JULY 1969

USGA GREEN SECTION RECORD

A Publication on Turf Management by the United States Golf Association

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COVER—
Introducing SUPER SAM:
Super Sam is a new contributor to the Green Section Record. Created by Tom Paprocki, retired Associated Press cartoonist, Sam will point out some turf management "do's and don'ts" in future issues. Tom Paprocki now resides in New Jersey and, has agreed to do this cartoon series for the Record between rounds of golf.

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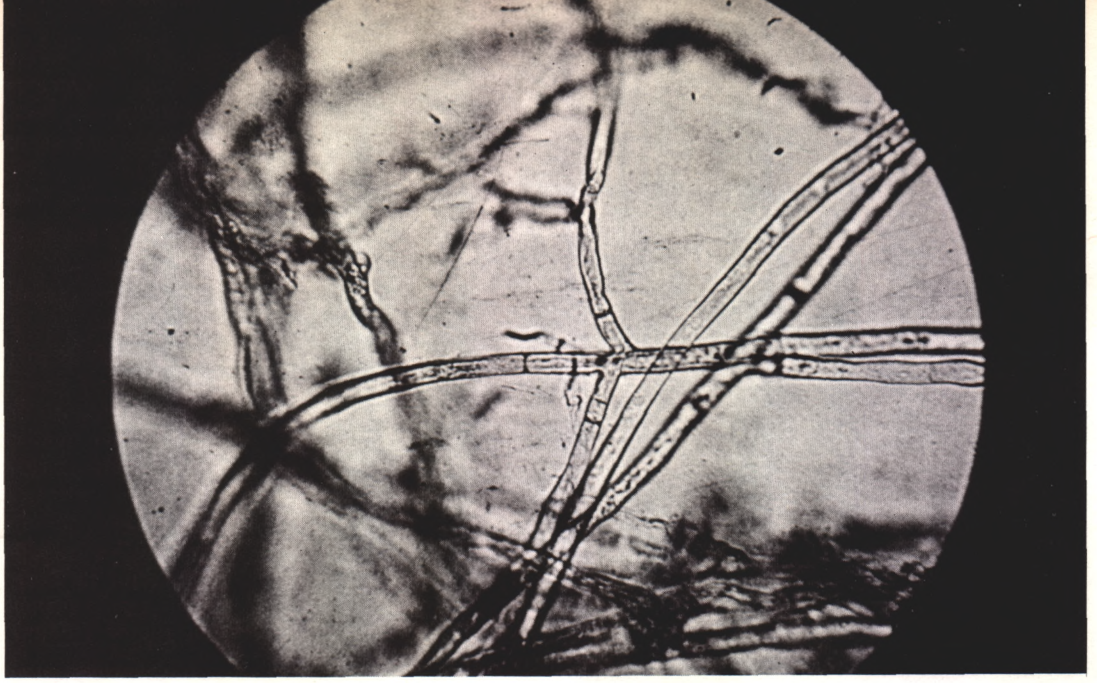


Fig. 1. **Rhizoctonia.** Hyphae, showing typical right-angle branching and crosswalls.

A Complete Disease Prevention and Control Program

by **JAMES W. TIMMERMAN,** USGA Green Section, Agronomist

Today more than ever, the golf course superintendent must understand the complete picture of disease and its relationship to plants if more effective control is to be achieved. Golfers' demands for the best playing conditions have forced those charged with course conditions to use higher rates of fertilizers, water more frequently, and mow closer and more often. Heavy traffic has led to compacted soils and added wear, which puts more stress on turf.

These conditions have resulted in an ideal environment for greater disease invasion. We must be completely prepared to meet this greater invasion in our efforts to achieve top conditions.

A complete disease prevention and control program can be grouped into five broad categories. These are:

- Nutrient relationship to disease.
- Visual recognition of turf disease characteristics.
- An understanding of fungicides and their use.
- An understanding of what disease is and how it occurs.
- A microscopic recognition of the disease-causing organisms.

Most of us are quite familiar with the first three categories. For example, we recognize that over-fertilization leads to more disease, and that brown patch disease is recognized by a characteristic smoke ring. However, it is in the last two categories that we usually find our knowledge lacking.

No longer can we get by just knowing disease is with us by noticing thread-like structures on the grass in the morning. The demands for quality turf compel us to know that these thread-like structures are called mycelium; why and how it got there; and how to recognize it under a microscope before it ever shows up on turf.

We must learn life and disease cycles of the causal organisms. We must know the terms related to disease so any material read or heard on disease is better understood. Becoming more familiar with disease and how it occurs, and being able to recognize the causal organisms under a microscope will allow us to become our own plant pathologist to a certain degree.

With this added knowledge, we can run ex-

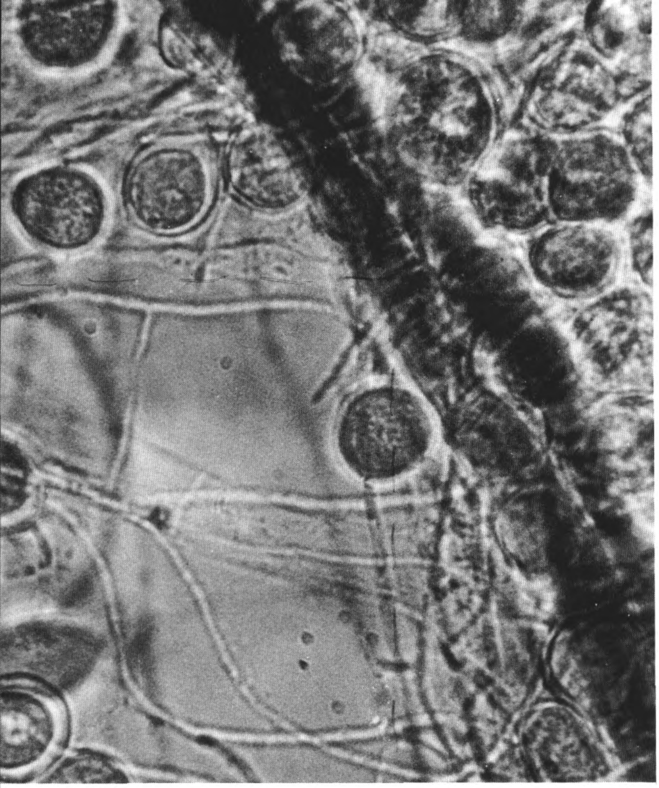


Fig. 2. **Pythium.** Hyphae without crosswalls. Spherical structures are called sporangia, in which nonsexual spores are produced.

ploratory tests before disease becomes prevalent. We can define quicker and to a more exact degree any disease outbreaks. Combining this information about the disease-causing organisms present in our soils and turf with our already existing knowledge of disease, we can plan prevention and control programs more precisely. A microscope should become part of every superintendent's equipment.

