Terms to Know

Biotic/Abiotic - of or relating to living organisms/non-living things

Disease - a destructive process in an organism; has (1) a specific cause and (2) characteristic symptoms

Lesion - function-imparing injury or other change in an organism's tissue

Necrotic - dead; describing a zone of dead tissue in an organism

Pathogen - an agent of any kind able to cause disease

Postulate - as in Koch's Postulates: prerequisites or basic principles

Saprophytic - living on dead or decaying organic matter

Senescence - aging; in plants, the growth phase between maturity and death

Symptom - a condition accompanying a disease and aiding in its diagnosis

Diagnosis of Root and Crown Diseases of Turfgrasses

by Eric B. Nelson

Root and crown diseases present unusually challenging diagnostic problems to turfgrass managers and diagnosticians. These challenges arise from a number of factors.

Problems bedeviling diagnosis

One of the greatest obstacles to the accurate diagnosis of root and crown diseases is the perennial nature of turfgrass plants. Roots of nearly all mature turfgrass plants are continuously infected with many, if not all, of the pathogens capable of causing disease on a particular turfgrass species. As a result, microscopic examination of roots and crowns usually fails to identify a single pathogen as the cause of an affliction.

Another factor complicating diagnosis is the presence of a large number of saprophytic fungi, which prefer to live on dead and decaying organic matter. Few of these fungi cause infection or disease in turfgrass plants, but they are readily observed on and in roots, rhizomes, stolons and crowns. Some of them may even penetrate the roots of some turfgrasses, but they rarely, if ever, cause direct plant damage.

The natural senescence of many turfgrass roots also presents diagnostic challenges. Roots of turfgrasses naturally age and wither at a rapid rate. In the process, they are often colonized by a vast array of microorganisms, both pathogenic and nonpathogenic. Since many of the pathogens causing root and crown problems prefer to live in a saprophytic mode, it is often not clear, when examining roots microscopically, whether a pathogen found in root tissue was the cause of its decline, or had colonized the root after that decline had begun. This dilemma is further complicated by the fact that, when examining roots microscopically, one can never be certain if the roots showing symptoms are from the current or the previous year, and if the latter, whether their decline was natural or disease induced.

One of the more aggravating problems in diagnosing root diseases is the difficulty of completing Koch's postulates satisfactorily (see the accompanying article for a discussion of these). The ability of root-infecting pathogens to cause significant damage depends heavily on environmental conditions and plant stresses. Turfgrass plants that are not under significant stress often fail to show foliar or root disease symptoms after infection of their roots. However, plants that are heavily stressed by excessively low mowing heights, excessively low or high fertilization regimes, excessively low or high soil moisture, excessive temperatures, high traffic, soil compaction and certain pesticide applications are more likely to decline as a result of root infection. In addition, those pathogens infecting root tips, root hairs or the epidermal layers of the root may not cause any significant necrosis, but may debilitate nutrient and water uptake through the root system. These types of pathogens may be particularly difficult to isolate from turfgrass roots, making it impossible to link them to the observed disease.

Obtaining a good sample for analysis

One of the critical aspects of diagnosing root diseases is proper sampling and recovery of root systems from soil, enabling their thorough examination. Roots are typically covered with soil and other organic debris. They may also be difficult to free from thatch. All of these factors make root observation difficult.

That difficulty is often compounded by a too-casual approach to examining the root systems of plants: clumps of turf are ripped from the ground, teased apart some, then examined superficially with the naked eye. This approach has serious deficiencies.

First, when roots have been infected with pathogens, the root tissues tend to be fragile and subject to easy breakage. When a clump of turf is pulled up, many of the diseased turfgrass roots are left behind in the soil, while healthy roots remain attached to the shoots. With just a casual inspection of such a sample, one might conclude that the roots were healthy, when in fact they might be seriously diseased.

Second, soil and thatch in the specimen can make suitable observations of roots nearly impossible. A more effective method of removing roots from soil is to cut a section of affected sod with a knife to a depth of approximately two inches, then place the turfgrass specimen under a stream of water and gently pull the specimen apart. The goal of this manipulation is to tease out individual plants with root systems intact and free of interfering thatch and soil debris. If special care is taken at this stage, more accurate diagnoses will be possible.

