AN INDEPENDENT NEWSLETTER FOR TURF MANAGERS

Turf Grass TRENDS

[Vol. 3]
~~Volume 4~~, Issue 6

June 1994

Rhizoctonia diseases

Brown patch and its cousins

by Christopher Sann

Photo provided by Dr. Eric B. Nelson, Cornell University

Rhizoctonia cerealis or winter brown patch.

R*hizoctonia* diseases are perhaps the most studied of all of the diseases that produce symptoms of managed turfgrass. Managers have been dealing with the effects of *Rhizoctonia* infestations for almost as long as they have been managing turfgrass.

The symptoms were first described in scientific literature in 1913 and the pathogen, *Rhizoctonia solani Kuhn*, was first identified in 1914 by C.D. Piper, a research scientist with the USDA and also director of the USGA Greens Section. In 1916-1917 Piper conducted a study that proved that *Rhizoctonia solani* was the pathogen for what had become known as "large brown patch." In 1917, Bordeaux mix was the first fungicide found to be effective at controlling *Rhizoctonia solani* and by the early 1920's was in wide use on golf courses.

Brown patch and its cousins

Until the early 1980's, *Rhizoctonia solani* was considered to be the only member of a genus of several dozen fungal species that caused brown patch symptoms on turf, but since then at least three other *Rhizoctonia* species have been identified that cause brown patch on as many as 13 different turfgrass species. These additional *Rhizoctonia* species are *Rhizoctonia zeae, R. oryzae, and R. cerealis* (See photo above).

Further studies have more correctly classified these *Rhizoctonia* species as properly belonging to several other different genera when the teleomorph, or sexual stages, were found and identified. For ease of this discussion and familiarity with the common name, *Rhizoctonia*, will be used.

Below are the accepted or popular names and the correct taxonomic names:

Popular name	Taxonomic name
Rhizoctonia solani	*Thanatephorus cucumeris*
R. zeae	*Waitea circinata*
R. oryzae	*Waitea circinata*
R. cerealis	*Epulorhiza spp.*

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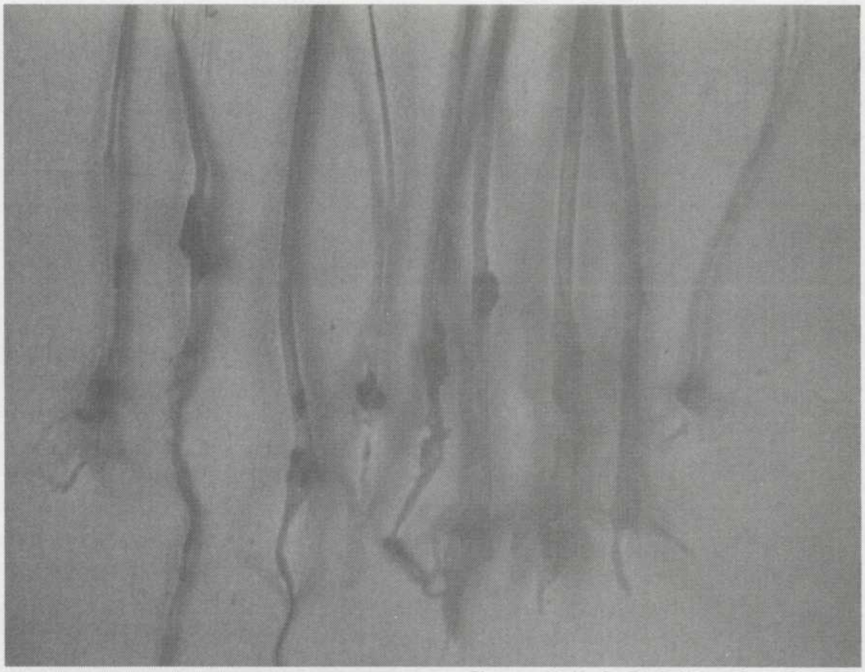


Rhizoctonia sclerotia on Astoria bentgrass. Photo provided by Dr. Eric B. Nelson, Cornell University

Morphology

The four identified *Rhizoctonia* species active on turfgrasses are very similar in morphology, i.e. size, shape, color, etc. As a group, they:

- do not have conidia (small multicellular spores that spread the pathogen to new hosts)
- have mycelium or hyphae (as their sole means of spreading) that do not have clamp connections or rhizomorphs
- usually have sclerotia (as resting bodies or survival mechanisms for periods that do not favor their growth) (See photo above).

However, within this group they can be further classified as either binucleate or multinucleate—meaning that the number of cell nuclei that are present in the vegetative hyphae growth stages is either two or greater than two. *Rhizoctonia solani, R. oryzae, R. zeae* have more than two nuclei per hyphae cell and are considered multinucleate, whereas *R. cerealis* has only two nuclei per cell and are considered binucleate.

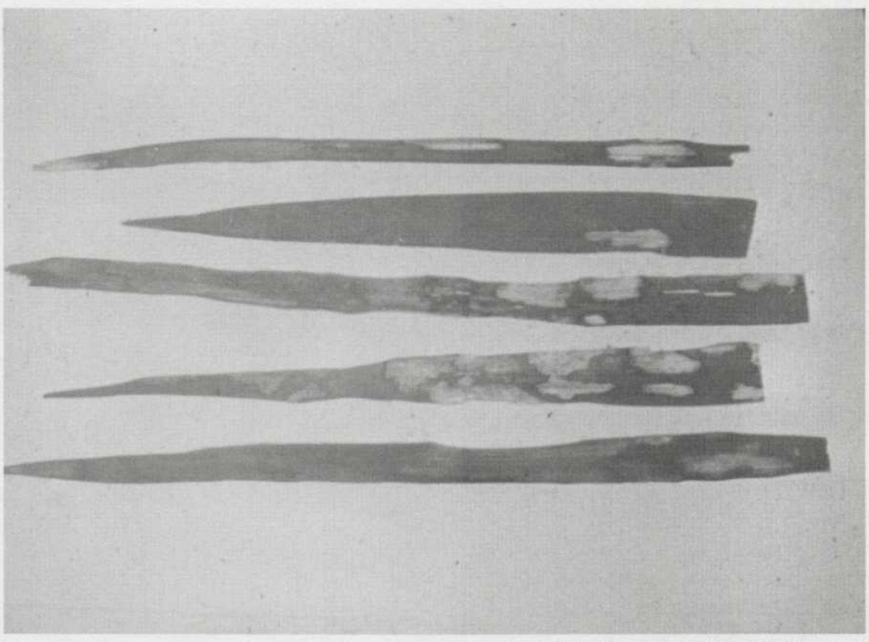
Conditions that favor growth

The environmental conditions that favor *Rhizoctonia* growth are high humidity and warm air temperatures. Recent research at the University of Nebraska-Lincoln on the effects of the turfgrass canopy structure on *Rhizoctonia* growth has shown that there appears to be a minimum threshold canopy humidity level required for the initiation and continued growth of *Rhizoctonia solani,* but variation of the humidity levels above that threshold have little effect on the severity of the infection.

