UT Extension
PB1632

Bermudagrass Athletic Field

Management Calendar

TURFGRASS SCIENCE
The University of Tennessee

THE UNIVERSITY of TENNESSEE

Bermudagrass Athletic Field Management Calendar

Tom Samples
Professor
Plant Sciences

John C. Sorochan
Assistant Professor
Plant Sciences

J. Scott McElroy
Assistant Professor
Plant Sciences

Frank A. Hale
Professor
Entomology and Plant Pathology

Hubert J. Savoy, Jr.
Associate Professor
Biosystems Engineering and Soil Science

and

Alan S. Windham
Professor
Entomology and Plant Pathology

Acknowledgements

The authors thank Gary Bates, Steven Garton, Wanda Russell and Jim Wills for editing this publication and Gary Dagnan for providing graphic design. Their encouragement, support and many talents are greatly appreciated.

Table of Contents

page

Table of Contents (cont.)

page

Bermudagrass Athletic Field Management Calendar

Introduction

Bermudagrasses are very aggressive, low-growing and wear-tolerant turfgrasses that provide a dense, resilient sports turf. They grow best at air temperatures from 80 to 95 F. In Tennessee, bermudagrasses are most often dormant in late fall, winter and early spring. Unless plants are severely injured during this dormancy period, they are capable of resuming growth as temperatures rise in the spring.

Bermudagrass varieties may vary in color, texture, density, vertical and lateral growth rate, low-temperature hardiness, disease resistance and method of establishment. Clonal, hybrid [e.g., interspecific cross between 'Common' bermudagrass (*Cynodon dactylon*) and 'African' bermudagrass (*C. transvaalensis*)] bermudagrasses do not produce viable seeds and must be established from sprigs, plugs or sod. Improved, common bermudagrasses such as 'Jackpot,' 'Mirage,' 'Pyramid,' 'Riviera,' 'Sundevil II' and 'Yukon' can be seeded. 'Quickstand' and 'Vamont' are low-temperature-tolerant, vegetatively established varieties. Because of its openness, the clonal variety Vamont is easily overseeded. The overall turf quality of Quickstand is similar to Vamont, but finer in texture. Quickstand has also demonstrated a very low incidence of spring dead spot. Although the low-temperature tolerance of 'Tifway' (Tifton 419) is limited and 'winterkill' tendency is quite high, this hybrid remains a popular choice for many newly constructed athletic fields. Tifway has cold hardiness superior to 'Tifgreen.' The hybrid Tifgreen (Tifton

328) is very dense, withstands very short mowing heights and often requires intensive management. 'Tifsport,' a dark-green, vegetatively established hybrid bermudagrass released for sod production in 1995 and adapted as far north as Stillwater, OK and Lexington, KY, is maintained on several newer athletic fields throughout the state. 'GN-1,' a recent introduction with patents in the U. S. and Australia, is darker green and has wider leaves than Tifway. 'Tifton 10,' a drought-resistant, high-temperature-tolerant variety was originally collected in Shanghai, China in 1974. Plants are coarse-textured and have dark bluish-green foliage. 'Patriot,' recently released by Oklahoma State University, is another vegetatively established variety being evaluated for potential use on athletic fields in Tennessee.

Location, soils and management influence bermudagrass performance. Climatic conditions, weed competition and pest activity often vary from year to year. Management programs may be adjusted annually, based on observed results. This management calendar is intended to serve as a quick reference and guide for the monthly care of bermudagrass athletic fields in Tennessee.

Equipment Needs

- Boom and hand-held (or back-pack) sprayers
- Core aerifier
- Drag mat
- Mower (reel mower preferred)
- Topdresser
- Tractor (with flotation or turf tires)
- Tractor-mounted rotary or pendulum spreader
- Utility vehicle
- Vertical mower or power rake
- Walk-behind rotary and drop spreaders

An assortment of equipment is needed to maintain high-quality athletic fields. Bermudagrasses require routine mowing, irrigation and fertilization. Coring (core aerification) several times throughout the growing season helps reduce soil compaction, a primary cause of turf loss. Vertical mowing is often necessary to remove thatch. Topdressing (e.g., 1/8-inch in depth) with sand or soil will smooth and firm the soil surface. Pesticide applications may be necessary to control troublesome weeds, disease and insects.

Mowing

Mow when the turf is dry. Reel mowers most often provide the highest-quality cut. Whenever possible, return clippings to the turf. As clippings decompose, essential nutrients are again available to plants.

Height:
Mow vegetatively established hybrids at a cutting height from 3/4 to 1½ inches; 'Common' and improved, common bermudagrasses, from 1 to 1½ inches. Raise the cutting height before low temperature and drought stresses of winter.

Frequency:
Mow often, removing no more than one-third of the aerial shoots each time.

Direction:
Change the direction of mowing often to distribute wear and soil compaction.

Figure 1. A power-driven reel mower.

Mowing Calendar

Month	J	F	M	A	M	J	J	A	S	O	N	D
Mow				m[1]	M[1]	M	M	M	m	m		

[1] m indicates that although mowing may be required this month, the rate of growth of bermudagrass may be slowed by low temperatures. M implies that warm temperatures may promote rapid vertical and lateral growth of bermudagrass during the month.

Irrigation

Irrigation is required for maintaining strong, wear-resistant bermudagrass. Actively growing plants often contain more than 75 percent water by weight. An underground, automatic sprinkler system is most often preferred when irrigating heavy-use sports turf.

Amount:
Irrigate to supplement rainfall. Actively growing bermudagrasses usually require from 1 to 1½ inches (about 635 to 940 gallons of water per 1,000 square feet) of water each week.

Frequency:
Try to water no more than twice each week. Moisten soil to a 6-inch depth each time.

When to Irrigate:
Watering during early morning hours (e. g., 5:00 a.m. to 10:00 a.m.) will limit the amount of time leaf tissue remains moist and will reduce the amount of water lost to evaporation.

Irrigation Calendar

Month	J	F	M	A	M	J	J	A	S	O	N	D
Irrigate				I[2]	I	I	I	I	I	I		

[2] I indicates that bermudagrass most often benefits from supplemental irrigation. Water lost to evaporation and transpiration this month most often exceeds the average total monthly rainfall received in many areas of Tennessee.

Figure 2. An underground sprinkler system with automatic controller.

Fertilization

Thirteen of the 16 nutrients essential for the growth and survival of bermudagrass are supplied by the soil. These mineral nutrients may be classified, according to the amount required by turfgrasses, as primary, secondary or micronutrients. The primary nutrient required in greatest amounts by bermudagrasses is nitrogen (N). The potassium (K) level in bermudagrass plant tissue is second to N, and phosphorus (P) ranks third. Fertilizers containing N, P and K are often applied during the growing season to meet the plant demand for these primary nutrients. A soil test is recommended every two to three years to determine P, K and acidity levels in the soil.

In Tennessee, many soils have enough secondary (calcium, magnesium, sulfur) and micronutrients (iron, manganese, boron, copper, zinc, molybdenum and chlorine). However, periodic fertilization with one or more of these essential minerals may be necessary to maintain nutrient balance, especially when bermudagrass is growing in soils amended with sand or organic matter. Soils can be tested to determine the amounts of secondary and micronutrients available to bermudagrasses. Leaf tissue can also be analyzed to evaluate the nutritional status of plants and to identify those nutrients that may be limiting growth.

Example Fertilization Program (Using Only Quickly Available N Sources)[a]

Late February to Mid-March[b] Apply a starter fertilizer with pre-emergence herbicide [e.g., a 5-5-25 fertilizer containing 5 percent N, 5 percent available phosphate (P_2O_5) and 25 percent water-soluble potash (K_2O) with 1.73% oxadiazon[c] (Ronstar®) at the rate of 175 pounds of product per acre (supplying about 2/10 pound of N and P_2O_5 and 1 pound of K_2O per 1,000 square feet)] for crabgrass and goosegrass control and to supply bermudagrass plants with N, P and K as they resume growth following winter dormancy. Water (½ inch) immediately after treating the turf.

Late April to Mid-May Apply a fertilizer containing a higher concentration of N than that applied in late February or March. For example, an application of 30-10-10 fertilizer at the rate of 150 pounds per acre will supply about 1 pound of N, 3/10 pound of P_2O_5 and 3/10 pound of K_2O per 1,000 square feet. Depending on the pre-emergence herbicide applied with the starter fertilizer in late February or March, the application of a fertilizer + pre-emergence herbicide combination may provide extended crabgrass and goosegrass control. Water the turf with at least ½ inch of water immediately after fertilizing.

---

[a] This program, using fertilizer materials containing quickly available N sources only, is intended to serve as an example. Choice of fertilizers should be based on soil test results, turf quality expectations and budget. Avoid the application of excessive amounts of highly water-soluble N. Apply no more than 1 pound of quickly available N per 1,000 square feet each time. The use of extended-release N sources can minimize the potential for fertilizer "burn" and promote more consistent bermudagrass growth above and below ground.
Ammonium nitrate (33-0-0), potassium nitrate (13-0-44) and urea (46-0-0) are examples of quickly available N sources. Sources including isobutylidene diurea (31-0-0), milorganite (6-2-0), polymer-coated urea (38-0-0), sulfur-coated urea (32-0-0) and ureaformaldehyde (38-0-0) contain slowly available N. These N sources can usually be applied less often, at higher rates compared to water-soluble, quickly available sources. A comparison of several N sources is presented in Table 1.

