two elements; 10-35% of your mix should contain silt, but Zwaska emphasized that the ratio of silt to clay is the main concern rather than the percent of silt alone.

Clay provides the color and moisture retention of your skin; 15-35% of mix has been the accepted range but again, it's the ratio of silt to clay that should concern turf managers, he said.

The big question is, How do I get the right mix for my field? Zwaska said there is no industry standard and most managers rely on trial and error, while being limited to mixes that are harvested regionally. "There is underuse of infield soil testing," he said. "You can fix what you have unless you know what's already in it."

To get a good sample, Zwaska said you must remove topdressing, and then go down 2 or 3 inches deep into your skin in 8-12 locations from the infield to take samples. Throw all these in box and mix them around, pulverize them, for one good sample. You then fill a quart-sized, zip-locked plastic bag to be tested.

The answers to two questions dictate what mix your field needs: 1) What are your facility's maintenance resources and practices, and 2) Do you have access to water? After soil test results are in, managers need to classify their fields: do you have water, and is your maintenance "regular," "limited," or "volunteer"? Define the issues through analysis and then solve those issues by implementing a strategy, Zwaska said.

Your soil test's particle analysis will tell you precisely the composition of your infield so you don't have to guess, and tell you the strengths and weaknesses of your existing base soil; Zwaska said to make sure that analysis contains a sand particle distribution test, and then look for the values that really matter—percentages of sand, silt and clay.

First, find you ideal sand content. Here are target numbers from your test: for professional fields, 58-62% sand, 38-45% medium sieve sand, and a 0.5 to 1.0 silt/clay ratio. For intermediate fields, you want 65-69% sand, 45-50% medium sieve sand, and a 0.5 to 1.0 silt/clay ratio. For recreational fields, 70-75% sand, more than 50% medium sieve sand, and a 0.5 to 1.0 ratio is desirable, Zwaska said. Does your sand content match your field type, e.g., professional, intermediate or recreational?

You find the silt/clay ratio by dividing silt content by clay content numbers; 3.0 is too high, for example. Too much or too little silt creates binding problems for your skin, said Zwaska. He said a high sand content and low silt/clay ratio leads to a too-loose skin that chunks out; that means you must increase the silt and clay content with a mix greater than 75%. Low sand content and high silt/clay ratio leads

to dusty, mucky and greasy surfaces; and low sand with high silt/clay ratio makes for "feathery" dirt. With low sand content your goal is to neutralize the excess silt content. Increase medium sand content and silt/clay content to lower the ratio.

Solving the problem

Once you know your base soil's composition, you can fix the problem, said Zwaska. A typical mix is 40% sand overall (60-75% retained on medium sieve) and 60% silt and clay combined. Your options include removing and replacing your dirt with a balanced mix and that is expensive; otherwise you will need to amend your existing soil. A lower sand content is the goal and you must align that with your facility's resources.

Mixes that work best are specific blends that can be replicated by using engineered soil technology use computers to custom blend amendments and mixes based on your needs. Zwaska said to ask for test results for brands that specify their soil composition.

Drainage

Of four options for providing drainage for your base soil, Zwaska said there is only one way to go: grading the surface ½ to 1%. A layer of sand below the skin's base soil means you are hoping it drains vertically, same with drain tile and sand layer, and those options, along with cutting in a trench drain, are not recommended.

When it comes to choosing your topdressing material, Zwaska said you need to learn the attributes of the various choices for this layer: calcined clay, vitrified clay, crushed aggregate, or diatomaceous earth. Do you need more moisture? Less moisture?

Topdressing advice

Zwaska stressed the benefits of topdressing, including:

- Slows evaporative process from base soil.
- Provides buffer zone between player's cleats and the base soil/
- Improves infield's resiliency and sliding surface.
- Improves playability in damp or wet conditions.
- Simplifies skin maintenance with less nail-dragging and more float dragging.
- Protects integrity of base soil.

Zwaska added that it's important not to nail-drag more than ¼ to ½ inch deep into the topdressing nor too often so as not to affect traction and playability. He said that topdressing is good for even a hard surface regardless of whether irrigation is available.-Eric Schroder ■

PREPARING
BASEBALL AND SOFTBALL FIELDS

Editor's note: *This material was provided by Turface Athletics.*

Spring maintenance on any playing field is a crucial step to ensuring a safe and fun season. To assist groundskeepers and field maintenance workers, here are some maintenance tips to assist with both baseball and softball infield preparation and outfield turf care.

