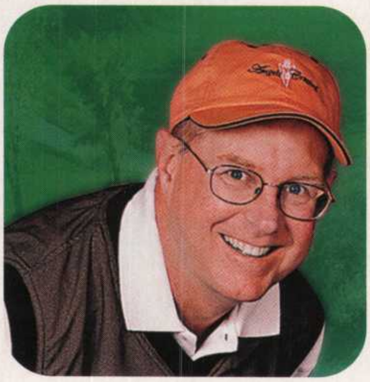

Architect Bruce Matthews advises new course owners to delay cart path installation. "Golfers will dictate where they should go," he says.

up shells or sand have also been used in places like Florida, where they are plentiful.

Weed says that cart path work should be budgeted carefully because it is such a substantial cost. Don't forget the prep work, he adds, which should be its own line item so it is scheduled appropriately.

When the management at Crystal Springs Golf Course in Burlingame, Calif., needed to purchase a new fleet of golf cars, a prerequisite became obvious: the need to replace damaged cart paths that would shorten the lifespan of new vehicles.

Tim Powers, the certified superintendent at the course south of San Francisco, says widening the paved surface was a key to the project, which he estimates cost about $700,000.

"It was a bit of a fight to get our company president to go to the 8 feet, but he finally relented," Powers says.

The width increases to 9 feet at the greens and tees, and Powers says 10 feet would've been better. Concrete was selected because it is less susceptible to breaking up and is easier to repair. It cost more at first, he says, but "in the long run, it's a better deal."

The public-access course is in an area that gets heavy winter rains — 48 inches last year, according to Powers — and the clay soils become impassible for golf cars. As a result, there are a lot of cart-path-only days at the facility, which opened in 1924.

A renovation master plan completed eight years ago by architect Gary Linn laid out routes for the new paths, changing four holes from the right side to left and creating some mounding to hide pathways in selected spots.

Pieces of the old paths were ground up, and some of that material was layered beneath the new paths. About 1,000 feet of curbing and a few drainage basins within the paths were added.

During what Powers describes as "three months of very, very long days," the work was completed without closing the course down. Only one or two holes were impacted at any given time, as the shaper timed his prep work to stay just ahead of the rest of the crew.

One lesson learned by Powers was to come in with a strong understanding of the irrigation system. The work caused a couple of pipe breaks and forced the relocation of a few heads, but those problems were limited by having his irrigation person work with the contractors.

The project's biggest kink involved a question about who was responsible for backfill. Soil was needed around the paths upon their completion, and because that wasn't discussed with the contractorbeforehand, there were some disagreements. "We finally got it worked out," Powers says.

Now, the 8-foot paths smoothly carry legions of golfers as well as the crew's fairway mowers and tractors. At Crystal Springs, a necessary evil has been turned to double advantage. ■

Allar, a freelance writer from Floyds Knobs, Ind., is a frequent contributor to Golfdom.

Spring Could Bring Agronomic Issues

BY KARL DANNEBERGER

THE EARLY MILD WINTER WAS GREAT FOR ROUNDS AND REVENUE, BUT NOT FOR BENTGRASS GREENS

Through much of the Midwest and Northeast, temperatures this past fall and early winter were mild enough that golf courses had considerable play. The mild weather provided revenue streams that benefited club finances and delighted many golfers.

The agronomic downside is that golf courses continued to mow late into January, considered additional snow mold applications, and will face *Poa annua* and wear issues come spring.

In most cases, mowing was done on greens that were a mix of creeping bentgrass and *Poa annua* for the purpose of providing a smooth surface. The *Poa annua* was green and growing for part of the winter (until a cold and snowy February set in) while the bentgrass was semidormant.

Even *Poa annua* seedheads were observed in areas, including the Mid-Atlantic, in early January. The result of the differential growth between *Poa annua* and creeping bentgrass was bumpy greens that required mowing. In some cases, plant growth regulators were used to slow *Poa annua* growth.

The combination of mild weather and wear from play favors *Poa annua* spread on greens. Germination the previous fall and rapid development occurred thanks to the mild conditions early in the winter. Additionally, the wear caused from golfers on greens caused open areas or gaps and a thinner turf, which favors *Poa annua* establishment and spread.

It's also highly probable that many golf course superintendents who have predominantly creeping bentgrass greens will see considerable *Poa annua* invasion this spring. If there is any good news, the *Poa annua* that has appeared and was not apparent in the fall will be mostly annual in nature and should disappear with the arrival of summertime temperatures.

