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Rhizoctonia diseases

Brown patch and its cousins

by Christopher Sann

Rhizoctonia cerealis or winter brown patch.

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

Rhizoctonia 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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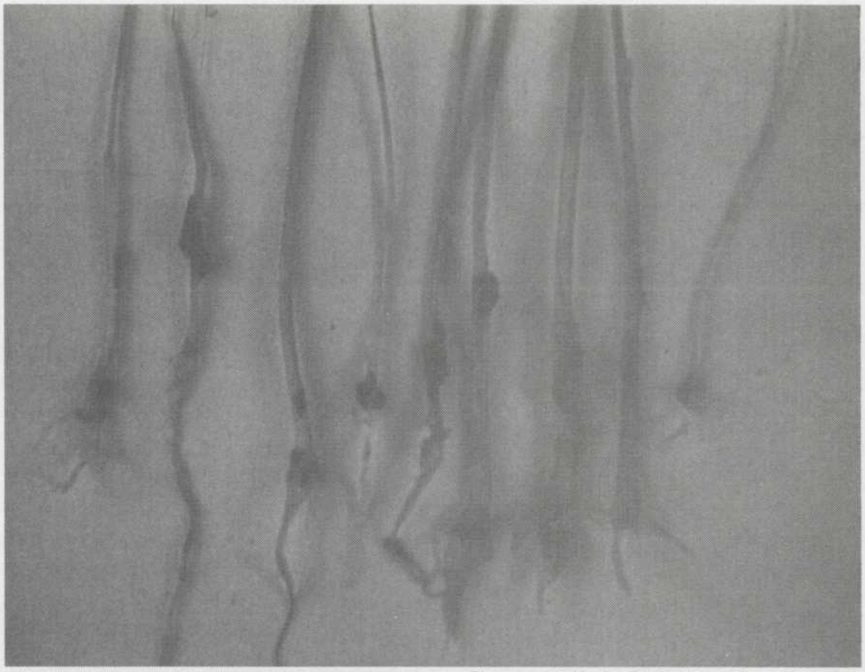


Rhizoctonia sclerotia on Astoria bentgrass. Photo provided by Dr. Eric B. Nelson, Cornell University

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.

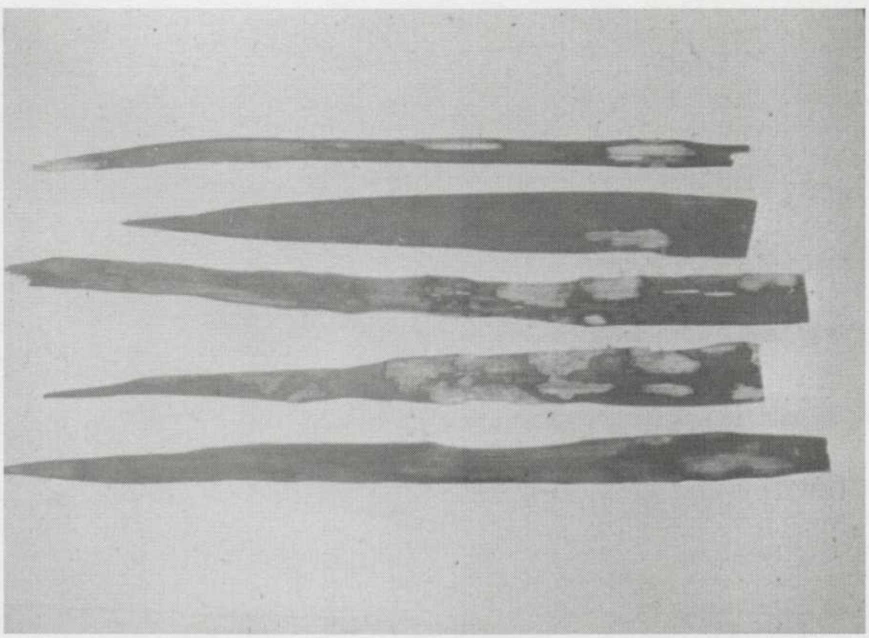
Conditions that favor growth

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.

