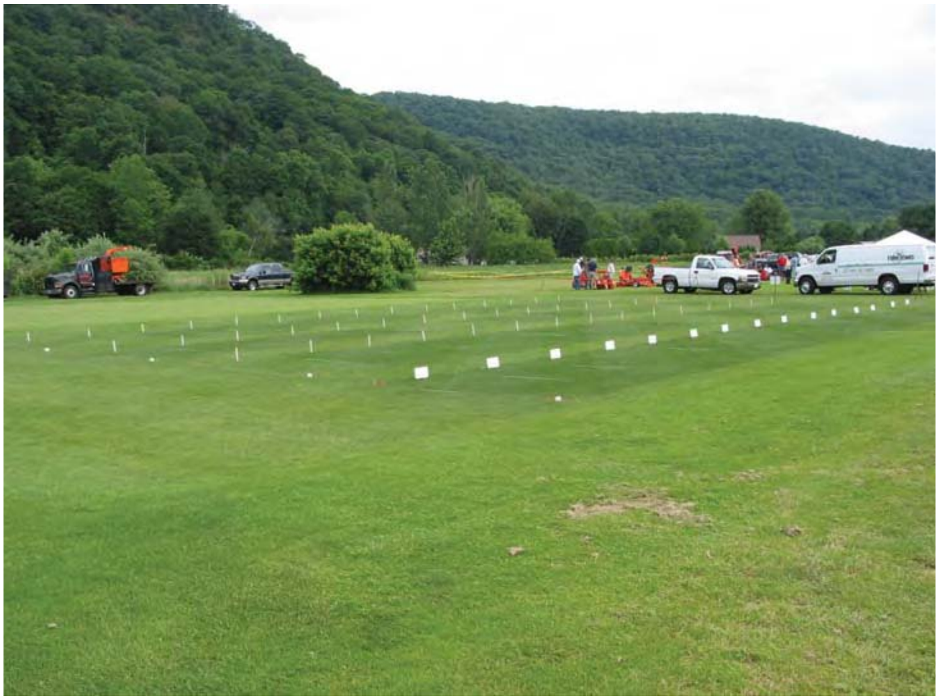

>> **PERENNIAL RYEGRASS STUDY AREA** at the University of Massachusetts-Amherst used to evaluate the effects of five rate levels of nitrogen on shoot and root growth under simulated traffic.

Enhancing nitrogen use efficiency of sports grass

A MAJOR CONCERN of society is to limit the application of water and nutrients such as nitrogen (N) to grassy surfaces including residential lawns and recreational turf. Water is a limited natural resource that must be conserved and protected. To that end, professional turf managers need to limit the use of N in order to protect surface and ground water from unnecessary contamination associated with the use of nitrogenous fertilizers when applied to turfgrass systems.

The conservation of N and water applied to turfgrass systems are closely related because the acquisition of water and N from the soil is dependent on rooting depth and density. As such, any cultural factors or conditions that inhibit rooting may reduce the turf system's ability to exploit the soil for these growth limiting resources. Eliminating any stresses that create an unfavorable environment for rooting will in turn allow the community of turfgrass plants to maintain turf function with less water and N. Sustaining turf function with less input from water and N fits nicely into "sustainable" turfgrass management practices, which is a term that has grown in popularity among turfgrass scientists and turf practitioners.

NUMEROUS OPPORTUNITIES

The opportunities to enhance N uptake by promoting rooting are numerous. All aspects of turfgrass maintenance practices such as height of cut (HOC), irrigation, and N fertilization directly influence rooting. In addition, there are as many conditions that exist in turf systems that are unfavorable to rooting such as excessive thatch, soil compaction, and strongly acidic soil pH, which can further impede rooting and reduce nitrogen use efficiency (NUE) of the turfgrass system. These unfavorable conditions and practices when considered alone may be harmful to rooting. Moreover, when these root-related stresses are active in combination they can interact and can be more inhibitory to rooting depth than any one practice or condition when considered alone.

