

USGA

Green Section **RECORD**



**Extensive Drainage Required
Where Salt is a Serious Problem**

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Salt Injury— An Increasing Problem

by **DONALD D. HOOS**
Western Director, USGA Green Section

Salt inhibits bermudagrass establishment on poor land site.



A PROBLEM OF increasing occurrence in Southern California and other areas of the Southwest is establishing and maintaining turfgrasses in areas of poor soil quality. This is particularly true of establishing grasses in areas of high salt accumulation. More and more golf courses are being built on sites unsuitable for any other purpose. Soil conditions on these sites are usually less than ideal. On the aridisols typically found in the Southwest, many sites used for golf courses are high in clay content with a great deal of calcium carbonate or gypsum present in the form of caliche. The soil pH is usually between 7.0 and 8.0 on these soils. If water used for irrigation is high in sodium, its combination with the aridisols can be a problem.

Problems occur when sodium cannot be leached below the root zone of the grass plant. Poor drainage in these clay soils is often a problem on poor land sites used for golf course construction. Because of the high salt content of both irrigation water and the soil, sodium has a tendency to accumulate at the soil surface. Evaporation rates in the Southwest tend to be high, and this further accentuates salt accumulation at the soil surface.

The use of effluent water for irrigation also adds to the problem of salt accumulation. Because of evaporation during the holding process as water moves from domestic use to the effluent processing plants, sodium levels become more concentrated. Effluent water generally has slightly higher sodium levels than subsurface water used for irrigation. The combined use of poor land sites and effluent water for irrigation of new golf course developments should be carefully screened for identification of salt-related problems.

High salt levels affect turfgrass visually by causing wilting and a blue-green appearance, followed by irregular stunting of growth. Tip burn is often present. An anaerobic layer is often formed in the upper root zone and thatch layer. This layer is typically black in color and exudes a readily identifiable odor. Under these conditions, less oxygen enters the root zone to promote aerobic microbial activity. Growth of roots in this layer is quite difficult, even for bermudagrass.

Drainage

Under high salt conditions, poor quality turfgrass develops in low spots and in poorly drained areas where sodium concentration is greatest. This

brings us to the major method in solving establishment and management problems under sodium conditions — drainage and leaching. If drainage can be improved to allow sufficient movement of water through the root zone and to leach accumulated salts, there is a better chance to avoid salt problems. If water can penetrate and move through the soil profile, there is less evaporation near the soil surface and thus less accumulation of sodium in the root zone.

Therefore, one of the first steps toward correcting a sodium problem should be to seek ways of improving drainage in any affected areas. Installation of French drains may be sufficient; other areas may need recontouring to allow surface drainage away from low spots. In some cases, redesign of the irrigation system may be needed. Relocation of sprinkler heads may also be needed to solve a sodium problem in low areas in front of greens. The overlap of green and fairway sprinkler heads in low areas in front of greens often results in accumulation of excess sodium. Often, by moving heads or reprogramming of the irrigation sequence, this problem can be overcome without additional measures.

Aeration

Another important process in establishing and maintaining grasses in high sodium areas is to aerate and cultivate affected areas regularly. The coring process relieves compaction and improves water penetration. It also encourages oxygen exchange in the root zone and helps prevent anaerobic conditions from developing.

Amendments

Most of the soils in the Southwest are typically high in calcium. For this reason, many of the soils exhibiting sodium problems do not respond to gypsum applications. In some cases, gypsum will modify the effects of irrigation water high in sodium and the turfgrass will benefit. This is especially true on sand and in putting greens. Acidifying the soil with sulfur or sulfur-containing materials will produce the most dramatic results in solving sodium problems. The sulfur tends to improve the soil's infiltration rate by dissolving calcium carbonates which accumulate on the soil particles and act as plugging agents. Lowering the soil pH as a result of regular sulfur applications also tends

Salt injury on bermudagrass has appearance of being diseased.





New salt-tolerant grasses are being developed.

to make needed soil nutrients, such as iron and phosphorus, more available to the turfgrass plant.

Grass Variety

Choosing the right grass variety for use under high salt conditions is another important consideration. There is no doubt that certain grasses tolerate much higher levels of salt than others. A great deal of research is being directed toward developing grasses that tolerate higher levels of salt than grasses presently available. In the past few years, several new grasses have been released that have a high tolerance for sodium. Fulst alkaligrass was released by Colorado State University several years ago. Under cool season grass conditions, it does remarkably well at higher salt levels. Adelaide and Futurf, varieties of *Paspalum vaginatum*, are warm season grasses that also tolerate relatively high levels of sodium. Their appearance and growth habits are similar to common bermudagrass. Research is being conducted at the University of California (Riverside) on these grass varieties to

determine the effects of common management practices on their growth and establishment.

Of presently available grasses for use on golf courses, the bermudagrasses have the best tolerance for sodium. Of the cool season grasses, creeping bentgrasses have a higher salt tolerance than perennial ryegrasses or Kentucky bluegrasses. All have a higher salt tolerance than *Poa annua*. Seaside creeping bentgrass has a higher salt tolerance than Pennncross.