Before starting any maintenance, walk the entire field and evaluate winter damage, vandalism and areas that require special attention. Putting together an action plan to address specific infield and turf needs is the next step.

"Get started as early as weather permits, and be sure to refer back to any plans you were unable to complete the prior year," said Jeff Langner, brand manager for Turface Athletics. "If you find you need assistance with soil testing, developing a maintenance plan or selecting appropriate products, your local field supply distributor may be a great resource."

Turf care can be organized by two categories: soil analysis and care, and establishing and maintaining vegetative growth. Soil analysis testing will help you determine pH level adjustments, the need for a fertility program, and the need for pre-emergent herbicides to help prevent weeds. Aerating the field when the temperature is cool will help relieve compaction and improve drainage. Topdressing the field helps modify the soil structure and levels the field which contributes to stronger grass plants.

To establish healthy grass growth, first you'll need to check the irrigation system and quick connects for leaks and damaged heads. Ideally, you'll need to establish a mowing routine that keeps the grass at a manageable and playable height, while never removing more than one third of the leaf. Making sure the mower blades or reels are sharpened is also an important step.

Preparing your infield or clay infield surface not only keeps the field in better condition, it helps prevent lips in skinned and grass transition areas that can lead to serious injury. First, you'll want to remove any grass or weeds on skinned areas by mechanical means or spraying with a turf labeled, non-selective herbicide.

Next, aggressively spike drag or scarify the skinned infield to integrate infield mix that may have segregated over the winter months. Removing any lips in skinned-to-grass transition areas is not only safer, it helps promote drainage and prevents puddling. You'll also need to regrade or add infield mix to fix holes and level the infield area. Mat drag to smooth the infield and edge the transition areas between skinned areas and turf.

Finally, you'll need to check the conditions of the bases, pitchers mound, batters boxes, bullpen and catchers area for holes and wear. You may want to consider installing specialized professional mound clay or clay blocks to these areas.

Top Tips for Infield Care

- Avoid folding mound and plate tarps; instead, roll the tarp on a tube or PVC pipe and hang for easy storage.
- Rake baselines lengthwise from home toward first and third.
- Make a single pass to "groove" a wet infield mix to create ridges, increasing surface area to speed drying time.
- Hand rake the 12-inch strip along the turf area after you have dragged the rest of the infield.
- Vary your raking start and stop locations as well as drag pattern.
- Use a soil conditioner or a specific drying agent that doesn't break down.
- To fill in holes in batters boxes or mounds with water and a tamp, sweep hole clean of loose material, moisten hole, add packing clay, and tamp.
- To remove standing water puddles on infields use a cup, sponge or pump, or a drying agent to absorb the remaining water.
- Remove the plugging bases before dragging an infield; rake or drag material from under the base and fill in the sliding pits. Roll or tamp pits.
- To line outfield grass use paint for lines in turf and consider painting lines on skinned area.
- Never leave the field "loose" from scarifying or tilling if heavy rains are expected and the field is to be used soon. ■

Will Schnell scalps Rose Bowl field under the lights.

Field takes center stage at the Rose Bowl

Editor's note: *This article was written by Danielle Marman, director of marketing for West Coast Turf*

As Ohio State and Oregon battled it out at the Rose Bowl on New Year's Day, a carefully planned, different Rose Bowl challenge was just beginning about 125 miles away in the California desert. The test? The Rose Bowl needed a fresh new field installed to host the BCS Citi National Championship game—and it had to be ready in just 6 days.

In 2007, a separate BCS National Championship game was added to the BCS system. University of Phoenix Stadium was the first venue to host the new game schedule, with the Fiesta Bowl played January 2, and the BCS National Championship 6 days later at the same location.

This presented a question. How exactly do you get a field perfect enough to accommodate the most important game in college football less than one week after the wear and tear of another major college bowl game? Arizona Diamondbacks' head groundskeeper Grant Trenbeath was called in to consult. "We didn't have much time to get the field ready or rooted, so we opted to use an 'overlay' technique that I'd used before at Chase Field for the Insight Bowl. With the overlay, you use thick-cut sod and put it right on top of the field that is in there. The sod is so heavy that it stays in place and doesn't move," Trenbeath said.

