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The Art and Invention Era in the Early Evolution of Turfs—1830 to 1952

James B Beard

A paper summarizing the key early inventions and art-related developments in the evolution of turfgrasses has not been addressed. Thus, over the past two decades this author has spent considerable time in the major libraries in the United States and the United Kingdom, including the Royal Horticultural Society, Kew Gardens, British Museum, Victoria and Albert Museum, and various Sports Association libraries. Through extensive study of the limited literature from a large number of unrelated writings over hundreds of years, this author has assimilated and presents the following chronology of key turfgrass developments in the early years, from 1830 to 1952. The criteria for their selection included the impact on all types of turf use, and not just one segment such as golf turf.

The evolution of turfs as we know them today occurred in association with animal agriculture in climates favorable for grass growth, especially rainfall and temperature. The earliest significant uses of turfs for lawns were in the United Kingdom, where the rainfall distribution throughout the year was reasonably good and the moderate temperatures favored the growth of cool-season turfgrasses, such as *Agrostis, Festuca, Lolium,* and *Poa.* In addition, the grazing of sheep, with close-grazing mouthparts, was a significant agricultural activity throughout the countryside.

The key advances that furthered the use of turfgrasses involved inventions and developments achieved through trial-and-error activities, which is termed the art of turfgrass culture. Twelve developments that highlighted the turfgrass discovery and invention era are summarized in Table 1, and are discussed in the following sections.

EVENT NO. 1—REEL MOWER

For years turfed areas were cut to a relatively uniform height either by the hand scythe or by a hand sickle in the case of closely maintained turf areas that were cut more frequently. The leaves of grasses were best cut by the scythe or sickle when the grass was wet, such as during early morning dews or after rains. This was a very laborious, time-consuming activity. Thus lawns of even a reasonable quality were limited primarily to wealthy estate owners. This started to change in 1830 with the invention of the reel mower by Edward Beard Budding, a textile engineer of Stroud, Gloucestershire, England. This first, manually pushed reel mower was more cost-effective, which allowed the opportunity for middle-class residents to maintain residential and village green turfs, which enhanced their quality of life. The original 1830 leaf cutting design of the Budding reel mowers continues to be used to this day—more than 170 years later. Also, it should be noted that one of the major developments in agriculture was the invention of the McCormick reaper. This occurred more than ten years after the development of the Budding reel mower, with a number of the design features of the McCormick reaper most probably having been derived from the earlier Budding patent.

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EVENT NO. 2—CLAY DRAIN TILE

Cylindrical clay tile subsurface drains were developed in England, in circa 1840s. This was the standard world-wide technique for subsurface drainage of soils for over 100 years. During most of that period the clay tiles were installed by manual digging of the trenches. Thus, these subsurface drains did not come into widespread use until the development of the powered mechanical trenching machine in the early 1900s.

EVENT NO. 3—WEED-FREE GRASS SEED

The next major advance occurred in the 1880s involving the marketing of weed-free grass seed based on proper seed cleaning–processing and testing techniques as pioneered by Orlando M. Scott of Marysville, Ohio. Initially "OM" utilized a manually-cranked, wooden seed cleaning machine that he had modified. Prior to that time, grass seed was harvested from pastures that were typically contaminated with weeds and the resultant seed sold directly to turf users. There were no effective, selective controls for the weeds in seed harvest fields or in the home lawns and turf areas planted with the weed seed-contaminated grass seed. Thus, the solution was the development of procedures to clean the weed seeds out of the grass seed. In addition, O.M. Scott pioneered seed testing procedures long before governmental agencies enacted laws requiring seed testing and labeling.

EVENT NO. 4—EARTHWORM MANAGEMENT

The next major advance, in the late 1890s, was the development of an earthworm management control by Peter W. Lees, greenkeeper at the Mid Surrey Golf Club, near London, England. Prior to this event the two main practices discussed in gardening books of the 1700s and 1800s were rolling and mowing of the turf, with rolling usually listed first. This can be attributed to the disruption of the surface by extensive earthworm activity, particularly in England where early turf culture evolved. Thus, with the development of an earthworm management material, rolling became substantially less important as a turfgrass cultural practice. In fact, rolling was eventually recognized in the 1920s as having negative effects in terms of soil compaction, especially on clayey soils. The procedure involved applying the irritant-control to the soil surface and watering it in with excess quantities of water. As a result the earthworms came to the surface, were raked into piles, shoveled onto wheelbarrows, and physically hauled off the turf area. It also should be noted that prior to this event the game of golf and golf courses had been limited principally to the coastal areas of Scotland and northern England, called linksland or seaside courses. Attempts to develop upland golf courses were relatively unsuccessful, principally because of the unplayable putting green surfaces caused by earthworms and their castings. The emergence and major expansion of golf courses on upland soils occurred at the same time, and could be attributed to the earthworm management procedure developed by Peter Lees.

