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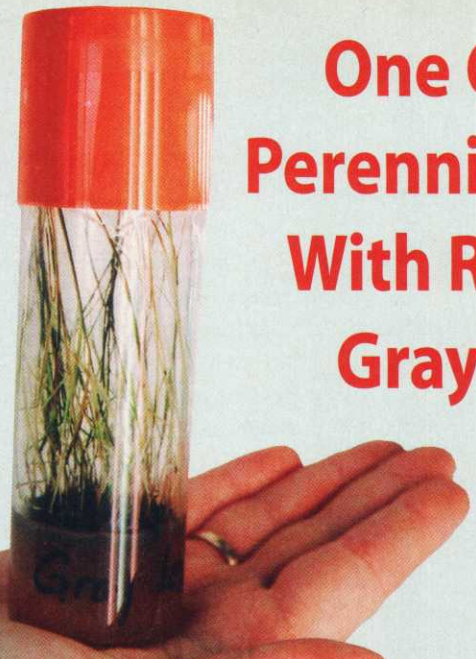

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Paragon GLR™ Perennial Ryegrass

One USGA agronomist says DryJect is an excellent technology to incorporate sand into the upper rootzone. Bob Graunke (right), certified superintendent of Tidewater Golf Club, uses gypsum in the machine to help soften the soil.

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become DryJect from Land Pride, a division of Great Plains Manufacturing. The partners then set out to put theory into practice by fine-tweaking the design to make it more durable and efficient.

"They had the machine and technology, they just couldn't get it to work," van Drumpt says. "Whenever you are dealing with a machine that uses water, it is tricky business. We redesigned it, and we've made it work."

Not only have they made the machine work, they have developed a successful business model that is capturing significant market share along the East Coast. Aware that it would be cost-prohibitive for courses to purchase the maintenance intensive DryJect machines, van Drumpt and des Garennes grow the business by selling franchises. Twenty-four DryJect franchises are sprinkled along the East Coast, the majority in Pennsylvania, New Jersey and Ohio.

"We've also penetrated the Carolinas, and we are starting to go after the Southern California market," van Drumpt says.

Take your best shot

Bob Graunke wasn't hit over the head with the DryJect sales pitch. He did, however, end up having a fateful conversation with a DryJect franchiser at a conference in Orlando, Fla., about using the machine for injecting greens with something other than sand.

"I wanted to know if you could use gypsum in the machines to soften the soil and move water through quickly," says Graunke, certified superintendent at Tidewater Golf Club in Cherry Grove Beach, S.C. "Because of our proximity to the [Atlantic] ocean, that's a big issue for us."

Big enough that Tidewater is on its third set of greens in 15 years. After two unsuccessful attempts at growing bentgrass, Tidewater officials opted for TifEagle bermuda two years ago. The hardy ultradwarf has been a success so far, says Graunke, but a chemical application issue shortly after the installation left him and his staff scrambling for a remedy.

"We were applying a lot of charcoal to combat it so we started to get charcoal buildup," Graunke says.

After the DryJect representative confirmed he could use gypsum as a soil amendment in the machine, Graunke contracted with a South Carolina-based franchise for a test run. After a few weeks, the buildup was virtually eradicated. But Graunke also noticed the late-spring transition from *Poa trivialis* to bermudagrass was smooth.

"In 3 acres of green surface we put down 23 to 25 tons of topdressing," Graunke says. "We are able to run golfers through the course as we are doing it. The beauty of the hydrojet is that once you inject the material you are able to blow off the excess material, water the greens, roll them, and they are ready to putt. We even do it during peak season because we don't have to worry about forfeiting the revenue."

Not forfeiting revenue was also a major concern for Todd Gribling, golf course manager at the Timers at Troy in Elkridge Md. The greens on the Alt Clark/Ken Killian-designed course had started to develop significant amounts of black layer three years ago, despite being only 8 years old at the time. Regular aerification wasn't eliminating the problem, so Gribling contacted a local DryJect franchiser about testing the machine on the chipping green.

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"We were able to get down 10 inches into the green," Gribling says. "With regular aerification we were getting down 6 inches, and we just couldn't get to the black layer. We decided to try it on all 18 greens. Two hours after we did it, the greens were playable. We were able to get down about 9.5 inches on all the greens."