[b] Due to variations in the soil surface temperature, the fertilizer + pre-emergence herbicide combination may need to be applied much earlier in West Tennessee than at higher elevations in East Tennessee.

[c] Several herbicides in addition to oxadiazon (Ronstar®) are labeled for the pre-emergence control of crabgrass and goosegrass in bermudagrass athletic fields. However, if bermudagrass has been severely injured during cold winter or spring months, and the athletic field must be sprigged, this pre-emergence herbicide is labeled for use when planting bermudagrass sprigs.

Mid-June Apply 125 pounds of ammonium nitrate (33-0-0) or 100 pounds of urea (46-0-0) per acre after core aerifying. This application will supply 1 pound of quickly available N per 1,000 square feet.[d] Water (½ inch) immediately after fertilizing.

Mid-July Apply 125 pounds of ammonium nitrate (33-0-0) or 100 pounds of urea (46-0-0) per acre after core aerifying. This application will supply 1 pound of quickly available N per 1,000 square feet. Water (½ inch) immediately after fertilizing.

Mid-August Apply 125 pounds of ammonium nitrate (33-0-0) or 100 pounds of urea (46-0-0) per acre after core aerifying. This application will supply 1 pound of quickly available N per 1,000 square feet. Water (½ inch) immediately after fertilizing.

Mid-September Apply a fertilizer containing N, P_2O_5 and K_2O. For example, 300 pounds of 15-5-30 per acre will supply about 1 pound of N, 1/3 pound of P_2O_5 and 2 pounds of K_2O per 1,000 square feet. Potassium applied in combination with N at this time could improve the low-temperature hardiness of bermudagrasses. Water (½ inch) immediately after fertilizing. This will be the final fertilization for this calendar year.

Figure 3. A tractor-mounted, broadcast spreader used to fertilize bermudagrass.

[d] If soils test low in P and K, a fertilizer containing N, P_2O_5 and K_2O may be substituted for ammonium nitrate or urea. For example, 30-10-10 fertilizer broadcast at a rate of 150 pounds per acre will supply about 1 pound of N, 3/10 pound of P_2O_5 and 3/10 pound of K_2O per 1,000 square feet. When soil test results indicate that P or K is in the very high range, further applications of the nutrient testing very high should be omitted. If grass clippings are collected and removed, the amount of K applied annually should be increased [for example, apply an additional 2 pounds K_2O per 1,000 square feet (about 88 pounds K_2O per acre) each year] to compensate for the amount of K lost.

Table 1. A Comparison of Several N Sources

Nitrogen Source	~ Content (%)[a]			Salt Index per Unit[b]	Cold-Water Solubility[c] (lbs. / gal.)	Comments
	N	P_2O_5	K_2O			
Fast-Release						
Ammonium nitrate	33	0	0	3.2 H	14.5	Contains both ammonium ions that are adsorbed by soil colloids and nitrate ions, that may be mobile in soils
Ammonium sulfate	21	0	0	3.3 H	5.7	Contains 24 percent sulfur and has the greatest acidifying effect of materials listed
Calcium nitrate	15	0	0	---	---	Contains 19 percent calcium in addition to nitrogen; absorbs moisture very rapidly
Diammonium phosphate	18	46	0	1.7 M	3.4	Provides both nitrogen and phosphorus; very soluble phosphate source
Monoammonium phosphate	11	48	0	2.7 H	1.9	Although less soluble than DAP, MAP has a greater salt index per unit
Potassium nitrate	13	0	44	5.3 H	1.0	May slightly increase soil pH as it rapidly releases nitrogen
Urea	45	0	0	1.7 M	6.2	This highly water-soluble nitrogen source contains the highest nitrogen concentration of any granular fertilizer
Extended Release						
IBDU (isobutylidene diurea)	31	0	0	0.2 L	SS	Contains two molecules of urea linked by a carbon group; nitrogen release is dependent on soil moisture (hydrolysis)
Milorganite	6	4	0	0.7 L	SS	Nitrogen in this activated sewage sludge is released by microbial activity
PCU [polymer (plastic) - coated urea]	38	0	0	---	SR	Soil moisture (osmosis) is required for nitrogen release
SCU (sulfur-coated urea)	32	0	0	0.7 L	SR	The permeable sulfur (molten) coating allows water to slowly move through the barrier, dissolving the enclosed urea; nitrogen release is dependent on microbial activity and soil moisture (hydrolysis)
UF (urea formaldehyde or methylene ureas)	38	0	0	0.3L	SS	Nitrogen is released from the various-size, 'chain-like' polymers of urea as a result of soil microorganism activity

[a] To calculate the phosphorus content (percent) of each fertilizer, multiply percent P_2O_5 by 0.44; and to calculate the potassium content (percent), multiply percent K_2O by 0.83.

[b] Partial salt index expressed as the relative salinity of mineral salts per unit of nutrient compared to sodium nitrate (6.3). High = 2.6 or greater; moderate = 1.0 to 2.5; and low = less than 1.0.

[c] SS = slowly soluble and SR = slow release.

Table 2. Some Common Sources of Phosphorus and Potassium in Turfgrass Fertilizers

Source	Approximate Content (%)			Salt Index per Unit[c]	Cold-Water Solubility (lbs. / gal.)	Comments
	N	P_2O_5[a]	K_2O[b]			
Diammonium phosphate	18	46	0	1.7 M	3.4	Very soluble phosphate source
Monoammonium phosphate	11	48	0	2.7 H	1.9	Although less soluble than DAP, MAP has a greater salt index per unit
Muriate of potash	0	0	60	1.9 M	2.8	Very commonly used source of potassium
Potassium magnesium sulfate	0	0	22	---	---	Contains about 18 percent magnesium and 23 percent sulfur in addition to potassium; releases nutrients rapidly
Potassium nitrate	13	0	44	5.3 H	1.0	May neutralize some soil acids as it rapidly releases nitrogen
Sulfate of potash	0	0	50	0.9 L	0.9	Has a lower foliar burn potential than muriate of potash and contains 18 percent sulfur
Superphosphate	0	20	0	0.4 L	0.2	Decreases soil acidity; contains calcium and sulfur in the gypsum ($CaSO_4$) component that acts as a drying agent
Treble superphosphate	0	44	0	0.2 L	0.3	Concentrated source of phosphorus

[a] To calculate the phosphorus content (percent) of each fertilizer, multiply percent P_2O_5 by 0.44.
[b] To calculate the potassium content (percent), multiply percent K_2O by 0.83.
[c] Expressed as the relative salinity of mineral salts per unit of nutrient compared to sodium nitrate (6.3). High = 2.6 or greater; moderate = 1.0 to 2.5; and low = less than 1.0.

Table 3. Some Common Sources of Calcium, Magnesium and Sulfur in Turfgrass Fertilizers

Source	Approximate Calcium Content (%)	Approximate Magnesium Content (%)	Approximate Sulfur Content (%)
Ammonium sulfate	0	0	24
Agricultural limestone (calcium carbonate)	32	0	0
Calcium hydroxide	46	1	0
Calcium metaphosphate	19	0	0
Calcium nitrate	19	2	0
Calcium oxide	52	0	0
Dolomitic limestone	22	11	0
Ferrous ammonium sulfate	0	0	16
Ferrous sulfate	0	0	18
Gypsum	22	0	19
Magnesium carbonate (magnesite)	0	28	0
Magnesium hydroxide	0	40	0
Magnesium oxide	0	55	0
Epsom salt (magnesium sulfate)	0	10	14
Potassium magnesium sulfate	0	11	22
Potassium sulfate	0	0	17
Sulfur, elemental	0	0	99
Superphosphate	21	0	12

Table 4. Some Common Sources of Micronutrients Applied to Turfgrasses

Micronutrient	Source	Approximate Content
Boron	Borax	11% boron
	Boric acid	17% boron
	Solubor	20% boron
Chlorine	Potassium chloride	47% chlorine
Copper	Copper chelate[a]	6 to 13% copper
	Copper oxide	75% copper
	Copper sulfate, pentahydrate	25% copper
Iron	Ferric oxide	69% iron
	Ferric sulfate	23% iron
	Ferrous ammonium sulfate	14% iron
	Ferrous oxide	77% iron
	Iron ammonium polyphosphate	22% iron
	Iron (ferrous) sulfate	20% iron
	Iron chelate[a]	5 to 14% iron
Manganese	Manganese carbonate	31% manganese
	Manganese chelate[a]	12% manganese
	Manganese chloride	17% manganese
	Manganese methoxyphenylpropane	10 to 12% manganese
	Manganese oxide	63% manganese
	Manganese sulfate	26 to 28% manganese
	Manganous oxide	41 to 68% manganese
Molybdenum	Ammonium molybdate	49% molybdenum
	Sodium molybdate	39% molybdenum
Zinc	Basic zinc sulfate	55% zinc
	Zinc carbonate	52% zinc
	Zinc chelate[a]	14% zinc
	Zinc oxide	78% zinc
	Zinc phosphate	51% zinc
	Zinc sulfate monohydrate	35% zinc
	Zinc sulfate heptahydrate	23% zinc

[a] Micronutrients can be combined with organic compounds to produce more stable or 'chelated' carriers. Chelated micronutrient carriers usually have a longer residual response in soils and are less prone to loss by leaching than other highly water-soluble carriers.

