JULY 1965

USGA GREEN SECTION RECORD

A Publication on Turf Management
by the United States Golf Association

Courtesy Stan Frederiksen, Mallinckrodt Chemical Works

DISEASES OF BERMUDAGRASSES

This is "Spring Deadspot!" Bermudagrass fairways in the St. Louis, Kansas City and Tulsa areas have been plagued by this disease.

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Diseases of Bermudagrasses

By **JAMES B. MONCRIEF,** Southeastern Agronomist, USGA Green Section

Bermudagrass, *Cyndon dactylon* (L.), has a wide adaptation and is therefore subjected to many diseases and adverse weather elements. Bermudagrass is believed to have been introduced from Africa or India. It is reported to have been brought to Savannah, Georgia, about 1751 in hay for horses or for packing purposes. This grass is very versatile, being used in all phases of sports, lawns, parks, and school grounds. In some areas, it is considered a noxious weed but it is often cursed and praised at the same time.

Bermudagrass is a warm season perennial, growing best with temperatures above 70° F. It will suffer with prolonged high temperatures accompanied by a shortage of water. Lack of cold hardiness limits the northern distribution, but new selections are gradually extending the area to which it is adapted. One reason for wanting to grow it on golf courses farther north is the desired playing condition it creates. Demands for better turf keep standards high for disease-free bermuda. Because of greater interest in diseases there is a need for still further evaluation on new selected bermudas.

Unfortunately, bermuda becomes dormant during the winter months except in the extreme southern portion of the United States. Bermuda on greens commonly is overseeded for winter play. Even fairways and tees are overseeded in some cases to mask the brown color. Overseeding creates two transition periods on the greens, one in autumn and the other in spring. Sometimes the spring transition can hold an unpleasant surprise. Frequent examination of rhizomes and stolons prior to the transition period in the spring can cause one to expect survival of bermuda following a severe winter. Subsequent late spring cold spells and disease activity may sometimes cause loss of turf after it apparently has survived the winter.

The transition of bermuda greens from cool season grasses in 1965 has been very favorable. Nevertheless recent visits to courses in the lower Piedmont area and in northern Alabama and Tennessee have shown considerable loss of grass from disease during the winter months. The gross symptoms of the disease activity appeared as circular areas from 6 inches to 3 to 4 feet in diameter. This is similar to the spring dead spots so common in the Missouri, Kansas, and Oklahoma areas. Some areas are showing regrowth while others show only dead grass and young weeds. The selections of bermuda may vary in their susceptibility. Considerable numbers of these circular areas were observed in early May on Tifway and Tifgreen fairways three years old and none was observed where the grass was one year old. This may indicate a gradual build-up of disease in the bermuda after being planted 2 to 4 years. In another instance Tifway on the lawn at a local sewerage disposal plant shows no disease pattern where the basic sewerage sludge was applied while the area fertilized with inorganic fertilizers was pitted with dead patches. This turf is three years old.

Pathologists have done an excellent job in keeping abreast of fungicides and evaluating their uses on the many strains of bermudas which have been selected during the past 10 to 15 years. Most states have published home

owners bulletins and fact sheets on turf diseases and their control, but few are directed toward golf courses. However, the same diseases may be found on the same grasses regardless of the purpose for which they are used. The home owners using the new selected bermudas are experiencing the same disease problems as are golf courses.

In 1932, the USGA Green Section published a bulletin entitled "Turf Diseases and Their Controls" by John Montieth, Jr. and Arnold S. Dahl. This bulletin established basic principles, many of which are used today in identification and control of turf diseases. It said in part:

"The question as to when diseases first appeared on golf course turf will probably never be settled. Among the older golfers there are many who insist that turf diseases never appeared on golf courses in the good old days. Other golfers of equally long experience testify that they observed browned areas of turf similar to the modern turf ailments when they first played the game. Some of the old cuts showing players near the cup indicate that the putting greens of early days were by no means exempt from thin and perhaps dead patches of turf which were possibly the result of diseases. It has been demonstrated many times that memory is not dependable for recording information of this type. From all information available it is entirely safe to assume that turf diseases date back much further than the origin of golf. It is quite apparent, however, that early golfers were not as critical of the turf on which they played as are the golfers of today, and consequently the question of disease was to them of little importance."

