# UNIVERSITY TURF RESEARCHERS ARE WORKING FOR YOU

## University of Massachusetts Amherst

The University of Massachusetts Turf Program conducts a wide range of research at both the UMass Joseph Troll Turf Research Center as well as at various field sites throughout the Northeast. Our goal is to enhance the functional use of turfgrasses while reducing the environmental impact of turf management practices. Numerous projects are at various stages of completion. Presented below is one project that may be of interest to some turf managers who are responsible for managing natural grass surfaces under intense traffic, especially lawn tennis courts. Little research specific to grass tennis has been conducted. In addition, wear and associated research is often simulated using wear machines whereas in the study summarized below the wear injury is the result of actual tennis match play.

**Carrying Capacity, Surface and Plant Characteristics of Natural Grass Tennis Courts**, *by J. Scott Ebdon, PhD, Michelle DaCosta, PhD, and William Dest, PhD.* Three official size single courts (78 by 27 ft.) were established in 2016. Each court was planted to evaluate pure stands of the same eight species and cultivars: 'Keeneland' Kentucky bluegrass (KB), 'Rubix' KB, 'Karma' perennial ryegrass (PR), 'Wicked' PR, 'Puritan' colonial bentgrass (CLB), '007' creeping bentgrass (CB), 'Villa' velvet bentgrass (VB) and the Chambers Bay Dunes mix (creeping red fescue and Chewings fescue, FF). The study is maintained at 0.375-inch height of cut. Net posts and base lines were installed and natural wear from actual match play was initiated in June 2017.

UMass Amherst grass tennis courts before match play in June 2017. Wear tolerance along with plant and surface properties are being evaluated. Mike Buras (left), Director of grounds at Longwood Cricket Club, Chestnut Hill, MA, is shown setting the court base lines.

Maintenance personnel from Longwood Cricket Club (Director of Grounds Mike Buras and crew) assisted in the design and installation of the courts.

The following surface characteristics important to tennis are being measured on the different species-cultivars, including ball bounce (i.e., coefficient of restitution, COR), surface friction (i.e., coefficient of friction, COF), surface hardness (Gmax, firmness), traction (Nm), soil moisture, as well as turfgrass physiological and morphological measurements. Court pace (speed of play) is being derived from COF and COR measurements. Lower COF of the surface increases horizontal velocity of the ball after bounce while lower COR decreases the time to react to ball bounce. Both lower COF and COR increase court pace. Hours of play on each court are recorded daily to compute carrying capacity of the different grass species and cultivars. Carrying capacity is derived from wear injury measured as the loss in grass cover at the base lines on all courts (replicates) and main plots. This study is a 3-year test with only one year (2017) completed. The New England Regional Turfgrass Foundation is sponsoring this study.

**EDITOR'S NOTE:** Once again we asked university turf program researchers to update us on their current projects. Thanks to Sam Bauer, University of Minnesota; Scott Ebdon, PhD, University of Massachusetts Amherst; Bryan Hopkins, PhD, Brigham Young University; Adam Thoms, PhD, Iowa State; and Ben Wherley, PhD, Texas A&M, for their time putting together these reports.


*Three single courts as replicates were planted to eight different species-cultivars. Eight main plots were used per court, each main plot measured 6.75 by 44 ft. Species-cultivar main plots extended 5 feet beyond the base line to capture base line traffic during match play.*

*Traction apparatus used to measure the force (Nm) to initiate slip on grass courts. Apparatus disc was fitted with the soles from grass tennis shoes and weighted with 75 pounds. Peak force required to tear (break) the grass surface was then measured.*

Seventy-two players participated in 2017 with an average of 22 players per week on each court. By the end of the playing season 76 hours of match play were recorded on all three courts. Carrying capacities (hrs) were calculated in terms of hours of play required to diminish grass cover from 100 to 70% cover at the base line. Species carrying capacities in 2017 to cause 70% grass cover were as followed: PR (69.2 hrs) = KB (61.8 hrs) > VB (52.9 hrs) > CB (30.7 hrs) = CLB (26.9 hrs) > FF (13.3 hrs). Cultivars of KB and PR exhibited a 2-fold greater carrying capacity (and wear tolerance) than most other species (bentgrass and fine fescue). After 76 hours of match play the courts were closed to begin overseeding of the base lines. Grass cover at the base line after 76 hours of match play corresponded to PR (77%) = KB (72%) = VB (65%) > CLB (39%) = CB (35%) = FF (11%). Grass cover and carrying capacity at termination of match play was highly correlated with shoot total cell wall content (cell wall

**BALL TO SURFACE INTERACTION IS RELATED TO COR WHICH IS DERIVED FROM THE SQUARE ROOT OF THE BALL BOUNCE-TO-DROP HEIGHT RATIO.**

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thickening). Species-cultivars with greater carrying capacities, grass cover, and wear tolerance at the base line were associated with greater total cell wall content measured in their shoots.

The soles from grass tennis shoes were fitted to a traction apparatus for measuring the ability of the grass surface to resist slippage when a rotational force (measured as Nm, Newton meter) is applied. Traction measurements indicated that grass surfaces with greater carrying capacities (and wear tolerance) are not necessarily the best for traction. Species traction measurements in 2017 were as followed: Bentgrasses (34 Nm) = KB (33.7 Nm) > FF (31.1 Nm) > PR (29.4 Nm). Preliminary results suggest that KB is the only species to combine both superior traction and wear tolerance under grass court conditions. Perennial ryegrass plots were among the most tolerant to wear but players may be more prone to slip when compared to the other species even when wearing grass court shoes.