From a disease perspective, the late-arriving snow caused many superintendents who applied snow mold fungicides, especially contacts, to contemplate reapplications. If conditions remain cool and wet this spring, microdochium patch is expected to be prevalent, especially in areas not retreated.

Wear and soil compaction issues are major concerns that come with any winter play. So a few maintenance suggestions are warranted on greens that are predominantly creeping bentgrass. Shoot growth on creeping bentgrass is normally slow in the spring, especially compared to *Poa annua*. So in early to midspring, avoid the temptation to push your greens with fertilizer to "jump start" them. Allow creeping bentgrass shoot growth to occur in its own natural time. Fertilizing will only promote the *Poa annua*, and might be detrimental to root growth if the fertility levels are too high.

Caution should also be taken with early spring coring of creeping bentgrass greens. The natural tendency is to core cultivate early in the spring to relieve compaction from winter play. Coring bentgrass when soil temperatures are still cold will only favor *Poa annua* spread. Additionally, nighttime temperatures are still cold in the early spring. This cold air will settle into coring holes and keep the soil temperatures depressed longer.

The key to creeping bentgrass greens management in the spring is not to be in a big hurry. Let the plant get started on its on own schedule — not yours — and then do the necessary practices.

If you are managing predominantly *Poa annua* greens, you do have some advantages. With both root growth and shoot growth starting earlier in spring compared to creeping bentgrass, corrective management practices can be initiated earlier.

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TURFGRASS TRENDS

CHEMICAL RESTRICTIONS

What's the Future of Perfect Turf?

By Ted Steinberg

This past spring, Quebec passed the most stringent pesticide code in all of North America, pulling more than 200 lawn-care products off the market. More than 70 municipalities in Canada, including Toronto, now have laws regulating the cosmetic use of lawn-care pesticides. Faced with such anti-lawn sentiment, the American Green Industry has banded together to form Project EverGreen to promote the health and other benefits of a good lawn, as well as the benefits of golf courses and other green spaces.

"The gloves are off," explained one Project EverGreen ad that pictured leather gardening gloves sitting on a beautiful green lawn. "Yes, legislation and regulations have been throwing the green industry some rough punches," the ad declares. "And we're about to start fighting back."

The idea of perfect turf — weed-free, super-green, ultra-trim grass — is under fire, making it a good time, as Green Industry leaders and activists brace for battle, to ask some important questions about the rise and potential fall of perfect turf. When and why did the idea of perfect grass rise to dominance across the U.S. landscape? What forces are helping pave the way for its downfall?

Even Augusta National Golf Club looked shaggy and unkempt as late as 1948.

Perfect turf is a very recent invention. Although lawns extend far back in American history, at least to the time of Washington and Jefferson, the notion of perfect grass is largely the product of the post-World War II period.

Several forces came together to drive the quest for perfection in turf care. Consider, first, the economic context. By the postwar years, American manufacturers had succeeded in refining mass production to the point where it was possible to produce a large volume of goods both efficiently and cheaply. Who would buy all these products was still an open question.

Ultimately, the idea of planned obsolescence, which first emerged in the 1920s, proved enormously attractive to American business in the postwar period. Perfect lawns, as it turned out, were the on-the-ground equivalent of annual model changes in the automobile industry. Growing non-native grass species to perfection was a high-energy, high-maintenance proposition that sent consumers continually back to the store for more products, helping solve, in part, America's underconsumption problem.

In addition to the economic context, trends in natural resource history also proved very conducive to the idea of perfect turf. In the postwar period, water and oil — the

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OUR SPONSORS

PHOTO 1

Turf research continues to develop more disease-resistant cultivars to mitigate the impact of pesticide bans.

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two major resources necessary for growing perfect grass — were abundant and inexpensive. As late as 1990, even arid Las Vegas still charged a flat fee for water, giving golf courses and other high-volume users a massive subsidy. Meanwhile, despite the oil crises of 1973 and 1979, oil was selling for less than bottled water by the end of the 1980s. Together, this favorable natural resource context combined with economic exigencies to underwrite the movement for perfect turf in the United States.

Organized golf clubs, for example, had existed in the United States since the late 19th century. But these early courses tended to be located on old pastures hardly known for their meticulous upkeep. Greens tended to be cut long, perhaps as much as half an inch or more. Even Augusta National Golf Club looked shaggy and unkempt as late as 1948.

