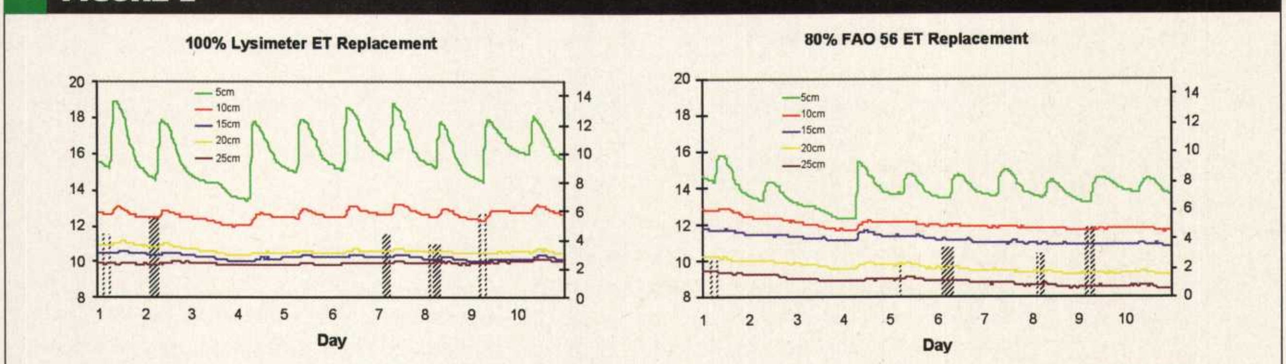
FIGURE 2



Comparison of sensor response at 5-, 10-, 15-, 20- and 25-centimeter depth over a 10-day period for the two treatments in experiment two. Irrigation input shown in background bar graph. Note: Irrigation on day three was cancelled due to high winds and made up on day four.

project indicate that irrigation which replaces 80 percent of estimated ET is sufficient to maintain turf quality. Deficit irrigation has great potential in conserving water resources in areas where rainfall occurs regularly since low irrigation volumes could be used to simply maintain minimum soil moisture levels between rain events which would recharge the rootzone.

One additional point of interest generated by this project is the depth of soil wetting under daily irrigation. The sensor data indicated that under daily irrigation replacement of lysimeter indicated ET loss, the soil is wetted to no deeper than 4 inches. This discovery seems to validate the adage that watering deeply and infrequently results in deeper rooting and uses less water than watering daily. However, keep in mind that, as dictated by their annual lifecycles, the rooting depth of cool-season grasses peaks in the fall and spring and recedes during the summer.

To settle the deep-and-infrequent vs. shallow-and-frequent debate, perhaps the best solution is a compromise: water deep and infrequently during the spring and fall when roots are at their deepest and water daily with smaller volumes during the summer stress periods when roots are most shallow. Any irrigation which goes deeper than the rootzone becomes an infiltration loss and represents wasted water. Know where roots are located.

ET estimation and *in situ* sensing are only two of many technologies being evaluated for water conservation in turfgrass culture. Other advances include but are not limited to:

- progress in plant breeding for low water use and drought tolerance;
- soil management and root zone construction;
- use of effluent, saline, and other non-potable water sources;
- subsurface irrigation;
- technological improvements in water delivery efficiency and uniformity; and
- continued research in deficit irrigation scheduling.

All of the above, along with ET estimation and sensing technology, gives superintendents and turf managers the decision-making criteria and flexibility to respond to the evolving water crisis and make management of turfgrass sustainable and profitable well into the 21st century.

Jon Sass is a master's student at the University of Minnesota, researching water conservation and turf irrigation. He's a former assistant superintendent. Dr. Brian Horgan is an assistant professor and turfgrass extension specialist at Minnesota. His research focus is on nutrient fate, water quality, and water conservation.

Funding and technical support for this project provided by The Toro Company.

REFERENCES

Allen, R.G., L.S. Pereira, D. Raes, and M. Smith. 1998. "Crop evapotranspiration - Guidelines for computing crop water requirements - FAO Irrigation and drainage paper 56. FAO - Food and Agriculture Organization of the United Nations, Rome.

Archambeau, G. 2003. "Dissolved oxygen may impact turf respiration." *Turfgrass Trends* (July).

Aronson, L.J., A.J. Gold, and R.J. Hull. 1987. "Cool-season turfgrass responses to drought stress." *Crop Science* 27 (6):1261-1266.

Bremer, D. 2003. "Soil moisture sensors can help regulate irrigation." *Turfgrass Trends* (June).

Carrow, R.N., P. Broomhall, R.R. Duncan, and C. Waltz. 2002a. "Turfgrass water conservation—part 1: primary strategies." *Golf Course Management* 70(5):49-53.

