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Understanding Take-All Patch

Peter H. Dernoeden

Take-all (formerly known as *Ophiobolus*) patch is incited by *Gaeumannomyces graminis* (Sacc.) Arx & Olivier var. *avenae* (Turner) Dennis and almost is exclusively a disease of creeping and colonial bentgrass turfs. It has been observed in annual bluegrass in England on rate occasions. Take-all was first reported in Holland in 1937 on a bentgrass putting green, but its occurrence in the United States was not documented until 1960, in western Washington. It was not until the 1970s that the disease was reported in the eastern United States. **Take-all is now known to occur anywhere bentgrass is grown. The fungal pathogen attacks roots and stems, and there are no distinctive leaf spot or sheath lesions.**

Take-all is most common on newly constructed golf courses, particularly those carved out of woodlands, peat bogs, or other areas that have not supported crops or grasses for decades. This disease can be especially damaging to rebuilt greens or tees on old golf courses or where methyl bromide has been used for renovation. Take-all also can be imported on infected bentgrass sod that is installed on new high-sand mixes or existing mineral soils. The disease tends to spread more rapidly and occurs with greater severity in sandy soils. Take-all may appear as early as the spring immediately following an autumn seeding. It generally becomes most severe in the second year following seeding.

The pathogen actively attacks roots during cool and wet periods, but symptoms may not appear until the advent of warmer and drier conditions. Symptoms of the disease are most conspicuous from late April throughout the summer, and may recur in autumn. Bentgrass affected by take-all in the spring may recover by summer. However, if irrigation is withheld, those areas affected in the spring are the first to die from drought stress. Initially, the circular patches of take-all affected bentgrass are only a few inches (3–5 cm) in diameter and reddish-brown or orange-bronze in color. Turf in affected patches may first develop the blue-gray color associated with wilt. This is due to the impaired ability of roots to take up sufficient amounts of water. Patches may increase to two feet (0.6 m) or more in diameter, particularly on chronically affected bentgrass sites. **Most patches range from 3 to 12 in. (7–30 cm) in diameter,** but they may develop in tight clusters that give the appearance of a single, large, 2 to 3 foot (60–90 cm) diameter patch. Patches also may coalesce, resulting in large, irregular areas of dead turf. When the disease is active, the perimeter of the patch usually assumes a bronzed appearance, and the turf eventually turns a bleached or tan color. Patches also frequently appear reddish-brown in color, and bronzing may be absent. The small, circular patches increase in size over a number of years, and dead bentgrass in the center of the patch may be colonized by weeds if herbicide use is restricted. Sometimes, small horseshoe-shaped crescents are

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associated with take-all. On rare occasions, the turf turns brick-red and thins out in a nonuniform pattern. Because the fungus attacks the root system, turf in affected areas is easily detached and is similar to the type of damage caused by white grubs.

In most cases, the disease will naturally decline over time, presumably due to a buildup of microorganisms that antagonize or in some other way prevent *G. graminis* var. *avenae* from damaging roots. This explains why take-all is normally not a problem on older golf courses. There are, however, exceptions. A 100-year-old golf club in Massachusetts developed take-all after they installed their first irrigation system (Dr. N. Jackson, personal communication). Soil at the site was high in lime. Furthermore, golf courses with a past problem with take-all may see the disease redevelop following a heavy application of lime. And, as previously noted, rebuilt tees or greens, the use of methyl bromide, or the installation of infected sod are associated with take-all outbreaks on older golf courses. The decline phenomenon may occur within 3 to 7 years from the time that the first disease symptoms were observed. During the decline phase of take-all severity, patches appear reddish-brown or chlorotic (yellow) and turf may thin out. Take-all, however, may persist indefinitely in highly buffered alkaline soils or where the irrigation water has a high pH.

