Research update: nitrate leaching

IN 2005, research began in 3 locations in Florida to quantify nitrate-N and phosphorus leaching under a variety of circumstances. The research is in response to increasing concerns regarding potential nutrient pollution of water resources from urban turf fertilization. Florida has experienced a growing number of fertilizer ordinances enacted at the local government level, often based on perceived notions rather than science. The research has been completely funded by the Florida Department of Environmental Protection. Sites and researchers include Dr. John Cisar at the Ft. Lauderdale Research and Education Center, Dr. Jerry Sartain (phosphorus) and Dr. Laurie Trenholm (nitrate-N) at the Plant Science Research and Education Unit in Gainesville, and Dr. Bryan Unruh at the West Florida Research and Education Center in Jay.

The research is broken down into various projects, most of which were conducted at two or three of the sites. Each project was conducted for a period from 2-4 years per site. While the research was specifically conducted on lawngrass species, results would be applicable to most warm-season grasses. Variations might occur on athletic turf due to the injury from traffic, but the anticipated outcomes would be similar to results seen here based on the treatments and condition of the turf. Here is a brief synopsis of results from some of the main projects in Gainesville.

Newly planted turf, whether sodded, seeded, sprigged, or plugged, should not be fertilized with N for at least 30 to 60 days after planting, due to the potential for large nutrient losses before a root and/or shoot system has been established.

GENERAL METHODOLOGY

Drainage lysimeters were installed in the center of each experimental plot at a depth of 4" below ground. The lysimeters were 22" in diameter and 42" tall (Figure 1). Tubing was fitted to the base of each unit, running to above ground boxes. A vacuum

▼ **FIGURE 1.** N Source Study Treatments

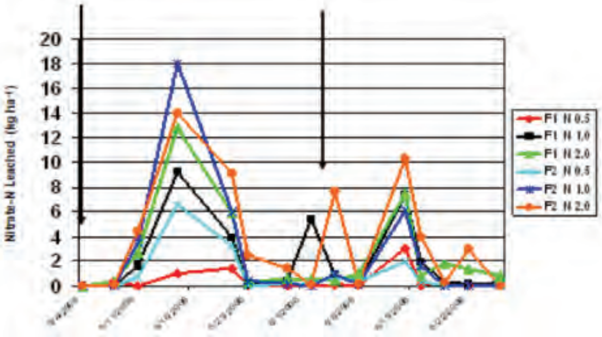
	N Rate (lb N 1,000 ft^{-2} per application)	Frequency of Application
Control	0	0
Ammonium nitrate	1	60 days
Urea	1	60 days
30% SCU	1	60 days
50% SCU	1	60 days
32.8% PCU	1	60 days
32.8% PCU	2	120 days
Milorganite	1	60 days

was applied to the tubing to evacuate the lysimeters weekly. Samples were sent to the Analytical Research Lab for analysis of nitrate-N. Data from all projects are expressed in units of kg ha-1, which is a measurement of the nitrate-N loading that occurred based on nitrate-N concentration and volume of leachate.

NITRATE-N LEACHING FROM NEWLY PLANTED TURFGRASS

'Empire' zoysiagrass and 'Floratam' St. Augustinegrass were sodded and N treatments were applied the same day at rates of 0.5, 1.0, 1.5, or 2.0 lbs N 1,000 ft-2. Nitrogen was applied as soluble urea. Half of the plots received the same treatments 30 days later.

▼ **FIGURE 2.** Nitrate-N leaching losses from newly planted Floratam St. Augustinegrass.



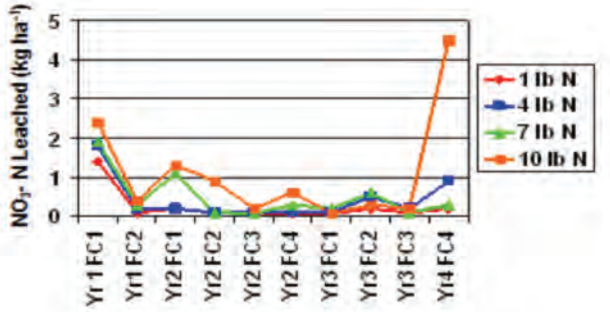
Nitrate-N leaching from both grasses over all years was considerably greater than from the established grass studies, regardless of N rate (Figure 2). The percent of applied N that leached from St. Augustinegrass in 2006 was 73.4% of what was applied the same day as planting in 2006. Leaching from the plots that received a second treatment 30 days later was reduced to 56.4% of the applied N. Similar results were seen in all years.

Newly planted turf, whether sodded, seeded, sprigged, or plugged, should not be fertilized with N for at least 30 to 60 days after planting, due to the potential for large nutrient losses before a root and/or shoot system has been established. This is now a Best Management Practices (BMP) recommendation.

NITRATE-N LEACHING FROM ESTABLISHED TURFGRASS

Nitrogen was applied to Empire zoysiagrass and Floratam St. Augustinegrass over a 3-year study. Annual N rates were 1, 4, 7, or 10 lbs N 1,000 ft-2 applied every 60 days throughout the growing season. Nitrogen was applied as soluble urea. Leaching data are presented for 2006 and 2007 for each of the four Fertilizer Cycles (defined as the 60-day interval between each fertilizer application). Fertilizer cycles are presented as spring (April-May), Early Summer (June-July), Late Summer (Aug-Sept), and fall (Oct-Nov).