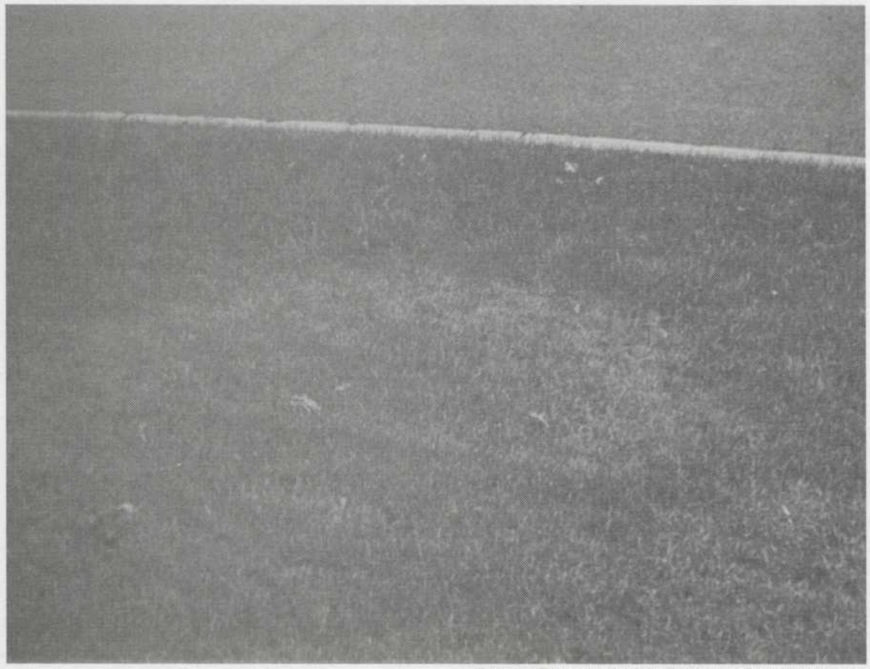
Unlike humidity, varying temperatures do play a significant role in infection and disease expression. The four *Rhizoctonia spp.* are active over several different temperature ranges and have been identified as causing at least four turfgrass disease symptoms: brown patch, yellow patch, and leaf and sheath spot (See photo below). Table 1 on page 3 lists the pathogen's common name, the nuclear condition, the turfgrass disease that it causes, and its temperature growth range.

Shade plays a role

Recent studies at the University of Arkansas indicate shade can also influence disease severity. In those studies several varieties of tall fescue grown at shaded sites showed a significant increase in disease versus the same varieties grown in full sun (See photo on page 3.). This 1993 study found that disease severity increased by an average of more



Rhizoctonia leaf spot. Photo provided by Dr. Eric B. Nelson, Cornell University than 55% at shaded sites versus full sun sites. However, the investigators concluded that this increase in disease was a function of the physiological changes that increased shade had caused in the turf and was not a function of special environmental conditions found at the shaded sites.


Brown patch on tall fescue. Photo provided by Dr. Eric B. Nelson, Cornell University

Fungus ranges from Canada to Mexico

Rhizoctonia species are widespread and can be found in almost any region of the country. Both cool- and warm-season grasses can serve as hosts.

Rhizoctonia solani can be found in both temperate and tropical regions of the world. The wide temperature range for this species produces excellent growing conditions during the summer months in Canada and the winter months in Mexico with the areas in between subject to outbreaks from spring through early fall. On cool-season grasses, *Rhizoctonia solani* is most commonly found during humid, warm summer periods when temperatures exceed 77 F (25 C). The infection begins when air temperatures reach 70 F (See top photo on page 5.). It can become extensive if leaves remain wet continuously for periods of 36 to 48 hours and temperatures rise into the mid-70's F. It can be severe for leaf wetness periods of as little as 8 to 12 hours at temperatures in the mid-80's F. On warm-season turf, *Rhizoctonia solani* occurs primarily in the spring and fall when temperatures are between 77 F and 85 F (25 C and 30 C).

The hot weather species, *R. oryzae* and *R. zeae*, are more commonly found in the southern half of the cool-season turfgrass range and throughout the warm-season turfgrass range. On all turf, *R. oryzae* and *R. zeae* are active predominately in the summer months at temperatures at or above 90 F (32 C).

The cooler season species, *R. cerealis*, ranges from the northern part of the warm-season turfgrass range to southern Canada. On cool-season turf, *R. cerealis* is active during the spring and fall months at temperatures approaching 65 F (18 C). However, it is primarily a problem in the prolonged cool wet weather of the fall when the temperature is between 53 and 68 F (10 and 20 C). On warm-season turf *R. cerealis* may be active during warmer periods of winter.

Table 1
Properties of Rhizoctonia species

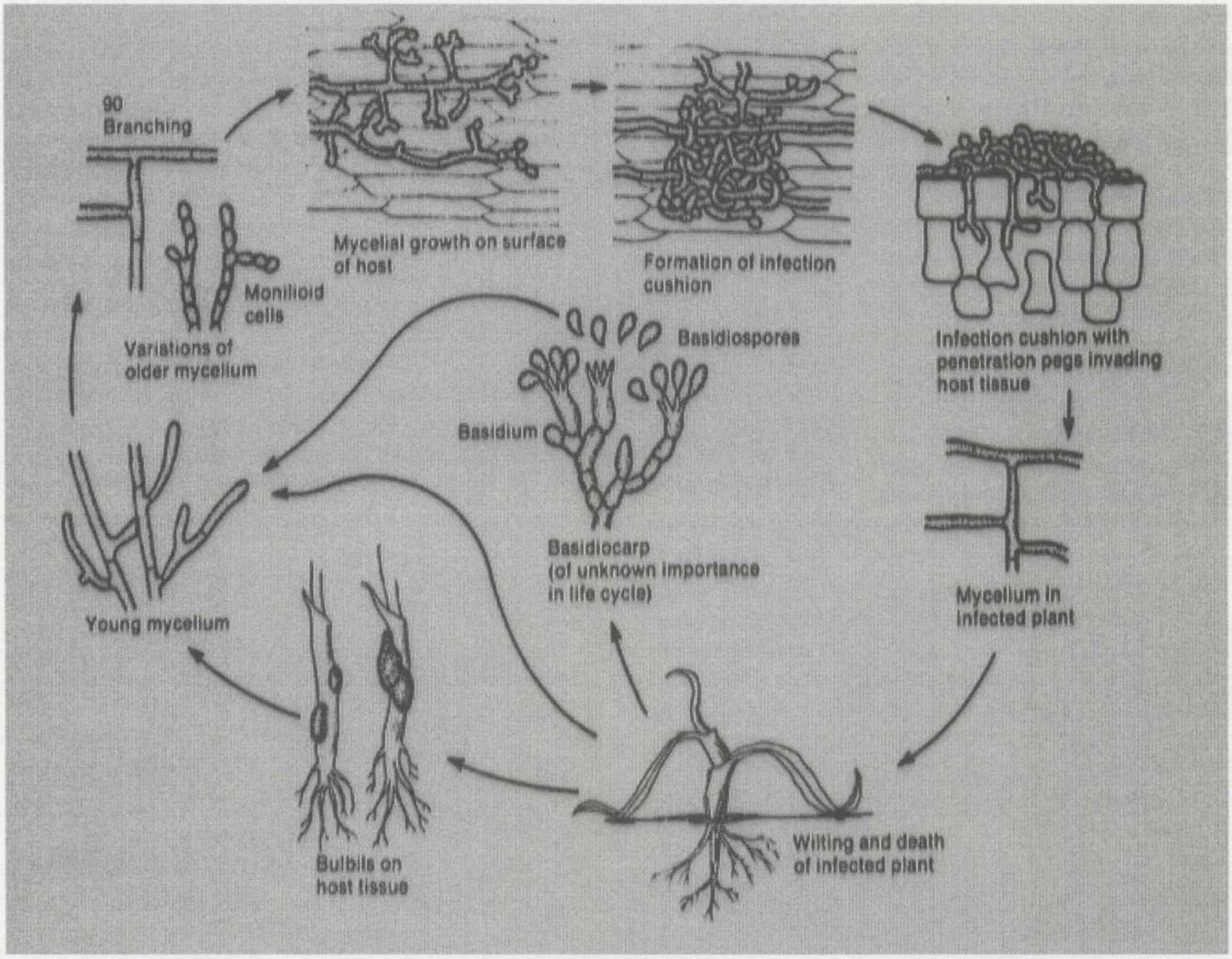
Pathogen	**Disease**	**Nuclei**	**Growth Range**
Rhizoctonia solani	brown patch	multinucleate	64-83 F (18-28 C)
R. cerealis	yellow patch	binucleate	73 F (23 C)
R. oryzae	leaf spot	multinucleate	90 F (32 C) sheath spot
R. zeae	leaf spot	multinucleate	90 F (32 C) sheath spot

Disease symptoms

Large-scale, easily-seen *Rhizoctonia* disease symptoms will vary depending on the host infected, the cutting height, and the level of management. Under wet conditions on closely-mowed, less than half-inch inch, dense, highly maintained cool-season hosts, i.e., bentgrass, bluegrass, ryegrass, and fine fescue, *Rhizoctonia solani* may produce a blue-gray ring of mycelium and diseased grass blades often referred to as a "smoke ring" (See bottom photo on page 5.). This "smoke ring" is seen at the actively growing edges of brown patches or circles of affected turf. Developing patches can range in size from a few inches to larger than three feet.