EVENT NO. 5—MULTIPLE GANG, SIDE-WHEEL DRIVE REEL MOWER

A set of lightweight, side-wheel drive mowers mounted on a multiple gang frame was developed and manufactured in 1919 by Charles C. Worthington of Shawnee, Pennsylvania. It was a major advancement and opened the way to economical, quality mowing of extensive turf areas in parks, golf course fairways, sports fields, recreational areas, and other large turfed areas. This basic multi-gang reel mower concept continues in use today, except for a change from a chain to a gear drive.

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Table 1. Key Events in the Turfgrass Discovery and Invention Era

Year (circa)	Contribution/Invention	Contributor
1830	reel mower, mechanical hand pushed	Edwin Beard Budding, England
1843	cylindrical clay tile drains	England
1880	weed-free grass seed processing, testing, and marketing	O.M. Scott, Ohio
1896	earthworm management/control	P.W. Lees, England
1919	side-wheel driven reel mowers on a multiple-gang frame	C.C. Worthington , Pennsylvania
1928	slow-release (organic), complete-analysis turf fertilizer	O.M. Scott and Sons Co., Ohio
1930–1932	turfgrass fungicide development	J.L. Monteith and A.S. Dahl, Washington, DC
1930s	powered rotary mower	Power Specialities Ltd., England
1930–1935	pop-up sprinkler heads	Thompson Co., California
1945	2,4-D–selective broadleaf weed control	G.F.F. Davis, Washington, DC
1946	powered coring machine	T.C. Mascaro, Pennsylvania
1952	powered vertical cutting machine	T.C. Mascaro, Pennsylvania

FEATURE ARTICLE

Clarifying the Fipronil Label for Control of Fire Ants and Nuisance Ants

Daniel A. Potter

Fipronil belongs to a relatively new class of insecticides known as phenyl pyrazoles. It is the active ingredient in some of the world's most effective insect-control products including Chipco® Choice™ for mole crickets; Combat®/MaxForce® for control of ants, cockroaches, and other household pests; Frontline® on-animal flea control; and Termidor®, a new termite product. **Fipronil is also highly active against ants, especially imported fire ants (*Solenopsis* spp.) as well as mound-building ants (e.g., *Lasius neoniger*) that are nuisance pests on golf courses.**

Recently Chipco/Aventis announced registration of TopChoice™, a new granular fipronil product for control of imported fire ants on golf courses, sports fields, commercial and home lawns, sod farms, and other turf sites. Applied at just 0.125 lb a.i./acre (87 lb product/acre), a single broadcast application in autumn to early spring (November to March) provides superior control of fire ants for up to a year. **That same rate will also control nuisance ants** (for three months or more), mole crickets (about four months), and fleas and ticks (about one month). Those pests are listed on the label as secondary targets. Fipronil is also available as FireStar™, a new bait formulation that can be used as a mound or broadcast treatment for fire ants.

Fipronil is relatively slow-acting, which is a big advantage for ant control. With faster-acting insecticides (e.g., pyrethroids, organophosphates), exposed worker ants are killed quickly, but the rest of the colony usually survives. With fipronil, however, foraging workers that contact or feed on the material do not die right away. This allows them to return to the underground nest where body-grooming and exchange of food among nest-mates transfers the insecticide throughout the colony, including the immature ants and queen. So, in this case, slower is better. **Granular fipronil often provides 95% control of existing ants in four to six weeks after application, with enough residual to eliminate developing queens and also new, winged queens that may enter the landscape.** Unlike baits, TopChoice™ does not lose effectiveness if it gets wet.