Fertilization Calendar

Month	J	F	M	A	M	J	J	A	S	O	N	D
Fertilize		Fh_1[3]	Fh_1	Fh_2[4]	Fh_2	F[5]	F	F	F			

[3] Fh_1 indicates that a fertilizer + pre-emergence herbicide combination is recommended from late February to mid-March to control summer annual weed grasses including crabgrasses and goosegrass while fertilizing bermudagrass. For example, oxadiazon (Ronstar®) will control crabgrasses and goosegrass before seedlings emerge from the soil and will not harm newly sprigged bermudagrass.

[4] Fh_2 indicates that fertilization will promote the growth of bermudagrass this month and, depending on the pre-emergence herbicide applied with the starter fertilizer in late February or March, a pre-emergence herbicide applied with fertilizer in late April or May could extend the crabgrass and goosegrass control period.

[5] F indicates that fertilization will promote the growth of bermudagrass this month.

Liming

Apply ground or pelletized limestone according to soil test results. If the acid content of the soil is low (e.g., soil pH from 6.0 to 7.0), liming is not recommended. Agricultural or ground limestone is available in either calcitic or dolomitic forms and is commonly used to neutralize soil acids. Calcitic limestone contains mostly calcium carbonate and supplies calcium to bermudagrass. Dolomitic limestone contains both calcium and magnesium. Some companies market agricultural limestone that has been compressed into pellet form for ease of spreading. Pelletized limestone is often much easier to apply than pulverized limestone. Rainfall or irrigation immediately after liming will help disperse the pellets.

When to Apply:
Limestone can be applied to bermudagrass athletic fields almost any time of year. For maintenance applications, do not broadcast more than 2,000 pounds of agricultural or pelletized-agricultural limestone per acre (about 50 pounds per 1,000 square feet) per application.

Figure 4. Pelletized dolomitic limestone.

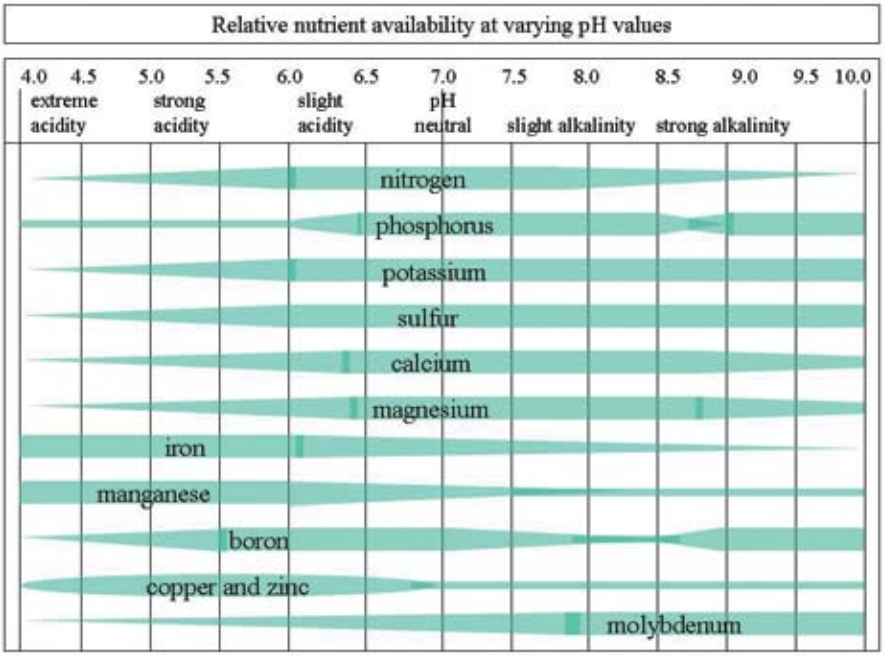

Figure 5. The influence of soil pH on nutrient availability.

For more detailed information, please refer to Extension **PB1096, Liming Acid Soils in Tennessee**.

Coring

Soil compaction is a major cause of bermudagrass loss on many athletic fields throughout Tennessee each year. In addition to relieving soil compaction, coring will improve the movement of water through thatch and into the soil. Fertilizing immediately after coring will help speed the movement of nutrients into the bermudagrass root zone. For best results when using a rotary-motion core aerifier, aerify several times across the turf and in several directions. Use a drag-mat or water the turf to break up the soil cores lying on the turf surface after coring.

Core compacted soils often during the bermudagrass growing season. In addition to relieving soil compaction, monthly coring from May to August will speed water infiltration and bermudagrass recovery.

Figure 6. A rotary-motion, hollow-tine core aerifier.

Figure 7. A deep-tine core aerifier.

Coring Calendar

Month	J	F	M	A	M	J	J	A	S	O	N	D
Coring					C[6]	C	C	C				

[6] *C indicates that bermudagrass may benefit from coring during the month.*

Topdressing

Topdressing, the application of a uniform layer of soil or sand to athletic fields, will help smooth the soil surface and build up low areas that may develop. Medium-textured sands and soils similar to the existing soil base may be used as topdressing materials. Topdressing to create a 1/4-inch thick layer is often especially effective immediately following core aerification. A drag mat may be used after topdressing to thoroughly mix topdressing materials and the soil from aeration cores with thatch.

Light applications (e. g., 1/8- to 1/4-inch deep) of topdressing materials can be made throughout the bermudagrass growing season.

Figure 8. A topdressing machine used to broadcast a thin, uniform layer of sand or soil over bermudagrass.

Table 5. The Volume of Material Required to Topdress Athletic Fields or Amend Soils

Amounts of topdressing or soil amendment needed:
1/8 inch in depth requires about 0.4 cubic yards per 1,000 square feet
1/4 inch in depth requires about 0.8 cubic yards per 1,000 square feet
1 inch in depth requires about 3.2 cubic yards per 1,000 square feet
6 inches in depth requires about 19.2 cubic yards per 1,000 square feet

Table 6. The Approximate Weight of Selected Materials

Material	Approximate Weight (Lbs./Cubic Yard)
Loam - Loose	2,200
Loam - Compact	2,550
Clay - Compact	2,700
Clay - Wet	3,050
Clay + Sand - Compact	3,250
Silty Sand - Wet	3,100
Sand - Dry	2,700
Peat Moss - Compact	450
Peat Moss - Loose	110

Topdressing Calendar

Month	J	F	M	A	M	J	J	A	S	O	N	D
Topdressing					T[7]	T	T	T				

[7] *T indicates that bermudagrass athletic fields are commonly topdressed during the month.*

Dethatching

Dethatch bermudagrass when the thatch layer reaches a depth of ½ inch or more. Dethatch in March, before bermudagrass resumes growth and pre-emergence herbicide is applied, or in the summer, when plants are growing rapidly and will recover quickly.

Bermudagrass produces new plant parts, "sloughing off" old leaves, stems and roots. A thatch layer forms when plants are growing rapidly and the rate of accumulation of old plant materials exceeds their rate of decay. Excessive thatch causes several problems. The entwined layer of undecomposed and partially decomposed roots, stems, leaves and grass clippings may restrict the movement of water, air and nutrients into the soil. Thatch provides an excellent environment for insect pests and fungal pathogens. Young bermudagrass plants rooted within the thatch layer are often susceptible to drought. Temperature fluctuations in the thatch layer are more extreme than those in the soil below.

Excessive nitrogen fertilization, scalping and prolonged drought favor an accumulation of thatch. Mechanical dethatching is recommended when a ½-inch layer of thatch forms. Power rakes and vertical mowers are engineered for thatch removal. Machines for mechanically removing thatch from the soil surface often have blades, knives or tines mounted on a reel that revolves on a vertical plane. They are most effective when set to penetrate the thatch layer, lightly striking the soil below. A power sweeper is very useful when removing the loosened organic material. The rate of recovery of bermudagrass after dethatching varies with the climatic conditions, soil fertility level and method of thatch removal.

Figure 9. A vertical mower used to remove thatch from bermudagrass.

Dethatching Calendar

Month	J	F	M	A	M	J	J	A	S	O	N	D
Dethatching			D[8]			D	D					

[8] D indicates that, if necessary, bermudagrass may be dethatched during the month. Thatch removal in March, while bermudagrass is dormant, may help speed spring green-up. Actively growing plants often recover quickly following dethatching in June or July. Dethatching is not generally recommended in August if a temporary reduction in turfgrass shear strength is unacceptable and the athletic field will receive heavy use in late summer and early fall.

Winter Protection

A uniform layer of straw, at a rate of about three tons per acre, will help insulate bermudagrass and conserve moisture during the winter dormancy period. Rake the straw off the turf surface when the threat of extended periods of freezing temperatures has passed. Although wheat and oat seeds in straw may germinate, seedlings of these cereal grains do not usually tolerate repeated mowing at a 3/4 to 1½ inch height of cut. During late spring and summer, bermudagrass competes with wheat and oat seedlings for available moisture, light and nutrients. Although some of the straw may deteriorate over winter, it may be possible to rake much of it from the turf surface and bale it for use the next year.

Winter protective covers (synthetic blankets) often vary in color, thickness, light interception, weight, insulation value and cost. Several help buffer bermudagrass from low-temperature extremes while allowing water and some light to pass through.