This "smoke ring" effect is actually a combination of the leaf tips rapidly dying back with a dense mycelial layer directly below. The necrotic leaf tips are blue-purple to black in color and the underlying mycelial mat is light brown to gray. The two combine to produce the "smoke ring". However, this diagnostic "smoke ring" can be very transitory and is often the exception rather than the rule. It can be most readily observed early in the morning when the turf is still covered with dew.

At turf heights of more than two inches and at lower leaf densities of homeowner or commercially maintained turf, the "smoke ring" is rarely seen. The reduced leaf density of the taller cut probably eliminates the development of the underlying mycelial growth connected with the ring. On warm-season turf, *Rhizoctonia spp.* combine extensive foliar damage with leaf sheath infections that may cover several square yards. Extensive infestations under prolonged warm and humid conditions can yield patches as large as 20 feet in diameter.



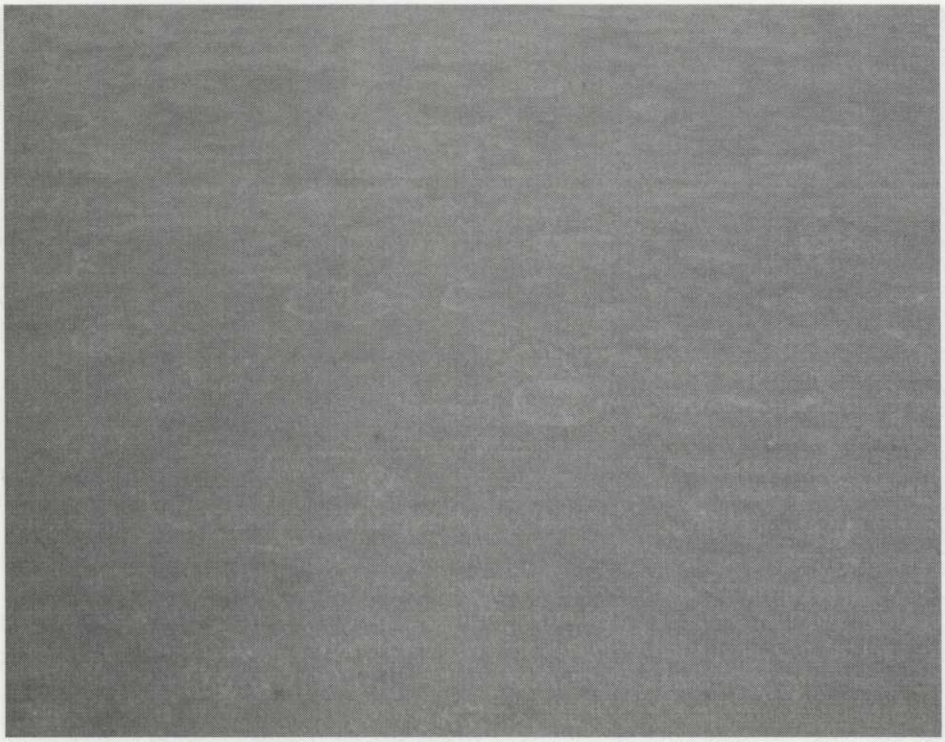
Rhizoctonia life cycle

Figure provided by Dr. Eric B. Nelson, Cornell University

Foliar symptoms

On cool-season turf, maintained as home or commercial lawns, the most common leaf blade symptoms are irregular lesions, silver to brown in color, with a thin dark brown border. This symptom is very common on tall fescue and often will include at least one leaf edge. On bluegrass and bentgrass, the lesion is often light brown with a darker border (See top photo on page 6.). It encompasses the leaf tip working its way down the leaf tip. On fine fescues the lesion will encompass the leaf blade, edge to edge. It is similar to Dollar Spot but there will be dark borders or necrotic tissue between the affected and the uninfected area.

Previously uninfected leaves of these hosts may show small newly infected spots where the mycelial growth from an adjacent infected leaf has contacted and infected this new leaf. Since *Rhizoctonia spp.* do not have conidia, the only means of spreading the disease is through vegetative hyphae or mycelia growth. As more leaves become infected and more hyphae are produced, the brown and yellow patches begin to appear.



Cool-season Rhizoctonia cerealis or yellow patch. Photo provided by Dr. Eric B. Nelson, Cornell University

sheath or in dead leaf tissue at or near the crown of the host plant. The germination takes place under moist conditions at temperatures that generally range from 50 to 68 F (10 to 20 C). Studies of sclerotial germination temperatures have found that they can germinate over a wide temperature range of from 43 to 86 F (6 to 30 C).

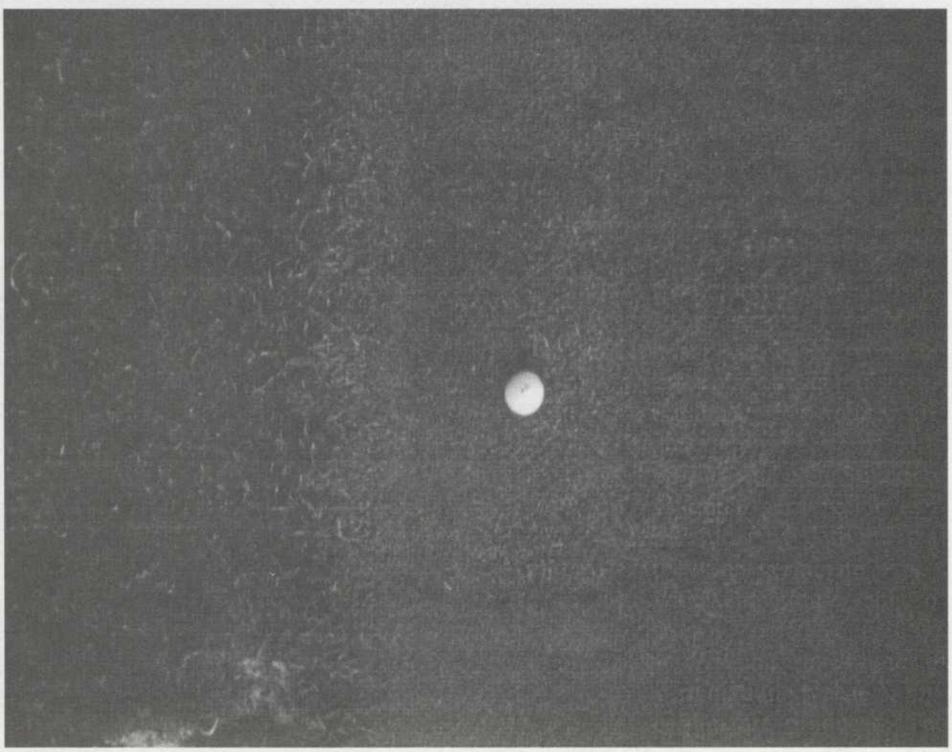
Within 12 to 24 hours of germination, hyphae or mycelium are produced. The mycelium grow at a rate of from 1/8 to 1/5 inch (3.4 to 5.0 mm) per day. These runner hyphae grow along the leaf surface where infection cushions are formed of aggregations of hyphael branches (See photo on page 6.).