Plant Disease and Its Cause

For any variety of plant there is an optimum set of environmental conditions for its growth and development. In nature, however, these optimum conditions seldom exist, and plants are subjected to fluctuation of the environment. When one or more factors in the environment become unfavorable, the development of the plant is altered in some way and, in comparison to plants growing under optimum conditions, it appears to have abnormal characteristics.

Diseased plants, therefore, are distinguished by changes in their morphological and physiological processes to a point where signs of such effects are noticeable. These obvious external signs, which are characteristic of a disease, are known as symptoms. Whether all deviation from the normal in structure and function is considered a disease depends upon our definition of "normal" for a particular plant.

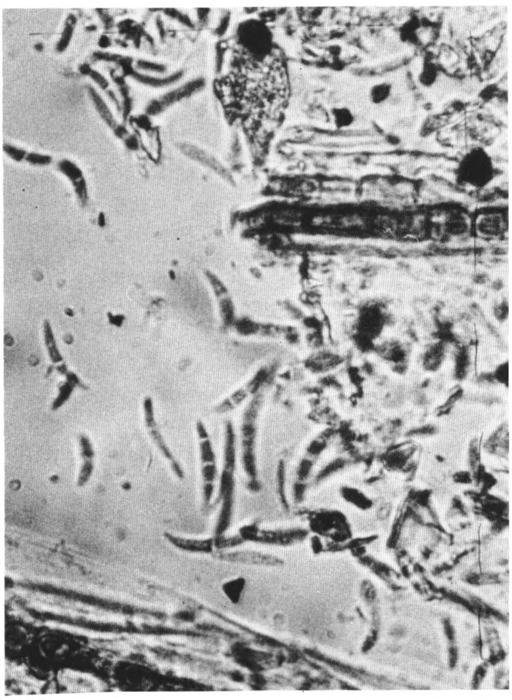
For our complete understanding of disease we must know what constitutes the cause of disease. The causes of disease are broken down into two groups—unfavorable environmental conditions and parasites. Adverse weather, air pollution and nutrient imbalance are examples of unfavorable environment and are easy to comprehend as a cause of disease when they interrupt plant processes.

However, when a parasitic micro-organism enters into the complex, as is the case with most turf diseases, the common tendency is to refer to the microbe as the cause of the disease. While this is true to a large extent, we must remember that variation in the environment is sometimes necessary to cause a plant to become susceptible to a parasite. Furthermore, the micro-organisms will require a certain range of favorable conditions to infect the plant.

Moreover, once a parasite has infected a plant, the interaction of plant and parasite which results in a disease is also subject to environmental influences which determine whether disease develops at all, at what rate, and to what degree.

Strictly speaking, it is not correct to refer to a given micro-organism as the sole cause of disease. Rather, it would be more correct to consider the microbe as the causal organism which is part of the causal complex.

Fig. 3. **Fusarium.** Nonsexual spores (conidia); sickle-shaped with 0 to 3 crosswalls.



Life and Disease Cycles

A complete disease program depends ultimately upon knowledge of parasite life and disease cycles and their behavior in nature. The control of parasitic agents is greatly complicated by their diversity and variability. Many have life cycles which involve more than one host plant. Others can live indefinitely as saprophytes, attacking living hosts only when the conditions are favorable. Some have spore stages specialized for dissemination in water, in air or in the soil, while others produce resting spores that can survive for many years under the proper conditions.

The chain of events in disease development is referred to as the disease cycle. When a parasite is involved, the disease cycle is intimately associated with the organism and is distinct from the life cycle, although part of it. The life cycle of an organism is composed of an overwintering (or oversummering) stage and the disease cycle.

The overwintering stage may be as dormant spores, sclerotia, hyphae or other organs; on other host plants; in debris of infected plants of the previous season; in or on seeds of the host plant; or in various other forms. Whatever the form, it becomes the source of inoculation. The disease cycle starts with inoculation, and is composed of four parts as follows:

Inoculation—refers to the set of conditions whereby the parasite and host plant come into contact with each other. This can be accomplished by any means that disseminate organs which can infect plants.

Penetration—refers to the initial invasion, either passive or active, of the host plant by the pathogen.

Infection—implies the establishment and development of a pathogen inside the host plant before any symptoms of the disease are noticeable.

Incubation—is the chain of events which occur between the time of infection and the complete expression of the disease.

Throughout the course of the disease cycle, reproductive organs are produced which can start the whole cycle over again. This second crop of infectious organs is referred to as the source of secondary inoculation.

A thorough understanding of life and disease cycles of plant parasites can easily lead to more effective control. It may be easier to control turf parasites before they come into contact with the plant, or once in contact, before disease expresses itself. Therefore, these should be studied carefully.

Fig. 4. **Helminthosporium.** Nonsexual spores (conidia); cylindrical-shaped with 1 to 10 crosswalls.

The Fungi and Turf Disease

The fungi are the group of microorganisms that cause the major turf diseases. Fortunately, only a small number of these are of particular importance to us. While it is possible for bacteria, viruses, and nematodes to infect turfgrasses, they have, up to this point, been of minor consequence.

The fungi are living organisms and therefore require a source of food. Since they lack chlorophyll, they cannot produce their own food (like plants do) and must obtain food from an external source. The fungi that attack living plants are called parasites and are grouped into two categories—obligate parasites (those which grow only on living host plants), and facultative parasites (those which grow on living plants but at times do grow on non-living plants). These are distinguished from saprophytic fungi which live only on non-living organic matter.

Characteristically, the fungi are composed of microscopic thread-like filaments (Fig. 1). Each individual filament is called a hypha (plural, hyphae), and the hyphae collectively are called mycelium. It is the mycelium that is sometimes seen on grass. The hyphae can have cross-walls (Fig. 1) or can be without cross-walls (Fig. 2). It can be colorless, brightly colored, dingy brown or black. Essentially, the filaments resemble the cells of other plants; that is, they are surrounded by a thin membraneous cell wall and are composed of protoplasm.