Management of Take-All

There is an interesting relationship between soil pH and take-all. **This disease can occur over a wide range of soil pH's, including acidic soils, but it is most severe and persistent where soils are in the neutral to alkaline range (i.e., pH>7.0).** Acidification of soil with ammonium forms of nitrogen fertilizer is the primary cultural approach to managing take-all. Nitrate forms of nitrogen, such as KNO_3, $CaNO_3$, and $NaNO_3$, however, can intensify take-all and other patch diseases caused by root attacking fungi. The early studies that were used to establish acidification as a method of control involved excessively high levels of nitrogen (e.g., 8 to 12 lb N/1000 ft^2/yr or 400 to 600 kg N/ha/yr). It is now known that as little as 3.0 lb N/1000 ft^2/yr (150 kg N/ha/yr) from either ammonium chloride or ammonium sulfate significantly reduces, but does not eliminate take-all. **Ammonium sulfate or ammonium chloride should be used as the primary N source for at least two years and perhaps longer where the disease is more persistent.** Ammonium-based fertilizers will provide very good winter color in turf, but they also encourage growth, and therefore cause slower putting green speeds and increased mowing into early winter. Sulfur is used to suppress this disease in the Pacific Northwest; however, ammonium-based N fertilizers remain the best and safest choice for take-all management in most regions of the United States. Elemental sulfur can be phytotoxic to bentgrass, particularly in the northeastern United States. The sulfur in ammonium sulfate (i.e., SO_4 anion), however, is oxidized and leaches, causing no damage to bentgrass.

Acidification of the rhizosphere (i.e., the root surface and microenvironment) is believed to be the primary factor responsible for alleviating take-all with ammonium forms of nitrogen. It has been suggested that acidification of soil water either directly reduces growth of the take-all fungus or favors growth of other microorganisms that effectively compete with or in some other way antagonize *G. graminis* var. *avenae.* More recently, manganese oxidation by microbes in soil has been linked to increased take-all in wheat. Manganese sulfate applied at 1 to 2 lb Mn/ac (50–100 kg Mn/ha) for a total of 6 to 8 lb Mn/ac/yr (300–400 kg Mn/ha/yr) can reduce the severity of take-all (Dr. B.B. Clarke, personal communication). Uptake of Mn by the plant may be improved by using a wetting agent. Acidification apparently also reduces the ability of microbes to oxidize manganese, and the resulting increase in manganese availability for root uptake assists plants in their defense against the take-all fungus.

Phosphorus (P) and potassium (K) also have been linked to reducing take-all severity. Phosphorus should be applied even when soil tests indicate moderate (>50 lb P/ac or >56 kg P/ha) or high P levels. For best results, an ammonium-based nitrogen fertilizer should be applied with P and K in a 3:1:2 ratio. The use of lime or topdressing at a pH above 6.0 should be avoided. Do not use topdressings that are augmented with lime. Thatch and soil compaction should be controlled through core cultivation and/or vertical cutting. Core cultivation, however, should be performed when symptoms are not evident and should be delayed if it causes lifting of the bentgrass turf. Check your irrigation water for pH. In extreme cases, acid injection of irrigation water may be required. Frequent syringing of affected areas often is required in the summer to prevent death of plants whose root system has been significantly damaged by the pathogen. Finally, the use of preemergence herbicides and ethofumesate (Prograss®) should be avoided where take-all is a problem.

Azoxystrobin (Heritage®), fenarimol (Rubigan®), propiconazole (Banner®), or triadimefon (Bayleton®) applied twice in late autumn or early winter and again in April and May should provide some protection against take-all. For additional suppression, these fungicides may have to be applied two to three times at 21-day intervals at the onset of symptoms in the spring.

FEATURE ARTICLE

Poa annua Terminology Clarified

James B Beard

The terminology related to the common names of the *Poa annua* group has been confusing. This is because **there is great variation within the *Poa annua* species in terms of numerous key plant characteristics,** as shown in the accompanying table.