Player wear injury at the base line after 42 hours of match play: 'Wicked' perennial ryegrass (left, 90% grass cover) and 'Puritan' colonial bentgrass (right, 58% grass cover).

Player wear injury at the base line after 42 hours of match play: Fine fescue mixture (center left, 22% grass cover) and '007' creeping bentgrass (center right, 55% grass cover).

Ball to surface interaction is related to COR which is derived from the square root of the ball bounce-to-drop height ratio. Fresh tennis balls are dropped from 100-inch height and higher COR increases with higher ball bounce. Higher ball bounce in turn increases the time between successive bounces, which slows the pace of play. Coefficient of restitution indicates the fraction of the inbound ball velocity retained immediately after interacting with the surface. Measurements of COR were made on concrete as well as on nearby hard court and clay court surfaces, which corresponded to COR of 0.74, 0.73, and 0.71, respectively. Species COR measured in 2017 were as followed: FF (0.63) > PR (0.61) = KB (0.60) > bentgrasses (0.54). All species retained at least 60% of the inbound ball velocity after bounce (i.e., COR > 0.60) except for the bentgrasses. All grass surfaces were associated with lower ball bounce (and COR) compared to artificial surfaces such as concrete, clay court, and hard court surfaces. This is largely due to surface hardness measured as Gmax. In 2017 greater surface hardness promoted higher ball bounce and COR. Fine fescue surfaces exhibited the highest surface hardness (119 Gmax) and bentgrasses the lowest hardness (100 Gmax) with KB (115 Gmax) and PR (111 Gmax) intermediate in their surface hardness.

HIGHER BALL BOUNCE IN TURN INCREASES THE TIME BETWEEN SUCCESSIVE BOUNCES, WHICH SLOWS THE PACE OF PLAY.

All species and cultivars selected for the grass court study summarized above were based on previous wear trails conducted as part of the National Turfgrass Evaluation Program (NTEP). In addition, the UMass faculty and staff are conducting a number of other research projects within the field of turf management. These include: (1) studies conducted by Geunhwa Jung, PhD, including rolling studies in the management of dollar spot, fungicide management of snow mold, and fungicide resistance management; (2) studies conducted by Michelle DaCosta, PhD, including the screening for drought resistant cultivars, quantifying ET and irrigation frequencies of turfgrass species; and (3) studies conducted by Robert Wick, PhD, on nematode management and biological alternatives to nematicides in reducing pesticide exposure to turf users. For more information on these and other projects, please visit the UMass Turf Program website at www.ag.umass.edu/turf and click on "Research."

## Iowa State University

**Shockwave Evaluation**. Finding time to relieve compaction on athletic fields is always hard to do with the constant use of the fields. Traditionally the field has to be closed for a period of time after aerification to allow the field to recover. A new device by Campey Imants (Campey Turf Care Systems, United Kingdom) called the Shockwave could potentially be a tool for this type of a situation. The device has knives that are offset and rotate to decompact the soil in a linear direction up to 10 inches deep, with minimal surface disruption. The offset knives give the soil a kick as they work the ground. A 2-year study is being conducted by graduate student Tim Dalsgaard comparing the Shockwave with one pass and two passes per month, monthly solid tine, monthly hollow tine aeration, and no aerification treatments all under simulated athletic field traffic. Data on surface hardness and turfgrass performance are being collected. Early results indicate that this device can be used during periods of field use with no negative effects to the playing surface. Full results will be presented in the coming years.

*The Shockwave offers the potential of linear decompaction of athletic fields with offset rotating blades up to 10 inches deep.*


*Tim Dalsgaard, a graduate research assistant, simulating athletic field traffic at the Iowa State Athletic Field Research Center with a modified Baldree Traffic Simulator.*

**Wetting Agents for Athletic Fields**. Managing moisture in the rootzone can be tricky for athletic field managers. Too much soil moisture can lead poor playing conditions, while too little can lead to a very hard surface. Wetting agents have been used for a while on golf courses to help combat localized dry spot, lower the frequency of irrigation, and increase infiltration rates. Data is lacking for wetting agent performance under simulated athletic field traffic. Various wetting agents (Alypso Plus, Dispatch, Revolution, Sixteen90, Triplo, Vivax, and an untreated control) and application timings (monthly and biweekly) are being tested under simulated traffic on a native soil athletic field to see how the playing surface will perform. Fall simulated traffic is being applied by graduate student Ben Pease, and he also is collecting data on turfgrass performance and safety. First-year results indicate that Sixteen90 and Vivax had lower surface hardness values than the control. All treatments performed similarly for percent green cover. A second-year of data will be collected this coming fall.

**Evaluating Corn Gluten Meal under Traffic**. Many municipalities and schools have undergone a synthetic pesticide ban, and traditional weed control methods are no longer acceptable. Corn gluten meal, a natural-based preemergent herbicide, has demonstrated use as a preemergent herbicide but has never been tested under simulated athletic field traffic. Twenty pounds of corn gluten meal per 1,000 square feet was applied to plots as a preemergence and compared to a traditional preemergence herbicide (Barricade), and a non-treated control. Simulated athletic field traffic was applied in the fall, and turfgrass performance and safety data we taken. First-year results indicate that corn gluten meal offers a natural weed control in situations where synthetic herbicides are banned, and demonstrated improved turf cover compared to untreated controls.

