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Nitrogen Fertilization's Effect On Turfgrass Disease Injury

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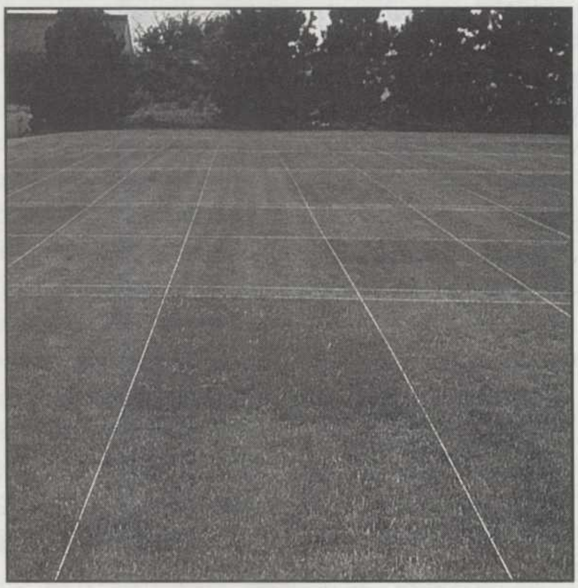
Fungi cause most of the diseases that occur on cool season turfgrasses in America. These fungal pathogens respond to both the environment and to cultural practices. Environment is the overriding factor that determines the seriousness of a disease outbreak. When environmental conditions favor the pathogen to the detriment of the host, disease occurs.

Turf managers must continually respond to changing environmental conditions in their battle against disease. Those who respond too slowly often watch in frustration as their turf dies despite their rescue efforts. However, managers that understand the relationship between the environment, cultural practices and disease development often can react quickly enough to prevent serious turf loss. Part of being able to modify cultural practices to discourage disease is knowing something about which, when, where and why diseases occur. One aspect of turf disease management is nitrogen fertilization.

It is impossible to generalize about the effects of fertilizers on all turfgrass diseases because of the differences in hosts and the variable characteristics of pathogens. Fertilizers do not directly affect the pathogen, but rather alter the host plant's metabolism or morphology to make it more or less susceptible or resistant to attack by pathogens.



Severe brown patch injury of perennial ryegrass plot (foreground) was caused by a low rate of N, 2 lbs./1,000 ft.^{2} Photo: J. Watkins.

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A good fertility program stimulates a deep and extensive root system, controls shoot growth and provides recuperative potential from injury. During the active growth period, fertility programs should try to achieve a 3-1-2 balance of nitrogen-phosphorous-potassium. Many turfgrass diseases are more severe when this ratio becomes out of balance, particularly when the nitrogen component is excessively high or low. Excess nitrogen prolongs vegetative shoot growth. The plants are more succulent and have thinner cell walls, which are more easily penetrated by fungal hyphae. High nitrate levels (NO_3-N) cause leaves to exude greater amounts of nitrogen-rich glutamine and carbohydrates, both of which may enhance fungal spore germination.

Turfgrass managers are well aware of dangers of over or under fertilizing turf, and that the fine line between adequate and too much or too little fertilizer is not always clear. That range of fertility at which host susceptibility is minimized depends on the interaction of the environment with the host and the pathogen. High nitrogen may enhance disease injury on one host, but on a different grass host, it may promote recovery of the grass so the turf shows less injury in the presence of the same disease. Brown patch is a good example. Observations in our research at the University of Nebraska-Lincoln showed that 6 to 8 lb. of actual N/1000 ft^2/season caused more severe brown patch development in tall fescue than 2 or 4 lb. of actual N/1000 ft^2. However, perennial ryegrass plots fertilized with 8 lb. N/1000 ft^2/season showed less brown patch injury than when fertilized at lower N rates, and they recovered more quickly from infection. In general, excessive nitrogen encourages the development of Rhizoctonia brown patch (on some hosts), Bipolaris and Drechslera leaf spots, summer patch, stripe smut, pink and gray snow molds and Pythium blight. Stem and crown rusts, anthracnose, dollar spot and red thread are often more severe when nitrogen is deficient. These nutrient-disease interactions are well documented in the scientific and technical literature. At the University of Nebraska-Lincoln, we have studied the effect of nitrogen rate on the development of brown patch on tall fescue and perennial ryegrass, dollar spot on bentgrass and crown rust on perennial ryegrass.

