FIGURE 3

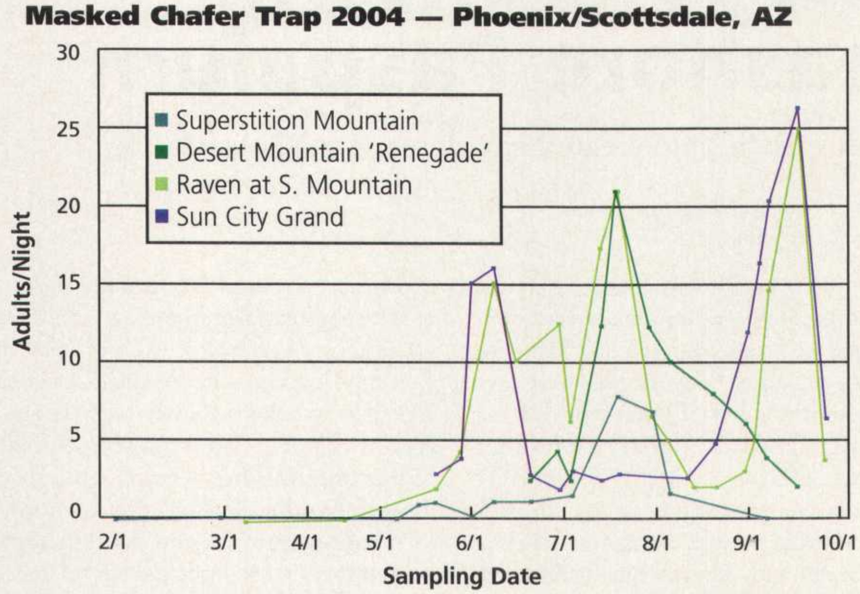

Figure 3. Timing of white grub adults light trap catches in the Phoenix/Scottsdale area illustrate a wide range of peak flights for different locations. (Data courtesy of K. Umeda and G. Towers, University of Arizona)

the survivability of the grubs would be fairly low during dry periods.

However, a new component has been added to the concept of irrigation and that is the use of effluent water. This is becoming an increasingly common trend and we do not fully understand all of the implications of using effluent water. There is an improved data base on effluent water from an agronomic perspective, but how does it influence pest problems and even various pesticides? We aren't sure.

My observations are that white grubs are more common in areas that are using effluent water. I don't have a survey to fully document this nor am I saying that if you use effluent water you will suffer from a serious grub problem. Rather, I do believe the two seem to go together. We are conducting field and greenhouse trials to document this phenomenon and determine why. We know that many beetles do prefer areas with more organic matter and maybe they are selectively going after specific areas that are made more attractive by effluent water. We do know that with the use of low rates of sulfur, for example, we can reduce the incidence of green June beetle grubs by 50 percent.

Green June beetles are one of the most common grubs we find in areas with elevated levels of organic matter. So developing a better understanding of the cues that beetles pick up on to determine in which turf areas they will lay their eggs could be an important step toward developing the means to reduce their abundance.

Research to develop a better understanding of white grub biology is under way in many locations. Despite past research efforts that have been of significant benefit in developing our management programs, there is still room for more information in a lot of geographic locations. Making sure turfgrass managers are working with information that applies to their part of the world is critical if you want to be cost effective. There are several new white grubs products we will see starting as early as this fall. They have been very effective in trials across the country. The effectiveness of new products will not, however, make it possible to ignore white grub biology when making an application.

Rick Brandenburg is a turfgrass entomologist and co-director of the Center for Turfgrass Environmental Research and Education at North Carolina State University.

Salt Tolerance in Seashore Paspalum

Not all varieties are created equal, research shows

By Paul L. Raymer

Salinity problems have become increasingly more prevalent in managed turfgrass over the last 10 years. Emphasis on water conversation strategies that use non-potable, alternative irrigation sources has been a primary contributor (Marcum, 2004).