Relative Salt Tolerance	Turfgrass
Good	Bermudagrass Zoysiagrass Creeping bentgrass
Medium	Tall fescue Perennial ryegrass
Poor	Red fescue Kentucky bluegrass Colonial bentgrass Centipedegrass

Summary

The turfgrass species, soil texture and depth of the salt concentration in the soil profile are all factors that can affect turfgrass growth under high salt concentrations. A high salt concentration impairs the absorption of water and essential plant nutrients. Impaired seed germination and poor vegetative establishment are often encountered when high sodium conditions exist. Physical properties of the soil are also altered when sodium levels are high. Sodium causes deflocculation of the soil colloids. This can lead to a reduction in soil aeration which increases susceptibility to compaction and decreases water infiltration rates.

The best solution to sodium problems is to leach away the excess sodium through improved drainage and increased aeration of problem areas. Soil amendments to acidify the area may be beneficial if leaching of excess sodium can also be achieved.

A PROGRESS REPORT

The Nature and Control of Decline and Dying-Out of Toronto C-15 Bentgrass

by **DR. H. B. COUCH**, Professor of Plant Pathology,
Virginia Polytechnic Institute and State University, Blacksburg, Virginia

IN AUGUST, 1980, a major research effort was launched to identify the cause and develop a control for the decline and dying-out that has been devastating Toronto C-15 bentgrass in the midwestern United States for the past decade. The program is under the joint sponsorship of the United States Golf Association, the Golf Course Superintendents Association of America, and the Chicago District Golf Foundation.

In organizing the program, it was decided to use a research team. This system has the advantage of concentrating a broad base of research expertise on a problem within a short period. As such, then, it offers greater possibility of arriving at a solution at an earlier date than the more classic approach of having a single investigator explore each factor of the problem a unit at a time. The responsibility for carrying out the various parts of the investigation was assumed by Dr. Houston B. Couch, of Virginia Tech; Dr. Philip Larsen, of the Ohio State University; Dr. David Wehner, of the University of Illinois; and Dr. Charles Krause, of the U.S. Department of Agriculture's Research Center at Delaware, Ohio. Dr. Couch serves as the coordinator.

The extent of the research to date has included both field and laboratory experiments. The field research has centered primarily around the development of an integrated control program based on the use of pesticides in conjunction with certain management practices that may in themselves be effective in reducing the severity of the disease. The laboratory-based experiments have concentrated on the identification of the microorganism that is causing the disease and determining what weather and management conditions are most conducive for its development. In these later studies,

particular emphasis has been placed on testing the theory that the disease is caused by a bacterium. However, the possible role of other organisms such as nematodes and fungi have also been given consideration in both the field and laboratory tests.

During the initial phase of the research, a field survey was conducted in the Chicago area. Questionnaires were distributed to the respective golf courses, and personal, on-site interviews and observations were made by a graduate research assistant from Virginia Tech trained in turfgrass management and in plant pathology. The purpose of the survey was to provide a thorough history of both the management practices of the affected courses and of golf courses in the immediate vicinity not affected by the disease. Also, during these visits, plant, soil and irrigation water samples were collected for laboratory studies.

THE SOIL SAMPLES were taken from the putting surface and the collars of greens that were showing visible symptoms of C-15 decline and were dying out, and from greens free of the disease. Irrigation water samples were taken from the water supplies of courses affected by the disease, and from nearby courses that have Toronto C-15 bentgrass, but do not have a history of this disease. Also, soil and water samples were taken from the two sod nurseries that have been serving as major suppliers of Toronto C-15 sod to the Chicago area.

Analyses were performed on all of these samples for pH, soluble salts, available nitrogen, phosphorus, calcium, copper, zinc, magnesium, manganese, boron, iron, cadmium and mercury. Also, the soil samples were checked for total organic matter content. With the exception of iron, there were no positive correlations between available levels of

these elements in the soil and the presence or absence of C-15 decline and dying-out.

All of the sites sampled that were free of decline and dying-out showed adequate levels of available iron in the soil, while those sites showing symptoms of the disease were low in iron. The analyses of the water samples did not show any correlations between concentration of any of these elements and the presence or absence of the disease.

In comparing locations with the disease and locations without C-15 decline, it was found that there was no relationship among these different sites in either the amount of fertilizer applied or in the manufacturer of the fertilizer. There does appear to be a relationship, however, between both the amount and the frequency of application of iron on these different locations. The Toronto C-15 in the sites showing decline and dying-out received iron at less frequent intervals or in less total amounts than areas where the disease was absent.

There is a relationship between the height of cut and the appearance of C-15 decline and dying-out. Low-cut grass (2/16 inch) is more likely to show the disease than plants at higher cuts. The disease does develop in the collars, but it is generally less severe in these areas than on the putting surface.

There is also a relationship between rainfall, air temperature, moisture-saturated soil, and radiant energy levels and the development of decline and dying-out in Toronto C-15. The disease is most severe following periods of cool air temperatures and continuing rainfall, particularly where soils drain slowly. Also, outbreaks of the disease are usually more severe when these periods of rainfall are followed by two or three bright days.

The soil samples collected on the survey were also assayed for parasitic nematodes. These determinations were

performed by Dr. L. T. Lucas, of the North Carolina State University. Eight species of parasitic forms were found. Certain of the populations were high in locations where the disease was present, but they were also high in certain areas where decline and dying-out were not evident. Also, population counts were low in samples taken from areas where the disease was high in severity. On the basis of these tests, then, it has been concluded that the presence of parasitic nematodes is not a necessary requirement in order for decline and dying-out to occur in Toronto C-15.

