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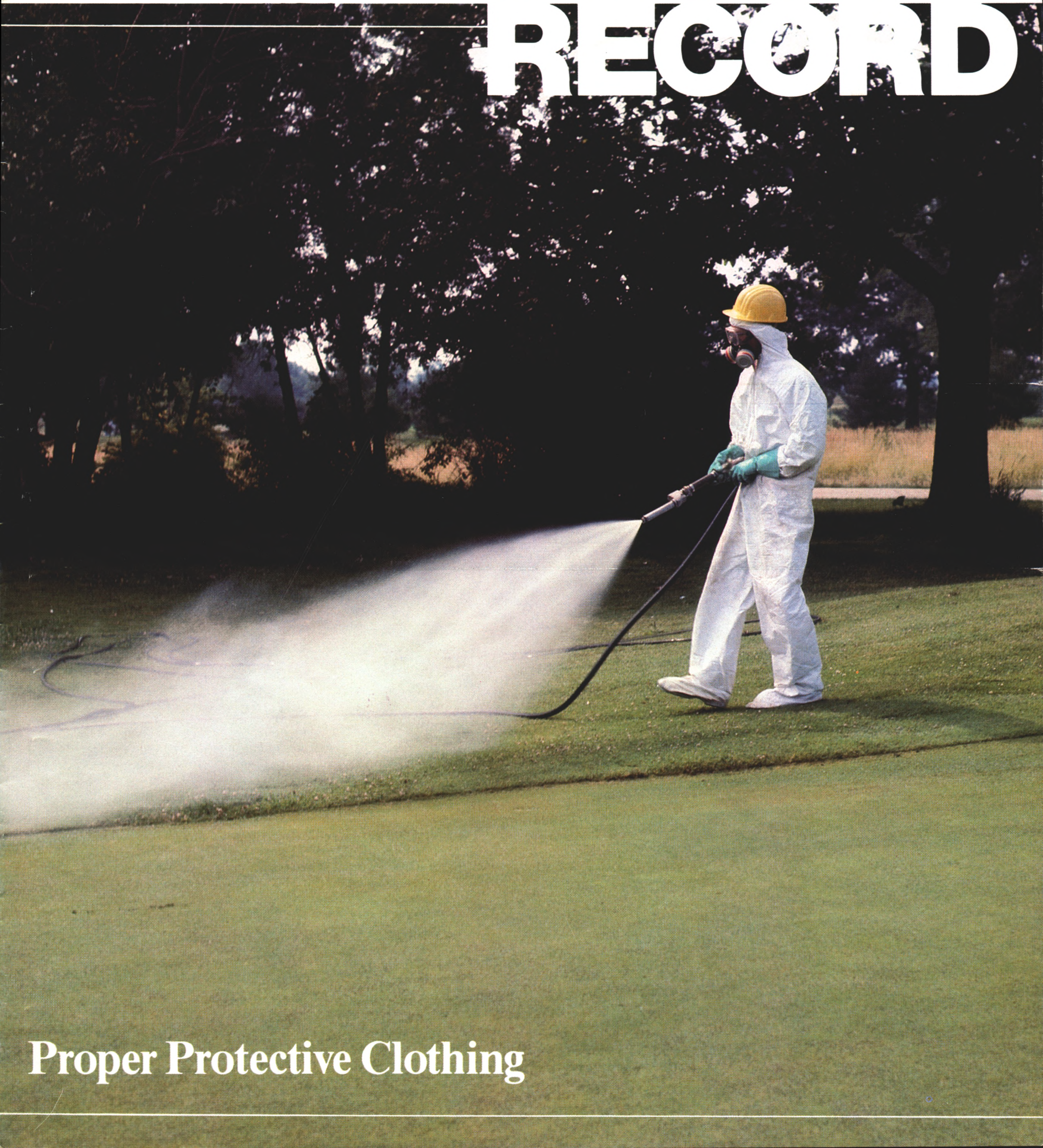

Proper Protective Clothing

USGA®

Green Section
RECORD

EDITOR:
William H. Bengeyfield
MANAGING EDITOR:
Robert Sommers
ART EDITOR:
Diane Chrenko

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Cover Photo:
Proper protective clothing is one example of how modern chemicals can be safely and effectively used.

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Pesticides are needed for golf turf survival even in the most natural surroundings. Crystal Downs Country Club, Michigan.

Another Pesticide Problem — LOCAL LAWS

by JAMES M. LATHAM
Director, Great Lakes Region, USGA Green Section

WILL YOU SIGN this petition to stop the poisoning of air in the community?" asked the young man at the door.

"What poisoning?"

"The stuff they use to kill mosquitoes with."

"What stuff?"

"The same type of chemical they used to make poison gas in World War II."

"Poison gas? World War II?"

"Sure, it's called malathion."

"Well, I don't know. I kinda like to sit on the deck occasionally and really can't stand to hear or feel mosquitoes. I'm not too fond of thinking about the encephalitis cases reported last year, either."

"Oh, there's a better control of mosquitoes now. It's called B.T."

"Bacillus thurengensis?"

"Yeah."

"Goodbye!"

The above is an excerpt from a conversation with a young volunteer solicitor last summer. He was in dead earnest and was wearing out his sandals on a door-to-door canvass for funds and signatures in the name of a citizens environmental group. But where do you suppose he got the poison gas routine? And the wrong war? From the people who survive and thrive on public fear of the unknown, science in general, and pesticides in particular.

The United States created the Environmental Protection Agency to develop a means of preventing the degradation of our habitat by our own hand. In spite of the Delaney Clause, the E.P.A.'s FIERA (Federal Insecticide, Fungicide and Rodenticide Act) is a strong but costly deterrent to fouling our own nest through ignorance of the materials discharged into the environment. It has been thoroughly cursed and praised since its inception, but with adequate restraints it functions well.

