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## PURPOSE

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# Selective Control Options for Bermudagrass Contamination in Zoysiagrass Turf: A Preliminary Report

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## SUMMARY

Ongoing research at the University of Tennessee is being conducted for selective postemergence bermudagrass control in zoysiagrass turf, weed control during seeded zoysiagrass establishment, and methods for converting bermudagrass fairways to seeded zoysiagrass varieties. Preliminary results to date suggest:

- Fluazifop (Fusilade II) tank-mixed with triclopyr (Turflon Ester)showed a safening affect when compared to fluazifop applied alone at 2- and 4-week intervals.
- Fluazifop alone at 6, 9, 12, and 15 fl. oz./acre on 2-week intervals causes unacceptable cover reduction to 'Compadre' and 'Palisade' zoysiagrass.
- Fluazifop is safe to apply up to 15 fl. oz./acre at 4-week intervals to 'Compadre' and 'Palisade' zoysiagrass when tank-mixed with triclopyr.
- Herbicides applied at zoysiagrass seeding led to poor zoysiagrass germination.
- Fluazifop tank-mixed triclopyr (6 and 12 fl. oz./acre) controlled goosegrass and broadleaf weed pressure, thereby increasing zoysiagrass germination.
- Applying fluazifop tank-mixed with triclopyr (6 fl. oz./acre) at 4 weeks after emergence produced 98% zoysiagrass cover by 10 weeks after emergence.
- Aggressive soil disturbance is needed to establish zoysiagrass from seed in killed bermudagrass areas.
- Establishing seeded zoysiagrass without soil disturbance in killed bermudagrass areas is not recommended.


The Weed Science Society of America defines a weed as any plant that is objectionable or interferes with the activities or welfare of man (11). A more common definition of a weed is simply a plant growing in an unwanted place. This definition holds true when speaking of bermudagrass (*Cynodon dactylon*) contamination in a zoysiagrass (*Zoysia spp.*) turf. It is thought that bermudagrass was first introduced to the Americas in the early 1800s at the ports of Savannah, Georgia as a contaminant in shipping ballasts. Since that time, bermudagrass has found several niches throughout the Southeast. Besides being a popular turfgrass species, it is also one of the most difficult weeds to control in turf and agronomic crops.

Once an area is contaminated, bermudagrass becomes an arduous weed to control due to its aggressive stoloniferous and rhizominous growth habit that can quickly establish itself in bare or weak areas. Bermudagrass contamination can best be observed in the early morning because its leaf blades will retain dew more readily than zoysiagrass (3). Both bermudagrass and zoysia-

Without appropriate weed control, competition from various broadleaf and grassy weeds can quickly overtake the slower establishing zoysiagrass. Weeds in photo include carpetweed, goosegrass, and yellow nutsedge.

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grass are warm-season turfgrasses that respond similarly to herbicide applications. This creates a difficult problem to control one without injuring the other. Nonselective herbicide applications are impractical because they lead to the death of both the weed and desired turf species, requiring the area to be reseeded or resodded. Furthermore, it takes multiple applications of glyphosate (Round-up) to control bermudagrass, which will continue to regrow from its extensive rhizome network and out-compete the slower recovering zoysiagrass (3).

When grown in the proper environment (lower transition zone), bermudagrass makes a wonderful playing surface with many positive attributes. But when grown in the improper environment (mid- to upper transition zone), bermudagrass is a "less than par" turf with several adaptive flaws. Bermudagrass has the lowest cold tolerance of any warm-season grass, often entering an early dormancy when soil temperatures near 50º F (4). Bermudagrass is also susceptible to many diseases that are common to the hot humid days and cool nights of the transition zone (13).

Due to these long standing problems, superintendents in the transition zone have been converting old bermudagrass golf courses to new seeded and vegetative varieties of zoysiagrass. Zoysiagrass is better adapted to the "high and low" extremes of the transition zone due to its cold hardiness, disease resistance, shade tolerance, and low nutrient requirements compared to bermudagrass (1, 4, 12, 13). Historically, zoysiagrass has been overlooked as a fairway turf within the transition zone due to its slow establishment rate from sprigs and the high cost of sod. New vegetative and seeded zoysiagrass varieties are considered equal or superior to the industry standard 'Meyer' zoysiagrass (*Zoysia japonica* Steud.) and are often cheaper and quicker to establish (10).