LABORATORY TESTS for the purpose of identifying the fungi associated with C-15 plants showing symptoms of decline and dying-out are being carried out by Dr. Philip Larsen. To date, the species of *Helminthosporium* that causes *Helminthosporium* leaf spot has been isolated from a few of the diseased specimens. There has been no consistency of these isolations with the outbreaks of the disease, however, and the species that causes red leaf spot has not been detected in any of the samples collected from C-15 greens that show symptoms of decline and dying-out. Also, the cool-temperature species of *Pythium* has not been found in any of the diseased plants. Other *Pythium* species have been isolated, however, and while it is felt that they are probably not the primary cause of this disease, it is possible that they do contribute to the stress pattern that precedes its appearance. Therefore, experiments designed to determine the capacity of these various isolates to infect and colonize Toronto C-15 plants and an assessment of the damage they are capable of inciting are being carried out by Dr. Larsen.

Histological examinations of the diseased plants have been carried out by Dr. Houston Couch. These studies have revealed that the disease is primarily one of the root system, and possibly in the later stages of development, the lower portions of the crown are involved. The tissue most affected appears to be the xylem (water-conducting elements). However, adjacent tissue becomes diseased also. The foliar symptoms associated with decline and dying-out are probably brought on by the disruption of the root system — specifically, the breakdown of the water-conducting tissue.

Dr. Charles Krause has been conducting studies of diseased C-15 tissue

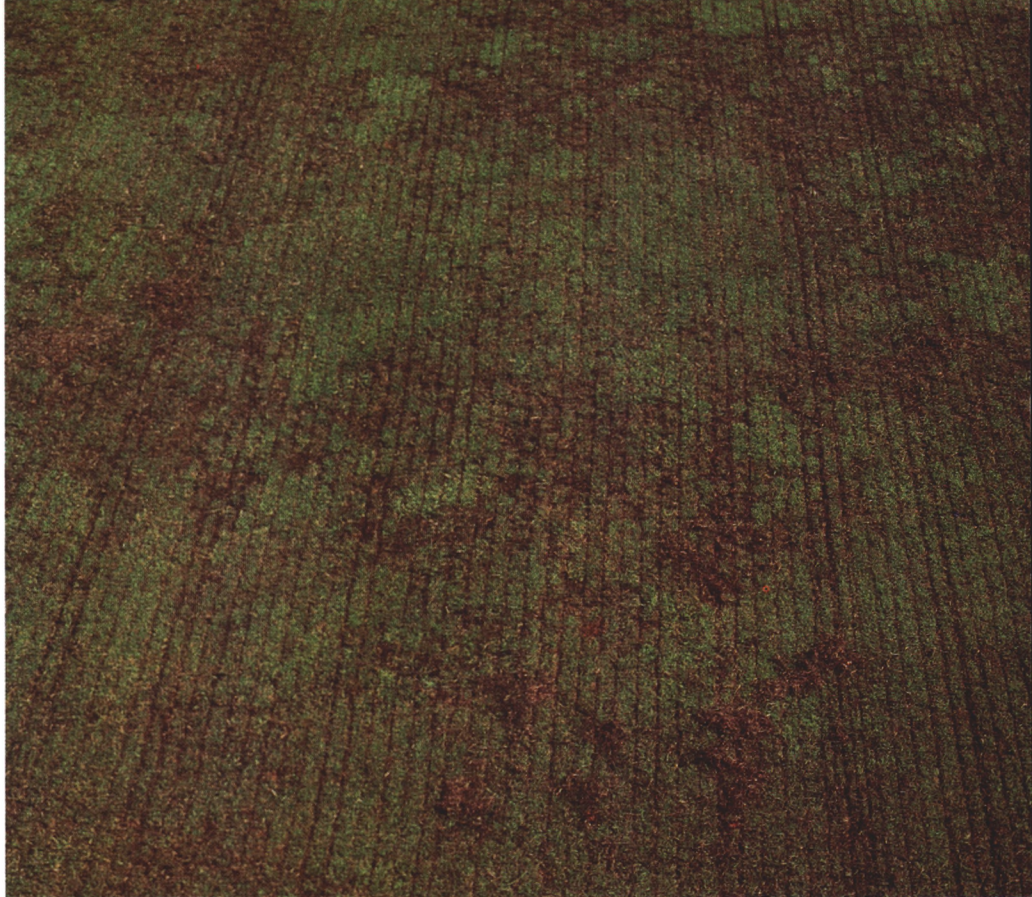


Figure 1.

Individual Toronto C-15 bentgrass plants affected by the decline and dying-out syndrome first show a tip dieback. At this time, they also become a darker green and become twisted and shriveled. In the final stages of disease development, the leaves turn brown, and the crowns and roots of the plants become brown and decomposed. In these last stages of development, the stand of grass commonly shows large areas of dead plants with intermingled tufts or streaks of green plants (see Figures 1 and 2).

Figure 2.



with the electron microscope. The purpose of this work has been to search for the presence of microorganisms and determine how consistently they are associated with diseased plants. Through this type of study, oftentimes a lead can be obtained on what particular type of causal agents to target for isolation and pathogenicity studies.