Fungi, like most biological entities, reproduce. They do this by forming microscopic bodies called spores. The spores of a fungus are similar to seeds of green plants and are designed for dissemination and reproduction. A spore, however, differs from a seed in that it contains no embryo. Spores may consist of a single cell or be a compound structure of several cells, each consisting of a mass of protoplasm surrounded by a firm containing wall.

Spores have many distinguishing characteristics. They vary greatly in size, shape, color and the ability to survive heat and cold, to name just a few. A small number can move under their own power, but the great majority are disseminated by wind or water.

Fungus spores are formed sexually and vegetatively (non-sexually); that is, they develop at the ends of hyphae by constriction of the walls. These vegetative spores can occur randomly over the surface, be dispersed throughout the mycelium, or be enclosed in a fruiting body. A fruiting body develops from existing hyphae, but differs from ordinary hyphae by having a distinct shape and color. Fruiting bodies serve as a useful means of identifying one fungus specie from another.

The non-sexual spores are typical of the early stages of disease, while the sexual spores occur later on in the disease cycle, usually during the period of winter dormancy. Non-sexual spores are produced in indefinite numbers, while sexual spores are produced in definite numbers.

Before discussing the classification of the various fungi it is necessary to define a number of terms used in describing spores and fruiting bodies. This list by no means includes all the terms applied to the fungi, but it does define and describe most of the structures encountered when studying turf diseases under a microscope.

ACERVULUS pl. acervuli—a mass of hyphae that produces a cushion-like mass of conidiophores, and is sometimes accompanied by stiff, sterile hyphae known as setae. The mass of hyphae (or stroma) forms just below and then ruptures the cuticle or epidermis of the leaf.

APOTHECIUM pl. apothecia—a cup-shaped or saucer-shaped fruiting body, inside which are numerous, closely packed, cylindrical or club-shaped asci.

ASCUS pl. asci—a structure found only in the Ascomycetes. It is a thin-walled sac containing spores. The number of spores in each

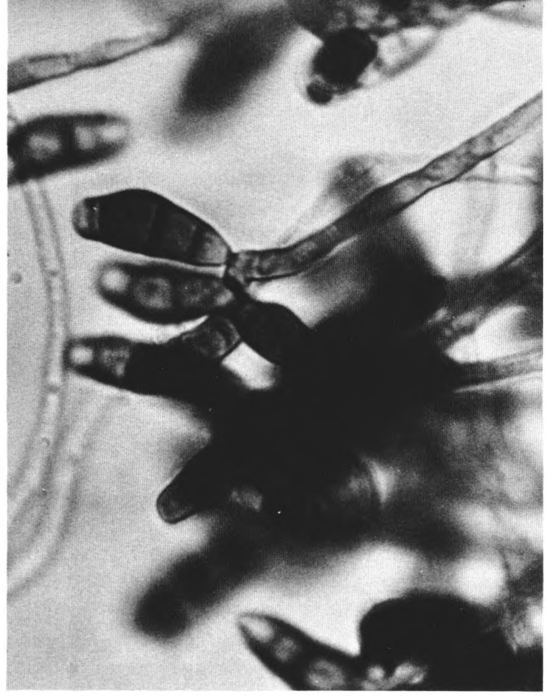


Fig. 5. **Curvularia.** Nonsexual spores (conidia) borne on tip of specialized hyphae called conidiophore. Spores distinctly bent with one of the center cells larger than others, 3 to 4 crosswalls.

ascus is usually eight, but in certain cases is some multiple of two. The ascus can be rounded, with the spores packed tightly inside or it can be cylindrical or club-shaped with the spores arranged in one or two rows.

BASIDIUM pl. basidia—an organ characteristic of the class Basidomycetes. It typically is a club-shaped or tubular organ bearing four tiny projections (sterigmata) on each of which a spore is borne.

CONIDIOPHORE (Fig. 5)—a specialized hyphae bearing conidia, either at the tip or rarely along its length. In some genera the conidiophore terminates in a series of branches on which conidia are formed.

CONIDIUM pl. conidia (Fig. 5)—a term applied to a variety of non-sexual spores. The spores are cut off successively from a phailide, which is a highly specialized terminal cell of a conidiophore, or more rarely, the conidiophore itself, more or less flask-shaped, which continually elongates, but as the conidia are cut off it remains sensibly constant.

PERITHECIUM pl. perithecia—a fruiting body found in the majority of Ascomycetes, and consisting of a receptacle in which asci are produced. The perithecium may be roughly spherical and break up at maturity to release the spores, or more usually, it is flask-shaped and liberates the spores through the neck.

PYCNIDIUM pl. pycnidia—a fruiting body resembling a perithecium, flask-shaped or somewhat irregular in shape, usually large enough to be seen with the naked eye. Unlike perithecia, pycnidia do not contain asci but are lined with short conidiophores. When crushed, it releases its spores as an irregular mass.

SCLEROTIUM pl. sclerotia—not a spore or spore-bearing structure, but a compacted mass of mycelium, often very hard, and varying in size from a millimeter to several millimeters in diameter. It serves as a resting body to carry a fungus through unfavorable weather and the impacts of other organisms, and is able to germinate and produce more hyphae.

SPORANGIOPHORE (Fig. 2)—the specialized hypha or system of hyphae that bear sporangia at its tip.

SPORANGIUM pl. sporangia (Fig. 2)—a closed receptacle, usually round or pear-shaped, borne on a sporangiophore and containing an indefinite number of spores.

STROMA—a mass of hyphae, bearing spores on very short conidiophores or having embedded in it perithecia or pycnidia.

The fungi are divided into four main classes. Because spores show much more variation between species, and at the same time are more constant in shape and color for any one specie, most systems of classification are based chiefly on methods of spore production and characteristics. However, mycelium and fruiting bodies are helpful.

The **Phycomycetes**—the mycelium of these fungi are mostly nonseptate (no cross-walls); mycelium lacking in some primitive forms. Sexual reproduction by oospores and zygospores. Non-sexual reproduction by sporangia and spores liberated may be motile in some cases and not in others. These fungi are primarily found in wet places. The Pythium fungi are of particular importance in this group.