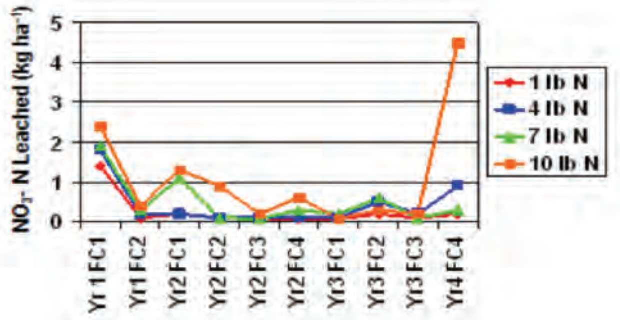
▼ **FIGURE 3.** Nitrate-N leaching losses from Floratam St. Augustinegrass due to N rate.



There were few statistical differences in nitrate-N leached due to N rate in St. Augustinegrass (Figure 3). Where there were differences (primarily Fall 2007), greatest nitrate-N load occurred at the highest N rate. During this study, the St. Augustinegrass was in good health and had good growth and cover. The dense root and shoot system provided the grass the ability to take up nitrogen at the excessively high rates applied to some of the plots (7 and 10 lbs 1,000 ft-2 yr-1, which far exceeds the current recommendations for fertilizing St. Augustinegrass in north central Florida). Nitrate leached did not exceed 1.4% of the applied N in any fertilizer cycle and was generally below 1% of that applied N. Increased leaching occurred in the fall of 2007 at the 10 lb N rate in response to increased disease and associated injury due to the high N rates. This reduced the cover and density of the grass, resulting in less ability for nutrient uptake and the higher N losses.

Zoysiagrass showed a greater tendency to leach more nitrate-N as N rate increased (Figure 4), but it is important to remember that many zoysiagrass cultivars stay green and healthy with less N. Plots that received the high N rates in this study had large patch disease and poor cover by the 3rd year. As seen in the St. Augustinegrass, this resulted in less ability to take up the N and therefore greater N losses.

▼ **FIGURE 4.** Nitrate-N leaching losses from Empire zoysiagrass due to N rate.



By late summer, the disease was suppressed and the grass had resumed active growth, slowing the high leaching losses down. When N is applied at the recommended rates for zoysiagrass, leaching is minimized as with St. Augustinegrass.

Results of this study clearly indicate that maintenance of a healthy grass that provides dense cover will minimize nitrate-N losses when N is applied at the recommended range of rates and at the correct times. All practices that help to maintain a healthy turfgrass, including proper irrigation and mowing contribute to a healthy turf. An interesting observation is that the lowest N losses generally occurred during the summer fertilizer cycles as opposed to spring or fall. This is, of course, the time of greatest warm-season grass growth and therefore also the time for the greatest demand for nutrients. This also corresponds with the time when many of the local fertilizer ordinances ban fertilization with N and P throughout the state.

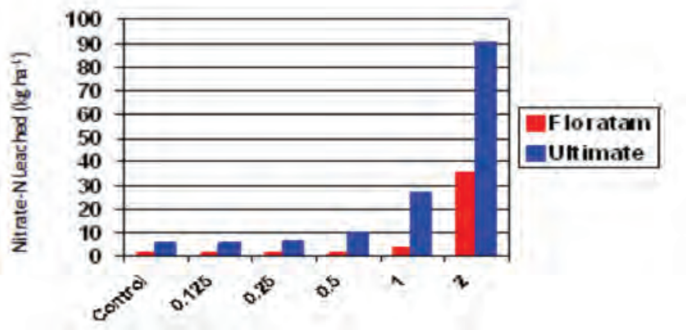
WINTER FERTILIZATION

This study was conducted in Gainesville (north-central Florida) and Jay (northwest Florida) to determine the impact of fertilizing dormant or semi-dormant turfgrass through the winter months. Floratam St. Augustinegrass and 'UltimateFlora' zoysiagrass were sodded in the fall of 2006. Nitrogen rate treatments were applied monthly as soluble urea. Rates applied were 0, 0.13, 0.25, 0.5, 1.0 and 2.0 lbs N 1,000 ft-2 mo-1.

Total nitrate-N leaching losses for the season differed due to an interaction of N rate and grass in years 1 and 2. In both of these cases, St. Augustinegrass had no differences in leaching between control and up to 1 lb N 1,000 ft-2, while zoysiagrass had greatest leaching from either the 1 or 2 lb N rate (Figure 5).

Nitrate-N leaching was also compared for differences between months (Table 2). In years 2 and 3, after the grass was well established, greatest leaching generally occurred in the winter and early

▼ **FIGURE 5.** Cumulative nitrate-N leaching losses from Nov-March.