Alternative irrigation water sources include recycled water, storm water, saline ground water and seawater blends. Many of these alternative water sources contain much higher salt levels than traditional irrigation waters. The trend for use of more salt-laden irrigation waters on turfgrass sites is expected to continue to rise at a rapid rate and to further increase interest in the use of more salt-tolerant grasses, especially halophytes (Carrow and Duncan, 2005; Lee et al., 2005; Marcum, 2002).

Seashore paspalum, Paspalum vaginatum, is warm-season, halophytic grass that has rapidly gained popularity for use as a fine turf on golf courses and other recreational sites, especially where salt is a problem or irrigation with salt-laden alternative water sources is anticipated (Duncan and Carrow, 2000). Seashore paspalum is considered the most salt-tolerant warm-season turfgrass species and also holds great promise for reclamation and soil stabilization of unmanaged salt-affected sites (Loch et al., 2003).

The existence of salt-tolerant plants (halophytes) and differences in salt tolerance among genotypes within plant species indicates that there is a genetic basis to salt response (Yamaguchi and Blumwald, 2005). Previous research has demonstrated that seashore paspalum ecotypes vary greatly in their level of tolerance to salt (Lee et al., 2004a, Lee et al., 2004b) and range from no better than the best bermudagrass hybrids to highly salt tolerant. Therefore, it is necessary to screen potential seashore paspalum cultivars prior to their release to ensure that they have high levels of salt tolerance. Genetically controlled variability for salt tolerance among genotypes infers that it may be possible to further improve salt tolerance of this species through breeding and selection.

A prerequisite for the development of new cultivars with improved salt tolerance is an efficient and effective salt tolerance screening method suitable for evaluation of large numbers of breeding lines. Such a screening method has been developed at the University of Georgia (Raymer et al., 2005). This screening technique was used to evaluate salt tolerance of 15 genotypes in a replicated greenhouse experiment.

Materials and methods

Three ebb and flow benches were used to provide daily sub-irrigation with a solution containing soluble fertilizer, according to the procedures outlined in Raymer et al., 2005.

The fertilizer solution was monitored weekly using a compact NO_3-nitrate ion meter and maintained between 200 mg and 300 mg per kilogram NO_3 (200 to 300 parts per million). A synthetic sea salt mix was gradually added to individual benches to achieve final salt concentrations of 0, 20 and 40 dS per meter (decisemins per meter, which measures electrical conductivity often used to quantify salinity). Electrical conductivity of the irrigation solution was monitored using a portable pH/conductivity meter equipped with a conductivity electrode.

Six replications of 15 genotypes, including 14 seashore paspalum genotypes and

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Merit has one active ingredient our competition doesn't.

TABLE 1

Visual and Growth Responses of Seashore Paspalum Genotypes to Varying Concentrations of Salt.