THE U.S.E.P.A. is only one agency; it can be dealt with, to some degree, in spite of its bureaucratic makeup. There is a serious weakness in the structure, however, which has opened the door to "anti-" groups of all sorts. While lower levels of government cannot weaken any EPA regulation, they can "strengthen" them. Thus, a state can establish equal or even more stringent regulations. A county can top that, and a municipal entity can go even further. Current federal and state statutes are ample and effective. We don't need preemptive local laws.

A manufacturer of pesticide just might be able to answer to USEPA or even to the 50 states, but not the nearly 80,000 units of local government in our country. Local rights are as highly prized as the states' rights that started the civil war, but when some of these poison gassers spread their own bit of venom, it is up to *local* defenders of pesticide use to respond. Bringing in outside experts with the best available information doesn't sway many town councils. Residents do.

Golf course properties need the protection afforded by pesticides. Our valuable golf-style turfgrass would not exist as we know it without them. Please note also that few golf course operations need restricted-use pesticides. Most of the products applied to golf turf, trees, and ornamentals can be purchased by anyone, and many of them are available in the nearby garden store. But they *are* pesticides. All weed killers equate to Agent Orange. (And its guilt has not been proven). All insecticides equate to DDT and thin egg shells (but no dead people). Ad infinitum.

HERE'S HOW some local laws can affect golf courses:

1. In Madison, Wisconsin (and other cities) a proposed law would require notification of neighbors if a pesticide was "applied outdoors to property or atmosphere by any means . . ." It also requires signs every 75 feet along the perimeter of the property, posting the name and telephone number of the pesticide user, the date of application and the phrase "This lawn chemically treated. Keep off for 48 hours." The name of the pesticide may also be included and the signs must be removed 48 hours after the application. The fine for violation may be $500. Each day is a separate violation.

2. In Milwaukee, a ruckus was raised over the use of Roundup herbicide to kill unwanted vegetation on public park land. At a request by the local union (District Council 48, AFSCME) the county's Park Committee banned it. When the whole truth about product safety and protectionist labor policy came out, the ban was rescinded. One can guess the real cause of resistance to a safe but labor-saving herbicide.

3. In Dade County, Florida, a proposal is on the table stating that even though pesticides play a major role in maintaining the tropic luxury of golf courses, parks, etc. and can be used, they cannot be stored on property within the core of influence of wells supplying public drinking water. These are big circles, encompassing several golf courses, both public and private.

4. Some states ban fungicides containing mercury, but not cadmium formulations, and other states do the reverse. Both have been used to control turf diseases for 50 years or so.

5. There is a very ambiguous law in Texas which prevents reentry by *anyone* into a "field" treated with "a pesticide," for a period of 24 to 48 hours after application. While the regulation is intended to protect farm workers, other interpretations can keep people off golf courses.

6. Even fertilizers can be included in local laws. Shoreview, Minnesota, limits phosphorus fertilizer to 0.5 pounds per 1,000 square feet per year. The aim is to reduce algae growth in lakes. Nitrogen fertilization of turf is under close scrutiny in Long Island and other areas with sandy soils and shallow water tables.

There are, of course, more instances.

IT SEEMS almost sinful to oppose groups like the Audubon Society and the Sierra Club. Their opposition to day-to-day professional use of herbicides, insecticides, and fungicides influences too many political climbers, especially at the local level. The Madison law, strongly supported by Audubon, can be applied to residents who use Raid at a cookout or Safer's Insecticide Soap on an organic garden. A pesticide is a pesticide.

a. Pesticide means
   1. Any substance or mixture of substances intended for preventing, destroying, repelling or mitigating any pest;
   2. Any substance or mixture of substances intended for use as a plant regulator, defoliant or desiccant.
b. User of pesticides means any person, including individuals and employees or members of any firm, partnership, organization or corporation whether public or private, who applies pesticides or causes pesticides to be applied out-

(Left) The Food Chain: Armadillos dig up golf greens in search of food.

(Bottom, left) Japanese beetle grubs are voracious. Insecticides make modern agriculture possible.

(Below) There is no "off season" for turf disease summer, winter, spring or fall. Fungicides make modern agriculture possible.

doors or the atmosphere by any means.

The future of high quality golf courses is now. Self defense for golfing institutions can begin with support for organizations dedicated to the responsible use or products needed to protect our environment. CAST — the Council for Agricultural Science and Technology — is a calm, studied voice in support of modern methods of food and fiber production needed to support the world's human population without destroying the environment. On a state or local level, agri-business councils help defend the responsible use of plant protectants and pest control materials. They also present positive statements on the benefits of agricultural chemicals to society and our environment. The Golf Course Superintendents Association of America stands ready to aid local individuals and organizations in defending good turf management practices involving pesticides. Information from these sources are *facts,* not fancy. Data is based on scientific evidence and analysis, not worst possible case suppositions. To do otherwise would be suicidal, with so many powerful organizations watching.

GOLF AND RELATED organizations must make themselves aware of state and local environmental affairs. The rules and ordinances do not write themselves. There must be a person or a group involved who has an axe to grind, an agency employee out to make a name for himself, or a politician fulfilling an election promise or trying to attract a vigorous voting bloc. They do not have to show scientific proof of anything. Their rhetoric is full of "may," "might," or "potential," and accompanied by mutagenic, teratogenic, carcinogenic and any other catch words that generate fear. Scientific studies are sometimes used but the information is often extrapolated to fit a given instance or otherwise twisted to comply with the train of thought being promoted. In all truth, pesticides are considered guilty until proven innocent.

A risk/benefit philosophy is anathema to the anti-science radicals. Zero risk is the only thing acceptable. One administrator of county environmental regulation told of a wonderful new instrument he had just purchased which was capable of detecting organic pollutants down to a level of one part per billion. When asked what that meant in determining permissible levels of toxicants, he said that if he can detect it, the product in which it was found would be banned. Just like that, even though no real toxicology data had been determined.

The passage of an ordinance or a law under our system of government requires a hearing so that all interested parties may make their feelings known. Unfortunately, few local proponents of pesticide use ever bother to find out about these things. Too many feel that the manufacturers and vendors handle the situation without their help. Agricultural scientists who defend beneficial agricultural chemicals are branded as tools of the agro-industrial complex and chained to them by research grant money. Their expert testimony is discredited by inference.

