grassy weed control. Prickly sida is a hardto-control broadleaf weed in compacted practice fields. It takes up to four applications of dicamba to control, says Barnes. Fields which aren't overseeded are aerified, topdressed and treated with preemergence herbicides in the fall.

Summer weed control at Broward County School District consists of spot treatments with postemergence herbicides with MSMA, metribuzin, 2,4-D and dicamba. "Many of our fields are common bermudagrass," Barnes states. "We drill seed in common bermudagrass seed to keep a dense stand of turf and to keep weeds from getting established."

Glyphosate is a major herbicide for control of winter weeds in Texas, says Dr. Bill Knoop, with Texas A&M University's extension center in Dallas. Many schools don't have the budgets to overseed, and even though glyphosate is a relatively expensive herbicide, it is cheaper in both cost and manpower requirements than overseeding.

The state even has a label for glyphosate at very low rates for summer weed control in bermudagrass. The winter rate is one quart per acre in 50 gallons of water, while the summer rate is one pint per acre. "You may hurt the bermudagrass a little or delay spring transition with glyphosate, but at these rates you won't kill it. If you can live through some temporary discoloration, you can control many tough weeds fairly effectively. You



Crabgrass. Photo courtesy: Max Badgley.

can also use glyphosate in cooler temperatures and get better control than with MSMA," Knoop explains.

TAG is another nonselective postemergence herbicide schools use to knock out winter grasses such as annual bluegrass and rescuegrass. Ryegrass and six weeks fescue are other grassy weeds in nonoverseeded field, says Knoop. "In overseeded turf, you wait until the bermudagrass comes back and then take out the grassy weeds with postemergents." Trimec-type herbicides take care of henbit and other winter broadleaf weeds. Knoop's list of summer weeds includes goosegrass, dallisgrass, crabgrass, spurge, johnsongrass and knotweed. Grassy perennial weeds in bermudagrass can be controlled during the summer with a light rate of glyphosate, one application of metribuzin, or several applications of MSMA. Trimectype herbicides are effective on summer broadleaf weeds. Some sports turf managers are mixing glyphosate with Trimec or Weedone DPC to make one herbicide application during the summer, says Knoop.

Both cool- and warm-season turfgrasses are used year-round in California, making weed control a mixture of different methods. Dr. David Cudney, weed specialist for the University of California at Riverside, states that kikuyugrass is the worst weed of all types of turfgrass in the state. The aggressive, low-maintenance grass was imported to Southern California from Africa for erosion control in 1918. It spreads both vegetatively and by seed produced in small seedheads which form below the cutting height of mowers. Kikuyugrass is best adapted to Mediterranean coastal climates. Once established, it forms a thick mat which makes the turf feel spongy but resists other weeds from invading.

Many sports turf managers and golf course superintendents find it easier to let the kikuyu take over since it resists weeds, requires less water and uses less fertilizer,"

continued on page 32



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Postemergence Weed Control continued from page 31

says Cudney. "But they will have to dethatch it heavily to keep it from getting spongy.' The only selective herbicide that will begin to control kikuyugrass is MSMA. Failing that, the only way to get rid of it is with nonselective postemergence herbicides. "You also need a barrier of turf without kikuyugrass around tees, fairways and fields to keep it from moving back in."

Common bermudagrass sports turf can be as much as 90 percent Poa annua in the winter, Cudney points out. Ethofumesate (Prograss) could be used to control it, but with poa being such a high percentage of the turf, it's better to manage it until the turf can be renovated, he says.

"Too many sports turf managers wait too late in the fall to overseed with perennial ryegrass," Cudney adds. They try to hold onto the bermudagrass until the last minute. As a result, the less agressive bermuda does not resist invasion by winter broadleaf weeds such as oxalis, clover, dandelion, plantain, dock and southern brass buttons. By overseeding earlier, the ryegrass can become competitive sooner. This is also one reason for some poa infestations, he adds.

Oxalis can be a problem on overseeded turfgrasses in Southern California in the winter. Cudney has had success with applications of triclopyr (Turflon) on oxalis.

