Stunt the Leaf, Save the Nutrients

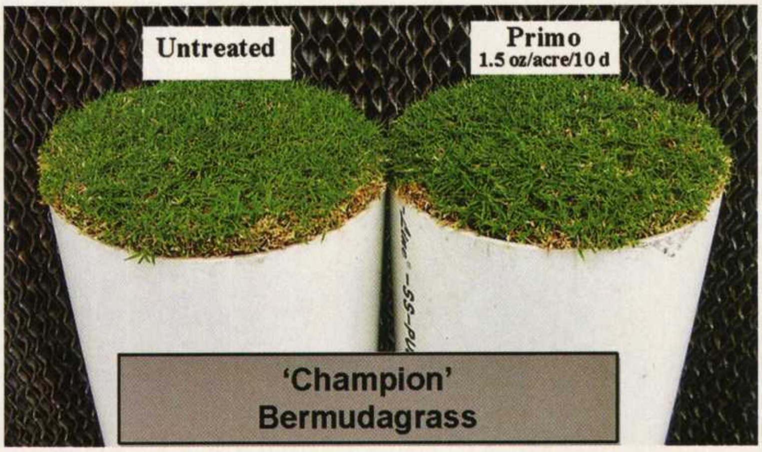
Plant growth regulators may improve efficiency of bermudagrass greens

By Patrick McCullough, Haibo Liu and Bert McCarty

Bermudagrass putting greens are the most heavily fertilized grasses in golf course management. Annual nitrogen requirements of bermudagrass greens range from 8 pounds to 24 pounds of nitrogen per 1,000 square feet to meet growth requirements and compensate for nutrient loss through daily clipping removal (McCarty and Miller, 2002). In some areas of the country, annual nitrogen inputs may even exceed this range to maintain bermudagrass putting green color and quality.

Routine close mowing and active shoot growth cause greater amounts of nutrients and photosynthate to be allocated to leaf tissue for nutrient assimilation. Inhibiting leaf growth with a plant growth regulator, such as trinexapac-ethyl, may alter the source-and-sink relationship to redirect photosynthate and nutrient partitioning away from leaf tissue production.

Greater amounts of nutrients stored in below-ground tissues could therefore improve nutrient-use efficiency of these heavily fertilized grasses. Greenhouse experiments were conducted to evaluate the effects of four nitrogen levels with and without trinexapac-ethyl on nutrient allocation of TifEagle bermudagrass.



Picture 1. TifEagle bermudagrass treated weekly with 0.125, 0.25, 0.375 and 0.5 pounds of nitrogen per 1,000 square feet shown after two months without (left) and with trinexapac-ethyl at 6 ounces per acre every three weeks.

Experiments

Research was conducted at the Clemson (S.C.) University Greenhouse Complex from September 2002 to January 2003 (Study 1) and January to May 2003 (Study 2).

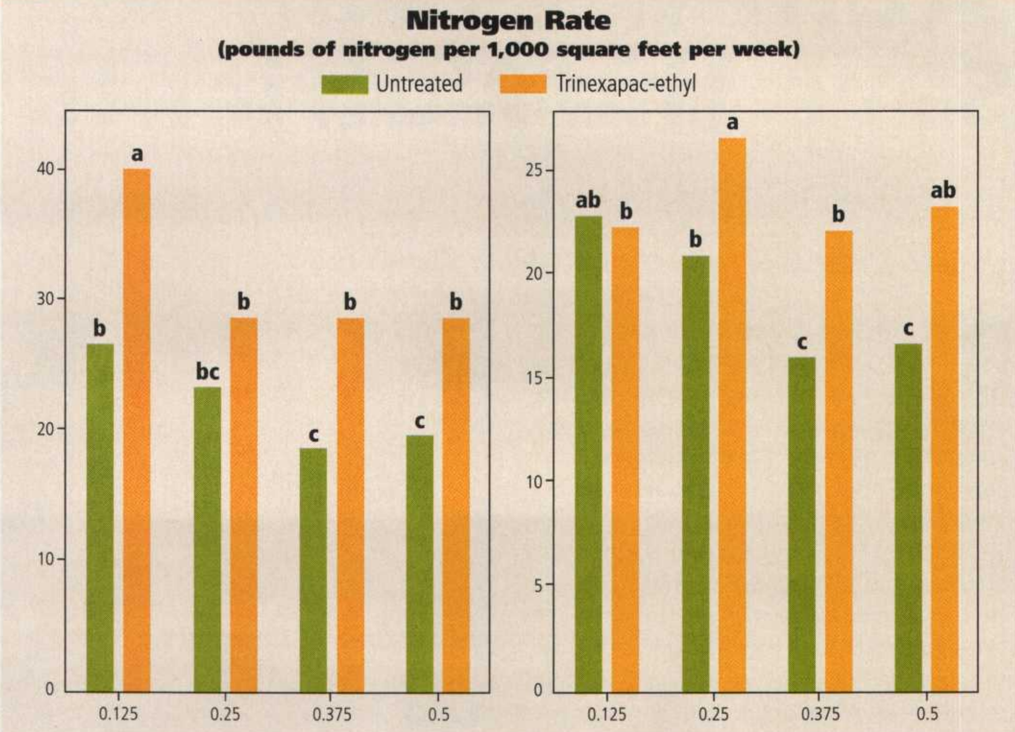
Greenhouse day/night temperatures were approximately 24 degrees Celsius and 19 degrees Celsius, respectively. The experimental design was a randomized complete block with four replications of eight experimental units per block. To minimize local environmental variations, blocks were rotated weekly and experimental units re-randomized within. Supplemental lighting was added for three hours per day to compensate for reduced natural lighting during winter months.