Hearing rooms are usually packed with supporters of the anti group. Factual testimony is often received by groans, catcalls, and other signs of dissent. It takes guts to defend one's point of view before an audience of one-issue folks who could care less for facts. Nevertheless, it has to be done or lose by default. No defense means no interest, so the antis win again. Lawmakers respond to those they hear.

Lack of early opposition to restrictive legislation is usually because voters in general don't know such a proposition is on an agenda. This is where a local electee or appointee can help if he or she knows of one's interest. Make them aware of your interest in environmental regulations so that they can keep you informed. The fine print in local newspapers is also a source of committee agenda information.

When you find out about such a proposal, get a copy of the proposed bill and study it closely for both straightforward and ambiguous wording. If it should be opposed, get background information on the issue, including who is sponsoring the action and why. Do a lot of homework and develop a copious quantity of hard data on this and related subjects. Rest assured that the sponsors of the bill or regulation will be loaded for bear and will be accompanied by a good cheering section.

OPPOSITION FOR its own sake doesn't change people's minds. Facts and support by voters do. Expert testimony by a "foreigner" is a great technical help, but the local applicators are the people who must live with the law and vote in elections. If they show no interest or defense, then the proposal will be accepted by default. Furthermore, letters and telephone calls can be used by defenders of pesticides as well as the prosecutors. Remember that the committee or council members need a good reason to vote against a proposition to save humanity from itself. They need all the help they can get from local experts who work with pesticides daily.

Never forget that once a law is on the books it is difficult, it not impossible, to change or expunge it. The same goes for administrative rules once they are published. No one likes to admit his mistakes. Corrective measures take time and money. Therefore, timely, preventive actions are always best.

There is another source of potential aggravation whose actions may prompt or support legislative or administrative activity: your employees. They can also enter litigation against an operation. You may be a beer-drinking buddy with your spray operator today, but you may not be next month or next year. Any violation of EPA or OSHA rules can come back to haunt you and your employer. Long term exposure to any pesticides may also prompt chronic illness liability actions.

"Right to Know" laws require that employees be made aware of any hazards from any chemical to which they are exposed, whether they apply them or not. Applicators should be given appropriate protective clothing, respirators, and safety glasses when they're necessary, and they should be compelled to wear them. If an employee refuses to use personal safety appliances or fails to follow injury-preventing work rules, that person should be subject to immediate censure, layoff, or discharge. Failure to enforce safety rules smacks of negligence by the supervisor and the employer. Work rules are good insurance, because any subsequent illness can be blamed on negligence of management.

Relative Toxicities of Common Herbicides and Familiar Chemical Compounds

Chemical Compound	Oral LD_{50} mg/kg body weight	Possible Lethal Dose for 150 lb. man
Dalapon	7,570	1 pint to 1 quart
Simazine	5,000	"
Roundup	4,320	1 ounce to 1 pint
Baking Soda	3,500	"
Atrazine	3,080	"
Table Salt	3,000	"
Dacthal	3,000	"
Banvel 4WS	2,900	"
Aspirin	1,240	"
Permanent Wave Solution	1,200	"
Silvex	375-1,200	"
2, 4-D ester	760	"
2, 4, 5-T	300	1 teaspoon to 1 ounce
Caffeine	200	"
Gasoline	150	"
Paraquat	150	"

Source: Wisconsin Forestry/Rights-of-Way/Turf Coalition

Ryegrass germinates fast. But knotweed is faster! Herbicides make modern agriculture possible.

(Below) Mother Nature deals harshly with golf course turf.

THE PESTICIDE LABEL is the law. It may be legal to apply less than the specified dosage, but never more. Employees can read, too, and misapplication can be used against the employer anytime.

Record keeping is absolutely essential. Write down all information concerning the application — date, rate, personnel involved, and any other details, whether they're required by law or not. Time of day, temperature and relative humidity, wind movement, etc. should also be recorded in case a claim of drift onto other property is made. Remember, too, that pesticide overspray (direct application to another property) is prima facie evidence of negligence.

The basic reason for environmental and safety regulations is sound. Chemical overuse, misuse and just plain carelessness made them necessary, as did our ignorance of the long term effects some chemicals had on our environment. But when the sillies influence regulations that go counter to the benefits, some voices of sanity must be raised. The most audible are those of people charged with developing and maintaining a beautiful, enjoyable, and safe environment in which people can enjoy golf, an environment in which living grass, flowers, and trees play major roles in healthful recreation, an environment needing thoughtful use of plant protectants to provide the venue for such an activity to take place, an environment capable of absorbing airborne pollutants and emitting life-supporting oxygen, and one that removes waterborne toxicants through a living turf filter so that groundwater is clear of contamination by golf course management operations. Golf without pesticides would still be golf, but the courses would be far from the enjoyable surroundings to which we have become accustomed. America's golf courses are the very best examples of how these chemicals can be effectively used by and among people to benefit our environment and our enjoyment of life.

Oh, by the way, our community still uses a mosquito fogger occasionally. It follows a police car with all lights flashing and a bullhorn advising us to close the windows and doors and get the kids and pets inside. We go too, not because of malathion, pyrethrum, or whatever chemical they are using. We just don't like the smell of burning diesel oil generated by the truck.

Acknowledgement

Information from the Forestry/Right-of-Way Turf Coalition Division of the Wisconsin Agri-Business Council, Madison, Wisconsin; James R. Ely, LDS Church Farms, Tacoma, Washington; and the Green Section files were used liberally in the preparation of this essay. The author appreciates their contribution.

Golf Course Design and Specifications Related to Maintenance

by **DR. MICHAEL J. HURDZAN,** Immediate Past President,
American Society of Golf Course Architects

IN NO OTHER FORM of construction is design and maintenance so closely intertwined. Both are driven by the wish to provide the golfer with the most pleasant recreational experience possible. To please the golfer, designers and superintendents must be fully sympathetic to the other's purposes and problems. Some issues must be addressed and some compromises made.