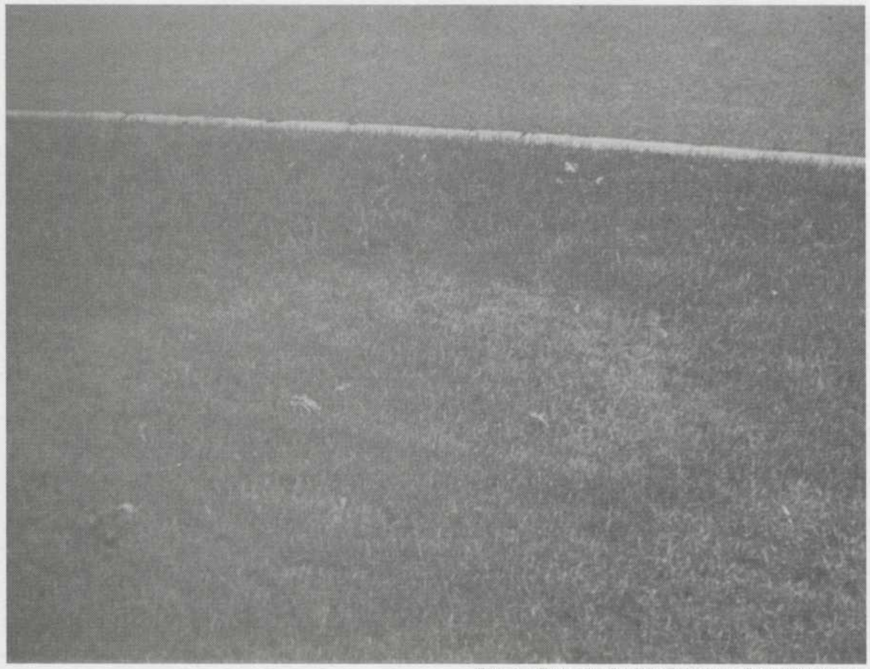
Unlike humidity, varying temperatures do play a significant role in infection and disease expression. The four *Rhizoctonia spp.* are active over several different temperature ranges and have been identified as causing at least four turfgrass disease symptoms: brown patch, yellow patch, and leaf and 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.

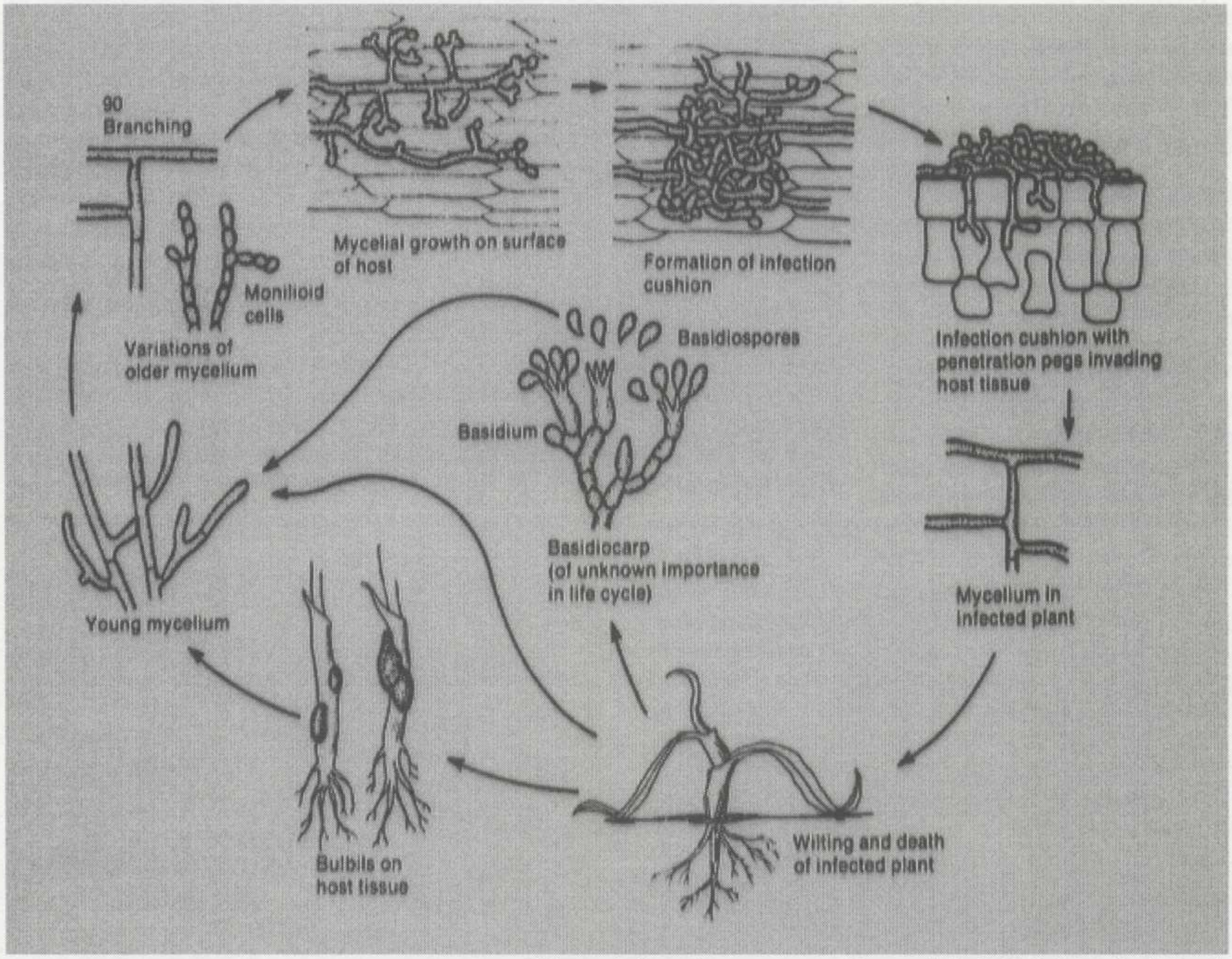
This "smoke ring" effect is actually a combination of the leaf tips rapidly dying back with a dense mycelial layer directly below. The necrotic leaf tips are blue-purple to black in color and the underlying mycelial mat is light brown to gray. The two combine to produce the "smoke ring". However, this 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.