Penetration pegs develop from these infection structures. These pegs enter the leaf at the stomata or penetrate the cuticle on the outside of the leaf and enter the spaces between the cells of the leaf. Although the process by which this penetration is accomplished has yet to be determined, it is probably achieved by force or the

These hyphae can be a particularly effective means of disseminating the pathogen. Pathogens that spread by means of conidia often require that the leaf be wet for the disease to establish on uninfected leaves. Unlike these pathogens which often show a considerable amount of variation in strain virulence, tests conducted to determine the virulence of different isolates of the four *Rhizoctonia spp.* of turfgrass collected from multiple sites have found them to be quite virulent and effective at producing disease symptoms. Under the right conditions a newly infected site can begin to produce infective mycelium in as little as 12 to 24 hours. This rapid production combined with the high hyphael growth rates produces an infection that can spread at a rapid rate for foliar diseases.

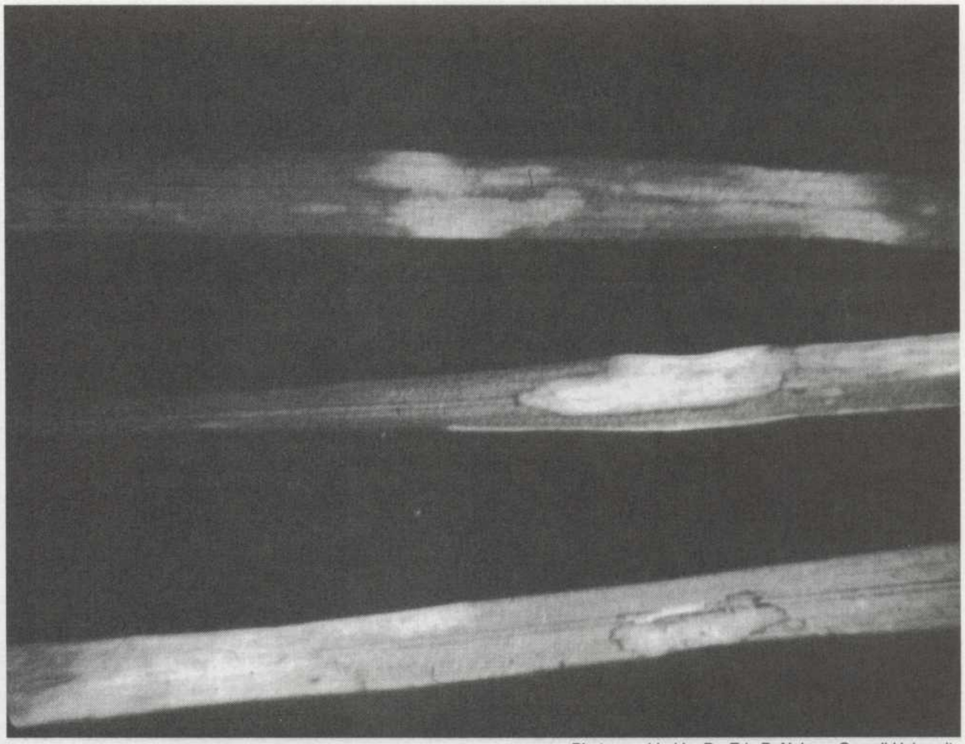
Biology of an infection

A simple, single-point infection begins with the germination of a sclerotia, or resting body, in a leaf



Brown patch "smoke ring." Photo provided by Dr. Eric B. Nelson, Cornell University action of enzymes attacking the plant tissues.

Once within the plant, colonization of the host is accomplished by two means: intercellular and intracellular hyphael growth. As these hyphae grow they cause the tissue damage or necrosis of the internal structures of the leaf and to cell walls by the dissolving action of exuded enzymes. The resulting breakdown compounds are utilized by the fungus to produce additional fungal growth structures, such as hyphae and sclerotia.



Rhizoctonia lesions on Kentucky Bluegrass Photo provided by Dr. Eric B. Nelson, Cornell University

As the leaf becomes colonized, additional hyphae are produced on the outside of the leaf usually at the penetration sites or lesions and they are subsequently infect adjacent leaves. These newly infected leaves become additional infection sources within 12 to 24 hours. In this manner *Rhizoctonia* infections grow outward to involve an ever-increasing number of plants covering an ever-increasing area.

If followed to its logical end, this disease with its ever-widening area of infection should be able to account for the size of the disease patches that are commonly seen by turfgrass managers. It does not. The mathematics of the single-site infestation described above argue against the development of large disease patches at either cool- or warm-season sites. Although the hyphae growth rate of the *Rhizoctonia spp.* is considered to be rapid by fungal standards, it alone cannot explain the rapid appearance of very large patches, — 3 to 20 feet in diameter — commonly seen in the field (See photo on page 7.). Large-scale site damage of this magnitude must be the product of simultaneous, multiple site germinations rather than long-lived, single infection site expansion. Hundreds to thousands of sclerotia from previous infections will germinate under the proper circumstances at the same time and combine to blight large areas of turf.

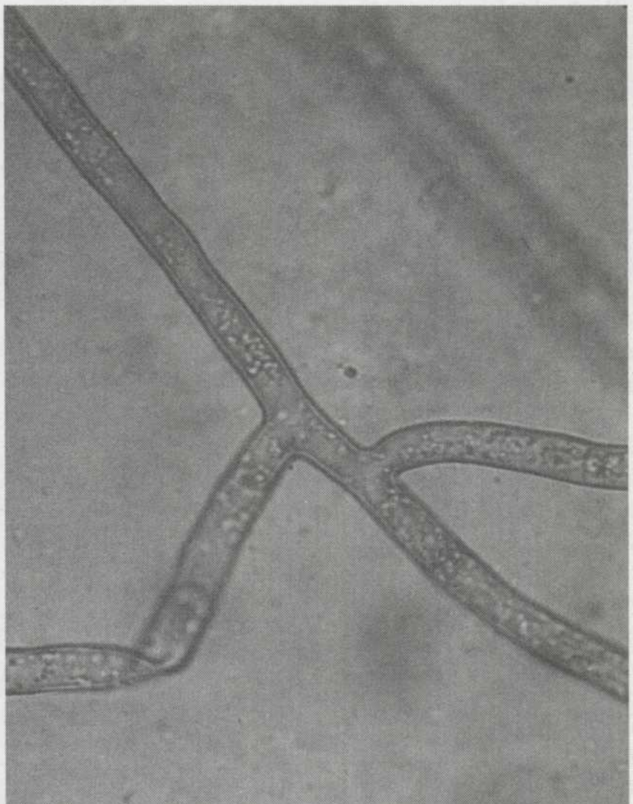


Photo provided by Dr. Eric B. Nelson, Cornell University

A right-angle hyphael branch of Rhizoctonia.

Infections don't always show symptoms

Recent greenhouse tests of sclerotial germination found that as many as 25 generations can develop in a nine month period. That means a new generation every four days on average. This rapid ability to establish new generations means that this pathogen can survive with only short periods of favorable weather, two to three days, and can be available to actively reinfect the site within a matter of hours. This fact combined with the wide germination range for sclerotia means that low level, non-symptomatic infections can occur for most of the turf growing

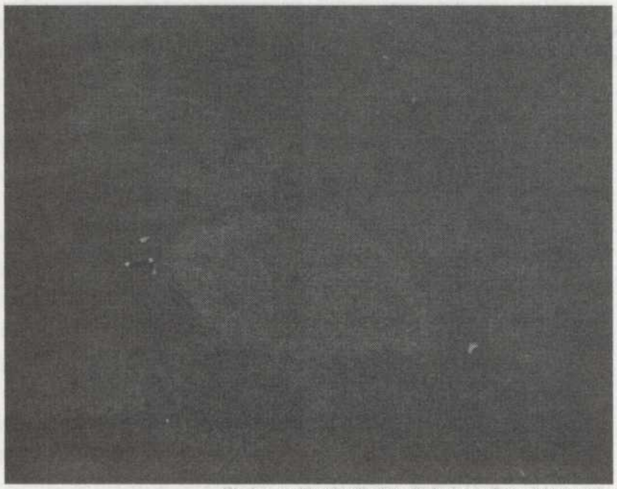


Photo provided by Dr. Eric B. Nelson, Cornell University

Large brown patches many feet in diameter.

season. This in turn can lead to the large-scale site damage that occurs in the field, when the host is stressed or compromised and the environmental conditions are optimum for extended periods.