In this work, Dr. Krause has found one bacterial type with characteristic cell wall markings in the xylem of diseased plants. The healthy C-15 plants are free of these bacteria. What appears to be this same species of bacterium has also been found in the xylem of diseased C-15 plants by Dr. Karen Baker and Mr. David Roberts, of the Center for Electron Optics, at Michigan State University. While the findings at these two laboratories are not conclusive proof that this particular bacterium is actually the cause of decline and dying-out of Toronto C-15, they do provide good circumstantial evidence in support

of the theory that the disease is bacterial in origin.

The field research in the Chicago area has added weight to the theory that a species of bacterium causes C-15 decline. This work is under the supervision of Dr. David Wehner. In these trials, fungicides were tested for control of the disease that are known to be effective in the control of Pythium-incited diseases and red leaf spot. In addition, two bactericides were tested — streptomycin and tetracycline. Also, the possible role of iron in reducing the severity of the disease was studied in these trials.

The fungicides did not provide any measure of disease control. These results, coupled with the failure to isolate either the cool-temperature species of Pythium or the red leaf spot pathogen from diseased C-15 tissue has led us to conclude that this disease is not related to either of these problems.

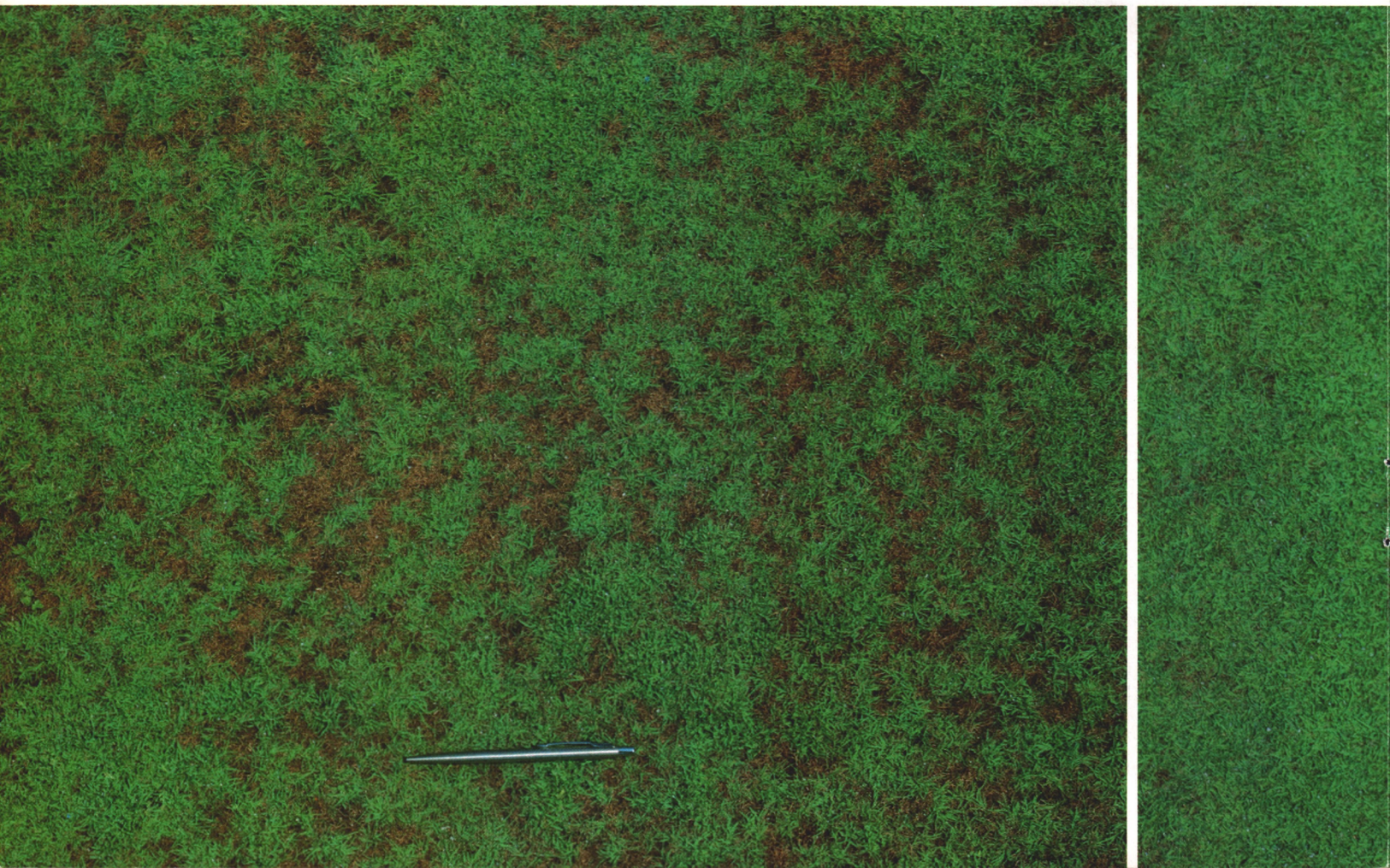
Of the two bactericides tested, the applications of streptomycin did not

reduce the severity of the disease. Tetracycline, on the other hand, gave very good control. (Note Figures 3 and 4.) These results, coupled with the electron microscopy studies of Drs. Krause and Baker, lends considerable weight in support of the theory that decline and dying-out of Toronto C-15 is caused by a bacterium. The final proof of this theory rests with pathogenicity tests. These are being conducted by both Dr. Couch and Mr. Roberts.

