. Augustinegrass is fast growing, it needs to be mowed frequently during the growing season using a rotary mower. It should never receive more than 4 pounds of nitrogen per 1,000 sq ft annually. At high rates of fertilization and irrigation, thatch buildup may become a problem. St. Augustinegrass is not tolerant of heavy traffic, compaction, or cold weather.

Carpetgrass spreads by stolons. Carpetgrass is a slow and low-growing, medium-green, coarsely textured lawngrass. It produces a low maintenance, general purpose turf. Carpetgrass resembles St. Augustinegrass and centipedegrass and is often mistaken for centipedegrass but has broader leaves. It grows well in full sun to moderate shade and performs well in wet, shaded, acid soils where other lawngrasses may not grow. It grows best in full sunlight when daytime temperatures are between 60 and 90°F, and does not tolerate cold, drought, salt, or traffic. Carpetgrass requires only 1 pound of nitrogen per 1,000 sq ft annually, and needs

to be mowed only infrequently at 1.5 inches.

Bahiagrass spreads by stolons and rhizomes. Bahia-grass is never recommended as a lawn grass because of its open canopy, unsightly seedheads, and difficulty in mowing. It is best used on roadsides where appearance is not a concern and low maintenance is the rule.

Soil temperature can be a good indicator of certain vegetative biological events for cool-season and warm-season grasses. To check your area’s soil temperature, visit the State Climate Office Web site: <http://nc-climate.ncsu.edu/jet/>. This can help you to decide on the best type of grass for your lawn.

A comparative chart of principal lawn grasses used in each region is provided in Table 2. Study the chart to help select the appropriate grass for the site and the intended use of the lawn. This information is based on cultivar (variety) trials and observations by turfgrass researchers at North Carolina State University.

The NC State TurfFiles Turf Select Decision Aid program (<http://www.TurfFiles.ncsu.edu/turfselect/>) is a free online tool designed to guide homeowners through the turf selection process. Cultivar performance recommendations are based on overall quality ratings for each of these commercially available varieties. The National Turf Evaluation Program (NTEP) trial research results have been consolidated into an easy-to-use question-and-answer program that provides proven grass types and cultivars suitable for your region and use.

Table 1. Responses to Soil Temperature for Cool- and Warm-season Grasses

Event	Temperature at Which Event Occurs	
	Cool-season Grasses	Warm-season Grasses
Shoot growth ceases due to heat	90°F	120°F
Root growth ceases due to heat	77°F	110°F
Maximum temperature for root growth of any consequence	70°F	N/A
Optimum shoot growth	60 - 75°F	80 - 90°F
Optimum root growth	50 - 65°F	75 - 85°F
Expected spring root decline triggered	N/A	64°F Roots turn brown and die within 1 or 2 days. This decline occurs only if a very cold winter is followed by a rapid spring warm-up.
Shoot growth ceases due to cold	40°F	N/A
Root growth ceases due to cold	33°F	50°F Root growth begins to slow below this temperature. Chilling injury resulting in discoloration is possible. Initiation of dormancy results in discoloration.
Low temperature kill possible	If temperature drops rapidly below 20°F	25°F

Table 2. Characteristics of Principal Lawn Grasses Grown in North Carolina

Lawn grass	Can Be Seeded?	Tolerance Ratings				Appearance		Preferred Season	Rate of Establishment*	Maintenance			
		Shade	Heat	Cold	Drought	Wear	Color			Texture	Cutting Height (in.)	Fertilizer (lb N/1,000 sq ft/yr)	Mowing Frequency**
MOUNTAINS													
Kentucky bluegrass	Yes	4	3	5	4	4	Med-dark	Medium	Fall	Moderate	1.5 to 2.5	2.5 to 3	Medium
Kentucky bluegrass/fine fescue mix	Yes	4	3	5	4	3	Med-dark	Fine-med	Fall	Moderate	1.5 to 2.5	2.5 to 3	Medium
Kentucky bluegrass/tall fescue mix	Yes	4	4	5	5	5	Med-dark	Med-coarse	Fall	Fast	2.5 to 3.5	2.5 to 3	High
Kentucky bluegrass/tall fescue/ fine fescue mix	Yes	5	4	5	5	5	Med-dark	Med-coarse	Fall	Fast	2.5 to 3.5	2.5 to 3	High
Kentucky bluegrass/ perennial ryegrass mix	Yes	4	3	5	4	5	Med-dark	Medium	Fall	Fast	2 to 3	2.5 to 3	Med-high
Tall fescue	Yes	4	4	5	5	5	Medium	Med-coarse	Fall	Fast	2.5 to 2.5	2.5 to 3	High
PIEDMONT													
Bermudagrass (common)	Yes	1	5	1	6	6	Medium	Medium	Spr, sum	Fast	0.75 to 1	4.5	Med-high
Bermudagrass (hybrid)	Yes	1	5	2	6	6	Light-dark	Fine	Spr, sum	Moderate	0.75	5 to 6	High
Bahiagrass	Yes	4	4	2	6	4	Med-dark	Coarse	Spr, sum	Moderate	2 to 3	1	High
Centipedegrass	Yes	4	4	2	4	1	Light	Coarse	Spr, sum	Slow	1	0.5	Low
Kentucky bluegrass/tall fescue mix	Yes	4	4	5	5	5	Med-dark	Med-coarse	Fall	Fast	2.5 to 3.5	3	High
Kentucky bluegrass/tall fescue/ fine fescue mix	Yes	5	4	5	5	5	Med-dark	Med-coarse	Fall	Fast	2.5 to 3.5	3	High
St. Augustinegrass	No	5	5	5	4	1	Med-dark	Coarse	Spr, sum	Moderate	2 to 3	2.5	Med-high
Tall fescue	Yes	4	4	5	5	5	Medium	Coarse	Fall	Fast	2.5 to 3.5	3	High
Zoysiagrass	Yes	4	5	4	6	4	Med-dark	Fine-med	Spr, sum	Very slow	0.75 to 1	1.5	Low-med
COASTAL PLAIN													
Bermudagrass (common)	Yes	1	5	1	6	6	Medium	Medium	Spr, sum	Fast	0.75 to 1	4.5	Med-high
Bermudagrass (hybrid)	No	1	5	2	6	6	Light-dark	Fine	Spr, sum	Moderate	0.75	5 to 6	Very high
Bahiagrass	Yes	4	5	2	6	4	Med-dark	Coarse	Spr, sum	Moderate	2 to 3	1	High
Centipedegrass	Yes	4	4	2	4	2	Light	Coarse	Spr, sum	Slow	1	0.5	Low
St. Augustinegrass	No	5	5	2	4	2	Med-dark	Coarse	Spr, sum	Moderate	2 to 3	2.5	Med-high
Tall fescue	Yes	4	4	5	5	5	Medium	Coarse	Fall	Fast	2.5 to 3.5	3	High
Zoysiagrass	Yes	4	5	4	6	4	Med-dark	Fine-med	Spr, sum	Very slow	0.75 to 1	1.5	Low-high

Key for tolerance ratings: 6—Excellent 5—Very good 4—Good 3—Fair 2—Poor 1—Very poor Abbreviations: Med—Medium, Spr—Spring, Sum—Summer
 Note: Some improved cultivars are better adapted and more pleasing in appearance than the comparison rating provided for a given lawn grass. Check with your county Cooperative Extension center concerning specific cultivars that have characteristics of interest to you. See Table 4 for suggested months of establishment.
 *Establishment rate is dictated by planting dates, seeding and planting rate, intensity of culture, and environment.
 ** Mowing frequency is dictated by season, intensity of management, and use.