Carrow, R.N., P. Broomhall, R.R. Duncan, and C. Waltz. 2002b. "Turfgrass water conservation—part 2: strategies and challenges." *Golf Course Management* 70(6):49-53.

SAS Institute. 1998. "System Version 7 for Windows." SAS Institution, Cary, N.C.

Mixing It Up

When it comes to tank mixing sulfonylureas, what you shouldn't do is clear

Scott McElroy and Greg Breeden

New sulfonylurea (SU) herbicides for use in turfgrass systems have revolutionized weed management in turf. Because of these new herbicides, such as Revolver (foramsulfuron), Monument (trifloxysulfuron) and TranXit (rimsulfuron), we now have options for some of our toughest weed control problems.

Weeds normally difficult to control — annual bluegrass (*Poa annua*), clumpy perennial ryegrass (*Lolium perenne*), yellow nutsedge (*Cyperus esculentus*) and *Kyllinga* spp. — can now be easily controlled in bermudagrass and zoysiagrass turf with these herbicides.

But while these herbicides can control many weeds, they are not the panacea that one would hope. For example, many SU herbicides will control some broadleaf weeds, but no one SU herbicide will control all broadleaf weeds. So for complete control of a broad range of broadleaf weeds, you may want to tank mix an SU herbicide with another herbicide to broaden your spectrum of weed control. But can you do this with out any antagonism occurring?

With regard to tank mixing SU herbicides with other herbicides to broaden the spectrum of weed control, we have some definite things we cannot do and there is much we simply do not know about tank mixing them. Let's start with what we know we cannot do.

There is only one definite "Do Not" with respect to tankmixing SU herbicides. Do not tankmix SU herbicides with the two herbicide families that only control grasses, cyclohexandiones and aryloxyphenoxy propionates, also know simply as graminicides (Table 1).

Herbicides in these families include Illoxan (diclofop), Fusilade II (fluazifop), Acclaim Extra (fenoxaprop), Vantage (sethoxydim) and Select (clethodim). There is firm evidence that indicates that tank mixing SU herbicides with graminicides will antagonize the activity of the graminicide. The activity of the SU herbicide will not be antagonized, however, so weeds targeted by the SU herbicide will still be controlled.

One potential problem that could arise would be the potential tank mixing of Monument for sedge control, and Illoxan for goosegrass control. Since Monument is an excellent herbicide for control of almost all sedges, including nutsedges (*Cyperus* spp.) and *Kyllinga* spp., you would observe excellent sedge control. Goosegrass control with Illoxan could be severely decreased, however, because of Monument antagonizing the herbicidal activity of Illoxan.

Continued on page 84

TABLE 1

A list of common sulfonylurea herbicides and graminicides used in turfgrass and landscape systems.

Sulfonylurea Herbicides	Graminicides	
	Cyclohexanedione *(-dims)*	Aryloxyphenoxy propionate *(-fops)*
chlorsulfuron [Corsair]	clethodim [Select]	diclofop [Illoxan]
foramsulfuron [Revolver]	sethoxydim [Vantage]	fenoxaprop [Acclaim Extra]
halosulfuron [Manage]		fluazifop [Fusilade II]
metsulfuron [Manor]		
rimsulfuron [TranXit]		
sulfosulfuron [Certainty]		
trifloxysulfuron [Monument]		

Grub Control & DG Pro

Merit® has been a time-tested insecticide for season-long white grub control in turf.

The Andersons have now combined the proven insecticide Merit with the revolutionary pesticide carrier DG Pro® to offer two unique, proprietary fairway products to the market. The first product is the 14-0-14 w/0.2% Merit, 100% Poly-S and DG Pro. The second product is a 0-0-5 w/0.2% Merit on the DG Pro dispersible carrier. Both of these premium products utilize Potassium Sulfate as the K source.

Merit is most effective in the early instar stages of white grubs, so preventative applications are more effective than curative applications.

*The recommended rate for Merit is 0.3# ai/acre.

Products codes for the above mentioned products are AGC82140.1 and AGCDGMR5. These are also available in 1000 lb. bulk bags.

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Merit

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Definitions of Herbicide Tank Mixture Effects (Vencill 2002)

Additive — An interaction of two herbicides would be considered additive when the observed weed control of the mixture is the combined effect of when the two herbicides are applied separately. Example: Product A and B each control crabgrass 50 percent, but when applied together they control crabgrass 100 percent.

Antagonism — An interaction of two herbicides such that the observed weed control when herbicides are combined is less than the weed control of the herbicides when they are applied separately. Example: Product A and B each control crabgrass 100 percent alone, but when applied together only 20-percent crabgrass control is achieved.