It worked. The first "stand alone" BCS National Championship game was played on a flawless new field with only 6 days to prepare.

Taking notes

Knowing their turn was coming, the Rose Bowl representatives (including head groundskeeper Will Schnell) were watching. "Will and I had some conversations," Trenbeath said. "He wanted to make sure he was making the right choice, so he investigated all of the details. You don't want any surprises, especially for a game of this magnitude. He wanted to know exactly what to expect and how to prepare. He did all of the homework."

The Rose Bowl had alternatives, but Schnell was confident that the overlay technique was the right option, and he didn't have to work very hard to convince others. The decision was made. "Will is an artist when it comes to our field," said Rose Bowl general manager Darryl Dunn. "We have the utmost confidence in his knowledge and opinion when it comes to the field. I wanted to be sure that this was the right thing to do to provide the best possible 'stage' for the biggest event of the year. I did ask him quite a few questions, and he provided the right answers. Will, Kevin Ash (chief administration officer of the Tournament of Roses), and I discussed this plan for more than a year and we went with it. I didn't lose any sleep, as I believe you can't trust your people just half the time; I trust Will Schnell."

The Rose Bowl used their regular sod supplier, Palm Desert, CA-based West Coast Turf. "They specialize in big roll athletic turf sod," Schnell said. "They provide a great product."

It also helped that West Coast Turf has had extensive experience in this particular

technique, as they were the growers and installers of sod for all of Trenbeath's projects in Arizona as well as "overlay fields" for Super Bowl XXXVIII at Reliant Stadium, and several other venues. Schnell worked closely with the sod supplier to prepare his strategy. He made regular visits out to the farm, and specified his turf variety, soil medium, and fertilization schedule. He also monitored the progress of the turf by taking soil samples and doing tissue testing monthly.

Being a perfectionist, Schnell even went so far as to do a simulation of the field installation when a U2 concert this past October presented the model scenario. After the concert a new overlay field surface was put in for a UCLA game scheduled 9 days later. Schnell imposed a 6-day timeframe for which to complete the field.

"Putting in a new field then was out of necessity, but it also worked out to be a great opportunity," said Dunn. "It was a great trial run."

But he didn't stop there. Although Schnell researched the overlay at University of Phoenix Stadium, he had a very different situation. In Arizona they have a roof on the facility so they can control the weather. The Rose Bowl doesn't. Even though "it never rains in California" as the old song goes, they couldn't take any chances with drainage.

So in early summer some soil testing was done to see how the Rose Bowl field's drainage system was performing. After the report came back, it was determined that a new complete system was essential. The only time available in the busy Rose Bowl calendar was to start the project November 22 right after the last UCLA game. Two layers of sod had to be removed, a new drainage system, growing medium and sod needed to be installed, and it all had to be completed in 13 days.

Schnell called Dan Almond to help him map out this daunting mission, and assembled a team to pull it off. Just Moving Dirt was contracted to remove the two sod layers totaling 3 inches, and another 6 inches of the old soil medium. GreenOne Industries installed the new drain matrix (their QwikDrain system). West Coast Sand and Gravel provided the new 6-inch, straight sand growing medium that topped the new

drain system. Bill Barkshire of Barkshire Laser Leveling was the final piece of the puzzle. He laser graded the growing medium in preparation for the sod to be laid December 4 and 5. Work was done around the clock to stay on schedule. This field had time to root, and hosted the Rose Bowl Game on January 1.

Doing the right thing?

The Capital One Bowl, held at the Citrus Bowl in Orlando, was televised just before this year's Rose Bowl game. On a scale from 1-10, field conditions went from a "1" in Orlando, to a "12" in Pasadena.

The Citrus Bowl field had been newly sodded with traditional sod a few weeks earlier. It did not root. Add in another bowl game 3 days prior, cold weather, and a downpour, and it made for a muddy, sloppy and unstable field come game time.

Minutes after Ohio State celebrated their Rose Bowl game victory, ABC's Brent Musburger revealed on air that the Rose Bowl was going to be getting a new field with new sod that very night for the BCS Championship game. That announcement prompted public alarm. With the current field still looking pristine, no one could quite figure out why they would risk taking a "perfectly good" field out, and put a new one in for a game less than a week away, especially after just witnessing the poor results of the new sod job at the Citrus Bowl.