Table 3. Cool-season Grass Cultivars with Excellent Performance in North Carolina

Grass Type	Cultivar Name			
Tall fescue	Avenger	Falcon II	Masterpiece	Rembrandt
	Barlexas	Falcon IV	Matador	Rendition
	Barlexas II	Fidelity	Millennium	Scorpion
	Barrera	Finesse II	Mustang	Second Millennium
	Barrington	Firebird	Mustang 3	Serengeti
	Biltmore	Focus	Olympic Gold	Signia
	Bingo	Grande II	Padre	Silverstar
	Bonsai	Greenkeeper	Picasso	Southern Choice II
	Bravo	Greystone	Plantation	Stetson
	Cayenne	Inferno	Proseeds 5301	Tarheel
	Constitution	Jaguar 3	Prospect	Titan Ltd
	Coyote	Justice	Pure Gold	Titanium
	Davinci	Kalahari	Quest	Tracer
	Dominion	Kitty Hawk 2000	Rebel Exeda	Ultimate
	Dynasty	Legitimate	Rebel Sentry	Watchdog
	Endeavor	Lexington	Regiment II	Wolfpack
	Kentucky bluegrass	Alpine	Bordeaux	Freedom II
Apollo		Boutique	Hallmark	Quantum Leap
Arcadia*		Brilliant	Impact	Rambo
Arrow		Cabernet	Jefferson	Rita
Award		Champagne	Jewel	Royce
Bariras		Champlain	Langara	Rugby
Baronie		Chicago	Liberator	Showcase
Bedazzled		Eagleton	Limousine	Sonoma
Blackstone		Envicta	Midnight	Total Eclipse
Bodacious		Everest	Moonlight	Unique
Boomerang		Everglade	Nuglade	Washington
Fine fescue		Ambassador	Jasper II	Quatro
	Berkshire	Musica*	Razor*	
	Compass*	Oxford	Reliant IV*	
	Edgewood*	Predator*	Scaldis	
Perennial ryegrass	Accent II	Harrier	Palmer III	Quicksilver
	Brighstar SLT	Inspire	Palmer IV	Revenge GLX
	Caddieshack II	Keystone II	Panther GLS	Secretariat II
	Charismatic II	Line Drive GLS	Paragon GLR	Silver Dollar
	Citation Fore	Manhattan 5 GLR	Pentium	Top Gun II
	DCM	Monterey 3	Premier	
	Fiesta 4	Palace	Primary	

A rating of *excellent* means that the cultivar was not significantly different from the top performing cultivar regarding overall quality.
 *These cultivars have not been tested in North Carolina but have performed well in surrounding states.

Table 4. Performance of Warm-season Grass Cultivars in North Carolina

Grass Type	Cultivar	Comments
Bermudagrass, seeded cultivars	Arizona Common Mohawk Numex Sahara Savannah Southern Star Sunbird Sundevil II Sunstar Transcontinental Yukon Riviera Princess	<p>These cultivars are available as seed and will produce acceptable quality under proper management. They closely resemble common bermudagrass in its coarse texture and light-green color.</p> <p>Transcontinental, Yukon, Riviera, and Princess are finer textured and denser than other seeded cultivars.</p> <p>Riviera and Yukon are noted for cold tolerance and are more likely to survive in the western and northern parts of the state.</p> <p><i>Note:</i> Seeded cultivars are grasses that do produce viable seed, which can be harvested and sold for use. The seeds they produce do retain the characteristics of the parent plant making them suitable for</p>
Bermudagrass, vegetative cultivars	Aussie Green Celebration GN-1 Patriot Tifsport Tifton 10 Tifway	<p>These cultivars produce excellent quality grass under proper management. They possess dark-green color, fine leaf texture, and dense growth habits. They are typically considered as high maintenance grasses and must be mowed with a reel mower at a height of 0.5 to 1 inch to achieve high quality. These grasses are primarily suited for use on golf courses as well as high-end athletic fields and home lawns.</p> <p>Tifsport performs best at 1 to 2 inches.</p> <p><i>Note:</i> Vegetative cultivars are only available as sprigs, plugs, or sod. This is because they are either sterile grasses that do not produce viable seed, or they may produce seed that does not retain characteristics true to the cultivar. Vegetative cultivars must be purchased from a sod farm that carries the variety.</p>
Centipedegrass	Common Tifblair	Tifblair is an improved cultivar that exhibits better cold tolerance compared to Common .
St. Augustinegrass	Common Raleigh	Raleigh is noted for its improved cold tolerance compared to Common St. Augustinegrass.
Zoysiagrass, coarsely textured varieties	Companion Crowne El Toro Empire Meyer Palisades Zenith	Seed is available for Companion and Zenith .
Zoysiagrass, finely textured varieties	Cavalier Diamond Emerald Zeon Zorro	

Because the release and evaluation of turfgrass cultivars changes rapidly, you are encouraged to contact the Cooperative Extension center in your county for the latest information on grass characteristics and selection (<http://www.NCSU TurfFiles.ncsu.edu/turfSelect/>).

Establishing a New Lawn

Establishing a healthy, attractive lawn means planting the best grass for your site at the right time and in a careful manner. Grass can be seeded or established using vegetation in the form of sprigs, plugs, or sod. The type of grass and the planting method you select will determine the best time of year to plant. Site and soil preparation, including fertilization, are especially important.

Site Preparation

Preparing the site involves removing weeds and debris, planning for drainage, and grading the site.

1. Control perennial weeds with a nonselective herbicide. Hard-to-control weeds may require the services of a professional.
2. Remove debris. Insist that the builder **not** use the site as a dumping ground for paint, concrete, and other materials.
3. Plan for easy maintenance and a pleasing appearance. Avoid terraces, steep grades, poorly drained areas, and heavily shaded spots.
4. Install tile drain in poorly drained areas. Get professional advice about the type of drain and installation.
5. Remove the topsoil (usually 4 to 8 inches) and stockpile it nearby if grading is needed. (If bringing topsoil from other sites, be cautious. It may contain hard-to-control weeds or weed seeds.)
6. Build protective walls to save trees if the final grade is to be appreciably higher than the present level.
7. Shape the underlying subsoil to the desired contour, and redistribute topsoil uniformly above the subsoil. A 2 to 3 percent slope is needed for proper drainage away from buildings. Make certain the soil is firmed after shaping. There should be no visible footprints after walking on it.
8. Water the area to enhance settling. Fill areas that settle unevenly to avoid standing water.
9. Mix 1 to 2 cubic yards of peat moss or compost per 1,000 sq ft into the top 6 to 8 inches of subsoil of heavy clay or very sandy soils. Clay soils are prone to compaction and require frequent aeration (removal of soil cores).

Soil Preparation

Well-prepared soil with adequate nutrients for growing grass encourages the development of a healthy lawn.

1. Take soil samples from the front yard and the backyard to determine soil pH and nutrient requirements. A single soil test may be all that is necessary if there are no obvious differences in soil texture, terrain, or troubled areas of the front yard and backyard. If the soils seem different, collect soil samples to a depth of 3 to 4 inches from several (10 to 15) locations and mix them together to produce a composite sample. Send approximately 1 cup of the air-dried soil sample to the NCDA & CS Agronomic Division Soil Testing Services, 1040 Mail Service Center, Raleigh NC 27607. Boxes and forms can be obtained at your county Cooperative Extension center or online at <http://www.ncagr.com/agronomi/pdffiles/issoil.pdf>. Allow several weeks for the results to be returned.
2. Based on the soil test report recommendations or the fertilization guidelines presented below, incorporate lime and fertilizer into the top 6 to 8 inches of the soil using a disk or rototiller. Regardless of the region, a deeper root system is able to extract more moisture and nutrients from the soil, improving drought tolerance and overall health of the plant.
3. Rake or harrow the site to establish a smooth and level final grade. Soil particles should be no larger than marble size, and pea gravel size is even better. Hand raking is the best way to level the soil and work out hills and hollows. Allow time for rain or irrigation to settle the soil, and roll or cultipack lightly to firm the soil before planting seed, sprigs, plugs, or sod. Hand rake again to break up the crusty surface before planting.



Figure 2. Give the grass a good start with a properly prepared seedbed.

Fertilization

As recommended above, it's best to submit a soil sample for testing when establishing a new lawn to determine how much lime and fertilizer should be added to your soil. This is especially important if you are planting centipedegrass. It prefers acidic soils and low levels of phosphorus and may not require the addition of lime and phosphorus.

Fertilize before planting. Apply fertilizer and lime when the soil is prepared based on these guidelines:

If you obtained a soil test: Apply the amount of lime and fertilizer recommended for your soil by the soil testing laboratory. For additional information about interpreting a soil test, visit this Web site: <http://www.ncagr.com/agronomi/pdffiles/issoil.pdf>

If you did not obtain a soil test: Follow these recommendations for all grasses except centipedegrass.

