>> **Figure 1. PANELS TO THE LEFT** show high maintenance soccer field while the panels to the right show low soccer maintenance field receiving the same level of use of 146 hours for the season.

Surface smoothness and overall field quality also improved as the bulk density increased (r = 0.81 and r = 0.58, respectively), largely a result of a firmer surface due to greater sand content. We previously had found a highly significant correlation between surface hardness and bulk density.

USE AND INJURIES

The only effect from hours of use was on turf density, hardness and penetration resistance. As the hours of use per year increased, turf density decreased while hardness and penetration resistance increased. A loss in turf density was related to an increase in player to surface injuries. This accounted for 39% of injuries related to the field surface with higher densities associated with fewer injuries. These results underscore the relative importance of sustaining higher turf density for better cushioning and safer playing surfaces. To that end, overall field quality increased with higher N with an average seasonal N rate in this study approaching 4.5 lbs per 1000ft2.

We found no relationship between overall field conditions and hours of use. See Figure 1 in which hours of use were the same for two fields but maintenance input differed. An increase in maintenance input was closely associated with an increase in shoot density, surface smoothness and overall field quality; the likely reason for fewer injuries being reported. Shoot density was the single most important factor accounting for 39% of field related injuries with higher densities associated with fewer injuries. ■

W. M. Dest is Associate Extension Professor emeritus, University of Connecticut Storrs and sports turf consultant specializing in soil physical properties. J. S. Ebdon is Associate Professor of Turfgrass Management at the University of Massachusetts Amherst.

Managing insect pests

BECOMING AN EXPERT in identifying pests, determining their life cycles, and managing the insect population are valuable skills for turf managers.

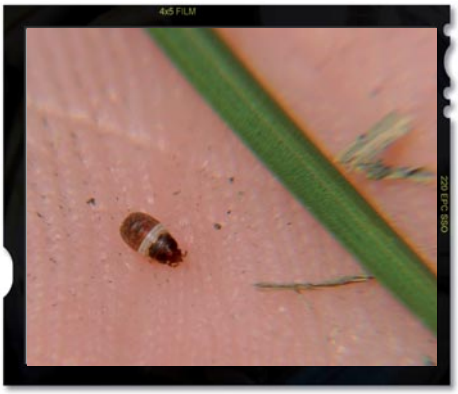
Detecting the presence of an insect is the first step in good pest control. Insect management begins once the early signs of injury or significant numbers of insects are observed. If the turf looks damaged, wilted, and water-starved, then an insect may be involved. Since some insects can only be controlled at certain times during their life cycles, it is essential to identify three key factors: type of insect; the insect's life cycle; and the level of infestation.

TOP PEST OFFENDERS

Various regions of the country experience unique pests. However, there are some fairly widespread turf pests that affect large areas of the United States. Some of the top offenders nationwide include white grub, chinch bugs and leatherjackets.

White grub. These small, plump, white larvae live below the soil and viciously chew on grass roots. Once the grass roots are destroyed, the turf will appear yellow in patches, just as if the lawn is dying out. The damage looks quite similar to symptoms of dryness, and many mistakenly assume that the turf needs only water to restore a lush, green appearance.

Other symptoms to watch for include animals such as skunks and raccoons digging up the turf and birds feeding on grubs, leaving pencil-sized holes. Often, damaged turf will roll back like a carpet. Serious damage can occur in the spring, summer and fall; and if the problem is ignored, the patches will get larger. The damaged areas will then fill in with weeds or crabgrass, so the best time to treat grubs is preventively rather than curatively.



Chinch bugs. These small insects live in and feed on grasses and can destroy turf with little warning. They live above the soil and feed on living grass plants by means of a piercing mouthpart called a stylet—sucking the juices out of the plant. The damage looks quite similar to drought symptoms and, again, many mistakenly assume that turf needs only water to restore its lush green appearance. Look out for suspicious brown patches starting to appear in the turf and, unlike fungal disease, the patches will not be symmetrical. If you determine the brown patches are due to lack of water, you can correct irrigating procedures.

Chinch bugs survive the winter and come out of hiding in the spring. Here they will mate and the females will seek a hot dry location in which to lay their eggs, which will hatch in about 3 weeks. The eggs are laid very close together so that

Mountain Pine Beetle

By Ken Kukorowski

THE MOUNTAIN PINE BEETLE (MPB) is a species of bark beetles native to western North America. The host range for MPB includes ponderosa, lodgepole, scotch and limber pine trees. Female MPB find large diameter, living trees to attack; there they produce pheromones to attract other beetles (especially males), mate, then bore into the host tree where eggs (could be as many as 75 per clutch) are deposited just under the bark.

