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RESEARCH & SCHOLARSHIP REQUESTS FUNDED AND/OR CO-FUNDED BY T.U.R.F. PROGRAM OF NORTHWEST TURFGRASS ASSOCIATION (NTA)

1998 R & S REQUESTS	*AMOUNT*	*FUNDED BY*
SCHOLARSHIPS:	$4,500.00	NTA
RESEARCH GRANTS:		
OSU-WSU CO-OP PROJECT: (Earthworm Study and Anthracnose Study)	$52,000.00	T.U.R.F. (NTA)
OSU (Development of a computer laboratory in Horticulture Lab)	$5,000.00 $5,000.00	T.U.R.F. (NTA) OREGON GCSA
WSU-PUYALLUP - OSU (Diagnostic Equipment and Supplies for Turfgrass Disease and Extension Education Programs)	$7,500.00	T.U.R.F (NTA)
UBC-VANCOUVER, B.C. CANADA (Second year of 2 YEAR PROJECT -$14,000 (US) requested) (Soil microbe populations and their relationship to plant health)	$7,000.00 $7,000.00	T.U.R.F (NTA) WESTERN CANADA TURFGRASS ASSOCIATION ($10,000.00 CAN) (CO-OP FUNDING)
Coeur d'Alene Resort - Floating Green Leachate Study	$36,000.00	U.S.G.A. $16,000; NTA, $5,000; WCTA, $5,000 (CAN $7,000); IEGCSA, $3,500; OGCSA, $3,500; Western Washington GCSA, $3,000
	$124,000.00 TOTAL FUNDING FOR RESEARCH & SCHOLARSHIP INFLUENCED BY NTA	

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PRESIDENT'S MESSAGE

A special word of thanks to each of you who took the time to attend this year's conference at the Sunriver Resort. This has always been one of our favorite places to go. There are many options from which to choose. You can stay at the lodge, rent a condominium, or even a house. The leisure activities are abundant from bicycling, walking trails, horseback riding and shopping, to name only a few. It is little wonder why Sunriver is such a popular place.

A highlight of our conference is the educational sessions. This year we brought out Dr. Peter Landschoot, Pennsylvania State University, and Dr. Bob Shearman, University of Nebraska. My personal favorite is Dr. Gwen Stahnke, who is always enjoyable and informative. Mr. Paul Backman, who is doing cooperative work with Oregon State University and Washington State University gave an excellent presentation. There are far too many to list each speaker, however, this was a conference to remember.

The Roy L Goss Golf Tournament, benefiting turfgrass research, was held at Crosswater. This has quickly become one of my favorite golf courses. Jim Ramey, golf course superintendent at Crosswater, and the golf course staff without question had the course prepared as well as any I have played.

Although I did not go on the turf tour, many said it was quite good. The tour included sports fields in Bend, a stop at Widgi Creek Golf Club's maintenance shop with attention paid to the state of the art wash water recycling system and came full circle to the Crosswater maintenance facility.

I would like to add here my thanks to all committee people who helped make this conference the success we have come to expect. Next year's conference will be held at the Coeur d'Alene Resort in beautiful Coeur d'Alene, Idaho, where John Anderson will be our host. The education program is already being put together and speakers are being contacted. This is a destination you should not miss. We have been promised great weather, good food and other enjoyable activities. Please consider attending the 1998 Conference, October 4-7, 1998

Tom Wolff
1996-97 President

Shedding Some Light on Anthracnose Basal Rot

Peter Landschoot and Bryce Hoyland, The Pennsylvania State University

When it was first reported in England during the 1950's anthracnose basal rot (ABR) was considered a disease of minor importance. Since that time, however, it has become a serious problem on many *Poa annua* and some bentgrass greens in Europe, Canada, and the northern U.S. Once established, ABR can quickly destroy the stems, crowns, and roots of susceptible turf, thus compromising the playability and appearance of greens.

Superintendents having to deal with ABR often find the experience frustrating. Not only is it difficult to predict where and when the disease will occur, fungicides are often ineffective in controlling the pathogen. Research into the causes and management of ABR is in progress at several universities. Although we are only beginning to understand this complex disease, some advances have been made in determining where and when it occurs, factors that predispose turf to infection, and ways it can be managed.

Two Anthracnose Diseases

Anthracnose basal rot is different in several ways from the more common anthracnose foliar blight (AFB). In fact, some plant pathologists now consider that we have two anthracnose diseases, AFB and ABR. Both these diseases are caused by the same pathogen, *Colletotrichum graminicola*.

On golf courses, AFB is primarily a disease of *Poa annua* fairways but it also can occur in greens. This disease sometimes affects creeping bentgrass fairways and greens, frequently in the early stages of establishment. Anthracnose foliar blight can also attack several other turfgrasses species, including the fine fescues and perennial ryegrass.

Anthracnose foliar blight occurs during periods of hot, humid weather in nearly all *Poa* aimua-growing regions in the U.S. It usually appears as irregular yellow or bronze patches of various sizes in *Poa annua* fairways. Lesions appear on the oldest (outermost) leaves first, then the disease progresses to a blighting of leaves and shoots. Anthracnose foliar blight can be managed by applying moderate amounts of nitrogen fertilizer and fungicides in the summer months.

Anthracnose basal rot has only been reported on *Poa annua* and bentgrasses and is found more often on greens than on fairways and tees. This disease is more common on *Poa annua* than on bentgrass, however, severe ABR outbreaks have occurred on bentgrass in some regions of the country.

We have not observed ABR on bentgrass in Pennsylvania.

In the northeast U.S., ABR can occur at any time of the year, but most outbreaks take place in early spring and in mid summer. On some golf courses the disease only occurs in early spring, whereas on others outbreaks take place only in mid summer. On a few courses, the disease occurs off and on throughout the entire growing season.

Studies of ABR in England showed that *C. graminicola* infects *Poa annua* root and stem tissue just below the crown. The fungus then moves into the crown and gradually works its way up into the stem region above the crown. This mode of infection is different from AFB in which the infection process begins in the leaves and then moves *down* into the stems. The fact that roots and crowns are infected first is one reason why ABR is highly destructive and more difficult to manage than AFB.

Symptoms and Diagnosis

Symptoms of ABR may vary depending on the grass species affected and the time of year the disease occurs. On *Poa annua,* symptoms usually appear as a bright yellowing of turf in irregular patterns. Patches vary in size from an inch or two in diameter to more than a foot across. Sometimes in early spring affected *Poa annua* will take on a bronze or orange color. Bentgrass turf affected with ABR appears as irregular red or bronze colored patches of various sizes and rarely appears yellow.

During the cooler portions of the year ABR-affected *Poa annua* may remain yellow for days or even weeks before succumbing to the disease. On greens composed of Poa *annua* and bentgrass mixtures, the bentgrass is usually not affected and fills in diseased areas almost as quickly as the *Poa annua* dies out. When the disease occurs during hot and humid portions of the growing season affected *Poa annua* may turn yellow and die quickly, leaving large, irregular patches of dead turf that may not recover for weeks. If significant amounts of bentgrass are present in these greens, stolons tend to colonize areas where *Poa annua* died out, but not as quickly as in cooler weather.

The most reliable diagnostic features of ABR are the dark coloration that occurs at the base of the plant and the presence of fungal fruiting structures called acervuli on stems and leaves. On newly-infected plants a dark brown color appears in the crown region. In some cases, this may actually occur just before the foliage begins to turn yellow. As the disease progresses the crowns, roots, and lower stem bases appear black. This is accompanied by yellowing of leaves, starting at the tips of older leaves and gradually progressing to sheathes, younger leaves, and shoots. No prominent lesions are present on leaf blades during the early stages of infection. As crowns and stems begin to turn black, shoots can be easily separated from the crown. Eventually, the plant dies, becoming a tan color with black, rotted tissue covering most of the stem base.

For those who are adept with a Macro-scope® (Turf-Tec International, Oakland Park, FL) or a low power microscope, fungal fruiting structures called acervuli can be observed on stems and leaves. Acervuli look like small pin cushions and contain hundreds of *C. graminicola* spores. Although acervuli are good diagnostic features, they usually develop in the later stages of infection and are not always present on newly infected plants.

Anthracnose Complexes

Some researchers have suggested that other pathogens may be working with *C. graminicola* to cause disease symptoms. When two or more pathogens act together to cause a disease, it is called a disease complex. In the early 1980's, researchers at Michigan State University reported a complex involving *Helminthosporium* fungi, *C. graminicola,* and senescence. The complex was called HAS decline. Another complex that was investigated in Rhode Island focused on the role nematodes play in predisposing bentgrass to ABR.

In a study conducted on velvet bentgrass, University of Rhode Island researchers found that *C. graminicola, Bipolaris sorokiniana, Phialophora graminicola,* and nematodes were associated with ABR. Control trials revealed that fungi cide/nematicide combinations gave good control of the disease in mid summer. It is not known if this complex is wide spread or restricted to a small area in New England. It is also not clear just what role the nematodes play in this complex. Further studies are needed to better understand this relationship and how it affects ABR management.

Situations have occurred in Pennsylvania where ABR and summer patch have been active on greens at the same time. On more than one occasion we have isolated both *C. graminicola* and *Magnaporthe poae,* the causal agent of summer patch, from the same plants. This suggests that an ABR/summer patch complex may exist in some areas. We have also isolated species of *Pythium* and *Rhizoctonia* (along with *C. graminicola)* from samples of ABR-diseased turf, but the role that these pathogens play in the disease, if any, is not understood.

Although complexes do not appear to be commonplace, they do occur from time to time and may explain instances of severe disease outbreaks. Disease complexes could be one reason why ABR is sometimes difficult to control with fungicide programs targeted only at *C. graminicola.*

Factors Affecting Disease Development

ABR is frequently associated with poor soil conditions. In nearly every severe case we have examined, some soil-related problem (i.e. compaction, layering, use of inferior root zone mixes, and/or improper construction) is causing restricted drainage and poor root development, resulting in favorable conditions for the development of ABR.

In several cases, anaerobic conditions in greens resulting from soil layering has led to severe outbreaks of ABR. In these situations we believe that the disease is not the primary problem, but rather, the result of extremely weak plants unable to defend against infection by *C. graminicola*. In such cases, ABR cannot be adequately controlled with fungicides, and will continue to persist until the soil problem is corrected.

Wet or moist soil conditions, especially near the turf/soil surface, appear to be essential for development of ABR. The disease is most likely to occur following periods of rainfall, excessive irrigation, and/or high humidity. Any condition that slows drying of the turf/soil surface, such as overcast periods, shade, poor air circulation, and poor drainage, tends to exacerbate ABR.