Genotype	Leaf[1] Firing	Total Clip Wt.	Verdure	Crown & Roots	Total Biomass	Biomass[2] Reduction
	Score	*grams*	*Grams*	*grams*	*Grams*	*%*
Fresh Water						
Adalayd	8.7	1.7	4.9	3.4	10.0	-
Excalibur	8.7	1.6	4.3	3.5	9.3	-
HI 10	8.6	1.9	4.0	3.5	9.4	-
HI 101	8.8	1.9	4.5	3.5	9.8	-
K 3	8.6	1.7	3.8	2.7	8.1	-
KC 8	8.7	2.2	4.5	3.5	10.2	-
SPS K1	9.0	2.1	4.5	3.0	9.6	-
SeaIsle 1	8.6	2.1	5.4	4.3	11.7	-
SeaIsle 2000	9.0	1.7	3.8	4.6	10.1	-
Salam	8.7	1.8	4.3	3.2	9.3	-
SeaSpray	8.8	1.9	4.0	3.4	9.3	-
SeaIsle Supreme	8.9	1.6	4.6	3.4	9.6	-
SI 99	8.6	1.7	4.6	2.8	9.1	-
TifEagle (Cynodon)	9.0	2.2	5.1	5.3	12.6	-
Tropic Shore	8.1	3.1	4.4	3.9	11.3	-
Mean	**8.7**	**1.9**	**4.4**	**3.6**	**10.0**	**-**
LSD 0.05	**0.2**	**0.5**	**0.9**	**0.8**	**1.6**	**-**
Std. Err.	**0.1**	**0.2**	**0.3**	**0.3**	**0.6**	**-**
20 dS m^{-1} Salt						
Adalayd	5.7	1.0	3.4	3.1	7.5	24.6
Excalibur	6.3	0.7	2.7	3.0	6.5	30.1
HI 10	6.2	1.0	3.1	3.2	7.3	22.3
HI 101	6.1	0.8	2.7	3.0	6.5	33.5
K 3	6.9	1.0	2.8	3.4	7.2	11.6
KC 8	6.0	1.3	3.7	3.8	8.8	13.7
SPS K1	7.0	0.9	3.6	3.1	7.6	20.6
SeaIsle 1	6.3	1.0	3.2	3.6	7.8	33.3
SeaIsle 2000	7.2	0.9	3.1	3.7	7.6	24.5
Salam	6.7	0.8	3.4	2.7	6.8	26.6
SeaSpray	6.5	0.9	2.8	2.6	6.3	32.8
SeaIsle Supreme	8.0	1.1	3.6	4.2	8.9	7.2
SI 99	8.1	1.2	4.8	4.2	10.1	-10.9
TifEagle (Cynodon)	5.1	0.8	3.4	3.7	7.8	37.5
Tropic Shore	3.3	1.0	2.1	2.5	5.6	50.3
Mean	**6.4**	**1.0**	**3.2**	**3.3**	**7.5**	**24.7**
LSD 0.05	**0.5**	**n.s.**	**0.9**	**0.8**	**1.2**	**-**
Std. Err.	**0.2**	**0.7**	**0.3**	**0.3**	**0.4**	**-**
40 dS m^{-1} Salt						
Adalayd	3.4	0.5	1.5	2.0	4.0	59.7
Excalibur	3.6	0.6	1.3	2.0	3.9	58.5
HI 10	3.4	0.8	1.5	2.8	5.1	46.2
HI 101	3.7	0.3	1.7	2.8	4.8	51.2
K 3	4.3	0.6	1.9	2.0	4.5	44.9
KC 8	3.6	1.0	2.1	2.7	5.8	43.7
SPS K1	4.3	0.4	1.7	2.0	4.2	56.2
SeaIsle 1	4.5	0.8	2.1	3.4	6.3	46.4
SeaIsle 2000	4.6	0.7	1.6	3.1	5.3	46.8
Salam	3.4	0.4	1.5	2.3	4.1	55.3
SeaSpray	3.9	0.8	1.4	2.5	4.7	49.5
SeaIsle Supreme	6.7	0.7	2.7	4.5	7.9	17.8
SI 99	6.3	0.6	2.4	3.9	7.0	23.3
TifEagle (Cynodon)	2.0	0.5	1.6	3.7	5.8	54.0
Tropic Shore	1.5	0.5	1.4	1.8	3.8	66.9
Mean	**3.9**	**0.6**	**1.8**	**2.8**	**5.1**	**48.4**
LSD 0.05	**0.7**	**0.3**	**1.0**	**0.8**	**1.2**	**-**
Std. Err.	**0.2**	**0.1**	**0.3**	**0.3**	**0.4**	**-**

1. Rated on a 1-9 scale with 9 = no leaf firing. 2. Reduction in total plant biomass when compared to the freshwater treatment. 3. dS m^{-1} (decisemins per meter)

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one ultra-dwarf bermudagrass genotype, TifEagle, were simultaneously evaluated at each of the three salt concentrations.

Ten genotypes previously evaluated for salt tolerance (Lee et al., 2004a, Lee et al., 2004b) and shown to range from sensitive to tolerant were included along with five genotypes with unknown tolerance levels. Plants for evaluation were grown in washed play sand in 10 centimeter pots on the ebb and flow tables and maintained by daily sub-irrigation with fertilizer solution for 30 days prior to initiating salt treatments.

Large genotypic differences were observed for all traits measured.