The **Ascomycetes**—possess several spore stages. Sexual spores formed in asci; normal number of spores in ascus eight; perithecia present. Non-sexual spores (conidia) often present and very varied in form and disposition; pycnidia present.

The **Basidiomycetes**—sexual spores exogenous (not enclosed), formed on basidia; normal number of spores on basidium four, rarely two. Non-sexual spores uncommon. The smut and rust fungi make up an important segment of this class. They have a modified basidium, called a promycelium, but it is clearly homologous to the true basidium.

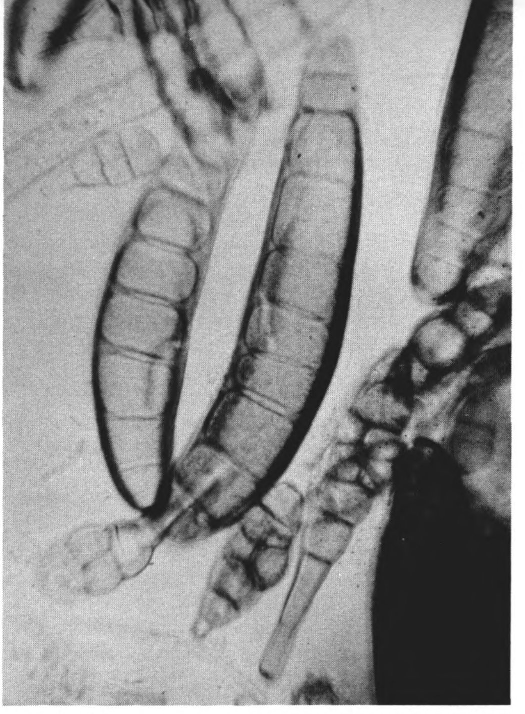


Fig. 7. Nonsexual spores and hyphae of the **Helminthosporium** and **Alternaria** genus of fungi. These structures have distinctive characteristics for each specie of the fungi and are extremely helpful in identifying a disease-causing organism microscopically.

The **Fungi Imperfecti**—no sexual spores known; reproduction exclusively by non-sexual spores. This group contains many of the leaf-spotting fungi.

The fungi are named according to the Latin binomial system of nomenclature. The fungus, if fully described, is given a specific name within a genus and this is referred to as the Latin binomial of the organism. The name, or abbreviation thereof, of the investigator who first described the species follows the binomial. These names are always put in italics when printed, and should be underlined when hand written. The genus name is always capitalized, but not the investigator's name.

The following features characterize the parasitic fungi of some of the more common turf diseases and are the ones to look for when studying the fungi microscopically.

RHIZOCTONIA (Fig. 1). Hyphae light to dark brown, characterized by rightangled branching with cross-walls; first cross-wall of branch slightly near parent hypha. No spores produced; may form sclerotia. **Brown Patch.**

SCLEROTINIA. Characterized by a fine white cobwebby mycelium; conidia borne singly on hyphae inside an apothecia; sclerotia black. **Dollar Spot.**

PYTHIUM (Fig. 2). Hyphae is colorless and has no cross-walls; sporangia spherical and terminal; spores rarely seen. Mycelium located in root and crown regions. **Pythium Blight.**

FUSARIUM (Fig. 3). Spores sickle or banana-shaped with 0 to 3 cross-walls. Mycelium white to faint pink or pale rose with cross-walls. **Pink Snow Mold.**

TYPHULA. Characteristic light to reddish-brown sclerotia that can be seen with the naked eye. Mycelium grayish-white. **Typhula Blight.**

HELMINTHOSPORIUM (Fig. 4). Spores more or less cylindrical, brown, with 1 to 10 cross-walls; hyphae (conidiophores) emerging from the stomates, brownish, with cross-walls. **Melting-out or Eyespot.**

CURVULARIA (Fig. 5). Spores, brown, distinctly curved or bent with one of center cells conspicuously larger than the other cells; end cells paler; three to four cross-walls. Hyphae emerging from stomates; brownish, with cross-walls.

PUCCINIA Spores (known as urediospores) are reddish-brown, roughly-rounded, with a slight constriction at the top. **Rust.**

There are numerous other diseases caused by fungi that strike turf-grasses, such as copper spot, pink patch and other leaf spot diseases, but these occur only rarely. However, these fungi should also be studied to familiarize ourselves with their characteristics.

It is not possible in an article of this size to give all the information useful in studying and identifying the fungi that cause turf diseases. Therefore, a list of books appears at the end that will be most helpful. These describe life and disease cycles in detail, identifying structures and other keys helpful in identifying fungi. They should be consulted and studied as a valuable aid in a disease control program.

A good microscope and a knowledge of isolation techniques are necessary to study the fungi effectively. There is a wide range of microscopes available, but a compound microscope that will magnify in a range of 3 to 1,000 times will be sufficient. Isolation in pure culture may be necessary to determine what fungus specie is causing the disease. However, before this is attempted study the tissue thoroughly under the microscope, because some fungi sporulate readily on diseased material, allowing for easy identification. Examine both healthy and diseased material for hyphae, spores and fruiting bodies. A portion of the leaf should be scraped with a moistened razor blade and the scrapings added to a drop of water on a microscope slide. Cover with a cover slip and examine.

Isolation in pure culture involves placing small pieces of both healthy and diseased tissue in petri dishes containing agar. Incubate for a few days, and examine for any spores or fruiting bodies produced. Because this is quite a tricky technique, the books listed at the end of this article, or a turf pathologist should be consulted to determine the proper technique and materials needed for pure isolation.

It should be emphasized that the turf disease situation is not static; it is always changing. Microorganisms are as variable in genetic make-up as any other organism, and no matter how up-to-date our information, there is always the chance new races able to attack formerly resistant varieties of turfgrasses will appear. We must be prepared to meet this possibility as well as be better prepared to prevent and control existing diseases if the goal of total turf perfection is to be met. By increasing our knowledge of disease with the use of a microscope we will be in a more advantageous position to gain effective control over them.