Anthracnose basal rot can occur during both cool *and* warm weather. Optimum temperatures for growth of the pathogen are between 70 and 82 ^{0}F, whereas the disease often occurs when temperatures are significantly lower or higher than this range. If temperature *does* play a role in this disease, its effects are probably more strongly related to increasing the susceptibility of the host plant than with favoring the growth of the pathogen. As *Poa annua* growth is slowed and plants are stressed during very cool (early spring) or very warm temperatures (mid summer), it is less able to defend against disease-causing activities of C. *graminicola*. When high temperatures are combined with other stresses such as traffic, topdressing, rolling, double mowing, and extremely low cutting heights, the disease pressure on plants is compounded and severe outbreaks can occur.

Research at Michigan State University has shown that nitrogen (N) fertility is an important factor in managing AFB in *Poa annua* fairways. We assume that N is also important in managing ABR, although there is little published research to substantiate this at the present time. If nothing else, light rates of N-fertilizer will aid in recovery from the disease provided that turf is not over stimulated during periods of heat stress. More research is needed on the effects of N fertility on preventing ABR development.

Wounding

A few years ago we began receiving reports of ABR outbreaks following aeration and/or topdressing operations on *Poa annua* greens. Similar reports were relayed to us by turf specialists from pacific northwest and the midwest. Although there may be several reasons why these outbreaks occur, we think that the main reason is because aerator tines and sand are creating wounds through which *C. graminicola* can enter plants and cause disease. Wounding is an important means through which some *Colletotrichum* pathogens gain entry into their hosts. Studies at Cornell University showed that puncture wounds in corn stalks allow *C gramincola* to incite a disease called anthracnose stalk rot. There is a crown rot disease of banana in which a wound is *required* for *Colletotrichurn* to get into the plant and cause disease.

To determine if our assumptions regarding wounding and ABR were correct, we began a series of experiments to look at how the *type* of wound (abrasion vs. puncture) and *location* of wound influenced ABR. We found that when puncture wounds were made at the crown level and inoculated with *C. graminicola,* ABR developed at a much faster rate than in non-wounded, inoculated plants. Yellowing of leaf tissue and rotting of the crowns occurred immediately following wounding and inoculation. Even wounds in the crown caused by rubbing emery paper on the base of the plant resulted in more diseased plants than with non-wounded plants.

When puncture wounds were made above the crown and inoculated, no obvious symptoms developed regardless of the type of wound (puncture or abrasion). We concluded from these experiments that wounds made in the crowns of Poa ann*ua* predisposed the plants to ABR and that wounds made above the crowns were less important or not important in ABR development.

Although these experiments do not prove that aeration and topdressing are responsible for predisposing *Poa annua* to ABR, they do show that radical puncture wounds as well as abrasion wounds allow *C graminicola* easy entry into the plant at a location where it can cause disease. More elaborate studies are needed to confirm our preliminary experiments and field observations, but in the meantime, we suggest that when ABR is active and when conditions favor disease development, aeration and topdressing with sand be curtailed until these conditions subside.

Management of Anthracnose Basal Rot

Since ABR is associated with poor drainage, compaction, and wet soils, any management practice that you can use to alleviate these conditions such as aeration, redirecting traffic, reduced watering, and tree pruning or removal, will help in reducing ABR severity. Where ABR is associated with severe soil problems such as layering or poor construction, drastic measures may be required to correct the problem before the disease can be adequately controlled.

Like most other root and crown diseases of *Poa annua,* ABR is made worse by placing stress on the plant. Obviously, there is nothing that you can do about adverse weather conditions, but with cooperation from your membership, you may be able to scale back on rolling, reduce mowing frequency, and raise mowing heights during periods of extreme heat stress. If hot, humid weather is forecast, curtail all topdressing and aeration activities.

Our knowledge of fungicide control of ABR is incomplete because of the limited number of trials conducted on greens. Most current recommendations and product label rates are based on tests performed on AFB on *Poa annua* fairways. Until more information becomes available, fungicide programs will have to be based primarily on AFB studies, a few studies conducted on ABR, and on some field observations.

For ABR problems in Pennsylvania, we suggest preventative applications of fungicides, beginning two to four weeks prior to the onset of the disease. Since disease outbreaks can occur at different times of the season even within a small geographical area, we suggest keeping records of when and under what conditions the disease occurs, then use this information as a guide for application timing the following year.

Once fungicide applications begin, we suggest making subsequent applications every two weeks until the threat of severe disease outbreaks has passed. One of the few studies conducted on ABR in California revealed that repeat applications of sterol inhibitor fungicides on 30 day intervals at rates labeled for AFB were not as effective as fungicides applied on a two week schedule.

It may be advantageous to apply low rates of N fertilizer concurrently with fungicide applications during the summer months. This practice has been shown to help control AFB and may also improve ABR control. Several superintendents in Pennsylvania have taken this approach and found that by using rates of 0.2 lb. N/1000 fi^2 per application every two or three weeks during the summer, benefits in disease control were obtained. Further research is required to substantiate these reports.
Studies in Rhode Island, California, and Kentucky on ABR on greens showed that combinations of sterol inhibitor or benzimidizol fungicides and chlorothalonil were effective in controlling ABR when applications were preventative (before the disease appeared) and on two-week intervals. In the Kentucky study, preventative applications of chlorothalonil alone was as effective as a sterol inhibitor/chlorothalonil combination in controlling ABR. Since only a few fungicides at specific rates were used in these trials, we still

have much to learn about chemical control of this disease.

Summary

Anthracnose basal rot is a destructive disease of *Poa annua* and some bentgrass greens in the U.S. It is distinct in several respects from AFB, thus management strategies that may work for AFB may not be successful with ABR. It is important to remember that this disease is associated with poor soil conditions and stressed plants, and unless provisions are made to improve the growing environment of *Poa annua,* control with fungicides may be inadequate.

Currently, our knowledge of this disease is based on limited research and field observations. Over time, our understanding of this disease will improve as will our abilities to manage it.

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RESPONSIBILITIES OF A WSU/OSU RESEARCH ASSOCIATE FUNDED BY THE NTA/WSGA ALLIANCE

Paul A. Backman, Research Associate,
Turfgrass Management, Department of Crop and Soil Sciences,
Washington State University, Puyallup, Washington.

Participation in the Washington Junior Golf Program provided me the opportunity to develop a life long interest in the game of golf I played four years at Olympia High School and two years of collegiate golf at Western Washington University. My golf course maintenance experience includes work at Tumwater Valley Golf Course, construction at Indian Summer Country Club, and Overlake Golf and Country Club.

In 1992 I graduated from Oregon State University with a B.S. in Turfgrass Management, which was partially funded by a Northwest Turfgrass Association Scholarship. After graduation I worked as the Assistant Superintendent at Everett Golf and Country Club for two years. I entered the Pennsylvania State University Master's Program in June of 1995, and graduated with a M.S. in Agronomy in August of 1997. The focus of my thesis project was anthracnose basal rot under the direction of Dr. Peter Landschoot, which lead to my present position.

The position of WSU/OSU Research Associate in Turfgrass Management is important to the turfgrass industry, multi-faceted, and personally rewarding. Many of my duties directly serve NTA members, and research efforts are designed to benefit the turfgrass industry as a whole. Initially, I will concentrate on two long term turfgrass research projects, and also cooperate on other existing or new projects with Dr. Gwen Stahnke and Dr. Eric Miltner.

My first priority is to establish research trials on golf courses in Washington and Oregon to develop an integrated management system for limiting earthworm castings on fairways. Five golf course sites have been selected in order to evaluate different fertilizer treatments and their acidifying affects on soils as a means of suppressing castings. In addition, the effects of liming, topdressing sands, and clipping removal will be assessed.
Developing disease management strategies for creeping bentgrass and annual bluegrass putting greens is my second priority. To accomplish this, I have assisted Dr. Stahnke with current fungicide trials at several existing greens at field sites in Washington. I will establish my own fungicide trials in 1998. Diseases of concern include take-all patch and downy mildew on creeping bentgrass, and anthracnose foliar blight and anthracnose basal rot (ABR) diseases on annual bluegrass.

In the spring of 1998, I plan to establish an annual bluegrass putting green at Farm 5 in Puyallup using aerification cores from putting greens. Hopefully, superintendents who have experienced severe ABR outbreaks will donate their cores following aerification. This research green will be used to test the effects of fertility levels and mowing heights on ABR symptom development. My fungicide work in 1998 will also focus on ABR.

My responsibilities to NTA members include providing turfgrass disease diagnostic services, developing written facts sheets, and presentations at conferences on current issues facing superintendents in the Northwest. In order to make the information more readily available, we will be creating and maintaining a web page to focus on seasonal trends in disease activity, appropriate management strategies, and other pertinent information. Our goal is to have the web page available to the industry before spring of 1998. Look for the web page add in your NTA newsletter.

I am excited about returning home to the Pacific Northwest to work with the NTA membership which includes so many of my friends and colleagues. I will be working very hard with Dr. Stahnke and Dr. Miltner to serve your industry needs. Please feel free to contact me for information about the disease diagnostic services or written facts sheets. I am available at *(253)*4454591 or by e-mail: backman@wsu.edu.

NTEP: Now & The Future!

Robert (Bob) C. Shearman; Executive Director,
National Turfgrass Evaluation Program;
377 Plant Science; Lincoln, Nebraska. 68583-0724

The National Turfgrass Evaluation Program (NTEP) is one of the most widely-known
turfgrass research programs in the world. The NTEP was created in 1980. This program was the brain child of Jack Murray, a USDA-ARS Turfgrass Scientist. Unfortunately, we lost Jack to cancer, but before he passed away he laid the ground work for NTEP as it exists today. He along with a number of individuals involved with NE-169 (i.e. Northeast Turfgrass Regional Research Committee) generated cooperative cultivar research and were instrumental in creating a sound scientific structure for the first U.S. regional turfgrass trial.

In 1968, the Regional Research Project initiated a cooperative trial to evaluate Kentucky bluegrass (Poa pratensis) at nineteen locations in the northeast and central U.S. Forty-three cultivars and experimental lines were chosen to evaluate with the entries being split between commercially available cultivars and experimental lines. Entries were chosen to represent diverse origins and a wide spectrum of Kentucky bluegrass plant growth types. As a result, about one-third (13) of the forty-three entries included were developed and owned by European breeding companies. Discussions ensued on appropriate plot size, seeding rate, management of trials, rating of turfgrass quality and other factors, statistical analysis needs, data reporting and interpretation of results that formed the foundation for much of the initial structure of NTEP. Also, NTEP still uses locations with varying soil types, textures and environments as was the case in the 1968 regional evaluations. That first regional evaluation was complted in 1972, with a new regional evaluation established in fall 1972.