1. Apply 75 pounds of ground limestone per 1,000 sq ft.
2. Apply a starter type fertilizer (one that is high in phosphorus) based on the type of grass and the planting method. Fertilizer bags have a three-number system indicating the primary nutrients, such as 8-8-8 or 5-10-10. These numbers denote the N-P-K ratio—the percentage of each nutrient in a fertilizer. The percentages are always noted in the following order:

N	Nitrogen for green color and growth.
P ₂ O ₅	Phosphorus for good establishment and rooting.
K ₂ O	Potassium to enhance pest and environmental stress tolerance.

Some common examples of starter type fertilizers required for a 1,000 sq ft area include 40 pounds of 5-10-10, 20 pounds of 10-20-20, or 16 pounds of 18-24-6. For sandy soils, typical to the coastal plain and sandhills of North Carolina, fertilizer rates should be increased by 20 percent.

Fertilize after planting. Apply fertilizers uniformly and with care using a centrifugal (rotary) or drop-type spreader. Apply half the fertilizer in one direction and the other half moving at right angles to the first pass to ensure thorough and uniform coverage (See Figure 3).

For seeded lawns: Fertilize the new seedlings approximately six to eight weeks after emergence. For more specific maintenance information on your grass type, refer to the NC State TurfFiles Maintenance Calendars at the Web sites listed under "For More Information" at the end of this publication. Use a complete N-P-K turf-grade fertilizer that provides about 1 pound of nitrogen per 1,000 sq ft or the amount recommended on your soil test. The fertilizer should have a 3-1-2 or 4-1-2 analysis (for example, 12-4-8 or 16-4-8), and one-fourth to one-half of the nitrogen should be a slow-release form.

For vegetatively planted warm-season grasses: Fertilize throughout the first growing season to encourage faster spread. Every three to four weeks during the growing season, add 0.5 to 1 pound of nitrogen per 1,000 sq ft until the plants have completely covered the desired lawn area.

To help reduce turf loss: Avoid high nitrogen fertilization of cool-season grasses in the late spring or summer and of warm-season grasses in the fall or winter.

When to Plant

Cool-season grasses

Seeding: Cool-season grasses are best seeded from mid-August to mid-September, depending on location (see Table 5). Seeding beyond these dates increases the chance of failure caused by winter injury. Spring or late-winter seedlings are often less than satisfactory because the seedling roots do not have time to become well established before the heat and drought of summer. If seeding of a cool-season grass is not accomplished in the fall, your best alternative date for the piedmont is mid-February to early March. Coastal plain areas would be seeded two weeks earlier, whereas

How to Determine Fertilizer Requirements

To apply 1 pound of nitrogen per 1,000 sq ft:

Divide 100 by the first number on the fertilizer bag to determine the amount of product to be used per 1,000 sq ft.

Example: A 16-4-8 fertilizer. 100 divided by 16 equals 6.25. Therefore, 6.25 pounds of fertilizer per 1,000 square feet will deliver 1 pound of nitrogen.

To apply 0.5 pound of nitrogen per 1,000 sq ft:

50 divided by the first number on the fertilizer bag equals the amount of product to be used per 1,000 sq ft.

Example: A 10-10-10 fertilizer. 50 divided by 10 equals 5. Therefore, 5 pounds of fertilizer per 1,000 sq ft will deliver 0.5 pound of nitrogen.

the mountain areas would be seeded two weeks later.

If you plan to seed a cool-season grass in the fall, such as tall fescue or Kentucky bluegrass, and your lawn site is ready for seeding in late March, April, May, or June, you can obtain a temporary cover by seeding annual ryegrass. Fertilize with 75 pounds of ground limestone and 15 pounds of a 0-10-20 fertilizer per 1,000 sq ft. Another alternative is to seed annual

(Italian) ryegrass at 1.5 to 2 pounds per 1,000 sq ft, fertilized with 15 to 20 pounds of 10-10-10 fertilizer per 1,000 sq ft. Instead of following the above suggestions, you may wish to seed the desired cool-season grass. This procedure may succeed in some years, but in any event will give you ground cover until fall, even if all of the grass dies.

Sodding: You may successfully install a cool-season

Table 5. Planting Dates and Rates for Cool- and Warm-season Grasses in North Carolina

Lawn Grass	Optimum Planting Date*	Planting Rate per 1,000 Square Feet		
		Seed (pounds)	Sprigs for Space Planting (bushels)	Sprigs for Broadcast (bushels)
Mountains				
Kentucky bluegrass	Aug. 15 to Sept. 1	1.5 to 2	–	–
Kentucky bluegrass/ fine fescue mix	Aug. 15 to Sept. 1	1.5 + 1.5	–	–
Kentucky bluegrass/ tall fescue mix	Aug. 15 to Sept. 1	1 + 5	–	–
Kentucky bluegrass/tall fescue/ fine fescue mix	Aug. 15 to Sept. 1	1 + 5 + 1	–	–
Kentucky bluegrass/ perennial ryegrass mix	Aug. 15 to Sept. 1	1.5 + 1	–	–
Tall fescue	Aug. 15 to Sept. 1	6	–	–
Piedmont				
Bermudagrass	April to July ^a	1 to 2	0.75	3 to 10
Bermudagrass (hybrid)	April to July	–	0.75	3 to 10
Bahiagrass	March to June	5	–	–
Centipedegrass	March to July	0.25 to 0.50	1 to 2 ^c	–
Kentucky bluegrass/ tall fescue mix	Sept. 1 to Sept. 15	–	–	–
Kentucky bluegrass/ tall fescue/ fine fescue mix	Aug. 1 to Sept. 1	1 + 5	–	–
St. Augustinegrass	April to July	–	1.0	1
Tall fescue	Sept. 1 to Sept. 15	6	–	–
Zoysiagrass	April to July ^a	1 to 2	1 to 2 ^c	3 to 10
Coastal Plain				
Bermudagrass	April to July	1 to 2	0.75	3 to 10
Bermudagrass (hybrid)	March to July ^a	–	0.75	3 to 10
Bahaiagrass	March to June	5	–	–
Centipedegrass	March to July	0.25 to 0.50	1 to 2 ^c	–
St. Augustinegrass	April to July	–	–	–
Tall fescue	Sept. 15 to Oct. 15	6	–	–
Zoysiagrass	March to July ^a	1 to 2	1 to 2 ^c	3 to 10

*Seeding beyond these dates increases the chance of failure. Sod consisting of cool-season grasses can be installed any time the ground is not frozen. Warm-season grasses can be installed as long as soil temperature exceeds 55°F.

^a For best results, choose earlier dates when using vegetative material.

^b 1 square yard of turf pulled apart is equivalent to 1 bushel of sprigs.

^c Often plugged using 3 square yards of turf cut into 2-inch squares on 12-inch centers to plant 1,000 sq ft

grass sod anytime in the cooler portions of the growing season when the ground is not frozen.

Warm-season grasses

Seeding: Warm-season grasses may be seeded successfully between March 1 and July 1, depending on the species used. See Table 5 for different species and locations.

Sodding: Warm-season grasses are best established by sodding at the same dates suggested for seeding, about April until July 1. Sod will not produce roots unless the soil temperature exceeds 55°F for several weeks. Professional sod installers have been successful in establishing lawns beyond those dates, but care must be given to ensure that the soil does not dry out.

Vegetative: Warm-season grasses may be planted vegetatively (by sprigs or plugs) from March through July. Best results are obtained by planting dormant sprigs in March.

How to Plant

Lawns can be established by seeding, sodding, or vegetative planting (sprigs or plugs). Buying poor-quality seed or plants often results in less-than-satisfactory performance, pest problems, and general disappointment. Selection of seeds or plants is especially important when establishing a lawn. Read the information on the seed tag carefully, and make sure you purchase seed with no noxious weed seed and low levels of other crop seed. One way to be sure you have seed or planting material that is true to type, free of noxious weed seed, and contains low levels of other crop seed, is to purchase certified seed or sod. A blue certified tag indicates that the seed or plants have met certain standards to assure high quality and low levels of contaminants. The North Carolina Crop Improvement Association (NCCIA) offers a list of certified seed producers on its Web site: <http://www.nccia.ncsu.edu/>.