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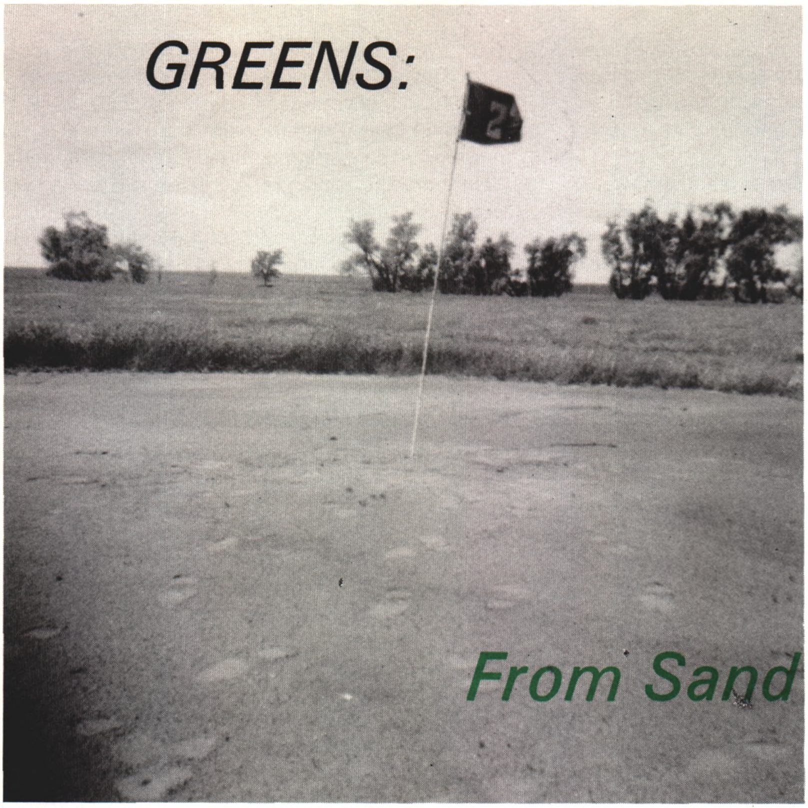
GREENS: From Sand to Grass



Sand greens at the Lennox Country Club in South Dakota. This club has just recently converted to grass greens.

by GENE REITER, Member, USGA Green Section Committee

South Dakota is perhaps one of the last states to have sand putting greens on a sizeable number of its golf courses. Approximately 90 golf courses are within the state, and about half are still playing on sand, although the number is constantly dwindling.

The retention of sand greens is due to the varying weather conditions in the state. The majority of sand green courses can be found in the central section, extending from the north to the south borders and from just east of the Missouri River to the Black Hills region. Maintenance on all of our golf courses, whether they have sand or grass greens, also varies with the regions of the state, and again this is due to the varying weather conditions.

Minnehaha Country Club came into existence in 1905 and was the first golf course in the state. It wasn't much of a golf course and the weeds were mowed by sheep. The greens, so-called, were dirt. A stick with a rug on it was used to smooth the surface before putting.

Not long after the club's formation a desire for something better developed. In 1914 the club acquired land for a new clubhouse and course. Grass greens came into existence with a new nine-hole layout. Additional ground was acquired in 1921 and another nine holes were constructed to form the present course.

The club has had its ups and downs. There were rough days during the 30's when drought and depression caused the membership to fade away. The club weathered the storm, however.

Our Unusual Conditions

There is another reason, other than dry weather, why large numbers of sand greens were developed in the state. With small populations in our cities and towns, it was impossible to get the money needed to build and maintain grass greens. Because so many liked to play golf, sand was the only alternative. I cannot speak as an authority, but from what I have been told sand green maintenance is very simple and inexpensive when compared with the complexities we encounter in maintaining bentgrass greens.

Every spring, several of the members would get together and prepare the greens for the season. This meant getting a supply of oil (used crankcase oil preferably) and washed concrete sand. The members would mix it as best they could and then apply it to the greens and level them for play. Most sand greens were small in size, varying from 1,000 to 1,500 square feet. Their cost depended on the amount of donated labor and materials, but was usually from zero to a few hundred dollars.

The maintenance cost of a sand green was practically negligible. The same could almost be said for fairways and tees; their only requirement was mowing. Fairways were unwatered, and in many cases the grass was buffalograss, which requires very little mowing from July on.

It has not been too many years ago in South Dakota that many of our golfers learned to play the game on sand greens. I can recall past State Championships that were held at our club where the entrants were from sand green golf courses. They entered because it gave them the opportunity to play on bentgrass greens. They marveled at the playing conditions of bentgrass and hoped that some day they would play the same conditions on their own golf course.

That day is slowly but surely coming. Every year a few more sand courses follow the trend and convert to bentgrass greens. I know that if the federal government continues with its Recreational Loan Program, with the increase in the number of players each year, and with golfer demands, the sand green will soon enter a past era in our state.

Of course, maintenance requirements for grass greens is much more involved and requires many additional practices. Penncross and seaside bent are the most commonly used grasses, with Penncross predominating. In the larger population and resort areas, watered fairways have come into being during the past few years. The grass cover for fairways continues to be mainly bluegrass; there are no bentgrass fairways in the state.

We find that as the years go by the players are asking for a better golf course and they seem willing to adjust to the necessary budget increase. The smaller courses in the more rural areas, however, are forced to hold their budget to the lowest possible level, and, therefore, maintenance and watering is restricted to greens and tee areas only.

I have to wonder what the old-time sand green players must think of sand on our present day golf courses. They played their game on nine sand greens that probably measured 1,000-2,000 square feet in size. Today's golf courses have 50 or more bunkers, many of which are twice the size of the old sand greens they used to play.

HOW TO BUILD SAND GREENS

1. Spade up the old sand green, including top sand and old bed. Work over this spaded material and smooth it down.
2. Mix some good clay with this old bed to get a good, firm base. Smooth off the base with a scraper and light roller.
3. Take some used crankcase oil and use an ordinary sprinkling can. Go over the newly-prepared bed with a good and thorough cover of this oil. Let the oil soak in.
4. Then, with some good screened sand and more oil, mix these together in an ordinary mortar box or cement mixer and spread this on the prepared bed to a thickness of three to four inches.
5. Next, work this sand over efficiently, with a scraper, until a nice level or flat surface is procured. Work this over again with a light roller for a fairly firm green.
6. Using a heavy weighted carpet, as a mop, roll the green, or mop it; start from the center and mop to the outside of the green in a circular motion.
7. The final step is to apply a $\frac{3}{4}$-inch layer of sand for the finished green surface, which is mopped only. Do not roll this or the finished green will be too hard.