First, it must be stressed that maintenance is more important to the golfer than design. Given a choice between a well designed but poorly maintained golf course, or a poorly designed but well maintained one, the golfer will nearly always choose the best maintained. Second, it should be remembered that maintenance has a greater influence on the difficulty and speed of play of a course than does design. When greens are kept fast, fairways lush, roughs long, and sand bunkers soft, the golf course will play difficult and slow. And last, it is the subleties or nuances of a golf course, such as flowers, shrubs, selected tree plantings, tee accessories, etc., that make a golf course memorable and enjoyable. In summary, this means that the golf course superintendent exercises far greater impact on the golf course and the golfer than does the designer. Hence, he should be aware of his power and responsibility, and likewise, he should be given full credit for making a round of golf an enjoyable experience.

These influences are 100 or more years old. In researching old magazines for a book I'm writing on golf course architecture, I continually find references to the great condition of this or that course, with only occasional mention of the design. So with the supreme role of maintenance established, let us then look at my real focus: Design and specifications related to maintenance.

First, we know that the single most important element of a golf course is drainage. I am certain you know the story about the well-known superintendent who was asked, "what does it take to keep a golf course so beautiful?" His reply was, "about 5% common sense and 95% drainage. An if you don't have much common sense, then put in more drainage."

TWO ELEMENTS of drainage must be studied and coordinated: 1) surface drainage and, 2) sub-surface drainage. This means that unless a site has perfect internal drainage, the entire area must be analyzed for its drainage characteristics and patterns. These should be planned to remove all the water from the site. This usually means a system of drainage swales and catch basins, that lead into pipes or tile, a tile system for every green and bunker, a series of ponds and drains, and sometimes a retention-detention basin. The exact mechanics of drainage is really not within the scope of this paper, but the fact that it is a design element critical to good maintenance is.

Greens are the most intensively maintained portion of the golf course, so design of greens is closely related to maintenance. Green design should first produce good surface and sub-surface drainage. One approach is to design greens that drain in three or four directions and do not collect all of the water and dump it to one area, usually the front. Second, install tile on 15- to 18-foot centers and gravel backfill them under all putting surfaces and bunkers. Next, specify a soil mix for greens that resists compaction and has good internal drainage. Greens should provide enough areas for hole locations to spread out foot traffic and add interest to the golf course.

On tees, the design intent is to provide not only strategy and interest through multiple tee settings, but also to enhance maintenance by providing surface drainage, adequate space to spread traffic and wear, insuring good air drainage across the tee, and providing an appropriate irrigation system.

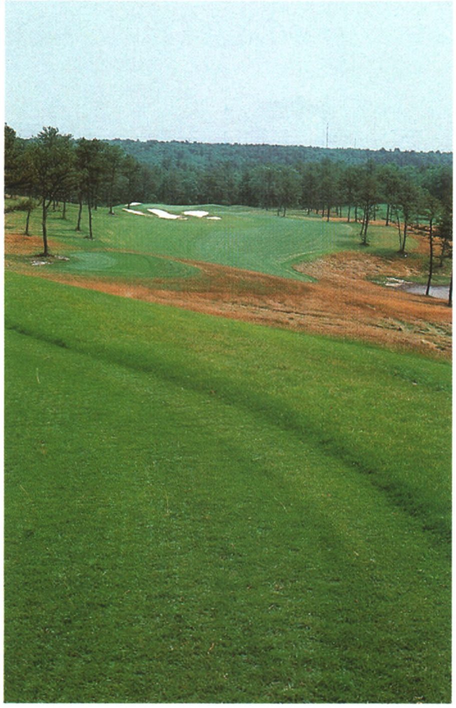
The style of bunkers, their shape, size, slope, and sand size, can evoke enough discussion to take up a conference. First, the bunker should be built so that it will reject surface water from running in, especially on sand faces, to reduce water erosion. This means that all edges of the bunkers should be at least a couple of inches above grade. Second, the bunker should be drained either by tile or a French drain. Third, the bunker bottom should be perfectly concave or bowl-shaped, smooth and compacted before sand is installed.

TO THIS POINT, my discussion has focused on the physical factors of design and has not addressed turfgrass, the single most important specification related to maintenance. No other factor under the control of the golf course architect will dictate the overall maintenance practices or playing conditions than the selection of turfgrass. The choices are varied. A few years ago this was not the case. Routine and standard specifications were acceptable. In view of the enormous advances in turfgrass breeding and selection over the past few years, this may not be the best practice today. In fact, I believe that each individual golf course site should be studied for its inherent climatic and edaphic qualities, along with local environmental restrictions and attitudes, before turfgrasses are selected and specified. Ideally, a probable maintenance regime should also be defined, within any budgetary limitations, before turfgrasses are selected. Then knowing specific site factors (drainage, soil fertility and texture, quantity and quality of irrigation water, proposed pesticide schedules, mowing equipment and height, etc.), climatic factors (wind, normal rainfall patterns, air drainage, and length of playing season), along with edaphic factors (soil chemistry, soil biology, and physical limitations), social factors (E.P.A. or conservation restriction, probable total play, private or public golf course, existing competition, etc.), and budget factors, turfgrasses may be selected.

(Right) *Note the contrast between an unmowed sheep fescue rough; the mowed hard fescue rough; bluegrass fairways and bentgrass greens.*

(Below) *At Cypress Point, California, native grasses, bentgrasses, fescues and beachgrasses all have their effect.*

Let me give you some concrete examples. Few golfers would deny that bentgrass is the finest playing surface in New England. It gives the best tee, fairway, and putting surface. But bentgrass is bentgrass whether it is on a tee, green or fairway, which means it is susceptible to the same insect and disease problems, requires similar fertility, water, management culture, etc. Bluegrass, on the other hand, cannot provide the beautiful playing conditions on tees and fairways that bent does, but it requires fewer pesticides, less fertility, less water, and presents fewer cultural problems. The difference in maintenance budgets is difficult to estimate, but I believe it to be in the $40,000 range. That is assuming the necessary water is there to sustain it through stress periods. Then the third alternative turf type would be a fine fescue mix, which would provide marginal playing qualities compared to bent or blue, but would require very little water, minimal fertilization, infrequent mowing, and almost no pesticides. Last, one might consider the fine-bladed tall fescues that would provide the least desirable playing conditions, but would be easy to care for. The point is that several choices and combinations of choices could be made, all of which will directly affect maintenance. The maintenance budgets may range from a low of $150,000 to in excess of $350,000.