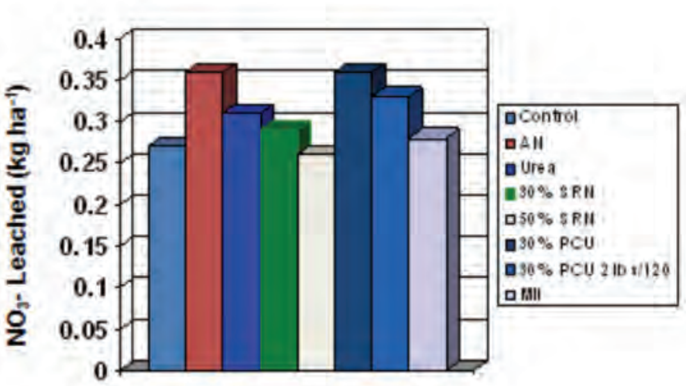
spring months as compared to the fall months. More N was able to be taken up in the fall when the grass still had a root system as compared to January through March, when the grass was in deeper dormancy and a large portion of the roots had sloughed off. While N fertilization is not recommended for home lawns during the winter months in north Florida, there is less potential for nitrate-N leaching from late fall fertilization than from fertilization during Jan-March. These results are based on north Florida conditions and do not apply to south Florida.

N SOURCE STUDY

This study ran from 2008 through 2011 on Floratam St. Augustinegrass and Empire zoysiagrass. Treatments are listed in Table 1 and were applied as granular treatments at 1 lb N 1,000 ft-2 every 60 days, unless noted otherwise. In 2008, this project began in July and therefore only two treatment applications were applied.

In 2008, St. Augustinegrass had no differences in total nitrate-N loading (Figure 6) Zoysiagrass had significantly greater leaching from ammonium nitrate than from any of the other N fertilizers,

▼ **FIGURE 6.** Cumulative nitrate-N leaching losses from Floratam St. Augustinegrass from April-Nov.



with no differences between the other products. In 2009, there were no differences in leaching due to either grass or N source. Similar results were seen in subsequent years.

While many automatically think that slow-release N sources are less likely to leach N, these results indicate that there are no differences in nitrate-N leaching from either soluble or slow release sources *when they are applied to healthy turfgrass*. Healthy turf that provides good ground cover is able to take up the fertilizer that is applied to it, as long as the fertilizer is properly applied.

CLOSING THOUGHTS

All of the research results from the 3 locations indicate that a healthy turfgrass cover mitigates nitrate-N leaching when fertilizer is applied correctly. Maintaining a healthy turfgrass cover includes proper irrigation, mowing, fertilization, and pest control. Following appropriate turf cultural practices to maintain a healthy turf can reduce nutrient leaching and potential nonpoint source pollution.

On athletic turf, traffic injury compounds management and turf health and often results in loss of density and bare ground. As our results clearly show, this is the time when there is greatest opportunity for nutrient movement that may result in nonpoint source pollution. Careful nutrient management, consisting of a spoon-feeding approach of low rates of N applied frequently to stimulate regrowth, is the best way to manage regrowth from injury while reducing N losses. In reality, the continuous demands placed on athletic fields often result in insufficient opportunity for turf to regrow before the next event, with little time to fertilize in a spoon-feeding manner. It is important that athletic field managers recognize the potential for nutrient losses on injured turf and plan their fertilization regimes as best as possible to minimize these losses from occurring. ■

Laurie E. Trenholm, PhD, is professor and graduate coordinator, Environmental Horticulture Department–Turfgrass Science Program, University of Florida.

▲ **SELECTED PERENNIAL RYEGRASS** plants placed into an isolation cage for crossing.

Turfgrass breeding for sports

TURFGRASS BREEDERS may have a more difficult job than most other plant breeders. For the most part they deal with more than one species, usually at least four major species and many minor ones, and a vast geographic area for each species. What also complicates the breeding for the seed propagated species is breeders must breed at the same time for turf quality, disease resistance and other characteristics for turf performance and also for seed yield.

Most turfgrass species are cross-pollinated, self-incompatible species, which means the same plant cannot be the mother and the father. This makes development of inbred lines for hybrids or seed propagated varieties with one genotype unfeasible. Breeders must cross similar plants together to start the breeding process selected for the characteristics desired in the new cultivar. This means traditional breeding operates as a form of population improvement, with each individual seed in a variety genetically related to but distinct from others. By taking the portion of the population with the best of a certain characteristic, darkest green, highest stress tolerance, least disease, and crossing these together the breeder moves the mean of that characteristic up. The selected plants must still match for

Improvement of turfgrass varieties is dependent on being able to efficiently screen large numbers of plants for the desired characteristic(s).

many other characteristics such as color, date of seedhead appearance and height to make a uniform variety.