Rhizoctonia bears close watching

Rhizoctonia diseases are a constant problem at closely cut, highly managed turf sites, particularly when the turf is stressed. At sites with taller turf they can be an occasional problem. But at either site their appearance can be rapid and unexpected with large areas of damage developing in a short period of time. Current management practices and applications of a fungicide at the earliest appearance of symptoms is the most effective means of controlling this disease as alternative control strategies are just beginning to be formulated. ■

Texas A & M study

Air, canopy and soil temperature relationships

A recent study at Texas A&M University of different turfgrass species' ability to tolerate prolonged periods of high heat produced data that showed the relationship between air, canopy and soil temperatures. The table lists the species, the air temperatures and the corresponding average canopy and soil temperatures.

TGT's view: Not surprisingly, fine fescues tolerated the high temperatures better than the other species. Even better than tall fescue that are supposed to tolerate heat.

Beyond species heat tolerance, soil temperatures at a three inch depth were consistently about 85% of the air temperatures, while canopy temperatures averaged about 94% of air temperatures with the very high heat averaging less.

This information about the relationship between air, canopy, and soil temperatures is important. Turfgrass managers with existing root damaging disease histories, such as Summer Patch and Takeall Patch, can use the 85% of air relationship to keep an eye track of the growth temperature ranges by monitoring air temperatures. Foliar diseases, such as Dollar Spot and Brown Patch, can be monitored by keeping track of canopy temperatures using the 94% relationship. Keep in mind that these figures are approximate and should be used as such when making control decisions. -CS

Species	**Air temp.**	**Canopy temp.***	**% Air temp.**	**Soil temp.****	**% Air temp.**
Bluegrasses	91 F. (33 C.)	93 F. (33.8 C.)	102	78 F. (25.4 C.)	86
Bentgrasses	" "	93 F. (33.6 C.)	102	77 F. (24.9 C.)	85
f. fescues	" "	89 F. (31.5 C.)	98	76 F. (24.5 C.)	84
t. fescues	" "	90 F. (31.9 C.)	99	76 F. (24.5 C.)	84
Ryegrasses	" "	92 F. (33.7 C.)	101	79 F. (26.0 C.)	87
Bluegrasses	110 F. (43 C.)	95 F. (35.2 C.)	86	90 F. (32.0 C.)	82
Bentgrasses	" "	100 F. (37.8 C.)	91	93 F. (33.9 C.)	85
f. fescues	" "	94 F. (34.2 C.)	85	95 F. (34.7 C.)	86
t. fescues	" "	98 F. (31.9 C.)	89	88 F. (31.3 C.)	80
Ryegrasses	" "	93 F. (34.1 C.)	85	91 F. (32.9 C.)	83

* measured using inferred thermometer

Brown patch - a different perspective

by Christopher Sann

Unlike many other turfgrass diseases, brown patch seems to stubbornly resist the many attempts to expand effective control strategies, other than the treatment with fungicides. The many other cultural and management practices used to control the severity of other foliar turfgrass diseases have not proven to be successful. Perhaps some of this is due more to a failure to understand the biology of the disease.

The common perception among turfgrass managers, that brown patch is a very common disease similar to other turfgrass diseases only more difficult to control, is a conclusion based on their observed experiences and is inaccurate. To be sure, *Rhizoctonia solani* is a difficult pathogen to control, but the idea that it is analogous to the other common diseases, such as leaf spot, is not correct. Actually *Rhizoctonia solani* is analogous to grey snow mold in its biology and to the root-damaging pathogens in the timing and expression of symptoms.

Dr. Gary Yuen and his associates at the University of Nebraska have recently released the results of several studies of the biology of *Rhizoctonia solani* on stands of tall fescue. These studies examined various aspects of the specific biology of *Rhizoctonia solani* and how the mechanical structure of a host contributed to the development and expression of disease symptoms. Dr. Yuen's work was primarily focused on four areas:

- Investigation of the correlation between observed laboratory resistance in several tall fescue varieties and actual field resistance of those varieties to *Rhizoctonia solani*
- The influence of the turfgrass canopy's structure and environment on the spread of *Rhizoctonia solani*
- The distribution of *Rhizoctonia solani* in asymptomatic portions of turfgrass stands at or near infection locations
- The possible biological control of *Rhizoctonia solani* using fungal antagonists.

Dr. Yuen's findings, particularly on the role of the canopy structure in the spread of the disease, should begin to provide a sharper picture of the biology of *Rhizoctonia solani* on turfgrasses and may lead to new strategies for dealing with this pathogen.

Laboratory versus field resistance

For many of the diseases of turfgrass there has been an assumed correlation between the measured genetic resistance of a turfgrass variety to a pathogen and subsequent resistance of that variety to the same pathogen in the field.

Table 1

How genetic and field resistance relate

Cultivar	% Blighted (genetic)	Rank	% Blighted (field)	Rank
K-31	18%	1	34%	1
Monarch	30	2	46	4
Apache	37	3	52	7
Silverado	38	4	44	3
Pacer	40	5	52	8
Trailblazer	40	6	60	9
Wrangler	42	7	48	6
Tribute	42	8	43	2
Rebell II	50	9	48	5

This was not the case for the *Rhizoctonia solani* infestations of the six varieties of tall fescue that Dr. Yuen studied in 1993.

In one study, three of the six varieties of tall fescue that were raised in growth chambers were identified as having genetic resistance to *Rhizoctonia solani,* while the other three did not. When these varieties were placed in the field plots and the plots were inoculated with *Rhizoctonia solani,* the six varieties did not show results that correlated to the results from the growth chamber testing. For example, in the field, the most resistant variety of tall fescue had previously been classified as susceptible and the second most susceptible variety had been considered to be a resistant variety.

Table 1 shows the results of another study and the relationship between the genetic resistance and the field resistance of nine tall fescue varieties.

Leaf density is correlated to disease severity

Since tissue resistance to *Rhizoctonia solani* did not strongly correlate (only a 30% to 40% correlation was found) to the actual field resistance, the researchers looked for additional factors. Dr.Yuen found that there is a strong (70% to 80%) correlation between a narrow leaf blade width with its subsequent higher leaf densities and increased *Rhizoctonia solani* disease severity in tall fescue.

A 1994 study found that the varieties with the lowest weight per leaf (narrowest) had the highest levels of disease and the varieties with the highest weight per leaf (widest) had the least amount of disease. Table 2 lists the same cultivars as Table 1 with the average weight per each leaf and the disease severity for that cultivar.

The data from a second study of seeding density and disease development more graphically demonstrated the very high correlation between blade density and disease severity. The tall fescue cultivar "Fawn", previously identified as being very susceptible to *Rhizoctonia solani* infection, was seeded at three different seeding rates: 10, 30, and 50 grams per square meter. The seeded plots were inoculated, and then evaluated for average lesion ratings over a one-month period beginning 20 days after inoculation. Over the period of the study, the average number of leaves increased 63% as the seeding rate increased from 10 to 30 grams, while the lesion rating (disease severity) increased 56%. The number of leaves increased 21% as the seeding rate increased from 30 to 50 grams and the lesion rating increased 29%.