It is interesting that the foregoing paragraph was written 33 years ago and yet sounds similar to conversations today.

In 1962, Dr. C. L. Lefebvre summarized turf research throughout the United States as indicated by projects in the files of the United States Department of Agriculture, Co-operative State Experiment Station Service. Of these 6,000 projects supported in part by Federal funds, only 69 were connected with turfgrass diseases. Nineteen dealt primarily with diseases of turfgrasses or of other grasses. The other 50 were concerned chiefly with cultural problems but were related to pathology in such connections as breeding for disease resistance, and fertilizer effect on diseases.[1]

MAJOR DISEASES

There are several fungi that attack bermudas but the ones that appear to be the most prevalent are species of the genera Helminthosporium, Rhizoctonia, Sclerotinia, Fusarium, and Curvularia. Fusarium species are active in the upper South during the winter, while *Pythium aphanidermatum* is very active on cool season grasses used for overseeding bermudas during warm periods. The frequency of attacks by these pathogens may depend upon variations in weather, growth, and vigor of the grass, the use of fungicides, the height of mowing, and other environmental factors. While local conditions may determine the pattern of disease activity to some extent, there usually is a similarity of behavior which appears to be independent of local conditions.

HELMINTHOSPORIUM

There have been about six species of Helminthosporium found on bermuda with varying degrees of damage, and no doubt there will be new ones as in-

1. Turf-Grass Disease Problems in Norrth America, Dr. C. R. Gould, Golf Course Reporter

Diseased spots on this green appear to be caused by the "spring deadspot" disease. While this problem usually occurs on fairways, it appears capable of attacking turf on greens also.

vestigations become more intensive. Symptoms of Helminthosporium are found on all parts of the bermuda plant in the form of small purple-like flecks. If these flecks are very numerous, indicating a serious infection, the plant begins to die. Under certain weather conditions, this disease can spread rapidly. While spores undoubtedly exist in turf in abundant numbers, airborne spores make it easy to spread and golfers track it from fairways and adjacent areas onto greens. Also, greensmowers may provide a means of transporting the fungi from infected areas into disease-free greens. Helminthosporium usually occurs in two stages, one affecting the leaf, the other the rhizomes and the terminal crown. When the roots and crown are affected severely, the condition is referred to as "crown rot or "root rot." These parts of the bermuda plants become dark or deep brown in color. They become limp and flaccid and decay occurs rapidly, permitting the affected parts to be torn apart easily.

The Helminthosporium species which have been found on bermuda are:

1. **Helminthosporium giganteum** causes a disease commonly referred to as zonate eyespot. It was first reported on bermudagrass in Texas in 1911.[2] It has an extended period of growth but usually occurs during times of excess moisture and warm weather. This

2. *New Species of Texas Fungi,* Head, F. D. and Worf, F. A., 1911

Dollarspot is an unusual disease. It attacks grass that is inadequately fertilized with nitrogen. In this photo, the area on the left is unfertilized and diseased badly, while the well fertilized strip on the right is much less severely damaged.

condition is aggravated by irrigating at night during the summer. The spores can multiply on leaves of grass on the golf course. It can over-winter in thatch and debris or in living parts of the plants. The increased use of vacuum machines for picking up clippings from vertical mowed fairways, tees and greens should decrease the debris. This disease is very common on bermuda (*Cynodon dactylon*) and is readily recognized by large circular spots on the leaves. Early morning watering alone has helped to reduce the seriousness of the disease.

2. **Helminthosporium vagans** Drechsler. The common name is Bluegrass Purple Spot and shows the best growth during cooler temperature ranges of 30 to 70° F. The disease has a purple black to a reddish brown appearance, later becoming lighter in the center. While this species is most commonly associated with the leafspot disease of bluegrass, it can seriously damage bermudagrass as well.