By having playable greens just two hours after the DryJect treatment, Gribling says the course saved around $10,000. And while the black layer has almost been eradicated, Gribling says he will continue to use the DryJect treatment even after it's gone.

"It really firms up our greens because we get the amount of material in there we need, and it is packed with water pressure," he says. "It is good preventative maintenance."

Continue aerification

Both Graunke and Gribling agree that DryJect is not a replacement for routine aerification. Rather, the machine can be used to strengthen the green, apply soil amendments and, in Tidewater's case, ease the transition between cool-season and warm-season grasses. O'Brien believes this is a prudent approach, and he cautions superintendents about looking at DryJect as a complete aerification solution.

"Since it does not remove any organic matter from the rootzone, it is not a substitute for aeration," he says. "It is technology to incorporate sand into the upper rootzone.

"I believe the DryJect technology is more of a topdressing practice and not truly an aeration of the greens," he continues. "The hole made by the sand blasting into the rootzone does provide added air and water movement where it occurs, but it is the sand added into the upper rootzone that dilutes the organic matter that is the major benefit." ■

Shane Sharp is a freelance writer based in Charlotte, N.C.

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TURFGRASS TRENDS

OVERSEEDING

In Search of Transition Dates

Color and quality of annual, perennial ryegrasses compared in Texas overseeding trial

By L.R. Nelson

It's important for superintendents to have a good idea of the transition date and turf quality that they can expect from their cool- and warm-season grass choices. At Texas A&M a study was conducted to compare two new varieties of turf-type annual ryegrass with varieties of perennial ryegrass, chewing fescue and *Poa trivialis* for turf quality, color and transition when overseeded onto a bermudagrass sod.

All entries of cool-season grasses were overseeded onto Texace Bermudagrass on Oct. 21, 2003. The seeding rates are presented in Table 1 on page 68.

Axcella and Panterra were tested at both 10 and 20 pounds per 1,000 square feet. The experiment was watered daily for the next eight days to ensure good germination, and a relatively good stand resulted. Thereafter the study was watered as needed. The test site was fertilized with nitrogen (N), phosphorus pentoxide (P_2O_5) and potassium oxide (K_2O) according to soil test and with nitrogen at 1 pound per 1,000 square feet on a monthly basis. The test was mowed at one-half inch height on a weekly basis. Plot size was 4 x 4 feet, with four replications.

Stands were acceptable, although several entries were rated below 50 percent stand after nine days; however, all entries filled in after about three weeks. Texture of all entries was quite good, and Winterlinks was rated best, followed by the perennials and the annuals.

As early as April 21 transition of Axcella, Panterra and possibly Winterlinks had begun.

For turf color, Brightstar, Citation Fore, and Allstar[2] were rated best for dark green color. Winterlinks, Axcella, and Panterra were rated acceptable but a lighter green color than the perennials in the study.

Turf rating for quality (Table 2) indicated that Axcella, Panterra and Winterlinks had good ratings from December through early April; however, in April their turf quality began to diminish. The perennial varieties had good turf quality throughout the study, even into May. The blend of Brightstar and Shadow II was similar to Brightstar and the other perennials. The lower seeding rate treatments on Axcella and Panterra resulted in a lower turf quality in December and January, and thereafter differences were not apparent.

Transition date of both the cool-season entries and the warm-season sod are shown in Table 3. Note that as early as April 21 transition of Axcella, Panterra and possibly Winterlinks had begun. By mid-May transition was nearing 50 percent, and by May 28 death of the annuals was nearly 100 percent. The perennials resisted transition, and it was very

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TABLE 1

Turf ratings of overseeded turfgrasses for stand, texture and color at Overton, Texas, during the 2003-2004 season.