Figure 10. Straw protecting a dormant bermudagrass football field from winter injury.

Table 7. The Effects of Soil Temperature on Bermudagrasses

Soil Temperature (F)	Plant Response
80 to 95	Optimum growth of aerial shoots
65 to 79	Reduction in the growth rate of aerial shoots
55 to 64	Plant hardening
50 to 54	Chilling temperatures damage leaves
32 to 49	Dormancy
20 to 31	Roots and aerial shoots are often severely injured and may die; nodes often live
Less than 20	Total low-temperature kill

Winter Protection Calendar

Month	J	F	M	A	M	J	J	A	S	O	N	D
Broadcast Straw for Winter Protection											St[9]	St
Remove Straw			St_r[10]									

[9] *St = Broadcast straw or install a winter protective cover in late November or early December to protect dormant bermudagrass from low-temperature extremes during winter.*
[10] *St_r = Remove straw or winter protection cover when the threat of extended periods of freezing temperatures is low (for example, from early to mid-March).*

Predicting the Probability of a Freeze

Freeze probabilities have been developed based on weather data recorded at 43 sites across Tennessee from 1921 through 1950. Air temperature recorded at each location was measured by thermometer about 4½ feet above ground in a weather instrument shelter. This information may be particularly helpful when scheduling bermudagrass maintenance practices in spring and fall.

Figure 11. Frost pattern on bermudagrass.

Table 8. The Probability of Freezing Temperatures (32 F) On or After Indicated Dates

Station	Probability[a] (%) - Spring				
	90	75	50	25	10
Ashwood	Mar. 26[b]	Apr. 1	Apr. 8	Apr. 15	Apr. 21
Bolivar	Mar. 12	Mar. 22	Apr. 3	Apr. 15	Apr. 25
Bristol	Apr. 2	Apr. 8	Apr. 16	Apr. 24	May 1
Brownsville	Mar. 11	Mar. 19	Mar. 28	Apr. 5	Apr. 13
Carthage	Mar. 20	Mar. 29	Apr. 7	Apr. 16	Apr. 25
Chattanooga WB Airport	Mar. 9	Mar. 17	Mar. 26	Apr. 4	Apr. 12
Clarksville	Mar. 19	Mar. 27	Apr. 4	Apr. 12	Apr. 20
Coldwater	Mar. 27	Apr. 3	Apr. 11	Apr. 19	Apr. 26
Copperhill	Mar. 28	Apr. 4	Apr. 11	Apr. 18	Apr. 24
Covington	Mar. 10	Mar. 18	Mar. 27	Apr. 4	Apr. 12
Crossville	Apr. 5	Apr. 13	Apr. 21	Apr. 29	May 7
Dale Hollow Dam	Mar. 31	Apr. 6	Apr. 13	Apr. 20	Apr. 26
Decatur	Mar. 31	Apr. 6	Apr. 14	Apr. 22	Apr. 30
Dickson	Mar. 25	Apr. 1	Apr. 10	Apr. 18	Apr. 26
Dover	Mar. 29	Apr. 6	Apr. 15	Apr. 24	May 2
Franklin	Mar. 27	Apr. 4	Apr. 12	Apr. 20	Apr. 28
Gatlinburg	Apr. 14	Apr. 21	Apr. 29	May 7	May 14
Greeneville Exp. Sta.	Apr. 5	Apr. 12	Apr. 20	Apr. 28	May 5
Jackson Exp. Sta.	Mar. 22	Mar. 29	Apr. 6	Apr. 14	Apr. 21
Kenton	Mar. 15	Mar. 23	Apr. 1	Apr. 10	Apr. 18
Knoxville WB Airport	Mar. 14	Mar. 22	Mar. 31	Apr. 9	Apr. 17
Lewisburg	Mar. 31	Apr. 6	Apr. 14	Apr. 22	Apr. 29
Loudon	Mar. 21	Mar. 31	Apr. 10	Apr. 20	Apr. 30
Lynnville	Mar. 26	Apr. 3	Apr. 13	Apr. 23	May 1
McMinnville	Mar. 21	Mar. 29	Apr. 8	Apr. 18	Apr. 26
Memphis WB Airport	Mar. 1	Mar. 10	Mar. 20	Mar. 30	Apr. 8
Milan	Mar. 16	Mar. 25	Apr. 4	Apr. 14	Apr. 23
Moscow	Mar. 18	Mar. 25	Apr. 2	Apr. 10	Apr. 17
Murfreesboro	Mar. 20	Mar. 28	Apr. 5	Apr. 13	Apr. 21
Nashville WB Airport	Mar. 12	Mar. 19	Mar. 28	Apr. 6	Apr. 13
Newbern	Mar. 11	Mar. 18	Mar. 27	Apr. 5	Apr. 12
Newport	Mar. 28	Apr. 4	Apr. 11	Apr. 18	Apr. 25
Norris Dam	Apr. 3	Apr. 9	Apr. 16	Apr. 23	Apr. 29
Palmetto	Mar. 27	Apr. 3	Apr. 10	Apr. 17	Apr. 24
Paris	Mar. 27	Apr. 3	Apr. 12	Apr. 21	Apr. 28
Rogersville	Apr. 4	Apr. 10	Apr. 17	Apr. 24	Apr. 30
Rugby	Apr. 17	Apr. 24	May 3	May 12	May 20
Samburg Wildlife Rfg.	Mar. 11	Mar. 20	Mar. 29	Apr. 7	Apr. 16
Savanaah	Mar. 17	Mar. 26	Apr. 4	Apr. 13	Apr. 22
Springfield Exp. Sta.	Mar. 24	Mar. 31	Apr. 7	Apr. 14	Apr. 21
Tullahoma	Mar. 26	Apr. 2	Apr. 10	Apr. 18	Apr. 25
Union City	Mar. 15	Mar. 22	Mar. 31	Apr.. 9	Apr.. 16
Waynesboro	Apr.. 1	Apr.. 9	Apr.. 18	Apr.. 27	May 5

[a] *Probabilities are intended to describe average conditions across the state.*

[b] *The listed probability of a spring freeze (32 F) occurring at Ashwood on or after March 26 is 90 percent (e.g., the odds of a spring freeze on or after March 26 are 9 to 1).*

Table 9. The Probability of Freezing Temperatures (32 F) On or Before Indicated Dates

Station	Probability[a] (%) - Fall				
	10	25	50	75	90
Ashwood	Oct. 9	Oct. 16	Oct. 24[b]	Nov. 1	Nov. 8
Bolivar	Oct. 6	Oct. 14	Oct. 23	Nov. 1	Nov. 9
Bristol	Oct. 8	Oct. 15	Oct. 23	Oct. 31	Nov. 7
Brownsville	Oct. 18	Oct. 24	Oct. 31	Nov. 7	Nov. 13
Carthage	Oct. 13	Oct. 20	Oct. 28	Nov. 5	Nov. 12
Chattanooga WB Airport	Oct. 27	Nov. 2	Nov. 9	Nov. 17	Nov. 25
Clarksville	Oct. 17	Oct. 23	Oct. 29	Nov. 4	Nov. 9
Coldwater	Oct. 6	Oct. 13	Oct. 21	Oct. 29	Nov. 6
Copperhill	Oct. 9	Oct. 16	Oct. 23	Oct. 30	Nov. 6
Covington	Oct. 23	Oct. 28	Nov. 3	Nov. 9	Nov. 14
Crossville	Sept. 26	Oct. 4	Oct. 14	Oct. 24	Nov. 1
Dale Hollow Dam	Oct. 4	Oct. 12	Oct. 21	Oct. 30	Nov. 7
Decatur	Oct. 11	Oct. 17	Oct. 24	Oct. 31	Nov. 6
Dickson	Oct. 8	Oct. 15	Oct. 23	Oct. 31	Nov. 7
Dover	Oct. 4	Oct. 11	Oct. 19	Oct. 27	Nov. 3
Franklin	Oct. 5	Oct. 13	Oct. 21	Oct. 29	Nov. 6
Gatlinburg	Oct. 1	Oct. 8	Oct. 16	Oct. 24	Oct. 31
Greeneville Exp. Sta.	Oct. 1	Oct. 8	Oct. 17	Oct. 26	Nov. 2
Jackson Exp. Sta.	Oct. 9	Oct. 16	Oct. 23	Oct. 30	Nov. 6
Kenton	Oct. 8	Oct. 16	Oct. 24	Nov. 1	Nov. 9
Knoxville WB Airport	Oct. 24	Oct. 30	Nov. 6	Nov. 13	Nov. 19
Lewisburg	Oct. 4	Oct. 12	Oct. 20	Oct. 28	Nov. 5
Loudon	Oct. 8	Oct. 16	Oct. 24	Nov. 1	Nov. 9
Lynnville	Oct. 5	Oct. 12	Oct. 20	Oct. 28	Nov. 4
McMinnville	Oct. 12	Oct. 20	Oct. 28	Nov. 5	Nov. 13
Memphis WB Airport	Oct. 26	Nov. 3	Nov. 12	Nov. 21	Nov. 29
Milan	Oct. 11	Oct. 18	Oct. 26	Nov. 3	Nov. 10
Moscow	Oct. 8	Oct. 16	Oct. 24	Nov. 1	Nov. 9
Murfreesboro	Oct. 10	Oct. 17	Oct. 25	Nov. 2	Nov. 9
Nashville WB Airport	Oct. 27	Nov. 1	Nov. 7	Nov. 13	Nov. 18
Newbern	Oct. 15	Oct. 22	Oct. 31	Nov. 9	Nov. 16
Newport	Oct. 9	Oct. 16	Oct. 24	Nov. 1	Nov. 8
Norris Dam	Oct. 12	Oct. 19	Oct. 27	Nov. 4	Nov. 11
Palmetto	Oct. 6	Oct. 14	Oct. 24	Nov. 3	Nov. 11
Paris	Oct. 19	Oct. 25	Oct. 31	Nov. 6	Nov. 12
Rogersville	Oct. 8	Oct. 16	Oct. 24	Nov. 1	Nov. 9
Rugby	Sept. 26	Oct. 2	Oct. 8	Oct. 14	Oct. 20
Samburg Wildlife Rfg.	Oct. 20	Oct. 26	Nov. 2	Nov. 9	Nov. 15
Savanaah	Oct. 11	Oct. 19	Oct. 28	Nov. 6	Nov. 14
Springfield Exp. Sta.	Oct. 18	Oct. 24	Oct. 30	Nov. 5	Nov. 11
Tullahoma	Oct. 10	Oct. 16	Oct. 23	Oct. 30	Nov. 5
Union City	Oct. 16	Oct. 22	Oct. 28	Nov. 3	Nov. 9
Waynesboro	Oct. 1	Oct. 8	Oct. 15	Oct. 22	Oct. 29