**Natural Products Herbicide Trials**. Continuing research on alternative products for sports turf managers under pesticide bans, a multi-state study is being conducted as part of the NCERA-221 to look at various natural products for post emergence broadleaf control. Products being tested include active ingredients including iron, clove oil, boric acid, rosemary oil, and cinnamon. Additional trials are being conducted with a Lawn Life to determine timings of various natural products for weed control. First-year results from previous work indicate that many natural herbicides will burn the tissue, but will not kill the plant. Often sprays must be made on 7 to 10-day intervals to limit the visual presence of weeds with these products.

**Hybrid Turf Evaluation**. A multi-university trial is underway with Iowa State, Michigan State, and the University of Tennessee to evaluate the performance of new hybrid turf systems containing Kentucky bluegrass compared to a non-hybrid Kentucky bluegrass turf. The hybrid systems include the Hero and Eclipse hybrid turf systems available from The Motz Group. Simulated athletic field traffic will start at all locations this summer.

**Paint Effects on Sand-Based Rootzone Characteristics**. It is well known that areas that receive regular paint often have lower infiltration rates than other locations on the field. A greenhouse trail is being conducted by graduate student Ryan May to investigate painting sand-based Kentucky bluegrass pots at regular intervals compared to non-painted Kentucky bluegrass pots. The objective of this work is to investigate the changes in rootzone characteristics with known regular applications of athletic field paint.

A MULTI-UNIVERSITY TRIAL IS UNDERWAY WITH IOWA STATE, MICHIGAN STATE, AND THE UNIVERSITY OF TENNESSEE TO EVALUATE THE PERFORMANCE OF NEW HYBRID TURF SYSTEMS CONTAINING KENTUCKY BLUEGRASS COMPARED TO A NON-HYBRID KENTUCKY BLUEGRASS TURF.

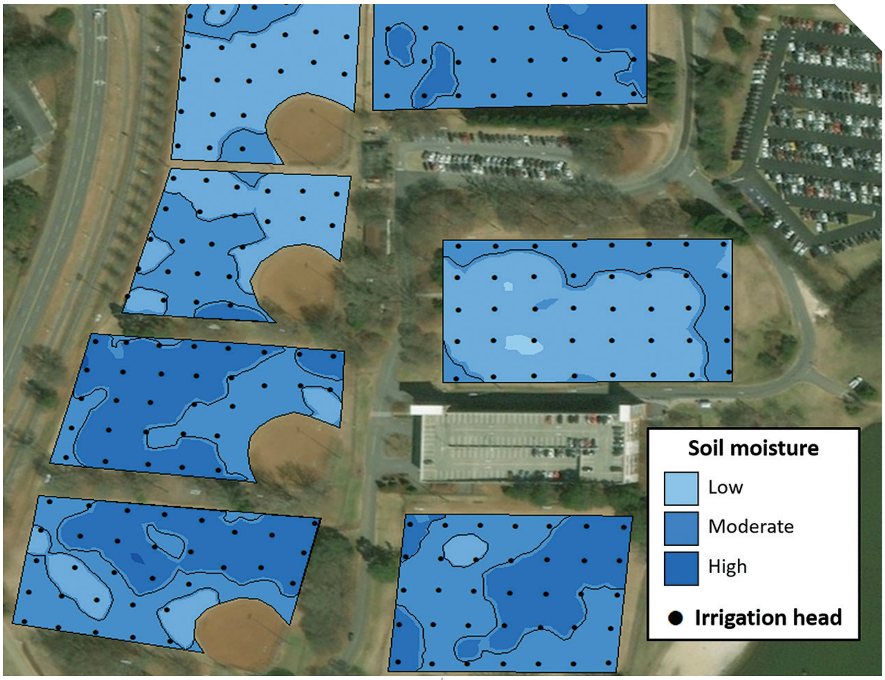
**2018 National Turfgrass Evaluation Program (NTEP) tall fescue test**. The 2018 NTEP tall fescue test will be seeded this fall to assess the tolerance of entries to wear applied with a traffic simulator. Traffic simulation will begin after the establishment of these entries. In addition to this cultivar test, Iowa State is also home to a 2018 Tall Fescue NTEP shade location and a 2017 Kentucky bluegrass NTEP shade and sun trial location. These studies will help guide turfgrass breeders and end-users in making selections for better performing turfgrasses.

*- By Adam Thoms, PhD, Assistant Professor and Turfgrass Extension Specialist.*

## University of Minnesota

**Site-specific Irrigation**. Precision turfgrass management involves site-specific applications of management inputs only where, when, and in the amount needed. GPS-equipped sampling devices to measure plant and soil properties can aid in creating maps to identify variations within a field. These maps are used to classify units for site-specific management, which can be employed by managing each unit independently. A 3-year study is in progress in Minnesota to encourage the adoption of precision irrigation technology through on-site application and demonstration of water savings. Using golf as an example, we will use a GPS-equipped mobile multi-sensor sampling device and unmanned aerial vehicle, as well as in-ground soil moisture sensors, to demonstrate a practical approach for creating irrigation management units, defining thresholds to trigger irrigation within each unit (based on plant available water and turfgrass quality), and programming an irrigation system to irrigate site-specifically by unit. Water consumption from this site-specific irrigation technique will be compared to traditional (irrigating when the turfgrass managers believes it is necessary) and evapotranspiration-based (using weather data) irrigation practices. Most sports fields are currently limited to predetermined irrigation zones (as opposed to golf where individual irrigation heads and zones can be manipulated). We hope our research findings will entice future development of irrigation system design and technology for site-specific irrigation application in all types of turfgrass areas.