As an adult, MPB is a small (<½ inch long) black beetle. Adults can appear as early as mid-June and continue to be present even through September, but in most locations adults emerging from lodgepole pines occur in late July and those emerging from ponderosa pines occur in mid-August.

As adults bore into the host trees, healthy trees produce pitch in the bored holes which often traps the adults and prevents successful attack. Within 2 weeks of egg deposit, the eggs hatch and the larvae tunnel through the phloem disrupting nutrient movement down the tree. With severe attacks, the larvae can cut off all nutrient and water flow movement and cause the tree to starve to death. These MPB larvae overwinter in a dormant state in the tree (under the bark) but resume feeding in the spring. They metamorphose into pupae in late spring, early summer (approx. June, depending on host attacked), then emerge as adults, to continue the next generation.

MPB is an effective vector of bluestain fungus, harbored near the mouthparts of MPB; when introduced to healthy pine trees, it blocks the trees defense response to produce pitch to entrap the boring MPB. Bluestain fungus also interferes with water and nutrient movement within the tree; further causing the tree to starve to death.

Since MPB has one generation per year, a spray of Sevin SL at a rate of 5 oz per gallon of water applied before adult emergence in June or July will provide preventative control of adult beetles before they bore into the new host.

This application should be made evenly over the entire circumference of the main trunk from the ground up until the diameter is 5 inches. One (1) gallon of finished spray will treat 50 sq. ft. of bark. ■

Ken Kukorowski is senior principal scientist manager of insecticides at Bayer Environmental Science.

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CENTRAL Garden & Pet

when they hatch the young begin feeding and small patches of small grass begin to appear. If the problem is ignored, the patches get bigger.

Leatherjacket. These flies, which also resemble mosquitoes, are primarily in coastal areas and feed on roots of grass plants resulting in a yellow-colored and wilted turf. If heavy infestations occur, turf can become brown or, even worse, the turf can completely die. Adults emerge mid-July through early October and begin mating immediately. Eggs hatch within a couple of weeks and larvae begin feeding throughout the fall and spend the winter below the surface of the turf. By March and April, heavy feeding occurs as larvae reach maturity. Larvae continue feeding until about mid-July. At this time they begin to pupate, then later transform into adult crane flies. Leatherjacket larvae are more easily controlled in fall or early winter while they are still young. Spring treatments are the best to control this pest.

MANAGEMENT

When it comes to pest management, you must treat the issue immediately in order to restore the turf back to its original, healthy state and to prevent the problem from reoccurring.

Normally, nature creates a balance between insects, natural predators and food supply. But if something such as a change in the weather pattern happens to change that balance, then insect populations increase and may cause extensive damage.

In addition to a solid pest management program that may include preventive and curative strategies, aeration can help to establish a sound root foundation that will be better able to withstand unwanted pests.

Remember, pest management starts with overall plant/turf health. ■

Jennifer Lemcke is chief operating officer of Turf Holdings Inc/Weed Man USA, a Canadian lawn care provider.

Annual Bluegrass Weevil

By Laurence Mudge and Rich Hanrahan

WHAT DOES IT LOOK LIKE?

The annual bluegrass weevil (ABW) has a long snout with an antenna that starts at the tip of the snout rather than the base. The blunt snout often causes the ABW to be mistaken for a turf-infesting billbug. ABWs typically measure 3 to 4mm long and their color differs between newly emerged adults and mature adults. Young adults, known as "callows" or "tenerals," are chestnut to brown in color, while the mature adults are darker ranging from gray to black. The body of an ABW is covered with thin, chestnut-colored hairs that shed with age, thus making the older adults appear shiny and black. These pests have rice-shaped eggs, about 1/32-inch long and gray. The larvae are cream colored with a C-shaped body and a distinct brown head. Young larvae are 1/32 inch and burrow and feed inside grass stems. After the larvae mature, they grow to be about 3/16 inch and feed externally.

ABW adults spend the winter protected near sites such as golf courses and other well manicured turf. In the EARLY spring, adults become active and migrate to shorter-cut turf where females lay eggs inside the leaf sheath of grass plants. By late May or early June, the damage becomes highly visible due to the larvae feeding on and killing stems. A single individual can injure up to 20 stems. The second-generation adults emerge in late June to early July and start the cycle again. This generation will reach the fifth instar by mid-July to early August. Damage from the second brood may become more severe if the first generation is left untreated.