IN SUMMARY, the research to date has led the research team to conclude that the decline and dying-out of Toronto C-15 bentgrass that was in evidence in the Chicago area in 1980-81 was not red leaf spot, nor was it caused by a cool-temperature species of Pythium. Also, plant parasitic nematodes are not the causal agents of the disease. While it is possible that soil pH and certain management practices may add to the severity of the disease,

In field trials in the Chicago area, effective control of decline and dying-out of Toronto C-15 has been achieved with applications of the bactericide tetracycline. The plot shown in Figure 3 was a non-treated control. The plot treated with tetracycline, shown in Figure 4, was immediately adjacent to the plot in Figure 3.

Figure 3.

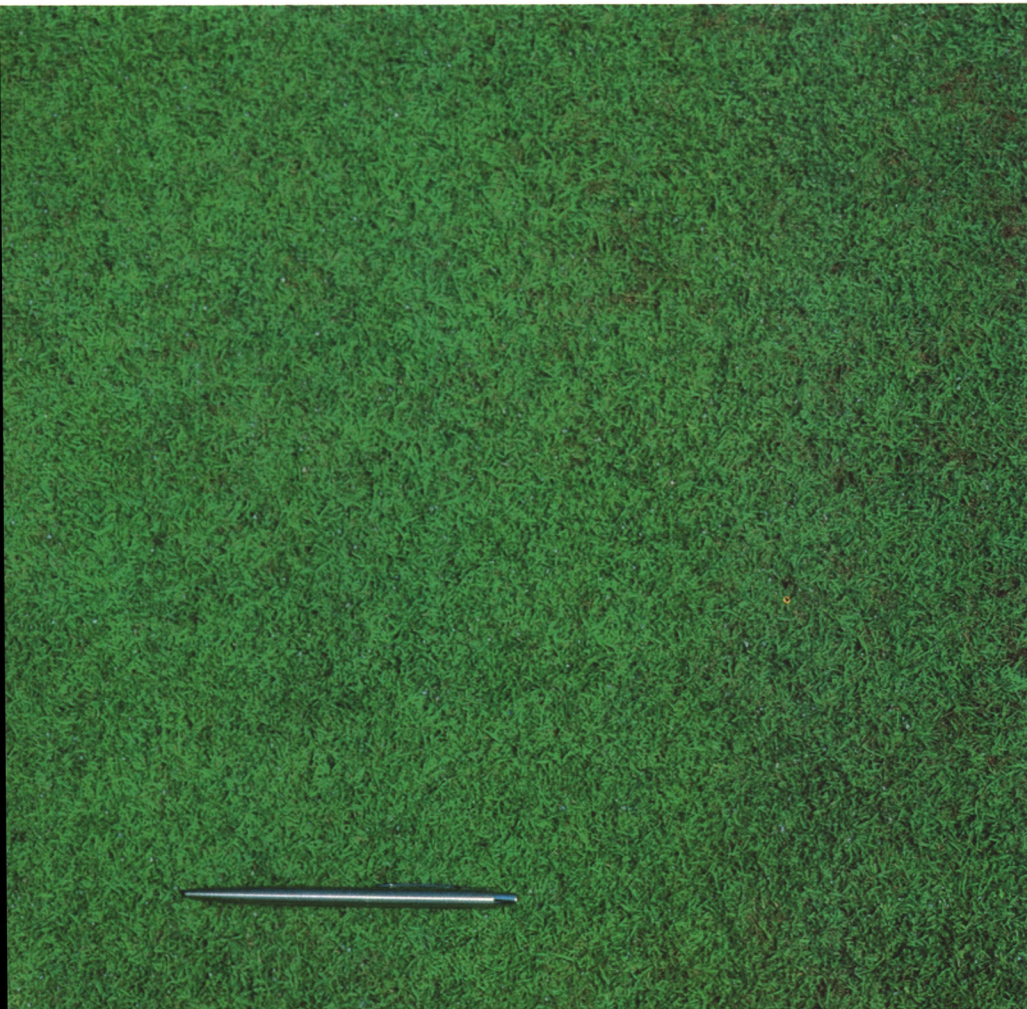


they are not in themselves the cause of the malady. Also, there is no relationship between manufacturer, analysis of fertilizer, or types and amounts of pesticides used and the occurrence of decline and dying-out of Toronto C-15. The observed occurrence of large numbers of bacterial cells in the xylem of diseased plants and their absence from healthy plants, and the control of the disease in the field with the bactericide tetracycline, are strong evidence in support of the theory that the disease is caused by a bacterium. The conditions that appear to be involved in outbreaks of the disease are high soil moisture brought about by poor drainage and/or prolonged periods of rainfall, low air temperatures, bright days immediately after the periods of rain, and low cutting heights. Another factor that contributes to the outbreaks of the disease is iron deficiency.