Synergism — An interaction of two herbicides such that the observed weed control when herbicides are combined is greater that the additive affect of the herbicides when they are applied separately. Example: Product A controls crabgrass 10 percent and Product B controls crabgrass 20 percent. When they are combined they control crabgrass 100 percent, instead of an additive affect of 30 percent.

Continued from page 82

Research conducted at the University of Tennessee in 2004 evaluated this potential problem. Treatments included Illoxan at 43.5 fluid ounces an acre, Monument at 0.56 fluid ounces an acre and Revolver at 28 fluid ounces an acre, with Monument and Revolver also being applied in tank mixture with Illoxan.

All treatments were applied twice, with the second application being made two weeks after the first. The first applications were made on Aug. 6. Goosegrass plants were producing seedheads at the time of application and contained from 8 tillers to 12 tillers. Ratings were taken three weeks after the second application.

As expected, Monument antagonized goosegrass control with Illoxan (Figure 1). In this scenario, however, if Monument controlled goosegrass, the antagonism would not be noticed simply because the SU herbicide activity is not disrupted (Burke et al. 2003). This is illustrated by treating goosegrass with a tank-mixture of Revolver and Illoxan. While this tank mixture is equivalent to Revolver or Illoxan alone with respect to goosegrass control, the observed control is most likely attributed to the activity of Revolver on goosegrass as opposed to Illoxan.

This study illustrates the problem with tank-mixing SU herbicides with graminicides. Tank-mixing SU herbicides with other herbicide groups is not as clear-cut however.

FIGURE 1

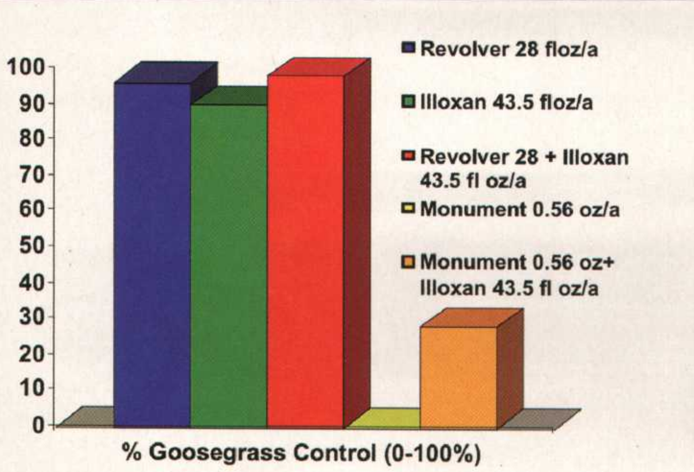

Figure 1. Goosegrass control with Revolver, Illoxan and Monument alone and in tank mixture. All treatments were applied twice with the second application applied two weeks after the first.

Broadleaf herbicides

When determining if you can tank mix SU herbicides with those other than graminicides, our knowledge of what you can and cannot tank mix is a little murkier.

Many SU herbicide labels allow for tank-mixtures with broadleaf herbicides, such as 2,4-D, dicamba, clopyralid and triclopyr to broaden the spectrum of weed control. While there is currently no current research evidence available to suggest that one of these herbicides would be antagonized or would antagonize an SU herbicide, there is little evidence to suggest that antagonism does not occur. And while there have been isolated reports of antagonism from superintendents and other turf managers this year who have used such tank mixtures, there countless others who have not had a problem or who have actually seen potential synergism of tank mixtures.

Other herbicides that are commonly applied in tank mixture with other herbicides are MSMA and Quicksilver (carfentrazone).

FIGURE 2

Goosegrass control with Revolver, Illoxan and a tank mixture of Illoxan + Monument. Note the high density of goosegrass in the treated plots. (Photographs taken one week after the second of two applications of each treatment.)

Again, isolated complaints of MSMA or Quicksilver antagonizing an SU herbicide have surfaced, but there is little evidence to suggest that these herbicide cause SU herbicide antagonism. To evaluate potential antagonism of one of these herbicides with an SU herbicide, a research trial was conducted at the University of Tennessee.

The trial evaluated Revolver, Monument and an unlabeled SU herbicide, flazasulfuron, for control of clumpy tall fescue in bermudagrass turf. Each of these herbicides are known to provide excellent control of tall fescue, however, in our study we applied each alone or in tank-mixture with 2,4-D, MSMA or quicksilver to determine if any of these herbicides antagonize tall fescue control.

In this situation there was no antagonism of any of the SU herbicides. All of the herbicide treatments evaluated controlled tall fescue from 85 percent to 100 percent, regardless if it was applied with one of the tank-mix herbicides or not.

This research was also conducted on tall fescue a second time to confirm the results and also on clumpy perennial ryegrass. In both of these additional cases, no antagonism of the SU herbicides was observed. Does this mean that there is no problem with tank mixing SU herbicides with these particular three herbicides? Not necessarily. There is still much research to be done to evaluate potential problems that may occur.

