The greens of numbers 3 through 6, located in slightly shielded areas, have poor drainage capabilities, he says.

The C-15, original turf at Hazeltine, had held up well since the course was built 23 years ago.

The problem spread. "By process of elimination we finally determined that it was bacterial wilt," says Hague. "You hate to admit it because there's only two things you can do—fumigate and resod or fumigate and reseed."

(The other alternative is to tear out all greens to a sufficient depth, as Firestone chose to do.)

Drs. Vargas and Roberts at Michigan State confirmed the disease in late June. This information was relayed to the greens chairman.

Membership was informed on July 8 by bulletins explaining the history of bacterial wilt. "The bulletins helped people understand that we were not alone, that this wasn't a first incidence," says Hague.

On July 17, Dr. Vargas and a USGA greens section official attended an open membership meeting to better explain the problem. The members, somewhat angry over the problem, "really eased off" after the meeting, says Hague. "From then on, it was 'how are we going to take care of this?'"

They decided not to use a bactericide for expense reasons. "Luckily we had the kind of summer where all greens stayed very puttable," says Hague. Nine different options were hammered out.

Hague and Hazeltine took a novel approach—they chose to fumigate in the fall and resod Penncross bentgrass in the spring. It's a technique that has not been tried previously, claims Hague.

There was one catch—members decided not to give up the course until Sept. 23! In Minnesota, it snows in early to mid-October. Hague and crew were faced with a race against Mother Nature.

They won, sort of.

The Hendricks and Dail Co., North Carolina-based fumigators, handled the methyl bromide (hot gas) treatment. Methyl bromide sterilizes the soil and must be applied at soil temperatures of over 50 degrees Fahrenheit. The gas is forced into the soil, covered by tightly-secured plastic to prevent leakage and ensure penetration.

Half the greens were fumigated the week of Oct. 1 and three others later in October. The remaining six holes (numbers 11, 13, 14, 15, 16, 17) will get the gas in the spring.

Hague says he hopes to resod the front nine the first two weeks of April and the back nine as soon as possible.

Ideally, golfers will be playing the front nine by early June and the back by the 15th.

"If we get a break at all, we'll get the course back to snuff by June 15," says Hague.

—Ken Kuhajda

**RECOGNIZING BACTERIAL WILT**

by David Roberts and Dr. Joseph Vargas Jr.

Bacterial wilt is a relatively new disease of turfgrasses in North America. The disease was originally called C-15 problem and C-15 decline, a devastating and unresolved occurrence on Toronto creeping bentgrass (C-15) for more than a decade.

Since the 1930s, Toronto creeping bentgrass was propagated on golf course putting greens throughout the Midwest. During the 1970s, the C-15 problem destroyed many Toronto greens. And in 1980, it gained national recognition when Toronto putting greens were destroyed at Butler National two weeks prior to the Western Open.

An intensive investigation began at many universities. With the aid of Michigan State University's electron microscope, bacteria were associated with the xylem tissues of diseased Toronto creeping bentgrass (Fig. 1). Xylem vessels of plants are responsible for the uptake of water and nutrients. The plugging of these xylem vessels by large numbers of bacteria naturally resulted in rapid wilting and death of turfgrass plants. The disease was subsequently named "bacterial wilt" of Toronto creeping bentgrass.

**Significance**

Prior to bacterial wilt on Toronto, no bacterial wilts of turfgrasses were previously known in North America. Using various analytical techniques, the bacterial wilt pathogen has now been characterized as Xanthomonas campestris pv. graminis.

This bacterium measures approximately 1/25,000th of an inch long and 1/50,000th of an inch wide. It reproduces every four to six hours.

Until it was isolated from Toronto creeping bentgrass in the United States, this bacterium was only found in Europe. Originally discovered in Switzerland in 1975, the bacterium has now spread to the British Isles, Netherlands, Germany, France, Norway, Denmark and New Zealand.

We presume that the bacterium was introduced from Europe to the United States, where it has virtually...
destroyed Toronto creeping bentgrass as a propagated turfgrass.

**Affected areas**

During the summer season of 1983 and 1984, bacterial wilt was found on Seaside and Nimisilia creeping bentgrasses and annual bluegrass. Whereas Toronto, Seaside and Nimisilia are not propagated to any appreciable extent on home lawns, annual bluegrass is a naturally-occurring turfgrass found in most regions of the temperate zone.

Bacterial wilt has been found on turfgrasses in eight states: Indiana, Illinois, Kansas, Michigan, Minnesota, Ohio, Pennsylvania and Wisconsin. This indicates that the bacterium is not only spreading to new host plants, but also to new geographical locations. The occurrence of bacterial wilt on annual bluegrass and the bentgrasses strongly suggests that Kentucky bluegrass and other grasses may also succumb to the disease.

Bacterial wilt of turfgrasses is analogous to several other diseases. The accidental introduction of pathogens that cause Dutch Elm disease and chestnut blight has practically eliminated American species of these trees in the United States. Another pathogen, Xanthomonas campestris pv. citri, the cause of Citrus canker in the southern United States, is closely related to Xanthomonas campestris pv. graminis, the cause of bacterial wilt of turfgrasses.

Millions of dollars, along with very strict quarantines, eliminate the citrus canker bacterium whenever and wherever it is detected. Unfortunately, the turfgrass industry is not sufficiently organized to mount this kind of action. So bacterial wilt continues to spread to additional states and new varieties of turfgrass.

**Cures?**

Even though bacterial wilt can be suppressed with the antibiotic oxytetracycline, the chemical is both expensive and may not be effective for a long duration as resistance by the bacterium is highly probable. Except for fumigation, followed by seeding and sodding with alternative turfgrasses, no other control measures are feasible.

**Diagnosis**

Bacterial wilt undoubtedly occurs on other turfgrasses in many regions of the country. However, absence of knowledge of the disease usually prevents accurate diagnosis. Unlike many turfgrass diseases, bacterial wilt does not occur in rings or patches; it is strictly random, affecting individual plants in large areas (Fig. 2).

One of the most important diagnostic features of the disease is a very rapid wilting. Leaf blades become shrunken, twisted and blue-green in color.

Unfortunately, accurate diagnosis can currently only be accomplished by trained personnel at university diagnostic laboratories, and then it can only be determined with fresh samples. Therefore, turf samples should be mailed through an overnight service. Accurate diagnosis is essential if management strategies are to be effective in combating this devastating disease.

If further information is desired, contact the authors at Plant Diagnostic Clinic, 141 Plant Biology, Michigan State University, East Lansing, MI, 48824-1312. Phone numbers are (517) 355-4536 and 353-9082.

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**Clubs affected by bacterial wilt**

Some golf and country wilt where bacterial wilt has been diagnosed by Michigan State University:

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**ILLINOIS**

St. Charles, Butler National, Cog Hill, Village Links, Kellogg, Timber Trails, Medina, Edgebrook Valley, Glen Oak, Riverside, Bloomington, Decatur, Park Hill, Olympic Fields, Midlothian, Pottawatomi, Glen Flora, Waukegan

**MICHIGAN**

Alpine, Bay Pointe, Leland, Goodrich, Maple Lane, Raisin River, Royal Oak, Evergreen, Birchwood Farms, Old Channel, Plymouth Park, Edgewood, Plum Hollow

**OHIO**

The Golf Club, TRW, Firestone, Muirfield Village, Silver Lake, Brandywine

**WISCONSIN**

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**ELSEWHERE**

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