The first recognized ABW to damage turf grass was reported in Connecticut in 1931. Since then, the insect has spread and is found most often in highly maintained turf in the Northeast and Mid-Atlantic. From 2006 to 2007, ABW was identified in Ohio, West Virginia and Virginia. And in 2008, the first-ever report in North Carolina came from a golf course near Asheville. Although ABW has spread throughout many states in the US, it still causes the most damage in the New England.

Prevention tips. Cultural management recommendations include proper nutrition and irrigation, which often help avoid symptoms of ABW damage. Converting from a susceptible turf species to one that is tolerant to ABW is also an effective strategy. Overwintering adults often populate in tree litter. However, tree removal is not recommended as these sites are not actually preferred locations for ABW.

TREATMENT TIPS

Controlling ABW with insecticides is currently the most effective strategy. Applications should be timed to control adult weevils as they depart overwintering sites and move into grass areas. Insecticide with the active ingredient imidacloprid provides optimum control when applications are made before the egg hatch.

The most important strategy to effectively prevent, manage, and treat ABW is to maintain optimum timing and rate of treatment with your applications. Applications should not be made when grass areas are waterlogged or the soil is saturated with water. Due to the level of infestation and the nature of the crop, as well as fluctuating water dilution rates, rainfall, mowing and other factors that can affect control, it is important to follow insecticide label instructions or contact your state cooperative extension service for more detailed information concerning the application timing. ■

Laurence Mudge is technical service coordinator at Bayer Environmental Science. Rich Hanrahan is northeast field representative for Bayer; for more information, see www.backedbybayer.com.

The most important strategy to effectively prevent, manage, and treat ABW is to maintain optimum timing and rate of treatment with your applications.

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Cleaning and the condition of artificial surfaces

I MUST TELL YOU that I have never been a proponent of artificial surfaces even though I know they have their place and certainly have made an impact in the sports world. My background as a head groundskeeper, for both the Cleveland Indians and Cleveland Browns, gave me a good understanding of sport surfaces. I occasionally dealt with artificial practice fields, but most of my activity was on natural grass.

When I started my own field maintenance company we competed with artificial field companies and I saw different aspects of these surfaces. I got to see the evolution from the directional Astroturf, improved Astroturf, poly-grass and infill cushioned turf. Most of them are sold as maintenance-free surfaces. I am not aware of anything that is maintenance free. Owners and managers were totally unaware that cleaning was a normal part of owning these surfaces. The life of these surfaces also was a question. Various materials performed differently and cleanliness is a factor.

Years ago, the first indication for me that cleaning could be an issue came from Spin Martin, head groundskeeper of the Indianapolis Colts. He suggested that I get into the artificial surface cleaning business; he said he was cleaning and spraying the Colts' surfaces regularly. I then talked to some executives at the leading artificial turf supplier in the US about disinfecting and cleaning turf. They seemed to be in denial about the subject.

No matter which carpet materials are used, cleaning makes it last longer.

I was worried about the liabilities that my company might face from both the players and the surface manufacturers. Years went by, and then my current business partner, Steve Smetana, reintroduced it to me. He has experience working and playing on turf in many uses and was looking into the cleaning process.

EQUIPMENT IMPROVEMENTS

The cleaning process has been improved due to the better cleaning equipment now available and more attention paid to player/disease questions. The early blades were difficult to clean due to their rough surface and shape. The newer poly blades are better because they are smooth and slick, but before the newer equipment it was impossible to clean and not remove the rubber infill. But those issues have been solved if you have the right equipment.

No matter which carpet materials are used, cleaning makes it last longer. Brushing will not remove dirt nor clean, but in fact drives the dirt down to the backing. Many facilities brush to clean. Brushing will pick up the blades and spread the infill, and the leaves appear cleaner, but in fact it will not remove the dirt.

The dirt we are concerned about is mostly hair, bodily fluids and skin, but we find pins, paper, uniform parts and various things that show up from the participants. I was very surprised at the amount of hair and dirt that we collect. Some indoor facilities even have dog shows and other non-sport activities, but do not clean afterwards. You would think that cleaning would be the natural thing to do, as most people consider it as a part

JOHN MASCARO'S PHOTO QUIZ

John Mascaro is President of Turf-Tec International

Can you identify this sports turf problem?