Cool-season turf lacks competitiveness during the summer in Cudney's area. Prostrate spurge, oxalis, dallisgrass, goosegrass and other weeds take advantage of the weak turf to get established. Spring seedings of cool-season grasses and late spring seedings with common bermudagrass need to be treated with bromoxynil to keep out summer broadleaf weeds, he says.

Overseeded perennial ryegrasses can hang on into late spring if the weather is mild and hybrid bermudagrasses don't necessarily go completely dormant. Sports turf managers should select ryegrasses with

low heat tolerance for overseeding for this reason

Steve Cockerham, director of the turf trials at the university, has seen some ryegrasses do exceptionally well throughout the year at Riverside. However, summer water requirements for ryegrass as compared to bermudagrass discourage their use. Turftype tall fescues are growing rapidly for residential and commercial uses in the area and have a lower water requirement than ryegrasses. But their use for sports turf remains limited.

A growing number of superintendents are maintaining creeping bentgrass greens in Southern California, especially resort courses. These superintendents have to watch the bent carefully for both summer weeds and diseases. They rely heavily on preemergence weed control and preventative disease control.

No matter in what part of the country sports turf managers strive to control weeds, the consistent factor in weed prevention is healthy, aggressive turf. Weed control cannot make up for poor maintenance during the year. Proper irrigation, fertilization, and drainage are the first steps in weed control. Periodic renovation may still be required under high use conditions to keep turf dense and weeds under control.

The good news is that the number of weeds in sports turf that have no effective control are decreasing as new herbicides reach the market. More golf course superintendents and sports turf managers are trying these products out with excellent results. Some may cost more than others on a single-application basis, but they can also reduce the total number of applications necessary.

If sports turf is truly important to the user, then funds will be found to accomplish weed control and basic maintenance procedures which assure the quality of the turf. The important thing is to know what can be done when adequate funding is provided.

t the turn of the century, a Connecticut engineer and entrepreneur, Sylvanus D Locke, developed a process for making stamped-steel drive chains more efficiently than the conventional cast-link chains which were then available.

He established the Locke Steel Chain Company in 1912 in Bridgeport, CT, to produce his invention. Its quick success soon made him a wealthy man, the owner of a large estate in central Connecticut.

The estate grounds were extensive and necessitated the finest of care to keep up appearances. But Locke was dissatisfied with the quality and performance of the mowers he had purchased. He wanted his lawn mowed properly for once.

Being a great believer in self-reliance, he drew up his own set of plans for an "ideal" mower and had the factory manufacture a prototype in 1924. He personally tested the quality of the prototype on his own estate's turf—and the results pleased him greatly.

Friends and acquaintances admired the quality of the cut, and asked Locke to build machines for them, too. In 1928, after several years of research, 11 production prototypes were sold. The Locke power mower was born.

This year Locke Manufacturing, Inc., will celebrate 60 years of continuous production of its mower. During those years, management has changed hands six times, but the production line goes on at a facility in downtown Bridgeport, CT, not far from the site of the company's original plant. The current factory is located in an old Remington Arms complex which the city has renovated.

The factory exudes old-time industrial traditions, and one might imagine that Locke's original production workers would find themselves at home in today's 25,000-squarefoot facility. Just up the stairs from the assembly floor, President Tom Herrmann keeps watch on quality control while he does business in his glass-sided office overlooking the production line.

Herrmann bought the company in 1986, six months after visiting the factory to pick up some parts for his own Locke mower. That mower had been one of the first to come off the original production line back in 1929, as Serial Number 210. It turns out that Herrmann's is the oldest Locke known to be in existence. Longevity is not an unusual attribute for these machines. In fact, according to records kept by the company, it's not unusual to find customers whose mowers are still running after 30 or 40 years.

Herrmann observes, "The mower is still made according to Sylvanus Locke's original design with the emphasis on performance and durability."

Bob Smith, director of stadium operations for the Los Angeles Dodgers for the past 20 years, is one of the company's customers with a story of long life to tell.

"We're using the same Locke mower in Dodger Stadium today that had been cutting the grass at the old Ebbets Field in Brooklyn over 30 years ago," Smith notes.



Brooklyn Dodgers Carl Erskine (left) and Karl Spooner with original mower at Ebbets Field in Brooklyn, NY.