Final thoughts

New herbicides and other pesticides in the turfgrass market often bring great benefit in solving pest problems that once had few, if any, solutions. With new chemistry usually can come with potential unforeseen problems.

To avoid potential antagonism problems, remember always to consult the herbicide label on proper mixing instructions and tank mix partners.

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REFERENCES

Burke, I.C. and J.W. Wilcut. 2003. Physiological basis for antagonism of clethodim by CGA 362622. Weed Sci. 51:671-677.

Burke, I.C., J.W. Wilcut, and D. Porterfield. 2002. CGA-362622 antagonizes annual grass control with clethodim. Weed Technol. 16:749-754.

Vencill, W.K. 2002. Herbicide Hanbook, 8th Edition. Weed Science Society of America: Lawrence, KS. pp. 493.

Bermudagrass is a widely used turfgrass species because of its desirable color, density and durability.

Drought Tolerance of Six Bermudagrass Cultivars

By C.M. Baldwin, H. Liu, L.B. McCarty, and W.L. Bauerle

Bermudagrass (*Cynodon* spp.), the most widely used warm-season turfgrass in the southern United States, is regarded as a drought-tolerant turf (Plate 1). However, it still requires sufficient water to maintain desirable turf (Turgeon, 2005).

Because of extended drought conditions in the Southeast in past years and concerns of water sources, water allocation for turfgrass irrigation continues to be debated. Therefore, selection of drought stress-tolerant cultivars is becoming an increasingly more important issue in turfgrass management.

Cultural practices to conserve water include proper mowing, fertilization and irrigation regimes. Higher mowed turfgrass allows for a deeper root system leading to a more water efficient turf. Excessive fertilization can adversely affect water uptake and high nitrogen application promotes increased shoot growth at the expense of root growth.

However, iron, manganese, potassium and calcium applications improve drought tolerance by increasing root depth, allowing plant water extraction deep in the soil profile. A best management practice is to irrigate deeply and infrequently for best overall turfgrass quality as drier conditions slow shoot growth and increase root growth and leaf water content (McCarty, 2005).

Turfgrass species have two main mechanisms for surviving drought conditions, including drought avoidance and tolerance (Turgeon, 2005). Drought avoidance mechanisms allow a plant to postpone tissue dehydration when available moisture is low by reducing transpiration (Fry and Huang, 2004). Drought tolerance allows the plant to maintain cell turgor at low water potential (Turgeon, 2005) by allowing an osmotic adjustment to maintain cell turgor and delay leaf wilt (Fry and Huang, 2004). Other turf species, such as buffalograss (*Buchloe dactyloides* (Nutt.) Englem) and tall fescue (*Festuca arundinacea* Schreb.), avoid drought stress by transporting deep soil water upward at night (hydraulic lift) (Fry and Huang, 2004).

Previous research has also reported differences in warm- and cool-season turfgrass drought responses (Karsten and MacAdam, 2001 and Schann et al., 2003). Therefore, the objective of this greenhouse study was to determine the response and drought tolerance of six bermudagrass cultivars to five-, 10- and 15-day irrigation intervals.

A two-year replicated greenhouse study was conducted at Clemson (S.C.) University in 2003 and 2004 to determine the drought tolerance of six selected bermudagrass cultivars (Table 1).

Three water stress treatments consisted of five- , 10- and 15-day irrigation intervals with a watered daily control. After each drought interval (5d, 10d, and 15d), plants were brought back to field capacity. Length of the study was one month and treatments were arranged in a randomized complete block design with four replications. Lysimeter dimensions were 15 centimeters (cm) or 6 inches in diameter and 46 cm (18 inches) in height filled with 10.14 cm (4 inches) of gravel and 30.48 cm (12 inches) of sandy loam topsoil. Soil was collected from the Clemson University athletic practice fields during renovations in May 2000.

Each cultivar was provided a complete fertilizer (16-4-8) at a rate of 48.83 kilograms of nitrogen per hectare every two weeks.

Data collection

Soil volumetric water content was measured in the top 15 cm and recorded daily between 11:30 a.m. and 1:30 p.m. using a ThetaProbe soil moisture sensor (ML2, Delta-T Devices Ltd., Cambridge CB5 OEJ, England).

Turf quality was visually rated from 1 to 9, where 1 = brown, dead turf, 7 = minimal acceptable turf, and 9 = healthy, green turf. Evapotranspiration rates were calculated by weighing each lysimeter every third day between 11:30 a.m. and 1:30 p.m. to determine water loss.