While the research to date has uncovered much about the nature and

control of decline and dying-out of Toronto C-15 bentgrass, there still remains much to be done. Proof of pathogenicity of the bacterium found in association with the disease needs to be established. If this organism is indeed the pathogen, then the next step should be a determination of how it spreads from diseased to healthy plants in the field. Also, it will need to be determined whether or not other varieties of creeping bentgrass are susceptible to it, and if they are affected by it, what their respective levels of vulnerability are. Top priority needs to be given also to the development of laboratory procedures for quick and accurate diagnosis of the disease in its early stages of development. Finally, the field research needs to be continued to develop a more complete picture of both rates and timing of pesticide applications for maximum effectiveness in the control of the disease. The technology to achieve these goals is available.

Figure 4.



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I certify that the statements made by me are correct and complete.

Robert Sommers, Managing Editor

Management For Better Roots

by DR. DOUGLAS T. HAWES

Mid-Continent Director, USGA Green Section

ROOTS ARE OFTEN the forgotten part of the turfgrass plant. Green Committee members attending Green Section Turf Advisory visits are often surprised to see the short root systems on greens that are maintained under poor soil and management conditions. I am often amazed at how superintendents keep greens alive under those conditions; some do not. It is equally amazing how extensive the root system can be at a 1/8-inch height of cut under ideal soil and management conditions.

Ideal conditions for production and longevity of grass roots are not impossible to obtain. These conditions will vary some between warm- and cool-season grasses. The only warm-season grass species commonly used in putting greens is bermudagrass. All other grasses used on putting greens are cool-season grasses. These include creeping bentgrass, *Poa annua* and the grasses that are used for fall and winter overseeding of bermudagrass greens. Roots grow best and perform their functions of mineral and water absorption most satisfactorily when soil temperatures are optimal, when oxygen and moisture levels are adequate, when not adversely affected by herbicides, nematodes or disease, and when the leaves are green and healthy.

The temperature of the soil in which roots grow affects the vigor of the root metabolism. Cool-season grass roots grow most vigorously and are initiated when soil temperatures are within 15 degrees of 55° Fahrenheit, either above or below. Soil temperatures are usually slightly above weekly average low air temperatures. Bermudagrass roots respond similarly to temperature, but at a 15- to 20-degree higher optimum. Roots do not necessarily die above and below these ranges, but they do not perform as well. There is little one can

do to modify soil temperature. Activated charcoal and sewage sludge have been used at times for their dark color to warm soils. Spring aeration is often used in the North and South to warm the soil and thus stimulate earlier growth of creeping bentgrass and bermudagrass. Temporary cooling is obtained by light watering and syringing.

The oxygen level in the soil air determines in part the ability of the roots to absorb water and minerals. We can do something about the oxygen level in the soil air. Any management practice which encourages movement of air into

the soil will be helpful in increasing the oxygen in the soil air. These helpful practices are aeration (coring), spiking, using soil mixes which remain porous after compaction, and careful irrigation practices. Water forces air out of the soil, but as the water moves down through the soil profile, air replaces the water in the pores. Saturated soil conditions after a heavy rain or irrigation result in low levels of oxygen in the soil. High soil temperatures increase all biological activity, i.e., root and microbe metabolism. All biological activity uses oxygen. Soils saturated with water in the summertime will have less oxygen in them than soils saturated in winter. Wet wilt is a common summer phenomenon caused by such conditions.

The more porous surface and channel created by a sand topdressing program makes root growth possible in hard-packed gumbo soil.



BY CAREFUL AERATION of creeping bentgrass and/or *Poa annua* greens in midsummer, superintendents have often been able to save grass thought to be close to dying. Careful management involves completing the full operation of aeration and related practices in the early morning when temperatures are at their lowest and so the grass is best able to withstand these maintenance procedures. In other words, operate on the patient when he is in good condition, and he will respond better than he would if operated upon when weak.

An excess of available nitrogen can be devastating to grass roots. Research on cool-season grasses has shown that root growth ceases and the total amount of roots may become less when available nitrogen is much above one-quarter pound per 1,000 square feet at soil temperatures above 50° Fahrenheit. Nitrogen available to the plant comes from fertilizers and from decomposition of soil organic matter. Decomposition of organic matter is most rapid between soil temperatures of 70° and 90° and



(Left) Roots flourish in aeration holes.

(Below) Aeration is a messy but necessary part of good management.



when moisture is adequate in the soil for microbial activity. Cool-season grasses often survive best through the summer when they receive little or no nitrogen from fertilizers. Excessive nitrogen under summer conditions stimulates top growth and uses up all available stored carbohydrates. Slow-release fertilizers and fertigation systems allow the superintendent to supply nitrogen to the turf at rates which do not stimulate excessive growth. Dormant fall feeding of cool-season grasses accomplishes the same results, because soil temperatures are not warm enough to result in rapid foliage growth.

RROOTS NEED FOOD (carbohydrates) produced by the photosynthetic process in the green leaves above. Therefore, scalping, disease of the leaf tissue and any other cause of leaf damage results in starvation of the roots.

Soil nematodes and fungi may injure roots. Herbicides often have time and again been shown to adversely affect grass root initiation and growth. Superintendents are usually aware of most of the cause-and-effect relationships to root health. It is difficult, however, to convince golfers that they will have better greens and root growth if greens are aerated. If holes created by aeration are filled, settled and refilled

so that the putting surface remains relatively smooth, superintendents can eliminate much of the objection golfers have against aeration of greens. Anyone wishing to convince an upset golfer of the need to aerate old soil greens merely has to cut out a plug from the green and show him the strong, healthy root growth in aeration holes. Roots hardly penetrate the compacted soil surrounding the aeration hole. Survival of stressed grass over aerifier holes is a common occurrence after winter desiccation.