**Influence of soil temperature on wetting agents' abilities to reduce soil water repellency**. Using wetting agents throughout the growing season for localized dry spot prevention is a common practice. A calendar-based application schedule can be convenient, but may be inefficient since soil water repellency is impacted by environmental and management factors. These products, since they are biodegradable, may also be influenced in the same



*An example of low, moderate, and high soil moisture site-specific management units at a sports complex. The unit classifications are based on soil moisture values obtained from a sampling device and indicate areas of low, moderate, and high soil moisture relative to this sports complex.*

way. With a focus on soil temperature, we will determine how long different wetting agent chemistries reduce soil water repellency from single applications. Results from this research are currently being analyzed.

**Biological nitrification inhibition in perennial turfgrass systems**. Nitrogen loss by nitrate leaching and gaseous nitrogen compounds is a problem in many landscapes using perennial grasses and fertilization management. These nitrogen compounds are detrimental to the environment when lost from a turfgrass system, causing water contamination and greenhouse gas emissions. At the University of Minnesota, are committed to look for innovative solution to overcome this important challenge. Biological nitrification inhibition (BNI) is the ability by plant-secreted root exudates to decrease soil nitrification rates and the loss of nitrogen; this has been previously described in pasture grasses and various cereal crops but never in perennial grass species. Preliminary results in our lab with a known perennial grass root exudate led to nitrification inhibition in soil slurry experiment. Further experiments are needed to validate these results and to determine which step of the nitrification pathway was inhibited. We are particularly interested in continuing to study lower input species such as the fine fescues, which require lower levels of nitrogen inputs and are used for parks, roadsides, lawns, and other sustainable turfgrass systems. Results from our research can be used to improve the efficient use of nitrogen in perennial grass systems and to develop new cultivars.

**Fine fescue breeding program**. Over the past 5 years, we have greatly expanded our efforts in improving fine fescues for low-input environments. This effort is part of a multi-institutional grant from the USDA Specialty Crop Research Initiative (http://lowinputturf.umn.edu/). Other partners in this project include Rutgers, Wisconsin-Madison, Purdue, Oregon St., and the USDA-ARS in Logan, UT. The overall breeding efforts of the multi-state team are focused primarily on a few traits that we know to be deficient in the fine fescues: heat stress tolerance, wear/traffic tolerance, and disease tolerance (focused primarily on summer patch and snow molds). This project also includes efforts to better understand how public land managers and other consumers make choices about purchasing grass seed. We are also working on the development of a turfgrass performance database that will allow for greater accessibility to turf data by consumers who would like to make informed seed purchasing decisions. In Minnesota, we aim to improve other traits that make these grasses very useful as low-input turfgrasses: weed suppression and shade tolerance.

SHADED ENVIRONMENTS PRESENT SIGNIFICANT CHALLENGES FOR TURFGRASS MANAGERS; INCREASING OUR UNDERSTANDING OF HOW COOL-SEASON TURFGRASSES RESPOND TO DIFFERENT TYPES OF SHADE CAN IMPROVE TURFGRASS MANAGEMENT RECOMMENDATIONS AND ALSO RESULT IN BETTER METHODS FOR SELECTING SHADE-TOLERANT PLANTS IN TURFGRASS BREEDING PROGRAMS.

**Breeding for natural weed suppression**. Allelopathy, a phenomenon when one plant negatively affects the growth of a nearby plant, has been shown to be present in the fine fescues; however, there has been little effort to develop cultivars possessing this trait. Breeding for natural weed suppression via allelopathy in turfgrasses has potential for reducing pesticide use in sports fields and other turfgrass systems. Field and greenhouse trials are currently in progress evaluating multiple genotypes of three fine fescue species, hard fescue, Chewings fescue, and strong creeping red fescue, for their ability to suppress crabgrass growth. A field trial planted in April 2017 in Saint Paul, MN and West Lafayette, IN demonstrated genetic differences within and across fine fescue species for their ability to suppress crabgrass growth. Genotypes that expressed the highest and lowest rates of weed suppression were planted in controlled environment experiments to better understand mechanisms of weed suppression. Field evaluations and growth chamber experiments will continue in 2018-2019. Further directions of this research include evaluating for allelopathy across multiple weed species and incorporating these findings into breeding efforts.