Foliar symptoms

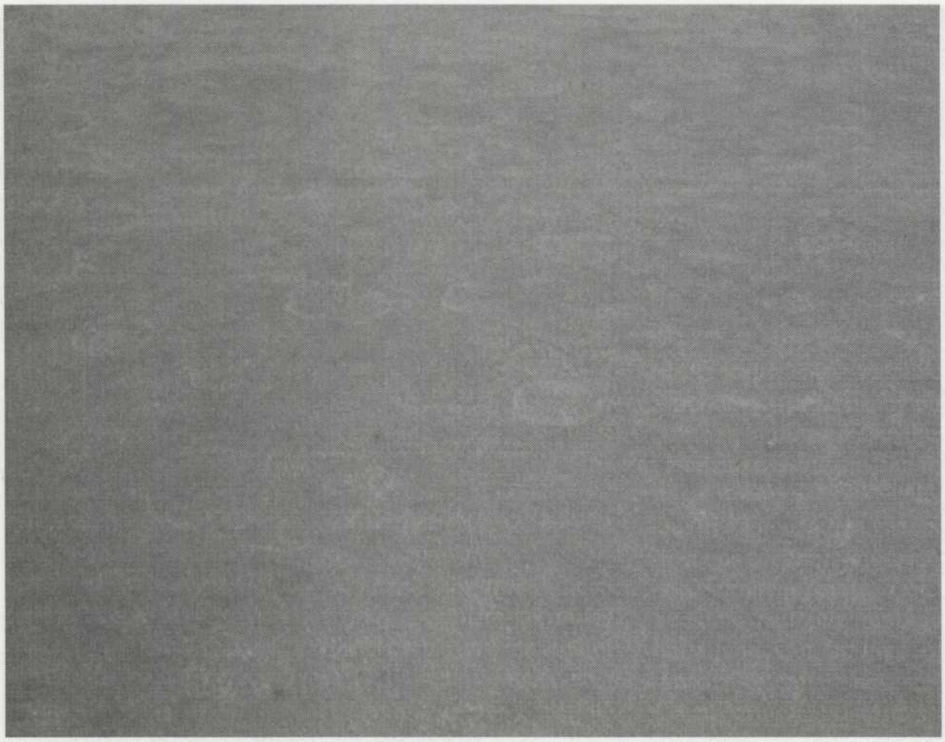
On cool-season turf, maintained as home or commercial lawns, the most common leaf blade symptoms are irregular lesions, silver to brown in color, with a thin dark brown border. This symptom is very common on tall fescue and often will include at least one leaf edge. On bluegrass and bentgrass, the lesion 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.