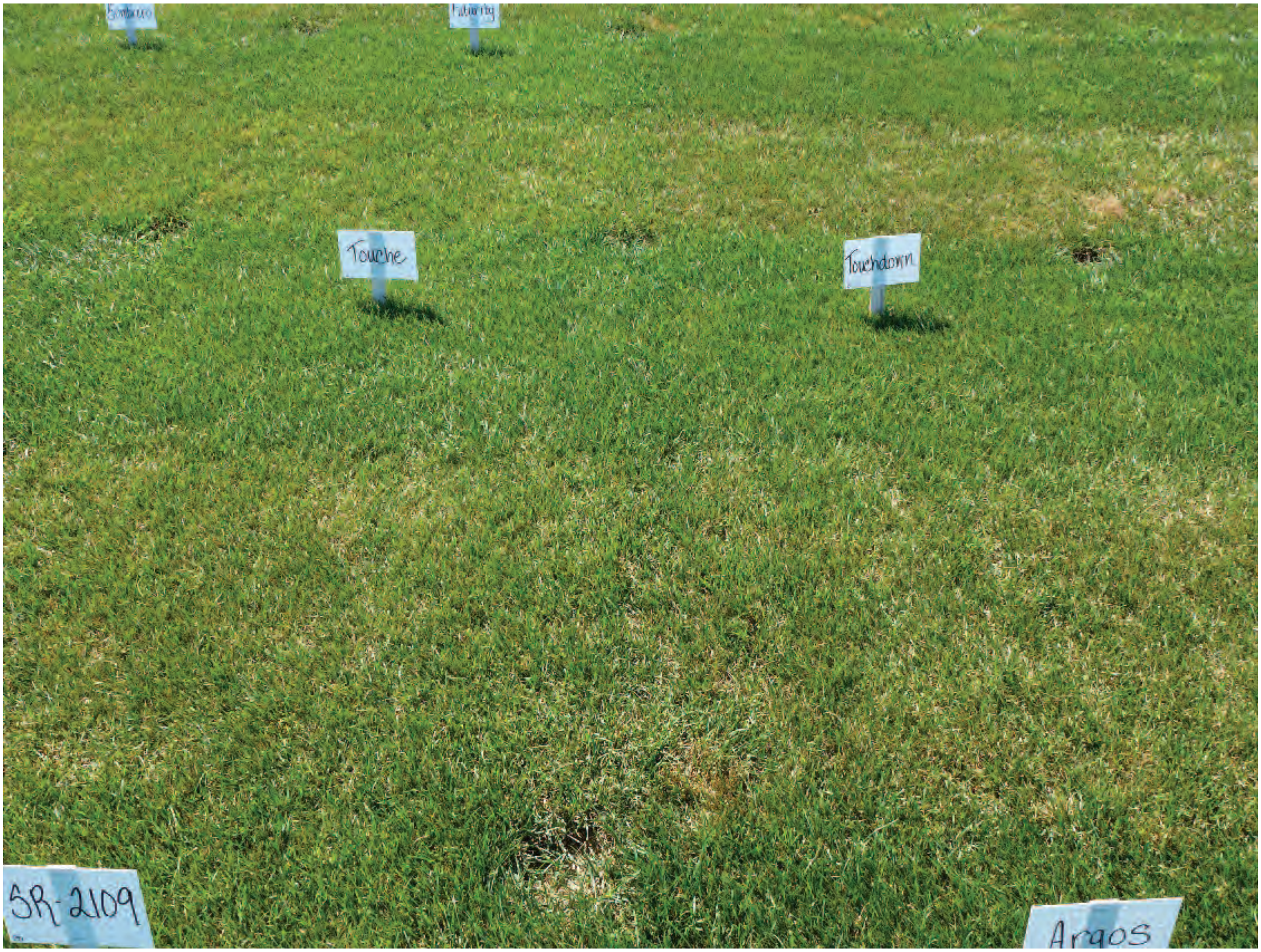
Kentucky bluegrass is the exception due to its apomictic reproduction. It is hard to get hybrids, with often only 10% of plants in a cross being the hybrids, the rest being genetically identical to the mother plant. These hybrids usually have all the chromosomes of the mother plant and about half of the father. Each plant is a shot in the dark but if you do get a good plant that is apomictic the progeny will all be the same and it can be a new variety.

The general outline for breeding is

1. Establish a goal (Improved wear tolerance, diseases resistance)
2. Decide how to screen for improvements (Select in turf trials or spaced plants)
3. Screen a large number of plants and select the best ones
4. Cross these plants together letting wind scatter the pollen (small crossing cages or bigger blocks of related plants), harvest seed, plant new trials
5. Evaluate progeny for selected improvement (perhaps select best plants again)
6. Seed from best plants or lines bulked together as Breeder Seed
7. Breeder Seed used to plant first seedstock field and enter into NTEP and other trials
8. Seedstock (Foundation) seed used to plant Certified fields

Improvement of turfgrass varieties is dependent on being able to efficiently screen large numbers of plants for the desired characteristic(s). The selected plants need to be crossed together and the progeny (offspring) evaluated again for the characteristic(s). If the characteristic is highly heritable the majority of the population may then have the characteristic or additional cycles of selection must be performed. Due to the complex inheritance of many desired characteristics being able to concentrate many of them in one population or variety is often difficult. It is often necessary to evaluate the selected plants and progeny over a number of years and environments to reliably screen for some characteristics. Screening for wear tolerance was

▼ **BREEDER BLOCK OF TALL FESCUE.** Seed from the isolated plants are planted in the greenhouse and spaced plants are established into a Breeder block (each row has plants derived from one plant). Look for uniformity and seed yield or these progeny. Usually also planted in turf plots. Poor performers will have the whole row eliminated.