**Breeding for shade tolerance**. Shaded environments present significant challenges for turfgrass managers; increasing our understanding of how cool-season turfgrasses respond to different types of shade can improve turfgrass management recommendations and also result in better methods for selecting shade-tolerant plants in turfgrass breeding programs. We have been screening a number of fine fescue cultivars and selections in a greenhouse under a photoselective plastic filter that alters the distribution of individual wavelengths of light similar to the effects from vegetative shade. We are monitoring tillering and plant height (etiolation), and are quantifying chlorophyll (a, b, and a:b) and specific leaf area (SLA). At the same time, we are also monitoring light intensity and wavelength distribution under various levels of natural shade at the Turfgrass Research and Outreach Center (TROE), and around the UMN St. Paul campus. This information will then be used to treat entries from each fine fescue species that exhibit strong or lack of shade avoidance responses in our greenhouse experiment with more extreme, as well as realistic, qualitative shade conditions within a growth chamber using far-red LEDs. Ultimately, we hope to improve methods for selecting shade-tolerant turfgrasses in our plant-breeding program.

Soil profile image of a sand-capped bermudagrass turf sports field.

Image of turfgrass shade research facility at Texas A&M University. The research is determining Daily Light Integral requirements for 9 cultivars of zoysiagrass and bermudagrass.

**Perennial ryegrass breeding program**. Perennial ryegrass is an important species for cool-season sports turf managers due to its rapid rate of establishment and excellent wear tolerance. In Minnesota and other areas that experience harsh winters, this species can often suffer severe winter damage. Over the past several years, our breeding program has focused on improving the winter hardiness of this species. Many cultivars of perennial ryegrass are infected with the fungal endophyte *Epichloe festucae* var. *lolii*, which gives these grasses tolerance to some stresses, especially those related to insect feeding. We have recently completed a project that found no direct effect of endophyte on perennial ryegrass freezing tolerance and are now studying how endophytes might be affecting stem and crown rust resistance in perennial ryegrass. To this point, plant breeders have struggled to develop cultivars with consistently high levels of crown rust resistance. Our current project should shed more light on this important problem. In addition, we are studying how we might modify the design of our breeding nurseries to better select for important turfgrass and seed production traits in this species.

**Fine Fescue Seed Size**. With five different species in the 2014 Fine Fescue NTEP fairway traffic trial, differences in seed size could influence how well they perform when seeded on a weight per area basis. Replicated thousand seed weights (TSW) were taken from remnant seed for the trial to assess the variation between species and within a species and used to calculate the number of seeds per pound. The entry with the greatest TSW was 2.75 times heavier than the entry with the lowest TSW, which equated to 282,000 seeds verses 776,000 seeds per pound respectively. Significant differences were seen among cultivars within a species with a difference ranging from 162,000 to 255,00 seeds per pound when comparing the cultivars with the highest and lowest TSW within a species. Further analysis will be done to determine if these differences correlate to ratings taken on the trial.

*Contributors: Sam Bauer; Chase Straw; Ryan Schwab; Dominic Petrella; Jon Trappe; Florence Sessoms; Garett Heineck; Eric Watkins; Brian Horgan; and Andrew Hollman.*

## Texas A&M University

**Management dynamics of sand-capped turf systems**. Sand-capping of athletic fields is a trend being driven by the need for improved growing and playing conditions, especially in high rainfall areas, or in areas where low-quality irrigation water and fine-textured soils exist. However, due to the significant cost sand-capping can add to a construction/renovation budget, less than optimal depths of sand are often placed atop the existing soil. The ideal placement depth ultimately depends on physical properties of the sand, environmental conditions, and providing a balance of water to air-filled porosity for optimal growing conditions. However, no specifications currently exist for sand-based construction atop an existing soil. This project seeks to develop science-based information that can contribute to development of such recommendations while offering insights on best management of irrigation, organic matter, and subsoil sodicity in these systems.

**Daily light integral requirements for bermudagrass and zoysiagrass cultivars**. Maintaining acceptable levels of turf quality in stadium shade is a management challenge for many sports field managers. Time of year, location, shade source, traffic intensity, and duration of direct sunlight all contribute to difficulty of specifying a minimum light requirement in terms of hours per day or percent of full sunlight a field may require. Rather than responding to a number of hours of direct sunlight or percent shade, plants respond to cumulative daily total number of photons (measured in moles/sq. meter/day) received within the photosynthetically active wavelengths (400-700 nm), termed daily light integral (DLI). To date, the limited turfgrass DLI research that has been conducted involves primarily short-term greenhouse experiments or has been focused on ultradwarf bermudagrass. This long-term field study has been conducted over 3 growing seasons in College Station, TX under replicated treatments offering 0 to 90% reductions in photosynthetic photon flux (PPF). Objectives of the study are to 1) Determine minimal DLI requirements for nine bermudagrass and zoysiagrass cultivars; 2) determine impacts of mowing height and trinexapac-ethyl (TE) on DLI requirements; and 3) determine whether DLI requirements change seasonally (spring, summer, and fall months).

