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Visit Agrium Advanced Technologies at GIS booth #1653 and discover smarter ways to grow lush healthy turf. You'll find the slow- and controlled-release fertilizers and turfgrass pesticides that you've trusted for years, along with exciting new products.

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When It Comes To Turf Quality, Ask Those Closest To It.

"I heard Nitroform® fertilize gets really high scores in tests by independent labs—that includes me."

– **Angus,** Randy Moody's Black Lab

Nitroform®

Slow-release Nitroform® fertilizer has made quite a positive impact on Superintendent Randy Moody and his dog, Angus, at Georgia's Longshadow Golf Club. "It's consistent, with no surge growth or flushes, so we save time and labor," says Randy.

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Smarter Ways To Grow

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The prediction here is that The Andersons' booth will be a frequent stop for folks wanting to pick up this cool action figure, which the company has named DG Man in honor of its new Contec DG dispersing granule technology.

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Dynamo, a new pre-emergent herbicide that not only provides pre-emergent coverage, but it also offers early post-emergent control of many broadleaf and grassy weeds, including crabgrass. Quincept, a multi-action and selective post-emergent herbicide, is another new product from the company that combines grassy and broadleaf weed control.

Grub buster

Folks at the Arysta LifeScience North America booth will undoubtedly be talking about the company's recent federal registration of new turf insecticide premixtures under the Aloft brand name, in both granular and sprayable formulations. The Aloft premix combines the residual activity of clothianidin with the knockdown activity of bifenthrin, providing two complementary modes of action.

Watch out big three!

Valent Professional Products will be touting the recent registration of Tourney Fungicide, which it says will provide superintendents with broad-spectrum control of the Big Three turf diseases — brown patch, anthracnose and dollar spot — among other diseases.

Tablet time

Bayer Environmental Science will tell you that its CoreTect tablets recently received registration from the Environmental Protection Agency. The new tablets are for use during tree and shrub installation or on established plants. They are a new treatment technology that combines the power of Merit insecticide with a fertilizer in convenient, easy-to-use tablets.

That's "P" for "Precision"

John Deere's new line of PrecisionCut Fairway Mowers (including models 7500, 7700, 8500 and 8700) will premiere at the show. The mowers provide superintendents a precise cut and straight line, according to Deere. The double-acting steering cylinders equalize left and right pressure to hold a straight line. The patented adjustable hydraulic down pressure keeps cutting units in close contact with the turf.

Phos-Free

Look for ZeroPhos at the booth of Grigg Brothers Foliar Fertilizers. ZeroPhos is a new phosphorus-free granular fertilizer that provides three-season feeding and improved visual appearance while mitigating phosphate impact.

Precedent part two

Club Car will introduce its Precedent i2 golf car at the show four years after introducing the Precedent. The Precedent i2 looks like its namesake, with its unique exterior styling. But the Precedent i2 also features the new Excel drive system, which continues the evolution of Club Car's electric platform with enhanced efficiency, reliability and control capabilities, according to the company.

The Precedent i2L, an upgrade of the Precedent i2 model, is aimed at upscale facilities.

Jake takes interactive route

Visitors to the Jacobsen booth will see advanced golf course maintenance on display through a variety of interactive exhibits. The booth will feature an up-close look at the first production models of the entire Eclipse walking greens mower line. Jacobsen's new AR-522 fine-cut rotary mower will also be on display with its new TrimTek cutting and mulching decks. Jacobsen will also have a few items in its booth that show why the equipment maker is thinking "green" these days.

Floratine plays TAPs

Floratine Products Group' representatives will tell visitors the philosophy behind its new Turf Action Plans (TAPs). Previously known as "Management Action Plans," TAPs aid superintendents in combating a wide variety of challenging yet difficult-to-treat turf issues. Each TAP includes Floratine product selections tailored for specific situations, conveniently packaged to allow for easy mixing and application. "After years of field research, working side-by-side with turf professionals, we developed TAPs to provide effective, consistent and convenient turf solutions," said Kevin Cavanaugh, Floratine's CEO.

