FEATURE ARTICLE

Hurricanes and Flooding Problems

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The hurricane season in the Atlantic Ocean has brought major flooding problems to eastern North America. The high winds associated with hurricanes typically result in the downing and uprooting of trees. This may result in the need for extensive debris removal from turf areas where tree limbs and various materials torn from buildings and other constructed facilities are strewn. This wood, metal, and similar debris should be removed as soon as possible in order to avoid interference with mowing operations and potential turf injury by light exclusion.

SOIL DEPOSITION

The dimension of hurricanes that can create the most injury to turfgrasses is the very intense rainfall and resultant flooding of turf areas. Recent intense rains on the east coast of the United States ranged from 10 inches (25 cm) to as high as 25 inches (63.5 cm) in less than 1 day. The lateral water flow from slopes onto lower areas of the floodwaters results in the deposition of soil, including clay, silt, and salt. **Salt deposited on the grass leaves should be washed off as soon as possible to prevent physiological desiccation and death of the turfgrass plants.** The deposition of clay and/or silt creates a fine-textured layer that is prone to compaction and can become relatively impermeable to downward soil water infiltration for years to come. Thus, **the removal of this soil deposition as soon as possible is very important, especially from high-sand root zones on putting greens and tees.** The thin layer of soil remaining after mechanical removal of thicker layers should be washed off to the extent possible using water that is pressurized and directed through large-volume hoses.

SUBMERSION INJURY

Flooding that persists for an extended period of time can cause the death of certain turfgrasses. **Complete submersion under water can result in soil oxygen depletion within a matter of hours.** This may result in death of the root hairs and subsequent yellowing of the turfgrass plants due to a nitrogen or iron deficiency. Ultimately, death of the turfgrass plant may occur by one of several mechanisms, including (a) a build-up of certain toxic compounds, such as ferrous and sulfide ions formed by reduction of anaerobic soil conditions, (b) the accumulation of toxic organic compounds, such as methane or carbon dioxide produced by the decomposition of soil organic matter, and (c) the accumulation of toxic by-products within the plant tissue under anaerobic conditions.

The relative degree of injury to turfgrass from submergence varies depending on the (a) turfgrass species, (b) submergence duration, (c) submergence depth, (d) water temperature, and (e) light intensity. The relative submersion tolerance of twenty turfgrasses is shown in the accompanying table. Submersion at high water temperatures of 86°F (30°C) can result in death of the fine leaf fescues (*Festuca* spp.) in one day, whereas creeping bentgrasses (*Agrostis stolonifera*) may survive more than 60 days submergence at low water temperatures of 50°F (10°C). Accordingly, **it is important to use submersion-tolerant turfgrass species on sites that are subject to frequent flooding.**

The extent of injury from submergence increases with increases in the depth of water coverage. Grasses with leaves extending above the water surface are able to survive much longer than if totally submerged. Also, **grasses under stagnant or standing water are more likely to be killed than when under flowing water.** However, one of the most important factors in the degree of injury that occurs during flooding is the actual water temperature. **The extent of death increases dramatically as the water temperature increases from 50°F (10°C) to 80°F (27°C).** Thus, submersion early in the year at cooler water temperatures is less likely to cause turfgrass injury than submersion later in the summer when water temperatures are high, and especially when also exposed to cloud-free, full-radiant sunlight levels.

INJURY ASSESSMENT

Once the debris is collected and any soil deposition removed as completely as possible, the next step is to assess the extent of damage to the turfgrass, which may appear as a totally brown canopy. Individual plants of the desired turfgrass species from numerous locations

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under flooding should be lifted out and examined carefully. **Cut a horizontal cross section through the grass crowns and the nodes on lateral stems to determine if they are white, firm, and healthy, or brown, mushy, and dead.** This will be an indicator of the amount of turfgrass recovery that can be anticipated. **Numerous multiple samplings are critical to get a representative assessment.** Then the decision must be made whether replanting of critical turf areas will be required to repair the damage. Removal of any dead turf plant material and thatch from the surface is important to avoid a future organic layer problem. If soil deposition has occurred, fairly intense core cultivation will aid in disrupting the clay or silt layer that has developed. The usual establishment procedures can then be followed.

The relative submersion tolerance of 20 turfgrasses.

Relative Submersion Tolerance	Turfgrass
excellent	seashore paspalum
	American buffalograss
	dactylon bermudagrass
	creeping bentgrass
	hybrid bermudagrass
good	tropical carpetgrass
	St. Augustinegrass
	turf timothy
	rough bluegrass
	tall fescue
	common carpetgrass
medium	meadow fescue
	Kentucky bluegrass
fair	crested wheatgrass
	annual bluegrass
	perennial ryegrass
poor	annual ryegrass
	red fescue
	hard fescue
	centipedegrass

Natural Organic Chelating Agents for Plant Nutrients

The organic matter component in soils is vital to a quality, living root zone. **It contributes significantly to adequate soil aeration, water retention, water movement, and nutrient availability, as well as providing a resilient upper root zone, which is important in the playing quality of numerous sport surfaces.** Organic matter also is a key substrate required for sustaining the life of numerous soil organisms, including bacteria, fungi, and actinomyces. In addition, the ongoing decomposition process of dead plant organic matter such as roots contributes to the recycling of plant nutrients. The soil organic matter content depends on the rate of soil organic matter accumulation relative to the decomposition rate. Grasses are known to be very effective in terms of a positive contribution to soil organic matter through their high-density, fibrous root system, which continues to grow and be replaced in a perennial manner.

Perhaps one of the least recognized and understood **beneficial contributions of organic matter is in providing organic compounds that function as natural chelating agents for a number of essential plant nutrients. Iron (Fe), manganese (Mn), copper (Cu), and zinc (Zn) become more soluble and plant-available in the soil solution by complexing with one of the numerous organic compounds.** In addition, these nutrients naturally chelated by the organic compounds are more easily moved to the uptake sites on the plant root hairs. Without the presence of these natural organic chelating agents both iron and manganese tend to be chemically bound in unavailable forms, while both copper and zinc are inherently water insoluble.

Some individuals advocate that the addition of organic matter in new high-sand root zone constructions is not needed, because it will eventually be formed through root decomposition. While roots will eventually contribute significantly to the soil organic matter content, the lack of needed organic compounds in the early developmental stages of the turf can result in significant turfgrass nutrient stresses that delay proper rooting and turf development. Thus, this natural chelating is one of a number of beneficial effects from organic matter that justify the inclusion of an organic matter component in the original high-sand root zone construction. In addition, it emphasizes the importance of developing an active, living root system in all soil textures, which will contribute significantly to a sustained, acceptable level of organic matter within the soil root zone.