Seeding is usually the fastest, most economical method of establishing grasses. To ensure uniform coverage, use a centrifugal (rotary) or drop-type spreader. Apply half the seed in one direction and the other half moving at right angles to the first pass (see Figure 3). Lightly cover the seed by hand raking or dragging with a mat or span of chain-link fence. Roll the soil lightly to firm the surface, and provide good seed-to-soil contact.

Mulch grass seed with weed-free small-grain straw or hay. Use one bale per 1,000 sq ft for warm-season grasses and one to two bales for cool-season grasses. This will help conserve moisture, control erosion, and

reduce surface crusting until establishment. Once in place, stabilize the mulch by rolling or watering. Twine netting can be used if wind displacement is a problem. If applied evenly and lightly, these materials need not be removed.

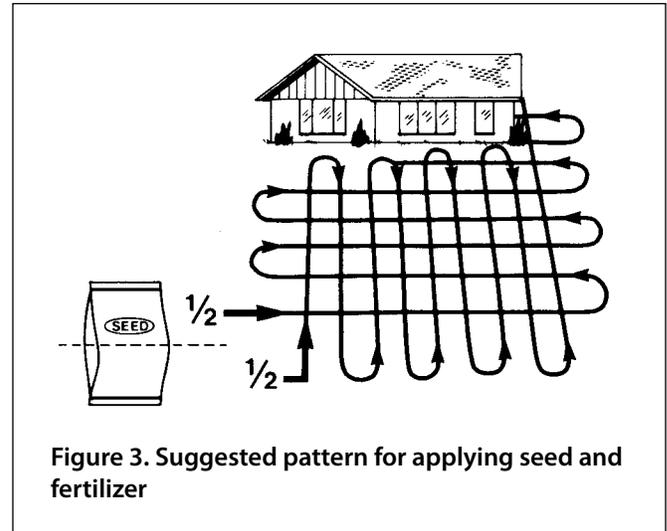


Figure 3. Suggested pattern for applying seed and fertilizer

Vegetative planting is necessary for some grasses that do not produce viable seed (seed that will germinate). When this method is used, the planting material must be kept fresh and moist from removal site to planting area. Keep planting material moist until established. Fertilize with 0.5 to 1 pound of nitrogen per 1,000 sq ft every one to three weeks for the fastest spread. Here are the methods most useful in lawn areas:

Space planting is the planting of separate shoots or sprigs (runners, cuttings, or stolons) at regular spacings. This labor-intensive method is best used for planting small areas. Spacing is determined by how fast the grass will spread, how fast you want it to cover, and how much material you have available. The closer the spacing, the faster the lawn will become established (see Figure 4).

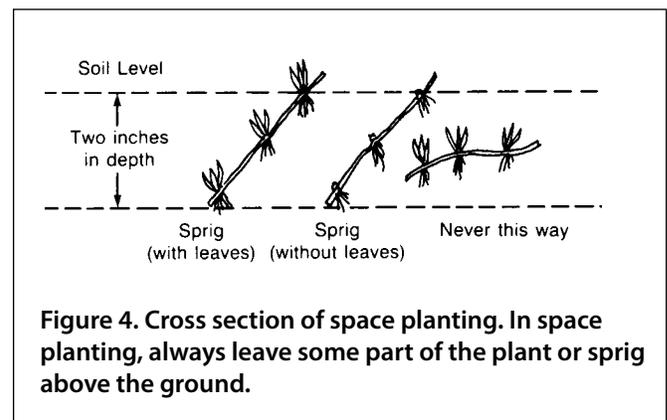


Figure 4. Cross section of space planting. In space planting, always leave some part of the plant or sprig above the ground.

Broadcasting is the uniform distribution of sprigs (cut stems) over the entire area. The sprigs are pressed into the top 0.5 to 1 inch of soil by hand or by using an old disk set straight, special planter, cultipacker, or roller. Large areas planted with Bermudagrass or zoysiagrass sprigs require a minimum of 3 to 5 bushels (yards) of sprigs per 1,000 square feet and 5 to 10 bushels (yards) for extremely fast cover. St. Augustinegrass is seldom established through broadcasting because the stems are too sensitive.

Plugging is planting individual pieces (2 inches or larger) of sod on 6-inch or 12-inch centers. This is an excellent way to introduce a more adapted lawn grass into an old lawn in an effort to replace old grass by crowding out. Zoysiagrass, St. Augustinegrass, and centipedegrass are often planted by plugging.

Sodding is placing sod stripped from one site to another for an “instant” lawn. Lay sod as soon as possible after it has been harvested to prevent injury.

1. Make sure the soil is moist (but not overly wet) before laying sod. Irrigating the soil several days before delivery is often adequate.
2. Install the sod within 24 hours of delivery. Plan to unstack and unroll the sod if it cannot be laid within 48 hours.
3. While installing, keep sod in the shade to lessen the chance of heat buildup.
4. Start sodding from a straight edge (driveway or sidewalk), and butt strips together, staggering them in a bricklike pattern (See Figure 5).
5. Avoid stretching sod. Use a knife or sharp spade for trimming to fit irregularly shaped areas.
6. Lay sod lengthwise across the face of slopes, and peg or stake the pieces to prevent slippage.
7. After the sod has been placed, roll the lawn to ensure good sod-to-soil contact. Then begin watering.

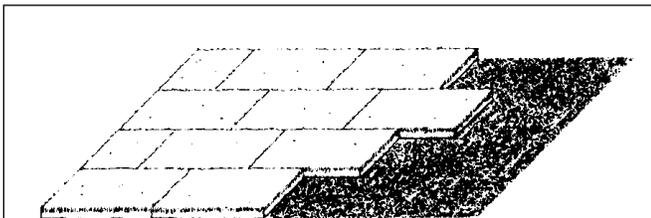


Figure 5. Start sodding from a straight edge and butt strips together in a bricklike pattern.

For a complete list of North Carolina sod producers and the varieties they carry, visit the North Carolina Sod Producers Association Web site: <http://www.ncsod.org>.

Again, to ensure high quality and better chance for success, it is highly recommended that certified sod be used. A list of producers growing certified sod can be found on the NCCIA Web site: <http://www.nccia.ncsu.edu/>.

The times and rates for planting vegetative grasses are given in Table 5.

Caring for a New Lawn

Irrigating

To prevent drying of planting material, keep the top 1.5 inches of the soil moist. This may require light watering two or three times a day for 15 to 20 days. Bluegrass takes 7 to 14 days longer to germinate than other cool-season grasses. As the seedlings grow and root, water less often but for longer periods. For mixtures containing bluegrass, do not make the mistake of decreasing water as soon as the seedlings appear. Continue watering until the bluegrass seedlings emerge. After the third mowing, water to a depth of 6 to 8 inches about once a week or when needed.

Mowing

Begin mowing as soon as the grass is 50 percent higher than the desired height. For example, mow tall fescue back to 3 inches when it reaches 4.5 inches. The frequency of mowing is governed by the amount of growth, which depends on temperature, fertility, moisture conditions, the season, and the natural growth rate of the grass. The suggested height of cut is given in Table 4. The homeowner should cut often enough that less than 50 percent of the total leaf surface is removed. Use a mower with a sharp blade. To reduce the danger of spreading disease and injuring the turf, mow when the soil and plants are dry. If clippings are heavy enough to hold the grass down or shade it, catch them or rake and remove them. Otherwise, do not bag the clippings. Allow them to fall into the turf where they will decay and release nutrients. This may reduce the need for fertilizer by 20 to 30 percent.

Pest Control

Fungicides and insecticides are rarely needed on new lawns, and different planting methods require different pest control methods. If pesticides are used, always read and follow label directions.

Seeding. Siduron (Tupersan 50WP) may be applied

to cool-season grasses at the time of spring seeding for selective pre-emergence control of some annual grassy weeds like crabgrass. Other herbicides may be applied to young seedlings during establishment. Get the latest recommendations by visiting the NC State TurfFiles Web site.

Broadleaf weeds are common in new seedings. However, many will be controlled with frequent mowing at the proper height. After the lawn has been mowed three times, remaining weeds may be controlled using the minimum label rate of a broadleaf herbicide. The particular herbicide used depends upon the weeds present and the tolerance of the turfgrass to the herbicide.