Toro takes to the air power

The Toro Co. will tout a variety of products, including the Toro Pro Force Debris Blower, which attaches to the back of a Toro Workman or similar utility vehicle and utilizes a high-efficiency turbine design to deliver air power to blow clippings from fairways, or leaves and other debris from a variety of maintained areas. Also at the Toro booth: the Groundsmaster 5900/5910 16-foot rotary mowers; the Mid-Duty Workman with a redesigned suspension system; and other products.

Golfdom will cover the GIS with a special edition of its Insider e-newsletter on Feb. 1. Also, watch for more show coverage in an upcoming Golfdom issue. ■

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Golfdom'S PRACTICAL RESEARCH DIGEST FOR TURF MANAGERS

TURFGRASS TRENDS

NITRATE CARBOHYDRATE INTERACTION

Optimum Root Growth Hinges on Nitrogen Partitioning and Metabolism

By Richard J. Hull and John T. Bushoven

In two recent TurfGrass Trends articles (Hull & Bushoven, July 2007, page 64 and August 2007, page 56), we considered the impact that nitrate-nitrogen (NO_3-N) can have on the growth and function of turfgrass roots, when used as a sole (or principal) nitrogen source.

It is generally recognized that soil nitrate (NO_3-), after being absorbed by turfgrass roots, must first be reduced to ammonia (NH_3) before it can be assimilated into amino acids and enter the nitrogen metabolism of a grass plant. This NO_3- reduction process requires a substantial amount of energy and can only occur where and when that energy is available in the form of metabolizable carbohydrates (sugars). We have shown that most cool-season turfgrasses reduce very little NO_3-N to NH_3-N in their roots but instead transport the NO_3- to their leaves where photosynthetic energy is available to reduce NO_3-N and assimilate the resulting NH_3-N into amino acids. Wherever this occurs in the plant, growth normally is stimulated because amino acids, the building materials for making nucleic acids and proteins, are available. We concluded this to be one reason why abundant available NO_3-N retards turfgrass root growth while stimulating leaf growth. Virtually all the evidence presented in the first two articles cited above is consistent with this idea.

If this hypothesis is true, turfgrass roots should be able to reduce NO_3-N to NH_3-N if they contained enough energy in the form of simple sugars. This could have practical value because root growth stimulated by NH_3-N should make turf more tolerant of common stresses including heavy traffic, high temperatures and drought. What follows is our attempt to test this conclusion.

Supplying more carbohydrates to roots

The simplest way to test our idea was to grow roots in a solution containing glucose: a simple sugar easily utilized by plant cells, including root cells. Roots of perennial ryegrass (*Lolium perenne L.* cv. Palmer III) were grown in nutrient solutions contain-

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ing 14 parts per million (ppm) NO_3-N with or without glucose.

The ability of roots to reduce NO_3-N was measured by assaying for nitrite (NO_2-), the product of the first reaction in the NO_3-reduction pathway:

$$NO_3^- + 2e^- + 2H^+ \quad NO_2^- + H_2O$$

When glucose was included in the root culture solution, the rate of NO_3- reduction was more than doubled. This confirmed our theory that NO_3- reduction in grass roots was at least partly limited by insufficient energy. We tested this further by growing turfgrass cultures in a confined atmosphere containing twice the normal amount of carbon dioxide (CO_2). Doubling the CO_2 level increases photosynthesis rates twofold. Much of the additional sugar produced in leaves by photosynthesis is translocated to the roots where it stimulates their growth (Newton et al. 1996). We found that the roots of plants growing in elevated CO_2 metabolized (reduced) NO_3- at twice the rate of plants growing in normal CO_2. The percentage of total plant NO_3- reduction that occurred in roots was three times greater in plants growing in elevated CO_2. This strongly supports our theory that NO_3- reduction in roots is normally energy limited and can be increased by providing roots with more energy in the form of photosynthetic products.

Which leads to a key question: Is greater root NO_3- reduction due to additional carbon from leaves?