Fipronil's advantages include long residual in soil, flexible timing, and low use rates. It targets the GABA receptors of insects, a unique mode of action. GABA acts to "switch off" nerve impulses—blocking this action severely disrupts the insect's nervous system. Fipronil binds about 100 times more tightly to insect receptors than to those of mammals, making it much less toxic to humans and pets than to insects. It is, however, potentially hazardous to birds and fish.

I've recently received questions concerning whether TopChoice™ or FireStar™ can be used by golf superintendents in northern states to control mound-building ants on putting greens. I've also seen some articles containing misinformation about labeled uses for fipronil. I'll try to clarify the situation. . . .

First, the granular TopChoice™ product is labeled for use only in 13 southern states, Alabama, Arkansas, California, Florida, Georgia, Louisiana, Mississippi, New Mexico, North Carolina, Oklahoma, South Carolina, Tennessee, and Texas, where fire ants occur. **So, golf superintendents in states other than those listed cannot legally apply fipronil products to control mound-building nuisance ants.**

For listed states, the label wording is vague with regard to nuisance ants (e.g., *Lasius*). It states (under Specific Use Directions) that "The primary purpose of this product is for fire ant control." But, the fact that nuisance ants are listed as secondary targets leaves the door open for use on putting greens and tees, so long as fire ants might also occur at or near the treated site. The FireStar™ bait formulation (which may also be broadcast), lists only imported fire ants on its label.

So, for now, fipronil is only available for use by southern turf managers. Aventis is actively seeking to broaden the fipronil label, so that granular products for nuisance ant control on northern golf courses will hopefully be available soon. In the meantime, superintendents in non-fire ant states may want to try a different approach: spot-treating nuisance ants on putting greens with Maxforce® fine granule insect bait, containing hydramethylnon. My tests showed it to be effective, and I've heard positive feedback from those who have tried it.

...Early Evolution of Turfs...

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EVENT NO. 6—SLOW-RELEASE, COMPLETE-ANALYSIS TURF FERTILIZER

The first commercially produced, slow-release, complete-analysis turf fertilizer was nationally marketed in 1928 by the O.M. Scott and Sons Company in Marysville, Ohio. It was a natural organic product developed at Ohio State University through research funded by the O.M. Scott and Sons Company. It was marketed in large cloth bags under the name of Scotts Turf Builder®. This branded slow-release fertilizer continues to be sold today—74 years later, in a synthetic organic formulation. An activated sewage sludge, Milorganite®, was first produced by the Milwaukee Metropolitan Sewerage District in Milwaukee, Wisconsin, in 1925, and subsequently was marketed nationally in bags as a speciality turf fertilizer in the mid-1930s.

EVENT NO. 7—TURFGRASS FUNGICIDES

During the late 1920s and early 1930s two fungicides for the control of a number of turfgrass diseases were developed by Drs. John L. Montieth and Arnold S. Dahl of the USDA-USGA Arlington Turf Research Center in Washington, DC. The first truly effective fungicides for the control of *Microdochium* patch, *Rhizoctonia* brown patch, *Sclerotinia* dollar spot, and *Typhula* blights involved the use of inorganic mercury and cadmium compounds, which continued for 40 years.

EVENT NO. 8—POWERED ROTARY MOWER

In the 1930s the first powered rotary mower was developed by Power Specialities Limited of England. The power source, a gasoline internal-combustion engine, generated the needed cutting-blade velocity to mow grasses. This resulted in the capability to mow minimal maintenance turfs at a higher height and a less frequent interval, which are conditions in which reel-type mowers are not very effective. Today a majority of residential lawns in the United States are mowed with powered rotary mowers.

EVENT NO. 9—POP-UP SPRINKLER HEAD

In the early 1930s the first underground pop-up sprinkler head was developed by the Thompson Company in California. This was a major advance compared to the numerous types of individual, fixed, hose-end sprinklers of the oscillating or rotating type previously available, as they had to be manually moved frequently for effective irrigation.

EVENT NO. 10—2,4-D-SELECTIVE BROADLEAF WEED CONTROL

In the mid-1940s the first truly effective herbicide for the selective removal of broadleaf weeds from perennial grasses was developed by Gretchen Fannie-Fern Davis in Washington, DC. Some of the earliest turfgrass tests were conducted on the turfed mall area between the U.S. Capital and Washington Monument. The development-use strategy for 2,4-D on turfgrasses was a major event. It remains a key herbicide in the management of quality turfgrass areas more than 50 years later.