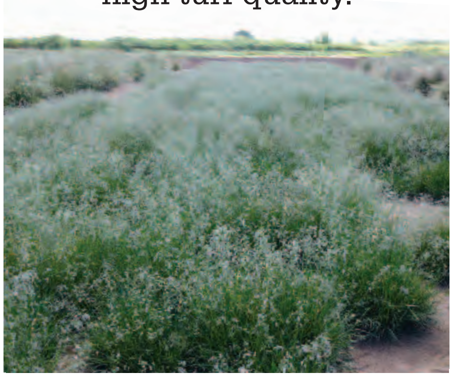


▲ **KENTUCKY BLUEGRASS TRIALS** at Rutgers University with wear done on front half of each plot. Cultivar names are in the back of the plot.

often difficult since the size and speed of the machines made it difficult to screen large numbers of turf plots. Recently Rutgers University developed the Rutgers Wear Stimulator (Turf Slapper) that can apply wear over a large number of plots and has enable wear tolerance and recovery to be more easily integrated into varietal development.

Tall fescues with improved wear tolerance and the ability to demonstrate wear tolerance as younger plants has been a recent emphasis. Recent information by Dr. David Miner of Iowa State University suggests that addition of large seed quantities early in the season, even with wear applied, increases the percentage of tall fescue, perennial ryegrass or Kentucky bluegrass in the stand. Increased establishment occurred at rates up to 200 kg/ha for perennial ryegrass and 40 kg/ha for

Perennial ryegrass breeding in the United States for many years has emphasized darker green dwarf varieties with high turf quality.



▲ **KENTUCKY BLUEGRASS BREEDER BLOCK**. Very uniform due to high apomixis.

Kentucky bluegrass. Tall fescues were only slightly less effective than perennial ryegrass in establishing during play. Additional breeding work in tall fescues has emphasized drought tolerance as well as brown patch resistance in multiple locations, for durable resistance.

Perennial ryegrass breeding in the United States for many years has emphasized darker green dwarf varieties with high turf quality. An important new characteristic has been the discovery and incorporation of genes for resistance to gray leaf spot disease, which is the same pathogen as rice blast disease, and has decimated stands of Perennial ryegrass breeding in the United States for many years has emphasized darker green dwarf varieties with high turf quality.perennial ryegrass in the transition zone of the United States. A balance must be achieved between resistance to this disease and resistance to other important pathogens such as brown patch and red thread. Wear tolerance as a major component in selecting new ryegrasses. Breeders have been crossing more winter-active wear tolerant ryegrasses with American germplasm to increase the wear tolerance during the colder months. An additional high priority in perennial ryegrass breeding has been salt tolerance. This is due to the increasing use of effluent water in many golf courses in the United States and elsewhere.

Hybrids of Texas bluegrass and Kentucky bluegrass have the potential to expand the range of Kentucky bluegrass. Many of these are more heat and drought tolerant than traditional Kentucky bluegrasses, although some new cultivars of Kentucky bluegrass have also been selected for more heat and drought tolerance. The other major advantage of these hybrids is their extensive rhizomes systems. In wear trials they have shown excellent wear tolerance, rapid recovery and more winter-active growth making them better suited for many applications.

▲ **PURE SEED COMPANY** seed yield trials for Kentucky bluegrass. Wide variability in maturity and appearance. Only a small fraction of these will make it to market.

▲ **WEAR TRIALS** on tall fescues at Rutgers University July 2011. New tall fescues are more wear tolerant even under heat stress.

In breeding of all species seed yield is just as important as diseases resistance or turf quality. Often if you find cultivars or experimentals that are only on the market a short time or are never marketed it is due to inadequate seed yield. We must often cycle one generation for a turf characteristic and then another for seed yield. Turf breeders have been very successful in improving turf quality and seed yield at the same time but we may not find that true in the future.

Development of new turf cultivars takes many steps and the diverse needs make it different from many other crops. Turf breeders must have patience and understand the many needs of customers plus seed growers. ■

Dr. Leah A. Brilman is the director of research and technical services for Pickseed/Seed Research of Oregon, www.sroseed.com.

10 years later:

Q&A with Vanini and Sorochan on using crumb rubber on natural turf

TEN YEARS after we published an article on their research into using crumb rubber on natural turf fields, and nearly 20 years after their original research at Michigan State, *SportsTurf* spoke with J. Tim Vanini, PhD, founder and president of New Dimensions Turfgrass, and Dr. John Sorochan, associate professor turfgrass science, University of Tennessee, regarding their current thoughts on the practice.

SportsTurf: Under what circumstances would you advise turf managers to try using crumb rubber on natural grass?

Vanini: You want to use crumb rubber in high traffic situations. You can make the case for a whole field application because for example soccer field complexes where they move around are used length-wise and width-wise. We have observed a benefit to the plant through the use of less water as the crumb rubber serves as a "mulch" at the surface to help retain water.

Sorochan: Native soil athletic fields often drain poorly because they are high silt and clay, so when it rains you can tear up the field. Like adding 2 inches of sand on top of a field will help drain excess moisture, as Alex Kowalewski's studies showed, adding ½ to ¾ inch of crumb rubber helps take away moisture from a field's surface. Even ¼ inch can help.