"My phone started ringing immediately," said West Coast Turf's project manager Tom Stafford. "People thought we were all crazy to replace the field. But what no one understood was that we've all been setting this up for over a year. They also didn't understand that we didn't expect the sod to root and that is why we were using thick-cut sod. We were 100% positive that it would work, and give the championship the ultimate surface for the game.

"Sure, the Rose Bowl field looked great on TV during the Oregon/Ohio State game, but it was also covered with gallons of paint for logos, and had a lot of pregame, halftime, and postgame festivities on it in addition to the game," Stafford said. "Could they have gotten that field ready again in 6 days? Yes, I'm sure. But that isn't how the Rose Bowl does things. They're famous for that field. It is their brand. Nothing less than perfect is good enough there."

And, it's not all just about how the grass looks. "We wanted to provide a non-used surface, so there's not a cleat mark out there when the kickoff takes place," Schnell explained. "You see a player go out there and put his hand down on the grass and say, 'Is this real, or is it fake?' that's a tremendous compliment. The first thing we want to do is provide a great playing surface for the athletes. Then you want it to look good on camera."

There was also a "Plan B." Had rain been in the forecast, the crew was prepared to replace only the painted endzones with new sod. Luckily, rain wasn't part of the program.

Right after kickoff on New Year's Day, West Coast Turf crews began their own "kickoff" and started harvesting the overseeded hybrid bermuda in the desert. They continued through the night. Rolls were cut 1 ½-feet thick, 30-feet long, and 42-inches wide. Fifty truckloads accommodated 110,000 square feet of sod. Trucks began arriving in Pasadena just a few hours after the final whistle was blown, and the last remnants of celebration were removed.

At the stadium, West Coast Turf supplied a crew of 24 installers, and the Rose Bowl added another 24, including some "Turf All-Stars." Schnell enlisted the help of Mets head groundskeeper Bill Deacon, Home Depot Center's Kyle Waters, Reno Aces' Eric Blanton, Neal Pate of the Browns, Justin Peliquin, and some of the Dodgers' ground crew. "Most importantly, I had my two assistants, Miguel Yopez and Martin Rodriguez, working hard the whole time, too. They deserve a lot of the credit," Schnell said.

Right after the game, crews scalped the field down to ¼ inch and started unrolling the new sod right on top.

"It took 21 hours from the time we started putting in the sod and rolling the field, leveling it out to get the pool table effect, as low and level as possible," said Schnell. Workers installed through the night, finishing just before sundown the next day.

The ground crew spent the next 5 days painting new logos, watering the turf at just the right levels, rolling and sweeping the grass, and mowing at exactly the right time and length so the grass would hit its peak condition on game day.

The final score

On January 7, the hard work paid off. The field looked bright green, seamless, lush, and pristine. Playing conditions could not have been better.

"When the field looks beautiful there's a sense of accomplishment amongst those on the inside," said Kevin Ash, chief administration officer of the Tournament of Roses. The millions of television viewers seemed to agree. Headlines read "Rose Bowl Goes Extra Yard," and some of the comments from the press were, "Field at the Rose Bowl is immaculate, not a blade of grass out of place; every BCS Championship should be held there," and "Rose Bowl field looks better than Augusta."

Before the game, Texas quarterback Colt McCoy was on the field and commented on air that he wished he had brought his pitching wedge.

But what did Schnell think? "Every time I do something I always look for ways to make it better. Even before the last play of the BCS, Tom Stafford and I were coming up with ways to make it better. There's always room for improvement. Two days before the game we saw we were going to have a really good field. I told my staff, 'OK guys, it is end of the 3rd quarter, and we're up by 14. I want it to be 21 by game time.' Too many times I have had projects that are going well, and then we back off. Boy, they turned it up a notch! By game time the grounds crew was up by 21 points. The Rose Bowl crew from top to bottom met the challenge head on, and had an incredible victory. Heck, it was a blow out! In my book, it ended up 'Grounds Crew 30, Failure 3.' The '3' is for improvement next time," Schnell said.

"People all over see a field that looks good. We know what it took to make that happen," Ash said.

And now we all know what it took, too. Trust in talented people, quality product, precise planning, clever strategy, hard work, and of course, cooperating weather.