After the 30-day grow-in period, all plants were clipped to a standard height of one-half inch and salt concentration increased in 6 dS per meter steps at four-day intervals until target concentrations were reached. All tables were sub-irrigated simultaneously using a single electronic timer. Sub-irrigation frequency was once per day for the first three weeks of the experiment and increased to twice per day thereafter. After reaching target salt concentration, all plants were scored for leaf firing and clipped to determine top growth dry weight at two-week intervals.

After six weeks at the target salt concentrations, plants were harvested, washed free of sand and verdure, and crown/root dry weights were determined.

Results

Large genotypic differences were observed for all traits measured (Table 1). Higher ratings of visual appearance of turf quality (presented as leaf firing ratings) and higher biomass production (clip weight,

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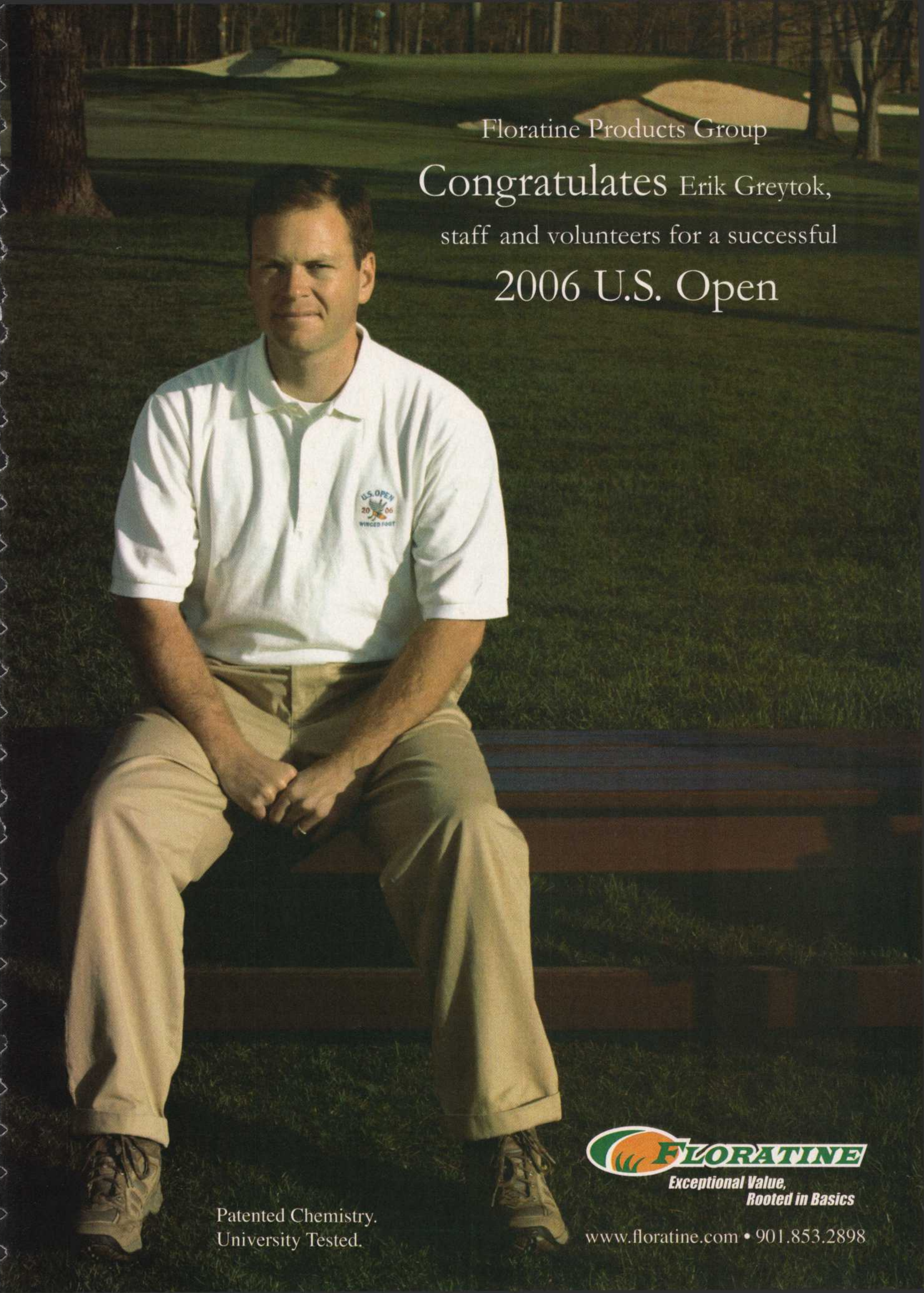
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verdure weight, crown and root weight, and total biomass weight) are positive indicators of salt tolerance. Salt- tolerant cultivars are expected to have the ability to maintain growth and thereby have minimal reduction in total biomass when exposed to salt. The salt treatments used in this experiment were 20 and 40 dS per meter. As a reference, consider that the salinity level of ocean water is approximately 54 dS per meter.