[a] *Probabilities are intended to describe average conditions across the state.*

[b] *The listed probability of a fall freeze (32 F) occurring in Ashwood on or before October 24 is 50 percent (e.g., the odds of a fall freeze on or before October 24 are 1 to 1).*

Providing Fall and Spring Color

Perennial ryegrass can be seeded ('overseeded') in late summer or early fall into established bermudagrass for color and improved winter playability. New, disease-resistant perennial ryegrass varieties and seed blends (two or more varieties of perennial ryegrass) are most often preferred. Annual ryegrass has very poor low-temperature hardiness and may lose stand density in the spring, creating a non-uniform turf surface. A typical perennial ryegrass overseeding rate is from 10 to 15 pounds of seed per 1,000 square feet. By decreasing the mowing height, collecting clippings, dethatching and dragging the bermudagrass with a drag mat before seeding, more ryegrass seeds should contact soil. The competition of perennial ryegrass plants for water, nutrients and light often lowers the density and overall quality of bermudagrass the following spring. Several green pigments and dyes are also available to color dormant bermudagrass. Although pigments are often more expensive than dyes, they usually provide color for a much longer period of time.

Perennial Ryegrass Overseeding Calendar

Month	J	F	M	A	M	J	J	A	S	O	N	D
Overseeding Established Bermudagrass with Perennial Ryegrass									PR[11]			

[11] PR indicates that bermudagrass can be overseeded with perennial ryegrass this month to provide color during the winter dormancy period.

Removing Perennial Ryegrass

Rising temperatures, N fertilization, dethatching and frequent mowing during late spring and summer usually favor the growth and recovery of bermudagrass. Perennial ryegrasses often experience high-temperature stress and are disease-prone (e.g., cottony blight, and Bipolaris, Drechslera and Rhizoctonia diseases) during hot weather, when bermudagrasses are growing rapidly. The herbicides foramsulfuron (Revolver®), trifloxysulfuron (Monument®) and rimsulfuron (TranXit®) are labeled for the selective removal of perennial ryegrass plants from established (at least 1-year-old) bermudagrass turf. Optimum timing for removal of perennial ryegrass overseeding is May 1 to June 15. These herbicides will control perennial ryegrass in 17 to 24 days following application, depending on temperature and moisture conditions. In addition, these herbicides can also be applied from seven to 21 days prior to overseeding bermudagrass with perennial ryegrass to control early-germinating annual bluegrass. See label recommendations for specific rate and timing.

Weeds and Their Control

The best weed control is a healthy, dense, actively growing turf. The presence of many weeds in bermudagrass usually indicates the need to adjust the overall management program.

Turfgrass weeds may produce many seeds, bulbs and above- or below-ground stems from which new plants establish. Weed seeds are transported by wind, water and animals. Wash the mower often. Stems, bulbs and seeds are easily transported by machinery and spread to other non-infested areas. Topdressing materials and straw used to smooth and mulch the soil surface, respectively, may contain weed seeds, bulbs, stolons and rhizomes.

An important first step in developing a successful weed management program is the identification of troublesome weed(s). Next, determine the extent of the problem. Are plants uniformly distributed throughout the turf or located in a limited number of zones? Are weeds competing with actively growing bermudagrass plants for available nutrients, water, light and space or merely reducing the turf's beauty? Can the competitiveness of bermudagrass be improved by mowing, fertilizing, watering, aerifying or dethatching or is a herbicide application necessary? If herbicide treatment is required, determine the stage of growth at which the target weed is most vulnerable and respond accordingly.

Turfgrass weeds are divided into two major groups: weed grasses and broadleaf weeds. Weed grasses (e.g., crabgrasses, goosegrass, ...) emerge from seed with a single seedling leaf. They have leaves with parallel veins. Broadleaf weeds (e.g., white clover, dandelion, ...) emerge from seed with two seedling leaves. The veins of leaves of broadleaf weeds form a network-like pattern. Turfgrass weeds may be annuals, biennials or perennials and are further subdivided by their season of growth.

Summer Annual Weed Grasses

Each year, smooth crabgrass, large crabgrass, goosegrass and foxtails germinate from seed and may compete with bermudagrass for available moisture, nutrients and light. These aggressive summer annual weed grasses begin emerging from seed in the spring, grow very fast during summer months and complete their life cycle or die by late fall.

Winter Annual Weed Grasses

Seeds of winter annual weed grasses (e.g., annual bluegrass and annual ryegrass) germinate in late summer, fall and winter. These weeds usually complete their life cycle in the spring.

Summer Annual Broadleaf Weeds

Lespedeza, prostrate spurge and prostrate knotweed are examples of low-growing, summer annual broadleaf weeds that begin emerging from seed in the spring and invade bermudagrass during summer months.

Figure 12. Crabgrass.

Figure 13. Goosegrass.

Figure 14. Annual Bluegrass.

Figure 15. Prostrate Knotweed.

Winter Annual Broadleaf Weeds

Common chickweed, purple deadnettle, henbit and speedwell are frequently observed growing in dormant bermudagrass. These winter annual broadleaf weeds complete their life cycle or die as air temperature increases in the spring.

Perennial Weeds

Perennial weed grasses and broadleaf weeds live for more than two years. Dallisgrass, nimblewill and orchardgrass are difficult-to-control perennial weed grasses. Mouse-ear chickweed, white clover, Virginia buttonweed and ground ivy are creeping perennials. Dandelion, broadleaf plantain, buckhorn plantain and curly dock are perennial broadleaf weeds that do not form creeping, above- or below-ground stems. Wild garlic and wild onion, found throughout Tennessee, reproduce by bulbs and seeds.

Indicator Weeds

Some weeds are very competitive when soil and climatic conditions are less than ideal for bermudagrass growth. The presence of annual bluegrass, annual lespedeza, broadleaf plantain, corn speedwell, goosegrass, prostrate knotweed or prostrate spurge often signals that the soil is compacted. Black medic and clover may indicate low or deficient levels of nitrogen. Annual lespedeza, goosegrass, prostrate knotweed, prostrate spurge and yellow woodsorrel are often problems on drought-prone sites. Algae, annual bluegrass, moss and rushes often thrive in excessively wet soils.

Selecting a Herbicide

An effective athletic field maintenance program can result in fewer herbicide applications. If a herbicide is necessary to suppress or control a weed problem, choose, purchase and apply an appropriate product very carefully. Some herbicides are applied just before weeds are expected to appear. These pre-emergence herbicides often reduce the need to apply post-emergence (to actively growing weeds) herbicides. Post-emergence herbicides are usually most effective when applied as foliar sprays to young, actively growing, emerged weeds.

Controlling Crabgrasses and Goosegrass

Pre-emergence

Crabgrass seeds usually begin to germinate shortly after forsythia blooms. Generally, goosegrass seeds begin to germinate about one month after crabgrasses. Apply an appropriate pre-emergence herbicide at the recommended (label) rate in the spring when daytime temperatures reach 65 F for four or more days. Examples of preemergence herbicides are: benefin (Balan®), benefin + oryzalin (XL®), benefin + trifluralin (Team®), bensulide (Bensumec®), bensulide + oxadiazon (Scott's Goose-

Figure 16. Henbit.

Figure 17. Dallisgrass.

Figure 18. Algae.

grass/Crabgrass Control®), dithiopyr (Dimension®), metolachlor (Pennant®), oryzalin (Surflan®), oxadiazon (Ronstar®), pendimethalin (Pendulum®) and prodiamine (Barricade®)]. Other combinations and formulations of these herbicides exist. The level of control often drops if pre-emergence herbicides are not activated by watering (½ inch) or rainfall within about seven days after treatment.