Any washed sand must be worked back onto the green, after a heavy rain in order to even it up.

ABOUT THE AUTHOR

Gene Reiter gives us an insight to a bygone era. The golf course superintendent at Minnehaha Country Club, Sioux Falls, S.D. since 1957 and a member of the USGA Green Section Committee for many years, Reiter also sent along the foregoing recipe for reconditioning, or with slight changes, actually building new sand greens. The information was furnished to him by Cliff A. Anderson and Ed Livingston, both deceased.

DRAINAGE — The Key to Better Golf Turf

by **ROBERT A. MAZUR**, Eastern Agronomist, USGA Green Section

Good drainage is essential to the production of healthy turfgrass! The greatest number of all the problems we encounter on golf courses either directly or indirectly involve drainage.

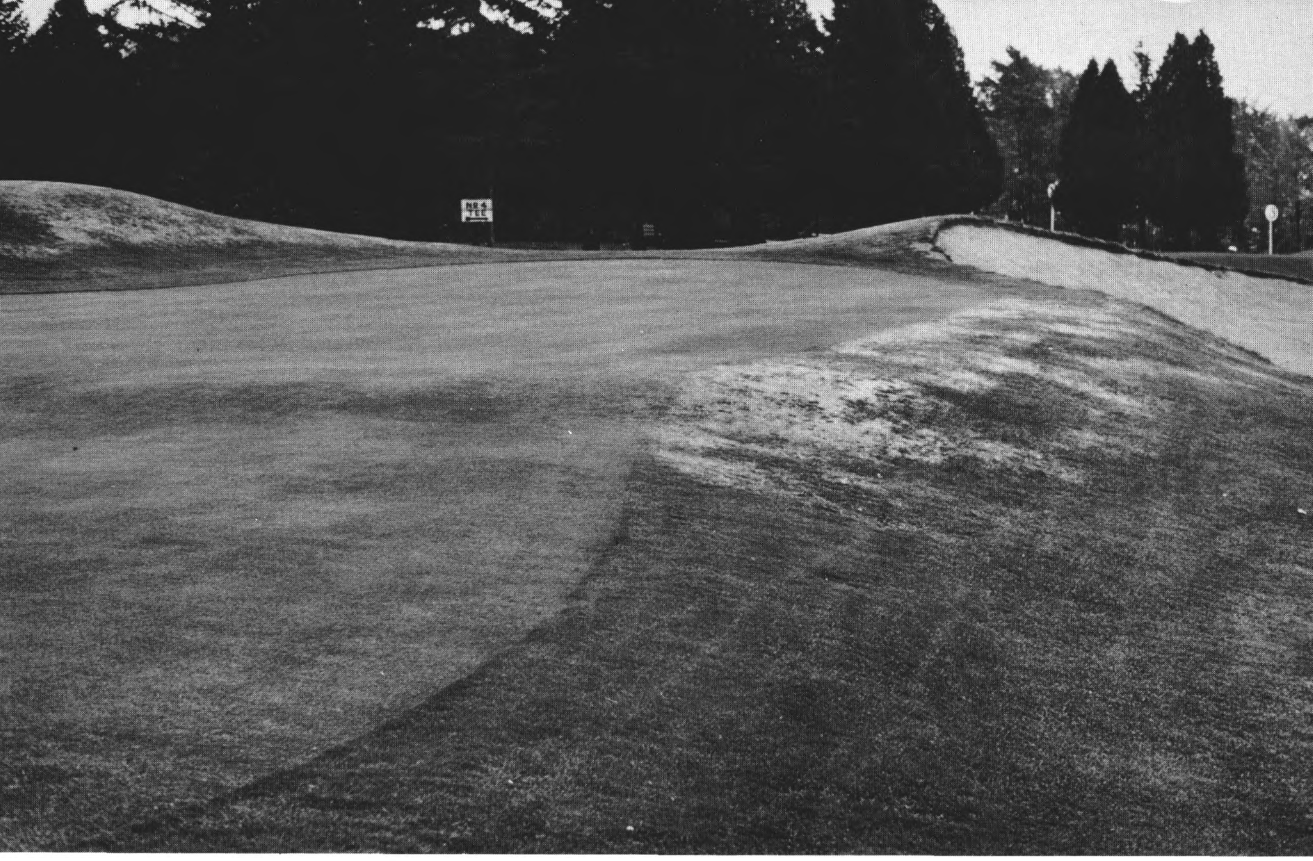
Effects on Growth

Drainage promotes many conditions favorable to the growth and development of plants and soil organisms. It promotes aggregation and reduces the effects of traffic and compaction. Even during the winter when turf is in a semi-dormant state, drainage is extremely important. It reduces damage from the alternate freezing and thawing action of the soil. Good surface drainage in northern regions can prevent the loss of turf, which often results when surface moisture collects and freezes in close proximity to the crown of the grass plant. Lowering the water table also promotes the development of a deep and effective root zone.

Each textural class of soil has different water retention as well as drainage characteristics. The textural class of a soil is determined by the relative amounts of sand, silt and clay that are present. The percentage of organic matter, although small, has a tremendous influence on the chemical and physical properties of soils. The drainage and moisture retention properties of a soil are essentially a product of pore size and not total pore space.

There are two size-classes of pores in soil; the large, or macropores, and the small, or micropores. Moisture in the large or macropores is subject to the pull of gravity, while the moisture in the micropores is held with such tenacity

Drainage problems not eliminated during construction must be solved at a later date.



Mounds and slopes tend to dry excessively and often require hand watering.

that it can be moved upward through the soil profile by capillary action.

A sandy soil consists primarily of macropores and is droughty by nature. Clay soils have primarily micropores and are basically wet soils. A well-granulated silt loam at the optimum level of moisture for plant growth would have a total pore space near 50 per cent. In this case, 25 per cent of the pores would be micropores containing moisture and 25 per cent would be macropores containing air.

The old saying, "In the spring, a wet soil is a cold soil" holds true for our turfgrass areas. Good drainage is imperative in the spring if the soil is to warm up rapidly and properly.