The comparative summary between the annual and perennial *Poa annua* biotypes shown in the table really is not that straightforward in nature. Actually **there are numerous intermediate biotypes between these two extremes—the annual and perennial—that evolve in naturalized populations under field conditions.** The scientific name implies the species is an annual, but in fact there are numerous biotypes, some of which are distinctly perennial. This situation has been accentuated by their culture as turfs, in which the perennial types increase and may become dominant within 5 years on fairways and sports fields that are mowed at a close height, fertilized with high nitrogen levels, and intensely irrigated.

However, **for the first time we now have a perennial cultivar of *Poa annua,* released by the Minnesota AES under the name of DW-184,** which is described as forming a dense, erect, dark-green turf that sustains this green color under low nitrogen nutritional levels. Furthermore, DW-184 produces few seedheads and only for a short time in the spring, and has improved resistance to a number of diseases.

To avoid confusion, ***Poa annua* var. *reptans* types have been assigned the common name creeping bluegrass, while the *Poa annua* type will continue to be called annual bluegrass.** Hopefully, this distinction between the two extreme types will reduce the confusion from a common name terminology standpoint.

Plant Characteristics	Annual Bluegrass (*Poa annua*)	Creeping Bentgrass (*Poa annua* var. *reptans*)
life cycle	annual	perennial
growth habit	erect, bunch-type	creeping, stolon-type
rooting	few adventitious	many adventitious
seedhead formation	many	few
seed dormancy	significant	minimal
herbicide tolerance	less	greater

Petroleum Spill Injury Symptoms

James B Beard

There are occasions when injury occurs to a turf which is attributed to a petroleum spill that is of an unknown source or is due to vandalism. In this case, the injury symptoms are important clues in diagnosing the particular type of petroleum spill. With this information one can then implement the appropriate corrective treatment, including the possible need for turf reestablishment.

With symptoms related to petroleum spills, there is always **the variable relating to the actual volume of the spill involved.** If there is penetration of the petroleum spill into the root zone, in addition to turf kill, then removal of the contaminated soil may be required. The lighter volume spills may affect only the turfgrass canopy, and can be more easily and sometimes quickly corrected. In addition, **the temperature of the petroleum fluid at the time of the spill** can affect the speed and extent of injury to the associated turfgrass. Based on these qualifying principles the typical symptoms of five types of petroleum spills are described as follows.

Brake Fluid. Initially, the leaves have a shiny, wet appearance, plus a distinctive brake fluid odor. The leaf blades retain the shiny appearance for about 30 minutes, but then begin to darken and dry, with some longitudinal leaf rolling evident. There may be no change after about 1 hour. The turf has a pale grayish-green color after about 16 hours, with extensive leaf rolling apparent. All shoots may be dead after 48 hours, with a distinct light-yellow color.

Gasoline. The turf is shiny, with a slight oily appearance. The most distinguishing initial feature of a gasoline spill is the pungent odor emitted from the turf. Within 30 minutes the turf is drying rapidly, as evidenced by its darker color and longitudinal leaf rolling. Severe leaf rolling occurs after 1 hour. The turf is completely brown after about 16 hours, with a faint smell of gasoline still lingering. Then, 40 hours after spillage, the turf is yellow to yellowish-brown in color.

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...Injury Symptoms

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Hydraulic Fluid. Initially, the turf appears shiny and water-soaked, but begins to dry rapidly. A definite drying of the turf occurs within 30 minutes, as evidenced by a darkening and rolling of the leaf blades. Severe leaf rolling occurs after about 1 hour, and the shoots begin to turn brown and die. A dark-brown color develops after about 16 hours, with some shoots that may remain green.

Motor Oil. The turf is shiny, with a distinct oily appearance. No visible change occurs during the first hour. The turf remains oily and shiny in appearance after about 16 hours, with a small amount of leaf rolling evident. Leaf browning becomes apparent after about 20 hours, with the turf retaining the lubricious appearance. At the end of 48 hours, approximately 50% of the shoots may be killed, and the shiny-oily appearance persists.

Grease. A layer of grease may be readily visible on the leaves, due to the viscosity of the petroleum product. No distinct injury symptoms are evident during the first 16 hours. The shoots are dead after about 48 hours, and the grease may still be present on many of the leaves.