As the conversion of bermudagrass fairways to zoysiagrass becomes increasingly popular within the transition zone, ongoing research at the University of Tennessee is being conducted for selective postemergence bermudagrass control in zoysiagrass turf, weed control during seeded zoysiagrass establishment, and methods for converting bermudagrass fairways to seeded zoysia-

This photo shows a contaminated area of bermudagrass in a zoysiagrass stand sprayed with one application of fluazifop (15 fl. oz./acre) plus triclopyr (32 fl. oz./acre). Notice the bermudagrass suppression with little to no visible injury to the zoysiagrass.

grass varieties. The information presented in the following are preliminary results from one year of research. All studies will be replicated for a second year data in 2008.

## Objectives

*Objective 1*

*To determine the optimal timing and rate of fluazifop with or without triclopyr to provide bermudagrass control without unacceptable zoysiagrass injury.*

Aryloxyphenoxypropionate (AOPP) herbicides have been used for selective post-emergence control of bermudagrass but were reported injurious to zoysiagrass (3, 5, 7, 8, 9). Recent research had demonstrated that tank-mixing the AOPP herbicide fluazifop (Fusilade II) with triclopyr (Turflon Ester), a synthetic auxin herbicide labeled for broadleaf control, resulted in bermudagrass suppression with minimal zoysiagrass injury (2, 9). We hypothesized that fluazifop tank-mixed with triclopyr could provide increased bermudagrass control with minimal zoysiagrass disturbance.

## Materials and Methods

Timing and rate study of fluazifop alone or tank-mixed with triclopyr was initiated in 2007 on 'Compadre' zoysiagrass (*Zoysia japonica* Steud.) at the University of Tennessee East Tennessee Research and Education Center - Plant Sciences Unit in Knoxville, TN and on 'Palisade' zoysiagrass [*Zoysia japonica* (L.) Merr.] at the Little Course in Franklin, TN. At both locations, plots measured 5' X 10' and were arranged in a randomized complete block design. Herbicide applications were applied at 3 mph with a $CO_2$-pressurized sprayer calibrated at 30 gal./acre. A total of 17 treatments with increasing rates of fluazifop and fluazifop plus triclopyr were applied at either 2- or 4-week intervals.

Trials were visually and digitally rated every two weeks. Digital images were taken every 2 weeks starting at 6 weeks after initiation of treatments. Images for each plot were taken utilizing a 0.28-$m^2$ light box equipped with a digital camera until 16 weeks after initiation. Images were analyzed using Sigma Scan for percent green turf cover, hue, saturation, and brightness value according to published methods. For points of discussion, only percent green cover data from