In 1980, a national Kentucky bluegrass test was proposed. About 50 cooperators in the U.S. volunteered to evaluate this test. Eighty-four entries were included in this trial. No entry fees were charged for this first national test nor were evaluators paid for testing the entries. All work was done on a volunteer basis including the coordination of entry submission, data collection, data analysis and reporting. Researchers and extension educators found the tests invaluable in learning about commercially available varieties and new experimental selections. Seed companies and plant breeders could quickly learn where grasses performed best and under what management conditions. Locating the plots at mainly state university locations allowed them to be viewed by many people at field days.

With the success of the 1980 National Kentucky Bluegrass Test, NTEP decided to coordinate a national perennial ryegrass test in 1982. This test was the beginning of NTEP tests that required payment of an entry fee. The entry fees helped NTEP to hire a full-time Technical Coordinator and is now the basis for NTEP operations. From 1983-86, NTEP continued with new tests of tall fescue, fine leaf fescue, bentgrass, and bermudagrass. In 1989, a St. Augustinegrass test was initiated, with buffalograss and zoysiagrass tests organized in 1991.

From its beginnings, it has expanded to the evaluation of seventeen turfgrass species in over 40 states and six Canadian provinces. Currently, NTEP is testing more than 600 cultivars and experimental lines. The information collected and summarized by NTEP is currently requested by individuals and companies in 30 countries. Additionally, many more people are exposed to NTEP data and information through its publications in trade journals and its web page on the internet (i.e. www.ntep.org/ntep).

Seed companies rely heavily on NTEP data to advertise and sell turfgrass varieties. Plant breeders use NTEP data to determine the adaptability and utility of experimental cultivars. Turfgrass researchers and extension personnel use NTEP data to make variety recommendations. Local and state government entities, such as parks and highway departments, use NTEP for writing specifications on turfgrass purchasing. Most important, the golf course superintendent, athletic field manager, parks and grounds manager, lawn care operator, sod grower and homeowner use NTEP extensively before purchasing seed or sod. It is the acceptance by the end-user that has made NTEP the standard for turfgrass evaluation in the USA and many other countries worldwide.

NTF headquarters is located at the United States Department of Agriculture (USDA), Beltsville Agricultural Research Center (BARC) in Beltsville, Maryland. The NTEP has a cooperative research agreement with USDA to conduct its business at BARC. USDA provides offices, a greenhouse, experimental field areas, seed storage and equipment facilities in support of NTEP. NTEP does not receive any direct funding from USDA; it funds 95% of its operating expenses by charging entry fees for turfgrass evaluations.

The NTEP operates like a corporation. The NTEP Policy Committee determines policy and procedures for NTEP and the members of the Policy Committee are its only members. In this way, the Policy Committee acts like a board of directors. This unusual arrangement allows the NTEP Policy Committee to control of the finances, resources and direction of NTEP. Currently, the following groups or organizations have one representative on the NTEP Policy Committee:

Regional Research Committees

Northeastern Regional Turfgrass Committee (NE-169)
Southern Regional Information and Exchange Group (SRIEG-16)
North Central Regional Turfgrass Committee (NCR-10)
Western Regional Coordinating Committee (WRCC-11)

Industry Membership Associations

American Seed Trade Association - Lawn Seed Division (ASTA)
Golf Course Superintendents Association of America (GCSAA)
Turfgrass Breeders Association (TBA)
Turfgrass Producers International (TPI)
United States Golf Association (USGA)

The four regional turfgrass committees represent the four major geographical regions in the U.S. Individuals involved in these committees are mainly turfgrass scientists from state universities. Each regional committee selects their NTEP representative. Their representation on the Policy Committee gives a broad perspective on the problems and research needs across the U.S.

The industry membership associations appoint individuals to represent their segment of the turfgrass industry. The ASTA members are companies that develop, produce, buy and sell seeds. GCSAA is a large membership organization serving the needs of the more than 14,000 golf course superintendents in the U.S. The TBA represents the needs and concerns of the public and private turfgrass breeders in the U.S. The TPI is an international association that provides information and resources to turfgrass sod producers. Finally, the USGA is involved in many aspects of golf including coordination of the U.S. Open and U.S. amateur tournaments, defining and administering the rules of golf and the handicap system in the U.S., determining what golf equipment (i.e., clubs, balls, etc.) is legal or illegal and extensive turfgrass research funding in the U.S.

The NTEP Executive Director and National Program Coordinator are non-voting members of the Policy Committee. The broad representation of private and public members gives the Policy Committee excellent perspective on the issues facing the turfgrass industry and how NTEP might address those issues.

Successful variety evaluations require considerable planning and forethought. First, the NTEP Policy Committee produces a testing schedule for the next three to five years. Scheduling tests up to five years in advance gives seed companies and plant breeders the time needed to evaluate experimental selections and choose the most promising for further evaluation. One to two years is needed to produce sufficient quantities of seed for entry into NTEP tests. The advance scheduling is important to university cooperators as they can better plan future field studies and the most efficient use of land resources.

Next, information is mailed to seed companies and plant breeders announcing the upcoming test. This official announcement is made 10-12 months in advance of the deadline for seed to be received at NTEP headquarters in Beltsville, Maryland. Included with the announcement is a questionnaire concerning the approximate number of entries each company will submit. Companies are not held to these numbers. At the same time, a questionnaire is mailed to university scientists to solicit those interested in evaluating this test. After the questionnaires are received and compiled, an advisory committee consisting of members from universities and industry make suggestions on the site locations, test management levels (i.e., fertility, mowing height and frequency, irrigation, etc.), seeding rates, standard entries and additional test data to be collected. For instance, the tall fescue advisory committee may suggest that traffic tolerance and brown patch resistance are two important testing needs. The NTEP administration would then seek locations that can adequately evaluate those characteristics. Additional funding is given to locations that perform these additional evaluations (called ancillary studies). In addition, funding proposals are often submitted by researchers. The advisory committee and the NTEP administration evaluate each proposal based on merit, cost and relevance of the research and makes a determination on whether to fund or not to fund.

Data are collected by cooperators at each university location and then submitted to NTEP at the end of the growing season. Data must be submitted to NTEP by February 1 following the year the data was collected. This allows NTEP to review, analyze and publish the data in a timely manner. Data for a particular year is published and released four to six months after the end of the calendar year. The data are statistically analyzed using an ANOVA (Analysis of Variance) procedure. ANOVA compares the data collected across replications and entries in terms of their means and variability. When all data sets have been reviewed, NTEP staff starts the summary report. Data are pooled and statistically analyzed using an LSD (Least Significant Difference) procedure. Data is analyzed over locations and months for turfgrass quality. Data is presented in computer generated table format. Data on individual characteristics such as genetic color, leaf texture, diseases, etc.

are analyzed separately and printed in its own table.

The National Turfgrass Evaluation Program (NTEP) Encourages the proper and ethical use of its data. Data should not be referenced out of context, nor should a cultivar's performance be elevated beyond the supporting NTEP data. Users of this data are encouraged to utilize complete tables, excluding only experimental lines not commercially available. If part of a table is used, the top and bottom cultivars should be listed and reference should be made to the fact that the entire table is available upon request. Tables should always reference the LSD value, the test location, the year test was established, the date(s) of data represented and indicated whether the data are means of 1-month, 1-year, or several years (Tables 1-3).

Readers and users of this data should be aware that cultivar differences are based on use of Least Significant Difference (LSD) statistics for mean separation. Each table contains a LSD value(s). To determine whether a cultivar's performance is truly different from another, subtract one entry mean from another entry mean. If this value is larger than the LSD value, the observed difference in cultivar performance is significant. For example, If the mean turfgrass quality value for cultivars "X" and "Y" are 7.0 and 5.0, respectively, and the LSD value for this test is 1.0, the difference between "X" and "Y" is 2.0. This difference exceeds the LSD value of 1.0, so cultivar ""X" truly differs from cultivar "Y" in its quality performance based on the conditions of this test. It is not out of reason for several cultivars in test to not be significantly different from one another, even though they may have different values. Therefore, always reference the LSD value when interpreting the test results.

The summary report (progress report) for that years' data is formatted, reviewed for errors and printed. These summary reports are mailed to thousands of individuals and companies. The reports are also loaded onto the NTEP World Wide Web site (http://www.ntep.org/ntep). All NTEP Progress reports produced in one year can be obtained by becoming a member of NTEP, a $30.00 annual fee.

Table 1. 1993 NATIONAL BENTGRASS TEST (Greens)- Entries and Sponsors

Entry No.	Name	Species	Sponsor
1	18th Green	creeping	Zajac Performance Seeds/Johnson Seeds, Ltd.
2	Regent	creeping	Barenbrug USA
3	BAR As 492	creeping	Barenbrug Holland
4	BAR Ws 42102	creeping	Barenbrug Holland
5	Trueline	creeping	Turf Merchants
6	Seaside	creeping	Standard entry
7	Cato	creeping	Pickseed West, Inc.
8	PRO/CUP	creeping	Forbes Seed & Grain, Inc.
9	Crenshaw	creeping	Loft's Seed, Inc.
10	Southshore	creeping	Loft's Seed, Inc.
11	Providence	creeping	Seed Research of OR, Inc.
12	SR 1020	creeping	Seed Research of OR, Inc.
13	Century (Syn 92-1)	creeping	E. F. Burlingham & Sons
14	Backspin (Syn 92-2)	creeping	Turf Merchants, Inc.
15	Imperial (Syn 92-5)	creeping	E. F. Burlingham & Sons
16	Penncross	creeping	Standard entry
17	Penn A-1 (A-1)	creeping	Tee-2-Green Corp.
18	Penn A-4 (A-4)	creeping	Tee-2-Green Corp.
19	Penn G-2 (G-2)	creeping	LESCO, Inc.
20	Penn G-6 (G-6)	creeping	Tee-2-Green Corp.
21	Pennlinks	creeping	Tee-2-Green Corp.
22	DG-P	creeping	ProSeeds Marketing
23	MSUEB	creeping	Mississippi State Univ.
24	Loft's L-93 (L-93)	creeping	Loft's Seed, Inc.
25	Lopez	creeping	Finelawn Research, Inc.
26	Tendenz	colonial	Finelawn Research, Inc.
27	ISI-Ap-89150	creeping	International Seeds, Inc.
28	Mariner (Syn-1-88)	creeping	Pickseed West, Inc.