3. **Helminthosporium cynodontis** Marig. This fungus is common on bermuda in the southern United States, especially along the seacoasts, north to Washington, D.C. and west to San Francisco. It sometimes disfigures turf but is not a serious parasite. Nattrass (1939) reported it as the cause of

A badly damaged flagstick area. The hole was left in one place too long during adverse weather conditions. Wear and disease combined to nearly eliminate the turf.

brown patch of bermuda lawns in Kenya.[3] This fungus is also reported as being present on goosegrass or crowfoot. These two grasses may be good hosts for this particular species.

4. Helminthosporium sativum P. K. B. was first described in Iowa in the United States in 1910 and in Russia in 1891. In Russia it is called *H. sorokinianum* Sacc. It seems that all our literature in the United States has used *H. sativum* and it is doubtful that it will ever be changed. The fungus appears to be universally adapted and is found on many turf grasses, mainly bluegrass. It is associated in the cereals with root rot and kernel blight.

The symptoms are purplish spots later turning light brown with purplish edges with age. In bermuda it is associated with brown blight and fading out. This is involved with what is known as the disease complex of Curvularia-Helminthosporium. Under environmental conditions the spores will germinate in 30 to 40 minutes. Temperatures of about 80° F. accompanied by sufficient moisture appear to be conducive to rapid development and infections may occur within 10 hours. Cooler weather will cause a decrease in disease activity.

5. Helminthosporium siccans Drechsler is commonly called Brown

3. *Diseases of Cereals and Grasses in North America,* Sprague, Roderick, Ph.D.

Blight and is active during cool weather. The symptoms start at the tip, blighting the leaf or elongated spots, and is associated with the condition described as melting out.

6. Helminthosporium rostratum Drechsler is called Leaf Spot and is found in a warmer climate. These fungi live in the soil as well as in thatch built up on many courses. The spores are spread by wind, traffic, and water.

7. Helminthosporium stenospilum Dreschsler is often called Brown Stripe and has been reported on bermudagrasses. It appears as very narrow linear brown streaks becoming extensive later.

There is no doubt that with this Helminthosporium spp. collection, wherever bermuda is grown there is apt to be some possible infection when the appropriate environmental conditions exist. Fortunately, the new selected hybrid bermudas appear to be more resistant than the common *Cynodon dactylon*. Helminthosporium can be reduced in activity by a good maintenance program and can be controlled in most cases by fungicides. The organic mercury fungicides are fairly effective as are some of the rather complex organic materials. One of the common materials that appears to offer a boost to mercury fungicides is ferrous sulfate.

CURVULARIA

Curvularia is mentioned almost always as a part of the Curvularia-Helminthosporium complex. Although Sprague[4] lists 4 species which attack grasses in North America, it is rather commonly believed that Curvularia on turfgrasses is a secondary ailment. It is seldom, if ever, found on grass that has not first been injured by some other agent or organism. Curvularia is not easily identified and can be confused with Helminthosporium, drought, chemical burn, and even nutrient deficiencies. A pathologist should be contacted for verification. One of the best control measures is healthy grass. The same fungicides used for Helminthosporium are suggested for Curvularia.

RHIZOCTONIA

Brown patch, a disease caused by *Rhizoctonia solani* Kuehn is associated with high temperature and high humidity, and high nitrogen in relation to phosphorus and potassium. It is characterized by the presence in the turf of a ring which has a light brownish center and a bluish periphery. The "smoke-ring" at the edge of the circle is an indication of active growth. The size of the ring can vary greatly. The disesase normally affects the leaves, sheaths, or culm bases of most turfgrasses and is considered to be a soil borne fungi. It survives the winter in plant tissue or in the soil surface in the sclerotial stage. The organism becomes active at about 67° F. but above 90° F. it is again less active. It has a wide range of host plants. It enters the plant through the stomates and the mowed or damaged part of the leaf. This is one reason that the mowers should be in excellent cutting condition at all times. Mercury base fungicides, PCNB, thiram, Acti-dione, and others are used for the control of this disease. Raising of the pH (5 pounds hydrated lime per 1,000 square feet) will sometimes reduce the disease as it does best under an acid condition. Removal of dew will help to reduce its progressiveness. Addition of nitrogen

4. Diseases of Cereals and Grasses in North America, Sprrague, Roderick, Ph.D.

seems to aggravate brown patch and the diseased area may become larger.