Table 2

Leaf weights and disease severity

Cultivar	Rank*	Rating**	Rank	Weight***	Rank
K-31	1	3.4	1	.0123	1
Tribute	2	5.3	6	.0083	4
Silverado	3	5.0	4	.0075	6
Monarch	4	5.6	8	.0076	5
Rebell II	5	4.9	2	.0074	8
Wrangler	6	5.4	7	.0066	9
Apache	7	5.3	5	.0084	3
Pacer	8	5.0	3	.0089	2
Trailblazer	9	6.1	9	.0074	7

* Ranking based on % blighted, field ranking from Table 1
** Rating 0-10, 0 = no lesions, 10 = most lesions
*** in grams (verdue weight/# of leaves = leaf weight), ranked greater to lesser
(Authors note: Table 2 is the result of calculations made by the author, using Dr. Yuen's data.)

Logically, the leaf to leaf transfer of the vegetative or hyphael matter that occurs with this and other *Rhizoctonia* pathogens of turf would be substantially enhanced by the increases in stand density that often come from narrower leaf blades. When the number of potential food sources, the leaves, per given area is increased by as much as a factor of one, by going from the wider leaf blades of older cultivars to narrower leaf blades of the newer varieties, then the potential for contacts between infected leaves and uninfected leaves, caused by wind or mechanical means, will dramatically increase and hence the potential for disease spread will dramatically increase.

The increased tendency of the newer hybrid tall fescue varieties to suffer from increased levels of *Rhizoctonia solani* had been observed by turfgrass managers and has been the subject of a number of complaints.

Dr. Yuen's identification of this purely mechanical method of disease movement for *Rhizoctonia solani* opens up the possibility that other non-biological factors can play significant roles in the spread of this and other diseases within the turfgrass canopy and that these factors are contributing to greater disease severity. Similar field observations for other diseases and hosts, such as the aforementioned increased incidence of *Rhizoctonia solani* infestations in newer cultivars of tall fescue, should lead to a thorough examination of other turfgrass diseases, their host's structure, and an examination of the effects of these non-biological factors on the course of symptom development.

Dr. Yuen said that this information also raises the strong possibility that future field studies to identify disease resistance for *Rhizoctonia solani* and other diseases in the many turfgrass varietal trials that are conducted will require that stands be of equal leaf densities prior to being rated for field disease resistance so that the varieties can be rated on an equal basis.

The asymptomatic distribution of R. solani

Dr. Yuen also studied the distribution of the *Rhizoctonia solani* pathogen on the leaves, in the thatch, and on the roots of asymptomatic bentgrass turf collected from areas immediately adjacent to infected locations.

The study, which used two methods of identifying the pathogen, established that the pathogen could be found in significant numbers and on a consistent basis on the leaves of asymptomatic bentgrass turf for a distance of up to 12

-continued on page 15

Poa to bentgrass

A successful fairway conversion program

by Richard Bator

This will be the first of two articles dealing with the conversion of fairways from poa to bentgrass at the Merion Golf Club in Ardmore, Pennsylvania, during the 1990 golf season while I was golf course superintendent.

This article and its accompanying sidebar will deal with my opening comments, the selling of the program to my greens chairman, the grounds committee, the board and finally membership. It will also deal with the extreme importance of researching the subject, the necessity to plan and organize every detail on paper and lastly, key areas of concern to incorporate into the program.

The second article will deal with the 16-step procedure, a list of equipment, and the corresponding staff job assignments. I will also list the observation on what I would do differently to improve the procedure. I will also outline what procedures are needed to be substituted, if one is to successfully convert from Bermuda-Ryegrass to Bentgrass in the transition zone. Finally, I will briefly give my views on the fumigation of greens prior to the conversion from Poa to Bentgrass.

Nothing new under the sun

My procedures are not new, different or necessarily better than another superintendent's, but for me they were successful. Any program can be improved upon and it is my hope that anyone who reads about my experience and who undertakes such a program should strive to seek a better way to fit his needs and course.

Another point to be stressed is that 100% poa control will not be attained. But, with a good initial conversion program and a fine-tuned bent management program, there is no reason why an 80% to 95% bent population cannot be achieved in the long term.

Two key factors: communication & research

I cannot stress enough the two basic factors that will lead to success. First, sell the greens chairman, committee and membership. This can only be achieved through exhaustive research on the subject after which time the information and choice is presented in person, first to the greens chairman and his committee and secondly to the board and membership in a membership meeting, as well as through a newsletter sent to the entire membership.

The key word is "informed". This should be carried out in such a manner that all information to the membership leaves no doubt in their minds that the program will succeed. A strong-willed greens chairman and committee is a must in order to sell the program to the membership. Sell the greens chairman and his committee and the membership will probably follow. The fact that the greens chairman at Merion was far sighted and strong in leadership made selling the program to the membership that much easier.

Before you begin

Course preparation

by Richard Bator

It would be wise to correct all surface and subsurface drainage problems prior to the undertaking of such a conversion program. With the use of the herbicide, Pro-Grass, this is imperative, as Pro-Grass tends to give an extremely quick kill of poa and native bents in extremely wet soils. Correcting drainage problems would also be necessary while employing any other type of conversion methods or chemicals.

At Merion, due to a lack of time, we made some drainage improvements prior to the program, with the majority being completed one to three years after its inception. Again, course preparation is much more beneficial to the overall success of the program than trying to fix things later.

For the same reasons, light diffusion and air drainage problems through tree removal, limb pruning, the cutting in of light windows and root pruning should also be completed prior to the start of the program.

At Merion these problems were corrected by initiating a three-year tree improvement program.

Water and air drainage and light diffusion are extremely critical to the success of the program, and if they are not undertaken and completed, one might not as well attempt such a conversion program, as only partial success will be achieved.

I liken this to rebuilding a green that exists in a heavily wooded and poorly drained area. If the underlying problems causing the poor condition of the green are not corrected, rebuilding the green would be a waste of time and money.

That was the first part. Communicating the program to the members who were not at any face-to-face meeting was made possible with a newsletter. The following newsletter was sent to the membership before I started the program:

To: Membership of the Merion Golf Club

From: Richard M. Bator, Course Superintendent

Date: July 23, 1990

Subject: East Course Fairway Bent Conversion Program, Scheduled August 6, 1990

In the following newsletter, I will attempt to outline, in every detail, the long awaited Fairway Conversion Program from Poa to Penncross Bentgrass. If no major turf loss occurs between this newsletter and August 6, it can be assumed that this project is what I've been stressing in all previous newsletters. It will get worse before it gets better. But, I would much rather lose turf to a planned and positive endeavor than through weather conditions or negligence on my part.

Well-running irrigation systems important

Make sure the automatic fairway irrigation system is more than functional for consistent coverage. You should also have a fairway quick coupling system for the hand watering of high spots or fairway perimeters that may not get adequate coverage from the automatic system under windy conditions.

Also be sure the irrigation pumps and motors have been rebuilt, if needed, before the program is begun. It would be a good idea to have the irrigation mechanic check the pumps and motors and make any necessary repairs or tune ups one to two weeks before the renovation process is initiated.

Light and frequent watering of the seedlings during the first two weeks after seeding will be another critical procedure contributing to the overall success.

Aerifying and dethatching is crucial

In order that an optimum seed bed be attained prior to the start of the program, I would recommend the following aerification and dethatching program:

• At least one year, but preferably two years, prior to the program, aerify between four and eight times, depending upon the severity of the thatch layer. Use any of the improved aerifiers, or the model that removes the most plugs and penetrates the deepest.

• Each time the turf is aerified, slice or dethatch at a depth deep enough to penetrate the thatch and reach the soil. Use a self-contained five gang unit, as these will not only dethatch and reach the soil, but will also pulverize the plugs, thus putting back the maximum amount of soil for optimum thatch decomposition.