Table 2. LOCATIONS SUBMITTING DATA FOR 1996

State	Location	Code
Arizona	Tucson	AZ1
Iowa	Amesl	A1
Illinois	Urbana	IL1
Illinois	Carbondale	IL2
Kansas	Manhattan	KS1
Kentucky	Lexington	KY1
Massachusetts	Amherst	MA1
Michigan	East Lansing	MI1
Minnesota	St. Paul	MN1
Missouri	Columbia	MO1
Mississippi	Mississippi State	MS1
New Jersey	North Brunswick	NJ1
Oklahoma	Stillwater	OK1
Pennsylvania	University Park	PA1
Quebec	Quebec	QE1
Rhode Island	Kingston	RI1
South Carolina	Florence	SC1
Texas	Dallas	TX1
Virginia	Blacksburg	VA1
Washington	Pullman	WA1
Washington	Puyallup (Native Soil)	WA3
Washington	Puyallup (Sand)	WA4
Wisconsin	Madison (Native Soil)	WI1
Wisconsin	Madison (Sand)	WI2

TABLE 3. 1996 LOCATIONS, SITE DESCRIPTIONS AND MANAGEMENT PRACTICES IN THE 1993 NATIONAL BENTGRASS (GREEN) TEST

LOCATION	SOIL TEXTURE	SOIL PH	SOIL PHOSPHOROUS (LBS/ACRE)	SOIL POTASSIUM (LBS/ACRE)	NITROGEN (LBS/1000 SQ FT)	SUN OR SHADE	MOWING HEIGHT (IN)	IRRIGATION PRACTICED
AZ1	SAND	7.6-8.5	0-60	0-150	5.1-6.0	FULL SUN	0.0-0.5	TO PREVENT STRESS
IA1	SILTY CLAY LOAM	7.1-7.5	0-60	241-375	3.1-4.0	FULL SUN	0.0-0.5	TO PREVENT STRESS
IL1	SILT LOAM AND SILT	6.1-6.5	0-60	376-500	3.1-4.0	FULL SUN	0.0-0.5	TO PREVENT STRESS
IL2	SILTY CLAY LOAM	6.1-6.5	51-270	151-240	4.1-5.0	FULL SUN	0.0-0.5	TO PREVENT STRESS
KS1	SILT LOAM AND SILT	6.6-7.0	151-270	241-375	4.1-5.0	FULL SUN	0.0-0.5	TO PREVENT STRESS
KY1	SAND	7.1-7.5	0-60	241-375	4.1-5.0	FULL SUN	0.0-0.5	TO PREVENT STRESS
MA1	SILT LOAM AND SILT	6.1-6.5	61-150	151-240	3.1-4.0	FULL SUN	0.0-0.5	TO PREVENT STRESS
MI1	SAND	7.6-8.5	61-150	1 51-240	6.1-7.0	FULL SUN	0.0-0.5	TO PREVENT STRESS
MN1	SILTY CLAY LOAM	7.1-7.5	151-270	0-150	5.1-6.0	FULL SUN	0.0-0.5	TO PREVENT STRESS
MO1	SAND	6.6-7.0	151-270	151-240	5.1-6.0	FULL SUN	0.0-0.5	TO PREVENT STRESS
MS1	SAND	5.6-6.0	61-150	0-150	4.1-5.0	FULL SUN	0.0-0.5	TO PREVENT STRESS
NJ1	SANDY LOAM	6-6.0	271-450	241-375	2.1-3.0	FULL SUN	0.0-0.5	TO PREVENT STRESS
OK1	SAND	6.6-7.0	61-150	241-375	4.1-5.0	FULL SUN	0.0-0.5	TO PREVENT STRESS
PA1	LOAMY SAND	6.1-6.5	61-150	0-150	2.1-3.0	FULL SUN	0.0-0.5	TO PREVENT STRESS
QE1	-	-	-	-	-	-	-	-
RI1	SILT LOAM AND SILT	6.6-7.0	-	0-150	4.1-5.0	FULL SUN	0.0-0.5	TO PREVENT STRESS
SC1	SANDY LOAM	6.1-6.5	-	-	5.1-6.0	FULL SUN	0.0-0.5	TO PREVENT STRESS
TX1	LOAMY SAND	6.1-6.5	0-60	0-150	7.1-8.0	FULL SUN	0.0-0.5	TO PREVENT STRESS
VA1	-	-	-	-	-	-	-	-
WA1	SILT LOAM AND SILT	5.6-6.0	271-450	501+	2.1-3.0	FULL SUN	0.0-0.5	TO PREVENT STRESS

WA3	SANDY LOAM	5.6-6.0	61-150	241-375	5.1-6.0	FULL SUN	0.0-0.5	TO PREVENT STRESS
WA4	SAND	6.1-6.5	0-60	151-240	7.1-8.0	FULL SUN	0.0-0.5	TO PREVENT STRESS
WI1	SILT LOAM AND SILT	7.1-7.5	271-450	376-500	2.1-3.0	FULL SUN	0.0-0.5	TO PREVENT STRESS
WI2	SILT LOAM AND SILT	7.1-7.5	271-450	376-500	2.1-3.0	FULL SUN	0.0-0.5	TO PREVENT STRESS

TABLE 3. (C0NT'D) FUNGICIDE USE IN 1996 (SUBMITTED TO NTEP)

LOCATION	FUNGICIDE	RATE (OZ/1000 SQ. FT.)	DATE(S) OF APPLICATION
KY1	CHOLOROTHALONIL	-	CURATIVE
NJ1	IPRODIONE	3	6/13, 7/23
	CHOLOROTHALONIL	6	7/1
MN1	CHOLOROTHALONIL	-	TWO APPLICATIONS
	MANCOZEB	-	ONE APPLICATION
OK1	CHOLOROTHALONIL	11	6/14, 7/3, 8/12
	CHOLOROTHALONIL	10	4/23, 7/23
	CHOLOROTHALONIL	8	5/10, 5/30, 8/27
	CHOLOROTHALONIL	6	6/21
	PROPAMOCARB	2	5/10
	PROPICONAZOLE	0.75	8/27
PA1	CHOLOROTHALONIL	4	JULY, AUG., SEPT. (TWICE)
	IPRODIONE	2	JULY, AUG., SEPT. (TWICE)
	TRIADIMEFON	0.1	JULY, AUG., SEPT. (TWICE)
TX1	CHOLOROTHALONIL	6	1/24, 3/18, 4/3, 4/23, 5/28, 6/3, 6/17, 7/15, 7/22, 8/14, 9/3, 9/17, 10/3, 10/22,
		1	1/21, 12/3, 12/12
	MANCOZEB	8	5/13
	BENZAMIDE	4	5/6
	BENZAMIDE	3	11/21, 12/12
	BENZAMIDE	2	6/17

TABLE 4. MEAN TURFGRASS QUALITY RATINGS OF BENTGRASS CULTIVARS FOR EACH MONTH GROWN ON A GREEN AT TWENTY-FOUR LOCATIONS IN THE U.S. AND CANADA
1996 DATA

TURFGRASS QUALITY RATINGS 1-9; 9 =IDEAL TURF: MONTHS 1/

NAME	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
LOFTS L-93 (L-93)	5.6	6.1	6.2	6.4	6.5	6.8	6.9	7.1	7.0	6.9	5.6	4.7	6.6
PENN A-1 (A-1)	5.3	5.9	6.5	6.5	6.3	6.6	6.9	6.8	6.9	6.9	5.8	5.0	6.5
PENN A-4 (A-4)	5.9	6.6	6.6	6.4	6.1	6.8	6.8	6.9	6.7	6.8	5.3	4.8	6.5
PENN G-2 (G-2)	5.3	5.8	6.3	6.0	6.2	6.5	6.6	6.6	6.6	6.8	5.3	5.0	6.3
CATO	4.8	5.9	6.3	6.2	6.0	6.6	6.9	6.8	6.6	6.5	4.9	4.3	6.3
PROVIDENCE	5.3	5.8	6.1	6.4	6.1	6.5	6.6	6.4	6.5	6.3	5.3	4.5	6.3
PENN G-6 (G-6)	4.7	5.4	6.4	6.2	5.9	6.3	6.6	6.4	6.3	6.5	5.1	4.7	6.2
SOUTHSHORE	4.9	5.8	6.0	6.2	6.1	6.4	6.5	6.2	6.2	6.2	5.0	4.4	6.1
CENTURY (SYN 92-1)	5.2	6.1	6.6	6.0	5.9	6.5	6.2	6.3	6.2	6.2	5.1	4.8	6.1
IMPERIAL (SYN 92-5)	5.0	5.4	6.0	5.8	5.9	6.4	6.2	6.4	6.3	6.3	5.1	4.8	6.1
BAR WS 42102	4.1	5.1	5.5	5.8	5.8	6.3	6.4	6.4	6.1	5.9	4.8	4.2	6.0
BACKSPIN (SYN 92-2)	4.6	5.7	5.9	5.7	5.7	6.3	6.3	6.4	6.1	5.9	5.1	4.5	5.9
PENNLINKS	4.8	5.2	5.6	5.7	5.8	6.1	6.1	6.0	6.3	6.1	4.9	4.4	5.9
DG-P	5.1	5.5	5.8	5.9	5.6	6.1	6.2	5.9	6.2	6.0	5.1	5.1	5.9
SR 1020	4.9	5.7	6.4	5.7	5.7	5.9	6.1	6.1	6.1	6.1	5.2	4.6	5.9
CRENSHAW	4.1	4.5	5.8	5.5	5.5	6.1	6.4	6.3	6.1	6.1	4.9	4.2	5.8
ISI-AP-89150	5.0	5.5	5.8	5.7	5.6	6.0	5.9	5.9	6.0	5.9	5.4	4.7	5.8
REGENT	4.7	5.3	5.4	5.4	5.6	6.0	6.0	5.9	6.0	5.9	5.1	4.6	5.8
PRO/CUP	4.4	4.9	5.4	5.8	5.7	6.0	6.1	5.8	5.9	5.8	4.7	4.3	5.7
TRUELINE	4.2	5.0	5.3	5.6	5.6	6.0	6.1	5.8	6.0	5.8	4.8	4.0	5.7
MSUEB	5.0	5.2	4.9	5.6	5.5	5.8	6.1	5.8	6.1	5.8	4.6	4.5	5.7
LOPEZ	4.4	4.8	5.5	5.6	5.5	6.0	6.0	6.0	5.9	5.9	4.4	4.2	5.7
MARINER (SYN-1-88)	5.0	4.8	5.2	5.2	5.2	5.6	5.7	5.7	5.7	5.5	4.7	4.4	5.4
PENNCROSS	4.5	5.0	5.0	5.3	5.3	5.6	5.8	5.5	5.7	5.5	4.7	4.3	5.4
18TH GREEN	3.8	4.7	5.5	5.1	5.3	5.7	5.9	5.7	5.4	5.1	3.9	3.8	5.3
SEASIDE	4.3	4.0	4.6	4.2	4.2	4.6	4.6	4.6	5.0	4.5	4.4	4.2	4.6
BAR AS 492	3.9	4.1	4.0	4.1	4.2	4.4	4.5	4.8	5.0	4.4	4.4	3.8	4.4
TENDENZ	3.8	3.9	4.4	4.4	4.3	4.5	4.4	4.3	4.5	4.2	4.1	3.8	4.3
LSD VALUE	1.0	0.9	0.9	0.6	0.5	0.4	0.4	0.5	0.5	0.5	0.9	1.1	0.4