At the moderate salt level of 20 dS per meter, leaf firing ratings averaged 6.4 for all genotypes tested, and ranged from 8.1 for the variety SI 99 to 3.3 for the salt-sensitive line, Tropic Shore. Total biomass values averaged 7.5 grams for all entries and ranged from a high of 10.1 grams for SI 99 to a low of 5.6 grams for Tropic Shore. SI 99 and SeaIsle Supreme formed the top statistical group at 20 dS per meter.

At the higher salt level of 40 dS per meter, leaf firing ratings averaged only 3.9 for all genotypes tested, and ranged from 6.7 for SeaIsle Supreme to 1.5 for the salt-sensitive line, Tropic Shore. Total biomass values averaged 5.1 grams for the 15 entries and ranged from a high of 7.9 grams for SeaIsle Supreme to a low of 3.8 grams for Tropic Shore. SI 99 and SeaIsle Supreme were in the top statistical group for all traits measured at 40 dS per meter. When the total biomass produced at 40 dS per meter was compared to that produced under freshwater conditions, biomass reductions for the 15 genotypes tested averaged 48.4 percent. The paspalum genotypes Adalayd, Excalibur, Salam and Tropic Shore as well as TifEagle bermudagrass all had biomass reductions of greater than 50 percent at the 40 dS per meter level.

In contrast, the total biomass values of SeaIsle Supreme and SI 99 were reduced by 17.8 percent and 23.3 percent, respectively.

In summary, two new genotypes, SeaIsle Supreme and SI 99, with salt tolerance levels superior to any previous reports were identified. SeaIsle Supreme was released by the Georgia Experiment Stations in 2004 and is now available for commercial sale by licensed growers.

Discussion

The genotypic variability among ecotypes demonstrated in this experiment combined with the development of a screening method to efficiently identify ecotypes with superior salt tolerance offers great promise for continued improvement of the level of salt tolerance within this halophytic species.

In our breeding program, we plan to exploit the observed genetic variability by recombining superior genotypes and selecting for further improvements in salt tolerance. Breeding efforts will be focused on development of cultivars for use as fine turf as well as on the development of cultivars for use in forage production and stabilization of salt affected areas.

Paul L. Raymer is a professor and turfgrass breeder with The University of Georgia Crop and Soil Sciences Department at the Griffin Campus. He can be reached at praymer@griffin.uga.edu.