A few days after the game, grass from the endzones and logos was removed from the field and taken back to the sod farm. There it was

laid back down, cut into small rolls, hydro-cooled, and shipped to New Jersey. It was then cut into 3 x 3-inch pieces, freeze dried, packaged into UV glass cases, and sold as "collectable souvenirs" for $100 to $250. The remaining championship sod was recycled, and used for repair work in other locations. ■

Update on university turf-related research projects, Part II

Editor's note: *Following are more reports from some leading turfgrass researchers in the US on their current studies. Part I appeared in our December 2009 issue.*

RUTGERS UNIVERSITY

Traffic stress research conducted on National Turfgrass Evaluation Program (NTEP) trials will continue at Rutgers University Horticultural Research Farm II, North Brunswick, NJ in 2010. Previously, the 2005 NTEP Kentucky bluegrass test received seasonal wear applications in fall 2006, summer 2007, spring and fall 2008, and summer 2009. This test is scheduled to receive wear in spring 2010

Wear stress is applied with a modified M24C5A Sweepster in which the steel brush on the unit was replaced with rubber paddles. The rotational movement of the paddles causes wear. The simulator allows control of both forward operating speed as well as paddle rpm. In addition to wear data, turfgrass quality has been assessed in the absence of wear since the inception of the test and 2009 data include entry susceptibility to dollar spot.

The 2006 NTEP tall fescue test has received season-specific applications of traffic (wear plus compaction) in fall 2007, summer 2008, and spring and fall 2009. Wear is applied with the modified Sweepster and compaction is applied with an approximately 1.0-ton vibratory roller. The test is scheduled to receive traffic in summer 2009. Other data include non-trafficked turfgrass quality (2007-09) and brown patch susceptibility ratings taken on multiple dates in both 2008 and 2009. Similarly, research results can be found at the aforementioned websites.

Wear was applied to entries comprising the 2004 NTEP Perennial Ryegrass trial in the fall of 2009.

In late 2009, the Rutgers Center for Turfgrass Science constructed a Cady Traffic Simulator to compliment its current wear simulator. The new traffic simulator will be integrated into future turfgrass traffic stress tolerance projects at Rutgers. Comparison of the Cady traffic simulator with the modified Sweepster (wear) simulator will be made.

Rutgers research personnel include:

- Brad Park, Sports Turf Research & Education Coordinator
- Dr. James Murphy, Extension Specialist in Turfgrass Management
- T.J. Lawson, Research Technician
- Bill Dickson, Research Farm Supervisor
- Joe Clark, Research Technician
- Dr. Bruce Clarke, Director, Center for Turfgrass Science

Research results can be accessed at www.ntep.org and in the Rutgers Turfgrass Proceedings (www.turf.rutgers.edu/research/reports/index.html). Specific URLS for some reports include:
http://www.turf.rutgers.edu/research/reports/2008/201.pdf and
http://www.turf.rutgers.edu/research/reports/2007/213.pdf
http://www.turf.rutgers.edu/research/reports/2006/179-196.pdf

Research is sponsored by the National Turfgrass Evaluation Program, Rutgers Center for Turfgrass Science, and New Jersey Agricultural Experiment Station.

For additional information, please contact Brad Park at park@aesop.rutgers.edu or murphy@aesop.rutgers.edu.

AUBURN UNIVERSITY

Weed management update: Indaziflam (Bayer CropScience), a new herbicide for preemergence and postemergence *Poa annua* control in warm-season turfgrass. Scott McElroy, Assistant Professor, and Jack Rose, Research Assistant.

Indaziflam is a new herbicide currently being evaluated for preemergence weed control in primarily warm-season turfgrass that was introduced at the 2009

Indaziflam is a new herbicide currently being evaluated for preemergence weed control in primarily warm-season turfgrass

Annual Meeting of the Weed Science Society of America (WSSA). Information about indaziflam presented in this research update was derived primarily from this WSSA abstract (Myers et al., 2009) and personal experience working with the product.

Indaziflam is classified as an alkylazine herbicide that inhibits cell wall biosynthesis. It possesses soil residual/preemergence activity, as well as postemergence activity on annual bluegrass. However, its preemergence control is the most promising aspect.

Numerous research trials have been conducted at Auburn evaluating indaziflam weed control efficacy. One trial evaluated the effect of application timing on indaziflam efficacy on *Poa annua* in non-overseeded bermudagrass turf. Herbicide, rates, and timing is presented in Table 1.