1/ TO DETERMINE STATISTICAL DIFFERENCES AMONG ENTRIES, SUBTRACT ONE ENTRY'S MEAN FROM ANOTHER ENTRY'S MEAN. STATISTICAL DIFFERENCES OCCUR WHEN THIS VALUE IS LARGER THAN THE CORRESPONDING LSD VALUE (LSD 0.05).

1997 WSU-Puyallup Research Update: Biocontrol of Fusarium patch and Take-all patch and Anthracnose Fungicide Trials

by Dr. Gwen K. Stahnke, Carrie Foss and Coleen Pidgeon,
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Field testing of antagonistic microorganisms for Fusarium patch control

In the spring of 1997, field trials were set up to test the reduction in development of Fusarium patch, *Microdochium nivale,* using antagonistic microorganisms and two fungicides, on a Poa/bentgrass sand putting green at the Farm 5 research facility at WSU-Puyallup. The experimental design was a randomized complete block with five replications. Plots were 5' by 5'. The seven treatments included: (1) Control, (2) Pathogen/Control, (3) 2-79 and (4) Q2-87, both fluorescent pseudomonads, (5) a mixture of *2-79/Q2-87,* (6) PCNB, a contact fungicide at 8 oz./1000 sq. ft. and (7) Heritage, a new fungicide chemistry at 0.4 oz./1000 sq. ft.. The two antagonists were chosen after two years of screening several known antagonistic microorganisms for suppression of Fusarium patch under greenhouse conditions.

The field experiment was fertilized with 2, 0.25 lb. N applications of urea prior to innoculation with the antagonistic microorganisms or the *Microdochium* spores. Antagonists were applied using a hand held sprayer on March 10 and 11,1997. On March 12, *Microdochium* spores at a concentration of 1.9×10^5 were applied to the plots using the same method. The *Microdochium* spores were washed from 147 plates that had been cultured one month prior to the experiment. Colony forming units (CF U's) were made after the pathogen application to determine the actual survival of antagonists on the turfgrass plants. PCNB and Heritage were applied on March 14, 1997.

Two weeks later on March 24 and 25, another application of antagonists was applied. Disease ratings were made at 4 weeks after the pathogen application or 2 weeks after the second set of antagonist applications (2 WAT). Table 1 shows that at 2 WAT, only PC NB, had significantly less disease than the control. At 4 WAT, (Table 2), both the PCNB and Heritage had a significant reduction in percent Fusarium patch and did not show any disease symptoms. The antagonistic microorganisms reduced the *Microdochium* spore numbers at 4 WAT, however, there was no statistical difference from the control. There was no synergistic effect on reducing the percent disease observed when the mixture of the two antagonists was applied, either. In fact, there was a slight increase in percent disease observed when the antagonistic mixture was applied as opposed to applying the antagonists separately.

At this point in the research, with no significant differences in disease reduction observed with applications of antagonistic microorganisms, it is necessary for a commercial company to work with the antagonist formulations, application techniques and timing of applications to try and increase efficacy of the antagonists. Our antagonist applications were not successful in reducing Fusarium patch. Only fungicide applications were effective in reducing the percent Fusarium patch present on the site at this time.

Take-all patch fungicide trials

Take-all patch, *Gaeumannomyces graminis* var. *avenae,* is a serious patch disease of bentgrass. It is usually most serious on newly constructed sand putting greens and tees planted with bentgrass. Two research sites were developed in fall of 1996 and followed into the fall of 1997 to test the efficacy of fungicide applications in controlling Take-all patch. Bentgrass putting greens at both Clover Park Technical College, Tacoma, WA and at Emerald Heights Retirement village, Redmond, WA, had severe Take-all patch symptoms. The results were similar for both test sites, so only the data from Emerald Heights will be discussed in this report. The putting green at Emerald Heights was planted to 'Providence' creeping bentgrass in spring of 1995. Large tan-orange colored patches from 8 to 18 inches in diameter appeared on the green by summer of 1996. The green was under a very low fertility program with little to no aeration or sand topdressing occurring initially. The experiment was set up as a randomized complete block with 8 treatments and 4 replications. The treatmens included: (1) Untreated, (2) Rubigan 2.7 lb. ai./A, spring (S), (3) Rubigan 1.4 lb. ai./A, 2 spring apps., 30 days apart (2S), (4) Rubigan 2.7 lb. ai./A, fall (F), (5) Rubigan 1.4 lb. ai./A, 2 fall apps., 30 days apart (2F), (6) Rubigan 1.4 lb. ai./A (25,2F), (7) Banner 1.8 lb. ai./A (S,F), and (8) Banner 1.6 lb. ai./A (2S, 2F). The first fungicide application was made on September 13,1996. A ninth treatment, Heritage at 0.4 oz./1000 sq. ft., was added in spring of 1997 as material became available for testing.

Two weeks after the initial fungicide application, the plots were rated for percent Take-all patch. Table 3 shows that the untreated plots had as much as 30% of the area infected with the disease. All of the fall fungicide applications significantly reduced the amount of disease present. The split applications of Rubigan and Banner were made 30 days later and rated on November 29, six weeks after the second fungicide application (6 WAT). Table 4 (10 WAT), shows a significant reduction in percent Take-all patch for all fall applications, with no difference between the split application and full application rates at this time. The untreated plots had 25% of the area affected by Take-all patch, while treated areas varied from 0 to 2% affected.

Fungicide application timings were based on average soil temperatures taken at a one inch depth at 10 a.m.. When soil temperatures were between 54 F to 68 F for three days in spring or late summer, the first fungicide application was made to the area. This timing schedule is based upon work done by Dr. Hank Wilkinson at University of Illinois, on the ideal time for infection of the crown and roots of the turfgrass plants. When temperatures are above or below the temperature range previously listed, conditions are not conducive for the fungus to attack the bentgrass. By using this soil temperature method, it is hoped to get maximum efficacy from the fungicides and still prevent disease development.

On April 10,1997, the soil temperatures had reached the appropriate levels for a fungicide application to be made. Disease ratings were made before the first fungicide application. Table 5 shows that there were still significant reductions in percent disease (17%) in the plots which had received a fall fungicide application. The second spring fungicide application was made on May 9, for those fungicides with split applications. By May, even the untreated plots showed a 15% reduction in Take-all patch. This was due to an improved fertility program on the green and aerification and topdressing of the green in late April. The plots were rated for percent Take-all patch on June 26, six weeks after the second spring fungicide application. Table 6 shows that all fungicide applications significantly reduced the disease, however those applications made in spring and those with spring/fall combinations reduced the incidence of Take-all patch to almost zero.

Soil temperatures were again monitored and the green was observed for symptoms. The first fall fungicide application in 1997 was made on August 22. Before the plots were treated, a percent disease rating was done. The infection level in the untreated plots had risen from 4.3% in June to 35% in August (Table 7). All treatments except Banner (S,F) and Rubigan 2.7 lb. ai./A (F) significantly reduced the percent Take-all patch present. Even though statistically the Rubigan 1.14 lb. ai./A (25,2F) was not different than the other spring applied fungicides, it was the only treatment which had no symptoms of Take-all patch developing on the plot area at the time of the first fall fungicide application. The other fungicide applications that were not statistically different, ranged from 14.3% to 4.3% Take-all patch present. The plots were rated again on September24, before the second fall fungicide application was made. The untreated plot had 36% area affected and was significantly different again from all fungicide aplications. Both Banner application rates had significantly greater disease present (21.3% and 17.3%) than the Heritage 0.4 oz./1 000 sq. ft. and Rubigan 1.4 lb. ai./A (28, 2F), (1% and 0.5%) respectively. All Rubigan applications showed significant disease reduction, however only the Rubigan 1.4 lb. ai./A (2S, 2F) had less than 1% Take-all patch present in the plots (Table 8).

Evaluations are continuing on the research site into the spring of 1998 to determine if Take-all symptoms continue to develop without further fungicide applications. At the present time, it would appear that no matter which fungicide is used, both spring and fall applications are necessary to keep symptoms of Take-all patch from developing. Our soil temperatures in the Pacific Northwest remain in the optimum infection range for a long period of time, thus allowing for greater infection throughout the spring and fall. From current disease ratings, it appears that the fall infection is more severe than the spring infection. Perhaps this is because of the continued slow growth of the bentgrass in the fall, whereas in the spring, the soil temperatures are just getting warm enough for the bentgrass to take off in a growth spurt and grow partially out of the symptoms as the soil temperatures rise. The Rubigan 1.4 lb. ai./A (25,2F) and the Heritage 0.4 oz./1000 sq. ft. (2S, 1F) were the most effective fungicide appications in reducing the incidence of Take-all patch. The lower rate of Heritage (0.2 oz./1000 sq. ft.) was not included in this study due to lack of space on the site. This rate should be investigated as to its potential, although even with 2 applications of Heritage at 0.4 oz./1 000 sq. ft. in spring in the current study, there was still 7.5% of the plot area affected by Take-all patch symptoms in the fall.