On severely compacted soils void of turf, weed growth often occurs only in aeration holes. The fear of weed invasion is often a legitimate reason for not spiking or aerating turf more frequently. Careful timing of these operations and combining them with a pre-emerge herbicide application is necessary where weeds are a special problem. Managers often lightly fertilize several days to a week before they aerate so that the holes will close more rapidly and thus reduce chances of weed seed germinating in aeration holes.

Poor soil conditions and too much nitrogen, water and traffic often cause short, stunted, weak root systems. If managers of fine turf do not have ideal soil mixes, careful control of nitrogen and water, along with spiking and aeration, are the tools they must employ to keep the roots healthy.

Important Message for USGA Member Clubs

Since 1953 the United States Golf Association has offered a Turf Advisory Service to assist Member Clubs with turfgrass problems.

Effective January 1, 1982, the fee for the Turf Advisory Service will be \$350.00 for one visit. The fee for two or more visits, **if payment is made prior to March 1**, is as follows:

- a. Two visits — \$500.
- b. Subsequent visits (three or more) — \$250. per visit

Although the fee has been increased because of the ever-increasing costs of operation, it is less than the price charged in 1977. The USGA Green Section Turf Advisory Service is a nonprofit effort. Green Section agronomists work to bring superintendents and green committeemen the latest in care and conditioning of golf course turfgrasses. We hope we can count on your continued support of the USGA through its Green Section and Turf Advisory Service.

Cool-Season/ Warm-Season Turfgrass Management in The Transition Zone

by **DR. A. R. MAZUR**, Associate Professor,
Clemson University, Clemson, South Carolina

THE MANAGEMENT and culture of turfgrass in transition zone areas of the United States is an extremely delicate task. Temperature and moisture are the climatic factors that influence adaptability of turfgrass species to the greatest extent.

Grasses are classified into broad categories based on season of most active growth. Warm-season turfgrasses are most active during the summer when temperatures are in the 80-95°F. range. These grasses generally have good to excellent drought resistance. The warm-season grasses grow very slowly when night temperatures are in the 60s, and they become dormant after the first killing frost. Excessive cold weather and/or frozen soil often cause injury to perennial stands of most of these turfgrasses. The range where warm-season turfgrasses can be used effectively is defined relatively well by geographical temperature delineations called isotherms. Seldom are these grasses used successfully where the daily average January temperature is less than 40°F.

The cool-season grasses grow most actively during the spring and fall when temperatures are in the 60-75°F. range. The cool-season grasses generally have poorer drought resistance than warm-season grasses. These grasses are under

stress when temperatures are in the 90-100°F. range. The cool-season grasses are seldom effectively used as permanent turf in regions where the daily average July temperature is greater than 75°F.

In many sections of the country the average daily January temperature is often less than 40°F. while the average daily July temperature frequently is greater than 75°F. These areas are referred to as the transition zones. In these areas we observe repeated injury to cool-season perennial species from complications induced by high temperatures. This situation is magnified in the areas east of the Mississippi River by the high relative humidity. In these areas, night temperatures remain in the 70°F. range, which weakens the turf due to high respirational activity. The weakened turf in the presence of plentiful moisture leads to extensive disease activity. During the winter in these same areas the persistence of cold temperatures with ice and snow can result in extensive injury to the warm-season species. Annuals proliferate in the transition zone because they go through the unfavorable hot, cold and dry periods as seed. It is for this reason that the transition zones have been called the crabgrass belt. Extending turfgrasses to their geographic limits means that management programs

become the margin between turf survival and the need for constant annual renovation.

IN THE TRANSITION regions the extended periods of high temperatures with drought, disease and insect pressure have resulted in the extensive use of warm-season grasses, particularly bermudagrass and zoysia. The weather, however, is sufficiently cold during the winter to result in dormancy of warm-season turfgrasses. The standard practice is to overseed high-management turf areas with cool-season grasses to provide aesthetically pleasing green turf and prevent attrition damage to the warm-season turf during its dormant winter period. The length of the overseeding period often may last from seven to nine months, depending on





Method of establishment and timing influence overseeded turf quality.

latitude and elevation. The overseeding period is longest farther north and at higher elevations. Effective overseeding requires 1) rapid germination; 2) good seedling vigor; 3) tolerance to close mowing, traffic and disease; and 4) gradual decline in the hot spring weather.

Ryegrass, red fescue, bentgrass and bluegrass have been evaluated at many locations on greens, fairways and tees with varying results. In the Piedmont region of South Carolina, perennial ryegrasses have shown rapid establishment and high turf quality on putting greens during the overseeding period. The red fescues generally had less seedling vigor and required a longer period to develop the desired quality and are effective principally when blended with the perennial ryegrasses. The bentgrasses and bluegrasses generally show poor

seedling vigor and establishment. They can only be used effectively as components of blends where their major need is during the spring period. Despite the rapid germination and excellent seedling vigor, annual ryegrass provides poor overseeding quality on greens because of its susceptibility to disease, its coarse leaf texture and poor color retention.