Dennis Highlands Golf Course on Cape Cod has contrasting grasses and still a playing time of 4½ hours.

WHICH IS the right turfgrass to specify? I have no idea, because each site has its own variables. The choice will be right as long as one considers:

1. site specific factors
2. climatic factors
3. edaphic factors
4. social factors
5. budget factors
6. the spectrum of genetic material available.

The process takes time, study, and understanding if it is to be properly done. A wrong choice can be costly and a right choice can make a golf course spectacular. Therefore, the golf course designer should be very deliberate and methodical in choosing turfgrass seed blends.

I have tried to establish a relationship between golf course design and specifications related to maintenance, and I have cited items that influence it. The most important thing to remember is that maintenance is more important than design.

Wee Tees

by JAMES T. SNOW
Director, Northeastern Region, USGA Green Section

THE SETTING: The small but scenic 16th tee at Secluded Woods Golf Club. Dappled light flickers on the teeing ground through the tall oaks. After several practice swings and a few divots, the golfers prepare to play.

THE COMMENT: "Why can't we grow grass on this tee!"

Only a lucky few golf course superintendents have never had to answer this question. Most superintendents speak of their problem tees with a hint of frustration and forced resignation, feeling that the ultimate solution to improving them would not be acceptable to the golfers. While this may be true in certain instances, it is often possible to make adjustments to the tee itself or to the surrounding environment so that acceptable turf can be maintained.

Problem tees usually suffer from one or more of the following maladies:

- small size
- tree effects
- poor construction
- insufficient maintenance and management

Most often a combination and interaction of three or four of these factors leads to turf failure, but it is probably safe to say most problem tees have one thing in common: they are simply too small to accommodate the play they must take. To a certain point, adequate tee size can compensate for almost any other weakness. The ability to distribute wear over a large enough area is the key.

A good rule suggests that there should be at least 100 square feet of usable teeing area for every 1,000 rounds of golf played annually, with 200 square feet available for every 1,000 rounds played from tees where irons are used. If this was the situation at most golf courses, there would most certainly be fewer problem tees.

Many tees were not small to begin with, but rather, they evolved over the years. Consider the great architects of the 1920s building golf courses to accommodate perhaps 5,000 to 10,000 rounds. Had they only known that today their courses are being stampeded by up to 40,000 to 50,000 golfers each year. Construction specifications, too, were not what they are today. Old tees built of native soils can't handle the same amount of traffic as a tee constructed to modern specifications.

Finally, the growing environment around many tees has changed over the years. The negative effects of maturing trees and the demands for more closely cut turf have pushed tees beyond their limits without intensifying maintenance practices. When this occurs, most golf clubs would be best advised to rebuild or enlarge their tees to better accommodate the traffic they recieve.

Tree Effects

A major complicating factor contributing to problem tees is the effect of near-

(Opposite page and below) At Whitinsville Golf Club, Massachusetts, the 4th tee before and after trees were removed.

(Bottom) But it is too late for this tee. Trees should have been removed years ago.

by trees. While most golfers consider the shade and aesthetic beauty of these trees, from a turf standpoint they are a nuisance. Shaded turf is inevitably weaker, less vigorous, more prone to traffic injury, and less able to recover quickly from damage. Too many trees block air circulation, leading to problems with heat and disease.

Wherever possible, nearby trees should be selectively culled, and branches on remaining trees should be pruned and thinned to increase sunlight and increase air circulation. If it is done carefully, the turf can be significantly improved without harming the aesthetic appeal of the area.

While it is easy enough to see how shade affects turf, tree roots are the hidden menace. Contrary to popular opinion, tree roots can extend well beyond the dripline in their search for moisture and nutrients, robbing the turf of essential elements. In most instances, root pruning around the outside of the tee can make a dramatic difference in the condition of the turf on the tee. Tree root pruning is easily done by slicing or digging a two- to three-inch-deep trench between the tee and trees. If a trench is used, place tar paper or sheets of heavy plastic along the wall of the trench and backfill. Root pruning may have to be repeated every three to five years, depending on the species and their proximity to the tee.

Trees also affect tees by effectively making them smaller. As trees planted off the front and sides of tees become larger, they block part of the tee. As a result, the actual useable teeing area is reduced, and the remaining surface is subjected to greater and greater play. Where this has occurred, trees should be removed or brances should be pruned back to help reclaim the entire surface.

Tee Construction

Many problem tees were unknowingly built to self-destruct. While it is common for new greens to be built to the latest improved specifications, such is not the case with many new tees. The use of pond dredgings or on-site topsoil, the lack of adequate drainage, and poor grading are among the common mistakes.

Where substantial quantities of fill are used, the material is not always compacted or allowed to settle adequately before the topmix is added and the finishing work is done. As a result, settling occurs later and the tee becomes uneven. When this happens, the useable area on the tee is reduced, and the remaining level areas are subjected to heavier play than anticipated.

New tee construction should receive the same kind of consideration as if it were for a green, especially where heavy play is anticipated.

The Role of Maintenance

Where time and resources are available, intensifying maintenance practices can partially overcome the effects of small size, poor construction, and tree competition on problem tees.

Any practice that improves the health and vigor of the turf is certainly helpful on problem tees. One of the easiest and yet most overlooked programs is turf fertilization. Tees frequently require twice as much nitrogen fertilizer as greens, yet they often receive less than greens. Because of heavy wear and their need to recover quickly from damage, use of 3/4 to one pound of nitrogen per 1,000 square feet per growing month is common.