Space-planting sprigs, broadcasting sprigs, and plugging. Atrazine (AAtrex) or simazine (Princep) may be applied for control of certain annual grass and broadleaf weeds when sprigging Bermudagrass, centipede grass, St. Augustine grass, and zoysiagrass. Do not apply these herbicides over the rooting areas of trees and ornamentals that are not listed as being tolerant on the herbicide label.

Sodding. Pre-emergence herbicides, such as siduron (Tupersan), DCPA (Dacthal), and bensulide (Betasan), can be applied for annual weedy grass control after sodding cool- and warm-season grasses.

Maintaining An Established Lawn

Consider your lawn established when you have mowed it three times. Lawn Care Maintenance Calendars for specific grass types are available online through the NC State TurfFiles Web site: <http://www.TurfFiles.ncsu.edu>.

Irrigating

Improper irrigation of lawns results in wasted water, added cost, and unhealthy plants. Water should be applied only when lawns show signs of moisture stress. A dark bluish-gray color; footprints that remain some time after walking; and wilted, folded, or curled leaves are indications that it is time to water. Any delay in watering at the first signs of wilt can result in permanent damage unless the turf is being allowed to go dormant.

1. Water in the early morning if possible. This is the preferred time to water because it reduces the risk of disease, water loss through evaporation, and improper water distribution. Also, the demand for water by industry and municipalities is usually low at this time.

2. Water established lawns to a depth of 6 to 8 inches to encourage deep rooting. Usually, 1 inch of water per week is adequate.
3. Use cans or a rain gauge to determine how much water is being delivered in a certain period of time. It takes 640 gallons of water to apply 1 inch of water per 1,000 sq. ft. Because clay soils accept water slowly, water should be measured to prevent wasteful runoff. Water clay soils until runoff is about to occur. Wait 30 minutes for the water to be absorbed. Then apply more water until the desired depth or amount is achieved. This same technique can be used on slopes and compacted soils. Few lawns established on clay soils can absorb more than 0.5 inch of water per hour. Sandy soils require more frequent watering. Applying 0.5 inch of water every third day is usually sufficient. Adjust any automatic irrigation system to supplement rainfall so that the lawn is not over-watered.

Take certain precautions if you do not plan to irrigate throughout the summer. Slowly ease a lush, actively growing lawn into dormancy. This can be accomplished by deep and infrequent watering, by mowing high, and by not over-fertilizing with nitrogen. In the absence of rain, water dormant lawns every three weeks to prevent turf loss from heat and drying. Brown, withered leaves are normal signs of dormancy; don't be alarmed by them. Turfgrasses are able to withstand prolonged periods of drought.

Do not regularly water established cool-season grasses during the summer unless you plan to do so all season. Many lawns are lost by discontinuing irrigation in midsummer.

Mowing

Use either a rotary (centrifugal) or reel (cylinder) mower. The reel mower is preferred if grasses are cut to less than 1 inch.

1. Keep the mower blades sharp and balanced. The cleanest cut and best mowing are obtained when the mower blades are sharp. Dull mower blades reduce lawn quality by tearing instead of cleanly cutting the grass. Tearing creates many ragged leaf ends that quickly wither and bleach and are easy ports of entry for disease. Using a sharp mower is especially important for difficult-to-mow grasses, such as zoysiagrass, bahiagrass, and certain types of perennial ryegrass cultivars. A properly sharpened and balanced mower blade will also reduce mower vibration, lengthen mower life, and reduce fuel consumption by as much as 22 percent.

2. Mow at the proper height. The frequency of mowing is governed by the desired grass height and by the amount of growth, which depends on temperature, fertility, moisture conditions, season, and the natural growth rate of the grass. In most instances, this may amount to biweekly and weekly mowing. To maintain a high-quality lawn, turfgrass should be cut often enough that less than 50 percent of the leaf surface is removed with each mowing. The proper mowing heights are presented in Table 4. If the lawn gets too high during wet seasons, raise the mower and cut off one-fourth to one-half of the present growth. Then lower the mower to its proper height and mow again in a day or two.
3. Leave clippings to decompose when they are short. Most homeowners bag lawn clippings because they think that the clippings add to the buildup of thatch, which can be harmful to the lawn. Actually, thatch is made up of roots, stems, and the lower portions of leaves that are below the mower blade. Frequent mowing, mowing when the grass is dry, and proper fertilization are the best ways to reduce thatch buildup. Though studies have shown that a

lawn of 1,000 square feet can produce 500 pounds of clippings in one growing season, these clippings contribute very little to thatch. In fact, clippings that remain on the lawn quickly decompose and release valuable nutrients. Fertilizer use can be reduced by 20 to 30 percent. For more information, read the NC State TurfFiles grasscycling publication: <http://www.TurfFiles.ncsu.edu/pubs/management/gc592.html>.

4. Rake, bag, and remove the clippings when mowing is delayed. If prolonged periods of rainfall prevent mowing, clippings may be long enough to shade or smother the grass. In this case, rake, bag, and remove the clippings. Collected clippings can be used as mulch around trees and shrubs or added to compost. Because yard trash accounts for 20 percent of the waste in our overflowing landfills, legislation has been passed that bans depositing yard trash in most public landfills. Homeowners must now look for other alternatives. Contact your county Cooperative Extension center for information about composting yard trash and other uses for this material.

Table 6. Suggested Maintenance Fertilization of Established Lawns

Lawn Grass Type	Monthly Application Rate in the Piedmont ^a (lb N/1,000 sq ft)												Total lb N per 1,000 sq ft/yr
	J	F	M	A	M	J	J	A ^b	S	O	N	D	
Bermudagrass					1	1	1	1					4
Centipedegrass ^c						0.5							0.5
Fescue, tall		1							1		1		3
Kentucky bluegrass		1							1		1		3
Kentucky bluegrass/ fine fescue mix		1							1		1		3
Kentucky bluegrass/ tall fescue mix		1							1		1		3
Kentucky bluegrass/tall fescue/fine fescue mix		1							1		1		3
Kentucky bluegrass/ perennial ryegrass mix		1							1		1		3
St. Augustinegrass					0.5	0.5	1	0.5					2.5
Zoysiagrass (Emerald and Meyer)				1		0.5		0.5					2
Other cultivars				1		1		1					3

Notes: All rates are per 1,000 sq ft. Multiply by 43.5 to convert to acres. Follow table suggestions in the absence of soil test recommendations to the contrary. With the exception of centipedegrass, use a complete (N-P-K) turf-grade fertilizer in which 1/4 to 1/2 of the nitrogen is slowly available and that has a 3-1-2 or 4-1-2 analysis (for example, 12-4-8 or 16-4-8). Fertilize established centipedegrass using a low phosphorus, high potassium fertilizer with an analysis approaching 1-1-2 or 1-1-3. Fertilizers without phosphorus are preferred if soils supporting centipedegrass show moderate to high levels of phosphorus.

^a Dates suggested are for the central piedmont. For the mountains, dates may be 1 to 2 weeks later in the spring and earlier in the fall. For the coastal plain, apply fertilizer 1 to 2 weeks earlier in the spring and 1 to 2 weeks later in the fall.

^b In the absence of soil test recommendations, apply about 1 lb of potassium per 1,000 sq ft, using 1.6 lb of muriate of potash (0-0-6), 5 lb of sul-po-mag (0-0-22), or 2 lb of potassium sulfate (0-0-50) to bermudagrass, centipedegrass, St. Augustinegrass, and zoysiagrass.

^c Centipedegrass should be fertilized very lightly after establishment. An additional fertilization in August may enhance centipedegrass performance in coastal locations. Avoid using any phosphorus on centipedegrass after establishment.

Fertilizing

A soil test should be made at least every two to three years to determine the amounts of lime, phosphorus, and potassium needed by your established lawn. See page 11 for the method used to obtain a good soil sample. A complete fertilizer with an N-P-K ratio of 4:1:2 or 4:1:3 can be used in lieu of a soil test, but it is a poor substitute.

Determine the amount of fertilizer, ratio of nutrients or fertilizer elements, and time of application based on the grasses being grown. See Table 6 to determine the amount of nitrogen fertilizer to apply and the time of application.