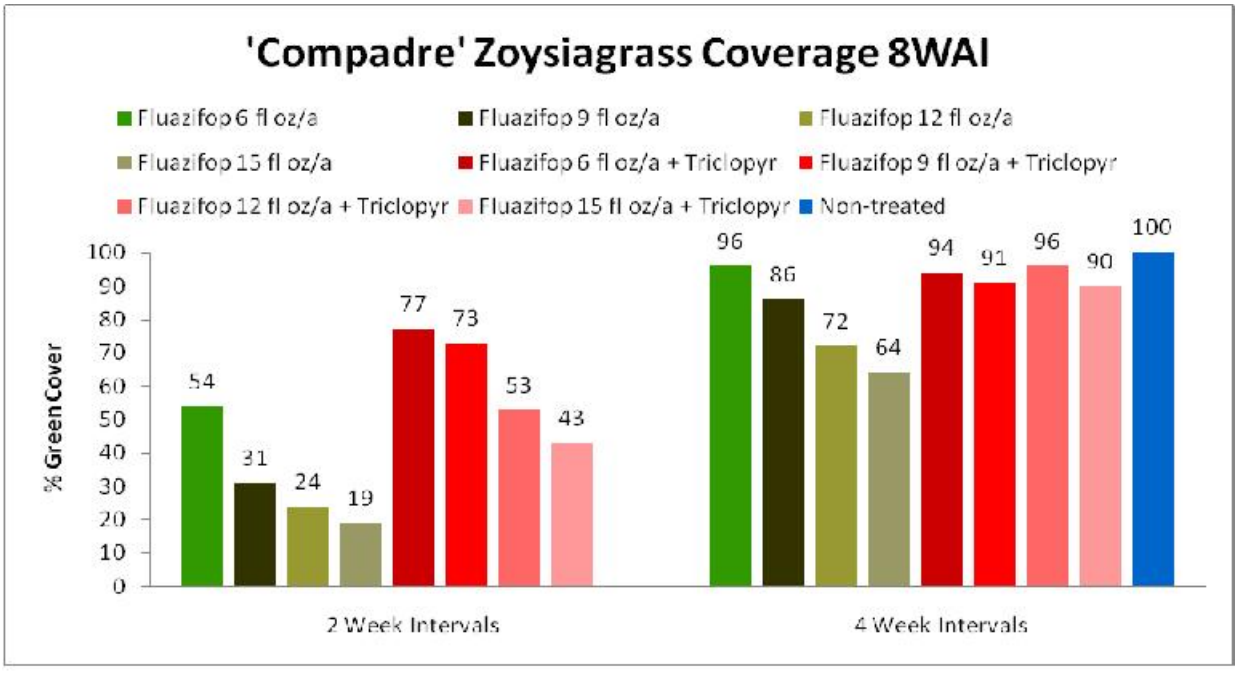


**Figure 1.** 'Compadre' zoysiagrass coverage 8 weeks after initial application

'Compadre' zoysiagrass 8 weeks after initiation will be presented.

## Results

At two-week intervals (0, 2, 4, 6 WAI), all rates of fluazifop alone (6-15 fl. oz./acre) reduced percent zoysiagrass cover to unacceptable levels (< 55% cover). When tank-mixed with triclopyr, a safening affect was observed, but cover was still reduced (<78% cover).

At four-week intervals (0, 4, 8, 12 WAI), fluazifop alone at 6 and 9 fl. oz./acre were safe to apply to zoysiagrass (>85% cover). However, percent zoysiagrass cover was reduced to unacceptable levels (<72% cover) at the higher rates of fluazifop. When tank-mixed with triclopyr, all rates of fluazifop applied at four-week intervals were safe to apply to zoysiagrass without causing significant cover reduction. Percent cover reduction is presented in Figure 1.

The study found that fluazifop tank-mixed with triclopyr showed a safening effect when compared to fluazifop applied alone at 2- and 4-week intervals. Also, fluazifop alone at 6, 9, 12, and 15 fl. oz./acre on 2-week intervals causes unacceptable cover reduction to 'Compadre' zoysiagrass. Finally, we found that fluazifop is safe to apply up to 15 fl. oz./acre at 4-week intervals when tank-mixed with triclopyr.

Trials will be replicated again in 2008 at the Honors Course, Ootlewah, TN on 'Meyer' zoysiagrass (*Zoysia japonica* Steud.), the Atlanta Athletic Club, Duluth, GA on 'Diamond' zoysiagrass [*Zoysia matrella* (L.) Merr.] and 'Zeon' zoysiagrass [*Zoysia matrella* (L.) Merr.], and the University of Tennessee East Tennessee Research and Education Center Plant Sciences Unit, Knoxville, TN on 'Compadre' zoysiagrass (*Zoysia japonica* Steud.). This trial will also be replicated at New Life Turf, Norway, SC on ‘Palisade’ and ‘Diamond’ zoysiagrass.

*Objective 2*

*To evaluate the sensitivity of seeded 'Zenith' zoysiagrass to fluazifop, triclopyr, and fluazifop plus triclopyr at seeding, two, or four weeks after emergence.*

With the increasing use of seeded zoysiagrass varieties, weed control during establishment necessary to yield optimal turf coverage. Competition from various broadleaf and grassy