Vegetative Planting Rates for Perennial Turfgrasses

James B Beard

The September–October 1998 issue of Turfax addressed the subject of seeding rates for turfgrasses, based on cultivar variability. A summary table provided an updated status. In the case of seeding rates there is a specific number of seeds per square inch for each turfgrass species that results in the most rapid rate of mature turf formation. Furthermore, as the seeding rate is increased or decreased from this optimum level, the time required to establish a mature turf is increased.

In the case of vegetative planting rates, this establishment profile does not exist. Rather, **as the planting rate of the vegetative material is increased, the more rapidly a mature turf is established.** For example, at sufficiently high planting rates a vegetative planting on a golf course putting green can result in a playable surface within 5 to 6 weeks, if sufficient fertilization and irrigation are provided.

The accompanying table shows the suggested planting rates for ten perennial turfgrasses. The planting methods for which rates are provided include broadcast sprigging or stolonizing, row sprigging, and plugging. A sprig is a lateral stem, which can be either a rhizome or stolon. Preferably, **a sprig should include a minimum of two nodes with attached internodes per sprig.**

One should note that the broadcast application rate is expressed in bushels. **In specifying the broadcast application rate one should identify the bushel as to whether it is to be an (a) official U.S. bushel of 1.24 ft^3 or (b) a Georgia bushel, which is used by some growers and has only 0.4 ft^3.** Note that the U.S. bushel rate is utilized in this table. It also should be noted that the quantity of actual live meristematic nodes within a bushel can vary depending on whether the soil and/or peat materials have been removed, and according to the conditions under which the stolons were grown. Harvesting from turfs maintained at very high cutting heights or even nonmowed areas results in elongated internodes, and thus fewer nodes per unit length of lateral stem.

When either manual or mechanical stolonizing is practiced, it is typically followed by topdressing and rolling. In contrast, both manual and mechanical broadcast sprigging are more commonly followed by press rolling, which is a combination of vertical blades that push the sprigs into the soil, followed by a roller, both mounted on the same mechanical attachment. Row sprigging machines operate with a rolling coulter, which opens up a vertical slice in the soil into which individual sprigs are dropped. **Depending on the particular mechanical sprigger design, some can plant at a rather close spacing between rows, while others are not able to do this.** Plug planting can be done either manually or by a mechanical machine.

In many cases the particular mechanical planter and/or pressed roller used has been designed and constructed by the company or contractor that has contracted for the planting operation. There are only a few models of commercial planters on the market, with many of the best contractors using their own modified machines. **Some mechanical planters operate best on sandy to loamy soils but not on clay soils; others function well on a wide range of soil textures.**

Guidelines for Vegetative Planting of Ten Perennial Turfgrasses

Turfgrass Common Name	Greens and Collars: Planting Method	Greens and Collars: Rate in U.S. Bushels* (per 1000 ft²)	Tees: Planting Method	Tees: Rate in U.S. Bushels* (per 1000 ft²)	Sports Fields, Fairways, and Primary Roughs — Row Sprigging: Row Spacing (in.)	Row Sprigging: Sprig Spacing** (in.)	Machine Broadcast Sprigging (U.S. bu/ac)	Plugging: Plug Size (in.)	Plugging: Plug Spacing (in.)
bentgrasses	stolonizing	8 to 12	stolonizing	6 to 10					
bermudagrasses	broadcast sprigging	8 to 15	broadcast sprigging	7 to 12	4 to 6	2 to 4	200 300		
buffalograss, American								4 to 6	8 to 16
carpetgrass,								4 to 6	8 to 16
centipedegrass								4	10 to 20
kikuyugrass			broadcast	8 to 14	4 to 7	3 to 6	250 350	2 to 4	10 to 14
paspalum,	broadcast	8 to 15	broadcast	7 to 12	4 to 6	2 to 4	200 300		
St. Augustinegrass							175 300	4	12 to 24
zoysiagrass, Japanese	broadcast	14 to 18	broadcast sprigging	9 to 16	2 to 4	2 to 3	300 400	2 to 4	8 to 16

*A U.S. bushel = 1.24 ft³ (0.035 m³), but a Georgia bushel is only 0.4 ft³ = 0.32 U.S. bushel; **Sprig spacing in a row; Use only in areas already infested; Diameter of turfed plug.