Pre-emergence Crabgrasses/Goosegrass Control Calendar

Month	J	F	M	A	M	J	J	A	S	O	N	D
Pre-emergence Crabgrasses/ Goosegrass Control		H_{pr1} CG[12]	H_{pr1} CG	H_{pr2} CG[13]	H_{pr2} CG							

[12] H_{pr1}CG indicates that, if necessary, a herbicide or granular fertilizer + herbicide combination may be applied from late February to mid-March for pre-emergence control of crabgrasses and goosegrass. For example, a pre-emergence herbicide + starter fertilizer (containing P, K and very little N) combination will control crabgrasses and goosegrass as weed seeds germinate while supplying bermudagrass with the essential primary nutrients.
[13] Depending on the pre-emergence herbicide or pre-emergence herbicide + starter fertilizer combination applied in late February or March, a second pre-emergence herbicide application from late April to mid-May could extend the crabgrass and goosegrass control period. The pre-emergence herbicide could be applied in combination with a fertilizer.

Post-emergence

Several products [e.g., disodium methanearsonate (DSMA), metribuzin (Sencor® – for application by commercial turfgrass applicators) and monosodium methane arsonate (MSMA)] are labeled for the control of emerged crabgrasses and goosegrass in bermudagrass. For example, MSMA may effectively control young crabgrass and goosegrass plants when applied at a rate of 2 pounds active ingredient per acre when the air temperature reaches 80 degrees F and soils are moist. For example, 1/3 gallon (42 2/3 ounces) of a product containing 6 pounds active ingredient (MSMA) per gallon applied per acre is the equivalent of 2 pounds active ingredient per acre. A second application may be necessary for best control of heavy infestations of crabgrasses and goosegrass. MSMA application(s) may temporarily discolor bermudagrass.

Post-emergence Crabgrasses/Goosegrass Control Calendar

Month	J	F	M	A	M	J	J	A	S	O	N	D
Post-emergence Crabgrass/ Goosegrass Control						H_{po}CG[14]	H_{po}CG					

[14] H_{po}CG indicates that, if necessary, a herbicide may be applied for post-emergence control of crabgrasses and goosegrass during the month.

Controlling Annual Bluegrass

Pre-emergence

Many herbicides labeled for the pre-emergence control of crabgrasses and goosegrass effectively control annual bluegrass. For best results, apply the herbicide in late summer, before seeds of this troublesome winter annual weed grass germinate, and water (½ inch) within one week following the herbicide application. Pre-emergence herbicide applications are not generally recommended for the control of annual bluegrass if bermudagrass will be overseeded with perennial ryegrass.[e]

Pre-emergence Annual Bluegrass Control Calendar

Month	J	F	M	A	M	J	J	A	S	O	N	D
Pre-emergence Annual Bluegrass Control								H_{pr}AB[15]	H_{pr}AB			

[15] H_{pr}AB indicates that, if necessary, a herbicide may be applied in August or September for pre-emergence control of annual bluegrass. A pre-emergence herbicide application is not generally recommended for the control of annual bluegrass if bermudagrass will be overseeded with perennial ryegrass.

[e] Perennial ryegrass can be overseeded six weeks after the application of Balan® 2.5G.

Post-emergence

Pronamide (Kerb®) provides post-emergence and pre-emergence control of annual bluegrass when applied in the fall or early winter (e.g., November 15 to December 15) before the soil freezes. The product may also be used in the spring to remove overseeded perennial ryegrass and should not be applied to bermudagrass intended to be overseeded. For information regarding additional products for post-emergence control of annual bluegrass and certain other winter annual broadleaf weeds, please refer to the section "Controlling Winter Annual and Perennial Broadleaf Weeds and Weed Grasses in Dormant Bermudagrass."

Controlling Annual Sedge, Purple Nutsedge and Yellow Nutsedge

Annual sedge (*Cyperus compressus*) produces seeds in clusters of flat, green spikes with a few long leaves suspended on bare stems. The seedhead of yellow nutsedge (*Cyperus esculentus)*, a creeping perennial, is yellowish-brown or straw-colored. The leaf tip is needle-like. Round, energy-storage organs (tubers) located at the end of below-ground stems (rhizomes) are capable of producing leaves and roots. Stems of yellow and purple (*Cyperus rotundus*) nutsedge are triangular. The seedhead of purple nutsedge is purple to reddish-brown. The leaf tip of purple nutsedge is blunt. Purple nutsedge plants may produce a network of below-ground chains of rhizomes and tubers.

Pre-emergence

The herbicide metolachlor (Pennant®) is labeled for the pre-emergence control of annual sedge in bermudagrass. Metolachlor also provides pre-emergence control of yellow nutsedge. Delay overseeding until four or more months following the application of metolachlor. Do not overseed four months before or six months after applying metolachlor. Oxadiazon (Ronstar®), pendimethalin (Pendulum®), prodiamine (Barricade®) and other herbicides that control crabgrass and goosegrass also control annual sedge pre-emergence; however, they will not control yellow nutsedge in this manner.

Figure 19. Annual Sedge.

Figure 21. Yellow Nutsedge.

Figure 20. Purple Nutsedge.

Post-emergence

Bentazon (Basagran®) is labeled for the post-emergence control of annual sedge and yellow nutsedge in established bermudagrass. Calcium methanearsonate (CMA), disodium methanearsonate (DSMA), halosulfuron (Manage®), imazaquin (Image®) and monosodium methanearsonate (MSMA) are labeled for post-emergence suppression or control of annual sedge, purple nutsedge and yellow nutsedge in bermudagrass turf (Table 10). Repeat applications (e.g., 10 to 14 days for bentazon and MSMA, three to four weeks for halosulfuron) are most often required for best results. Trifloxysulfuron (Monument®) and sulfosulfuron (Certainty®) are also labeled for post-emergence sedge control. These herbicides provide the broadest control of sedge species compared to MSMA and other traditional herbicides.

Table 10. Relative Post-Emergence Sedge Control and Tolerance of Bermudagrass and Perennial Ryegrass to Several Herbicides

Herbicide(s): Common Name (Trade Name)	Control			Bermudagrass Tolerance[a]	Perennial Ryegrass Tolerance[a]
	Annual Sedge	Purple Nutsedge	Yellow Nutsedge		
Bentazon (Basagran®)	Good	Poor	Fair to Good	Safe	Safe
CMA/DSMA/MSMA (Several Brands)	Good	Poor to Fair	Fair	Intermediate Safety to Safe	Not Registered
Halosulfuron (Sedgehammer®)	Good	Fair to Good	Good to Excellent	Safe	Safe
Imazaquin (Image®)	Good	Fair to Good	Good	Intermediate Safety to Safe	Not Registered
Imazaquin (Image®) + DSMA/MSMA (Several Brands)	Good to Excellent	Good	Good to Excellent	Intermediate Safety	Not Registered
Trifloxysulfuron (Monument ®)	Excellent	Good to Excellent	Excellent	Safe	Not Registered
Sulfosulfuron (Certainty®)	Excellent	Good	Excellent	Safe	Not Registered

[a] Safe = safe at labeled rates on healthy and mature turf. Intermediate Safety = may cause minor damage to healthy and mature turf. Not intended to be applied to turfgrasses exposed to stress. Consider applying reduced rates. Not Registered = not registered for use and/or damages this turfgrass species.

Controlling Summer Annual and Perennial Broadleaf Weeds

Post-emergence

Post-emergence herbicides such as 2,4-D amine, mecoprop (MCPP), dicamba, fluroxypyr, triclopyr and clopyralid are usually applied as a foliar spray within 30 days following the emergence of susceptible broadleaf weeds. For example, 2,4-D amine at a rate of 1 to 2 quarts formulation (3.8 lbs. active ingredient per gallon formulation) per acre applied in June or July often controls emerged summer annual (e.g., prostrate knotweed and spurge) and perennial (e.g., dandelion and white clover) broadleaf weeds. For improved post-emergence control of crabgrasses, goosegrass and foxtails, MSMA can be tank mixed with 2,4-D amine.[f] The addition of a surface active agent (surfactant) to the spray solution may improve herbicide effectiveness. Do not apply 2,4-D amine, MCPP or dicamba during spring green-up.

[f] Several formulations containing 2,4-D amine (e.g., 2,4-D amine + MCPP, 2,4-D amine + dicamba, 2,4-D amine + MCPP + dicamba, ...) are also labeled for the control of emerged broadleaf weeds in bermudagrass and may be compatible with MSMA.

Controlling Winter Annual and Perennial Broadleaf Weeds

Post-emergence

The herbicide 2,4-D amine (2 qts. of the 3.8 pounds active ingredient per gallon formulation per acre) may also be applied in November or December to control emerged broadleaf weeds such as clover, dandelions, plantains, wild garlic and wild onion. A second (e.g., mid-January to mid-February) application may be necessary for best control of wild garlic and other broadleaf weeds. Please refer to product labels for more precise information and mixing instructions.