At the end of the study, roots were extracted from the soil and soil removed by washing. Roots were then clipped from the base of the shoot tissue and placed in an oven at 80 degrees Celsius (176 degrees Fahrenheit) and dried for 48 hours. Once dried, samples were weighed for total root biomass.

Data analysis

All statistical computations were conducted using analysis of variance (ANOVA) within the

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TABLE 1

Bermudagrass cultivars selected for a greenhouse study to evaluate drought tolerance.

Species	Propagation	Sponsor	Scientific Name
'SWI-1012'	Seeded	Seeds West, Inc.	*Cynodon dactylon* (L.) Pers. var. *dactylon*)
'Arizona Common'	Seeded	Standard Entry	*Cynodon dactylon* (L.) Pers. var. *dactylon*)
'Tift No. 3'	Vegetative	Wayne Hanna -- USDA-ARS	*C. dactylon* X *C. tans vaalensis*
'Tifsport'	Vegetative	Standard Entry	*C. dactylon* X *C. tansvaalensis*
'Aussie Green'	Vegetative	Greg Norman Turf Co.	*C. dactylon* X *C. tansvaalensis*
'Celebration'	Vegetative	Sod Solutions	*C. dactylon* X *C. tansvaalensis*

TABLE 2

Turfgrass quality of each selected cultivar recorded weekly without drought stress and with five days (5d) of water stress.

	Control					5d				
Turfgrass	Day 1	Week 1	Week 2	Week 3	Week 4	Day 1	Week 1	Week 2	Week 3	Week 4
	Turfgrass Quality (1-9)§									
SWI¶	6.6abc†	6.9bc	7.3a	7.1ab	7.0a	6.3ab	5.8c	6.6ab	6.1a	6.1
AC	5.9c	5.9d	6.4d	6.1c	6.3b	5.3b	5.0c	5.1c	4.9b	5.3
TN3	6.4bc	6.8c	7.0bc	6.9ab	6.8ab	6.5a	6.0bc	5.8bc	5.9b	5.8
TS	6.4bc	6.6c	6.6cd	6.8b	7.1a	6.3ab	6.0bc	6.0bc	6.1a	6.0
AG	7.3a	7.5ab	7.5ab	7.3ab	7.4a	7.1a	6.9ab	7.0a	6.8a	6.5
CN	7.0ab	7.6a	7.8a	7.4a	7.4a	7.1a	7.1a	7.0a	6.8a	6.5
LSD	0.76	0.71	0.55	0.56	0.76	1.03	1.11	0.94	1.19	0.90
p-value	0.01‡	0.01	0.01	0.01	0.03	0.01	0.01	0.01	0.03	0.06

†Values within a column followed by the same letter are not significantly different at P<0.05 by protected LSD.

‡Indicates statistical difference at p=0.05.

§Turfgrass quality based on a scale of 1 - 9, 1 = brown/dead turf, 7 = minimally acceptable turf, 9 = healthy/green turf.

¶Abbreviations: SWI='SWI-1012', AC='Arizona Common', TN3='Tift.No3', TS='Tifsport', AG='Aussie Green', CN='Celebration'.

TABLE 3

Turfgrass quality of each selected cultivar recorded weekly with ten (10d) and 15 days (15d) of water stress.

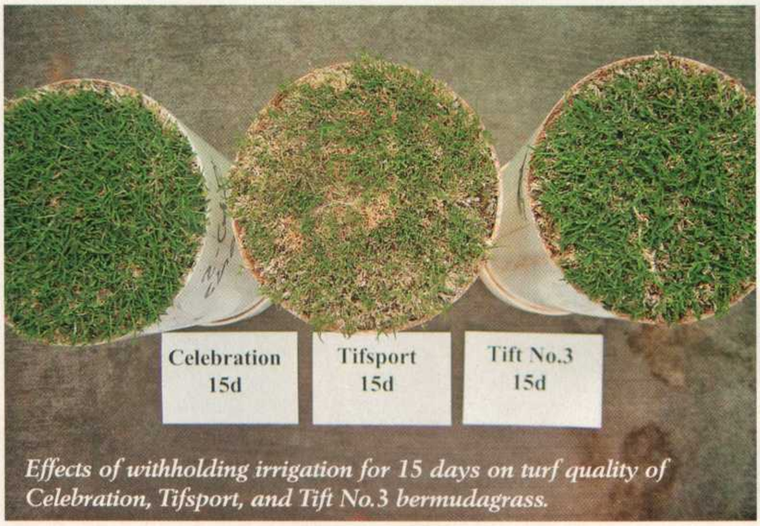
	10d					15d				
Turfgrass	Day 1	Week 1	Week 2	Week 3	Week 4	Day 1	Week 1	Week 2	Week 3	Week 4
	Turfgrass Quality (1-9)§									
SWI¶	6.8abc†	6.3	6.4	5.1	4.8a	6.8ab	6.4ab	5.6a	5.3	3.8
AC	6.1c	5.8	5.0	4.4	3.0b	5.8c	4.8c	4.0b	3.9	2.6
TN3	6.1c	5.6	5.6	5.3	5.1a	6.1bc	5.5abc	5.4a	4.8	4.3
TS	6.3bc	5.9	6.3	5.5	5.6a	6.5abc	5.3bc	4.8ab	4.3	4.4
AG	7.1ab	6.1	6.0	5.5	4.6a	7.3a	6.5a	5.8a	5.3	4.0
CN	7.3a	6.9	6.5	6.0	4.8a	7.1a	6.4ab	5.7a	5.4	3.8
LSD	0.92	1.22	1.11	1.32	1.18	0.81	1.13	1.04	1.21	1.28
p-value	0.05‡	0.36	0.08	0.26	0.01	0.01	0.01	0.01	0.08	0.10