The above experiments did not prove that increased NO_3- reduction by roots was actually caused by the roots having more available energy in the form of carbohydrates. We know NO_3- metabolism is regulated by signal molecules, including NO_3- itself (Kaiser and Huber 1994). High NO_3-N concentrations in leaves will signal roots to absorb less NO_3- from the soil and reduce less NO_3- to NH_3. One such signal is a lessening of sugar translocation from leaves to roots when NO_3- has accumulated in the leaves. Under these conditions, photosynthetic energy in leaves is diverted toward the reduction of NO_3- to NH_3 and the assimilation of NH_3 to amino acids resulting in the stimulation of leaf growth. Thus, we cannot be certain that greater carbohydrate availability in roots was the direct cause for their increased rates of NO_3- reduction and metabolism.

To resolve this doubt, we grew perennial ryegrass in solution cultures at high and low CO_2 concentrations. On the fourth day after initiating the CO_2 treatments, grass leaves were exposed for 30 minutes to CO_2 containing the radioactive carbon isotope: carbon-14 (^{14}C). After exposure to $^{14}CO_2$, grasses were allowed to grow for an additional 24 hours in their earlier high or low CO_2 levels after which they were harvested and assayed for ^{14}C in addition to NO_3- reduction rates in leaves and roots.

We observed that the rate of NO_3-

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PHOTO 1

John Bushoven makes adjustments to growth chamber-mounted units for exposing leaves of turfgrass cultures to elevated CO_2 concentrations or $^{14}CO_2$.

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Superintendents must be ready to tackle many different problems that require a specific plan of action to overcome. As a superintendent-owned company, Floratine Products Group recognizes these challenges and offers Turf Action Plans to help superintendents combat a wide variety of challenging turf issues. Developed after years of consultative work with superintendents in the field, each TAP includes Floratine product selections tailored for specific situations like rapid recovery, fairway color, fall rooting and recovery, heat stress, mining, spring start, tournament prep and winter strength. Each TAP is conveniently packaged to allow for easy mixing and application, and instructions are presented in both U.S. and international standards. For more information of customized turf maintenance, visit www.floratine.com.

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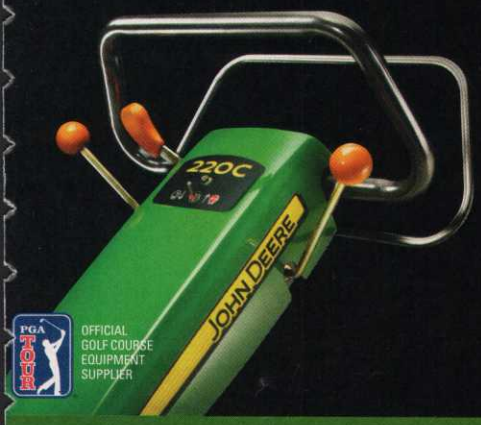

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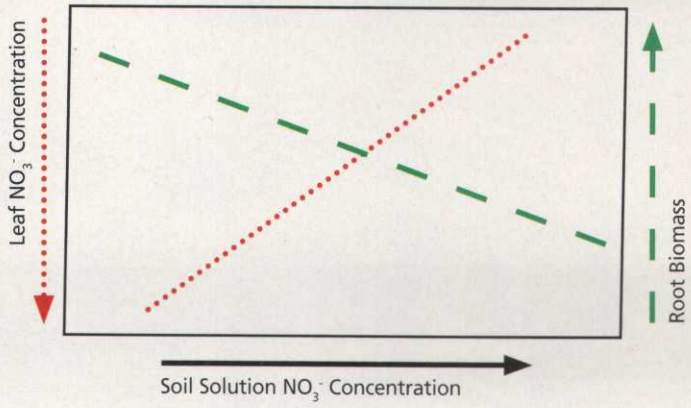
FIGURE 1

Relationship between leaf NO_3^-, root biomass and soil solution NO_3^- concentration (Generalized Relationships)



Relationship between leaf NO_3-, root biomass and soil solution NO_3- concentration (generalized relationships).

JOHN DEERE

QUICK TIP

Turf conditions undoubtedly vary throughout the year. For consistency, try a mower that uses adjustable hydraulic down pressure. The pressure helps keep the rear roller on the turf, yielding a consistent quality of cut without the use of springs or mechanical linkages. For information on these systems on the new line of John Deere fairway mowers, contact your local John Deere Golf distributor or visit www.johndeere.com/golf.