Nitrogen Effect On Brown Patch Injury

Brown patch, caused by the fungus *Rhizoctonia solani*, is a serious pathogen on all commonly cultivated turfgrasses. Symptoms vary depending on turfgrass species and mowing height. On home lawns, golf course fairways and similar turfs, two general types of symptoms can appear either simultaneously or separately. Field expression is the presence of patches or roughly circular rings of dead and dying grass surrounding areas of dead turf. These patches may be up to 2 feet in diameter. The individual lesions on leaf blades are distinctive and appear as long, irregularly shaped, ash-gray spots surrounded by dark brown borders. Symptoms on bentgrass greens appear as straw-colored patches that range in diameter from 3 inches to 3 feet. When the turf is wet, a narrow dark gray ring or arc composed of fungal mycelium and wilted grass blades mark the advancing edge of the patch. This halo is referred to as the "smoke ring" and is best observed in early morning.

Nitrogen is the key nutrient in plant nutrition and must be available to the grass at a constant uniform rate. The turfgrass manager should determine the turf's nutrient needs based on soil tests and the intensity of management desired. For example, golf course turf is an intensively managed grass community in which considerable stress is placed on its plants. Along with the intense management comes increased nitrogen use and a greater need for disease management. Golf course superintendents can use their nitrogen fertility program to advantage in reducing brown patch injury by promoting rapid recovery of infected turf.

Table 1. Effects of nitrogen fertilizer rates on brown patch injury to Rebel tall fescue, 1990.

	*Visual brown patch ratings**		
Lb. N/1000 ft²/season	*July 10*	*July 23*	*Sept. 4*
0	2.0	1.3	1.0
2	3.0	3.3	1.3
4	5.0	4.8	2.8
6	5.5	6.5	4.8
8	6.3	6.5	5.3

*Brown patch injury was rated as 0 = no visible injury, 5 = 45-55% of the plot with injury, and 10 = 100% of the plot with injury. Research plots were inoculated annually in early June with R. solani cultured on sterilized oat seed to promote disease development. Liquid urea, 46-0-0 was applied monthly from April through October.

In practice, plant growth can be controlled more precisely with several small nitrogen applications during the growing season than with an initial heavy application of a slow-release nitrogen fertilizer in the spring. In regions of North America where turf goes dormant in late fall, a fertilizer application in October, November or December is practical and often advantageous when the surface soil is frozen. There is little loss of soluble nutrients during winter, and they are in a position to aid in early recovery from winter injury and damage from snow molds. The concept of fall fertilization dates back to the 1930s. This approach works well for fertilizers such as urea, IBDU or ammonium nitrate which are not highly dependent on microbial activity or elevated temperature for nitrogen release. When applied at temperatures below 60 F., root growth is favored over shoot growth. This encourages the turf to photosynthesize long into the season, resulting in better fall and winter color, earlier spring green-up and higher levels of stored carbohydrates.

A study at the University of Nebraska-Lincoln showed that nitrogen levels of 6 and 8 lb. of actual N/1000 ft²/season caused significantly greater brown patch injury than 4 or less lb of nitrogen on a Rebel tall fescue turf (Table 1).

As expected, brown patch was more severe at higher nitrogen levels. The turf in those plots receiving no nitrogen was chlorotic, lacked vigor and was not aesthetically acceptable but contained little disease. However, at 2 lb. of nitrogen, the turf quality was acceptable while the disease injury remained low. At 4 lb. of applied nitrogen disease injury was intermediate. The 6 and 8 lb. nitrogen rates produced moderately severe brown patch injury. At these higher nitrogen rates the turf was more vigorous, but the disease injury remained higher later into the season.