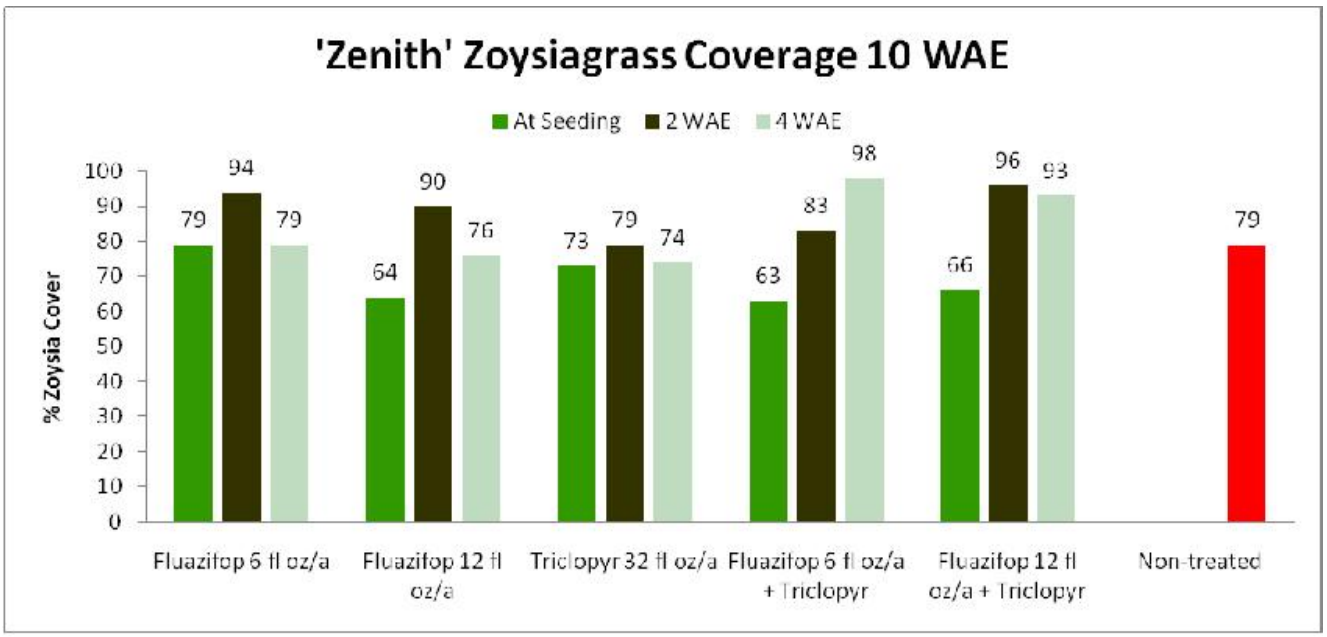


**Figure 2.** 'Zentih' zoysiagrass coverage 10 weeks after emergence

weeds can quickly overtake the slower establishing zoysiagrass. Postemergence applications of fluazifop are effective in controlling grassy weeds, but was reported injurious to emerging zoyisagrass (10). We hypothesized that fluazifop tank-mixed with triclopyr could provide both broadleaf and grassy weed control with minimal zoysiagrass injury.

## Materials and Methods

'Zenith' zoysiagrass (*Zoysia japonica* Steud.) establishment studies for 2007 were conducted at the University of Tennessee East Tennessee Research and Education Center - Plant Sciences Unit in Knoxville, TN on Sequatchie loam soil. Plots were seeded with 'Zenith' zoysiagrass at a rate of 1 lb. seed/1000 $ft^2$ into a tilled bed and a starter fertilizer was applied at 1 lb. N/1000 $ft^2$ per year. Soil pH was 6.2 and organic matter was 2.1% (by weight). Plots were managed at 1-inch mowing height and lowered to 0.5-inch fairway height after seedlings matured. The trial was seeded and initial treatments were applied on May 24, 2007.

Treatments were applied in various rates at seeding, 2, and 4 weeks after emergence. Plots measured 5 X 5 ft. and were arranged in a randomized complete block design. A pre-emergence treatment of turpersan (Siduron) was applied at 12 lbs./acre for crabgrass control. Herbicide applications were applied at 3 mph with a $CO_2$-pressurized sprayer calibrated at 30 gal./acre. A total of 16 treatments with increasing rates of fluazifop, triclopyr, and fluazifop plus triclopyr were applied at seeding, 2, or 4 weeks after emergence.

Trials were visually rated every two weeks. Zoysiagrass injury was rated on a scale of 0-100%. A plot with the rating of 0% would equal no visual injury, while a plot with the rating of 100% would equal complete plant death. Weeds rated for percent control included crabgrass (*Digitaria spp.*), goosegrass (*Eleusine indica*) and carpetweed (*Mollugo verticillata*). Percent cover was rated on 12th week after seeding and grid counts were also taken.

## Results

When applied at seeding, all herbicide treatments caused a decrease in zoysiagrass germination. Control of carpetweed and goosegrass was also unaffected by all herbicide treatments. Crabgrass control was 100% throughout the study from the turpersan pre-emergence treatment.

Ratings one week after the 2-week-after-emergence application indicated no herbicide treatment injured the zoysiagrass seedlings more than 20%. Fluazifop alone (6 and 12 fl. oz./acre) controlled goosegrass (<40%), triclopyr at >50%, and fluazifop plus triclopyr (6 and12 oz./acre) had the greatest control (>70%). Carpetweed was controlled at >70% with triclopyr alone and fluazifop plus triclopyr (6 and 12 fl. oz./acre). Crabgrass control remained 100%.