SCLEROTINIA

Sclerotinia homoeocarpa, a pathogen causing the disease known as dollarspot, is about the size of a silver dollar and has a white straw or bleached appearance. The small spots run together if the fungus is allowed to extend its infection, and the coalescing spots soon lose their original characteristic. Ormond bermuda is quite susceptible to dollarspot, but fortunately in Florida the use of nitrogen does an excellent job in reducing the disease. Usually dollarspot is not a problem on properly managed bermuda.

FAIRY RING

Fairy ring is usually associated with *Marasmius oreades, Agaricus campestris, Calvatia cyathiformis,* and *Lepiota morgani,* as well as numerous other species. These fairy rings are widely adapted throughout the world. Repeated heavy applications of phenyl mercuric acetate, captan, and other fungicides have been suggested as a control means. Deep aerification, fertilization and irrigation are practices which have helped the grass recover from this damage.

MULCHING GREENS AND TEES

Mulching of bermudagrass greens during the winter with clean straw, pine needles, or some other type of fiber is practiced to some extent. Either the course is closed or the golfers play on temporary winter greens. By mulching, the bermuda starts growth earlier and the greens are in solid bermuda turf sooner in the spring. Before the greens are covered with a mulch, they should be treated with an organic base mercury fungicide or some other fungicide that will keep the disease activity to a minimum. It is advisable to leave the mulch on the bermuda until danger of heavy frosts has passed.

If bermuda greens are not mulched or played, disease can still be a problem. It is advisable that the dormant bermuda be sprayed 2 to 3 times during the winter to keep disease attacks to a minimum.

Tees that are mulched could be handled in the same manner as the greens, except usually a portion of the tee is played and then sodded in the spring where the grass is worn out.

Mulching, when practiced in combination with adequate disease control, will provide very satisfactory turf during the growing season. The club must decide whether this "insurance" is worth the trouble and expense of alternate greens and tees during the winter months.

PUTTING GREEN CONSTRUCTION ASSISTANCE

Greens constructed according to procedures outlined by the USGA Green Section must have a seedbed that conforms to a rather narrow specified range of physical qualities. The tests for determining the mixture of your materials which will most nearly meet these requirements are available through the Green Section. Cost of the analysis is $10.00. Contact any Green Section office for further details. (*See inside front cover*).

The Golf Course at Bellerive

By **MARVIN H. FERGUSON,** Mid-Continent Director, USGA Green Section

The golf course of Bellerive Country Club in St. Louis, site of the Open Championship last month, is the youngest on which an Open has been played since World War II. Only a half dozen years ago what now is Bellerive was a farm.

Bellerive was built on a rolling piece of land, part of which could be characterized as upland and part lying along a creek which is still partially wooded. It is the kind of terrain upon which many interesting and challenging golf holes could be built. Such was the case at Bellerive. The noted golf course architect, Robert Trent Jones, made good use of terrain in forming a chain of holes each of which offers a different problem.

Bellerive's members enjoyed the advantage of living at one site while the new course was being built. Because the members could play a well-kept golf course at their former club site, there was no clamor to get the new course built and ready to play. This fact proved a decided advantage for A. "Gus" Schnatzmeyer, the golf course superintendent at that time. Schnatzmeyer and his crew anticipated the move and were able to develop excellent nurseries of planting stock of both grass and trees for the new site.

The greens at Bellerive are considerably larger than average, and are quite rolling in character. They were planted to a mixture of Arlington (C-1) and Congressional (C-19) bentgrass. This mechanical mixture of two distinct strains has worked quite well in the St. Louis area.

It is worth noting at this point that St. Louis is one of the most difficult spots in the United States to grow golf course turf. Its' summers with round-the-clock high temperature and high humidity day after day provide excellent growing conditions for pathogenic fungi and many weed pests. On the other hand these conditions cause bentgrass roots to become short and the turf is consequently subject to wilt.