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FEATURE ARTICLE

Annual Bluegrass Resistance to Dinitroaniline Herbicides Identified

Fred Yelverton

In a previous issue of Turfax, we discussed the mechanisms of herbicide resistance in weed populations. To summarize, herbicides do not cause genetic changes in plants that trigger resistance. Continuous use of the same herbicide, family of herbicides, or herbicides with the same mode-of-action selects for a weed population that has resistance to the herbicide. For instance, for a weed population to become resistant to an herbicide, there must be at least one plant in the original population that has the genetic make up to be resistant to that herbicide. This is why herbicide resistance never occurs in some weed populations with some herbicides; the naturally occurring plants that have genetic resistance do not exist in the wild population. Therefore, it can be stated that the development of herbicide resistance is an evolutionary process that is a result of selection pressure exerted by an herbicide.

In recent years on golf courses in North Carolina and Mississippi, annual bluegrass (*Poa annua*) resistance to triazine herbicides has been identified. However, these are not the first cases of resistance identified with triazines and annual bluegrass. Triazine-resistance in annual bluegrass was first identified in France in 1975 on a highway roadside. However, a case of annual bluegrass resistance to dinitroaniline herbicides has not previously been identified. Recently, in North Carolina, we **identified the first case of annual bluegrass resistance to dinitroanilines.** The following is an example of what happened on this golf course and the herbicide program for annual bluegrass control.

The golf course was constructed and grow-in was completed in 1990. An herbicide program for annual bluegrass control of the winter-annual biotype was initiated in the autumn of 1991, and proceeded until herbicide resistance was identified in 1998.

Starting in 1996, the golf course superintendent at this site noticed control from his herbicide program was starting to deteriorate. In the autumn of 1997 and the spring of 1998, control from Barricade was very poor. It should be noted that annual bluegrass control of the annual biotypes of *Poa annua* is very good with Barricade. Samples were taken from the annual bluegrass population and appropriate greenhouse and laboratory tests identified resistance as the reason for poor control.

It should also be noted that in this case, **herbicide resistance developed to a group of herbicides with a similar mode-of-action.** Simply rotating herbicides with the same mode-of-action will not break the resistance cycle. Dimension is not a dinitroaniline herbicide, but the mode-of-action is the same as that of dinitroanilines. Therefore, Dimension will not break the resistance cycle.

Rotating herbicides with a different mode-of-action is the only way to prevent herbicide resistance from developing. Annual bluegrass is a species that is known to have many different biotypes, which indicates genetic diversity. It should be expected that annual bluegrass populations have the genetic make up to be resistant to many different herbicide modes-of-action. With annual bluegrass management, rotating herbicides with different modes-of-action will be important in preventing the development of herbicide resistance.

Year	Herbicide	Herbicide Family	Herbicide Mode of Action
1991	Dimension	pyridine	mitotic inhibitor
1992	Dimension	pyridine	mitotic inhibitor
1993	Surflan	dinitroaniline	mitotic inhibitor
1994	Surflan	dinitroaniline	mitotic inhibitor
1995	Team	dinitroaniline	mitotic inhibitor
1996	Team	dinitroaniline	mitotic inhibitor
1997	Barricade	dinitroaniline	mitotic inhibitor

The Amazing Grass Plant

The grasses (*Poaceae* plant family) are the most ubiquitous of the higher plant groups found on this earth. With an estimated 600 genera and 7,500 species, the *Poaceae* ranks third in number of genera among families of flowering plants. With respect to completeness of representation in all regions of the world and to percentage of the total world's vegetation, grasses surpass all other genera. Grasses are one of the first permanent vegetations to reappear after disasters, such as volcanic activity, extended droughts, floods, fires, explosions, abandoned urban ghettos, and battlefields. Without the forgiveness of grasses, many ill-advised construction excavations and agricultural activities would have had far more disastrous effects on our vital natural resource—the earth's surface soil mantle.