†Values within a column followed by the same letter are not significantly different at P<0.05 by protected LSD.

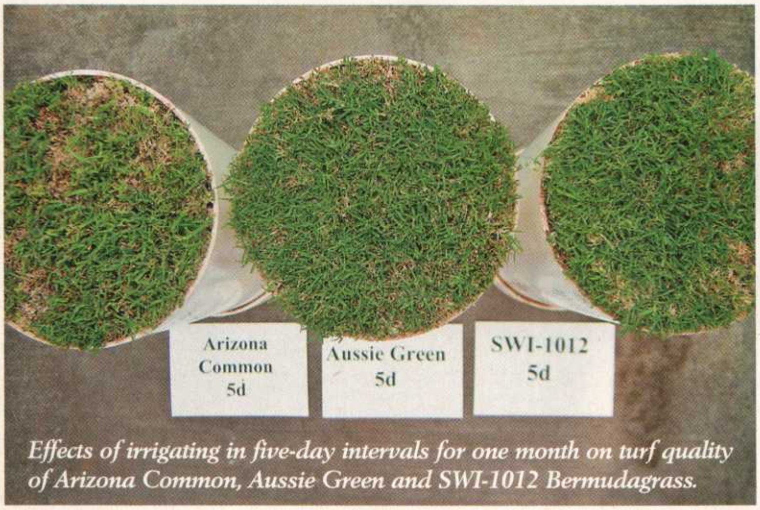
‡Indicates statistical difference at p=0.05.

§Turfgrass quality based on a scale of 1 - 9, 1 = brown/dead turf, 7 = minimally acceptable turf, 9 = healthy/green turf.

¶Abbreviations: SWI='SWI-1012', AC='Arizona Common', TN3='Tift.No3', TS='Tifsport', AG='Aussie Green', CN='Celebration'.

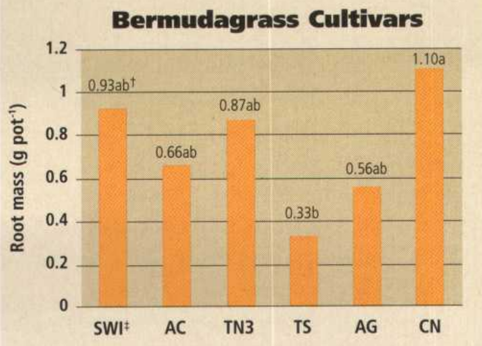


Effects of withholding irrigation for 15 days on turf quality of Celebration, Tifsport, and Tift No.3 bermudagrass.



Effects of irrigating in five-day intervals for one month on turf quality of Arizona Common, Aussie Green and SWI-1012 Bermudagrass.

FIGURE 1

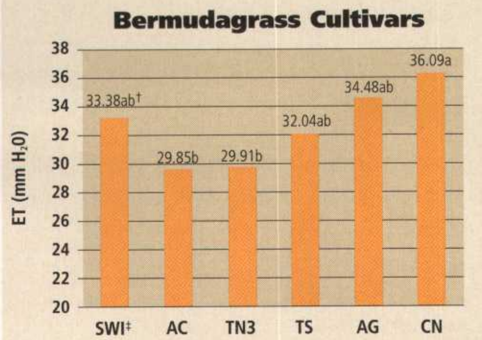


Comparison of six bermudagrass cultivars total root biomass after two fifteen-day (15d) irrigation cycles.

†Mean data points followed by the same letter are not significantly different.

‡Abbreviations: SWI='SWI-1012', AC='Arizona Common', TN3='Tift.No3', TS='Tifsport', AG='Aussie Green', CN='Celebration'.

FIGURE 2



Comparison of six bermudagrass cultivars total evapotranspiration (ET) rates after two fifteen-day (15d) irrigation cycles.