Anthracnose fungicide trials

Anthracnose is another disease which has become more prevalent on both *Poa* and bentgrass greens. This is primarily due to lower mowing heights, reduced fertility rates and increased stresses on the turfgrass plants in order to achieve faster putting surfaces. This trial was conducted in cooperation with Dr. Gary Chastagner, WSU-Puyallup Plant Pathologist. The study began late in the season (August) at the High Cedars Golf Course, Orting, WA, on their #8 green on the Executive Course. The disease was very well established on the plot area before the first fungicide application was ever made. The study was designed as a randomized complete block with five replications. The six treatments consisted of: (1) Untreated, (2) Daconil 3 lb. ai./A, (3) Daconil 6 lb. ai./A, (4) Daconil 15 lb. ai./A, (5) Heritage 0.2 oz./1000 sq. ft., and (6) Heritage 0.4 oz./1000 sq. ft.. The two low rates of Daconil and the 0.2 oz./1000 sq. ft. rate of Heritage were applied every 14 days, while the 15 lb. ai./A rate of Daconil and 0.4 oz./1000 sq. ft. rate of Heritage were applied every 30 days.

The first fungicide application was made on August 15,1997 and 1 week after treatment (1 WAT), only the 0.4 oz. rate of Heritage had significantly less disease than all other treatments and the untreated plots. On August 29, 2WAT, all fungicide treatments had significantly less disease than the untreated plots. The 3 lb. ai./A rate of Daconil had the most disease after the untreated plots, while the other four fungicide treatments were not significantly different from each other, but were significantly different from the control. Both rates of Heritage also had significantly less disease than the 3 lb. rate of Daconil (Table 9).

The second fungicide applications of the low rates of Daconil and Heritage were applied on August 29,1997. Four days after the second application, the disease rating showed that the 15 lb. ai./A rate of Daconil and both rates of Heritage had significantly less disease symptoms than the untreated plots (Table 10). The study was conducted for another two weeks, and a third fungicide application was made for the low fungicide rates, while a second fungicide application for the high fungicide rates was applied. Disease symptoms were rated four days after the last fungicide treatment. Only the 0.4 oz. rate of Heritage had significantly less disease symptoms than the untreated plots (Table 11). The previously low disease symptoms of the 0.2 oz. Heritage rate increased 3-fo1d to be no different than the untreated plots over the two-week period. The stress on the *Poa* was high enough that only the high rate of Heritage was effective in reducing the amount of anthracnose symptoms and allowed for some recovery of the turfgrass.

Table 1. Percent Fusarium patch disease on 4/11/97 on a *Poa*/bentgrass putting green 2WAT

Treatment	% Disease	
Mixture	12.8	a
Pathogen/Control	10.0	ab
Heritage, 0.4 oz/M	6.8	ab
2-79	6.6	ab
Q2-87	5.8	ab
Control	5.6	ab
PCNB, 8 oz./M	3.2	b

Table 2. Percent Fusarium patch disease on 4/22/97 on a *Poa*/bentgrass putting green 4WAT.

Treatment	% Disease	
Control	29.4	a
Mixture	25.2	a
Pathogen/Control	24.4	a
2-79	22.8	a
Q2-87	18.0	a
Heritage, 0.4oz./M	0	b
PCNB, 8oz./M	0	b

Table 3. Percent Take-all Patch on 9/27/96, 2WAT.*

Treatment	% Disease	
Untreated	30	a
Rubigan, 2.7 lb.a.i./A, (S)	23	ab
Rubigan, 1.4 lb.a.i./A, (2S)	18.8	abc
Banner, 1.6 lb.a.i./A, (S,F)	16.3	bc
Rubigan, 2.7 lb. a.i./A, (F)	14.3	bc
Rubigan, 1.4 lb. a.i./A, (2F)	11.3	bc
Banner, 1.6 lb.a.i./A, (2S,2F)	11	bc
Rubigan, 1.4 lb.a.i./A, (2S,2F)	8.8	c

*Emerald Heights Ret. Village, Redmond WA

Table 4. Percent Take-all Patch on 11/29/96, 10WAT.*		
Treatment	% Disease	
Rubigan, 2.7 lb. a.i./A, (S)	31.3	a
Untreated	25	ab
Rubigan, 1.4 lb.a.i./A, (2S)	17.5	b
Rubigan, 2.7 lb.a.i/A, (F)	1.8	c
Banner, 1.6 lb.a.i./A, (S,F)	0.5	c
Rubigan, 1.4 lb.a.i./A, (2S,2F)	0.5	c
Banner, 1.6 lb. a.i./A, (2S,2F)	0	c
Rubigan, 1.4 lb.a.i./A, (2F)	0	c

*Emerald Heights Ret. Village, Redmond, WA (2F apps.)

Table 5. Percent Take-all Patch on 4/10/97.*		
Treatment	% Disease	
Rubigan, 2.7 lb. a.i./A, (S)	36.3	a
Heritage, 0.4 oz./M.(2S)	27.5	ab
Untreated	22.5	b
Rubigan, 1.4 lb a.i./A, (2S)	17.5	bc
Rubigan, 2.7 lb. a.i./A, (F)	10.5	cd
Rubigan, 1.4 lb. a.i./A, (2S,2F)	5	d
Rubigan, 1.4 lb a.i./ A, (2F)	4.8	d
Banner, 1.6 lb. a.i./A, (S,F)	4.8	d
Banner, 1.6 lb a.i./A, (2S,2F)	4.3	d

*Emerald Heights Ret. Village, Redmond, WA (2F apps.)

Table 6. Percent Take-all Patch on 6/26/97, 6WAT.*

Treatment	% Disease	
Untreated	4.3	a
Rubigan, 2.7 lb. a.i./A, (F)	2.3	b
Rubigan, 1.4 lb a.i./A, (2F)	1.0	bc
Rubigan, 2.7 lb. a.i./A, (S)	0.5	bc
Rubigan, 1.4 lb. a.i./A, (2S,2F)	0	c
Rubigan, 1.4 lb. a.i./A, (2S)	0	c
Banner, 1.6 lb. a.i./A,(2S,2F)	0	c
Banner, 1.6 lb. a.i./A,(S,F)	0	c
Heritage, 0.4 oz/M, (2S)	0	c

*Emerald Heights Ret. Village, Redmond, WA (2F,2S)

Table 7. Percent Take-all Patch on 8/22/97, 14WAT.*

Treatment	% Disease	
Untreated	35.0	a
Banner, 1.6lb. a.i./A, (S.F)	30.0	ab
Rubigan, 2.7lb. a.i./A, (F)	27.5	ab
Banner, 1.6lb. a.i./A, (2S,2F)	14.3	bc
Rubigan, 1.4lb. a.i./A, (2F)	11.3	c
Heritage, 0.4oz./M, (2s)	7.5	c
Rubigan, 2.7lb. a.i./A, (S)	7.0	c
Rubigan, 1.4lb. a.i./A, (2S)	4.3	c
Rubigan, 1.4lb. a.i./A, (2S,2F)	0	c

*Emerald Heights Ret. Village, Redmond, WA. (2F,2S)

Table 8. Percent Take-all Patch on 9/24/97, 2WAT.*

Treatment	% Disease	
Untreated	36.3	a
Banner, 1.6 lb a.i./A, (S,F)	21.3	b
Banner, 1.6 lb. a.i./A, (2S,2F)	17.3	bc
Rubigan, 2.7 lb. a.i./A, (F)	10.5	bcd
Rubigan, 2.7 lb, a.i./A, (S)	7.5	cd
Rubigan, 1.4 lb. a.i./A, (2S)	7.5	cd
Rubigan, 1.4 lb. a.i./A, (2F)	6.0	cd
Heritage, 0.4 oz. a.i./M, (2S,1F)	1.0	cd
Rubigan, 1.4 lb. a.i./A, (2S,2F)	0.5	d

*Emerald Heights Ret. Village, Redmond, WA. (2S,1F)

Table 9. Anthracnose Disease Rating, 8/29/97, 2 WAT.

Treatment	Rating (1-9*)	
Untreated	4.2	a
Daconil 3 lb. a.i./A	2.2	b
Daconil 6 lb. a.i./A	1.6	bc
Daconil 15 lb. a.i./A	1.0	bc
Heritage 0.2 oz./M	0.4	c
Heritage 0.4 oz./M	0.2	c

(High Cedars G.C., #8 Exec.)

(*0 = no disease, 9 = 90% diseased)

Table 10. Anthracnose Disease Rating, 9/2/97, 18 DAT.

Treatment	Rating (1-9)*	
Untreated	2.8	a
Daconil 3 lb. a.i./A, 2 app.	2.0	ab
Daconil 6 lb. a.i./A, 2 app.	1.6	abc
Daconil 15 lb. a.i./A.	1.0	bc
Heritage 0.2 oz./M, 2 app.	0.4	c
Heritage 0.4 oz./M.	0.2	c

(High Cedars G.C., #8 Exec.)

(*0 = no disease, 9 = 90% diseased)

Table 11. Anthracnose Disease Rating, 9/15/97, 3WAT.

Treatment	Rating (1-9)*	
Untreated	2.4	a
Daconil 6 lb. a.i./A, 3 app.	1.6	ab
Heritage 0.2 oz./M, 3 app.	1.2	ab
Daconil 3 lb. a.i./A, 3 app.	1.0	ab
Daconil 15 lb. a.i./A, 2 app.	0.8	ab
Heritage 0.4 oz./M, 2 app.	0.4	b

(High Cedars G.C., #8 Exec.)

(*0 = no disease, 9 = 90% diseased)

USING COMPOSTS TO IMPROVE TURF PERFORMANCE

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For landscapers and grounds managers looking for ways to improve poor or marginal soils, compost may be the best deal around. In many cases, compost production sites are located near areas of intensive turf use, providing a readily-available and inexpensive source of organic matter. In many cases, compost is cheaper than topsoil.

Composts are used as soil amendments during turfgrass establishment, as topdressings on established turf, and as low-analysis fertilizers. In heavy clay soils, a good quality compost will increase permeability to air and water, enhance aggregation of soil particles, reduce surface crusting and compaction, and provide nutrients. In sandy soils, the organic matter in compost will increase water holding capacity and nutrient retention. The effects of good quality composts on turf include faster establishment, improved density and color, increased rooting, and less need for fertilizer and irrigation.

Before jumping on the compost bandwagon, there are a few things that you need to consider. Perhaps the most important of these is that not all composts are alike. Composts are made from many different sources, including municipal solid wastes (garbage), leaves and grass clippings, sewage sludges, animal manures, paper mill by-products, and food wastes, just to name a few. The influence of a particular compost on turf depends on the source and how it is produced, its chemical and physical properties, and how it is applied.