To help overcome the effects of heavy traffic and soil compaction, aerify (core cultivate) problem tees as often as possible. If the soil is poor, remove the cores and incorporate good quality topdressing into the holes, then overseed the tee with the appropriate type of grass, which in the case of problem tees is often perennial ryegrass. Ryegrass germinates and developes quickly, is wear tolerant, and it survives on shaded, compacted tees better than bentgrass.

Root pruning along right side of tee to eliminate tree root competition. Garden City Golf Club, New York.

One of the best techniques for encouraging quick recovery of damaged areas is to fill divot scars daily, weekly, or as often as possible with a mixture of topdressing and seed. This helps to keep the tee surface smoothed and helps minimize the establishment of certain weeds.

Because mowing problem tees with triplex mowers can contribute to soil compaction and turfgrass wear problems, try to use walk-behind units. If this can't be done, then request that the triplex mower make its turns off the teeing surface itself.

In the realm of tee management, many things can be done to maximize useable teeing area and to take advantage of every available square foot of space. Depressions should be selectively topdressed on a regular basis until they conform with adjacent turf. Severe undulations or settling over irrigation lines may require that the sod be lifted, the subsurface levelled and the sod replaced.

Trees which interfere with play or block the use of part of a tee should be removed or pruned back so that golfers can legitimately use the entire surface.

Where the situation presents itself, build ladies tees (or forward tees) to take a certain amount of traffic off the regular tee and to open up a new area for the regular markers where the forward markers had previously been placed. The construction of alternate tees at a different distance or angle would serve a similar purpose.

Careful movement of tee markers from day to day can also be very helpful in distributing traffic over the entire useable area. Using just 1/3 or 1/2 the width of the tee when possible, move the markers in a set rotation so the golfers are forced to use the entire tee over a period of time and not just their favorite areas.

Some of these practices and programs may sound out of reach to the less affluent courses, but since there are often just one or two problem tees, many should be within the realm of most maintenance programs.

Dealing successfully with problem tees involves intensifying maintenance and management practices and minimizing the effects of nearby trees. When this does not resolve the problem satisfactorily, enlarging or rebuilding the tee to good specifications is the only alternative.

Pythium-Induced Root Dysfunction of Creeping Bentgrass on High Sand Content Greens

by CLINTON F. HODGES, Professor of Horticulture and Plant Pathology, Department of Horticulture, Iowa State University, Ames, Iowa

A PYTHIUM DISEASE of creeping bentgrass has been recognized that attacks the roots of plants growing in high sand content greens. The disease occurs primarily on old golf courses where the greens have been rebuilt with high sand content mixes. It is found rarely on newly constructed golf courses with sand-base greens. Creeping bentgrass established on the renovated greens in the fall of the growing season grows well and establishes a good cover by winter. The grass continues to grow well during the mild periods of spring and early summer of the following year. With the arrival of hot, humid weather, the turf begins to die in a pattern typical of *Pythium*-induced "cottony blight" or "foliar blight" *(Figures 1, 2, and 3)*. Entire greens die within seven to 14 days. Close examination of diseased plants, however, fails to show any *Pythium* infection of above ground protions of the plants.

Examination of root systems of diseased plants reveals white, normal appearing healthy roots. No lesions or rot are present on the roots. When such roots are incubated under laboratory conditions, *Pythium* species grow from root tissues within six to 12 hours. Case histories of greens that have been attacked show that the disease may reoccur and severely damage the greens up to three growing seasons after the first outbreak of the problem. After three years, the disease may cease to be a problem or may occur at a much reduced level of activity.

Between 1977 and 1983, three *Pythium* species were found associated with roots of creeping bentgrass afflicted with the disease. The three species have been identified as *P. arrhenomanes, P. aristosporum,* and *P. vanterpoolii*. They were acquired from greens in midwestern and eastern states, and from Ontario, Canada. *P. vanterpoolii* has been implicated in foliar blights for many years and is commonly associated with turf. *P. arrhenomanes* and *P. aristosporum* are not commonly associated with turf culture. *P. arrhenomanes,* however, is widely distributed in North America and is well established as a root pathogen of cereals, corn, and sugarcane. It is also associated with species of fescue, quackgrass, and smooth bromegrass. *P. aristosporum* is primarily found in the cooler regions of North America and Japan and is the cause of snow rot of cereals. Of the diseased plants examined, *P. aristosporum* has been isolated only one time; *P. arrhenomanes* has been the most commonly isolated species.

CONTROLLED inoculations of secondary roots of creeping bentgrass with the various *Pythium* species has established *P. arrhenomanes* and *P. aristosporum* as the primary pathogens. *P. vanterpoolii* was not pathogenic to the roots of creeping bentgrass in our studies. Growth of creeping bentgrass in sand is severely reduced by roots infected by *P. arrhenomanes* or *P. aristosporum (Figure 4)*. Total weights of root-infected plants are markedly reduced when plants are grown in sand; both roots and shoots show a decrease in dry weight *(Figure 5)*. Inoculated roots of plants grown in a 50:50 sand-soil mix show less damage; it should be noted, however, that this disease has not been found on greens with a high soil content.

Figure 1.

Figure 2.

Figure 1. Early symptoms of Pythium-*induced root dysfunction may be characterized by a chlorotic strip of turf at the interface of the new high sand content mix and the original collar apron soil of the renovated green.*

Figure 2. Within a few days creeping bentgrass shows irregular patches of chlorotic and necrotic turf that expand very rapidly. The rate of disease spread and general appearance is typical of Pythium *blight, but without any foliar infection.*

Roots inoculated with, or naturally infected by, *P. aristosporum* or *P. arrhenomanes* may be white to slightly buff-colored and do not show lesions or rot. Roots collected two to four weeks after inoculation and incubated in culture chambers show mycelial development in root hairs *(Figure 6A)*. Roots collected four to eight weeks after inoculation, and roots collected from naturally infected plants in the field, show bulbous root tips *(Figure 6B)* as well as disorganized and devitalized tips *(Figure 6C)*. Diseased root tips incubated 12 hours in culture chambers show extensive mycelial growth from intact cortical tissue in the region or elongation *(Figure 6B)*.