To humans, grasses are the most important of all plants. The cereal grains and corn—all members of the grass family—serve as food for humans and animals. A host of grazing ruminant animals use grasses for their major food source as forage, pasture, and prepared feeds. Bamboo, a grass, is a major building

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Treatments of Petroleum Spills on Bermudagrass Turf

A field study was conducted on Tifgreen hybrid bermudagrass (*Cynodon dactylon* x *C. transvaalensis*) to determine the best corrective treatments and subsequent turf recovery rates from various petroleum spill damage. Five petroleum products commonly used in turfgrass maintenance equipment were applied as spill treatments to the turf growing on Lufkin fine sandy loam. Three replicate spray treatments of gasoline, motor oil, hydraulic fluid, and brake fluid, plus direct spreading of grease were made over 1-m^2 plots. Calcined clay fines, activated charcoal, and detergent were evaluated as potential corrective treatments. Each corrective treatment was applied within 20 minutes of each spill in three replications.

The detergent corrective treatment proved effective in enhancing turf recovery in 3 to 4 weeks from motor oil, hydraulic fluid, and brake fluid damage. None of the corrective treatments were effective on either the gasoline or grease-damaged turf. The turf recovered rapidly in 3 to 4 weeks from gasoline spills without corrective procedures. More than 10 weeks were required for turf recovery from grease spills.

Comments. The removal of spilled hydraulic fluid and motor oil by means of a detergent washing proved to be an effective corrective treatment for enhancing turfgrass recovery from the initial foliar injury. In both cases, complete recovery of the turf was achieved 3 to 6 weeks sooner than with the other corrective procedures, such as calcined clay, activated charcoal, or a water drench. Also, detergent washing enhanced turfgrass recovery by 1 week in the case of brake fluid spills.

The detergent is sprinkled over the spill area, then thoroughly drenched with water, and the suds are completely removed from the surface area, preferably with a vacuum. **Use of this corrective detergent treatment should be restricted to within the boundaries of the spill area to avoid transferring the spilled material to the surrounding turf, where additional turfgrass injury is likely to occur.** It is worthwhile to treat a petroleum spill even if the shoots are severely damaged, because **removal of the petroleum residue from the grass shoots enhances the turfgrass recovery rate from the nodes of lateral stems.** This situation would be negated in the less common occurrence where (a) large-volume spills are lethal to the auxiliary buds or lateral stems, (b) the underlying soil becomes saturated with the spilled petroleum, and/or (c) the grass species has a bunch-type growth habit.

Under field operating conditions, the heat from hydraulic fluid or motor oil could cause additional damage to the upper nodes of lateral stems and retard turf recovery. Although the hydraulic fluid and motor oil applied to the bermudagrass in this study were at ambient temperatures, death of leaves and some lateral shoots did occur. Thus, a corrective detergent washing could still be used effectively to enhance turf recovery. Field observations where the detergent washing technique has been used on high-temperature hydraulic fluid spills support this position. **Source: Effects and treatment of petroleum spills on bermudagrass turf. By D. Johns and J.B Beard. *Agronomy Journal,* 71:945–947.**

The Amazing Grass Plant

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material. Grasses of all types represent a large source of biomass for production of methanol, an energy source.

Our perennial turfgrass species evolved more than 45 million years ago during the Paleocene Epoch of the Tertiary Period, which is relatively recent in the earth's history. They have been cultured by humans to provide an enhanced environment and quality-of-life for more than 10 centuries. The complexity and extent of the environmental benefits that improve our quality-of-life are now quantitatively documented (1, 2).