Soil aeration is perhaps the factor affected to the greatest degree by drainage. Generally one-half or more of the pore space of a well-drained soil is occupied by air. This is again a factor of soil texture as air adequately supplied with oxygen is usually contained in the large or macropores.

In the fine-textured soils, however, air space may be well below 50 per cent of the total porosity. Most of the pores are micro-size and tenaciously retain their water.

The atmosphere that is present is likely to be too low in oxygen to supply plant roots with the amounts of oxygen needed for metabolic processes. Under these conditions nutrient intake is slowed down even in the presence of abundant amounts of essential elements and the growth of aerobic soil organisms is adversely affected. The lack of adequate percolation of water through the subsoil can also result in an excess accumulation of soluble salts in the root zone.

The most apparent effect of poor drainage and soil aeration is a decrease in the rate of organic matter oxidation. This reduction seems to be associated more with the lack of oxygen than with the accumulation of excess carbon dioxide. The slow rate of decay of plant residues in swampy areas is an exaggerated example of how a lack of oxygen prevents rapid decomposition. All aerobic organisms are unable to function properly in the absence of gaseous oxygen. This includes the symbiotic and non-symbiotic nitrogen fixing groups. The anerobic organisms that are able to function under these situations, using combined oxygen, consistently yield reduced forms of iron and manganese, which are phytotoxic.

If a turf area is saturated by a heavy rain and then exposed to bright sunlight, the turf, in many instances, will severely wilt in a short period of time. This condition, "wet wilt," is most severe under conditions of poor drainage. It is caused by a retardation of water absorption as a result of water replacing the soil atmosphere and leaving the roots poorly aerated. When transpiration occurs at a rapid rate in bright sunlight, the combined effect of accelerated water loss with retarded water absorption results in the development of a water deficit in the plant.

There are several reasons why poor aeration and drainage retard water absorption. They slow down the metabolic rate and, conversely, the uptake of nutrients and moisture. Secondly, the poor exchange of gases in the soil could result in an accumulation of CO_2 which appears to increase the viscosity of protoplasm and reduces permeability. This in turn retards water absorption.

Pathogenic turf fungi are promoted under conditions of poor drainage where liberal quantities of moisture are available. Saturated soils and high localized humidity create ideal conditions for their rapid development. Under conditions of prolonged excess moisture, you get a development of soft growth, a low pH, and a state of reduced vigor which facilitates invasion by pathogens.

Solving the Existing Problems

In many cases the only remedy for poor drainage on established greens and tees is reconstruction. Generally, reconstruction is the answer where existing soil has poor texture and structure, or the area lacks surface drainage. Minor depressions or low areas that hold surface water can be eliminated by stripping off the sod, filling and grading the area and replacing the sod. In northern regions where water collects in depressions when the soil is frozen, tile drains are of no value. Surface drainage is the only answer!

Sandy areas and steep banks around greens and tees tend to dry excessively and require frequent supplemental moisture to maintain satisfactory growth. Aeration and soil conditioners have been effective in reducing runoff and conserving moisture in these areas.

Tile or slit trenches can be used to correct poor drainage caused by impervious subsoils. Drains function on the principle that they can conduct water faster than the surrounding soil. Where a fairway has been constructed on heavy soil that requires uniform drainage over the entire area, a simple gridiron or herringbone pattern of drains will usually remedy the situation. Where tile or slit trenches will not function properly because of high groundwater levels, open ditches or grass waterways would be more suitable. In extensively low and wet areas, relief wells or reservoirs equipped with relief pumps may be the only means of lowering the water table.

Drainage encourages healthy, vigorous growth and reduces management problems. Drainage also keeps the player's feet dry, provides him with firm footing and smooth resilient surfaces for putting. Drainage promotes better overall conditions for both golf and turf.

Alexander Joins Green Section

Dr. Paul Alexander, recently of Clemson University, Clemson, S. C., has joined the USGA Green Section Staff effective July 1. He will be based in the mid-continent regional office in Chicago with F. Lee Record.

Dr. Alexander received his Bachelor of Science degree from California State Polytechnic College. He later earned a Masters degree and Ph.D. from Ohio State University. Most recently Dr. Alexander served in the Department of Horticulture at Clemson University.

He was actively involved in producing the USGA Green Section movie, "The ABC's of Putting Green Construction," which was filmed at Clemson. He has a smooth golf swing as well as an excellent background in turfgrass management.

Topdressing Is Not Top Secret

by **PAUL W. NEFF**, Member, USGA Green Section Committee

"He had a 20-foot putt, mostly against the grain." How often have we heard such a remark on television or in the locker room?

Though I realize that grain is harder to control in some varieties of grasses than in others, one of the most neglected tools for combating it is sufficient top-dressing. Years ago many superintendents top-dressed every month of the growing season. Later it became fashionable to quit this practice because it was "too much work, too expensive and really not necessary."

In another few years there was the cry of thatch, mat, grain and too much traffic. Expensive machines were designed and used to beat the grass into submission.

Some superintendents who have managed to get some top-dressing on a few times a year did not know all the answers, but neither did they have all the problems. The bentgrass plant is put into an unnatural environment and usage on a putting green. To offset these brutalities it needs some tender loving care.

A small amount of top-dressing properly applied and dragged into the turf will cover some joints and initiate new growth. The putting surface will reach a new plateau a fraction of an inch above the old surface. Decomposition of dead matter will be hastened and the green will be more resilient and will hold more shots. The new elements in the new material seem to invigorate the grass and bring more disease resistance and less winter-kill.

I like to aerify the greens before top-dressing because this is the nearest to cultivation that it is possible to do. Weather and play permitting, I try to top-dress in early May, late June, late August and in October. By breaking up the aerifier cores there is enough material available for a light dressing, but additional material is usually added. If the soil under the green is very dense, an application of calcined clay may help. It may be added before aerification, or during any step of the process before dragging. Flexible mats pulled behind a truckster are used for dragging.

The old-timers had one fault that should not be repeated today. Each superintendent had his own favorite soil mix. He would use it on the greens wherever he went. As superintendents changed jobs, so did the mix. By looking at a soil profile on a green, you could tell just when superintendents changed jobs. Some layers became so bad that water movement and root development were impeded. I feel you should use a mixture just like the one in the green, or mix calcine clay or sand with a similar mixture if the soil under the green needs modifying.