What to Look for in a Compost

Although the appearance of composts will differ slightly among products, the color of the end product should resemble a dark topsoil and should be friable. It should be free of large stones, large pieces of wood, trash (especially glass), and other objectionable objects. For use in turf a compost should pass through a 3/8 inch screen and preferably 1/4 inch. A good quality compost should have an earthy smell and should not emit offensive odors.

Organic matter: When using composts as organic matter supplements, keep in mind that not all of the product is organic. In fact, some composts contain less that 50% by weight of organic matter. Organic matter content can be determined by a lab test, but the most common procedure employed by labs will consider everything that is combustible as organic matter (including wood chips, bark, leaves, and possibly even garbage). Hence, a lab test may not tell you everything about the quality of the organic matter. Although it is impossible to determine how much organic matter is present simply by looking at the product, a visual examination may tell you if the compost contains mostly well-graded humus-like material or if it is mostly undecomposed material, such as wood.

Moisture content: The moisture content of a compost is important where an even application and uniform mixing with soil is desired. Composts with moisture contents between 30 and *50%* are usually ideal for handling, surface applications, and soil incorporation.

Wet composts (greater than 60% moisture content) tend to form clumps that are difficult to break apart. Thus, they do not spread evenly when applied as topdressings. Rototilling wet material into soil results in poor mixing and a less-than-desirable establishment. Wet composts are also heavy and difficult to handle.

A dry compost (less than 20% moisture content) is easy to handle and spreads easily, but may produce a lot of dust. On windy days, the dust may leave a film on windows or siding. Dust may be inhaled or get into the eyes of the applicator. Dry composts that are high in organic matter content tend to 'float' on the surface while attempting to incorporate them into the soil. In this case, the equipment operator may have to spend more time and effort working the material into the soil.

pH: The pH of most composts is between 6.0 and 8.0, a range favorable for turf root growth. A few composts, however, fall outside of this range. The pH of a compost may be detrimental when very high (greater than 8.5) or very low (less than 5.5). Extremes in pH may result in reduced availability of some plant nutrients and/or toxicity problems. In an establishment study at Penn State we noticed seedling inhibition following incorporation of a 2 inch layer of poultry manure compost (pH of 9.1) into a clay loam soil. It is likely that the high pH and presence of ammonium in the compost caused ammonia toxicity and subsequent death of the seedlings. Fortunately, most soils are buffered against rapid and drastic changes in pH and even composts with extremes in pH may not alter the overall soil pH a great deal. To be on the safe side, however, try using materials with a pH as near to neutral (7.0) as possible.

Nutrients: When compared with fertilizers, composts generally contain low amounts of plant nutrients. Whereas a small amount of quick-release ammonium nitrogen is present in some composts, most nitrogen is in the organic form and is slowly available to turf. Studies with composted sewage sludges show that only about 10% of the total nitrogen is available to plants during the first growing season. This means that large amounts of compost must be applied to supply all or most of the turfs nutrient requirements. Little is known about the nitrogen release characteristics of other composts.

Other nutrients, such as phosphorus, potassium, calcium, and magnesium can be present in significant quantities in composts. Some composts, however, may contain very low concentrations of one or more of these nutrients, thus, fertilizer supplements may be required. Many questions remain concerning the availability of nutrients from composts.

Whereas a certain compost may contain a high amount of phospho-

Tips on Application

Soil incorporation: When choosing a compost as a soil amendment it is important that you are familiar with the product and its effects on turf. If you have never used the product, be sure to examine it for proper moisture content, particle size, and odors. It may be worth your while to visit the site where the compost is stored to make sure it is not contaminated with weeds or weed seeds. If you plan to use compost in your business, try to find a product that is consistent from batch to batch and preferably one that has been used successfully by other professionals for turf establishment.

In most cases, composts are applied to the soil surface at a rate between a one inch layer (approximately 2.2 cubic yards per 1000 if^2) and a two inch layer (about 4.4 cubic yards per 1000 ft^2) then incorporated into the soil to a depth of 4 to 6 inches. In order to get maximum performance from your application make sure the compost is thoroughly mixed with the soil and is not forming a layer at the soil surface. Depending on the material, this may require several passes with rototilling equipment. The lower rate (1 inch layer) would be better for fertile soils and the higher rate (2 inch layer) for sandy soils, clay soils, or sub soils low in organic matter. We have found that if more than two inches are used, it may be difficult to mix the material 4 to 6 inches into the soil. On heavy soils, it is helpful to rototill the soil first, then apply the compost and incorporate.

Although high-nutrient composts, such as composted sewage sludges or composted manures, can usually supply enough nutrients for good establishment, some composts (such as yard wastes or municipal solid wastes) may require additional phosphorus and potassium as well as starter fertilizer for vigorous seedling growth. Although many composts can raise soil pH, for soils with a very low pH (below 5.5) additional lime may be required. If you plan to use a compost with a high soluble salt concentration, make sure to thoroughly irrigate the site several times in order to leach the salts before seeding.

***Use on established turf**:* Composts are frequently used as topdressings on established turf. This practice is one means of gradually incorporating organic matter into the soil without causing extensive disruption of the surface. The two most limiting factors with this practice are finding suitable application equipment and working the material into the soil.

Since compost is light and bulky, a spreader with a large hopper is preferred. Modified manure spreaders with conveyor belts and brushes mounted on the back are ideal for spreading compost over large areas. Conventional tractor-mounted fertilizer spreaders have been used successfully, but may require many refills.

When applying composts as topdressings, it is important to apply a thin layer (about 1/4 inch) and work it into the soil. Successive applications of thick layers without soil incorporation will result in a build-up of organic matter that may cause rapid surface drying and form a layer that restricts rooting into the soil. The best way of incorporating compost into the soil is through aeration. We have observed successful applications on athletic fields where the compost is applied first, followed by several passes with an aerator equipped with hollow-tines and a steel drag mat attached. The drag mat will break-up the cores and mix the compost with the soil, dragging some of the mix back into the holes. This operation is best performed during cool/moist seasons when grass is actively growing. Aeration and dragging can be stressful to the turf during hot, dry weather.

Summary

Good quality composts can improve poor soils and turfgrass quality. There are many different composts to choose from and most of these will vary in chemical and physical characteristics. In order to get the most from your compost application, become familiar with the product and how it should be used on turf. Before you use any new product, make sure it has been tested on turf before using it in your business.

Managing Intensively Trafficked Turfs

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Intensively used turfgrass sites are especially exposed to wear injury and compaction stress, occurring from foot or vehicular traffic. Maintaining quality turf under these conditions requires a high degree of expertise and management skills.

The immediate effect of trafficking any turf is wear injury, which results from the crushing, tearing and shearing actions of foot or vehicular traffic. The longer or more chronic effect occurs from compaction injury. Compaction stress coincides with increased bulk density, loss of soil structure, reduced large pore space, poor aeration, reduced oxygen diffusion rates, decreased infiltration and percolation rates, and increased variation in soil temperatures. These soil changes result in poor growing conditions and an overall decline in growth, vigor, persistence and turfgrass quality. Turfgrass wear injury is relatively easily recognized, but compaction stress can often be confused with other environmental stresses like heat and drought.

Turfgrass Species and Cultivars. Turfgrass species and cultivars differ in wear and compaction stress tolerance (Table 1). Warm season species, like bermudagrass and zoysiagrass, are generally considered to be more wear tolerant than most cool season turfgrass species. Tall fescue is an exception. It has very good wear tolerance. Bermudagrass has very good compaction stress tolerance. This characteristic combined with its excellent wear tolerance makes it one of the best species for highly trafficked areas. Generally this is true, except when bermudagrass is dormant. Trafficking dormant turf results in a significant decline in turfgrass traffic stress tolerance.

For those in the cool-season regions, perennial ryegrass offers the best combination of wear and compaction stress tolerance. Tall fescue, on the other hand, has excellent wear tolerance but only moderate tolerance to compaction stress.

Annual bluegrass is a very competitive species under compacted soil conditions. This is one of the reason it becomes such a weed in close mowed, intensively trafficked turfgrass sites.

If you are uncertain about the traffic stress tolerance of turfgrass species or cultivars, it is best to check with researchers in your area. Data from the National Turfgrass Evaluation Program can be helpful as well. Selecting grasses that have demonstrated vigorous, well-adapted growth and high quality performance in your area. Turfgrass traffic stress tolerance increases with as plant tissue succulence decreases, cell wall content of tissue increases, and root production depth and extent increases.

Cultural Practices. Traffic stress tolerance increases with mowing height. Higher mowing heights producer greater verdure, root production, rooting depth, and extent rhizome and stolon development than low mowing heights. Greater verdure has a cushioning effect on the crowns of heavily trafficked turfs. This influences the extent of wear injury and the degree of soil compaction.

The overall approach to improve turfgrass traffic stress tolerance must include a well-balanced nutrition program that adequately meets the nutritional needs of the turfgrass plant. Soil tests should be used to base the fertilization program. Turfgrass wear tolerance increases with nitrogen nutrition up to a critical point. Beyond this point , excess nitrogen results in lush succulent growth that is more susceptible to wear injury. It is best to meet the nutritional needs of the turfgrass, because both excess and deficient nutrition results in reduced traffic stress tolerance. Turfgrass traffic tolerance increases with potassium nutrition. In order to obtain wear tolerance benefits from potassium, applications prior to and during periods of intensive traffic give the best results. On sandy growing media, apply potassium in light frequent applications or use slow-release sources for improved performance.

Soil Cultivation. Soil cultivation should be an integral part of a management program for traffic stress tolerance (Table 2). Soil cultivation reduces runoff and increases plant water uptake. The cultivation procedures like coring, slicing, spiking, and high pressure injection can be used to reduce compaction stress. Each procedure has its advantages and disadvantages. Core cultivation of intensively used turfgrass sites is one of the more beneficial procedures that can be used in reducing soil compaction. Intensively used areas should be core cultivated at least twice a year. Cool season turfgrasses should receive soil cultivation when they are actively growing (i.e. spring and/or fall). Warm season species should be cultivated after green up and before they go dormant in the fall. Heavily used area may require more frequent cultivation. Use small tines for core cultivation during the playing season. Some times slicing and spiking can be used with minimal effects on play. Properly selected and used, coring, slicng, spiking and high pressure injection can be effective for alleviating compaction stress and enhancing surface soil moisture conditions without disrupting play.