EVENT NO. 11—POWERED CORING MACHINE

In 1946 the first powered, mechanical coring machine was invented by Thomas C. Mascaro in West Point, Pennsylvania. A manual three- to four-tined coring unit was developed in England in the 1920s. However, it was not a widely used practice because of the very intense manual labor involved. It was not until the development of the mechanically powered, hollow-tined coring unit by Tom Mascaro that extensive coring of intensively trafficked turf areas came into widespread use, and continues to be used.

EVENT NO. 12—VERTICAL CUTTING MACHINE

In 1952 the first powered, mechanical vertical cutting machine was developed by Thomas C. Mascaro of West Point, Pennsylvania. Thatch had been a continuing problem on turf areas for a long time, and there was no truly effective way of selectively removing an excessive accumulation of thatch, other than the total physical removal of the turf-thatch profile with a sod cutter and reestablishment. For the first time, in 1952, there was an efficient, effective method for vertical cutting into the turf canopy and removing the excess, dead organic material without totally destroying the living turf canopy. The basic design of the original vertical-cutting unit continues to be the standard in use to this day.

SUMMARY

In our modern times of the 21st century some of these top 12 events seem of minimal significance. However, at the time they were developed or invented these contributions were very major advances in improving the quality and lowering the cost of turfgrass maintenance. Modern turfgrass science evolved gradually based on these early inventions and art-dominated trial and error developments between 1800 and 1952. These pioneering individuals and companies need our utmost respect for their very important contributions.

ACKNOWLEDGMENT

This topic was first formally presented as a keynote address at the 9th International Turfgrass Research Conference in Toronto, Ontario, Canada, in July 2001. It is derived from a draft of a book on the history of turf being prepared by J.B Beard.

FEATURE ARTICLE

Large Patch of Zoysiagrass

Peter H. Dernoeden

Large patch (also known as zoysia patch and Rhizoctonia blight) is caused by the fungus *Rhizoctonia solani.* Diseases of turf incited by *R. solani* are generally referred to as brown patch. This is not the case for zoysiagrass, primarily because the disease was once believed to have been caused by a root pathogen, and thus was initially named zoysia patch. Eventually, the name large patch was assigned after *R. solani* was shown to be the causal agent. The disease primarily occurs in 'Meyer' Japanese zoysiagrass (*Zoysia japonica*) grown on golf course fairways and sod farms in transition zone regions of the United States. Most of the newer and finer-textured zoysiagrass cultivars (i.e., *Z. matrella* and *Z. tenuifolia*) are very susceptible to large patch. The disease appears during extended rainy overcast periods, particularly in late autumn and early spring. *Rhizoctonia solani* is most damaging to cool-season grasses during periods of high humidity and high-temperature stress. High temperatures impair the vigor of cool-season grasses in the summer, giving *R. solani* a competitive advantage. Conversely, warm-season grasses, including zoysiagrass, centipedegrass (*Eremochloa ophiuroides*), and St. Augustinegrass (*Stenotaphrum secundatum*), are rendered susceptible to *R. solani* when cool temperatures slow their growth in the autumn and spring. Hence, zoysiagrass and other warm-season grasses are predisposed to *R. solani* as their growth slows in response to cool temperatures prior to autumn dormancy and at spring greenup.

Symptoms. The disease is characterized by large rings of circular patches that range from 2 to 10 ft (0.6–3.0 m) or more in diameter. Patches are brown, yellow, or orange in color. At the periphery of patches, the turf may exhibit a brilliant orange color. The "orange firing" symptom is most prevalent in the autumn. When weather conditions are especially favorable for the disease, a "smoke ring" may also appear at the periphery of patches. Patches and rings tend to develop in the same areas from year to year. Large rings or areas of dead turf are similar in appearance to those associated with fairy rings. In severe cases, rings or patches of dead or thinned-out turf may remain evident in the summer due to slow recovery of the damaged turf.