Locke Mowers: Still Making the Cut After 60 Years

Apparently, he's been pleased enough with the performance of that veteran machine to come back for more, after 30 years. Smith recently ordered two new Lockes: a 25-inch Single and a 70-inch Triplex with reverse and sulky, to maintain the new playing field installed last December at Dodger Stadium.

Smith is not the only "big name" on the company's honor roll of customers. The mowers have been used at a world's fair; the past five Summer Olympics; in Yankee



Two new mowers purchased by Los Angeles Dodgers at Dodger Stadium.

Stadium; at the White House (There's a color photo in the factory lobby at Bridgeport of a mower appearing right at home on the Executive Mansion's front lawn); and, long before *Glasnost* was "in," a Locke kept lawns groomed at the Kremlin.

The mower's outward appearance has changed little over the past 60 years. However, under Herrmann's direction, the company now offers an option to the traditional Briggs and Stratton engine. It's a Honda engine—which may surprise some, since it powers such a traditional, madein-America machine.

What other changes or improvements are on the horizon for Locke Manufacturing during the next 60 years? Judging from the past 60, which saw a continuous evolution of the original design, you might expect the company to have a similar production line in the same factory on Boston Avenue in Bridgeport. Perhaps...but Hermann is considering alternatives.

"We're experimenting with some very sophisticated technologies right now," he reveals. "We've yet to determine if it will be economically practical, but the Locke of the future might very well incorporate a laser that is selective to certain types of materials, like grass.."

CHALKBOARD

TIPS FROM THE PROS

Thoughts on the Black Layer

By Lee Berndt and Joe Vargas

s with other poorly understood phenomena, a great deal of controversy exists regarding the black layer. Hypotheses have arisen suggesting that the occurrence of black layer and its turfgrass decline may be directly related to rootinfecting fungi, algae, excess water, improper construction, poor management, topdressing or sulfur.

Root-infecting fungi probably have little to do with the actual black layer development. These organisms (i.e., Pythium spp.) may, however, invade root tissue secondarily in response to stress related to black layer development, and further contribute to the decline. If these organisms were solely responsible, the decline would be easily controlled with the excellent fungicides currently available.

Algae, topdressing, improper contruction, and sometimes poor management come into play by effecting conditions of soil anaerobiosis (lack of available oxygen). Algae, for instance, can be very prolific in soil systems. When conditions become favorable for algal growth, soil oxygen may become limiting due to algal consumption and surface crusting, which restricts diffusion.

The muco-polysaccharidic slime manufactured by algae may also physically plug soil pores, thus reducing oxygen diffusion. If topdressing contains an appreciable amount of silt or clay, or is of dissimilar particle size compared to the base mix, repeated use might contribute to soil layering, possibly restricting oxygen diffusion and water drainage by creating perched water tables.

However, it is our contention that black layer (or the black coloration of the soil profile) results directly from anaerobic dissimilatory sulfate reduction. This is the biological reduction of sulfate (oxidized sulfur) to sulfide (reduced sulfur) mediated by a select group of anaerobic bacteria (i.e., Desulfovibrio).

Biologically produced hydrogen sulfide subsequently reacts with soil metals, such as iron, to produce metallic sulfide particles which deposit within the soil pore space. These particles are black compounds that generally lose their color upon exposure to atmospheric oxygen.

Where the coloration occurs depends on subsurface water movement, sulfate/organic matter distribution and dynamic oxygen gradients affecting microbial activity. It is possible in some instances that algae or topdressing may play a role in the sulfatereducton process by creating the necessary anaerobic condition and contributing organic matter for the anaerobic bacteria. However, many black layers have been observed where no visible evidence of algal growth exists.

Research at Michigan State University supports the sulfate-reduction hypothesis. When washed dune sands receiving either one or five pounds of sulfur per 1,000 square feet were inoculated with lactate-enriched. mixed cultures of sulfate reducers and were subjected to waterlogging (i.e., anaerobiosis), a black layer was formed.

When these same soils did not receive sulfur applications, but were subjected to identical inoculations and water conditions, the black layer did not develop. Also, when a creeping bentgrass golf green composed of similar sand soils was subjected to extensive waterlogging, a black layer was formed.