When plots were visually rated one week after the 4-week-after-emergence application, no herbicide treatment injured the zoysiagrass seedlings more than 20%. Fluazifop alone (6 and 12 fl. oz./acre), triclopyr (32 fl. oz./acre), and fluazifop plus triclopyr controlled goosegrass >75%, while fluazifop plus triclopyr (6 fl. oz./acre) led to more than 80% control. Carpetweed control was more than 90% for all plots due to the lowered mowing heights. Again, crabgrass control remained 100%.

At 10 weeks after emergence, plots were analyzed for percent zoysiagrass cover (Figure 2). For plots that were treated at seeding, fluazifop (12 fl. oz./acre) and fluazifop plus triclopyr (6 and 12 fl. oz./acre) had <70% cover, triclopyr (32 fl. oz./acre) had 73% cover, and fluazifop (6 fl. oz./acre) had 79%. For plots treated 2 weeks after emergence, triclopyr (32 fl. oz./acre) had 79% cover, fluazifop plus triclopyr (6 fl. oz./acre) led to 83%, while fluazifop (6 and 12 fl. oz./acre) had <95% and fluazifop plus triclopyr (12 fl. oz./acre) led to 96% cover. At 4 WAE, both rates of fluazifop and triclopyr had <80% cover whereas fluazifop plus triclopyr (12 fl. oz./acre) led to 93% and fluazifop plus triclopyr (6 fl. oz./acre) had the greatest at 98% cover.

Controlling weed pressure throughout zoysiagrass establishment is necessary for uni-

| Herbicide Treatments and Cultural Practices | Application Description | Product Rate |
|---|---|---|
| Fluazifop | 28 days after emergence followed by treatment every 28 days | 6 fl.oz./acre |
| Fluazifop plus Triclopyr | 28 days after emergence followed by treatment every 28 days | 6 fl.oz./acre plus 32 fl.oz./acre |
| Fluazifop<br>Verticutting | 28 days after emergence followed by treatment every 28 days<br>at seeding | 6 fl.oz./acre<br>¼" depth x 2 directions |
| Fluazifop plus Triclopyr<br>Verticutting | 28 days after emergence followed by treatment every 28 days<br>at seeding | 6 fl.oz./acre plus 32 fl.oz./acre<br>¼" depth x 2 directions |
| Verticutting | at seeding | ¼" depth x 2 directions |
| Dazomet | 21 days prior to seeding | 350 lb./acre |
| Dazomet<br>Fluazifop | 21 days prior to seeding<br>28 days after emergence followed treatment every 28 days | 350 lb./acre<br>6 fl.oz./acre |
| Dazomet<br>Fluazifop plus Triclopyr | 21 days prior to seeding<br>28 days after emergence followed | 350 lb./acre<br>6 fl.oz./acre plus 32 fl.oz./acre |
| Glyphosate | 21 days prior to seeding | 2 qt./acre |
| Glyphosate<br>Fluazifop | 21 days prior to seeding<br>28 days after emergence followed by treatment every 28 days | 2 qt./acre<br>6 fl.oz./acre |
| Glyphosate<br>Fluazifop plus Triclopyr | 21 days prior to seeding<br>28 days after emergence followed by treatment every 28 days | 2 qt./acre<br>6 fl.oz./acreplus 32 fl.oz./acre |
| Glyphosate Strip Kill | 21 days prior to seeding | 2 qt./acre |
| Glyphosate Strip Kill<br>Fluazifop | 21 days prior to seeding<br>28 days after emergence followed by treatment every 28 days | 2 qt./acre<br>6 fl.oz./acre |
| Glyphosate Strip Kill<br>Fluazifop plus Triclopyr | 21 days prior to seeding<br>28 days after emergence followed by treatment every 28 days | 2 qt./acre<br>6 fl.oz./acre plus 32 fl.oz./acre |
| Fluazifop plus Triclopyr<br>Fluazifop | 42 days prior to seeding<br>14 days prior to seeding | 6 fl.oz./acre plus 32 fl.oz./acre<br>6 fl.oz./acre |
| Fluazifop plus Triclopyr<br>Fluazifop plus Triclopyr<br>Fluazifop | 42 days prior to seeding<br>14 days prior to seeding<br>28 days after emergence followed by treatment every 28 days | 6 fl.oz./acre plus 32 fl.oz./acre<br>6 fl.oz./acre plus 32 fl.oz./acre<br>6 fl.oz./acre |
| Fluazifop plus Triclopyr<br>Fluazifop plus Triclopyr<br>Fluazifop plus Triclopyr | 42 days prior to seeding<br>14 days prior to seeding<br>28 days after emergence followed by treatment every 28 days | 6 fl.oz./acre plus 32 fl.oz./acre<br>6 fl.oz./acre plus 32 fl.oz./acre<br>6 fl.oz./acre plus 32 fl.oz./acre |
| Non-treated | ---------- | ---------- |