In this kind of environment the sturdy wear resistant and disease resistant qualities of Arlington (C-1) bent become quite important. But Arlington bent alone is not satisfactory as a putting green turf. The color is not especially pleasing and the grass tends to swirl and become grainy. For this reason the addition of Congressional (C-19) benefits the putting surface. Congressional is a beautiful bentgrass with a pleasing color. It is relatively free of grain. Thus the mixture of the two selections provides a turf in which the good qualities of each grass tend to compensate for the weaknesses of the other.

Mixture of Bents

The late Bill Glover, builder and superintendent of the Fairfax Country Club (now a part of Army-Navy Country Club near Washington, D.C.) must be credited with discovering the advantages of mixing these two grasses. They have been the basis of good turf on many a putting green in such difficult areas as St. Louis and Washington. Strangely, there is probably not a single green in existence planted to one of these grasses without the other.

Fairways and tees offered a different problem at Bellerive. For many years bluegrass was the basis for fairway turf in St. Louis. It still exists on some St. Louis fairways and it offers a

great many advantages. Most golfers, however, want closely cut fairways. Because of the weather problems of the area and the demands for close cutting, bluegrass has trouble surviving. Bluegrass is at its weakest period at the time when crabgrass (sometimes facetiously called "St. Louis bent") is thriving. Consequently, a great many clubs have turned to bermudagrass for the solution to fairway problems.

Bermudagrass will tolerate the close mowing that golfers demand and it is not particularly affected by crabgrass because it too thrives in warm humid weather. When the new course at Bellerive was planted the green committee chose to use U-3 bermudagrass. It has proved to be a good choice. It has provided good playing conditions continuously.

U-3 bermudagrass is not, however, without its problems. In St. Louis bermudagrass is near its northern limit of adaptation. Often the difference in microclimate between a north and a south exposure on a slope can be equivalent to a distance of two or three hundred miles geographically. Therefore on some of Bellerive's north slopes, bermudagrass does well to survive.

Added to weather difficulties is the scourge of the disease known as *spring dead spot*. The causal agent of this malady is as yet undetermined. Annually, it causes large dead spots in bermuda turf. It apparently kills during the winter months when the bermudagrass is dormant. In spring these spots simply fail to grow. Hence the name spring dead spot.

In 1964, a new superintendent assumed the responsibilities of maintaining the Bellerive golf course. Mr. Schnatzmeyer's successor was Ernie Schneider, who had earned an excellent reputation as a manager of bermudagrass in Evansville, Ind. and Louisville, Ky.

In a little more than a year Schneider used his energetic and talented management abilities to polish and groom the Bellerive course to a point of excellent condition for the Open. But his troubles were numerous. He dealt with flooding on the lower part of the course; some greens were partially raised and recontoured. He experienced winterkill on some fairways and considerable areas of U-3 bermuda were replanted.

Several new tees were built, and Schneider's crew provided much of the labor for shaping and planting. Ponds were dredged out, new bridges built, the creek straightened and the abandoned creekbed was graded and planted. The bunkers were reworked and filled with new sand; areas along fairway edges were repaired and numerous

TURF BOOK AVAILABLE

The book "Turf Management," a popular educational printing of all matters pertaining to turf, is available at $10.95 per copy from the USGA, 40 East 38th Street, New York, N. Y. 10016; the USGA Green Section Regional Offices; the McGraw-Hill Book Co., 330 West 42nd Street, New York, N. Y. 10036, or at local bookstores.

"Turf Management" is a complete and authoritative book written by Professor H. Burton Musser and sponsored by the USGA. The author is Professor Emeritus of Agronomy at Pennsylvania State University.

erosion problems were checked.

In the conditioning, superintendent Schneider was aided by a green committee under the chairmanship of John Ferring, III which was dedicated to helping him get the job done. One member, Art Feuerbacher, manned the weed control spray rig and assumed the job of eliminating broadleaf weeds on the golf course.

The spectators and the golfers at the Open Championship may not have been overly aware of the excellence of the golf course, nor of the thought and the energy that were expended in grooming the turf. It is characteristic, and rightly so, that the golfer seldom gives a great deal of thought to the course condition unless it is poor and he finds himself disadvantaged even after playing a fine shot. The condition at Bellerive is such that a golfer seldom finds a bad lie if his shot does not stray.