In addition, many conditions (thatch and soil compaction) or practices (excessively close HOC, excess N and over-watering) that inhibit rooting and the efficiency of the turf system to acquire water and N can also promote waste as runoff and leaching. While runoff and leaching events are wasteful of water, these same practices or conditions can move fertilizer N into surface and ground water, respectively. By maximizing rooting depth and the turf system's NUE, the ability of the turf system to minimize N leaching is also enhanced, especially for irrigated turf in summer, when high soil temperature stress inhibits rooting of cool-season turfgrass.

The key to sustainable turfgrass management is to keep costly inputs such as N and water to their lowest possible level while sustaining optimal turf function. For optimal function under intensely trafficked sports fields, good shoot density and vigor is essential for wear tolerance and recovery. Furthermore, high turf density is also critical for keeping field related injuries to their lowest possible level. Nitrogen has competing affects on shoot growth and root growth and therefore "balancing N" to achieve optimum turf density and wear tolerance without diminishing rooting depth and NUE of the turfgrass system is important.

Five years of study was conducted at the University of Massachusetts-Amherst to evaluate the response of perennial ryegrass to incremental increases in N from 1 to 9 pounds per 1000ft2 per year. Perennial ryegrass was maintained at 1.25 inch HOC, irrigated to prevent drought stress and fungicides were applied to prevent disease. Our published research indicated a linear response to N in shoot growth (leaf growth rate and shoot density) and root growth (total mg root dry wt. cm-3 to a soil depth of 18 inch).

Each incremental increase in N caused sig-

While the gains in leaf growth are large in response to N there are diminishing returns with added N.

nificant increases in shoot density (no. cm-2) and leaf growth rates (measured as clipping yield, g dry wt. m-2 day-1). Leaf growth rates increased with N at a greater rate than shoot density. Shoot density increased with N by only 27% while leaf growth rates increased by a factor of 4.44 (444%). The gains in leaf growth with increasing N exceeded shoot density while rooting depth decreased by a factor of 2 in response to increasing N.

While the gains in leaf growth are large in response to N there are diminishing returns with added N. Unlike shoot and root responses to N, which are linear, acceptable wear tolerance (>6, 9=no injury) peaked at 3 to 5 lb N 1000ft-2 yr-1. Any opportunities to reduce N within this optimal range can provide the benefit of promoting 20% greater rooting and increase NUE without any loss in wear tolerance or recovery. In addition, greater rooting can improve the water use efficiency (WUE) of the turfgrass system by improving soil moisture acquisition with soil depth.

An incremental increase in leaf growth (leaf area) promotes higher evapotranspiration (ET) rates, which accelerates soil moisture depletion and wilting tendencies. The relationship between leaf area and N and their effect on turf ET in cool-season turfgrass is well established. Therefore, keeping N to its lowest possible level without compromising turf function (i.e., higher NUE) helps to promote deeper rooting while minimizing ET. The overall effect of less N is the potential for deeper rooting with lower ET, which may help to lengthen the irrigation cycle (days between irrigation). Any opportunity to add as many days to the irrigation cycle as possible can increase the potential for natural rainfall events to meet the water requirements of our turf system, rather than relying on costly (supplemental) irrigation. Like NUE, WUE can be improved by eliminating as many root related stresses as possible for maximum acquisition of either N or water.

Irrigating using ET replacement (recharging the rootzones based on turf ET) helps to minimize leaching losses of N and water, thus improving the NUE and WUE of the turf system by alleviating waste. Furthermore, irrigating using ET replacement applied at mild wilt (tissue dehydration indicated by leaf roll or leaf fold) has been shown to length the irrigation cycle by enhancing rooting depth in perennial ryegrass. The use of slow release N (SRN) or spoon feeding at reduced N rates are other opportunities to improve the NUE of the turf system by eliminating waste as leaching. So, the opportunities to enhance NUE (and WUE) of turf systems are numerous because there are many practices and conditions that exist in turf that either affect rooting or promote waste or both; most of which are manageable by the turf practitioner. ■

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