Unlike brown patch in cool-season grasses, *R. solani* attacks basal portions of zoysiagrass leaf sheaths in the thatch region, producing small reddish-brown or black lesions. Eyespot lesions may appear on basal stems and stolons. Leaves are blighted, and stems may be infected and tillers killed. Turf within affected areas thins-out, and 85 to 90% of the shoots may die. Diseased shoots are easily detached from the stolons. Turf within these large, almost dead-appearing rings or patches, eventually recovers, but the process is very slow. As temperatures increase in the spring, the disease subsides and stolon growth results in a slow improvement in turf density. These symptoms are similar to those observed in St. Augustinegrass and centipedegrass affected by brown patch in the spring or autumn.

Management. Increasing mowing height to 1.5 to 2.0 in. (4.0–5.0 cm) prior to the onset of cool and wet weather in the autumn is perhaps the most effective means of slowing or reducing disease progress and enhancing turf recovery in the spring. This may be unacceptable on fairways at some golf clubs, but the autumn mowing height should be increased above 1.0 inch (2.5 cm) where the disease is chronic. Core aerification and vertical cutting affected sites following spring greenup and active growth of the turf stimulates stolon growth and helps to reduce thatch. Thatch reduction is important because most damage to tillers occurs primarily within the thatch layer. Redistribution of soil from cores also assists in thatch degradation. Do not apply any nitrogen fertilizer or perform core aerification or vertical cutting until disease activity has ceased. Research conducted in Kansas indicated that most nitrogen fertilizers including urea and composted turkey litter help to stimulate recovery, but they do not appear to suppress disease development. Spring application of water-soluble N-sources can enhance large patch when the disease is still active. The total amount of nitrogen applied to zoysiagrass generally should not exceed 2.0 lb N/1,000 ft^2 per year (100 kg N/ha). Nitrogen should be applied to damaged turf after the disease subsides, using a water-soluble N-source at 0.5 lb N/1,000 ft^2 (25 kg/ha) every two weeks until recovery has occurred. Try not to exceed the 2.0 lb N/1,000 ft^2 annual limit. Large patch is also enhanced by overwatering in the spring and autumn, and tends to be most severe in poorly drained or shaded sites. Hence, irrigate only when a turf shows signs of wilt and avoid night irrigation. The use of wetting agents may help

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JB Comments

Enhancing One's Professional Image

A key to enhancing the professional image of an individual in the turfgrass industry is the proper use of the language associated with the profession. There is a body of technical terms that is unique to the turfgrass profession, which distinguishes this profession. Also, effective communication among turfgrass professionals relies on the understanding and proper use of the turfgrass terminology that has evolved.

A cornerstone in appropriate terminology use is the full proper name of each turfgrass species. For example, a well-known national golf course architect recommended the temporary winter seeding of fairways that had been sprigged to Tifway hybrid bermudagrass but coverage had not been achieved before the onset of winter dormancy. Consequently, the recommendation was to stabilize the fairways against erosion until permanent coverage could be achieved via spring growth of the bermudagrass. The architect had "recommended rye" when he actually wanted annual ryegrass. Annual ryegrass is *Lolium multiflorum,* whereas cereal rye is *Secale cereale.* They planted the cereal rye and next spring the result was four-foot (1.2 m) high cereal rye and a total loss of the sprigged bermudagrass. The fairways had to be resprigged. This failure to use proper terminology was costly to the owners/investors of the golf course. The architect's reaction was that they should have known better. Actually the architect should have known better.

Another example is a sod grower in a northern cool-humid climatic region who wanted to plant an acreage of fine-leaf fescue for use in shaded environments. He directed his seed supplier to obtain "fescue." What he received was tall fescue (*Festuca arundinaceae*) rather than fine-leaf fescue (*Festuca rubra*). He planted the former. Evidently he could not even recognize the difference between the seeds of the two species. Upon discovering the error the next growing season following an autumn planting, the entire area had to be plowed up. Again a costly mistake! The sod grower should have specified the fine-leaf fescue desired either creeping red or Chewing's and then included the scientific name as either *Festuca rubra* or *Festuca rubra* var. *commutata.*

Another misuse of terms that is frequently used is shortening of names, such as bermuda when the correct term is bermudagrass. Bermuda is an island in the Atlantic Ocean. **There is also misuse of turfgrass cultivar names.** For example, use of the experimental number, such as "328" when the correct name to be used professionally is Tifgreen hybrid bermudagrass. Another is the use of "419," which was the original experimental number, but the correct name is Tifway hybrid bermudagrass.

