POLLUTION

SUPERINTENDENTS: ARE YOU MAKING WASTEFUL PURCHASES?

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Injury caused by air pollution to turfgrasses can be misdiagnosed by superintendents as a disease or as an insect or nematode invasion. Knowing what the symptoms are of pollution damage to turfgrasses can stop a costly and ineffective prevention program before it begins

Direct toxic injury to turfgrasses by atmospheric pollutants is a new factor affecting the growth and look of turfgrasses. Although the complete loss of a turf from these toxic atmospheric gases or aerosols has rarely been observed to date, the injurious effects, however, a) reduce drastically the visual quality of turfgrass, b) lowers carbohydrate reserve because of injury to plant chlorophyll and c) weakens turfgrass plants, making them prone to damage from diseases, insects, nematodes and traffic.

These atmospheric pollutant injury symptoms can easily be misinterpreted as resulting from disease, nematode or insect activity. It is important, therefore, to make the correct identification of the cause. Otherwise an expensive program of fungicide, nematicide or insecticide applications may be initiated that will not be effective and will waste time and money. Thus, it is extremely important to properly document and identify the specific cause.

Up to now the injury problems to the turfgrass leaf tissue have been primarily chronic. Higher, acute injury, causing extensive damage to the turf, may result if higher concentrations of these toxic atmospheric pollutants occur in the future. Hopefully, the latter condition can be avoided if the pollution sources can be eliminated or controlled. The most common phytotoxic atmospheric pollutants of concern in the turfgrass culture are (a) sulfur dioxide (SO_2), b) fluoride, (c) peroxy acetyl nitrate (PAN) and d) ozone. The latter two are commonly called smog.

Injury symptoms

Visual symptoms of injury from atmospheric pollutants generally occur to the leaf tissues, which are intimately exposed to the toxic atmospheric pollutants. Specific leaf injury symptoms are associated with each of the four pollutants (Table 1). These symptoms can be used to identify the pollutant involved.

The location where the injury occurred should also be considered. As a general rule, ozone injury is more common along the Atlantic coast of North America whereas PAN is more common along the Pacific coast. Sulfur dioxide injury is generally associated with urban or industrial areas where sulfur containing fuels, such as coal and oil, are used or where sulfide ores are smelted.

Fluoride injury is not as common as the other three and is restricted to more isolated, localized areas ad-

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jacent to industries which release fluoride gases into the atmosphere.

Factors affecting injury

Actual inhibition of shoot growth can occur before visual injury symptoms appear. The toxic gases are absorbed into the leaf through the stomatal openings. This is particularly true of ozone and PAN. Injury most commonly occurs to young, actively growing tissues where the stomata have formed and are functional. Old, senescing leaves and the very youngest leaves are usually less sensitive to ozone and PAN. Growth inhibition is generally the result of chlorophyll destruction, which inhibits the photosynthetic process.

The environmental conditions can also affect the relative susceptibility of turfgrasses to injury, particularly from sulfur dioxide. The same environmental factors that ensure maximum opening of the stomata will also increase susceptibility to injury from atmospheric pollutants, particularly ozone and PAN.

Certain cultural practices also influence the relative susceptibility to injury from atmospheric pollutants. It is important to avoid nutrient deficiencies, which weakens the plant. A plant nitrogen deficiency, in particular, increases injury. Similarly it is important to utilize the proper mowing height and frequency to ensure optimum turfgrass health, carbohydrate reserve and recuperative potential. Avoiding practices such as excessively close mowing, removal of excessive quantities of leaf tissue in any one mowing or excessively high nitrogen levels are particularly important in order to maintain a high carbohydrate reserve. Generally the effects of atmospheric pollutants are of short duration in which chronic injury symptoms develop.

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Table 1. Turfgrass injury symptoms associated with the four most common atmospheric pollutants.*

Type of chemical pollutant	Turfgrass injury symptoms — Acute	Chronic
Fluoride	Dull, water-soaked appearance in the interveinal tissue at the leaf tip, plus transverse banding across the lower portion of the leaf	Gray-green, water-soaked appearance at the leaf tip; subsequently, light-tan to reddish-brown lesions appear and extend down the blade in a fairly uniform front
Ozone	Initially, light brown lesions appear; necrosis and bleaching of the leaf tips follow; red fescue has minute, dark-brown stipples; ryegrass has a glossy dark-brown necrosis of the entire leaf	Same
PAN	Initially, the lower leaf surface appears oily; followed by a metallic silver or bronze sheen or glazed appearance over the upper portion of the leaf; annual bluegrass has a tan transverse banding; ryegrass has a purple transverse banding; eventually chlorosis develops and extends down the leaf	Same
Sulfur dioxide	Dull, water-soaked appearance on the margins and interveinal tissue of leaf tip; subsequently the leaf dries and bleaches to an ivory color	Gradual yellowing of the leaf interveinal area progressing to a bleached appearance; the leaf tissue does not collapse

*Based on the available information which will probably be refined through additional research.

Table 2. The relative susceptibility of the commonly used turfgrasses to injury by four atmospheric pollutants.

Type of chemical pollutant	Relative susceptibility — Low	Medium	High
Fluoride	Redtop	Kentucky bluegrass	Annual bluegrass Perennial ryegrass Red fescue
Ozone	Zoysiagrass Bermudagrass Chewings fescue	Kentucky bluegrass Perennial ryegrass Red fescue	Creeping bentgrass Annual bluegrass
PAN	Kentucky bluegrass Bermudagrass Zoysiagrass	Italian ryegrass Perennial ryegrass	Annual bluegrass
Sulfur dioxide	Bermudagrass Zoysiagrass Redtop	Annual bluegrass Kentucky bluegrass Perennial ryegrass	Chewings fescue Red fescue Creeping bentgrass

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New leaf growth will generally replace the injured tissues within a short time unless phytotoxic concentrations persist in the atmosphere. Thus, it is important to maintain a high carbohydrate reserve so that an adequate level of carbohydrates is available for new shoot growth during those recuperative periods following leaf injury and the associated loss of chlorophyll. The degree of injury is also associated with the concentration of the atmospheric pollutant and the duration of exposure.

Species, cultivar susceptibility

Turfgrass species vary in their susceptibility to the four atmospheric pollutants (Table 2). Also, the relative susceptibility is not necessarily the same for all four pollutants. As a group, the warm season turfgrass species are more tolerant of atmospheric pollutants than the cool season species. Kentucky bluegrass generally ranks intermediate whereas the creeping bentgrasses and annual bluegrass are very susceptible to injury. Annual bluegrass is very prone to injury from ozone and PAN. This is quite significant because creeping bentgrass and annual bluegrass are widely used on golf course greens, tees and fairways.

There is also considerable variability in the relative susceptibility to pollutants among the varieties within a given turfgrass species. For example, Santa Ana bermudagrass was selected for its superior resistance to ozone and PAN as compared to Tifgreen. Among the bentgrasses, Kingston velvet bentgrass and Highland colonial bentgrass are the least sensitive to ozone; Penncross creeping bentgrass is intermediate; Astoria colonial bentgrass and Seaside and Cohansey creeping bentgrass are the most sensitive to ozone injury. Among the Kentucky bluegrasses, Merion and Kenblue are less susceptible to ozone injury than Belturf. Delta is even less sensitive than Merion.

To date no specific cultural practices or techniques have been developed or studied sufficiently so that they can be used to reduce the severity of atmospheric pollutant injury to any significant extent. The best solution now is to use the more tolerant turfgrass varieties and species. □