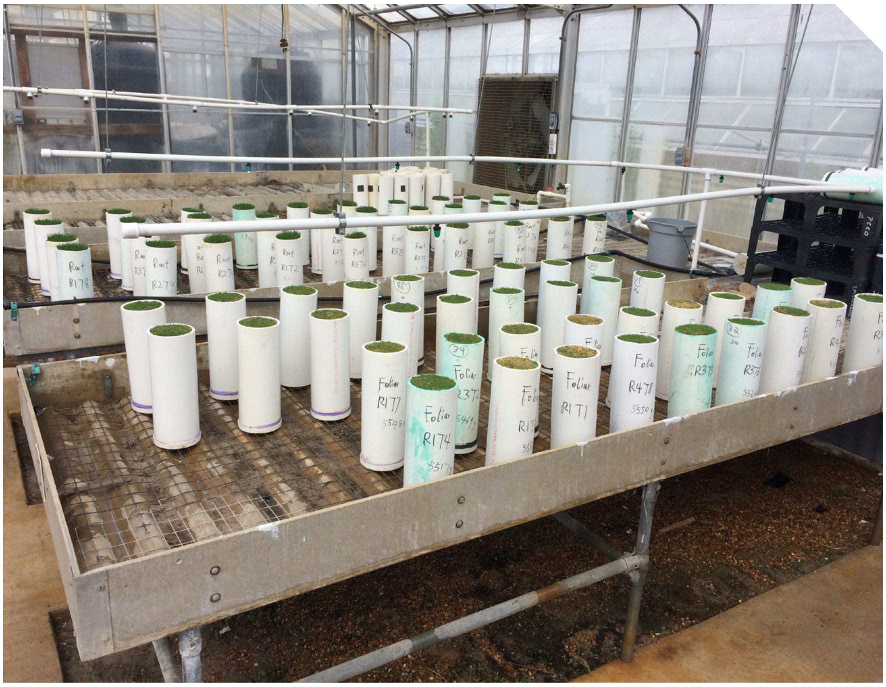


*Image of fertilizer N source x irrigation chemistry study at Texas A&M University.*

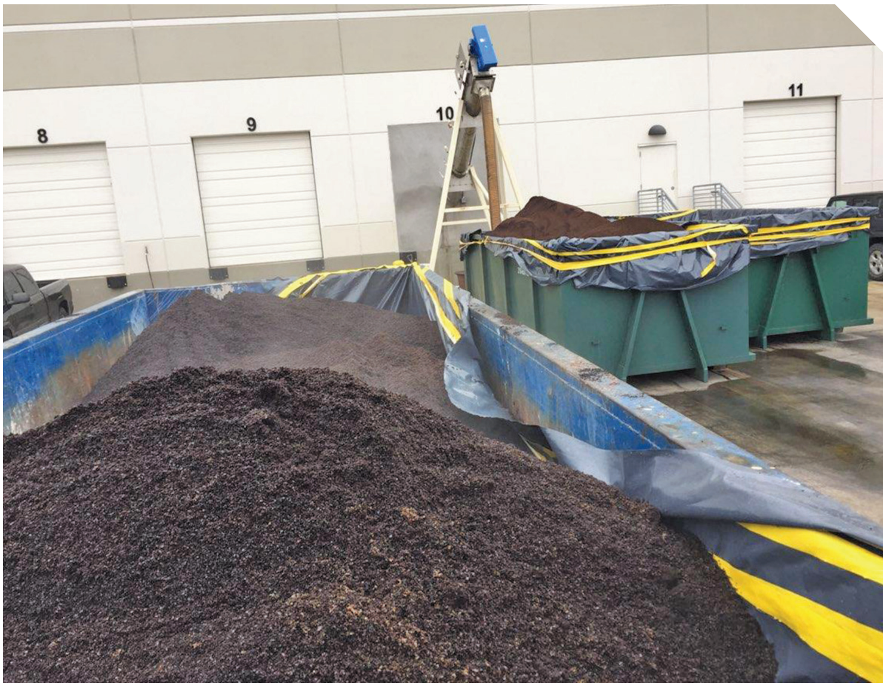



*Image of dumpster full of spent coffee grounds, a byproduct of cold-brew coffee production. Substantial quantities are being generated and evaluated for use as a root zone amendment or topdressing material for sports fields at Texas A&M.*

MAINTAINING ACCEPTABLE LEVELS OF TURF QUALITY IN STADIUM SHADE IS A MANAGEMENT CHALLENGE FOR MANY SPORTS FIELD MANAGERS. TIME OF YEAR, LOCATION, SHADE SOURCE, TRAFFIC INTENSITY, AND DURATION OF DIRECT SUNLIGHT ALL CONTRIBUTE TO DIFFICULTY OF SPECIFYING A MINIMUM LIGHT REQUIREMENT IN TERMS OF HOURS PER DAY OR PERCENT OF FULL SUNLIGHT A FIELD MAY REQUIRE.

**Irrigation Chemistry and N Source Impacts on Fertilization Efficiency**. As availability of potable water for irrigation of turfgrass systems declines, sports turf managers must increasingly manage turfgrass using lower quality water sources often characterized by elevated salinity, pH, sodium, and/or bicarbonates. Irrigation chemistry has been shown to directly impact plant growth, evapotranspiration rates, and soil physical properties, but there has been little research aimed at determining impacts of irrigation and/or tank mix water chemistry and nitrogen (N) source interactions on uptake efficiency in bermudagrass. Knowledge of potential interactions of water chemistry on foliar or root uptake efficiency of various inorganic N sources would be important for optimizing plant health as well as for minimizing environmental losses of N. Objectives of this research are to 1) Utilize various combinations of N-labeled fertilizer N (urea, ammonium sulfate, and potassium nitrate) and water sources (reverse osmosis, saline (2.5, 5, and 10 dS/m), and sodic potable containing 200 ppm Na, elevated bicarbonates ~500 ppm, and pH 8.2) to determine the influence of irrigation/tank mix water chemistry on foliar and root N uptake efficiency in bermudagrass. We also seek to determine define thresholds at which increasing root zone salinity begins to impair bermudagrass N uptake efficiency.