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reduction in roots was again more than doubled by the elevated CO_2 concentration. The recovery of ^{14}C in roots was also greater in plants growing at the higher CO_2 level. In this experiment, the ^{14}C served as a tracer for photosynthetic products (sugars) produced during the 30 minutes of leaf exposure to $^{14}CO_2$. Its greater concentration in roots 24 hours later, when NO_3- reduction rates were also greater, proves that more photosynthetic product was present when NO_3- metabolism was stimulated and it likely contributed to that enhanced NO_3- utilization.

Plants were also grown at high and low NO_3- concentrations and the above observations were most evident in grass grown at low NO_3- levels (0.5 ppm NO_3-N). These findings are also consistent with our observations and those of others that NO_3- accumulation in grass leaves correlates inversely with root biomass over the long term. That is, NO_3- in leaves diverts photosynthetic energy away from roots and toward greater shoot growth. From the perspective of sound turf management, that is not a good situation.

Conclusions

It appears that managing turf for maximum root growth is intimately related to managing nitrogen partitioning and metabolism within turfgrass plants. Any practice that slows the rate of NO_3- absorption by roots should allow greater NO_3- metabolism in the roots and less transport to the leaves. This relationship is governed by photosynthetic energy distribution within the grass plants. If sugars (energy) are translocated sufficiently to roots, NO_3- will be metabolized there and root growth will be promoted.

If the turf manager understands this relationship, he/she should be able to adjust their programs to promote the allocation of plant resources from shoot growth to optimize root development. Several examples of such practices were suggested in an earlier article (Hull & Bushoven 2007b). The validity of these management strategies need to be evaluated in the field and the details likely will require refinement for each situation.

Richard J. Hull, Ph.D., is professor emeritus of plant physiology in the Plant Sciences Department at the University of Rhode Island in Kingston, R.I., and an adjunct professor in the Horticulture Department at Clemson University in Clemson, S.C.

John T. Bushoven, Ph.D., is an assistant professor of horticulture in the Department of Plant Science at California State University — Fresno in California.

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– Mary, Tom Leahy's Black Lab

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High-Tech Tools Mow Down Test Turfgrass in Greenhouses

By Shawn Askew

Imagine mowing your rough with scissors. That was threatening to be the situation for students at Virginia Tech as we continued to add greenhouse research trials to the project's docket.

PHOTO 1

Adjustable metal racks hold potted turfgrass beneath angle-iron tracks.

PHOTO 2

A cordless lawn mower traverses the bench and mows potted turf. Clippings are collected in a bag made of quarter-inch hardware cloth.

Some trials require more than 1,000 pots of turfgrass that must be mowed weekly or more often depending on the desired height. The old way of mowing these pots was to pick up the pot, turn it sideways over a garbage can, and cut the turf to a desired height using scissors. Small pruning shears provided an alternative method of mowing the grass, but neither option could be done efficiently.

We felt there must be an easier way. Last spring I sat down with my technician, Phil Keating, and a local machinist, John Long, and designed a greenhouse system for turfgrass culture.

The system consists of adjustable metal racks that hold potted turfgrass beneath angle-iron tracks. The tracks allow a cordless lawn mower to traverse the bench and mow potted turf. Clippings are collected in a bag made of quarter-inch hardware cloth after it was noted that the manufacturer's bag limited airflow such that clippings fell through the bench and not into the bag.

The system allows for the culture of thousands of potted turfgrass plants, and mowing takes only a few minutes instead of several hours. Thus, superintendents who would like to experiment with pesticide combinations without risking the aesthetics of the golf course can maintain turf in the greenhouse with minimal input.

The system at Virginia Tech utilizes a lawn timer to automate irrigation. Irrigation to the benches is supplied by a half-inch PVC pipe with small sprinkler nozzles spaced every 4 feet. The whole irrigation system for 2,000 pots cost $200.

The mowing track was about $2,500, and the cordless lawn mower (Black and Decker) was $300.

This system allows us to culture turf-

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