A similar study compared the effect of nitrogen rates on brown patch injury in perennial ryegrass. Preliminary results in Table 2 show that as nitrogen rate increased from 0 to 8 lb., brown patch injury decreased. This trend was consistent between the two cultivars as well as for the blend. The color and quality of the turf fertilized at 4 and 8 lb. N was visibly better than that fertilized at 0 and 2 lb. N.

We had expected just the opposite, i.e. higher N promoting/greater disease injury. Plots receiving little N become thin, recovered poorly from disease injury and developed a weed problem. Those receiving the higher N rates recovered quickly from disease injury and maintained good verdure, color and quality. The key to why there was less brown patch injury in the high N plots may have been that they were fertilized monthly for five months. Essentially, they were spoon fed and did not receive a large amount of fertilizer at any given time. This study is a long-term project scheduled for completion in 1996 or 1997.

Suppression of Dollar Spot Injury On Bentgrass With Nitrogen

In 1993 and 1994, dollar spot was one of the most active turf diseases in the Great Plains. Abundant rainfall created ideal conditions for infection by *Sclerotinia homeocarpa*, the causal fungus of dollar spot.

Table 2. Effect of nitrogen and cultivar blend on brown patch injury of perennial ryegrass, 1993.

	Brown patch injury *					
	Manhattan		Manhattan II		Manhattan/Manhattan II Blend	
Lb. N/1000 ft²/season	Aug. 2	Aug. 24	Aug. 2	Aug. 24	Aug. 2	Aug. 24
0	6.1	7.2	4.9	6.0	4.4	6.3
2	6.2	7.2	4.5	5.9	5.6	6.1
4	5.7	6.4	3.5	4.8	5.0	5.7
8	5.4	5.4	4.2	3.2	3.9	3.7

*Brown patch injury was rated as 0 = no visible injury, 5 = 45-55% of the plot with injury, and 10 = 100% of the plot with injury. Research plots were inoculated annually in early June with R. solani cultured on sterilized oat seed to promote disease development. Fertilizer (urea 46-0-0 or sulfur-coated urea-32-0-0) was applied monthly from April through October.

Dollar spot symptoms vary depending on turfgrass species, mowing height and nutrition level. Under close mowing, symptoms appear as small, round, straw-colored spots roughly the size of a silver dollar. These can become so numerous on bentgrass that large areas will appear blighted. Turf maintained at taller heights shows a mottled, straw-colored pattern made up of 4- to 8-inch patches of blighted turf. Individual grass blades develop hourglass-shaped, bleached lesions surrounded by a reddish-tan border. Symptom development and turf injury are enhanced when nitrogen is deficient.

A study initiated in 1993 and continued through 1995 at the University of Nebraska-Lincoln showed that higher rates of fertilizer nitrogen suppressed dollar spot injury in bentgrass (Table 3). This study also compared quick-release urea (46-0-0) with slow-release, sulfur-coated urea (32-0-0) at 0, 2, 4, 6 and 8 lb. N/1000 ft²/year (results not shown). Fertilizer treatments were started in May and continued monthly until the respective amounts of nitrogen had been applied.

Dollar spot injury was effectively suppressed at the 6 and 8 lb. nitrogen rates. There was no interaction between nitrogen rates and the slow- or fast-release carrier; however, by mid-season, the quick-release urea was giving greater disease suppression than the sulfur-coated urea. This was probably due to more nitrogen being available at a given time with the quick-release carrier than with the slow-release. Urea at the 6 and 8 lb. rate significantly burned the turf. Some fertilizer injury also occurred with the slow-release, sulfur-coated urea at 8 lb., but it in no way compared to the injury caused by urea at that equivalent high rate.

Based on these results, it appears the use of sulfur-coated urea at 4 to 6 lb. N/1000 ft² can suppress dollar spot development. At these rates, bentgrass is able to recover quickly from dollar spot injury.

Table 3. Effect of nitrogen rate on dollar spot injury to bentgrass turf, 1993 and 1994.