**Spent Coffee Grounds as an alternative Root Zone Amendment for Sand-Based Turf Systems**. Given the current and anticipated growth of the cold-brew coffee production industry nationally and worldwide, there is growing importance in evaluating the agronomic merits/demerits of spent coffee grounds for use in golf course turf applications. This is especially true in light of the growing environmental and ecological concerns relating to peat production. Considering that peat continues to be the predominant amendment used for golf course sands in many parts of the world, spent coffee grounds could offer an opportunity for use of a more sustainable, renewable resource in many regions. Lab testing, greenhouse and field studies are currently underway at Texas A&M to begin to explore the agronomic merits of spent coffee grounds in turf systems. This project will evaluate the potential benefits of both fresh and composted spent coffee grounds as a turf fertilizer and/or amendment (field tests) and/or sand-based rootzone amendment (greenhouse tests).

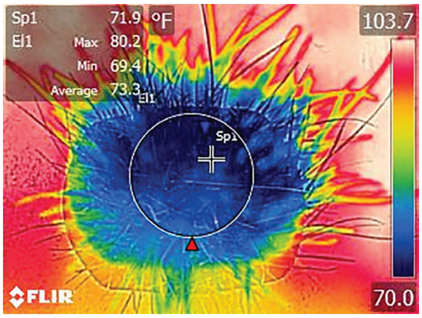
*Summary compiled by Dr. Ben Wherley, Associate Professor of Turfgrass Science & Ecology, Texas A&M University, with assistance from graduate research assistants Reagan Hejl, Manuel Chavarria, Baoxin Chang, Garrett Flores, and Will Bowling. Aforementioned projects have been made possible through support from United States Golf Association, Golf Course Superintendents Association of America Environmental Institute for Golf, Aqua-Aid Inc., and GeoJava, LLC.*

## Brigham Young University

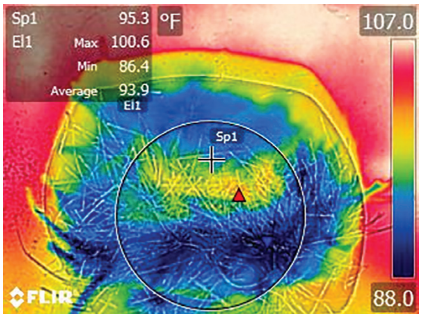
**Reducing maintenance costs with nitrogen management**. Nitrogen is the key nutrient for plant health and water conservation. Apply too little and plants die; but too much stimulates shoot growth over roots, causing excessive mowing, water demand, and increased risk of pathogen pressure.

Nitrogen management can be done by small, frequent (2-4 weeks) applications, typically by foliar sprays or injecting it

Duration, a polymer-coated urea, is on the left; uncoated urea is on the right at BYU. These amounts show that we can use less PCU than uncoated urea. Photo by Bryan Hopkins.




*Fleer image showing temperature differences as a function of moisture and nitrogen; this example is Optimum N and 60% ET Avg. Canopy temp = 22.9 C.*




*Another Fleer image example that shows temperature differences as a function of moisture and nitrogen: Excessive N and 60% ET Avg. Canopy temp = 34.4 C.*

*Aerial image of nitrogen-irrigation interaction research plots.*

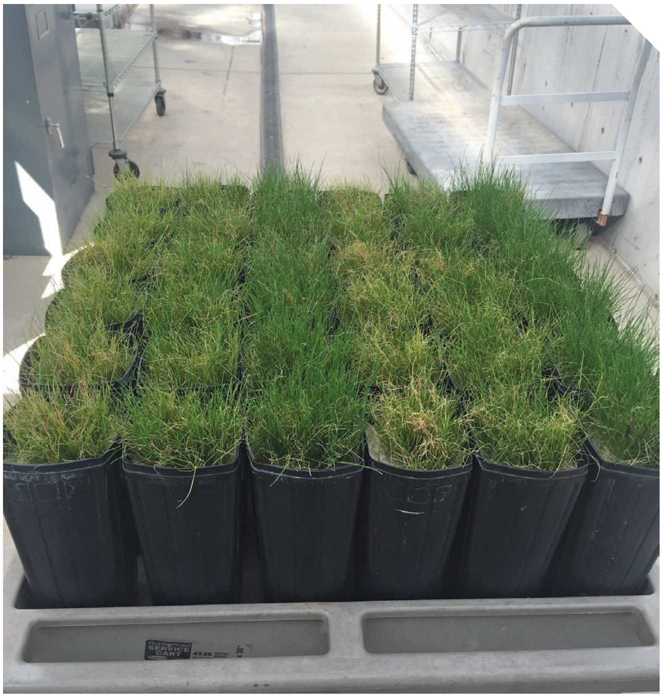
into irrigation water. This can be difficult and detrimental to plants if adjustments inaccurately account for total nitrogen applied to the system and mineralization of nitrogen from soil organic matter during the warmest months.