Randomly collected 1.5-cm pieces of older roots from inoculated plants, and from naturally infected plants from the field, incubated in culture show mycelial growth from the vascular cylinder at the cut ends of the roots within six hours *(Figure 6D)*. Some of the initial growth from the cut ends of the roots seems to develop from the interface of the cortex and vascular cylinder *(Figure 6E)*. Within 12 hours, extensive mycelial growth develops from all root tissue at the cut ends *(Figure 6F)*. Within 12 hours, mycelial growth occurs directly from cortical tissues over the entire length of infected roots. *(Figure 6G)*.

There is no immediate explanation for the source of the pathogens in the renovated greens or for why the disease has been observed only in high sand content media. The pathogens may be introduced with the sand or peat, or they may be present in the collar-apron soil that is commonly left during renovation to the sand medium. The severity of the disease in sand media may be related to the microbiology of sand. The microbiology of sand may be different from that of soil, or the microbial population may be poorly established. In either instance, the ability of the *Pythium* species to function in sand may be related to inadequate competition from other microbes. There is evidence that *P. aristosporum* and *P. arrhenomanes* are more destructive on cereals, grasses, tomatoes, and beans on light and sandy soils. The observation that the severity of the disease decreases over a three-year period may relate to a more competitive microflora becoming established in the sand.

THE ROOT DISEASE induced by *P. aristosporum* and *P. arrhenomanes* has been termed "*Pythium*-induced root dysfunction." Both *Pythium* species thoroughly colonize infected roots, but both fail to produce a root rot. The decrease in growth of plants infected by either pathogen is extensive *(Figure 4)*, but infected plants in controlled studies were not killed. This suggests that, under optimal growing conditions, the roots may become extensively infected, and the host and pathogen may co-exist without evidence of the disease. This may explain why the infected plants are killed very rapidly during periods of high temperature. Rapid death of the root-infected plants in the absence of rotting suggests that under stress, infected roots dysfunction relative to water uptake and translocation. Both *Pythium* species become associated with the vascular cylinder *(Figure 6D and 6E)* and with the root tip *(Figure 6B and 6C)*. There is no evidence of physical blockage of vascular tissue; however, the water content of wheat seedlings is reduced when roots are infected by *P. arrhenomanes*, and filtrates of *P. arrhenomanes* also inhibit water uptake by wheat seedlings.

The asexual (sporangia) and sexual (oospores) reproductive structures of *P. aristosporum* or *P. arrhenomanes* are rarely found in creeping bentgrass roots. Transferring either pathogen to Bacto-ager (3% v/v) or cornmeal agar results in abundant production of lobate sporangia and oospores on the respective media. Inoculation of orchardgrass roots with either pathogen also results in production of sporangia and oospores in cortical and vascular tissues. These responses suggest that creeping bentgrass may not be an ideal host for either pathogen. These developmental characteristics also may relate to the three-year persistence of the disease. If the *Pythium* species survive primarily in a vegetative state within creeping bentgrass roots, they could be vulnerable to the potential development of microbial competitors in the sand.

CONTROL OF *Pythium*-induced root dysfunction is not promising with present technology. Contact and systemic fungicides specific for *Pythium* species are not effective for control of root dysfunction. The primary problem is that there is no effective means of getting the fungicides to the root zone, and there also is some question of their effectiveness in the root zone. At present, intense aerification with application of the fungicides into the aerifier holes may slow the disease, but not stop it. Wetting agents in conjunction with the fungicides have been useful sometimes. Unfortunately, our experience indicates that most efforts to control the disease chemically are futile, and on most diseased greens, the turf must be reestablished after the stressful period of the growing season.

Figure 3. Appearance of greens afflicted with Pythium-*induced root dysfunction seven to 10 days after the disease is first noticed.*

Acknowledgement

The research conducted at Iowa State University on "*Pythium*-induced root dysfunction" of creeping bentgrass has been partly supported by a grant from the O. J. Noer Research Foundation.

Figure 3.

Figure 4. Growth of creeping bentgrass after eight weeks in response to inoculation of roots with Pythium *isolates. A) Control plant. B) Canadian isolate of* P. arrhenomanes. *C) Iowa isolate of* P arrhenomanes. *D)* P. aristosporum.
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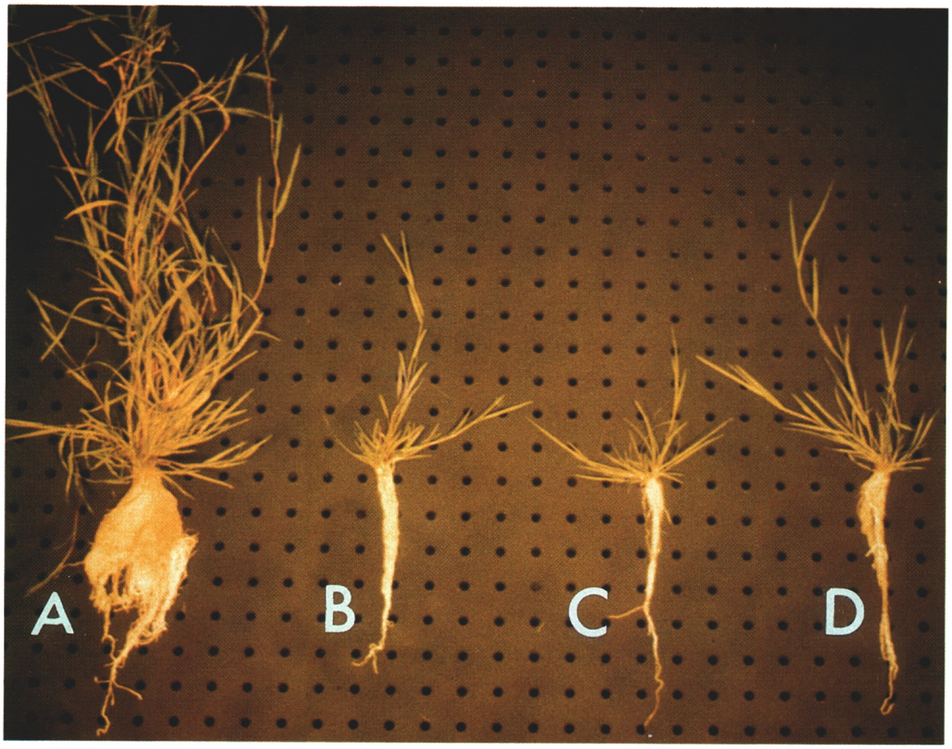

Figure 4.