Table 1. Herbicide, rate, and timing of treatments applied for *Poa annua* control in dormant bermudagrass turf. Indaziflam is presented in metric units, rather than English units.

All treatments were applied with a CO^2 pressurized sprayer calibrated to deliver approximately 30 gallons per acre. No surfactant was included in any treatment. *Poa annua* control was rated monthly beginning January 2009. Control was rated on a 0 to 100% scale where 0 equals no injury and 100 equals complete elimination of all plant with no green tissue surviving. Greater than 80% control was considered commercially acceptable control based on turfgrass manager preferences. Bermudagrass green-up was rated on a similar 0 to 100% scale; however, no treatments delayed bermudagrass green-up at any time.

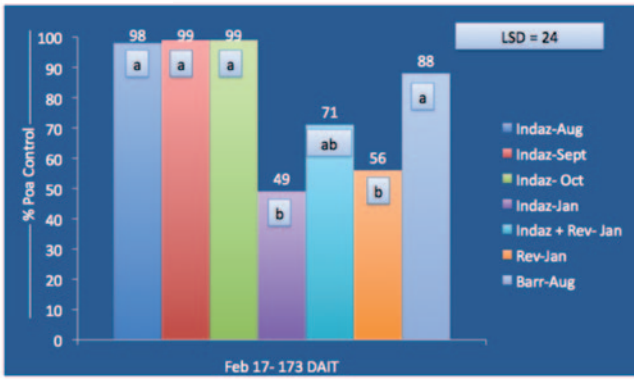
Herbicide	Rate	Timing	Abbreviation
Indaziflam	80 g ai/ha	August 28	Indaz-Aug
Indaziflam	80 g ai/ha	September 30	Indaz-Sept
Indaziflam	80 g ai/ha	October 30	Indaz-Oct
Indaziflam	80 g ai/ha	January 9	Indaz-Jan
Indaziflam + Revolver	80 g ai/ha + 17.4 fl oz/a	January 9	Indaz+Rev-Jan
Revolver	17.4 fl oz/a	January 9	Rev-Jan
Barricade	1 lb ai/a	August 28	Barr-August

Table 1

Only a single rate of indaziflam was evaluated over four timings from August to January (Figure 1). Indaziflam applied at August to October controlled *Poa annua* >98% when rated 173 days after initial treatment on 17 February 2009. Barricade at 1 lb ai/a applied 28 August controlled *Poa annua* 88%, equivalent to indaziflam treatments applied August to October.

Indaziflam alone, Indaziflam plus Revolver, and Revolver alone applied in January controlled *Poa annua* unacceptably (<80%). There are two reasons for decreased control with indaziflam applied in January. First, decreased temperatures can decrease effectiveness. This is known to occur with Revolver and is thought to be the cause of the decrease in control with Revolver alone at this timing. Second, *Poa annua* plants were >3

Figure 1



tillers when applied in January. Larger plants could simply be harder to control. Similarly, ethofumesate is known to decrease in control as plants become larger due to a decrease in herbicide absorption. A similar phenomenon could be occurring with indaziflam.

By April 10 rating, Revolver containing treatments control of *Poa annua* was >90% and equivalent to indaziflam alone treatments. Revolver is known for its "slowness" when applied during colder temperatures, especially in removing overseeded perennial ryegrass; however, Revolver is much more active on *Poa annua* than perennial ryegrass. As demonstrated in this study, Revolver control of *Poa annua* is just a matter of time.

Conclusion: Initial results with indaziflam are promising. There are currently no herbicides on the market that control *Poa annua* both pre and postemergence. Such a product would be well received and highly beneficial to the turfgrass industry.

Literature Cited

Myers, D.F., et al. 2009. Indaziflam/BCS-AA10717- A new herbicide for pre-emergent control of grasses and broadleaf weeds for turf and ornamentals. Proc., Weed Sci. Soc. Am. No. 386.

PURDUE UNIVERSITY

The Turf Science research program continues to reap the benefits of the extremely generous support of the Mid-West Regional Turf Foundation and many industry partners.