Capitalizing on the inexpensive cost of water, golf courses in the 1960s rushed to install automatic irrigation systems. Automatic irrigation systems used vastly more water than the older method which relied on workers to haul hoses and sprinklers around the course. Suddenly, cool-season species like bentgrass — originally found only on greens — were being planted on tees and fairways as well.

By the 1970s, superintendents rescued the Stimpmeter, invented in the 1930s, from obscurity and began reducing mowing height in the quest for faster and more perfect-looking greens. The grass height on greens trended downward from half an inch to as low as an eighth of an inch by the 1990s. The ecological impact of mowing low, meanwhile, increased the demand for both water and pesticides as the rage for perfection and faster greens gripped the golf landscape.

Pre-emption

Today, however, it seems clear that the perfect turf ideal has entered a vulnerable period in its history. Though the green industry is as eager as it was in the 1950s to move it products by selling golf course superintendents and homeowners more chemical inputs, water and oil are more expensive.

In a move to save on water, the city of Las Vegas in the late 1990s passed a law applicable to new homes that limited turf to 50 percent of

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OFFICIAL GOLF COURSE EQUIPMENT SUPPLIER
For courses that roll,
meet the mower that rocks.


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the front yard. In 2005, increased demand for oil in China combined with the devastation wrought to the Gulf of Mexico by Hurricane Katrina sent the price of oil to $70 a barrel. The spike in oil prices has made the entire idea of high-energy grass seem like one big ecological conceit.

Perhaps an even more formidable threat to perfect turf can be found in trends in the history of law, specifically the development of the precautionary principle. In the early 1970s, the Germans, dealing with the threat of air pollution, pioneered the idea of Vorsorgeprinzip, the first substantive attempt to deal pre-emptively with environmental and health problems based on the weight of scientific evidence but before any conclusive determinations could be made. The precautionary principle was invoked in 1987 at the Second International Conference on the Protection of the North Sea where it was held necessary to protect the waters in the face of chemicals threats "even before a causal link has been established by absolutely clear scientific evidence." It has since found its way into a number of important international treaties. More important for our concerns here, the principle was articulated in law for the first time in North America in the Supreme Court of Canada's Hudson decision.

The current trend toward banning pesticides in Canada began more than a decade ago when Hudson, a small town outside of Montreal, passed a law prohibiting the use of pesticides for cosmetic purposes. The political scientist Sarah Pralle has argued that the driving forces behind Canada's anti-lawn pesticide movement include not simply the embrace of the precautionary principle but clever organizing on the part of activists who have questioned the logic of lawn perfection and the risk that lawn chemicals pose to children's health.

Opposing these activists were two lawn-care companies, which violated the Hudson ordinance sending the case all the way up to the nation's Supreme Court, where, in 2001, the law was upheld. "In the context of the precautionary principle's tenets," the court ruled, "the Town's concerns about pesticides fit well under their rubric of preventive action." Following the ruling, Quebec's environment minister André Boisclair declared, "People's health is more important than the perfect lawn."

Pre-emption laws on the books in 41 U.S. states prevent local municipalities from following in the direct footsteps of their neighbors to the north. But the forces that have aligned to produce anti-perfect lawn activism in Canada are finding some fertile ground here in the United States as well. For example, the risk of eutrophication spurred the city of Madison, Wis., to ban the use of phosphorus in fertilizer, as did the seven counties that make up the Twin Cities area around Minneapolis and St. Paul. The industry challenged the Madison regulation in court, arguing that Wisconsin's Pre-emption legislation — which forbids local municipalities from passing their own pesticide ordinances — prohibited the city from applying such a rule to weed-and-feed products. But in late 2005 the 7th U.S. Circuit Court of Appeals upheld the legality of the phosphorus ban.

What, in short, will be the future of perfect turf? It is difficult to say for sure. But in an era of natural resource scarcity and increasing concern about chemical use, it seems likely that more people may be inclined toward the conclusion of former East Hampton, N.Y., town supervisor, Jay Schneiderman, who called for more pesticide regulation after he began fearing that pesticide-contaminated drinking water played a role in the strikingly high number of lymphoma cases found among graduates of a local high school.

"People like their green lawns, but a green lawn should not come at the expense of public health and safety," he said. "I'd rather see dandelions than leukemia."