Problem: Green turf with brown rectangular area
Turfgrass area: Private boarding High School
Location: Dedham, Massachusetts
Grass Variety: 50% Bluegrass/50% Ryegrass

Answer to John Mascaro's Photo Quiz on Page 33

Background illustration courtesy of istockphoto.com

>> **VACUUM BAG** with surface debris.

of standard of living. Most testing done on artificial surfaces for bacteria and fungus are on new surfaces. I am sure that growth on the new carpet samples is not a question, but growth on the nasty debris that accumulates in the surface is a different story.

In the 1930's and 1940's salesmen went door to door selling vacuum cleaners. The sales pitch was to vacuum on half of an area and then dump the collected material, removed from the carpet, on the rest of the carpet. This demonstrated how much dirt was still in the carpet.

I was surprised that the owners and operators of synthetic turf fields do not seem to worry about the buildup of dirt that is in playing surfaces. I suppose the question is what responsibility the owners or operators have or what should the customer expect. I would be taken aback if the hotel room I book does not have a clean floor, clean towels and sheets. Is this different? I do not think so. We are presently doing the same thing as the vacuum salesman of yesteryear and it still works.

Most facilities we visit do a great job cleaning locker rooms, eating and spectator areas. Why should it stop at the playing surface door? You know that a dirty locker room is not a good sign of the quality of the operation, but you cannot see the dirt in the field. There are also ways to make this a positive for a business. As in the hotel business, the customers want to know you have their interest at heart. Signs for the cleaning times do work. We have owners who say that they want the customers to know that they are spending time cleaning.

DISINFECTING

Disinfecting is a different process and just as important. The NFL has set some parameters and some of the surface manufacturers have as well. I do not know if there is presently a problem with bacteria or fungus growth, but in time it is possible. *(Editor's note: Dr. Andy McNitt, director of The Center for Sports Surface Research at Penn State, says outdoor synthetic fields do not need disinfectant applications but indoor synthetic fields should be disinfected, and that using a solution with Tide detergent is as effective as commercial disinfectants.)* As mentioned before, the disease that one would worry about would more likely be a host of the accumulated dirt. Another problem is the ever-changing reaction that people have to viruses and bacteria. Disinfecting slows or stops that process and will make any surface safer.

I have not mentioned the difference between the outdoor surfaces and the indoor surfaces. It is easy to see that indoor surfaces, with consistent heat and moisture, make a better environment for bacteria growth.

Outdoor surfaces have the help of the sun, rain and freezing weather to curb bacteria and fungus growth. For your information, the beauty of natural grass surfaces is that the soil and grass comes with its own bacteria that eliminates or competes with the unwanted strains. It is understood that the natural grass surface cannot survive around the clock activities, but they do cost less to install, last longer and if you have enough area for all the activities, will provide a good surface.

One other factor regarding any surface is the cushion capability. This is measured in the form of G-Max. This science is rather new, and I am not sure that the understanding of the data is conclusive. We do know that it will measure consistency of cushion throughout the surface. These measurements do change in any playing surface do to use, age and weather. The same is true for both natural grass and artificial surfaces. Softness, cushion and cleanliness change the characteristics of foot release, which can be a safety concern. The early synthetic surfaces actually got sticky when they were dirty.

The bottom line for most field improvement is the cost and benefits. The money spent on each facility can be affected by competition. In some situations, the competition between sports may take competitors to different venues. The Hertz rental car theory is, "The cleaner the vehicle, the better the customer takes care of it" has always been of interest to me. If the entrance to a building, parking lot or associated areas are trashed, what would you think the inside looks like? Cleaning is a part of any presentation and cost effective. ■

>> **INDOOR SURFACES, with consistent heat and moisture, make a better environment for bacteria growth.**

David Frey is a former groundskeeper for the Cleveland Indians and Cleveland Browns, a past president of STMA, owner of Field Specialties, a sports and equestrian surface contractor, and a partner of Pro Turf Clean, Inc.

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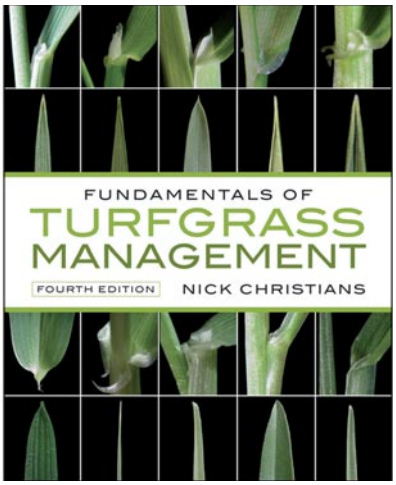