Thanks to the green committee, the maintenance crew, and especially to Gus Schnatzmeyer and Ernie Schneider, Bellerive represents a remarkable achievement—the result of a very great and talented effort.

Greens—Some Observations

By **JAMES L. HOLMES,** Mid-Western Agronomist, USGA Green Section

It is becoming increasingly apparent that loss of turf on putting greens is becoming less of a problem yearly, as more technical data is made available and golf course superintendents develop superior maintenance skills. At most clubs in the Mid-West, members can expect adequate putting surfaces at all times during the playing season. We have progressed considerably in construction methods of putting greens including design, soils, technical abilities, and know-how in using the information we have.

As a result of information derived from sound research and continuous observations, reputable and knowledgeable architects and builders now insist upon constructing greens so that adequate surface and sub-surface drainage is assured at all times. This drainage includes both water and air. In order to assure proper drainage, the relationship between capillary, non-capillary and total pore space must be properly determined for each specific soil used. Where greens have been constructed with drainage principles protected, turf has developed well and observations indicate that it will be possible to maintain adequate putting surfaces at all times with a minimum of headaches. It has been determined that water infiltration rates between 1/2 and 1 inch per hour when the soil is compacted are optimal.

It is important to note that this infiltration rate must be assured even when soils are compacted. This is paramount because putting green compaction is an extremely serious problem and one which has caused the golf course superintendent considerable chagrin.

If one is to be assured of a proper infiltration rate or an infiltration rate which can be effectively controlled, a "perched" or "false" water table relationship is essential. In building to produce this phenomenon, one must be extremely careful that excess water is not held. If so, the infiltration principle is destroyed. Observations indicate that if one does not use the proper per-

centage of sandy materials, it is usually better to use no sand whatsoever; but rather simply to use the soil present and to construct greens so that surface drainage is assured. It has been observed repeatedly that greens built with native soils have produced excellent putting qualities for a number of years. Therefore, if the entire concept of the permeable soil construction is not followed — exactly — one is compelled to suggest that the native soil present on the building site be used.

Overwatering or water-saturated soil continues to be one of the most serious problems in maintaining greens which cannot or do not drain. If all the technical improvements currently known are incorporated when greens are constructed or rebuilt, this serious factor will become less of a problem. When one considers the tremendous amount of work done and equipment used to "aerate" green soils, he immediately becomes aware of the necessity for and lack of drainage—both air and water .

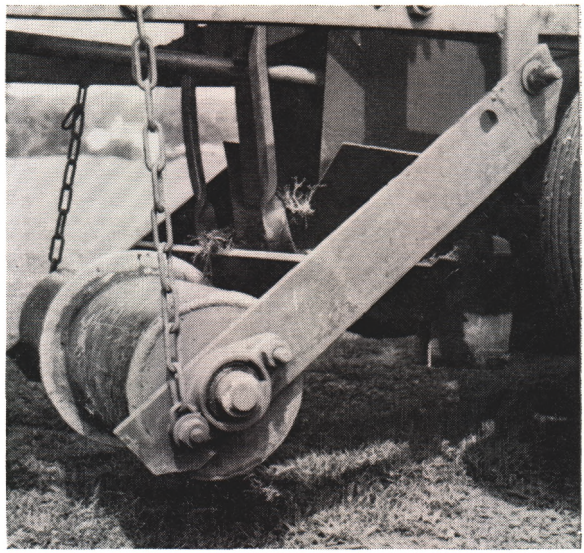
Developments in improved bentgrasses have been extremely slow since the results obtained from selections made in the "pie green" work sponsored by the Green Section in the late 1930s. At the present time the majority of grasses used for putting greens are still those developed in this testing work. Developments in this field are limited primarily to Penncross bentgrass. However, new selections such as Evansville are being released and it appears it is only a matter of time until superior bents are available.

Poa annua is the last serious weed problem in putting greens. Of course, there is always the question of whether *Poa annua* is a friend or foe. When one considers the severe damage done to *Poa annua* during the recent winters, this plant must be considered a foe on putting greens in the Mid-West. Presently, work is being accomplished in enzymatic control of various plants. Surely, it is only a matter of time until we can eradicate *Poa annua* without running the chance of seriously damaging desirable bentgrasses.