Vanini: Last year I partnered with Liberty Tire on a program that gave several schools 1 ton of crumb rubber to work with; we learned that, for cool-season turf at least, the crumb rubber depth had to be a minimum of 25% of the mowing height to protect the crown tissue of the plants. And it's important you have 100% turf coverage on a field before using crumb rubber—it won't resurrect your grass on a cool-season field.

When budgets are getting less, consider that crumb rubber use can stabilize your field's surface and make it not too hard or too soft, i.e., more consistent playing surface, improved traction,etc.

ST: How expensive is using crumb rubber and where do you buy it?

Vanini: Right now the cost is approximately $.25 a pound. But the cost of freight plays a role in the overall cost; it depends from where the product is

> ***When budgets are getting less,***
> **consider that crumb rubber use can stabilize your field's surface and make it not too hard or too soft.**

▲ **THE FOUL PLAY AREAS** were airfield and topdressed with crumb rubber one month before a baseball tourney in Cranberry, PA. The first base side (**2**) had crumb rubber applied, and third base side did not (**3**). After the tourney (15 games and 3.5 inches of rain), the first base side was just worn (**4**), and the third base side had no grass (**5**).

shipped. Besides Liberty there are other companies selling it to [sports turf managers].

Sorochan: It isn't sold through distributors though there is a landscape supply company in Tennessee that has a supply because of the research we are doing at the university (Sorochan is director of the Center for Safer Athletic Fields in Knoxville).

Vanini: Actually I am a distributor for Liberty Tire for crumb rubber that is used on natural turf only.

We have started a pilot program with one school and one municipality who are buying more crumb rubber, and we are also involved in another project, with Rebecca Auchter of Cranberry Township, PA. *Editor's note: see article on page 8 of our April issue written by Auchter.* Because she has liked how the crumb rubber has helped in the foul territory areas of the township's Baseball Field I, Rebecca has convinced the local soccer association to let us use 5-6 tons of crumb rubber on an enlarged rectangular area on their Dick's Sportsplex at Graham Park soccer field G.

Let's say you were going to do an entire football field including the sidelines; that is 80,000 square feet. Say the mowing height is 2 inches, so you are going to put down ½ inch of crumb rubber, which is approximately two truckloads; adding in freight costs, that might be $22,000 to $27,000.

Sorochan: We are looking at the long-term effects on the soil; in bluegrass it might stay on the surface longer but bermudagrass grows above it and buries in the crumb rubber like thatch, so you have to add 1/8 inch to ¼ inch every 2-3 weeks. It should be noted that you don't get "walk off" effects with the crumb rubber on natural turf as you do on synthetic turf. But if the turf has worn areas it will wash off.

ST: How should turf managers determine what particle size to employ?

Sorochan: For bermudagrass we currently are investigating particle sizes and are finding that varying particle size adds stability to a field. Most people are using 10/20 mesh-sized particles, which is similar to that used in synthetic turf, a bit on the coarser side. It is easier to incorporate a finer particle, for example 20 mesh, in bermudagrass as well as cool-season turf [for comparison's sake, USGA-spec sand is 30 mesh].

Vanini: I have observed that .25 particle size is better for cool-season turf. Turf managers need to be mindful when applying crumb rubber to get down at least ¼ inch depth down every time they apply. You can put down ¼ inch now and then another ¼ inch 2 weeks later. The crumb rubber works its way down, even if you apply ½ inch of 10/20 mesh.

You do run into static electricity and hydrophobicity (repelling water) issues when you first put the crumb rubber down. Use a wetting agent or spread out your applications to combat this.

ST: How do maintenance practices change when employing crumb rubber on natural grass?

Sorochan: You need to do what you should be doing—all the normal cultural practices that optimize turfgrass growth. There is no need to do anything differently, including using sand topdressing.

Vanini: You still want disruption at the surface; the sand will make it past the crumb rubber because it has a higher particle weight. Crumb rubber topdressing should be considered another tool to com-

USING CRUMB RUBBER ON NATURAL TURF

Here are some of the findings from Drs. Vanini and Sorochan's research:

"It is important to maintain a high quality, athletic-field stand that will hold up to aggressive wear, while continuing to provide consistent, stable cover. Maintaining quality turf stands that withstand athletic-field conditions has always been a challenge. This is particularly evident when many athletic-field events are scheduled to be played when growing conditions are not favorable for turfgrass recovery from wear. Proper implementation of the five primary cultural practices (mowing, irrigation, fertilization, cultivation, and pest control) and the use of non-traditional methods are important management practices in maximizing turfgrass vigor. Non-traditional methods can be cost beneficial and can extend the performance of the athletic field in the long run. The use of crumb rubber as a topdressing is a method that has demonstrated improved turfgrass functionality.

Crumb rubber severs two functions when topdressed, this blanket of rubber or "rubber thatch" reduces soil compaction and improves wear tolerance of the turfgrass stand. No different than the "padding" used to protect an athlete, crumb rubber for an athletic-field acts as a "padding" for protecting the turfgrass. If the crown tissue area of a turfgrass plant is damaged by the cleats of an athlete, the turf will quickly die because the point of rejuvenation has been damaged beyond repair. However, if crumb rubber is used, the crown tissue of the turfgrass is protected by the crumb rubber. This limits the direct impact of an athletes cleat/shoe, thus resulting in the prolonged wear tolerance of the turf stand.