Cool season grasses. Avoid any nitrogen fertilization of cool-season grasses, such as tall fescue, after the February application until September for the central piedmont.

If one additional application of nitrogen is made between these dates to improve the color, the rate should not exceed 0.5 pound of nitrogen per 1,000 square feet. This nitrogen should be applied in the central piedmont no later than April 15 (two weeks earlier in the coastal plain and two weeks later in the mountains). This application will not improve the longevity of tall fescue but will enhance its green color. The application of high rates or repeated low rates of nitrogen to cool-season grasses in the spring or summer greatly increases the severity of brown patch (*Rhizoctonia* species), which can kill the grass and should be avoided.

Warm-season grasses. Avoid late summer, fall, or winter applications of nitrogen to reduce winter injury.

Lime. Most soils in North Carolina are acidic and often require the application of lime to sweeten the soil. For most turfgrasses, except centipedegrass, soil pH should be between 6.5 and 7.0 for optimum nutrient availability. Centipedegrass requires more acidic soil with a pH close to 5.5. Lime may be put on any time during the year. Winter is usually best, however, because there is less traffic. Gentle winter rains minimize runoff, and alternate freezing and thawing help incorporate lime into the soil.

Fertilizers and lime should be applied uniformly with a centrifugal (rotary) or drop-type spreader. Apply half the fertilizer in one direction and the other half moving at right angles to the first pass to ensure uniform coverage (see Figure 3).

Coring (Aerification)

Soils that are subject to heavy traffic are prone to compaction. Coring will alleviate this condition. Use a

device that removes soil cores. Chop up the cores, and, if possible, distribute them by dragging with a span of chain-link fence or a mat.

Coring should be accomplished when the lawn is actively growing so that it can recover from any injury. Core cool-season grasses in fall or early spring. Core warm-season grasses in late spring or early summer. Some lawn care and landscape companies offer coring service if rental equipment is not available.

Power Raking (Verticutting)

Sod-forming grasses, such as Kentucky bluegrass, bermudagrass, zoysiagrass, St. Augustinegrass, and centipedegrass, tend to build up thatch when they are heavily fertilized and watered. When thatch exceeds 0.75 inch, lawns should be power raked and cored.

A light power raking is better than trying to remove too much debris at one time. When not excessive, thatch buildup can be removed from warm-season grasses by cutting as closely as possible at spring green up and then raking by hand. To avoid seriously injuring the lawn, a 3-inch blade spacing is required to remove thatch from centipedegrass and St. Augustinegrass. Some lawn care and landscape companies have specialized equipment and offer power raking services.

Renovating a Lawn

Lawn renovation refers to any procedure beyond normal maintenance (short of soil modification) required to upgrade an existing lawn. A deteriorated lawn is often a symptom of some underlying problem. Failure to identify and correct the exact problem can lead to further lawn deterioration and the need for repeated renovation. These are some of the major causes of turf deterioration:

- poor establishment procedures
- improper lawn management
- poorly adapted lawn grasses
- improper nutrient balance
- excessive thatch buildup
- disease, insect, or weed infestation

The problems that caused the lawn to deteriorate must be corrected before the renovation process begins.

When to Renovate

Late summer to early fall is the best time to renovate cool-season lawns. Warm-season lawns are best renovated in late spring to early summer. Attempts to upgrade existing lawns when conditions are not conducive to good growth are difficult at best.

Weed Control

The first step in lawn renovation is the control of undesirable vegetation that will compete with newly planted grasses. Some weeds growing in small areas may be controlled by hand weeding or removal using a small hoe, rake, or shovel. Hard-to-control weeds, such as perennial grasses with underground shoots or weeds in large areas, are best controlled with herbicides.

Spray most postemergence broadleaf herbicides four to six weeks before seeding. Selective postemergence herbicides to control annual grassy weeds, such as crabgrass, should also be applied at least four weeks before seeding.

To control perennial grassy weeds, undesirable turfgrasses, annual grasses, and broadleaf weeds, spray the nonselective herbicide glyphosate (Roundup or Kleenup). However, it will take several applications spaced three to four weeks apart to completely control bermudagrass. If perennial grassy weeds like bermudagrass are scattered throughout, consider killing the entire lawn.

When using glyphosate, do not disturb the soil or plants before treatment. Tillage or renovation techniques such as vertical mowing, coring, or slicing should be delayed for seven days after application to allow proper movement of the herbicide into underground parts of the weeds.

Young and actively growing weeds are easiest to control, so make sure that the soil is moist several days before application. Carefully read and follow directions and precautions on the herbicide labels. Treat only those areas that need it.

Preparation for Seeding

Preplanting renovation procedures are designed to create the optimum environment for the establishment of newly planted grasses. This process includes the following steps:

1. Reduce competition from existing grasses and remove unwanted vegetation, including thatch.
2. Apply the required fertilizer and lime.
3. Prepare a good seedbed.

Reduce competition. Set the rotary or reel mower at the lowest setting, mow, and collect the clippings. Remove all undesirable vegetation, dead grass, thatch, and weeds so that the soil is exposed. This may not be necessary if a slit seeder is used. A rake or hoe is ideal for small areas. Several passes with a dethatcher (power raker or vertical mower) is usually the best

choice for large areas. If thatch is excessive, it may be necessary to make another pass with a dethatcher after mowing. Both mowing and dethatching reduce plant competition and enhance light penetration for good germination and fast establishment.

Apply fertilizer and lime. Uniformly apply needed fertilizer and lime based on soil test results. Hand application is fine for small areas, but a rotary or drop-type spreader should be used on large areas to ensure uniform application.

Prepare a good seedbed. In small bare spots, loosen the top 4 to 6 inches of the soil with a rake, hoe, or shovel. On soils difficult to loosen with hand equipment, loosen the top 2 to 3 inches for good to excellent results. Fill in low areas, and smooth the surface so clods are smaller than marbles. Large areas and areas that contain 50 percent desirable grasses are best prepared for seeding by using a piece of equipment (such as an aerator or coring machine) that brings small soil cores to the surface. This will bring soil to the surface with minimal disruption and create an environment for good seed-to-soil contact. Core in several directions, allow plugs to dry, and then pulverize them with a mower, dethatcher, or span of chain link fence. Because tines have a difficult time penetrating dry, compacted soils, coring is best achieved when the soil is damp.

Seeding

Bare spots larger than 4 inches in diameter should be replanted. Smaller areas tend to fill in naturally, provided the lawn grass is capable of spreading. Tall fescue and perennial ryegrass exhibit a bunch-type growth habit and are incapable of spreading. Choose a blend or mixture that is compatible with the environment and the existing lawn.

To ensure uniform coverage, use a rotary or drop-type spreader, applying half the seed in one direction and the other half at right angles to the first pass. Incorporate seed and fertilizer into the top 1/8-inch of soil by lightly pulling a leaf rake over loosened soil or running a vertical slicer over areas that were just power raked and cored.

A slit seeder, consisting of a vertical grooving seeder and seed box, can be used to drill seed to ensure good seed-to-soil contact with minimum disruption. Seed should be drilled in a diamond-shaped pattern. Dry, compacted soils, obstructions such as rocks and trees, and excessive slopes may limit the usefulness of a slit seeder. Bare areas that are seeded should be mulched to enhance germination.

Plugging

Plugging can be used for those grasses that spread laterally—not bunch-type grasses such as tall fescue, ryegrass, bahiagrass, and fine fescue. Place plugs on either 6-inch or 12-inch centers, depending on the desired establishment speed. Use a plugging device to remove plugs of soil from bare areas, and switch them with plugs collected from healthy areas. Apply a starter-type fertilizer, such as 10 pounds per 1,000 square feet of 5-10-10 fertilizer.

Sprigging Large Areas

Large areas of 15,000 sq ft or more can be sprigged using this method, which is often reserved for bermudagrass. Rototill the recommended amount of fertilizer and lime, indicated by soil test results, or apply 75 pounds of lime and 20 pounds of 10-10-10 fertilizer to the area to be sprigged. Spread sprigs over the surface using rates provided in Table 5 for new areas. Press them into the top 0.5 to 1 inch of soil using an old disk set straight, special planter, cultipacker, or roller. Roll the area to firm the soil and ensure sprig-to-soil contact.