Pest management studies: Weed management studies have continued to evaluate the use of various novel herbicides like Tenacity for creeping bentgrass removal in Kentucky bluegrass athletic fields. This herbicide is being increasingly adopted by several regional cool-season athletic field managers and is being applied using an autumn application regimen. In addition, several continuing projects have identified various herbicide and management techniques to minimize roughstalk bluegrass encroachment in golf turf.

Insect studies have been evaluating the use of novel endophytes and entomopathogenic nematodes, as well as the role of fertilizer nutrient ratios on turfgrass health and the ability for turfgrasses to resist surface and sub-surface dwelling insects without the use of synthetic pesticides. Additionally, our entomology team has been closely monitoring a newly documented pest problem throughout the Ohio River valley, the occurrence of significant billbug damage in zoysiagrass.

Disease management: Our disease management team has been continuing to investigate various alternatives to traditional fungicides, including biorational products and the potential for disease forecasting models to better time fungicide applications. Furthermore, a multi-year study has been investigating the role of spray carrier volume on fungicide efficacy.

Species and cultivar evaluations: Bermudagrass cultivars—Being located at the northern edge of the upper transition zone, we continue to be an excellent location for the evaluation of bermudagrass cultivars for cold hardiness. In the third week of January, 2009, the air temperatures in West Lafayette plummeted to -22F without snow cover. These environmental conditions negatively affected the winter survival of several standard cultivars like Tifway and TifSport. By contrast, several cultivars with superior performance like the old "stand-bys" Midlawn, VaMont and Quickstand, and the more recent generation, Patriot, Riviera, Yukon, and GN-1, continue to perform well in successive years. In addition, there are some promising new experimental cultivars under development which show promise for the future. These have been developed by the Oklahoma State breeding program and include: OKC-7018, OKC-1119, OKC-1134 and OKS-2004.

Ryegrass—For the cool-season species several studies have focused on the perennial ryegrass. Field and laboratory studies have been conducted to determine the ploidy level of the collection of USDA ryegrass accessions and are evaluating the drought tolerance of these at three contrasting locations throughout Indiana. Using molecular techniques it was determined that in general the plants in the USDA collection as well as many of our commercially available cultivars are very much genetically similar. This information may be of use to our plant breeders as they expand their selection for plant material with improved traits for superior turf performance.

Bermudagrass overseeding: A field study was conducted over two years to determine optimum perennial ryegrass seeding rates for overseeding Patriot bermudagrass football fields and determine if multiple seeding events were superior to a single event for PRG establishment and persistence. This study was arranged in a 3 x 5 factorial with five seeding rates (12.5, 25, 50, 75, and 100 lbs/A/yr) and three application strategies (applying 100% of the seed in one application (100), 70% of total seed in the initial application plus 10% of total seed in each of three successive applications ten days apart (70/10/10/10), or four equal applications of 25% of the total seed applied ten days apart (25/25/25/25). Seed was initially planted the third week of August. The results of this study showed that ryegrass coverage rarely increased at seeding rates > 50 lbs/A/yr regardless of seeding strategy. The 25/25/25/25 seeding strategy consistently resulted in the most coverage, 55-77%, when rated in mid-Nov., regardless of seeding rate, followed by the 70/10/10/10 and 100 strategies with 46-62% and 20-52%, respectively. The relatively low ryegrass coverage values could be due to seedling competition with actively growing Patriot bermudagrass. These data indicate that when overseeding Patriot bermudagrass in the upper transition zone multiple seeding events appear to be superior to a single event and there is little benefit for exceeding seeding rates > 50 lbs/A/yr.

Cale Bigelow, Tim Gibb, Yiwei Jiang, Rick Latin, Zac Reicher and Doug Richmond: Departments of Agronomy, Botany and Plant Pathology and Entomology, respectively.

UNIVERSITY OF MASSACHUSETTS

Traffic, wear & compaction studies by J. Scott Ebdon, PhD:
Effects of Nitrogen and Potassium on Wear Stress Mechanisms in Perennial Ryegrass. Fertility trials were established to investigate the effects of five N rates in combination with three K rates on wear tolerance and associated mechanisms. Wear was applied using wear simulators fitted with metal soccer cleats. Optimum fertility for maximum wear tolerance and recovery was found to be 3 to 5 lbs N/1000ft2/yr. N rates exceeding 5 lbs caused excessive shoot growth rates, higher shoot water content and loss in cell wall components. Shoot density played a secondary role to shoot water content and leaf growth rates in accounting