Entry§	Seeding rate lb/ 1000 ft²	Stand %	Texture Rating 1-9†	Color Ratings 1-9†	
		Oct. 30	Mar. 15	Feb. 16	Apr. 21
Axcella	20	80	5.0	5.8	4.5
Panterra	20	66	5.2	6.0	5.2
Allstar²	16	61	7.5	7.8	7.8
Derby Supreme	16	58	7.2	6.8	6.0
Lh A-00 M146-2-18	18	53	7.5	6.8	6.0
Blazer 4	18	40	7.8	7.8	7.0
Brightstar + Shadow II‡	15	35	7.2	7.8	6.8
Brightstar	15	35	7.2	8.5	7.2
Citation Fore	15	40	7.5	8.2	7.2
Quick Trans	15	45	7.8	7.8	6.8
Winterlinks	7	13	9.0	5.0	5.0
Check	0	0	0.0	0.0	0.0
Axcella	10	50	4.8	6.0	4.8
Panterra	10	40	4.8	6.0	5.0
Mean	—	44	6.6	6.7	6.0
CV	—	31	6.7	7.2	6.4
LSD (0.5)	—	19	0.6	0.7	0.5

† — Texture rating and color ratings were 1-9 where 9 = best.

‡ — Mixture of 75 percent Brightstar and 25 percent Shadow II by weight.

§ — Axcella and Panterra are annual ryegrasses, Allstar², Derby Supreme, Blazer 4, Brightstar, Citation Fore, and Quick Trans are perennial ryegrasses, Winterlinks is a *Poa trivialis*, Shadow II is a chewing fescue, Lh A-00 M146-2-18 is an experimental intermediate ryegrass.

TABLE 2

Turf quality ratings on overseeded turfgrass entries at Overton, Texas, during the 2003-2004 season.

Entry	Turf Rating 0-9† Date of Rating				
	12/22/03	1/13/04	2/16/04	3/15/04	4/04/04
Axcella	8.0	7.8	7.2	5.8	4.8
Panterra	7.8	6.5	7.2	5.0	5.8
Allstar²	7.8	7.0	6.8	6.8	6.2
Derby Supreme	7.2	7.5	6.8	6.8	6.2
Lh A-00 M146-2-18	6.8	7.0	7.5	7.0	6.2
Blazer 4	7.2	7.0	7.5	7.5	7.0
Brightstar + Shadow II	6.5	6.5	6.8	6.2	6.5
Brightstar	6.8	6.8	6.8	6.8	6.8
Citation Fore	7.0	6.5	6.8	6.5	6.8
Quick Trans	5.8	6.5	6.8	6.0	6.2
Winterlinks	5.8	5.8	6.5	5.8	5.8
Check	0.0	0.0	0.0	0.0	0.0
Axcella‡	6.2	7.0	7.0	4.8	5.2
Panterra‡	6.2	6.8	6.8	5.0	5.5
Mean	6.5	6.0	6.5	5.9	5.9
CV	9.4	27.2	12.6	15.1	9.9
LSD (0.5)	0.8	2.4	1.2	1.3	0.8

† — Turf ratings are on a 0-9 scale where 9 = best.

‡ — Seeding rate was one half or 10 pounds per 1,000 feet².

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gradual through June, and about 25 percent of perennial plants remained alive on July 6.

The transition of the warm-season sod indicates a much more rapid green-up after the annuals. Green-up after the perennials occurred much later or was delayed into July. With both annuals and perennials there is a period of time when the bermudagrass sod appearance is diminished. With annuals, this period will normally occur in mid to late May and last about two weeks. With perennials, this period will be in June or later and last for a longer period of time. Environmental conditions such as hot, dry and/or windy conditions will speed up the death of the cool-season grass, while cool, wet growing conditions will delay the death of the cool-season turf.

L.R. Nelson is a professor and ryegrass breeder at the Texas A&M University Agricultural Research and Extension Center at Overton, Texas. He has developed and released annual ryegrass varieties that are suited for either turf or forage purposes but not both, since forage types are not at all suited for turf. Turf varieties are selected for dwarf plant stature, improved color, high tillering and crown rust resistance.

TABLE 3

Transition of cool-season grass from turf in spring of 2004 at Overton, Texas.