On fairways, however, annual ryegrass shows results superior to the other species. The more rapid growth of annual ryegrass provides greater effect, while the coarse leaf texture does not detract. The decline of annual ryegrass in the spring provides for better bermudagrass emergence earlier in the spring. The small seeds of perennial cool-season species were totally ineffective for use on fairways.

PROPER TIMING is critical to the success of an overseeding. Seeding times vary with location and are dependent primarily on prevailing temperatures in the area. Overseeding too early can result in poor quality due to the high incidence of *Pythium* and/or bermudagrass competition during warm, humid weather. When seeded too late, germination is slow and the stand remains open due to the lack of adequate growing temperatures. The best indicator of optimum seeding period is when the night temperatures remain in the low 60°F. range.

Studies have consistently shown that the soluble nitrogen source fertilizer materials such as ammonium nitrate provide the highest quality turf during the cool winter months. Comparable quality can be obtained with IBDU only

if all of the nitrogen is applied initially in a single application at three to four pounds N per 1,000 square feet. At one pound N per 1,000 square feet per month, the hydalization rate was not adequate to provide high-quality turf. The reduced microbial activity during the cool winter periods is responsible for poor response to the sewage sludge and urea-formaldehyde materials.

An alternative approach to annual overseeding of dormant bermudagrass in the transition zone areas would be the management of permanent warm- and cool-season turf swards. Compatibility of turfgrasses for use in integrated swards is dependent on physiological as well as morphological characteristics. Compatibility requires the uniform mixing of the two grasses so as to avoid the dense colonization of grasses in isolates within the sward. Segregation of turf stands in isolates results in serious reduction in turf quality in the transition between the successive spring, summer, fall and winter seasons. Common bermudagrass and Kentucky bluegrass have shown the greatest potential for use in the integrated stands of warm- and cool-season grasses. Management

is the key to maintaining the delicate balance in these mixed stands.

STUDIES WITH mixed stands of common bermudagrass and Kentucky bluegrass showed that mowing at $\frac{3}{4}$ inch resulted in an increased bermudagrass population with a general reduction in turf quality when compared with the $1\frac{1}{2}$ -inch height. The source and timing of nitrogen fertilizer applications had a distinct influence on grass composition and quality of the turf sward. Acceptable turf quality can be maintained on mixed stands of common bermudagrass and Kentucky bluegrass in the transition zone areas by using readily available nitrogen sources and fertilizing primarily during the cooler portions of the year. The key to success is dependent on maintaining a strong bluegrass population. Fertility programs that increase bermudagrass competition result in reduced turf quality, particularly during the critical winter months. The higher height of cut and the use of periodical vertical mowing to thin bermudagrass in the late summer strengthens bluegrass populations and increases general turfgrass quality.

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MAINTENANCE Aids

A TIP FROM

GREG WOJICK, Golf Course Superintendent,
Willimantic Country Club, Willimantic, Connecticut

SUPERINTENDENT Greg Wojick welded a seat and a footrest on the spreader shown. The purpose is twofold: First, it provides additional worker comfort and stability, and secondly, it allows the worker attending the topdressing flow more freedom of movement. This unit, drawn by a truckster, makes several passes and turns during topdressing operations on putting greens. With the seat, the worker has freedom of both hands and a stability not before possible standing on the bar while the unit moves and turns.



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TURF TWISTERS

DON'T BE JEOPARDIZED

Question: Can you rototill organic matter into a sand mix and produce a satisfactory topmix for a putting green? (Ohio and Virginia)

Answer: There are several problems concerned with the use of a rototiller in preparing topmix for a putting green. First, it is impossible to mix materials of such diverse nature as sand, clay, silt, and organic matter uniformly by on-site rototilling. Secondly, rototilling "beats" the fine particles to the top, thus creating a layer at the surface. A cardinal principle of water movement in the soil is that water moves very, very slowly from fine to coarse soils. Also, when organic matter is incorporated into only the top four to six inches of a 12-inch topmix, a second condition of impaired water movement from fine to coarse materials is established within the 12-inch topmix. Rototilling on site to a depth of four to six inches, therefore, provides double jeopardy insofar as good water movement through soils is concerned. Organic matter also should always be mixed into the entire 12 inches of topmix. Off-site mixing is preferable by far; in fact, it is the only satisfactory way to prepare a mixture for greens built to USGA specifications.

BY HEAVY SALT INTAKE

Question: I had my green soils tested, and the lab report indicated that our soils are potassium deficient. Seven pounds actual per 1,000 square feet was recommended. Should this amount be applied all in one application? (New Jersey)

Answer: No matter how deficient your putting green soils, it is always good policy to apply nutrients in moderation. Established putting greens should not be subjected to heavy rates of nutrients, especially those of high salt index, and, therefore, it could be dangerous to attempt it. When in doubt, it is always good policy to apply nutrients more frequently at light rates.

AND LACK OF AERATION AND TOPDRESSING

Question: Does sand topdressing on putting greens encourage winter desiccation problems? (Colorado and Nebraska)

Answer: Not from our spring, 1981, observations made in Colorado, Nebraska, Montana and the Dakotas. Observation showed that golf courses on a sand topdressing program suffered no more desiccation than those that were topdressed with other materials. Most desiccation was observed on golf courses that were neither topdressed nor aerated at all, and thus were victimized by a fairly heavy layer of thatch or a compacted putting green soil.