Alternatively, many slow and control release nitrogen fertilizers claim only a single application is required, thus potentially reducing mowing and fertilization labor costs. We conducted several research trials on Kentucky bluegrass grown on sand based and "regular" soil over several years to evaluate these various fertilizers. To date, we have found:

- None of the several products, sold as "one application" annually, that we evaluated performed as well as the practice of "spoon feeding" nitrogen every few weeks. Growth was uneven, with an initial spike, ultimately degrading to poor verdure and health (as measured by visual assessment, crown density, clipping volume, and Normalized Difference Vegetative Index or NDVI) within ~4-6 months.
- In contrast, two applications of control release nitrogen fertilizer gave statistically similar results as spoon feeding. Growth and, thus, mowing, was even and plant health was uniformly good over the growing season.
- High quality polymer coated urea (PCU) products gave the longest and most even release timing compared to other slow release products (such as sulfur coated urea and urea formaldehyde) and urease and nitrification inhibitors.
- Although slow and control release fertilizers are effective, we have shown repeatedly that the timing of release for most of these products is quicker than what is typically listed by the manufacturer. Most of the reactions of these enhanced efficiency nitrogen fertilizer are temperature controlled or influenced. The estimates from the manufacturers of these nitrogen products for their release rates are often based on agricultural tests with fertilizer buried in the soil (where temperatures are moderated) and/or in lab tests (at room temperature). Fertilizer applied to turfgrass is not typically incorporated into the soil and surface temperatures can easily reach 120F on a sunny day. As a result, we found that all PCU products tested had greater than 90% of their nitrogen released/converted with ~35-40 days after application even though their suggested ranges in timing were 45-360 days (we did find that their estimates were accurate when the fertilizer was buried in the soil). We suggest this is why a single application of nitrogen fertilizer will not work as well as two or more applications, even when using a product with a claim of a 180 day or longer release pattern.
- Regardless, slow and control release nitrogen fertilizers (especially PCU) are effective nitrogen sources, partially due to having significantly less environmental loss due to leaching, volatilization, and denitrification. As a result, we have found that nitrogen fertilizer rates can be reduced by 25-50% when using PCU.
- The best current program for Kentucky bluegrass (and presumably other cool season species) for quality turfgrass with minimal maintenance and fertilizer costs is: 0.5 to 1 lbs. of nitrogen applied per 1000 ft2 at spring green-up and 1 to 2 lbs. at late summer/early fall, with 2/3 of this applied as PCU and 1/3 as ammonium sulfate (or urea if sulfur is not needed).

Although initially successful in the short-term (2-3 years) with this low rate program, we are evaluating long-term impacts and how heavy traffic may impact the recommendation. For now, we recommend the higher rate for heavy traffic areas, especially sand based fields that may need up to 150% more total application.

We note that at rates higher than those listed above we observe good color



*Nitrogen-irrigation interaction greenhouse pot study.*

initially, but the long-term impact is poor root growth and increased problems in several related areas, including water-oxygen relations, nutrition, pathogens, and insects.

**Nitrogen and water interactions**. Water is increasingly scarce. Turfgrass watering is often restricted during intense drought cycles, such as the recent severe drought in California.

Excess nitrogen stimulates shoot growth at the expense of roots, leading to higher water demand with less access to deep water. Instead, turf needs a consistent nitrogen supply, minimizing any availability spikes. Additionally, cool season grasses need adequate nitrogen in the fall when plants are preparing for winter.

So, how do we manage nitrogen during severe water stress? We have shown that deficient nitrogen negatively impacts water stressed turfgrass, due partly to higher canopy temperatures. It also reduces turfgrass potential to recover after dormancy induced by drought. Excess nitrogen increases water demand and potentially induces moisture stress faster.

We are running additional trials to quantify these results and provide specific recommendations for nitrogen rate, source, and timing, as well as water needs. In addition, we are also evaluating a variety of soil and canopy sensors for managing both nitrogen and water.

**Carbon based fertilizers**. Carbon as a nutrient or additive is often misunderstood. Many fertilizer products claim to be "carbon fertilizers." We conducted a variety of tests on carbon based fertilizers over several years and found the following:

- We measured positive results with several phosphorus fertilizers mixed or bonded with various carbon based organic acids. Often, the carbon gets the credit, but our results show the enhanced phosphorus nutrition makes the difference; the carbon is incidental as part of the overall molecule in the same way as urea fertilizer, which has both carbon and nitrogen, but the effect we get from urea is from the nitrogen. Note: we also measured similar benefits with some micronutrients in agricultural row crops, but we haven't seen consistent results in turfgrass with micronutrients bonded to organic acids.
- Adding these carbon fertilizers often results in improved verdure and plant health. However, there is no difference between these and neighboring plots treated with identical rates of the other nutrients (such as nitrogen, phosphorus, and potassium) found in these carbon fertilizers. The carbon concentration of the grasses is not increased with these carbon fertilizers. Thus, the effect on improved turfgrass is a function of other nutrients, not carbon. Note: about half of the dry weight of plants are made from carbon because they are very adept at pulling it from the air.
- Incorporating high rates of compost and similar materials high in carbon (organic matter) enhances soil quality initially. This increases water and nutrient holding capacity, infuses nutrients, and can help with soil aggregation. But adding these materials at high rates to the surface of established turfgrass often increases disease incidence. We advise caution in doing so, especially on short mowed sports turf. It is noteworthy that turfgrass is particularly adept at increasing the organic matter content of the soil naturally over time, with soil organic matter levels often double in comparison to similar soil that is not vegetated as fully or is in a tillage cropping system. Thus, adding large quantities of materials high in organic matter is not generally beneficial to turfgrass.

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