Entry	Percent									
	Winter Grass Remaining					Green Bermudagrass in Turf				
	Apr. 21	May 14	May 28	June 10	July 6	Apr. 21	May 14	May 28	June 10	July 6
Axcella	85	41	3	0	0	15	48	85	88	100
Panterra	88	40	2	0	0	13	50	86	93	100
Allstar²	94	90	79	73	35	6	10	21	28	43
Derby Supreme	91	90	81	71	13	9	10	19	29	48
Lh A-00 M146-2-18	94	88	78	66	9	6	13	19	26	63
Blazer 4	90	93	84	76	19	10	8	16	24	55
Brightstar + Shadow II†	90	90	78	75	25	11	10	23	25	53
Brightstar	90	91	76	73	25	10	9	24	28	55
Citation Fore	90	91	78	71	29	10	9	20	29	50
Quik Trans	89	70	65	63	6	11	10	45	38	73
Winterlinks	90	91	13	13	0	10	9	43	48	85
Check	0	0	0	0	0	18	31	86	78	100
Axcella‡	81	44	2	0	0	19	56	90	93	100
Panterra‡	83	48	3	0	0	18	51	90	94	100
Mean	85	73	50	46	13	11	23	48	50	71
CV	4.4	13.0	14.6	24.3	77	33.0	19.5	17	29.6	17.4
LSD (0.5)	5.2	13.4	10.4	15.6	14	5.3	6.2	11	20.2	17.7

† — Brightstar + Shadow is a mixture of 75 percent and 25 percent, respectively, by weight.

‡ — Seeding rate was one half or 10 pounds per 1,000 feet².


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Sulfonylureas Target ALS Enzyme to Control Grasses, Broadleaf Weeds

By Sowmya Mitra

The herbicidal properties of sulfonylureas (SU's) were first reported in 1966 (Koog, 1966). The early SU's were derivatives of triazine herbicides. George Levitt of DuPont noted that SU's having aniline as the aryl group exhibited weak plant-growth regulatory activity while the aminopyrimidine derivative displayed very high biological activity (Levitt, 1983; Sauers and Levitt, 1984).

Soon companies produced SU herbicides having up to 100 times the activity of conventional herbicides, prompting one of the most exciting breakthroughs in the field of herbicide research in several decades (Kearney and Kaufman 1988). All the SU herbicides have a general backbone consisting of an aryl group, a SU bridge and a nitrogen-containing heterocycle. Most of the SU herbicides have low acute oral, dermal and inhalation toxicity in mammals. The acute oral lethal dose (LD_{50}) value of table salt in rats is 3,000 milligram per kilogram while most of the SU herbicides have LD_{50} values greater than 4,000 milligram per kilogram of body weight (Sax Irving, 1979). Most SU's are not mutagenic or teratogenic, and they exhibit low toxicity to fish, wildlife, honeybees and dogs (Kearney and Kaufman, 1988). Low toxicity, combined with very low application rates of the SU's (2 to 35 grams actual ingredient per hectare), makes them especially attractive from an environmental and human health standpoint.

The potential of ground water contamination through seepage, percolation, run-off or infiltration is low.

How do they work?

SU's are potent inhibitors of plant growth, root and shoot growth in sensitive seedlings. Depending on the plant species, dose and environmental conditions, various secondary plant responses often develop. Secondary responses as enhanced anthocyanin formation, loss of leaf nyctinasty, abscission, vein discoloration, terminal bud death, chlorosis and necrosis have been reported (Kearney and Kaufman, 1988). These secondary effects are often slow to develop and sometimes do not occur until a couple of weeks or more following treatment.

A study of the mode of action of SU's was first reported by Ray (1982) and Hatzios and Howe (1982). Concentrations of various SU herbicides as low as 2.8 nM (1 ppb) significantly inhibited root growth, and higher concentrations effectively reduced shoot growth within two to four hours of treatment.

SU herbicides inhibit the activity of an enzyme called acetolactate synthase (ALS), also known as acetohydroxyacid synthase (AHAS), which is a key enzyme in the branched chain amino acid biosynthetic pathway of bacteria, fungi and higher plants. The branched chain amino acid pathway is responsible in producing three essential amino acids, valine, isoleucine and leucine.

All the SU herbicides display unusual "slow-binding" behavior with the enzyme, and this behavior may help explain the efficacy of the herbicides. These herbicides are also called as ALS or AHAS herbicides.

Herbicide selectivity

The differential response of SU herbicides to different plants led to the study of selectivity of these classes of herbicides. Differences in sensitivity to chlorsulfuron of up to 4,000-fold were observed between highly sensitive broadleaf plants, such as mustard, sugar beet, soybean and cotton (Sweetser et. al., 1982).