†Mean data points followed by the same letter are not significantly different.

‡Abbreviations: SWI='SWI-1012', AC='Arizona Common', TN3='Tift.No3', TS='Tifsport', AG='Aussie Green', CN='Celebration'.

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Statistical Analysis System (SAS Institute, 1999). Means were separated by Fisher's Least Significant Difference (LSD) test. An alpha of 0.05 was used for all parameters measured.

Tables 2 and 3 list weekly variations in visual total quality (TQ) ratings. When irrigated daily for four weeks, Aussie Green and Celebration maintained a highest quality rating of 7.4. Also, Aussie Green and Celebration were able to maintain an acceptable TQ rating (>7) at week two (five-day treatment) showing 27-percent and 17-percent higher quality ratings compared to Arizona Common and Tift No.3 (Table 2). At the 10-day and 15-day drought intervals, all cultivars saw dramatic reductions in TQ by week one (Table 3).

Previous field studies indicate TQ increases as turf is irrigated in two and four-day intervals rather than daily (Johnson, 2003 and Jordan et al., 2003). Results from this study indicate that irrigating in 10- and 15-day intervals has negative affects on TQ, however, results may differ in a field study as turf could access water deep in the soil profile.

After two 15-day water cycles, Celebration produced 70-percent greater total root biomass than Tifsport (Figure 1). All cultivars receiving daily irrigation produced roots in the top 10.2 cm to 12.7 cm, while cultivars at the 15-day treatment produced roots greater than 30.4 cm (Data not shown). This was expected, as root length and growth increase as water becomes limited. The main function of a root is to intercept water and nutrients and as water decreases, roots continue growing downward in the soil profile in search of water.

Johnson (2003) reported prairie junegrass

(*Koeleria macrantha* (Ledeb.)) root system absorbed water at 30 cm when irrigated in four- to six-day intervals. Bonos and Murphy (1999) also noted an increase in Kentucky bluegrass (*Poa pratensis L.*) cultivar root growth as drought stress was imposed.

Statistical differences were observed for evapotranspiration (ET) rates (Figure 2).

Celebration and Aussie Green had 17-percent and 13-percent greater ET than Arizona Common and Tift No. 3. This data possibly indicates these cultivars undergo a greater osmotic adjustment leading to an enhanced response to drought compared to the other four cultivars. However, further investigation of water potential data is needed to verify this.

Conclusions

Watering turfgrass during extended intervals should proceed with caution as only two cultivars, Aussie Green and Celebration, maintained acceptable turf quality after two weeks at the 5d treatment. As drought stress was imposed longer than the 5d interval, all cultivars quickly declined in turf quality.

Celebration produced superior rooting with a 70-percent increase compared to Tifsport and as drought intervals increased, root depth increased. Also, Celebration had 17-percent greater ET than Arizona Common after two 15-day irrigation cycles.

Future studies should investigate the response of these cultivars to other soil types. Also, screening new cultivars from the National Turfgrass Evaluation Program for drought tolerance may prove beneficial for turfgrass breeders.

Christian Baldwin is a Ph.D. candidate in turfgrass science. Dr. H. Liu is an associate professor and Dr. L.B. McCarty is a professor of horticulture specializing in turfgrass science and management. Dr. W.L. Bauerle is an assistant professor of horticulture specializing in tree stress physiology and terrestrial ecosystem modeling. All are at Clemson (S.C.) University.

REFERENCES

Bonos, S.A. and J.A. Murphy. 1999. Growth responses and performance of Kentucky bluegrass under summer stress. *Crop Sci.* 39:770-774.

Fry, J. and B. Huang. 2004. Applied Turfgrass Science and Physiology. John Wiley and Sons, Inc., Hoboken, NJ. 310p.

Johnson, P.G. 2003. The influence of frequent or infrequent irrigation on turfgrasses in the cool-arid west. USGA Turfgrass and Environmental Research Online 2:1-8.

Jordan, J.E., R.H. White, D.M. Vietor, T.C. Hale, J.C. Thomas, and M.C. Engelke. 2003. Effect of irrigation frequency on turf quality, shoot density, and root length density of five bentgrass cultivars. *Crop Sci.* 43:282-287.

Karsten, H.G. and J.W. MacAdam. 2001. Effect of drought on growth, carbohydrates, and soil water use by perennial ryegrass, tall fescue, and white clover. *Crop Sci.* 41:156-166.

McCarty, L.B. 2005. Best Golf Course Management Practices, 2nd ed. Upper Saddle River, NJ. Prentice-Hall Inc. 868p.

SAS Institute Inc. 1999. SAS Version 8.0. SAS Inst., Cary, NC.