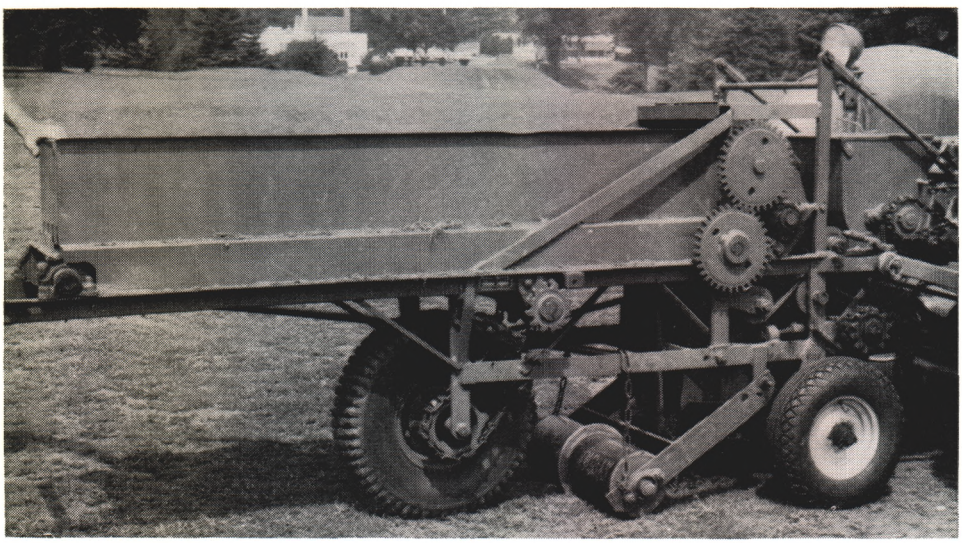
Many golf course superintendents continue to apply lead arsenate to putting surfaces in an effort to retard *Poa annua* vigor as well as grub and wormproof the soil. This appears to be excellent practice.

COMING EVENTS

July 8	Michigan Turfgrass Field Day Michigan State University East Lansing, Michigan
July 21	Turfgrass Field Day Texas A&M University College Station, Texas
August 12	Golf & Utility Turf Field Day Rutgers University New Brunswick, N. J.
August 16-17	Midwest Regional Turf Field Day Purdue University Lafayette, Ind.
August 25	Golf Course Supts. Field Day Rhode Island Agr. Experiment Station Kingston, R. I.
September 15-16	Penn State Turfgrass Field Day Pennsylvania State University University Park, Pa.



A modification on a mechanical bermudagrass sprig planter made by Marshall Farnham, Bala Golf Club, Philadelphia. Mr. Farnham credits Mr. Lee Dieter, Superintendent of Washington Golf & Country Club, Arlington, Va. for this innovation. A solid steel band is welded to the center of the roller which firmly tamps sprigs into the channel made by the modified plow share.



On The Research Front

Editor's Note: These are abstracts of papers prepared for the annual meetings of the American Society of Agronomy and published in "Agronomy Abstracts."

Soil Warming For Turf Areas

W. H. DANIEL and **J. R. BARRETT,**
Purdue University and United States Department of Agriculture, Agricultural Research

Investigations were begun in Indiana in 1962 to determine the fundamental requirements for installation and management of electric soil heating cable systems to maintain suitable growth conditions for turf in heavy-use areas. Bluegrass sod transplanted November 10 remained dormant on unheated soil, while root extension was 3-5 inches by December 31 on heated

areas. Warmed turf areas had improved playability and increased root growth during the winter, extended growth period in the fall, earlier growth in the spring, and in high wattage areas, growth throughout the winter. Plastic coverings over warmed areas reduced the electric energy required, maintained more greenness in leaf blades and favored growth. However, extra attention to remove and even replace covers to avoid excessively high temperatures and disease buildup was necessary. Heating cables varied from 4-8″ depth, 6-24″ in spacing, 0.8 to 13 watts/sq. ft. in intensity and controlled by thermostats located 1″ below sod, in the thatch, and in the air combinations. Plot size varied from 20 to 1200 sq. ft.