Rhizoctonia life cycle

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



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).

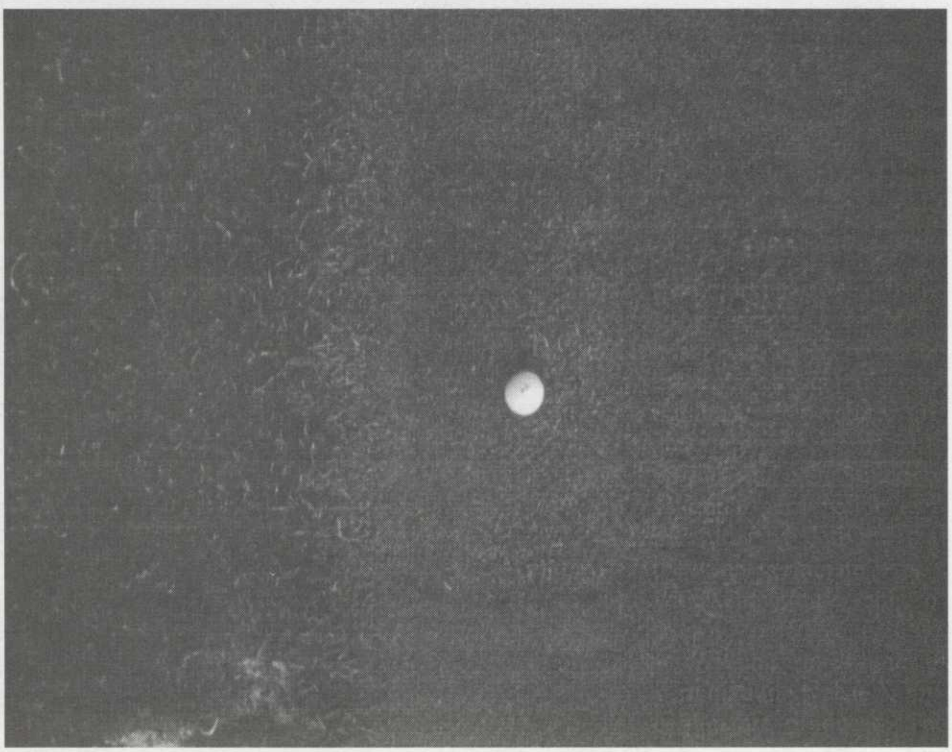
Within 12 to 24 hours of germination, hyphae or mycelium are produced. The mycelium grow at a rate of from 1/8 to 1/5 inch (3.4 to 5.0 mm) per day. These runner hyphae grow along the leaf surface where infection cushions are formed of aggregations of hyphael branches (See photo on page 6.).