Sod was collected from a TifEagle bermudagrass green established in July 2002 at the Turf Service Center in Clemson. Soil was washed and plugs placed in polyvinyl chloride containers with 40-centimeter depths and 324-square-centimeter surface areas built to United States Golf Association specification (USGA Green Section Staff, 1993) with an 85:15 (by volume) of sand and peat moss rootzone mix. Starting fertilizer (9-18-17) at 48 kilograms of nitrogen per hectare was mixed into the soil, and bermudagrass was established four and six weeks in Studies 1 and 2, respectively, before treatments.

Urea-based nitrogen fertilizer (16-4-8) with complete micronutrients was applied to all containers at 24 kilograms of nitrogen per hectare two weeks before initial treatments and at 12 kilograms of nitrogen per hectare eight weeks after experiment initiation.

Continued on page 74

FIGURE 1



Editor's note: There is no significant statistical difference between results within each of the a,b,c categories; however, there is a significant performance difference between each category.

Continued from page 73

Bermudagrass was irrigated and mowed daily with automatic grass sheers (Black and Decker, Towson, Md.) at 4 millimeters. The eight treatments were a factorial combination of four nitrogen levels and two trinexapac-ethyl levels. Ammonium nitrate (34-0-0) solution was applied at 6, 12, 18 and 24 kilograms of nitrogen per hectare per week.

Beginning nine days after initial fertilizations, trinexapac-ethyl (1 emulsifiable compound) was applied at 0 or 0.05 kilograms of nitrogen per hectare every three weeks. Treatments were made at 300 liters per hectare with a greenhouse spray cabinet, Devries Manufacturing (Hollandale, Minn.) model SB6-094, with a Craftsman model 919.165110 pump supplying air pressure.

Tissue and soil tests were conducted at the Clemson Agriculture Service Laboratory. Nitrogen concentrations were determined using a LECO FP528 Nitrogen Combustion analyzer (Warrendale, Pa.). Other plant tissue nutrients were determined using wet ashing procedures with a Digestion Block Magnum Series Block Digester and an ICP model TJA-61E auto sampler (Madison, Wis.). Soil nitrate-nitrogen extractions were made with an ISE Electrode (Beverly, Mass.). Data analyses were made using the analysis of variance with SAS General Linear Model procedure.

Results

One week after the first application, TifEagle bermudagrass treated with trinexapac-ethyl had 6-percent lower leaf nitrogen concentrations (Figure 1). This trend continued through week 12 with lower leaf nitrogen concentrations in trinexapac-ethyl-treated turf, ranging from 2-percent to 10-percent reductions.

Bermudagrass putting greens have the highest nitrogen fertilization requirements of all grasses in the turf industry.

Root and thatch nitrogen concentrations ascended linearly with increasing nitrogen rate. For turf treated with trinexapac-ethyl, root nitrogen concentrations were approximately 10-percent higher than the untreated after 16 weeks.

Leaf phosphorus and potassium concentrations in trinexapac-ethyl-treated bermudagrass

Continued on page 76

Continued from page 74

were reduced 8 percent and 14 percent, respectively, one week after initial trinexapac-ethyl treatments. However, higher nitrogen rates increased phosphorus concentrated in leaf tissue and reduced phosphorus concentrations in roots and thatch.

Increasing nitrogen rate reduced root and thatch potassium concentrations. Root potassium concentrations were 29-percent greater in trinexapac-ethyl-treated turf after 16 weeks. Furthermore, trinexapac-ethyl-treated turf had a 0.06-percent range of root potassium concentrations from low to high nitrogen inputs vs. the 0.25 percent range from low to high nitrogen inputs in untreated turf.