These large differences in sensitivity could not be explained in terms of differences in penetration or translocation; nor could they be explained by differences in the sensitivities of the ALS enzymes from these plants to chlorsulfuron (Ray, 1984).

Resistance to these herbicides has been developed through a number of different procedures, and the mechanism of resistance is through changes in sensitivity of the enzyme to the herbicides (Stidham, 1991). The herbicides

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Sulfonylureas promise to be a great tool to control sedges, such as those in this photograph from a sod farm in Australia.

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have been reported to be competitive with the amino acids for binding to the enzyme.

Acetolactate synthase inhibiting herbicides bind to the regulatory site on the enzyme (Subramanian et. al., 1991).

In 1987 an SU herbicide-resistant prickly lettuce biotype was identified in a no-till, continuous winter wheat field that had been treated with SU's for five years near Lewiton, Idaho, in April 1987 (Mallory-Smith et. al., 1990).

SU resistance has also been reported in natural populations of kochia [*Kochia scoparia* (L.) Schrad.], Russian thistle (*Salsola iberica*, Sennen and Pau), common chickweed [*Stellaria media* (L.) Vill.] (Thill et. al., 1989), perennial ryegrass (*Lolium perenne* L.) (Smith et. al., 1990) and rigid ryegrass (*Lolium rigidum* Gaudin) (Heap and Knight, 1986). Mallory-Smith et. al., (1990) reported that the SU herbicide resistance trait was controlled by a single nuclear gene.

Applications in turfgrasses

SU's can be used for selective post-emergence control of certain sedges, grasses and broadleaf weeds in warm-season turfgrasses like bermudagrass and zyosiagrass (Yelverton, 2004). These herbicides can also be used as tools in a successful overseeding program.

They can be used on the bermudagrass before overseeding with cool-season turfgrasses like perennial ryegrass or *Poa trivialis* in the fall or can be used during spring transition to remove the cool-season turfgrass in the spring.

Several SU herbicides have been registered for use on golf courses, such as metsulfuron (Manor or Blade), chlorsulfuron (Corsair), foramsulfuron (Revolver), halosulfuron (Manage), rimsulfuron (TranXit GTA), flazasulfuron (Katana), and sulfosulfuron (Certainty). Another new herbicide, bispyribac-sodium (Velocity), has also been introduced which works on the same ALS enzyme.

SU herbicides are translocated via the phloem in the plants to the storage organs like rhizomes, stolons, tubers or bulbs and hence they are very effective in controlling hard-to-control weeds like quackgrass (*Elytrigia repens*) or different sedges.

Herbicides like trifloxysulfuron (Monument) have been reported to control yellow (*Cyperus esculentus*) and purple nutsedge (*C. rotundus*) as well as green kyllinga (*Kyllinga brevifolia*) and false green kyllinga (*K. gracillima*) (Yelverton, 2004).

Sulfosulfuron (Certainty), bispyribac-sodium (Velocity), and trifloxysulfuron (Monument) have been reported to effectively control annual bluegrass in non-overseeded bermudagrass stands.

Benefits of using SU's

These herbicides have very low rates of application, low mammalian toxicity and are very selective in nature. They can be used to control sedges, grasses and broadleaf weeds with single or sequential applications.

Since these herbicides effect the production of essential amino acids, the symptoms develop slowly and the speed at which they control cool-season grasses or weeds during overseeding can vary based on the products and environmental conditions.

Superintendents, sports turf managers, and landscape maintenance managers can use these herbicides as tools to achieve a successful overseeding program or spring transition or control various difficult-to-control weeds.

Some of the SU herbicides absorb very strongly on clay and organic matter under low pH conditions so they are quite safe under slightly acidic conditions. Under alkaline pH conditions these herbicides are desorbed into the soil solution and can be taken up by the turfgrasses leading to injury. The portion of the herbicide present in the soil solution generally causes phytoxicity since it is easily taken up by the turfgrass roots.

Lateral movement or tracking of these herbicides might injure sensitive turf. Turfgrasses grown on coarse textured soils like sandy soils and low organic matter soils are more prone to injury with SU herbicides. Applications should be made to actively growing weeds in order to get optimum weed control since the herbicide

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