Factors In The Adaptation Of Turfgrasses To Heavy Shade

J. B. BEARD, Michigan State University

Seven grasses in 18 mixtures were studied under heavy shade (5% of incident sunlight) provided by mature maple trees. The area received only natural rainfall, was cut at a 2-inch height, and received 2% of nitrogen per 1,000 square feet per year. Three years results show disease incidence to be the major factor influencing adaptation. Powdery mildew (*Erysiphe graminis*) infection of common and Merion Kentucky bluegrasses resulted in 98% loss of stand with no recovery in subsequent years. Pennlawn red fescue showed a 90% reduction in stand due to leafspot (*Helminthosporium sativium*) but exhibited over 50% recovery the subsequent spring. However, each year reinfection occurred with the advent of warmer weather. Kentucky 31 tall fescue, common perennial ryegrass and Norlea ryegrass performed poorly due to snow mold (Typhula spp.) and low temperature injury during the winter period. Roughstalk bluegrass produced an acceptable turf for two summers but was severely thinned by disease in the third year which correlated with thatch accumulation. The higher humidities, extended dew periods and more succulent growth in shade resulted in disease being a more important factor in adaptation that light intensity or moisture.

Effect Of Nitrogen On Organic Food Reserves And Some Physiological Responses Of Bentgrass And Bermudagrass Grown In Various Temperatures

R. E. BLASER and **R. E. SCHMIDT,** Virginia Polytechnic Institute

Bermudagrass and bentgrass were grown 45 days at 50, 70, and 90°F. with high and low N fertility. Total and protein N were highest in bermuda at 50 and 70° F. and in bent at 90° F. Bermuda rhizomes subjected to 50° F. were higher in acid extractable carbohydrate ((AEC) than those at higher temperatures. Bent stolons and leaf AEC decreased as temperatures increased. The ethanol extractable portion of AEC was greater in bent than in bermuda. Clipping weights increased with temperature, especially with bermuda. Yield of bent roots increased as temperature decreased. Bermuda roots developed best at 70° F. and poorest at 50° F. Net assimilation rate was largest at 70° F. for both grasses and smallest at 50 and 90° F. for bermuda and bent, respectively. High N rate increased respiration, net assimilation rate, clipping weights, and total and protein N, but decreased root weights and reserve carbohydrates.

USGA GREEN SECTION RECORD
40 East 38th Street, New York, N. Y. 10016

TURF TWISTERS

PRE-EMERGENCE HERBICIDES

Question: We have used a pre-emergence herbicide on our greens and the turf is suffering. Did we do something wrong? How do we treat the turf? (ILLINOIS and TEXAS)

Answer: Many of the pre-emergence herbicides have been used experimentally with very good results. However, you may have noticed that good investigators nearly always qualify their reports by saying something like "at this location and under the conditions which prevailed when these tests were conducted, these were the results."

It is a good idea to check new products on *your* turf, using *your* equipment, and *your* methods. A nursery area or a practice green is a good spot for trying new products.

There probably is little you can do now. Don't take any drastic measures. Water as carefully as possible to prevent wilting. Distribute traffic as much as possible. Give the grass plants time to recover from the shock. Before next season, do some more experimenting to determine whether there is a safe rate and method of application for your turf.

UNIFORM IRRIGATION

Question: Our irrigation system is not doing a good job. Around each riser we have a wet area. Then there is a dry circle. Out near the perimeter of the sprinkler pattern there is another wet ring. Do we have the wrong kind of sprinklers? (ARIZONA)

Answer: It would appear that the nozzle of your sprinkler is not breaking up the stream effectively. Your water pressure may have dropped since this size sprinkler was installed. Experiment with slightly smaller nozzles. Set out coffee cans about every 5 feet from the sprinkler to the edge of the pattern. The amount of water collected in each can will give you an indication of the degree of uniformity you are achieving.

When you use smaller nozzles, you may reduce the diameter of your pattern. Be sure you are still getting sufficient overlapping of the individual sprinkler coverages to insure the application of adequate moisture over the whole area.