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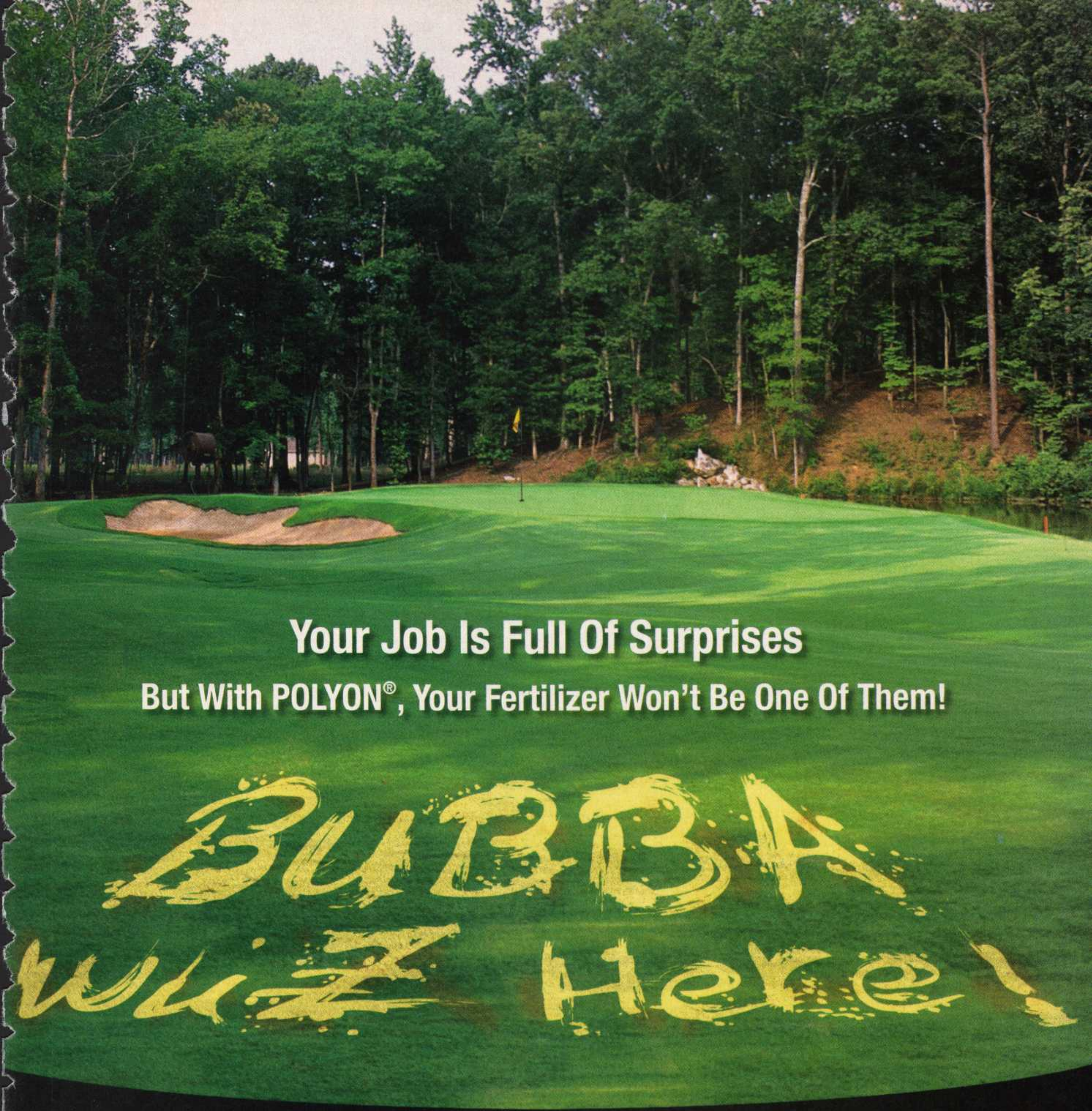

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Jumpstarting Bermuda

SUs provides superintendents options to achieve spring transition

By Kai Umed

In the southwest United States, spring transition can be a challenge in higher-cut turf such as golf course roughs, greens surrounds, shaded areas or sports turf facilities.

Eliminating perennial ryegrass as early as possible and trying to "jumpstart" the bermudagrass provides for an optimal long summer growing season before the overseeding starts again in the fall. The summer season objective is to produce a vigorous bermudagrass foundation that has healthy rhizomes that have amassed substantial carbohydrate reserves for surviving the winter and to emerge during the next spring season transition.

Golf course greens, tees and fairways can often be mechanically transitioned in concert with increasing spring air temperatures that "burn out" the ryegrass or *Poa* trivialis. Increasing soil temperatures also encourage the bermudagrass to green up and then grow out of winter dormancy. At about 1,000 feet of elevation in the Phoenix area, reducing water and lowering mowing heights to 0.5 inch or less stresses the winter turfgrass and provides room for the bermudagrass to fill in during mid-May through June.