Care After Planting

Keep renovated areas moist with light sprinklings several times a day. As the seedlings, plugs, or sprigs grow, continue to decrease the frequency of waterings while increasing the duration to promote deep rooting. After the third mowing, water to a depth of 6 inches.

Mow the area as you normally would, using a sharp blade. But continue to severely stunt existing vegetation by mowing short until desirable grasses have germinated and the desired mowing height is achieved. This will reduce the competition for new seedlings.

Fertilize the new seedlings of cool-season grasses as described for “fertilize after planting” in the section on *Fertilization* (page 12). Use the example provided in that section to determine how much fertilizer to use.

Warm-season grasses can be fertilized every four weeks until coverage is complete. Use a complete N-P-K fertilizer that provides about 1 pound of nitrogen per 1,000 sq ft. Biweekly applications of a nitrogen-only fertilizer that provides about 0.5 pound of nitrogen per 1,000 sq ft may help warm-season grasses fill in more rapidly. Keep unnecessary traffic off the renovated lawn until it is well established.

Integrated Pest Management

People are becoming more aware of and concerned about the effects of chemicals on our environment. Research indicates that pesticide use poses a minimal threat to the health of humans, animals, and the environment. But because we can't be certain, many people choose to avoid pesticides. So how would you handle a pest problem that is destroying the appearance of your lawn? Do you use pesticides, change cultural practices, or both?

The balanced use of all available control methods is called *integrated pest management* (IPM). The idea is simple. All available prevention and control methods are used to keep pests from reaching damaging levels. Pesticides are used only when necessary.

Planting the best-adapted grass and then watering, mowing, and fertilizing it properly form the basis for integrated pest management. Keeping the lawn healthy enables it to tolerate low levels of pests and makes the area a good habitat for beneficial organisms that help control pests.

To best use natural controls, it is important to develop a sound understanding of the biology and ecology of the lawn environment. Fortunately, many books and other educational materials are now available to assist the homeowner. Also, many companies offer materials for organic lawn care. These range from nematodes that attack caterpillars to traps and repellents. Some of these are quite effective, whereas the effectiveness of others has not been documented. As each product is tested and proven to be effective, it will be added to the list of available options for turf pest management. In the meantime, if chemical control is necessary, select the safest effective pesticide and follow label recommendations. Chemicals should be applied when the pest is most susceptible. Treat only those areas in need, and regard pesticides as only one of many tools available in lawn care. Integrated pest management can be successful, but homeowners must realize that more time and labor are required and high expectations may not be met when pest pressures and environmental conditions are severe.

Glossary

Active ingredient

The chemical in a pesticide that controls the target pest.

Adjuvant

Chemical added to a pesticide formulation or tank-mix to improve mixing, application, or activity of a herbicide. Spray adjuvant examples include fertilizers, surfactants, methylated seed oils, and crop oil concentrates.

Aerification

Removal of soil cores from a turf with hollow tines or spoons.

Alternate

Leaves appear singly at each node as in prostrate knotweed.

Annual

A plant that starts from seed and completes its life cycle within the same growing season.

Auricle

A claw-like appendage projecting from the collar of the leaf.

Basal

Arising from the base of the stem.

Biennial

A plant that starts from seed and requires two years to complete its life cycle.

Blade

The flat portion of the grass leaf above the sheath.

Blend, seed

A combination of two or more cultivars of the same species, for example Rebel and Falcon tall fescue.

Broadcast

Uniform application to an entire area.

Broadleaf plants

Plants with flattened leaves; dicots, plants that possess two seedling leaves.

Bud leaf

First emerged leaf of a grass plant.

Bunchgrass, bunch-type growth

Plant development in the absence of rhizome and stolon production; a nonspreading grass.

Capsule

A dry type of fruit that contains seed.

Carrier

An inert material added to an active ingredient to prepare a formulation of a pesticide.

Collar

A narrow band marking the place where the blade and sheath of a grass leaf join.

- divided—collar divided by the midrib
- continuous—collar not divided by the midrib

Control

Keeping pests at tolerated levels.

Cool-season grasses

Turf species that have optimum growth at temperatures between 60 and 75°F.

Coring

See aerification.

Corm

A short, thickened, upright underground stem.

Creeping growth habit

Plant development at or near the soil surface that results in lateral spreading by rhizomes, stolons, or both.

Crop seed

Any seed grown for profit, often including undesirable grassy weeds, such as orchardgrass.

Crown

The portion of a grass plant that includes the stem apex, unelongated internodes, and lower nodes from which secondary roots begin.

Culm

A stem of a grass plant.

Cultivar

A cultivated variety of a species, such as K-31 and Rebel.

Cultivation

In turf, the working of the soil without the destruction of the turf.

Decumbent

Lying flat with the apex tip growing upward.

Emulsion

One liquid suspended in another, such as oil in water.

Dicot

A plant having two seed leaves or cotyledons. Generally refers to broadleaf plants.

Dormancy

The resting stage of a plant or ripe seeds during which nearly all manifestations of life come to an almost complete standstill.

Eradication

Total removal of a pest.

Flowable

A suspension consisting of finely ground, insoluble active ingredients in solid form mixed with a liquid and inert ingredients.

Fumigant, soil

A volatile material that vaporizes and destroys pests, such as methyl bromide.

Fungi

A major group of microorganisms commonly known as molds, mushrooms, and mildews; some cause disease.

Fungicide

A pesticide used to kill fungi.

Herbaceous

Refers to plants with nonwoody stems that normally die back to the ground in the winter.

Herbicide

A pesticide used to kill weeds.

Herbicide, arsonate

This class of herbicides poses very little toxicity to humans. Their mode of action is not well understood. The arsonates are also very water soluble. Arsonates include DSMA, MSMA (Buono 6, MSMA Turf), and CMA.

Herbicide, contact

Herbicide that injures only those portions of a plant with which it comes into contact.

Herbicide, dinitroaniline (DNA)

A class of herbicides that includes some of the most important soil-applied herbicides in turf. These herbicides are formulated as liquids, wettable dispersible granules, and granules. Herbicides in this class are mostly used to control crabgrass and goosegrass seedlings, as well as some small-seeded broadleaves. DNA herbicides are root inhibitors, and their primary mode of action is inhibition of mitosis. Examples include prodiamine (Barricade), benefin (Balan), pendimethalin (Pendulum, Pre-M, Weedgrass Control), and oryzalin (Surflan).

Herbicide, nonselective

Herbicide that kills or injures all plants. Some plant species may exhibit more tolerance than others. Examples include glyphosate (Roundup, Touchdown Pro), and glufosinate (Finale).

Herbicide, plant growth regulator (PGR)

This class of herbicides is used on more land area worldwide than any other herbicide group. The mode of action is not well understood, but in general they interfere with plant metabolism and transport. In turf, they are 2,4-D, 2,4-DB, clopyralid (Lontrel), triclopyr (Turflon Ester), and dicamba (Banvel).

Herbicide, postemergence (POST)

Herbicide that needs to be applied after weeds emerge to be effective.

Herbicide, pre-emergence (PRE)

Herbicide that needs to be applied before weeds emerge to be effective. Can be applied before or after turf establishment. Rainfall or irrigation is often needed to move the chemical into the top few inches of the soil for best activity.

Herbicide, selective

Herbicide that kills or injures some plants without harming others.

Herbicide, sulfonyleurea (SU)

A class of herbicides with high levels of activity at low application rates. In general, the SU herbicides are used to control annual bluegrass and perennial ryegrass during bermudagrass spring transition, as well as certain broadleaf weeds. Some members of this herbicide family also provide control of nutsedge and kyllinga species, and also dallisgrass when used with MSMA. The mode of action for this class is inhibition of the ALS enzyme that is used in biosynthesis. These chemicals are rapidly translocated, and resistance can become an issue. Examples include sulfosulfuron (Certainty), metsulfuron (Manor), trifloxysulfuron (Monument), foramsulfuron (Revolver), and rimsulfuron (TranXit GTA).

Herbicide, systemic

Herbicide that is taken up through contact with the leaves or through the soil (via contact with the roots) and is moved throughout the plant to kill the whole plant.