The entire goal here is to create the best growing medium for the new seed. This process is also paramount to the success of the program.

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After nearly six months of research with like programs of other superintendents, university research, my years of experience in renovation, and lastly, working with Dr. Jack Hall, the extension agronomist from Virginia Tech University, we have made our decision.

There were three choices. One, using the non-selective herbicide RoundUp to totally eliminate all existing turf and start from "square one", secondly, using PGR's in conjunction with a twice per season overseeding with bentgrass, (this would take between three and six years to successfully convert), thirdly, and the one that I chose, using the more gradual method (6 to 12 months) of Poa elimination while employing the herbicide Pro-Grass. I am extremely confident that this is the correct choice for the Merion East fairways, as well as for the Merion membership. This decision has been well thought out and planned, with every likelihood for success taken into consideration.

Briefly, my decision is based on the following considerations:

1. The bent populations, although predominately Colonial in nature, with some Penncross and Ryegrass evident, range from 35% to 65%. With this high a percentage, it would be a shame to kill that high a bent population using the herbicide Round-Up. Of course, the higher the bent populations from the start, the quicker it will take in achieving the desired 90% bent population, and vice versa, if Poa population are extremely high.

2. Due to the fact that we mow our fairways with triplex greens-mowers at 3/8" and remove clippings, along with an increased mowing frequency of five times per week, I have noticed an increase of bent in the short eight moths that I have been at Merion. This occurrence is what really had me leaning towards a gradual elimination. It certainly has encouraged my decision.

3. Having the services of Dr. Jack Hall from Virginia Tech has also helped greatly in my decision. He has been working with this particular herbicide since 1981 and knows its pluses and minuses as well as, or better than, anyone in the country.

4. Also, while at Pine Valley, we worked with Dr. Hall with this herbicide on an experimental basis, with the results being impressive.

5. This particular chemical has been used for years in the South for the control of Poa in Bermuda grass, and in the winter overseeding of Ryegrass. Their success rates have also been impressive.

6. Lastly, I feel that the majority of superintendents in the northeast have not been successful with this method because it has not been used frequently enough, and when used, the program was not correctly planned or carried out in order that total success was achieved.

I suppose, for me, in regards to this last statement, the challenge element comes to my mind and nature.

During this week of renovation, we apologize for the temporary interruption of play, but when completed, our fairway turf should be one of the finest in the country.

It has always been my belief that the majority of failures in life occur because of the fear of failure. Opportunities in this profession, or chances when presented, should be acted upon.

In closing, please remember, no matter how well one plans, minor distractions and failure occur. In carrying out this program, however, I have taken as much as is humanly possible into consideration for its success, and the Lord willing, we will believe this to occur.

Respectfully, Richard M. Bator Golf Course Superintendent

That important communication — in newsletter form to the entire club membership — proved successful. Equally important was the emphasis on planning and organizing. One cannot over-plan or over-organize when undertaking such an important program. You must write out every detail, procedure, rates, equipment used, job description and employee assignments and a contingency plan for rain dates, possible mistakes and possible manpower no-shows.

Once all of the planning and organizing is finished it is time to present the details to the green committee chairman, the committee itself, board and membership. This is all part of the line of communications that has been set up in the selling of the program.

Pre-implementation considerations

Check with fellow turf managers who have undertaken such a program, and try to enlist a top university researcher or professor who is well grounded, both technically and practically, in such a procedure.

I would implement the plan between the last week of July and the first two weeks of August, but no later. Be sure to include a rain date week in the event of prolonged rains.

Make sure the plan has assignments and equipment match ups, in writing. Present these to your assistants and mechanics, and posting them for the entire staff to read. Naturally, give copies to the greens committee chairman, members of the committee, the board and, if you desire, to the membership.

During the execution of the program have one or two staff meetings to explain the procedures and each employee's assignment. Take as many meetings as would be needed just to make sure all employees are know to what their job assignments are and how they should do these jobs. Impress upon them that this procedure will take from four to five days to complete — long days, if necessary.

An excellent way to practice would be to have a dry run on a par three or short par four course the week before the start of the program. This worked well at Merion. One could liken the dry run as a war game prior to the major battle.

Well in advance, be sure purchase, rent, borrow or beg all necessary equipment. Rebuild any equipment in need of major repairs, replace all tines and slicing blades and tune up all motors. Keep on hand enough spare tines and slicing blades for four complete changes, as well as key parts that would normally have a tendency to break under such stress. Service all equipment each night after the day's procedures are completed.

Keeping the course closed afterwards

The longer you can keep the course closed for play after the program is completed, obviously, the better for the new turf. Between two and four weeks is a good length of time.

Check for residual chemicals

If you have recently taken over the course or have been there for several seasons and have a history of using long-term soil residual pre-emergence crabgrass or goosegrass herbicides, have all fairways, collars and intermediate roughs checked for residual chemical levels. Even if you are reasonably sure that no such chemicals have been used for two or more seasons, check to make sure they have not. Leave nothing for chance.

If, after testing, these levels exceed the acceptable thresholds, hold off on the initiation of the program until these levels are lowered. Remember, this type of herbicide does not leach from the soil, but degrades through microbial action and in sunlight. There are two known procedures that will speed the degrading process. These are aerifying and dethatching. Applying activated charcoal after each aerification helps, too. Then retest the soils every one to two months. Once lower levels have been achieved, undertake the conversion program.

Stock and use fungicides

Before starting the program, (especially if the dates are in July and August) stock enough fungicides for at least two to three applications for the control of pythium blight, and to control brown patch and dollar spot.

Applications should be made within two to seven days of germination, but no later. The initial applications will obviously depend upon the severity of the disease pressure.

If you use RoundUp, definitely attempt to close for three to four weeks. If carts are permitted on fairways during the regular season, keep them off the new turf for six weeks.

Amazingly, though, we opened the course one day after the entire program was completed. We didn't allow carts and I felt foot damage would be minimal. This proved correct. We filled divot holes daily, and with this we gained new bent overall.

Within three to seven days after the completion of the last fairways and after germination was complete, color and

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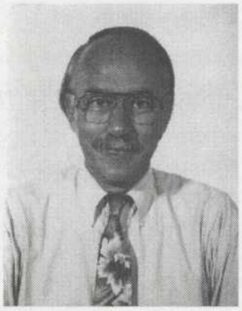
INTERACTIONS: COMMENTS & OBSERVATIONS

A change of season

by Juergen Haber



Summer will arrive officially this month. But in some parts of the country we've already had our taste of summer; here in Washington, DC, air conditioners are humming everywhere as the humidity exaggerates the temperature.

These are ideal conditions for *Rhizoctonia* diseases as our Field Editor Chris Sann reminds us. Speaking of this disease, Chris' second story this month: "Brown patch — a different perspective," serves to introduce the work of Dr. Gary Yuen of the University of Nebraska.

On that note I'd also like to introduce our newest contributor, Richard Bator. Until now *Turf Grass Trends* has focused on turf diseases and pests and government regulation. Dick launches us into a new world of practical problems.

In this issue he begins the first of a two-part series of his experience of converting a golf course from poa to bentgrass. Now, some readers who are not golf course superintendents might say, "How does this help me?" Dick's golf course conversion program has applicability not only to golf courses but any turf grass stand. Dick's perspective, though, is that of a golf course turf manager. And he's got pretty impressive credentials, too.

Before he became an independent golf course turf grass advisor, he was the superintendent at the world-ranked Merion Golf Club in Ardmore, Pennsylvania. He also held similar positions at the Oak Hill Country Club in Rochester, New York, and Pine Valley Golf Club in Clementon, New Jersey. He prepared Oak Hill for the 1980 P.G.A. Championship and Pine Valley for the 1985 Walker Cup. He then returned to Rochester to design and build the championship Blue Heron Hills Country Club as well as the Gypsum Mills Golf Club, a nine-hole executive course.