Ted Steinberg is Davee Professor of History and Professor of Law at Case Western Reserve University in Cleveland. He is the author of "American Green: The Obsessive Quest for the Perfect Lawn" (W.W. Norton, 2006).

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Bolster Turf's Ability to Use Natural Defenses Against Stress

The key is managing rootzone moisture conditions

By Erik H. Ervin

Several years of research at Virginia Tech indicate that improving certain rootzone environment conditions, particularly overcoming water repellency and providing consistent water availability, enhanced turf ability to avoid drought stress resulting in more efficient photosynthesis and greater up-regulation of defenses for tolerating stress.

Photosynthesis can be said to be the basic plant process —producing the chemical energy (carbohydrates) required for all growth and maintenance processes. Anything that interferes with efficient photosynthesis will reduce turf health and ability to deal with stress; anything that favors efficient photosynthesis will bolster turf's health and ability to withstand and defend itself against stress. Growing conditions in the rootzone have a significant impact on the level of photosynthetic efficiency that a plant can achieve.

Two stress-related dynamics in plant physiology are the production of free radicals and antioxidants. Free radicals disrupt key plant functions, and one of the key roles of antioxidants is to "deactivate" or "neutralize" these free radicals.

Production of free radicals occurs even under optimum conditions, but it is significantly higher when conditions for photosynthesis are suboptimal. Production of antioxidants is natural, but it can be hindered when carbohydrate reserves are low or rootzone conditions are unfavorable. This is also related to how efficient photosynthesis has been. It is clear that rootzone conditions affect both stress occurrence and turf's ability to defend itself against that stress.

To understand all this further, and the impact of cultural practices affecting the rootzone environment, it might help to review the complex machinery of the plant.

Plants consist of millions of cells, each of which contains organelles. Each type of organelle has a specific function. For example, chloroplasts capture light energy; the nucleus directs growth, and mitochondria respire energy to fuel growth. All cells and their organelles are suspended within a water-based solution and are bounded by membranes. The membranes provide structural integrity while allowing substances to diffuse in and out as required for efficient growth and maintenance.

Chloroplast membranes contain light-harvesting green pigments called chlorophyll. There are two types of chlorophyll designated as chlorophyll-a and chlorophyll-b. In full sun, chlorophyll-a outnumbers chlorophyll-b by three to one. Chlorophyll forms complexes with proteins in the chloroplast's membranes called photosystems. The photosystems capture light energy and turn it into chemical energy.

Here's how it works. Light hits a chlorophyll-a molecule and causes an electron within the chlorophyll molecule to go to a higher energy level. The energy from these excited electrons is then used to split water from the soil and release more electrons. These electrons are then transferred through the protein-based photosystems to produce energy in the form of NADPH (nicotinamide adenine dinucleotide phosphate) and ATP (adenosine tri-phosphate). The plant uses this as energy to drive carbon dioxide (CO_2) fixation and produce carbohydrates.

Some key ingredients for this process to occur include light, oxygen, water and nutrients from the soil. The consistency or inconsistency of supply of all of these has a direct impact on the levels of photosynthesis that will be able to take place.

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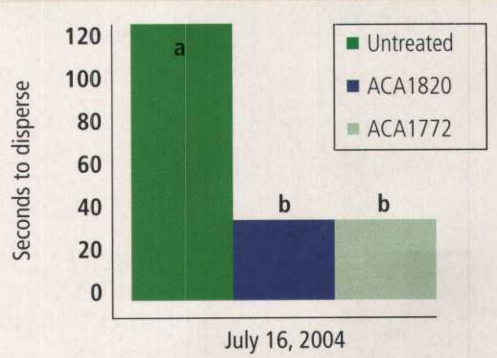
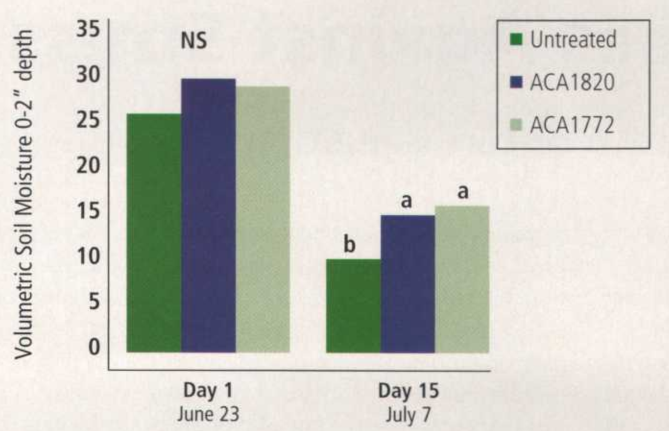
TABLE 1