Herbicide, triazine

A class of herbicides that inhibits photosynthesis as the main mode of action. They are readily absorbed by both the roots and foliage of plants. This class of herbicides has tight restrictions due to concerns about atrazine leaching into groundwater. Triazines include atrazine (Purge, AAtrex), simazine (Princep, Regal Wynstar), and metribuzin (Sencor 75 Turf).

Herbicide, two-, three-, or four-way broadleaf

A combination product which is a mixture of either two, three, or four broadleaf herbicides that should be used when there are several different weed species present in the area being treated. Examples include Chaser 2 Amine (2,4-D amine + triclopyr), Trimec Classic (2,4-D amine, + mecoprop + dicamba), Escalade (2,4-D amine + fluroxypyr + dicamba), and Speed Zone (2,4-D ester + mecoprop + dicamba + carfentrazone).

Hybrid

The progeny resulting from a cross of individuals differing in one or more heritable characters.

Inflorescence

The flowering portion of a plant.

Insect

Members of the animal kingdom; all mature insects have six legs and three body segments.

Insecticide

A pesticide used to kill insects.

Larva

A stage in the development of certain insects, caterpillars (butterfly larva), or grubs (beetle larva).

LD 50

A lethal dose for 50 percent of the test animals.

Lesion

A localized area of diseased tissue.

Ligule

A thin projection from the top of the leaf sheath in grasses; it may be a fringe of hairs, membranous, or absent.

Lobe

Any rounded portion of a leaf.

Mixture, seed

A combination of seeds of two or more species, for example Kentucky bluegrass and perennial ryegrass.

Monocot

A plant having one seed leaf or cotyledon.

Mycelium

A cobweb-like growth of fungal tissue.

Nematicide

A pesticide used to kill nematodes.

Nematode

A microscopic, worm-like organism.

Nitrogen, quick release

Readily available sources of nitrogen that exhibit fast turf greening, short residual, and high burn potential, such as ammonium nitrate.

Nitrogen, slow release

Slowly available sources of nitrogen that exhibit slow turf green-up, long residual, and low burn potential, such as IBDU, urea formaldehyde.

Node

A joint where leaves, roots, branches, or stems arise.

Nymph

A stage in the development of certain insects where the young resemble the adult in form, eat the same food, and reside in the same environment.

Opposite

Leaves appear in pairs at each node along the stem.

Palmate

Leaflets attached to the petiole as fingers are on a hand.

Panicle

Seedhead in which the side branches are attached to the main axis with a stalk; may form a triangular shape.

Parallel

Leaf veins begin at the base of the leaf and run lengthwise along the whole leaf.

Parts per million (PPM)

The number of parts by weight or volume of a constituent in 1,000,000 parts of the final mixture, by weight or volume.

Pathogen

The causal agent of disease.

Perennial plant

A plant that may or may not start from seed, may or may not produce seed, and lives more than two years.

Phytotoxic

Poisonous to plants.

Pinnate

Leaflets arranged along the sides of a common axis; feather-like.

PSI

Pounds per square inch.

Prophyll

The first leaf of a branch off the main axis; a sheath-like structure.

Prostrate

Low growing; hugging the ground.

Puffiness

A spongy, irregular surface.

Raceme

Seedhead in which more than one slender spike is attached along the end of the stem. Individual spikes can be attached at one point or along the top of the stem in an alternate fashion.

Raking, power

Removal of debris with rapidly rotating vertical tines or brush.

Rhizome

An underground creeping stem that can produce roots and shoots at each node.

Rosette

A cluster of leaves radiating out from a central axis.

Scalping

Excessive removal of turf leaves by close mowing. Results in a brown, stubbly appearance.

Sclerotia

Seed-like, compact masses of fungal tissue that allow fungi to survive unfavorable conditions.

Seed, certified

A seed lot inspected to meet minimum standards and to ensure trueness to type for a given cultivar.

Semiarid turfgrass

Turfgrasses adapted to grow in semiarid regions without irrigation, such as buffalograss, gramagrass, and wheatgrasses.

Sepals

The floral organs found at the base of the flower; usually green and somewhat leaflike.

Sessile

Directly attached without a stem or stalk.

Sheath

The basal portion of the leaf surrounding the grass stem. In grass plants, it is usually split with overlapping edges.

Site or mode of action

The way that a pesticide works to kill an organism.

Slicing

Penetration of turf in a vertical plane by a series of solid flat tines.

Solution

Physically uniform mixture of two or more liquids.

Spike

Seedhead in which the side branches are attached to the main axis without a stalk.

Spiking

Penetration of turf in a vertical plane by series of solid round tines.

Spore

A microscopic seed-like reproductive unit that can germinate and give rise to more fungi.

Spreader

An ingredient that helps pesticides come in close contact with the plant surface.

Sprig

A stolon or rhizome used to establish turf.

Stamen

The male part of a flower that produces the pollen.

Sterilant, soil

Any chemical applied to the soil that prevents growth of plants for a long time.

Sticker

An ingredient that helps pesticides stick to plants.

Stipule

Appendage at the base of a leaf.

Stolon

An above-ground creeping stem that can produce roots and shoots at each node.

Surfactant

Several classes of chemicals that reduce the interfacial tension between water and plant material or other liquids. Classes of surfactants include wetting agents, spreaders, and stickers. Types of surfactants include anionic, cationic, and nonionic. The most common type of surfactant used in herbicide applications is nonionic.

Symptom

The visual characteristics associated with a given disease.

Thatch

A tightly intermingled layer of undecomposed roots, stems, and shoots located between the soil surface and the green vegetation of the turf grass.

Throat

The region between the sheath and blade on the ligule side of the leaf.

Tiller

A grass plant shoot arising in the axes of leaves in the unelongated portion of the stem.

Tolerance, turf

Ability of a turf species to withstand application of a pesticide (herbicide) at the normal dosage without being killed or injured. Specific tolerance may be associated with an anatomical or physiological characteristic in the plant.

Topdressing

A sand or prepared soil mix applied to the turf to help smooth the surface, enhance establishment, and reduce thatch buildup.

Toxicity

A term used to define a product's hazard potential.

Trifoliate

Leaf consisting of three leaflets, such as clover.

Tuber

An underground stem modified for food storage that is attached to the root system as found in yellow nutsedge.

Turf

A covering of mowed vegetation, usually a grass.

Turfgrass

A species or cultivar of grass, usually of spreading habit, which is maintained as a mowed turf.

Vernation

An arrangement of the youngest leaf in the bud shoot; rolled or folded.

Venation, leaf

Appearance of veins in the leaves. Leaf venation can be defined as pinnate, palmate, or parallel.

Volatile

Likely to vaporize.

Warm-season grasses

Turf that has its optimum growth at temperatures between 80 and 95°F.

Weed

A plant growing where it is not wanted.

Wetting agent

A chemical that aids in liquid-to-surface contact.

Whorl

Three or more flowers, branches, or leaves located at one node.

For More Information

This and the following Extension publications about lawns are available on the NC State TurfFiles Web site: <http://www.TurfFiles.ncsu.edu/>. Or contact your county Cooperative Extension center for copies.

Tall Fescue Lawn Maintenance Calendar (AG-367)

<http://www.TurfFiles.ncsu.edu/pubs/management/ag367.html>

Centipedegrass Lawn Maintenance Calendar (AG-381)

<http://www.TurfFiles.ncsu.edu/pubs/management/ag381.html>

Bermudagrass Lawn Calendar (AG-431)

<http://www.TurfFiles.ncsu.edu/pubs/management/ag431.html>

Zoysiagrass Lawn Calendar (AG-432)

<http://www.TurfFiles.ncsu.edu/pubs/management/ag432.html>

Diseases of Warm-Season Grasses (AG-360)

<http://www.TurfFiles.ncsu.edu/pubs/pathol/ag360.html>

Controlling White Grubs in Turf (AG-366)

<http://www.TurfFiles.ncsu.edu/pubs/insects/ag366.html>

Carolina Lawns is also available online: <http://www.TurfFiles.ncsu.edu/pubs/management/ag69.html>

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30,000 copies of this public document were printed at a cost of \$11,139, or \$0.37 per copy.

Published by

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