	Visual dollar spot ratings*			
Lb. N/1000 ft²	1993		1994	
per season	June 30	Aug. 24	June 30	Aug. 24
0	1.8	7.4	3.0	7.5
2	1.3	5.3	2.6	6.3
4	1.3	4.3	1.1	4.1
6	1.5	2.6	0.95	1.2
8	1.0	1.0	0.85	0.85

*Dollar spot injury was rated as 0 = no visible injury, 5 = 45-55% of the plot with injury and 10 = 100% of the plot with injury.

Less Crown Rust at High Nitrogen Rates

As research plant pathologists we are opportunists, and when an unexpected disease outbreak occurs in a research plot, we take advantage of it. Such was the situation in 1994, when crown rust caused by *Puccinia coronata* became endemic in our brown patch-perennial ryegrass-N rate plots discussed previously in Table 2 of this article. Warm days and cool nights created long periods of dew which were ideal for crown rust development. Crown

Table 4. Effect of nitrogen rate and cultivar on crown rust development in perennial ryegrass, 1994.

	Manhattan		Manhattan II		Manhattan/Manhattan II Blend	
Lb N/1000 ft^2/season	Crown rust*	Turf quality**	Crown rust	Turf quality	Crown rust	Turf quality
0	7.6	4.3	5.1	6.4	4.7	5.5
2	7.1	4.6	4.1	7.0	3.3	6.9
4	6.7	5.1	2.6	7.4	4.5	6.8
8	3.6	6.6	1.4	8.4	2.1	8.0

*Crown rust was rated on a scale of 0-10 with 0 = no disease, 5 = moderate disease and 10 = severe disease.

**Turf quality was rated on a 1-10 scale with 10 being the highest quality.

rust was detected in late August, developed rapidly through September, becoming severe by early October. Table 4 shows that crown rust was effectively suppressed at the 8 lb. N rate on both Manhattan and Manhattan II and on the blend. Turf quality was also highest at the 8 lb. N rate. These results were not surprising since rust diseases respond to nitrogen fertilization. Slow growing, undernourished turf is prone to severe rust injury, while actively growing turf that is mowed regularly recovers rapidly from rust injury.

Quantity, Timing of Nitrogen Applications Impact Disease Injury

As shown by these examples (brown patch, dollar spot and crown rust), the quantity and timing of fertilizer-N applications have a major impact on turfgrass disease injury. Overstimulated turfs may divert plant defense chemicals to nitrogen metabolism and leaf production, thus opening the way for infection. Nutrient-deficient turfs lack vigor and this allows the fungus to colonize new tissues. The recuperative potential of nitrogen-starved turf is poor. A balanced fertility program based on frequent light applications of nitrogen during the growing season should discourage disease infection and will provide the energy needed for recovery from any disease injury that occurs. Through prudent management practices, turfgrass managers should be able to integrate their fertilizer program with the use of fungicides and cultural practices to keep disease injury to a minimum.

Dr. John E. Watkins is a professor at the University of Nebraska-Lincoln in the Department of Plant Pathology. He has degrees in microbiology from the University of Wyoming and plant pathology from North Dakota State University. Dr. Watkins is active in extension and research on integrated management approaches for disease control in turfgrass and small grains. His current emphasis in turfgrass research is developing an integrated nitrogen fertilization-fungicide application program for control of dollar spot on creeping bentgrass.

Dr. Richard J. Hull, author of the following article, entitled *Nitrogen Usage by Turfgrass,* is the science advisor of ***TurfGrass Trends.*** Hull, a professor of Plant Science and Chairman of the Plant Sciences Department at the University of Rhode Island, was recently named chairman of the C-5 Division (Turfgrass Sciences) of the Crop Science Society of America. He has degrees in agronomy and botany from the University of Rhode Island and the University of California, Davis. His research has concentrated on nutrient use efficiency and photosynthate partitioning in turfgrasses and woody ornamental plants. He teaches applied plant physiology and plant nutrition. Dr. Hull is a frequent contributor to *TurfGrass Trends.*