Schaan, C.M., D.A. Devitt, R.L. Morris, and L. Clark. 2003. Cyclic irrigation of turfgrass using a shallow saline aquifer. *Agron J.* 95:660-667.

Turgeon, A.J. 2005. Turfgrass Management, 7th ed. Upper Saddle River, NJ. Prentice- Hall Inc. 415p.

TURFGRASS TRENDS

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The Company Line

PRODUCTS & SERVICES

Wireless POGO soil sensor

Stevens Water Monitoring Systems, a developer and manufacturer of environmental monitoring solutions, introduces the POGO Soil Sensor, a portable device that enables superintendents to spot-check any area of the green for instant data on soil moisture, salinity and temperature for better watering and fertilization management. The POGO sensor sends the information to a detachable PDA or to a laptop using Bluetooth wireless technology, for easy data storage and analysis.

For more information, contact 800-452-5272 or www.stevenswater.com.

GreenCast upgraded

GreenCast (*www.greencastonline.com*), a Web-based technology from Syngenta Professional Products designed to help superintendents more efficiently run their business operations, is now even easier to use, according to Syngenta.

GreenCast users can gain valuable information in a central location that will help them to make more informed agronomic and business decisions. The redesign now provides users with the ability to customize the site to display only the tools and resources they choose for their operations. In addition, the site has new, market-specific pages dedicated to golf so industry professionals can find information relevant to their markets faster.

For more information, contact 866-SYNGENTA or www.syngentaprofessionalproducts.com.

Hybrid triplex greens mower

John Deere Golf & Turf introduces the 2500E Hybrid Tri-Plex Greens Mower, which operates on a traditional engine that drives an alternator which powers electric reel mowers to drive the cutting units.

The design eliminates more than 90 percent of the most likely leak points while also reducing sound levels and increasing fuel efficiency, the company says. Because the 2500E is not dependent on battery power for run time, it can keep the same frequency of clip on every green.

John Deere also offers the 1200 Hydro Bunker and Field Rake, which features the same high standards as the 1200A with the added operational ease offered by a hydrostatic drive system.

For more information, contact 800-537-8233 or www.JohnDeere.com.

Pump station

Rain Bird's new Pump Station is designed to provide superintendents with a completely integrated irrigation system. Rain Bird says its custom-built-to-fit-customer-specifications pump stations integrate with central-control software through the exclusive Smart Pump feature to optimize the entire irrigation cycle, from reservoir to rotor.

The pump stations communicate in real time with Smart Pump, which constantly compares actual flow at the pump station to the expected flow. Any time actual flow differs from the expected flow, Smart Pump automatically reacts to balance the supply and demand between the pump station and irrigation schedule.

For more information, contact www.rainbird.com.

Disposable bedknife

The **Jacobsen** Mag Razor is the industry's first disposable bedknife, according to the company. Jacobsen describes it as a "revolutionary bedbar system that uses ultra-strong magnetic technology to securely hold bedknives to bedbars."

"Like a disposable razor, it cuts like new because each blade is new," according to Jacobsen. "(There's) no sharpening, (and) no tedious work over a grinder."

The MagRazor gives the user the ability to remove the blades with just a pair of gloves.

For more information, contact www.jacobsen.com.

Topdresser

Dakota Peat & Equipment introduces the 414 Turf Tender to its topdresser product line. Built at the request of customers, the 414 features a 4-yard hopper and is designed to spread any type of material needed for turf maintenance or construction. The 414 also features an electrically controlled hydraulic system that allows the operator to control spinner speed and belt speed from the tractor seat.

For more information, contact 800-477-8415 or www.dakotapeat.com.

Insecticide

Arvesta introduces ARENA Insecticide for control of grubs, chinch bugs, webworms and other damaging pests in turf. ARENA also offers suppression of cutworms and mole crickets.

ARENA works through contact and ingestion to stop damaging pests immediately. It also works systemically providing season-long, residual control of some insects, which is important when maintaining healthy turf.

ARENA Insecticide also offers a favorable toxicological profile, making it an idea tool for an insect management program. It's available as a 0.5 percent granular and a 50-percent water dispersible granule.

For more information, contact www.arvesta.com.

Hydro Verti-Drain

Redexim Charterhouse offers a new version of the Verti-Drain

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Labels in Spanish

PBI/Gordon Corp. has added Spanish versions of the labels and MSDS information for its most popular products – SpeedZone, Trimec Classic and Trimec 992 – to its Web site.

"We have long recognized the value the Hispanic workforce is bringing to this industry," said Bill Brocker, vice president of marketing for the company. "With the number of Hispanic workers increasing each year, there is a need to assure that label directions are clear so our products will be used appropriately."

The labels can be accessed at *www.pbigordon.com*. Copies of Spanish labels can also be obtained by calling 800-821-7925.