Post-emergence Broadleaf Weed Control Calendars

Month	J	F	M	A	M	J	J	A	S	O	N	D
Post-emergence Summer Broadleaf Weed Control						$H_{po}SB$[16]	$H_{po}SB$					

[16] *$H_{po}SB$ indicates that a herbicide or herbicide combination may be applied, as needed, for the post-emergence control of many summer annual and perennial broadleaf weeds this month.*

Month	J	F	M	A	M	J	J	A	S	O	N	D
Post-emergence Winter Broadleaf Weed Control	$H_{po}WB$[17]	$H_{po}WB$									$H_{po}WB$	$H_{po}WB$

[17] *$H_{po}WB$ indicates that a herbicide or herbicide combination may be applied, as needed, for post-emergence control of many winter annual and perennial broadleaf weeds this month.*

Controlling Winter Annual and Perennial Broadleaf Weeds and Weed Grasses in Dormant Bermudagrass

Pre-emergence and Early Post-emergence in Dormant Bermudagrass

Like pronamide (Kerb®), simazine (e.g., Princep®) will control annual bluegrass in dormant bermudagrass. Since simazine enters weeds mainly through their roots, moisture is necessary to move the herbicide through thatch and into the root zone of the target weed(s). Simazine will also control several winter annual and perennial broadleaf weeds. Annual bluegrass resistance to triazine herbicides, such as simazine, has been reported in Tennessee and other Southeastern states. Failure to control annual bluegrass with simazine could indicate a resistant population.

Pre-emergence and Early Post-emergence Winter Weed Control in Dormant Bermudagrass Calendar

Month	J	F	M	A	M	J	J	A	S	O	N	D
Early Post-emergence and Pre-emergence Winter Weed Control											$H_{prepo}WW$[18]	$H_{prepo}WW$

[18] *$H_{prepo}WW$ indicates that, if necessary, either pronamide (Kerb®) or simazine (e.g. Princep® and Regal Wynstar®) can be applied to dormant bermudagrass this month (either in November or December), for pre-emergence and early post-emergence control of annual bluegrass and certain winter annual and perennial broadleaf weeds.* **CAUTION: Simazine or pronamide should not be applied to bermudagrass overseeded with perennial ryegrass for fall and spring color.**

Post-emergence in Dormant Bermudagrass

Several herbicides, including diquat (Reward®), glyphosate (Roundup® Pro) and metribuzin (Sencor® – for application by commercial turfgrass applicators), are labeled for the post-emergence control of certain broadleaf weeds and weed grasses in dormant bermudagrass. These herbicides are applied in liquid to actively growing weeds before bermudagrasses green-up. Bermudagrass must be dormant. Adding a non-ionic surfactant to a herbicide solution containing diquat or glyphosate may improve herbicide performance. Please read and follow label directions very carefully. Diquat, glyphosate and metribuzin will severely damage or kill ryegrass; therefore, these herbicides should not be applied to dormant bermudagrass overseeded with perennial ryegrass. The addition of metsulfuron, trifloxysulfuron or traditional broadleaf herbicides can potentially aid in controlling difficult-to-control winter weeds such as wild garlic and white clover.

Post-emergence Winter Weed Control in Dormant Bermudagrass Calendar

Month	J	F	M	A	M	J	J	A	S	O	N	D
Post-emergence Winter Weed Control in Dormant Bermudagrass	$H_{pod}WW$[19]	$H_{pod}WW$										

[19] $H_{pod}WW$ indicates that diquat (Reward®), glyphosate (Roundup® Pro) or metribuzin (Sencor® – by commercial turfgrass applicators) can be applied to dormant bermudagrass this month for post-emergence control of annual bluegrass and certain winter annual and perennial broadleaf weeds.
CAUTION: Diquat, glyphosate or metribuzin should not be applied to bermudagrass overseeded with perennial ryegrass for fall and spring color. Bermudagrass must be dormant.

For more precise information regarding herbicides and application rates, please refer to Extension **PB1539, Weed Management Recommendations for Professional Turfgrass Managers: Athletic Fields, Golf Courses, Commercial Lawns and Turfgrass-sod**.

Diseases

Bermudagrasses are susceptible to several diseases. A combination of three factors is required for a disease to develop. These are: a susceptible host (bermudagrass), a pathogen and a favorable environment. For example, several pathogens require free water on bermudagrass leaves and optimum temperatures to cause disease. For specific disease control recommendations, please refer to Extension **PB842, Turfgrass Diseases and Their Control**.

Figure 22. Dollar Spot.

Figure 23. Spring Dead Spot.

Table 11. Symptoms of Several Common Diseases of Bermudagrass

Disease	Symptoms
Brown Patch	Brown patches up to 12 feet in diameter develop during spring green-up.
Dollar Spot	Small, round spots approximately 1 to 3 inches in diameter develop on closely mowed turf. Larger patches of bleached grass develop in bermudagrass maintained at a higher cutting height. Light tan lesions with a distinct dark margin at each edge may appear on infected bermudagrass leaves. Short, fuzzy white mycelium may be visible on lesions when dew is present.
Fairy Rings	Symptoms vary from small to large circles of dark green bermudagrass, dead bermudagrass, mushrooms or puffballs or as combinations of these symptoms. Soils in the rings are often difficult to wet during the summer and fall.
Helminthosporium Diseases	These fungi can affect bermudagrass leaves, crowns or roots. Helminthosporium leaf spot diseases are characterized by small, brown circular lesions that may eventually enlarge and girdle leaves, causing plants to appear light brown or tan. When these diseases attack bermudagrass roots and crowns, the turf may appear to fade out and become thin. These fungi may also affect bermudagrass developing from seed.
Spring Dead Spot	Dead spots may appear in mature (e.g., 3 to 5 years old) bermudagrass as growth resumes after the winter dormancy period. Each spring, for the next three to four years, the spots appear in the same location and expand. After the second or third year of disease activity, rings of dead grass may appear. Bermudagrass may slowly cover these rings of dead grass during summer. The disease may disappear after three to four years.

Table 12. Common Diseases of Bermudagrass and Factors Favoring Their Development

Disease	Factors Favoring Disease Development
Brown Patch	Warm, wet weather; high N fertility level; common on bermudagrass during spring green-up
Dollar Spot	Wet weather; heavy dew; low N fertility level; warm days and cool nights
Fairy Rings	Mushrooms often appear in wet weather
Helminthosporium Leaf Spot	Wet weather and a high level of N fertility
Spring Dead Spot	Cold weather, excessive thatch and high N fertility

Bermudagrass Disease Calendar

Month	J	F	M	A	M	J	J	A	S	O	N	D
Brown Patch				X[20]	X	X	X	X	X			
Dollar Spot					X	X	X	X	X			
Fairy Rings	X	X	X	X	X	X	X	X	X	X	X	X
Helminthosporium Leaf Spot					X	X	X	X	X	X		
Spring Dead Spot			X	X								

[20] X indicates that the disease may occur during the month. Depending on the disease severity, application(s) of an appropriate fungicide may be required. Spring dead spot may be controlled by applying an appropriate fungicide in the fall before climatic conditions favor disease development.

Insects

Very few of the many insects living in the turf injure bermudagrass. Insects that do cause damage are classified as root-feeding, shoot-feeding or burrowing. Grubs, billbugs and mole crickets feed on bermudagrass roots. Sod webworms, armyworms, cutworms and chinch bugs feed on aerial shoots. Ants, burrowing bees and wasps often nest in the turf. For information regarding insect control in bermudagrass, please refer to Extension **PB1342, Commercial Turfgrass Insect Control**.

Table 13. Common Insect Pests of Bermudagrass

Pest(s)	Comments
Ants	Usually present, ants are generally not pests. When populations are large, ants can excavate soil, covering bermudagrass plants. Mounds disrupt the uniformity of the soil surface and bermudagrass plants usually wilt.
Armyworms and Cutworms[21]	Occasional pests, armyworm caterpillars measure approximately 1½ inches long at maturity; cutworms, 1½ to 2 inches in length. Armyworms have distinct stripes along the sides of their bodies. Cutworms are larvae of night-flying moths. Several generations of armyworms and cutworms may occur in one growing season.
Bees and Wasps	Some species of bees and wasps burrow into bermudagrass to form their nests. They are usually present and are generally not considered major pests.
Billbugs	Billbugs are considered occasional pests. Overwintering adults usually lay eggs in bermudagrass stems. Larvae feed within stems and hollow them out. They eventually migrate to the roots to feed.
White Grubs[22]	Larvae of several Scarab beetles are frequent pests of bermudagrass in Tennessee. These include green June beetle, Japanese beetle, black turfgrass ataenius and chafers. When large white grub populations exist, severely damaged turf can often be rolled back like a carpet.
Mole Crickets	These occasional pests feed on bermudagrass roots. Plants may be uprooted as mole crickets burrow through the soil.
Sod Webworms[21]	Sod webworm larvae live in thatch during the day and feed on bermudagrass leaves at night. Mature larvae are about 3/4 inch in length, tan and spotted.

[21] To check for cutworms and sod webworms, prepare a soap solution by adding 2 teaspoons of liquid dishwashing detergent to a gallon of water. Pour this solution over 4 square feet of turf. Treat with an appropriate insecticide when one or more cutworms or four or more sod webworms are found per 4 square feet.

[22] Several insecticides effectively control white grubs. Treat bermudagrass when the population reaches the economic "aesthetic" threshold for the problem grub species. Sample several 1 square-foot sections of turf to determine the white grub population. Use a shovel or spade to cut out and lift each section of turf 1 to 2 inches deep and count the number of grubs present. Treat in early to mid-August when the economic threshold has been reached.