Under the microscope

Once individual plants with more or less intact root systems are in hand, it is relatively easy to determine whether their roots show any disease symptoms. It may be useful to examine roots of apparently healthy turfgrass plants for comparison. Things to look for (and record) are:

- the absence of root hairs
- discolorations of the root system, particularly at the root tips
- noticeable lesions or other deformities and their specific appearance
- the condition of the crown area
- whether discolorations or rotting appear to be progressing from the crown to the roots or from the roots to the crown
- visible fungal structures on or in the root and crown area (this usually requires a 10x or better hand lens)
- the nature of the rotting on the root system (For example, do the roots exhibit a wet, gooey rot or a dry rot? The former is more characteristic of pathogens such as *Pythium* species, while the latter is more representative of other patch disease root pathogens such as *Magnaporthe* and *Leptosphaeria*.)
- the presence of dark fungal mycelium growing on the surfaces of root and crown tissues (These structures are often observable with a 10x hand lens or a dissecting microscope and are indicative of problems associated with patch diseases.)

In nearly all cases, however, definitive diagnosis of root diseases requires a microscopic examination. This is necessary to actually observe the presence of the pathogen in infected and rotting roots and crowns. Small sections of symptomatic root, crown, rhizome or stolon tissue are placed on a microscope slide and stained with chemicals designed to color the pathogen but not the plant tissues. In some cases, diagnosticians may remove the contents of root cells with special chemicals, making detection of fungal structures in root tissues easier.

Occasionally, pathogen structures are not apparent. In these cases, the laboratory diagnostician may attempt to isolate and culture the pathogens from root or crown tissues. This is usually accomplished by placing pieces of fresh root tissue on sterile synthetic culture media that foster the growth of microorganisms. Sometimes, if a specific group of pathogens is suspected, turfgrass roots may be placed on media containing chemicals that will only allow that group of organisms to grow. If pathogens are present, they will usually emerge from the infected roots and grow on the culture medium, enabling a more detailed study of the organism. Once potential pathogens have been recovered from infected roots, attempts can be made to complete Koch's postulates.

Most of the techniques used to diagnose root and crown diseases require specialized equipment and considerable expertise. Even experienced turfgrass pathologists have difficulties diagnosing some root and crown diseases on turfgrasses. As we learn more about the biology of root-infecting turfgrass pathogens, however, and as more sophisticated techniques for their detection and identification are developed, root disease diagnosis will become more accurate.

Not to be overlooked

Abiotic factors can also contribute to root dysfunction and decline, in particular high concentrations of soluble salts, root zone oxygen depletion and excessive soil temperatures. The natural senescence of turfgrass roots, particularly during the summer months, further complicates the picture. These factors must always be taken into account when contemplating, or conducting, root disease diagnosis, and should be included in any routine diagnostic procedure.

Terms to Know

Rhizome - a plant stem, usually horizontal, usually under the soil surface, with leaves or shoots above and roots below the nodes

Pre-/Post-emergent - before/after the emergence (of a weedy plant, for instance)

Surfactant - surface active agent; when added to liquids, surface active agents reduce surface tension, increasing the liquid's spreading and wetting properties

Tuber - a short, thickened, fleshy part of an underground stem; contains nodes and buds

Yellow Nutsedge: Biology and Control In Cool-Season Turf

by Joseph C. Neal

About the weed

Yellow nutsedge (*Cyperus esculentus*), often referred to as "nutgrass," is a tough-to-control perennial weed that infests most crops and turfgrass areas throughout most of the United States. Although grasslike in many ways, yellow nutsedge is not a grass; it is a sedge.

Sedges are easily distinguished from grasses by their leafy shoots, which are triangular in cross section. Shoots of grasses, on the other hand, are either flat or round. Distinguishing between grasses and sedges is very important, as most herbicides for grass control do not control sedges.

Yellow nutsedge emerges between late spring and midsummer, producing leafy clumps of long, narrow, light green and glossy, grasslike foliage. Yellow nutsedge spreads by rhizomes (underground stems), which produce "daughter" plants. Starting in late June, when days begin to get shorter, small, egg-shaped tubers begin to form at the tips of the rhizomes. Tubers mature in late July to mid-August. Under optimum conditions, a single plant can produce up to 7,000 tubers!

Plants flower in mid- to late-summer, producing slender, yellowish-green flower stalks with leaflike bracts subtending small flowers at the top of a leafless stem. Plants shoots die with frost. While some viable seed are produced, the tubers are the primary means of propagation.

Most tubers sprout the following spring. Some, however, may remain dormant in the soil for up to 10 years, waiting for the opportunity to germinate. Consequently, nutsedge control strategies must include a long-term commitment to preventing new tuber formation.