No question there have been concerns about topdressing crumb rubber if too much water takes over an area i.e. rainfall or excessive irrigation. Crumb rubber is half the density of a soil particle, thus causing it to float. Strategies to deal with this problem are first, be in tune with the weather second, do not put too much crumb rubber down at one time. Our recommendation is that no more than ¼ inch of crumb rubber should be topdressed in a single application. Remember, you can always add more crumb rubber. A final strategy is to fertilize more frequently, budget permitting. Obviously, the grass will grow more vigorously and crumb rubber will gravitate quicker down to the surface.

plement your normal maintenance practices. Using crumb rubber is not bullet proof; you will still have wear but it will wear more slowly.

ST: How should turf managers respond to any environmental concerns expressed over the use of crumb rubber?

Sorochan: The Environmental Protection Agency has tested and approved the use of crumb rubber in synthetic turf. In natural grass the likelihood of any exposure to the crumb rubber is unlikely.

Vanini: I agree with John; other agencies, such as the Connecticut Agricultural Experiment Station, and New York State, have looked at it and found no health problems. Parents should be more concerned about exposure on synthetic turf, not to mention the heat factor with synthetic fields. Microbial activity eventually breaks down the rubber in natural turf.

Sorochan: Also, with the moisture that is held on the natural fields, it means less dust in the air. We should rely on research data to understand that no results show the crumb rubber to be unsafe; rather, using it makes fields safer.

Vanini: More research is coming regarding the environmental, agronomic, and biomechanical benefits of using crumb rubber. It can make a difference in poorly managed fields. ■

CRUMB RUBBER SUPPLIER ANSWERS QUESTIONS

WE ASKED ONE OF THE MOST PROMINENT COMPANIES supplying crumb rubber for natural turf and synthetic turf fields, Liberty Tire Recycling, to answer some questions about their products. John Ripp, an account executive for Liberty, responded:

ST: How should turf managers wanting to incorporate crumb rubber into their natural fields determine what particle size to buy?

Ripp: It all depends on what type of turf stand it is. If it's a situation where we are treating a tight Bermuda or bentgrass stand, a 20 minus or 30 minus will work just fine. If it's a cool season grass stand, we suggest the 10:20 mesh (commonly used for synthetic turf infill), a 1-3 mm mesh or 1-5 mm mesh (commonly used in track construction).

ST: Do you have recommendations for how to best incorporate the product—when and how often?

Ripp: Although it may be directly topdressed over existing turf, we suggest you aerify first and then topdress. We suggest applying a ¼ inch per application(s) (600 lbs/1000 sq ft.) and brushing it in. [We suggest] two applications in medium traffic areas and three applications in heavy traffic areas. In cool season turf, ¾" can be achieved with two 900-lb./per 1000 sq. ft. applications.

ST: How (or perhaps more appropriately, where) can turf managers buy your product? Any recommendations on reducing shipping costs?

Ripp: Liberty has seven locations in the US and three locations in Canada where these products are available. As with any product, the more you order the lower the freight cost. I suggest you develop a plan of attack and order the amount necessary to complete a job successfully. For crumb rubber to be effective, multiple applications within a month's time are preferred. The objective is to cover and protect the crown of the plant as soon as possible.

Drought conditions and player safety

Editor's note: *This article was produced by Aquatrols, a provider of soil surfactants and other technologies used to optimize soil-water-plant interactions.*

THE ISSUE OF PLAYER SAFETY has taken center stage in recent years. Advancements in our understanding of sports injuries and their long-term affects on the human body have made us more aware of the tremendous risks athletes take every time they step onto the playing field.

Officials in every sport and at every level are now working to ensure that the health and safety of players is never again taken for granted. Many leagues are changing rules and upgrading equipment in an attempt to make the games safer.

However, ensuring player safety often begins with something much more basic than the rulebook: the playing surface itself. A consistent playing surface lays the foundation for safety, allowing athletes to do what they do best without having to think twice about making a sharp cut or leaving their feet to make a play.

Playing conditions are often compromised during inclement weather. Despite turf managers' best efforts, rain and snow events can quickly make conditions dangerous and unplayable. The 2013 baseball season has already seen its fair share of rain (and snow) delays. While we normally associate interruptions in play with this type of stormy weather, a lack of precipitation can be equally damaging.

In 2012, drought conditions across large sections of the United States left turf managers struggling to keep their turf alive and playable. Some counties and school districts were forced to shut down their playing fields because of turf damage brought on by prolonged drought conditions. The extremely dry weather made field conditions simply too dangerous for student-athletes.

As we head into the summer months, it's important to think about how drought can impact playing conditions and ultimately the health and safety of players. Turf managers must take steps to ensure that a lack of rain will not interfere with their most important task: keeping players safe.