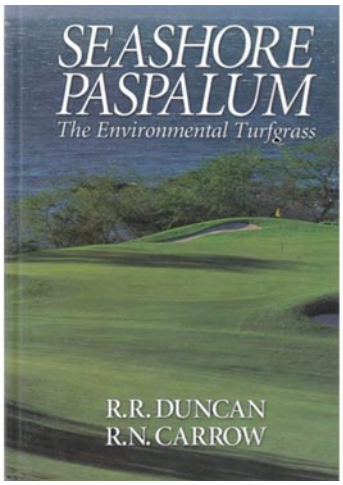

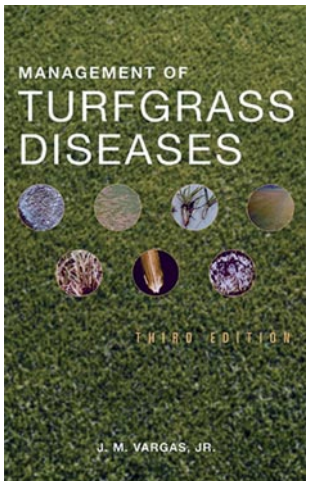

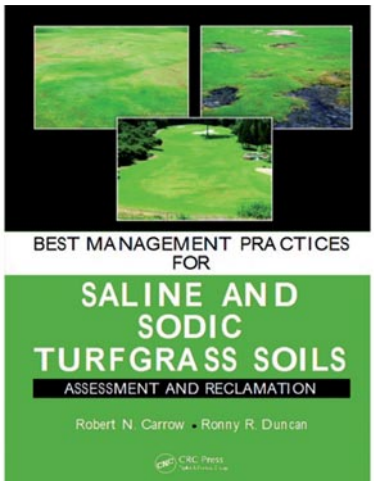

Turf textbooks 101: what's currently being taught

Editor's note: *The idea behind this article was hatched at a meeting for STMA Committee members before the association's conference opened in Austin last January. Chad Follis, a horticulture instructor at Mineral Area College, Park Hills, MO gets an "A" for thinking it would be interesting to poll turfgrass professors on their favorite textbooks.*

HERE ARE THE QUESTIONS we sent some of the most prominent turfgrass teaching professionals in the country:

What textbook(s) is required for your introductory college course on turfgrass management? Why was this book chosen?

What textbook(s) is required for any advanced courses college courses related to pest management, soils, plant science?

Besides your introductory turf text and, most likely, *Sports Fields: A Manual for Design, Construction and Maintenance,* what other turf book(s) would you recommend turf managers have on their reference shelves?

GREG BELL, PhD,
Oklahoma State

I use Nick Christians' book, *Fundamentals of Turfgrass Management*, for my introductory turfgrass class and will be using my own book, *Turfgrass Physiology and Ecology: Advanced Management Principles* that was published in January, for my advanced class. I also like Al Turgeon's *Turfgrass Management*, as an introductory text. However, I prefer the Christians' book slightly because it is a little more practical and a little bit easier to read.

I believe that Jim Beard's *Turfgrass: Science and Culture*, is still a good reference in spite of being published in 1973, and his book, *Turf Management for Golf Courses*, and the Bert McCarty et al. book, *Best Golf Course Management Practices*, are also excellent for understanding and practicing the agronomic practices necessary for sports field management.

For basic field construction and maintenance questions I usually refer to Puhalla, Krans, and Goatley, *Sports Fields: A Manual for Design, Construction, and Maintenance.*

The McEntire and Jakobsen book, *Practical Drainage for Golf, Sportsturf, and Horticulture* is great for learning drainage principles, and the Pira book, *A Guide to Golf Course Irrigation System Design and Drainage*, is good for learning more advanced design and theory for both drainage and irrigation. I look to Carrow, Waddington, and Rieke, *Turfgrass Soil Fertility and Chemical Problems: Assessment and Management*, for help with soil problems.

My favorite disease book is Houston Couch, *Diseases of Turfgrass*, although it predates some of the recently discovered diseases and some major problems such as gray leaf spot on perennial rye. The *Compendium of Turfgrass Diseases*, 3rd edition, by Smiley, Dernoeden, and Clarke is also very good, reasonably priced, and more up to date. My favorite insect book is Dan Potter's *Destructive Turfgrass Insects*.

TROY MCQUILLEN,
Kirkwood Community College (IA)

Fundamentals of Turfgrass Management by Nick Christians of Iowa State University is the required textbook for our introductory

Teaching in an applied science program, it's nice to have textbooks that reflect the hands-on learning techniques we as faculty promote in the classroom.