Both layers were shown by inorganic spot analysis to be composed of reduced iron and sulfur compounds. Thus, it appears that the presence of sulfur (from whatever source), metals, anaerobiosis and soil bacteria are necessary for black layer formation.

As far as sulfur is concerned, there is usually a considerable input to most highly maintained turfgrass soils, even though most soil sulfur is considered to be tied up in organic matter. Sulfur may accumulate in soils through the application of elemental sulfur, fertilizers, iron sulfate, irrigation water, acid rain, thiol-based fungicides and pesticides, micronutrient solutions, organic matter containing sulfur amino acids, and direct adsorption of gaseous sulfur dioxide.

In fact, it is estimated that in cities such as Gary, IN it is not unusual to have greater than 50# sulfur per 1,000 square feet per year deposited from rainfall alone. Thus we believe that the anaerobic chemistry of such sulfur compounds (originating from whatever source) is related to black layer development.

The appearance of the black layer itself may not initially be detrimental to turfgrass growth, but is an indication of "reducing" soil conditions, which may eventually lead to turf thinning and loss. The decline of turfgrass is probably due to the lack of available oxygen, and the accumulation of toxic anaerobic metabolites such as hydrogen sulfide, methyl mercaptans, volatile fatty acids, alcohols and ethylene which naturally occur with anaerobiosis.

However, if lengthy anaerobic conditions remain, as when spring and fall rains occur, metallic sulfides may accumulate in pore spaces and eventually produce a layer or profile with a gluelike consistency. The metallic sulfide particles in the gluelike layer may then actually help maintain the anaerobic conditions by chemically attracting and binding diffusing oxygen.

When diffusing oxygen is scavenged in this way, it becomes unavailable for respiration, and the detrimental effects produced by lack of oxygen and accumulation of toxic soil compounds can be extended. Sulfur will not initially induce anaerobic conditions in soil. However, if sulfur is present in sufficient quantities and is allowed to reduce, the resulting compound(s) will make diffusing oxygen less available. In fact, reduced sulfur compounds are routinely used as "reducing agents" to chemically scavenge oxygen in anaerobic microbiological media, as microbiologists know.

In summary, dissimilatory sulfate reduction plays a key role in anaerobic black layer formation and the associated turfgrass decline, regardless of whether the sulfur originated in organic matter, acid rain, irrigation water, or from supplemental input. Reduced sulfur compounds such as ferrous sulfide (FeS) impart the characteristic black color commonly associated with many black layers. This has been experimentally shown in our laboratory.

These reduced sulfur compounds also bind diffusing oxygen, making it less available to the turf plant. Thus, if you have experienced problems with black layer in your soil, additional sulfur will only aggravate the situation if conditions for black layer again become favorable.

The key ingredients for black layer development include anaerobic conditions, the presence of sulfur compounds and soil metals (from whatever source), organic matter and sulfate-reducing bacteria. Reduced sulfur compounds, such as hydrogen sulfide and methyl mercaptans, in association with naturally occurring anaerobic metabolites such as ethylene, fatty acids and carbon dioxide, impart the characteristic foul odor associated with the layer and are thought to be responsible for the observed turfgrass decline.

Thus it is clear that the anaerobic biochemistry of black layer (and its related anaerobic metabolites) should receive the brunt of research attention, since giving the golfer or sports turf user a playable surface with acceptable aesthetics is the name of the turf-management game.

Editor's Note: The authors are researchers at Michigan State University, East Lansing, MI.



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SURVEY REVEALS GOLF FUNGICIDE USE

A survey of golf course superintendents across the U.S. by Ciba-Geigy Corporation has revealed that golf courses in the Northeast purchase the most fungicides, while courses in the West buy the least. The national average for fungicide purchases is \$11,000 per course.

The superintendents indicated a high preference for preventiveuse fungicides over curative use for control of the three major turf diseases, *Pythium*, dollar spot and brown patch. While *Pythium* is not as prevalent as either dollar spot or brown patch, the superintendents said it was the most difficult to control. The other diseases considered important on golf courses are anthracnose, leaf spot, fusarium patch, fusarium blight and snow mold.