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

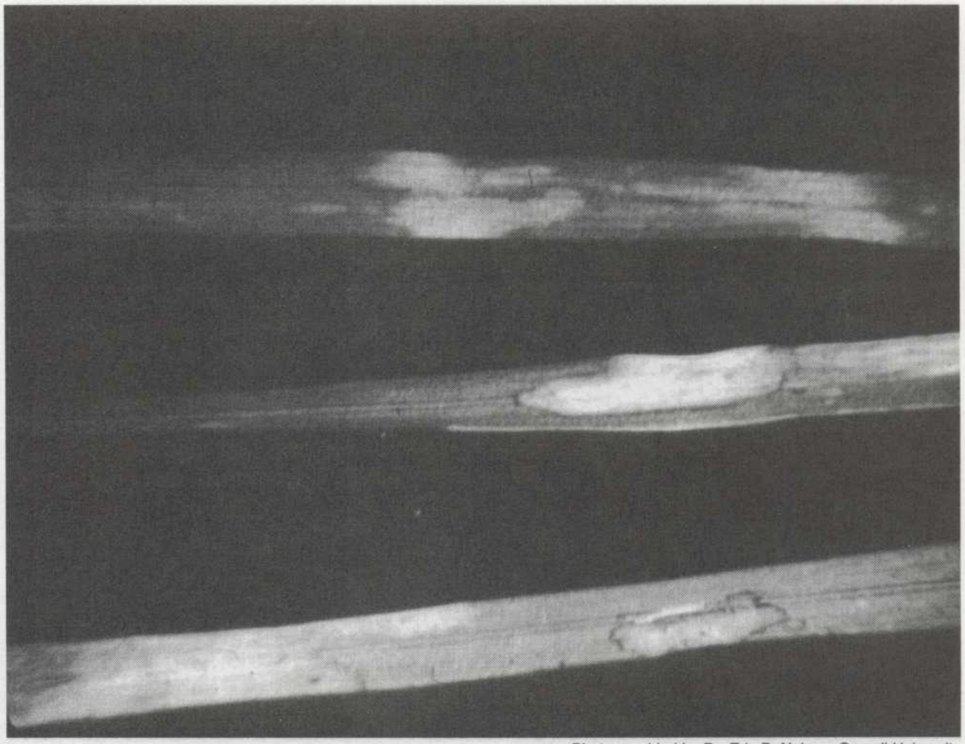
A simple, single-point infection begins with the germination of a sclerotia, or resting body, in a leaf



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.

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.



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

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.

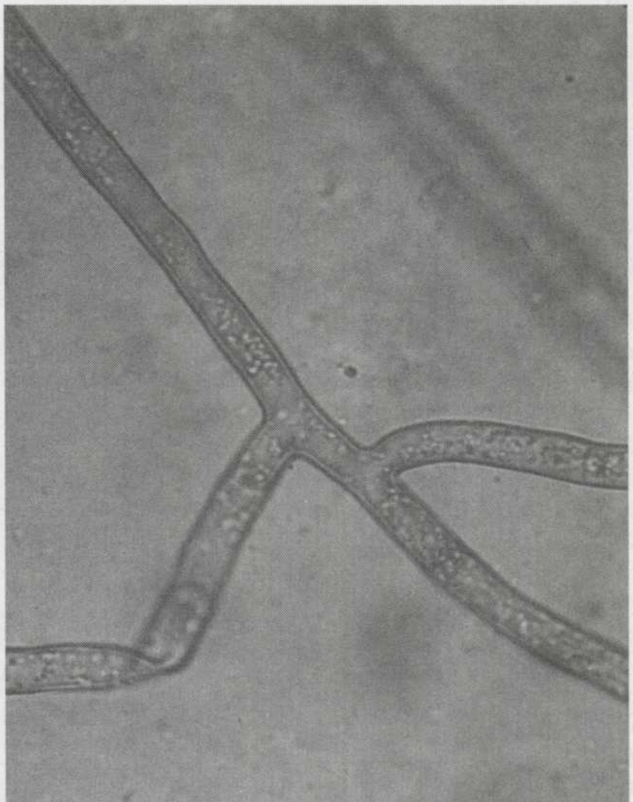


Photo provided by Dr. Eric B. Nelson, Cornell University
A right-angle hyphael branch of Rhizoctonia.

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

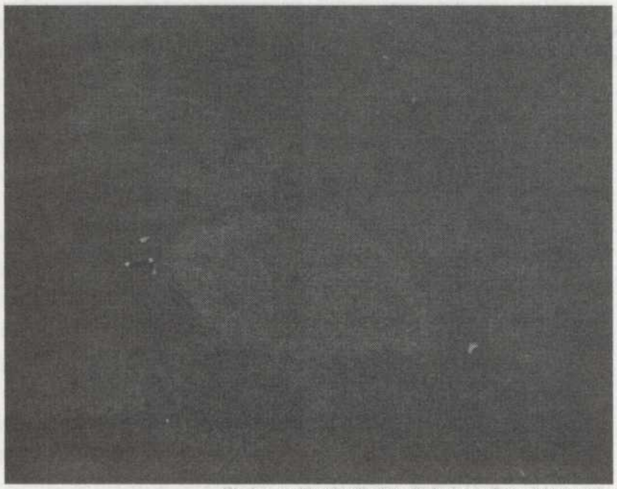


Photo provided by Dr. Eric B. Nelson, Cornell University
Large brown patches many feet in diameter.

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