In 1992, he left the Merion Golf Club to start his new endeavor, that of an independent golf course turfgrass advisor.

Dick's second article in the series, complete with manpower and equipment tables, will appear in the July issue.

Speaking of contributors, we've got another change this month. Science Advisor Eric Nelson has, sadly, announced he will resign his post. In his resignation letter, Eric cites the workload at Cornell University as his reason for not being able to continue. But all is not lost. He will continue to be a contributor. We value Eric's contributions highly and we'll be looking forward eagerly for his manuscripts here at *Turf Grass Trends.* ■

***Conversion** continued from page 12*

density of the turf was nearly 75% of what it was just prior to the start of the procedure. By the 14th day, it was barely evident that such an extensive renovation program had been undertaken and was completed.

Choice of bentgrass

If one starts such a program in July or August, one can expect germination in three and one-half to four days. With the new pre-germinated seed on the market now, this can be cut down to two days.

As far as the choice of bentgrass, it will be up to the superintendent, especially considering that, during the last three to five years new and vastly improved varieties have appeared.

To properly evaluate the choice, I would recommend a visit to the turf plots at the turfgrass universities in the area and adjoining areas. Talk to the researchers in detail about their results. Secondly, I would contact any superintendent in the country who has been experimenting in his nursery with new varieties. Two outstanding superintendents that have an excellent and abundant field experiment with these new varieties are Doug Peterson of the Baltimore Country Club in Baltimore, Maryland, and David Stone of the Honors Club in Tennessee.

Seed producers and their distributors can also be of help, but remember their evaluations and observations may be biased.

How to treat roughs and collar areas

Because the six- to twelve-foot intermediate roughs of the course will normally be infested with poa and bents, it would be advisable to treat these at the same time as the fairways. I prefer to apply RoundUp to intermediate roughs, scalp mow them and seed them with a mixture of improved ryegrasses.

If there is a need to re-contour the fairways, this would be the ideal time frame to accomplish this most important aesthetic improvement. It would also be wise to treat the collars in the same manner as the fairways, as poa and thatch are normally a serious problem in these difficult-to-maintain areas.

Don't forget Murphy's law

Remember though, no matter how well you have researched the program, planned, organized, educated the staff and even completed one fairway, intermediate rough and collar, something will usually go wrong. But, if you have planned well, these problems should be minor in nature and easy to overcome. ■

Michigan State Study

Threshold levels of anthracnose spores identified

A recent Michigan State University study established the relationship between periods of leaf wetness, temperature, and spore concentration as they relate to the expression of anthracnose disease symptoms. The study confirmed the close relationship between leaf wetness periods and optimum spore growth temperatures as well as established the concentration of conidia required to produce maximum disease symptoms.

The growth temperature range for *Colletotrichum* graminicola monitoring by this experiment was 68 F (20 C) to 86 F (30 C) with the optimum growth occurring at 77 F (25 C) to 86 F (30 C). The table below lists the spore concentration, the temperature, the length of time of leaf wetness, and the percent of leaves infected by *Colletotrichum graminicola.*

TGT's view: The Michigan State data show a strong relationship between conidia concentration, moderate to heavy, extended periods of leaf wetness, 24 to 48 hours, consistent temperatures, 77 F (25 C) to 86 F (30 C), with very high levels of plant infection, 60% to 100%.

Anthracnose Colletotrichum graminicola *should not be a major problem on* Poa annua *stands that do not have a history of infection. However, stands with a moderate or previous history of infection should be closely examined when periods of leaf wetness exceed 48 hours at consistent temperatures above 77 F (25 C). Stands with chronic infections should be closely monitored any time leaf wetness periods exceed 24 hours at constant temperatures of 77 F (25 C) or greater.*

At warm temperatures with forecast wet spells, turfgrass managers should attempt to lessen periods of extended leaf wetness on vulnerable annual bluegrass stands by spraying foliage with wetting agents, accelerating leaf drying by the use of fans or blowers or any combination of these actions. Shutting down stand sprinkler heads for 24 to 48 hours after rainfalls may lessen the canopy humidity levels enough to avoid exacerbating an existing problem.

This study clearly illustrates the relationship between inoculum levels, leaf wetness periods, and temperatures on infection of annual bluegrass. It is an excellent example of the disease triangle (host, pathogen, and environment) and how changes in pathogen levels, temperature variations and changing stand cultivars can dramatically effect the symptom expression of any disease. -CS

Percent infection of annual bluegrass by Anthracnose

Concentration	Temp.(C)	Wetness(hrs.)	% Infected
10,000/ml.	20	12	0
" "	"	24	10
" "	"	48	10
" "	"	72	10
" "	25	12	0
" "	"	24	10
" "	"	48	15
" "	"	72	20
" "	30	12	0
" "	"	24	20
" "	"	48	20
" "	"	72	20
100,000/ml.	20	12	0
" "	"	24	20
" "	"	48	40
" "	"	72	70
" "	25	12	5
" "	"	24	40

Concentration	Temp.(C)	Wetness(hrs.)	% Infected
100,000/ml.	25	48	70
" "	"	72	100
" "	30	12	10
" "	"	24	60
" "	"	48	80
" "	"	72	100
1,000,000/ml.	20	12	0
" "	"	24	20
" "	"	48	80
" "	"	72	100
" "	25	12	10
" "	"	24	60
" "	"	48	100
" "	"	72	100
" "	30	12	20
" "	"	24	80
" "	"	48	100
" "	"	72	100

***Brown patch** continued from page 9*

inches from the edges of existing disease patches. To a lesser extent the pathogen could be also identified as being present in the thatch of asymptomatic areas, but, contrary to isolated reports, it was not present in the roots of the same plants. This study confirmed that the *Rhizoctonia solani* pathogen is primarily concentrated on turfgrass foliage surfaces and that it can exist there in substantial numbers in an area that appears asymptomatic. The data from this study should provide the basis for further studies that attempt to formulate new control strategies. Additionally, this information bolsters the argument used in the already existing practice aimed at reducing the periods of leaf gutation by syringing with water and the applications of wetting agents to turf foliage.

Biological controls are studied

Dr. Yuen also conducted a study of two promising strains of antagonistic fungi, one a non-pathogenic, binucleate form of *Rhizoctonia* and the other an isolate of *Giocladium virens,* to see if the suppression of *Rhizoctonia solani* demonstrated in the lab would transfer into the field. In the lab, the binucleate *Rhizoctonia spp. (GM 460)* had reduced expression on tall fescue seedlings by 74% and the *G. virens (TRBG)* strain had reduced symptoms by 40%, when rated 10 days after the introduction of the pathogen.

In a field test of the GM 640 strain, one application, consisting of colonized millet seed, made one week before the introduction of the pathogen, reduced the level of disease expression by 46% 27 days after inoculation. When a second application of GM 640 was made at the time of the inoculation the disease expression was reduced by 63%, just a few percentage points short of the rating set for the uninfested control plot in the study.

When both strains were applied singly, at multiple rates, and mixed, they showed only marginal improvements in disease suppression over the two months of the study. Single and multiple applications of GM 640 were slightly better at disease suppression than the corresponding applications of TRBG. But the combination applications of triple rates of both strains produced results that averaged a 37% reduction in disease severity compared to the untreated inoculated control over the nine weeks of the test. Also the disease reduction averaged 49% when the turf was rated 7 to 10 days after each application.

The results of these tests produced good and bad news. The good news was that at least one strain, GM 460, could survive on leaf surfaces for periods longer than 30 days thereby approximating existing fungicide reapplication schedules. The bad news was that the level of disease control of these two strains did not approach the commercial threshold of 80%. ■

Coming attractions

July Issue

Pythium diseases
by Dr. Eric B. Nelson

A successful fairway conversion program, part two
by Richard Bator

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Turf Grass Trends
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