In the Scottsdale area where the elevation climbs to better than 2,500 feet, and sometimes even at the lower desert floor, cooler spring temperatures may not be conducive for effectively eliminating ryegrass, especially in higher-cut turf areas. In roughs that were allowed to grow to 1.5-inch heights during the winter season, lowering the ryegrass mowing heights to 0.75 inch still presented effective competition to deter healthy bermudagrass transition.

The introduction of the sulfonylurea (SU) herbicides provides golf course superintendents and sports turf managers a variety of options to address and achieve spring transition.

The SU family of herbicides was originally discovered as very potent broad-spectrum herbicides. Over time, the molecules were manipulated to confer selectivity in various crops while maintaining very good efficacy against weeds. Many of these SU herbicides demonstrated good safety and weed-control efficacy on grass crops such as corn, wheat, barley and rice. Additionally, many of these products applied on grasses at sub-lethal rates demonstrated growth-regulating activity such as shortening the height or preventing seedhead formation. These SU herbicides can selectively remove perennial ryegrass from bermudagrass turf at different rates of speed at different rates of use depending on several conditions.

The SU herbicides can be influenced by weather and the health of the turfgrasses.

TABLE 1

Sulfonylurea herbicides evaluated for transition

Herbicide treatment	Product rate (oz/A)	Rate (lb a.i./A)
foramsulfuron (Revolver*)	8.8	0.013
rimsulfuron (TranXit*)	1.0	0.016
trifloxysulfuron (Monument*)	0.1	0.0047
sulfosulfuron (Certainty*)	1.25	0.059
flazasulfuron (Katana* proposed)	0.5	0.0078

Warmer temperatures will favor bermudagrass vigor so that it can tolerate the SU herbicides better than the susceptible ryegrass, which will be stressed by both high temperature and the active SU herbicide.

Field trials

Our objective in a series of field trials was to achieve a gradual or "natural" transition that would occur when the ryegrass thins out because of heat and cultural practices that could be augmented with the use of SU herbicides to effectively remove ryegrass.

The SU herbicide rates applied in our experiments were the lower label rates (Table 1) with a non-ionic surfactant added to all sprays in 30 gallons per acre of water that were applied using a backpack sprayer equipped with a hand-held boom. The experiments were conducted on different cultivars of perennial ryegrass being maintained at rough heights of cut at about 1.5 inches.

The earliest small plot trial was initiated in late April, where single and sequential applications of herbicides were evaluated for ryegrass removal efficacy. Two additional trials were conducted in late May-early June with single applications of transition-aid herbicides.

In late April, soil temperatures at 4-inch depth were in the mid-60 degrees Fahrenheit and average high temperatures during the day was in the mid-70s with nighttime low temperatures in the low 50s range. In late May, soil temperatures were in the low 80s with daytime temperatures getting above 100 and nights dropping to the low 60s range.

Sequential applications of Revolver, TranXit, Monument, Certainty and flazasulfuron made in late April and followed two weeks later effectively removed ryegrass before the end of May. Single applications in late May and early June removed ryegrass before the end of June.

The transition was highly acceptable in the turf wherever bermudagrass was able to fill-in for the eliminated ryegrass. Wherever bermudagrass was not actively filling in for the removed ryegrass, unsightly bare patches were identified. This was especially pronounced where ryegrass was nearly completely removed during May with early sequential treatments.

Sequential applications that were initiated in late April and not resprayed within two weeks gradually removed ryegrass. At seven weeks after the first April application, the remaining ryegrass was sprayed again and eliminated at the end of June.

The transition-aid herbicides augmented standard cultural management practices that included lowering mowing heights, core aerification and verticutting. Where ryegrass was effectively removed and unsightly bare patches resulted, early identification could enable early remedial actions to resod, sprig, seed or encourage bermudagrass to re-establish a solid foundation.

It is important to grow, establish and maintain the foundation of bermudagrass turf with healthy and vigorous roots, rhizomes and stolons. Without this solid bermudagrass foundation, there would be very little to transition back to in the spring or bermudagrass will not adequately fill in where removed ryegrass creates a void.