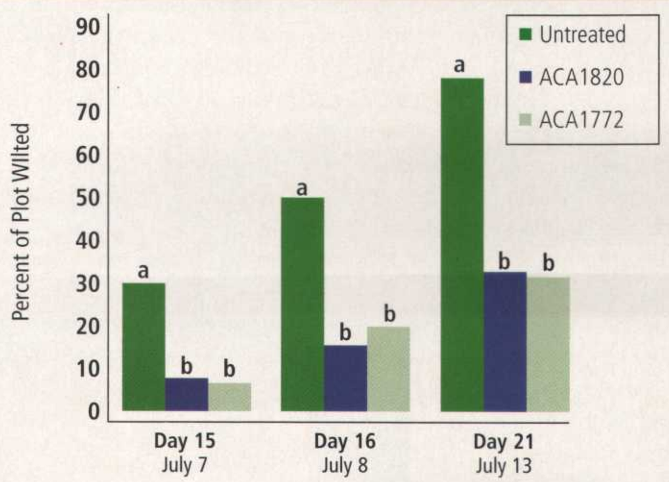
Seconds required for droplet dispersion into treated plugs pulled from the test green; droplet was placed at the thatch/soil interface. Irrigation was withheld over a 21-day period in 2004. Treatments were initiated on June 16. Bars labeled with different **a** or **b** letters are significantly different at a 95% probability level.

TABLE 2



Effect of a surfactant on 0-2" depth volumetric soil moisture content as irrigation was withheld over a 15-day period in 2004. Treatments were initiated on June 16. **NS**=no significant difference. Different **a** or **b** letters are significantly different with 95% probability.

TABLE 3



Percent of plot wilted as irrigation was withheld over a 21-day period in 2004. Treatments were initiated on June 16. Bars labeled with different **a** or **b** letters are significantly different at a 95% probability level.

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Turf coping mechanisms

Even under optimum temperature, light, and moisture conditions there is waste in the system resulting in inefficiencies and the production of free radicals in chloroplast photosystems. Similar to a car engine, there are a number of toxic chemical emissions or byproducts of photosystem function that the plant must deal with to remain healthy. Under less than optimal temperature, light and moisture conditions, the inefficiencies will be greater.

Why do these inefficiencies occur? Photosystems of plants that are completely dependent on a C3 (or Calvin-cycle) photosynthetic pathway are not immediately capable of using all the excited electrons that are created when chlorophyll electrons are excited by light. Generally, this inefficiency is due to the inability of the enzyme Rubisco to fix enough CO_2 to utilize all of the available light for carbohydrate production. Although Rubisco preferentially fixes CO_2, it also fixes O_2 in a process called photorespiration. As temperatures build and stomates narrow in response to limited soil moisture, the internal concentration of O_2 increases relative to that of CO_2, increasing photorespiration and the inefficiency of light capture. The unused excited electrons are either lost directly as heat or as a light emission called chlorophyll fluorescence — or they react with "good" (ground state) oxygen (chemically represented as $^{3}O_2$) and form free radicals such as "bad" singlet oxygen ($^{1}O_2$), the superoxide radical ($^{X}O_{2-}$), and hydrogen peroxide (H_2O_2).

Chlorophyll fluorescence is a natural phenomenon that is measured easily on turfgrass canopies with a chlorophyll fluorometer and converted to a standard measure in plant physiology called photochemical efficiency. Briefly, the more light being given off (or fluoresced) from the canopy, the less efficiently that light energy is being used by the photosystems to run the photosynthetic reactions and produce carbohydrates. Optimized turfgrass canopies have photochemical efficiencies of about 0.7, while those under stress are at 0.55 or below.

Free radicals, if not quickly converted to water and ground-state oxygen by antioxidants, damage proteins and DNA, bleach chlorophyll, and disrupt membrane integrity. Left unchecked, free radicals can lead to plant death.

To address these inefficiencies, the plant has various natural coping and defense mechanisms. To deal with the free radicals, healthy plants have a robust defense system that produces antioxidants to "deactivate" or "neutralize" the damaging free radicals. Three of the

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