Only five percent of the superintendents said they use a combination of fungicides, even though disease resistance to particular fungicides was one of their major concerns. Product safety was the biggest concern of the superintendents.

The study revealed that 25 percent of the golf courses spend between \$2,500 and \$5,000 per year on fungicides, while 20 percent spend more than \$15,000 a year.

OWLS ADD HAZARDS TO FLORIDA COURSES



A pair of owls stand guard by their hole at Sombrero Country Club.

Jack Ostrander has become used to repairing the damage of mole crickets and moles as a superintendent on courses in southern Florida. It's part of the job. But the latest pest has him stumped. Owls are digging holes all over his course, next to the greens, tees and in the middle of fairways. The worst part, says Ostrander, is that the owls nest in the holes and turf equipment can harm the protected birds.

Ostrander, who works at Sombrero Country Club in Marathon. FL, says golfers in general respect the wise fowl. But they lose their tempers when a good approach shot rolls into an owl's nest. To protect his members and himself from possible legal problems, Ostrander is seeking humane solutions to his owl problem. He invites fellow superintendents, and bird lovers, to stop by the private course for a look.

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LITTLE LEAGUE BUILDS TWO BASEBALL CENTERS

Little League Baseball of Williamsport, PA, is completing construction of a new championship baseball center in Bristol, CT, and is accepting bids on another center for Indianapolis, IN. The new complexes will be used for regional championship games prior to the national championship held each year in Williamsport. The organization currently has championship facilities in St. Petersburg, FL, San Bernardino, CA, and Waco, TX.

"This year we will have more than 2.75 million boys and one million girls participating on Little League teams," says Elmer Lehostsky, director of education for the organization. "We have more than 400,000 managers of teams across the U.S. To provide these managers and athletes with championship quality fields and to handle the crowds they attract during the championships, we are building baseball facilities to the same standards of our Williamsport headquarters facilities. Lehostsky says the next baseball center will be built either in Portland, OR, or Seattle, WA, in the next decade.

"Little League overall enjoys safe playing conditions at nearly all of the thousands of parks and schools it uses across the country," points out Lehostsky. The injury rate is I.9 injuries per 100 players per season. "We strongly encourage managers to provide safe fields. Injuries can only harm the real purpose of the League, to provide kids with self-confidence and to learn to work as a team."

SPORTS TURF CONTRACTOR PURCHASED BY OLD FOX

The Greenway Co., an athletic turf renovation and maintenance company in Peabody, MA, has been sold to the lawn maintenance division of Old Fox Inc., in Danvers, MA. Last year Old Fox purchased Controlled Ecology, a golf course maintenance company in Burlington, MA. The acquisitions signal that the chemical and seed supply company was expanding from lawn maintenance into sports turf maintenance.

Before the purchase was completed, TruGreen Corp., a national lawn maintenance company based in Atlanta, GA, purchased the lawn maintenance division of Old Fox. It is unknown at this time whether TruGreen will expand athletic field and golf course maintenance to match its presence in the lawn care industry.

Kevin McCarthy, owner of The Greenway Co., said rising insurance rates were part of the reason for the sale. "It's hard for small guys to pay rising insurance premiums to stay in the pesticide application business," he stated. "The small custom applicator is hard-pressed by such increases."

Greenway performs all types of turf maintenance for municipalities and school districts in the Boston area. The company has all the large equipment necessary for deep aeration, seeding, fertilizer and pesticide applications, drainage improvement and mowing.

PGMS AND PORTER BROS. COSPONSOR SPORTS SEMINAR

The Professional Grounds Management Society and Porter Brothers, Inc., will cosponsor a seminar on athletic facilities maintenance management this summer in the City of Lenoir, NC. The City of Lenoir is helping with the event by providing its recreation center on July 19-20.

The two-day program will feature field demonstrations and classes on fertilization, facility scheduling, geotextiles, bleachers and backstops, drainage, field preparation and maintenance. More information on the event is available from PGMS, 12 Galloway Ave., Suite 1E, Cockeysville, MD 21030, (301) 667-1833. PGMS is cosponsoring another seminar on sports turf this summer in Worcester, MA, with the Sports Turf Managers Association.