Traffic Control. Traffic control is an important component of a management program for intensively used turfs (Table 3). The design of the turfgrass facility plays an important part in routing traffic and in reducing traffic stress. By spreading the intensity of traffic over a large area, traffic injury can be reduced. Golf course superintendents use traffic control to their benefit by cup placement and movement, and by manipulating cart traffic as they leave the path. Using barriers, like ropes and posts, helps to temporarily route traffic around potential problem areas. Cart and pedestrian traffic can also be distributed by using signage to direct traffic. Sports field managers reduce traffic stress by limiting practices, reducing miscellaneous foot traffic, and manipulating field boundaries. Developing adequate practice facilities also helps avoid stressing the primary turfgrass facility.

Conclusion. Selecting the proper turfgrass species and cultivars, manipulating cultural practices, and practicing traffic control procedures are just a part of the methods that turfgrass managers can use to maintain turf on heavily used sites. Regardless of the methods selected, turfgrass managers must use their expertise to develop effective systems for maintaining quality turf on intensively used sites.

Table 1. Turfgrass Species and Their Relative Traffic Stress Tolerance

Species	Wear Tolerance	Compaction Tolerance
Bermudagrass	Very High	Very High To High
Zoysiagrass	Very High	High To Medium
Tall Fescue	Very High to High	Medium
Perennial Ryegrass	High	Very High to High
Kentucky Bluegrass	Medium	High to Medium
Creeping Bentgrass	Medium to Low	Medium to Low
Hard Fescue	Medium to Low	Medium to Low
Creeping Red Fescue	Low	Low
Chewings Fescue	Low	Low
Annual Bluegrass	Very Low	Very High to High
Rough Bluegrass	Very Low	Very Low

Table 2. Soil Cultivation Equipment and the Advantages of Cultivation on Heavily Trafficked Turfs.	
SOIL CULTIVATION	**SOIL CULTIVATION**
Types :	Advantages:
Coring	Better Water/ Fertilizer Uptake
Slicing	Reduced Runoff
Spiking	Better Rooting
High Pressure/Injection	Less Compaction
	Reduced Thatch

Table 3. Traffic Control Is Important Role In Maintaining Quality Turf on Heavily Used Sites.
Traffic Control:
Design
Portable Devices
Barriers
Limited Use

IS IT IS, OR IS IT AIN'T ANTHRACNOSE?

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Having problems controlling *Pythium*? Or maybe you have an anthracnose problem that's causing you conniptions. Have you diligently used fungicides according to the proper schedule and still have poor looking turf? Are you wondering why the chemical companies can't produce a product that will work the way it is supposed to? Maybe the fungicide isn't the problem. Maybe the real problem is that you are trying to treat for a fungus that isn't there.

In recent years there have been several disease problems in Northwest golf greens that have defied accurate diagnosis and treatment. Anthracnose, patch symptoms, and unexplained thinning of annual bluegrass have become common. Some superintendents have reported diseases that are difficult to control. What is going on?

Objective

The primary objective of this study was to determine what fungi are present in diseased and symptomless turf samples over the course of a year at participating golf courses. We hoped that by doing this we could establish which pathogens are actually out there, if there are any new diseases present, and if fungi that cause disease are present in symptomless turf. Answers to these questions would give us insight into the behavior of the pathogens and perhaps enable enhanced disease control.

A secondary objective was to see if normal greens management practices influenced development of anthracnose.

What did we do and how did we do it?

Six golf courses participated throughout the course of this study. Two were in the Puget Sound area, one in the Seattle area, one in Northwest Oregon, and one each in the Northern and Southern parts of the Willamette Valley in Oregon.

We asked each of the superintendents to fill out a detailed questionnaire about their management practices, background information about the green they selected to work with, and fungicide use philosophy. We asked them to select one green that had a history of disease and send in two samples from that green that were showing symptoms and one sample that was not showing symptoms. The latter sample was considered "healthy." These samples were to be submitted once each month for 12 months. The samples were to be accompanied with an additional information sheet that described the symptoms, asked for a tentative diagnosis, and listed the date of the last fungicide application.

The participating greens were well-established, sand based, and consisted primarily of *Poa annua*.

Once in the lab the samples were processed within 24 hours. Leaves, crowns, and roots of individual plants were dissected and mounted onto microscope slides for examination. Additional plants were surface disinfected and plated onto nutrient media. Again leaves, crowns, and roots were treated separately. Fungi that grew from the tissue pieces were sub-cultured and identified as far as was possible.

What did we find?

A study such as this one is different that those in which variables under study are strictly controlled. This was more of an ecological study which tracked the incidence of various fungi throughout the course of a year. Samples were taken from the same green, but were not necessarily taken from the same spot each time. The results below are therefore indications of general trends over the course of the study and are not necessarily the full story. With that in mind, there are some interesting trends that appeared.

General findings

Recent fungicide applications interfered with recovery of pathogens.

This should come as no surprise. However many times it is not considered when turf samples are submitted to a laboratory for analysis. Labs that depend on culturing of the sample to recover fungi may not arrive at the correct diagnosis if the turf has been sprayed two to six days prior to sampling. If you want a reliable diagnosis, take the sample BEFORE the green is treated.

The ability to correctly diagnose a disease problem varied widely, even within a club.

Only two clubs were correct with every diagnosis made. Four of the clubs just as often made an incorrect diagnosis as a correct one. An incorrect diagnosis was considered one where the disease identified by the club was not substantiated by laboratory results. Instances where fungicides may have interfered with recovery of the suspected pathogen were not counted as correct or incorrect diagnoses.

Some clubs were unable to consistently recognize a particular disease. Anthracnose was most frequently misdiagnosed. Fungi present in samples diagnosed as anthracnose included *Microdochium bolleyi*, *Curvularia*, *Fusarium* spp. and *Rhizoctonia*.

The problem most clubs correctly diagnosed was Microdochium patch.

Pathogens do not appear singly in diseased plants.

There were many different fungi associated with a particular disease. For example with Microdochium patch, in addition to *M. nivale* we recovered

Pythium, *Fusarium*, *Drechslera*, *Curvularia*, *Spermospora*, *Microdochium bolleyi*, and various sterile fungi. Many of these species of fungi can be pathogenic. Does that mean they are also causing disease? Not necessarily. Some of these fungi are normal soil residents. It does mean that their overall relationship to the presenting disease should be considered when interpreting laboratory results.

Specific findings

The primary disease problems were Microdochium patch, anthracnose, and Yellow patch.

Microdochium patch (= Fusarium patch) was the most frequent disease present, followed closely by anthracnose, and distantly by yellow patch. The periods during which the causal fungi occurred are given below. *Rhizoctonia solani* was present in both diseased and healthy turf samples, but was recovered only in February and May. Other diseases are discussed separately below.

The fungus *Microdochium bolleyi* was recovered in both healthy and diseased samples in high numbers.

This was one of the most interesting results of the study. This fungus has been considered a saprophyte, a weak parasite, and a serious pathogen depending on which host species has been looked at (most of the work with this organism has been done on cereals). In Iowa *M. bolleyi* has been found in association with thinning and dying creeping bentgrass that was of low vigor in high-sand greens (Hodges and Campbell). Inoculation experiments in Iowa showed that *M. bolleyi* could infect roots of bentgrass and that infections resulted in decreased growth under both cool and warm weather conditions.

No work has been published on the importance of this fungus in *Poa annua*. However, the symptoms it causes have been mistaken as anthracnose in both published accounts (Smiley, Dernoeden, and Clarke) and in this study. In the present study, *M. bolleyi* was present on at least eight occasions when the disease predicted by the club did not match laboratory findings. The role of this fungus in disease development in *Poa annua* should be evaluated.

Pythium was present year-round in both healthy and diseased plants.

Pythium is widely distributed in soils and in roots. There are both saprophytic and pathogenic species of *Pythium*, as well as species that feed on other fungi. The presence of this fungus in roots does not always mean the plants have Pythium disease. *Pythium* was found to be causing disease in only **one** sample in the entire study.

Pythium diseases in Western Oregon and Washington are probably not as common as is believed. They can certainly occur, but are not likely in mature turf that is not being overfertilzed and overwatered (or flooded).

Leaf spot diseases were minor in incidence and overall importance.

Curvularia lunata, *Spermospora*, and *Drechslera* were sporadically present, but represented a small portion of the fungi recovered. The incidence of *C. lunata* in healthy samples was the same as or greater than the incidence in diseased samples.

***Microdochium nivale* and *Colletotrichum* were found only twice in "healthy" samples.** One of the things we were interested in discovering was if these fungi were present in healthy looking turf. In other words, are these fungi present in an inactive state in symptomless plants? No. Healthy looking grass was generally free of major pathogens. In the two samples where these fungi were present, there were a few individual plants that were symptomatic but which had not been noticed by the sampler. Disease development could result from these few individual plants that act as centers of infection.

***Fusarium* species were ubiquitous in both healthy and diseased samples.**

Fusarium is a genus that contains both pathogenic and saprophytic members, even within the same species. Therefore there is no way to determine if a particular species is actually causing disease without applying the fungus to some healthy turf and seeing if disease develops. So what is the importance of this finding? This: if you send your turf samples to a laboratory and they tell you *Fusarium* is present, don't automatically assume you need to apply a fungicide. The fusaria that are there may be normal residents of the site.

Anthracnose

There were no apparent associations between anthracnose development and practices such as vertical mowing, top-dressing, and coring.

Sometimes anthracnose occurred after these operations, but as often it did not. These factors in themselves did not appear sufficient to predispose the greens to anthracnose.

There was no consistent association between the presence of the anthracnose fungus and other fungi.

Many other fungi were also present with *Colletotrichum*, but there was no consistent recovery of any particular one.

"Winter" anthracnose was not limited to winter.

Anthracnose in some texts on turf diseases refers only to the foliar phase that occurs in summer under conditions of high temperature and humidity. This type of anthracnose was not present on any of the courses during this study. The so-called winter anthracnose, also known as crown rot or basal rot anthracnose, *was* found and occurred from late summer through early spring.

Summary discussion

This study was undertaken to determine the fungi present in healthy and diseased turf in greens in Western Oregon and Washington. The preponderance of published research on turfgrass pathology has originated from the Mid-West and East, where growing conditions are much different than in the Pacific Northwest. It is important that disease information be gathered in our region because conclusions drawn from different geographic regions may not be applicable here. For example during the course of this study *Pythium* was a minor problem in the greens of the participating golf courses, only the crown rot phase of anthracnose was present, and *Microdochium bolleyi* may have been causing or contributing to a disease similar in appearance to anthracnose. It is only when local disease problems are resolved that appropriate, effective control measures can be determined.

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