Functional Benefits Include:

- Excellent soil erosion control and dust stabilization, thereby protecting a vital soil resource.
- Improved quality protection and recharge of groundwater, plus flood control.
- Enhanced entrapment and biodegradation of synthetic organic compounds.
- Soil improvement via organic matter–carbon additions.
- Accelerated restoration of disturbed lands.
- Substantial urban heat dissipation and temperature moderation.
- Reduced noise, visual glare, and visual pollution problems.
- Decreased noxious pest problems and allergy-related pollens.
- Lowered fire hazard via open, green turfed firebreaks.
- Safety in vehicle operation on roadsides and engine longevity on airfields.
- Improved security provided by high-visibility turfed zones.

Recreational Benefits Include:

- A low-cost surface for outdoor sports and leisure activities.
- Enhanced physical health of participants.
- A unique low-cost cushion against personal impact injuries.

Aesthetic Benefits Include:

- Enhanced beauty and attractiveness.
- Improved mental health, with a positive therapeutic impact and social harmony.
- Improved work productivity.
- Complimentary relationship with the ecosystem of flowers, shrubs, and trees.
- An overall better quality-of-life, especially in densely populated urban areas.

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Trees and Government

A law has now been passed in the country of Greece specifying that no one may cut down a pine tree without permission from a government Forest Inspector, even if that tree is growing on their own property. Certainly trees are great, but the question can certainly be raised as to whether this is in fact excessive government intrusion.

The Amazing Grass Plant

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JB COMMENTS

Failure to Use Chemical Soil Test Findings

It is amazing how often I am called in for a technical assistance visitation to a turfgrass facility that is experiencing problems and/or even failure of the turf. Typically, in these situations there are multiple causes for the problem. One of these may involve the turfgrass nutritional strategy. It is not uncommon for the turf facility manager to have chemical soil tests analyses conducted for the problem area. Yet the individual does not implement changes in the fertilization program to correct the indicated individual nutrient deficiencies. The most common occurrences are deficiencies of potassium (K), magnesium (Mg), iron (Fe), and manganese (Mn). In contrast, there are situations where excessive levels of either copper (Cu) and/or zinc (Zn) are indicated, which are red flags that all applications of these two nutrients should cease in order to prevent potentially serious root zone toxicity problems.

Even though chemical soil tests are in hand, too many turf facility managers fail to implement the needed corrections. Why? Is it the failure to read and/or comprehend the soil test results, or is it a lack of confidence that the chemical soil tests are meaningful in the decision-making process to develop a fertilization program? My guess is the latter.

Perhaps some confusion is created by inadequate interpretation of chemical soil test analyses by the laboratory involved. It is important that all chemical soil test values be interpreted by a professional knowledgeable in turfgrass nutrition. A summary interpretive report should be included with the actual soil chemical analysis. This hopefully will aid the turf facility manager in implementing adjustments in the fertilization program, as well as providing confidence as to the importance of implementing the findings.

ASK DR. BEARD

Q *The new cultivar planted onto a putting green is quite hard, with a high ball bounce that is causing complaints from the golfers. What is wrong?*

A I assume that the old greens on the golf course were constructed by what is termed push-up greens using nearby soil. Typically, such root zones have higher clay and lower sand contents. As a consequence, these greens are less hard, with a low ball bounce, which can be accentuated by excessive applications of water and/or an underlying thatch accumulation.

Typically, new putting greens constructed with a USGA specification high-sand root zone tend to be harder, with a higher ball bounce during the initial 2 to 3 years. Once an underlying root biomass and a modest surface mat accumulation form and are fully decomposed through intermixing of topdressing, the green will become softer, with fewer complaints from golfers. The decomposition of both the thatch/mat and the underlying root biomass is accelerated if cultural practices are followed that stimulate the rate of development of a living soil, which has active microbial, fungal, and insect populations that maximize organic matter decomposition.

In your case, the contrasting situation between the new green and the older putting greens on the golf course creates distinct differential playing conditions among the greens. To summarize, it is not the turfgrass cultivar that is creating the so-called hard greens, but most probably it results from the underlying high-sand content root zone, which requires time to form a living, biologically active root zone which is less hard.

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