Table 14. Threshold Targets for White Grubs[23]

Pest	Number of Grubs per Square Foot
Annual White Grubs (Japanese Beetle, Oriental Beetle, European Chafer and Asiatic Garden Beetle)	5 to 10
Masked Chafer (Annual White Grub)	15 to 20
Black Turfgrass Ataenius	30 to 60
May/June Beetles	3 to 8
Green June Beetle	6 to 8

[23] Assuming adequate growing conditions and no digging animals.

Bermudagrass Insect Calendar

Month	J	F	M	A	M	J	J	A	S	O	N	D
Ant(s)	X[24]	X	X	X	X	X	X	X	X	X		
Armyworms, Cutworms				X	X	X	X	X	X			
Bees and Wasps						X	X	X	X	X		
Billbugs					X	X	X					
White Grubs		X	X	X			X	X	X			
Green June Beetle Grubs			X	X			X	X	X			
Mole Crickets			X	X								
Sod Webworm						X	X	X	X	X		

[24] X indicates that the insect may be present this month. An insecticide application may be required when damage is apparent.

Figure 24. Green June Beetle Larvae.

Figure 25. Fall Armyworm Larvae.

Bermudagrass Athletic Field Management Calendar

Maintenance Practice by Month

Month / Management Practice	J	F	M	A	M	J	J	A	S	O	N	D
Mowing				m[1]	M[1]	M	M	M	m	m		
Irrigation				I[2]	I	I	I	I	I	I		
Fertilization		Fh_1[3]	Fh_1	Fh_2[4]	Fh_2	F[5]	F	F	F			
Coring					C[6]	C	C	C				
Topdressing					T[7]	T	T	T				
Dethatching			D[8]			D	D					
Broadcast Straw for Winter Protection											St[9]	St
Remove Straw			St_r[10]									
Overseeding Established Bermudagrass with Perennial Ryegrass									PR[11]			

[1] m indicates that although mowing may be required this month, the rate of growth of bermudagrass may be slowed by low temperatures. M implies that warm temperatures may promote rapid vertical and lateral growth of bermudagrass.

[2] I indicates that water lost to evaporation and transpiration during the month most often exceeds the average total monthly rainfall received in many areas of Tennessee. Bermudagrass most often benefits from supplemental irrigation this month.

[3] Fh_1 indicates that a fertilizer + pre-emergence herbicide combination is recommended from late February to mid-March to control summer annual weed grasses including crabgrasses and goosegrass while fertilizing bermudagrass. For example, oxadiazon (Ronstar®) will control crabgrasses and goosegrass before seedlings emerge from the soil and will not harm newly sprigged bermudagrass.

[4] Fh_2 indicates that fertilization will promote the growth of bermudagrass this month and, depending on the pre-emergence herbicide applied with the starter fertilizer in late February or March, a pre-emergence herbicide applied with fertilizer in late April or May could extend the crabgrass and goosegrass control period.

[5] F indicates that fertilization will promote the growth of bermudagrass this month.

[6] C indicates that bermudagrass may benefit from coring during the month.

[7] T indicates that bermudagrass may be topdressed as needed during the month.

[8] D indicates that, if necessary, bermudagrass may be dethatched during the month. Thatch removal in March, while bermudagrass is dormant, may help speed spring green-up. Actively growing plants often recover quickly following dethatching in June or July. Dethatching is not generally recommended in August if a temporary reduction in turfgrass shear strength is unacceptable and the athletic field will receive heavy use in late summer and early fall.

[9] St = Broadcast straw in late November or early December to protect dormant bermudagrass from low-temperature extremes during winter.

[10] St_r = Remove straw when the threat of extended periods of freezing temperatures is low (for example, from early to mid-March).

[11] PR indicates that bermudagrass can be overseeded with perennial ryegrass this month to provide color during the winter dormancy period.

Crabgrass Control by Month

Month	J	F	M	A	M	J	J	A	S	O	N	D
Pre-emergence		H_{pr1} CG[12]	H_{pr1} CG	H_{pr2} CG[13]	H_{pr2} CG							
Post-emergence						H_{po}CG[14]	H_{po}CG					

[12] *H_{pr1}CG indicates that, if necessary, a herbicide or granular fertilizer + herbicide combination may be applied from late February to mid-March for pre-emergence control of crabgrass and goosegrass. For example, a pre-emergence herbicide + starter fertilizer (containing P, K and very little N) combination will control crabgrass and goosegrass as weed seeds germinate while supplying bermudagrass with the essential primary nutrients.*

[13] *Depending on the pre-emergence herbicide or herbicide + starter fertilizer combination applied in late February or March, a second pre-emergence herbicide application from late April to mid-May could extend the crabgrass and goosegrass control period. The pre-emergence herbicide could be applied in combination with fertilizer.*

[14] *H_{po}CG indicates that, if necessary, a herbicide may be applied for post-emergence control of crabgrass and goosegrass during the month.*

Annual Bluegrass Control by Month

Month	J	F	M	A	M	J	J	A	S	O	N	D
Pre-emergence								H_{pr}AB[1]	H_{pr}AB			

[15] *H_{pr}AB indicates that, if necessary, a herbicide may be applied in August or September for pre-emergence control of annual bluegrass. Several herbicides labeled for pre-emergence control of crabgrasses and goosegrass also control annual bluegrass when applied just before seeds of this winter annual weed grass germinate. A pre-emergence herbicide application is not generally recommended for the control of annual bluegrass if bermudagrass will be overseeded with perennial ryegrass.*

Summer Broadleaf Weed Control by Month

Month	J	F	M	A	M	J	J	A	S	O	N	D
Post-emergence						H_{po}SB[16]	H_{po}SB					

[16] *H_{po}SB indicates that a herbicide or herbicide combination may be applied, as needed, for the post-emergence control of many summer annual and perennial broadleaf weeds this month.*

Winter Broadleaf Weed Control by Month

Month	J	F	M	A	M	J	J	A	S	O	N	D
Post-emergence	H_{po}WB[17]	H_{po}WB									H_{po}WB	H_{po}WB

[17] *H_{po}WB indicates that a herbicide or herbicide combination may be applied, as needed, for post-emergence control of many winter annual and perennial broadleaf weeds this month.*

Winter Weed Control in Dormant Bermudagrass by Month

Month	J	F	M	A	M	J	J	A	S	O	N	D
Pre-emergence and Early Post-emergence in Dormant Bermudagrass											H_{prepo}WW[18]	H_{prepo}WW

[18] *H_{prepo}WW indicates that, if necessary, either pronamide (Kerb®) or simazine (Princep® and Regal Wynstar®) can be applied to <u>dormant</u> bermudagrass this month (either in November or December), for pre-emergence and early post-emergence control of annual bluegrass and certain winter annual and perennial broadleaf weeds.* **CAUTION: Simazine or pronamide should <u>not</u> be applied to bermudagrass overseeded with perennial ryegrass for fall and spring color.**

Month	J	F	M	A	M	J	J	A	S	O	N	D
Post-emergence in Dormant Bermudagrass	$H_{pod}WW$[19]	$H_{pod}WW$										

[19] $H_{pod}WW$ indicates that diquat (Reward®), glyphosate (Roundup® Pro) or metribuzin (Sencor® – by commercial applicators) can be applied to dormant bermudagrass this month for post-emergence control of annual bluegrass and certain winter annual and perennial broadleaf weeds. **CAUTION: Diquat, glyphosate or metribuzin should not be applied to bermudagrass overseeded with perennial ryegrass for fall and spring color. Bermudagrass must be dormant.**

Recommendations of specific herbicides are included in this publication as a convenience to the reader. The use of brand names and any mention or listing does not imply endorsement by the University of Tennessee nor discrimination against similar products not mentioned. Individuals using herbicides are responsible for ensuring that the intended use complies with current regulations and the product label. Always read the label before selecting, purchasing, mixing and applying a herbicide and follow label directions very carefully.

References

Boyd, J. 1998. Turfgrass Weed Control for Professionals. University of Arkansas. Division of Agriculture, Cooperative Extension Service, MP 370, pp. 9-10.

McCarty, B. 2000. 2000 Clemson University Pest Control Recommendations for Professional Turfgrass Managers. South Carolina Cooperative Extension Service, Clemson University, EC699, pp. 68-69.

Pickett, B. S. and M. H. Bailey. 1964. Freeze probabilities in Tennessee. University of Tennessee Agric. Exp. Sta. and Weather Bureau, U. S. Dept. of Commerce cooperating, Bull. 374.

Potter, D. A. 1982. Influence of Feeding by Grubs of the Southern Masked Chafer on Quality and Yield of Kentucky Bluegrass. J. Econ. Entomol. 75: 21-24.

Schumann, G. L., P. J. Vittum, M. L. Elliott and P. P. Cobb. 1998. IPM Handbook for Golf Courses. Ann Arbor Press, Inc., Chelsea, MI, p. 168.

Sheltar, D. J. 1992. "Lawns and Turf/North" in *1992 Insect Control Guide*, F. R. Hall, E. L. Knake, R. H. McCarty, J. Mortvedt and D. L. Terry [eds.], Meister Publishing Co., Willoughby, OH, pp. 324-325

Turgeon, A. J. 1985. "Fertilization" in *Turfgrass Management*, Prentice-Hall, Inc., Englewood Cliffs, NJ, pp. 164-165.

Visit the UT Extension Web site at
http://www.utextension.utk.edu/

PB1632-2M-6/07 E12-5115-00-016-07 07-0238