On five sampling dates, trinexapac-ethyl-treated bermudagrass had higher leaf calcium, magnesium and sulfur concentrations, increasing to 27 percent, 11 percent, and 15 percent, respectively. Trinexapac-ethyl did not influence primary or secondary thatch nutrient concentrations. Increasing nitrogen rate caused reductions in thatch sulfur concentrations but differences were not observed in roots or thatch of trinexapac-ethyl-treated turf.

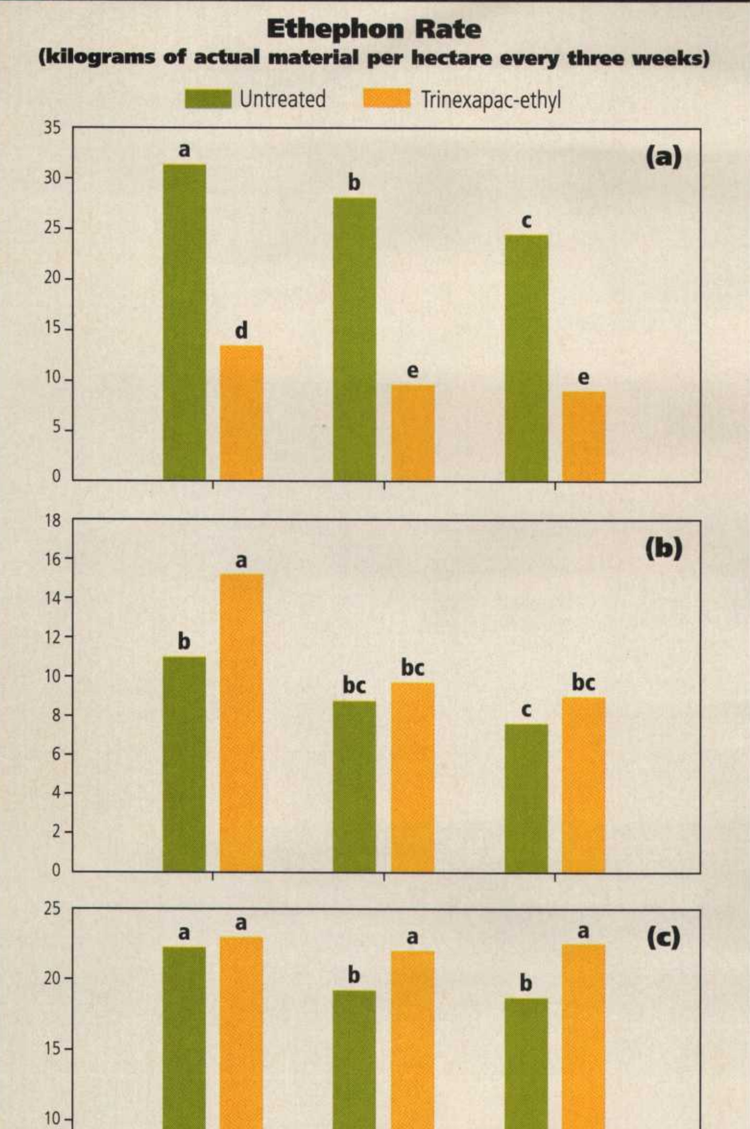
For micronutrients, higher nitrogen inputs increased leaf concentrations with the exception of iron. Similarly, increased nitrogen rate resulted in higher micronutrient concentrations in thatch and roots. Bermudagrass treated with trinexapac-ethyl had approximately 15-percent reduced zinc, copper and manganese in thatch and 30-percent reduced root copper concentrations.

Leaf iron levels were unaffected by nitrogen input; however, trinexapac-ethyl-treated turf had lower leaf iron concentrations from week 9 to week 16. Increasing nitrogen rate linearly increased root and thatch iron concentrations but remained similar to the untreated when treated with trinexapac-ethyl.

From six sampling dates, nitrogen and trinexapac-ethyl effects were highly significant for total nitrogen, phosphorus, potassium, magnesium, sulfur, zinc, copper and manganese recovered through clippings. Increased nutrients removed through clippings occurred with increased nitrogen rates; however, total nutrient recoveries were reduced 69 percent to 79 percent when trinexapac-ethyl was applied (Table 1).

Bermudagrass treated with trinexapac-ethyl, regardless of nitrogen input, had similar amounts of nutrients removed through clippings as the low rate of nitrogen without trinexapac-ethyl. TifEagle bermudagrass treated with trinexapac-ethyl had 50-percent higher nitrogen recovered in roots after 16 weeks compared to untreated turf from increased root nitrogen concentrations plus greater root mass (Table 1). Primary, secondary and micronutrients recovered in roots ranged from approximately 25-percent to 105-percent

FIGURE 2



Editor's note: There is no significant statistical difference between results within each of the a,b,c categories; however, there is a significant performance difference between each category.

greater in trinexapac-ethyl-treated bermudagrass than the untreated.