In summary, the proper approach is to use the full common name plus the scientific name.

Updating Common and Scientific Name Changes

There have been some updates of both common names and scientific names of cool- and warm-season turfgrass species. These are summarized in the following table. The specific change involved is presented in boldface.

Scientific Name		Common Name	
Current	**Former**	**Current**	**Former**
Poa annua var. *reptans*	—	**creeping bluegrass**	annual bluegrass
Poa annua var. *annua*	—	**annual bluegrass**	annual bluegrass
Agrostis stolonifera	*A. palustris*	creeping bentgrass	—
Agrostis capillaris	*A. tenuis*	colonial bentgrass	—
Agrostis gigantea	*A. alba*	redtop	—
Cynodon dactylon	—	**dactylon bermudagrass**	common bermudagrass
Zoysia matrella* var. *matrella	*Z. matrella*	manila zoysiagrass	—
Zoysia matrella* var. *tenuifolia	*Z. tenuifolia*	mascarene zoysiagrass	—
Axonopus fissifolius	*A. affinis*	common carpetgrass	—

You will note two common name changes, specifically creeping bluegrass and dactylon bermudagrass. The introduction of cultivars of these two species has necessitated the name change. In addition, there are three scientific name changes within the *Agrostis* as well as two for *Zoysia* and one for *Axonopus.* In the case of the scientific name changes, these are the result of additional studies by grass taxonomists.

Research Summary

Turf Versus Ornamental Landscape Nutrient Loss

There are many claims by certain environmental activists that nitrogen leaching is reduced via the use of mixed ornamental species in comparison to a turfed landscape. **An investigation was established to evaluate the nitrogen leaching and runoff loss between a St. Augustinegrass (*Stenotaphrum secundatum*) turf versus a mixed species landscape composed of 11 different dicotyledons.** The alternate mixed ornamental species were chosen by the Florida Yards and Neighborhoods Program based on their theories of low nitrogen requirements. Included were two species of ground covers, one ornamental grass species, six shrub species, and three tree species. Seven of the twelve species were native to Florida. The plot size was 50 m^2 (538 ft^2), with a typical medium-fine sand root zone having a depth of 75 cm (30 inches). The two comparative landscape treatments were replicated four times at the Fort Lauderdale Research and Education Center of the University of Florida. Both surface runoff and subsurface percolate were collected and analyzed for nitrogen content of the ammonia and nitrate fractions. The various species used were commercially available and purchased locally. A eucalyptus mulch was applied to a depth of 7.5 cm (3.0 in.) on all the mixed ornamental species plot areas. Construction of the experimental site was conducted in the autumn of 1998, which included a 10% slope for collection of surface runoff. Irrigation was applied as needed. A 26-3-11 (N-P_2O_5-K_2O) fertilizer was applied at a rate equivalent to 300 kg N ha^{-1} yr^{-1} (6.0 lbs N/1,000 ft^2 yr^{-1}) for the St. Augustinegrass turf and 150 kg N ha^{-1} yr^{-1} (3.0 lb N/1,000 ft^2 yr^{-1}) for the mixed ornamental species. The rates used were typical of those recommended by landscape specialists in Florida.

Results. **The results throughout the first year following installation of the landscapes revealed that the fertilizer nitrogen loss via surface runoff was insignificant.** In contrast, **nitrogen leaching losses were significantly greater on the mixed ornamental species landscape than from the St. Augustinegrass turf,** with annual total losses of 48.3 kg N/hectare versus 4.1 kg N/hectare (0.96 lb vs. 0.08 lb N/1,000 ft^2), respectively. **This represents more than a 10-fold greater loss of nitrogen by leaching from the mixed ornamental landscape compared to the St. Augustinegrass turf during the initial year following establishment.** This occurred even though the turfgrass was fertilized at twice the rate for the mixed ornamental species landscape.