Figure 5.

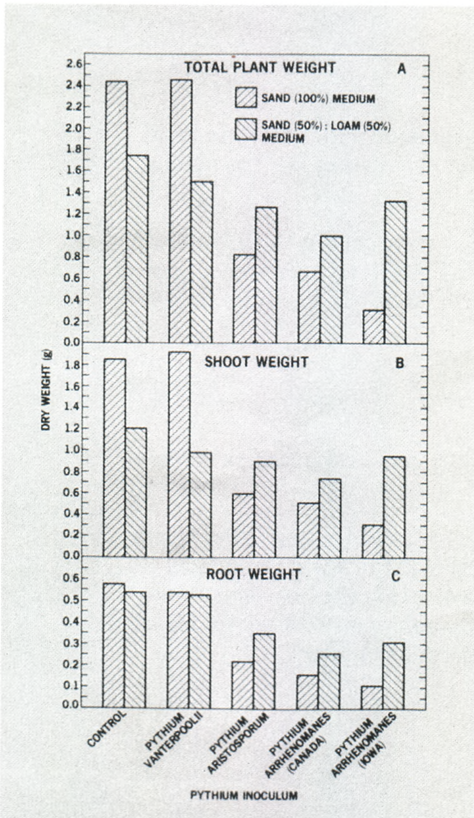

Figure 6.

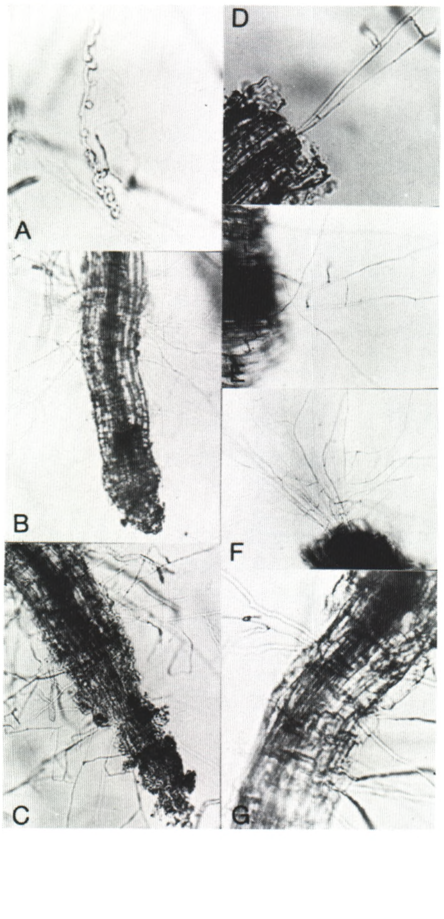

Figure 5. Growth of creeping bentgrass in sand (100%) and sand-loam (50/50%) media eight weeks after innoculation of roots with Pythium aristosporum, P. arrhenomanes, *or* P. vanterpoolii. *Differences between* Pythium *isolates (a/) and growing media (/a) followed by the same letter are not significantly different. Least significant difference (LSD), P = 0.05.*
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Figure 6. Symptomatology and histopathology of creeping bentgrass infected by Pythium aristosporum *or* P. arrhenomanes. *A) Mycelium in root hair two to four weeks after inoculation. B) Bulbous root tip and growth of mycelium from region of elongation. C) Devitalized root tip. D) Growth of mycelium from vascular cylinder within six hours after incubation. E) Growth of mycelium from the interface of the cortex and vascular cylinder. F) Massive growth of mycelium from all root tissue after 12 hours of incubation. G) Direct growth of mycelium from cortical tissue of root. Note absence of rotted tissue or lesions.*
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USGA GREEN SECTION RECORD
SEPTEMBER/OCTOBER 1985

10280537CAP545CEVO JUL86
MR RODNEY D CHAPMN
545 NORTH CLEVELAND AVE
LOVELAND CO 80537

TURF TWISTERS

THE BOUNCING BALL

Question: As my members approach our greens, many want some kind of indicator showing the location of the cup; *i.e.,* front, middle or rear. The "moveable ball" idea on the flag stick is a good one, but all too often the ball somehow moves up or down during the day. Then I have unhappy members! Any other ideas? (California)

Answer: Club Professional Doug Vilven, at Park City Golf Club, in Utah, has another idea; use different colored flags to indicate hole position. For example, red - forward, yellow - middle, blue - rear. Assuming a balanced yardage golf course, that means six red flags, six yellow, and six blue flags appropriately moved by the cup setter on his rounds. Happy members!

NEEDS DEFENSE

Question: We're considering building a golf course, but we foresee problems with environmental groups with regard to pesticides and fertilizers. Is information available that can be used to defend pesticide and fertilizer use? (New York)

Answer: Although efforts to put together such information are largely in the formative states, the Professional Lawn Care Association of America (PLCAA) is trying to coordinate these activities on a national scale. Its address is 1225 Ferry Road, N.E., Suite B-220, Marietta, GA 30067 (404) 977-5222.

AT THE END OF THE SEASON

Question: What is the best way to blow out an irrigation system at the end of the season? (New Hampshire)

Answer: Evacuating the water in sections by isolating the upper, middle, and lower third of the system works very well. Use enough pressure to operate the heads if the system is automatic. Attach quick-couplers on a manual system to insure that the lines and valves are as water-free as possible. Clearing the system in sections enables you to check for leaks or damage in the isolation valves as well as prepare the system for winter.