Clippings vs. nutrients

The presence of clippings on golf greens interferes with the direction and velocity of ball roll and their removal is necessary (Beard, 1973). However, substantial amounts of essential plant nutrients are removed through routine clipping collection on bermudagrass putting greens (Williams and McCarty, 2005).

Inhibiting leaf growth with trinexapac-ethyl decreases nutrient losses through daily clipping collection and may help balance photosynthate and nutrient partitioning within the plant. Redirected nutrients away from leaf growth for storage in below-ground plant tissues may improve nutrient-use efficiency and reduce fertility requirements of ultradwarf bermudagrass putting greens treated with trinexapac-ethyl.

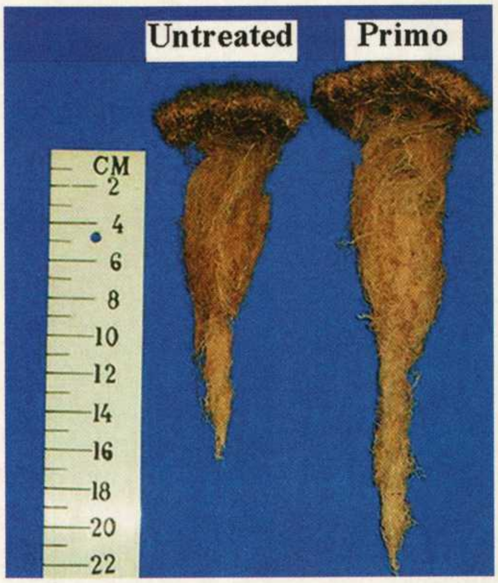
Increased nitrogen rates resulted in higher phosphorus concentrations in leaf tissue and reduced phosphorus concentrations in below-

TifEagle bermudagrass reallocated nitrogen to roots and rhizomes when leaf growth was inhibited.

ground plant tissues. This likely occurred as bermudagrass required higher adenosine triphosphate concentrated in actively growing leaf tissue for nitrogen assimilation. Conversely, lower leaf nitrogen, phosphorus and potassium concentrations occurred one week after initial trinexapac-ethyl applications, while increased concentrations were observed in roots after 16 weeks.

These results exemplify an altered bermudagrass source and sink relationship under shoot growth inhibition with trinexapac-ethyl.

TifEagle bermudagrass reallocated nitrogen to roots and rhizomes when leaf growth was inhibited. Decreased phosphorus concentration in leaf tissue may occur from higher adenosine triphosphate concentrations in below-ground tissues. Less nitrate moving to leaves results in more energy and plant sugars directed to roots for root nitrate assimilation (Hull, 2003).



TifEagle bermudagrass treated with trinexapac-ethyl had 50-percent higher nitrogen recovered in roots after 16 weeks compared to untreated turf.

TifEagle bermudagrass may therefore have improved nutrient-use efficiency as higher amounts of nutrients are concentrated in below-ground tissue which may be readily allocated to leaves to prevent nutrient deficiencies.

Improved nutrient-use efficiency will reduce the high fertility requirements of these grasses. This is an important finding since bermudagrass putting greens have the highest nitrogen fertilization requirements of all grasses used in the turf industry. Inhibiting shoot growth with trinexapac-ethyl reduced nutrients removed through clippings; consequently color enhancements resulted to where fertilizations may be unnecessary to promote turf quality.

Overall, consistent maintenance with trinexapac-ethyl may effectively enhance turf quality and improve nutrient-use efficiency of dwarf-type bermudagrass.

REFERENCES

Beard, J.B. 1973. *Turfgrass: Science and Culture.* Prentice-Hall, Inc. Englewood Cliffs, NJ.

Hull, R.J. 2003. Small amounts of molybdenum streamlines nitrogen uptake. *Turfgrass Trends* 12(1):42-44.

McCarty, L.B. and G.L. Miller. 2002. *Managing Bermudagrass Turf: Selection, Construction, Cultural Practices and Pest Management Strategies.* Sleeping Bear Press. Chelsea, MI.

United States Golf Association Green Section Staff. 1993. USGA recommendations for a method of putting green construction. The 1993 Revision. *USGA Green Section Record.* 31(2):1-3.

Williams, D. and B. McCarty. 2005. Cultural practices for golf courses. p. 423-455. In: McCarty, L.B. (ed). *Best Golf Course Management Practices,* 2nd ed. Prentice-Hall, Upper Saddle River, NJ.