Comments. Obviously these results are the direct opposite of the theories expounded by many so-called environmentalists who have a basic anti-turf philosophy. More studies of this type are needed in other areas of the country to document the true situation relative to nitrogen leaching from turfgrass versus alternate ornamental landscapes. This study was conducted with a high-sand root zone, a condition typical of Florida. Studies with finer-textured soils are also needed. Research has shown that nitrate levels in groundwater are elevated in areas where human population densities are higher. Accusations have been made that this is a result of fertilizing turfgrass areas. In contrast, this study indicates that this in fact is not the case. **It emphasizes the importance of basing strategies for the use of landscapes on sound research rather than ill-conceived theories promoted by well-funded environmental activists.**

Source. J.E. Erickson, J.L. Cisar, J.C. Volin, and G.H. Snyder. 2001. Comparing nitrogen runoff and leaching between newly established St. Augustinegrass turf and an alternative residential landscape. *Crop Sci.* 41:1889–1895.

Large Patch of Zoysiagrass

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to reduce leaf wetness duration and disease severity. Improve drainage and prune or remove trees and brush in sites where large patch is a chronic problem.

Fungicides assist in blight reduction, but generally do not prevent the disease. A fungicide application in late September to mid-October is recommended where the disease is chronic. Azoxystrobin (Heritage®), flutalonil (ProStar®), iprodione (Chipco 26 GT®), PCNB (Penstar®, Terraclor®), myclobutanil (Eagle®), propiconazole (Banner MAXX®), triadimefon (Bayleton®), and triticonazole (Triton®) have been shown to provide satisfactory disease suppression and their use is associated with more rapid turf recovery from the disease. Flutalonil is the preferred fungicide for curative treatment of large patch in the spring. Curative control may require several applications of high fungicides rates. Preventive applications of fungicides to sites where the disease is a chronic problem are the best approach to large patch management.

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EDITOR'S NOTE

This issue of TurFax has been delayed as I have been involved in two trips to the hospital in the past month for approximately a one-week stay each. In the process I have learned that I have diabetes and must follow a strict diet, and the second trip involved a pacemaker replaced with a dual pacemaker/defibrillator. I am under restricted activities for approximately 8 to 10 weeks until the chest area has fully healed, and then can resume normal activities again. In this Holiday Season, it was thought appropriate to include a unique and longer article on the early history of the turfgrass industry and how it evolved during the Art and Invention Era. Hopefully you will find it of interest. It is important that we understand the origins and evolution of the profession to which we devote our life's work.

James B Beard

Ask Dr. Beard

Q. *At what temperature could Tifway bermudagrass be injured during the winter period? The location is in the transition zone.*

A. Anyone who gives you an answer to this question in terms of a specific temperature does not understand the causes and injury mechanisms of direct low-temperature kill. First, please note that **it is the soil temperature that is the most critical influence on lethal tissue temperatures, and not the air temperature.** Injury to a turf may only occur at very low air temperatures if the soil temperature is relatively high, whereas a turf can be damaged at higher relative air temperatures if the soil temperature has been below freezing for several weeks.

In addition there are numerous physiological and environmental factors that influence the specific lethal low-temperature. **Foremost is the degree of hydration of the meristematic tissues on lateral stems and crowns of turfgrasses.** The more hardy turfgrass species have the capability of lowering the hydration level during the late autumn hardening period in the order of 15 to 25% from a growing season norm of 85% tissue water content. If hardening temperatures in the range of 35 to 45°F (2–7°C) have persisted for 3 to 4 weeks, the turf should be fully hardened and possess the maximum survival capability. In contrast, **cold-hardened turfs that have been exposed to standing water for a period of time during the course of a winter thaw will exhibit a drastic increase in proneness to low-temperature kill** because of an elevated water content in the meristematic tissues.

In addition, the specific lethal low-temperature is controlled by the (a) rate of freezing, (b) rate of thawing, (c) number of times that freezing–thawing cycles occur, and (d) duration of the freezing exposure. Also, **turfgrasses growing in shaded environments are much more prone to low-temperature kill than those growing in full sun.** A typical example is St. Augustinegrass (*Stenotaphrum secundatum*). Cultural factors that can influence the lethal low-temperature include (a) the nitrogen fertility level, with modest to low nutritional levels best, (b) the height of cut, with a somewhat higher cut than the norm preferred, and (c) the potassium level, with higher levels preferred. **With this multiplicity of environmental and cultural factors influencing the potential for low-temperature kill, it is not possible to predict the lethal killing temperature unless all of these criteria are fully described for each specific site in question.**

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