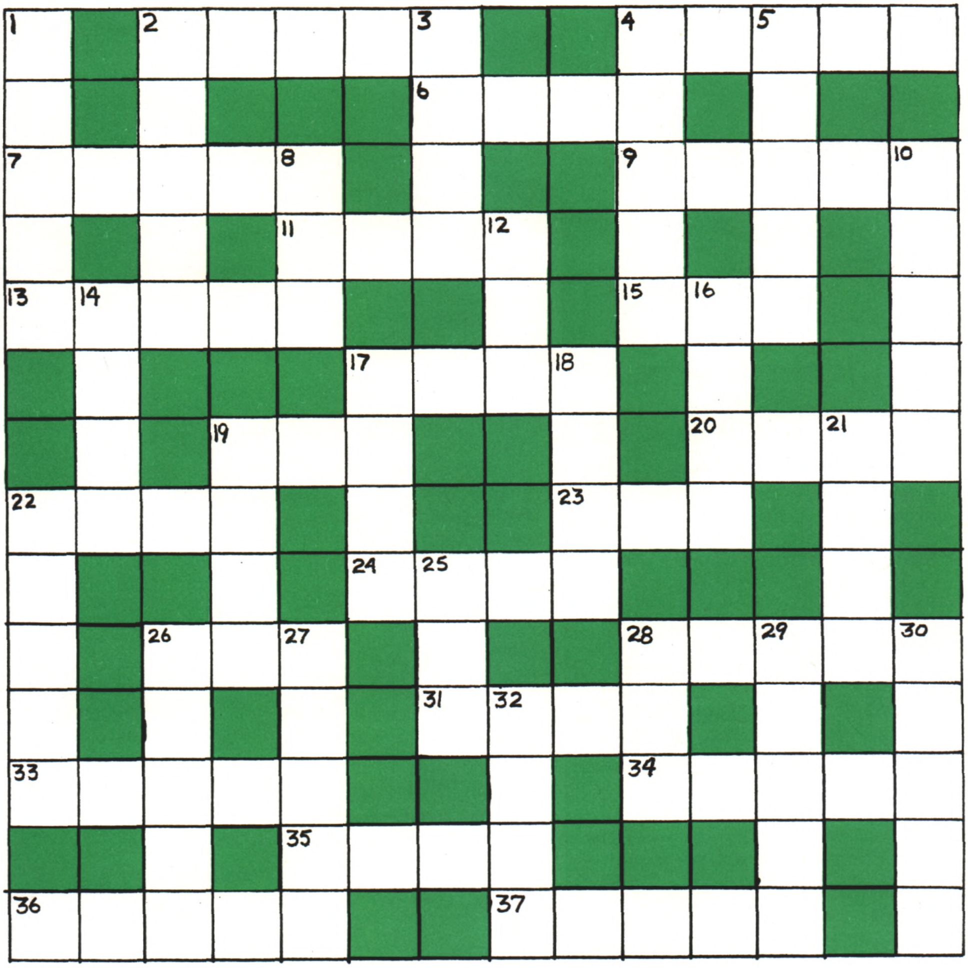
Top-dressing is not the hard work it used to be. We now have power shredders to condition and mix the soil; a tractor loader to feed the material into the shredder; a power spreader to apply the material to the green; and a drag mat pulled by cart power.

You will also find that the price is really not too high; members and guests will soon be telling you, "they putt the same from any direction."

For A Summer Evening

Green Section Record Crossword Puzzle #2

Katherine Cardwell, Mid-Western District



ACROSS

2. A type of blade.
4. Wet wilt.
6. Direction.
7. Took apart.
9. Martini ingredient.
11. Place ball from unplayable lie.
13. What seed will do in a flood.
15. Hole-in-one.
17. Accumulation of vegetable matter formed by partial decomposition under anaerobic conditions.
19. Greasy substance.
20. $CACO_3$.
22. To sow.
23. Deciduous tree.
24. Characteristic carrier.
26. Arid.
28. Green scum.
31. Soil.
33. First.
34. Wear away.
35. Carry golfers uphill.
36. Too much hot fertilizer.
37. Does to green before seeding.

DOWN

1. Fill, pack firmly.
2. Audio part of a tractor.
3. Biggest little city.
4. Escape for moisture vapor.
5. Difficult to keep during hot, humid weather.
8. Insecticide.
10. Top country clubs.
12. Bluegrass.
14. What the fourth man in a four-ball usually is.
16. Jointed stem of grass.
17. Small sod piece.
18. Woody perennial.
19. Occurs following spring or winter kill.
21. Powerful (comb, form).
22. Results if mower is set too low.
25. Finish.
26. Less humid.
27. Time measures.
28. What the golfer did in the halfway house.
29. Continuous upward.
30. What the course needs to be in top shape for.
32. It is completely surrounded.

USGA GREEN SECTION RECORD
JULY 1969

TURF TWISTERS

NOT WHEN BUT HOW MUCH!

Question: Does watering in the heat of the summer day hurt turfgrasses on greens? (New York)

Answer: When correct amounts of water are applied to turfgrasses any time of the day or night there is little danger of injury. This includes watering in the very hot sun, as superintendents are sometimes forced to do, to keep grasses from wilting. It's not when, but how much water is applied that is important.

BENTGRASS

Question: We have a putting green that is very thin because of wet wilt damage and an ensuing occurrence of algae. Should we reseed it now (late July) or will we just waste our seed? (Oklahoma)

Answer: July is not all bad for overseeding greens. In fact, some have had very good results from a mid-summer seeding program. First, aerify and/or spike the green to prepare a good seed bed. Then overseed with seaside (three pounds per 1,000 sq. ft.) or Penncross (one pound per 1,000 sq. ft.).

GOOSEGRASS

Question: My Penncross greens are loaded with goosegrass. How can I eliminate it? (Georgia)

Answer: There is very little you can do in the way of post emergent treatment except hand pick the goosegrass. Any post emergent chemical which would kill the goosegrass would also kill the bent. As a control the following year you should use one of the pre-emergent chemicals recommended for goosegrass to stop it before it becomes established.

RYEGRASS

Question: I hear there are some new ryegrass varieties for overseeding bermuda. Are they available? (Louisiana)

Answer: The grasses being evaluated look far superior to those now being used, but availability will be limited this fall. I would suggest you keep in touch with your supplier of grass seed.