When transition is complete, bermudagrass should optimally have at least 100 days of good summer growing conditions prior to fall overseeding.

Another way to approach transition is to calculate backwards 100 days from the next intended overseeding date. For example, if overseeding is planned for early October, ryegrass should be eliminated by using SU herbicides about July 4 to allow for 100 days of bermudagrass growth.

Kai Umeda is an area extension agent for turfgrass science working with golf course superintendents, sports turf managers and commercial turfgrass managers in Maricopa County and adjacent counties in Arizona. Since 1994, Umeda has worked closely with the University of Arizona's College of Agriculture and Life Sciences research and extension faculty and in 2003 assumed his turfgrass science responsibilities. His turfgrass extension program areas of emphasis are weed science, pest management and disease diagnostics/prevention/control.

Better Safe Than Sorry Applies Here

BY JIM BLACK

The other day my boss came up to me and said, "Jim, the company has decided to embark on a safety campaign. We would like you to keep an eye out for signs of potentially hazardous conditions on the golf course involving the crew and give us a full report."

Filled with enthusiasm for this important assignment, I jumped into my golf car and sped off in search of signs of safety hazards, left foot dangling out the side.

It was a beautiful sunny day, and the course was packed with golfers. Interspersed among the play, the crew was dutifully going about its assignments mowing fairways, raking bunkers, string trimming and edging cart paths.

I took my time touring the entire course, making sure I didn't miss any opportunity to note hazardous conditions and situations that needed to be corrected. What I saw was quite surprising, as I didn't really expect to find so many unsafe situations involving the crew.

Armed with lots of gathered safe-practices information, I sped back to the maintenance barn and, entering the second bay at high speed, locked my brakes and power slid to a halt just inches shy of the flammables cabinet.

I leapt from the car over the puddle of spilled hydraulic fluid, made my way past the mechanic who was grinding a weld with his safety glasses set firmly on the workbench, and headed for my computer to file the following safety report.

Dear Public Golf Course Owner and Operator,

After touring the golf course in search of potential safety hazards, I've compiled a list of these hazards for your review. I think we should all work diligently to resolve these issues so as to maintain safe conditions on the course wherever possible.

Hazard one: Steve the irrigation guy was working on a fairway head on No. 1 and was unaware there was a group on the tee. The group also failed to warn him they were teeing off. They shrugged their shoulders and hit away, the third player's shot hitting the fender of Steve's cart. The ball careened off the plastic and whizzed past his left ear on its way out of bounds.

HEY, WAIT A MINUTE, AREN'T PEOPLE PEOPLE? IF A GOLFER WOULDN'T HIT INTO ANOTHER GOLFER, WHY WOULD HE HIT INTO THE CREW?

The hazard was created when the golfers failed to warn Steve they were hitting so he could move out of harm's way.

Solution: Ask the golfers to have respect for the crew. I asked that golfer if he would have hit away if Steve had been a player instead of on the crew and he answered, "No way." Hey, wait a minute, aren't people people? If a golfer wouldn't hit into another golfer, why would he hit into the crew?

Hazard two: As Jose was mowing fairways, he pulled over his mower to the rough to let a group play through. Jose throttled the mower's engine down and cut it off. A player had hit his tee shot near where Jose had parked. When he topped his approach shot and advanced it about 20 feet closer to the green, he immediately looked at Jose and began swearing at him and shaking his club at him as if it were Jose's fault.

Solution: More lessons, less beer.

Hazard three: Sidney Sidewinder, our local wannabe golf course architect, planted the 16th green precariously at the edge of a 50-foot ravine. I've watched in horror on many occasions as mowing equipment, along with its respective operators, disappeared over the edge into the abyss. There seems to be no safe way for the crew to be able to mow this type of contrived green complex.

Solution: Ask architects to think a little beyond their self-made monuments to the people who will actually maintain them.

In conclusion, I must say it would seem that aside from the usual, obvious safety precautions like eye and ear protection and proper equipment operation training, there are many other safety issues that could be addressed — some of which begin on the first tee.

Black is a former superintendent and a current turf expert and contributing editor to Golfdom.