DROUGHT'S EFFECT ON TURFGRASS

It's no secret that water is vital to the growth of healthy turfgrass. Water keeps plants hydrated and plays an important role in photosynthesis. It also serves as the natural delivery mechanism for most other applied inputs on a sports field. A lack of water can cause turf to wilt, go dormant, or die altogether in a short period of time. Drought stress also leaves plants more susceptible to regular summer stresses, such as increased traffic, heat stress and disease pressure from pathogens and insects.

▲**TROY SMITH, CSFM,** Denver Broncos, is a former president of the Sports Turf Managers Association.

These added obstacles can create a nasty ripple effect for turf managers. Troy Smith, who served as the Turf Manager at the Denver Broncos practice facility for more than a decade, has seen the effects of drought firsthand.

"Without the correct amount of water, the plant will be compromised and cannot complete its life cycle. Drought makes it difficult to predict how much water is needed for the fields and interrupts subsequent maintenance practices, such as aerification and fertilization," he said.

Without adequate water and these important cultural practices, field conditions can quickly deteriorate and become unfit for play.

"Field hardness is a real concern, especially for turf managers who don't have the ability to water adequately," Smith said.

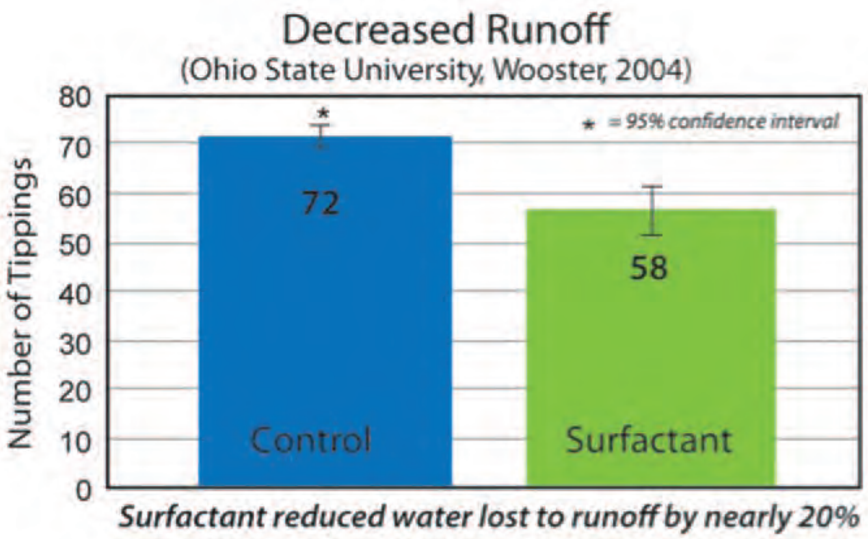
Field harness can make grass surfaces feel more like concrete. This can result in increased rates of injury in both contact and non-contact sports.

Over time, soils can naturally become water repellent, meaning they can no longer properly absorb water. If a soil has become water repellent, when rain finally does come, it will not be able to penetrate the soil surface properly. Most of it will simply run off the surface.

SEEKING SOLUTIONS

"Drought opens your eyes to how important water is to your fields on a consistent basis. Once you go through drought conditions, you are always on the look out for products that will help you manage your turf more efficiently during dry periods," said Smith.

Smith turned to soil surfactants to help offset the stress brought on by drought conditions. He explained that soil surfactants help to overcome issues with water repellency, ensuring even distribution of water throughout the soil profile. This helps to cre-



A 2004 study at Ohio State University showed that a soil surfactant helped to reduce water waste lost to run-off by nearly 20%

ate more uniformity at and below the surface.

"It is important to evenly distribute water through the soil profile to provide adequate hydration for the plants," he said.

When it comes to creating safe playing conditions, uniformity is key. Patchy or uneven turf growth can create a hazard for athletes. By helping to balance air and water in the rootzone, soil surfactants encourage more uniform root growth and more consistency on the surface.

Soil surfactants can also help to reduce the amount of water lost to run-off, which is critical for turf managers who are dealing with water-use restrictions. By cutting back on waste and making more efficient use of applied water, soil surfactants can produce monetary savings and potentially stretch the time between irrigation events.

Because most soil surfactants can be tank mixed with a wide variety of other inputs, there is no added labor cost involved. Turf managers can simply add the soil surfactant to their regular spray program. Smith cited this ease of use another bonus of his surfactant program. "Being on a two-week spray schedule made it very easy to apply surfactant on a regular basis," he said.

GETTING A HEAD START

The key to any successful surfactant program is to start early. Although soil surfactants can help turf recover from existing drought damage, instituting a proven surfactant program before drought conditions develop can provide a number of benefits.

By increasing soil moisture uniformity, soil surfactants help to create a healthier and more consistent growing environment. If the growing environment is managed to its peak potential early in the season, turf will be healthier and better able to defend itself when drought stress kicks in. In addition, water and monetary savings produced early in the season can be banked for the late summer months when the need for frequent irrigation becomes greater.

Seasons like 2012 remind us that we are often at the whim of unpredictable weather conditions. While a repeat of last year's historic drought isn't guaranteed, turf managers should be prepared for another difficult season in 2013. By maximizing water use efficiency, soil surfactants can help turf managers offset the physical and financial strain of a drought year and ensure safer playing conditions for all athletes. The key is to *start early*. ■