**Table 1.** Herbicide treatments and cultural practices with related application timings and rates

form coverage, although all herbicide treatments at seeding led to a decrease in zoysiagrass germination. Fluazifop tank-mixed triclopyr (6 and 12 fl. oz./acre) controlled goosegrass and broadleaf weed pressure, thereby increasing zoysiagrass germination. Applying fluazifop tank-mixed with triclopyr (6 fl. oz./acre) at 4 weeks after emergence produced 98% zoysiagrass cover by 10 weeks after emergence.

This trial will be replicated in 2008 at the University of Tennessee East Tennessee Research and Education Center - Plant Sciences Unit in Knoxville, TN. Herbicide rates and applications timings will be the same as those for 2007.

*Objective 3*

*To evaluate cultural and chemical applications to determine the best low-impact fairway renovation strategy for converting bermudagrass to seeded 'Zenith' zoysiagrass (Zoysia japonica Steud.).*

Renovating golf course fairways is not a task taken lightly, especially when converting from an existing stand of bermudagrass. Research has been done to show various methods for successful conversion of cool-season turf to bermudagrass (6). However, no published research has presented a solution for a low-tillage conversion of bermudagrass to seeded varieties of zoysiagrass. We hypothesized that applying fluazifop tank-mixed with triclopyr prior to zoysiagrass seeding and after zoysiagrass emergence could provide substantial bermudagrass suppression and weed control for increased zoysiagrass establishment.

## Materials and Methods

Fairway renovation study was initiated in 2007 on common bermudagrass (*Cynodon dactylon*) at the University of Tennessee East Tennessee Research and Education Center - Plant Sciences Unit in Knoxville, TN and on 'Tifway 419' bermudagrass (*Cynodon dactylon* x *C. transvaalensis*) at the West Tennessee Research and Education Center in Jackson, TN. At both locations, plot units measured 5 X 10 ft. and were arranged in a randomized complete block design. Plots were seeded with 'Zenith' zoysiagrass (*Zoysia japonica* Steud.) at a rate of 1 lb. seed/1000 $ft^2$.

Prior to seeding, the existing bermudagrass fairway was managed to the specifications of a zoysiagrass fairway in the transition zone. Nitrogen rates were lowered to 1 lb. N/1000 $ft^2$ and irrigation was used sparingly. Herbicide applications were applied at 3 mph with a $CO_2$-pressurized sprayer calibrated at 30 gal./acre. A total of 18 treatments with and without cultural practices were applied. Herbicide treatments, rates, and cultural practices are listed in Table 1.

Trials were visually rated every two weeks. Bermudagrass suppression was rated on a scale of 0-100%. A plot with the rating of 0% would equal no visual injury, while a plot with the rating of 100% would equal complete plant death. After seeding, zoysiagrass cover and injury would be rated on a scale of 0-100%. Bermudagrass and zoysiagrass cover will be subject to grid counts. Digital imaging will also be taken to determine percent green cover throughout the study. Visual, grid, and digital ratings will continue until the zoysiagrass becomes dormant.

## Results

All herbicide treatments and soil sterilants applied prior to seeding led to >90% bermudagrass suppression. No zoysiagrass germination was reported at either site locations in any treatment area. Bermudagrass recovered more quickly than the slower-establishing zoysiagrass. Aggressive soil disturbance is needed to establish zoysiagrass from seed in killed bermudagrass areas. Establishing seeded zoysiagrass without soil disturbance in killed bermudagrass areas is not recommended.

This trial will be repeated in 2008 at the University of Tennessee East Tennessee Research and Education Center - Plant Sciences Unit in Knoxville, TN. The herbicide treatments will

remain the same as those in 2007. In addition, several verticutting and aeration treatments will be included to more aggressively disturb the soil surface in an effort to improve establishment.


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## Literature Cited


1. Beard, J. B. 1973. Turfgrass: science and culture. Prentice Hall Inc., Englewood Cliffs, NJ. (TGIF Record 294)

2. Bell, G .E., D. L. Martin, R. M. Kuzmic, M. L. Stone, and J. B. Solie. 2000. Herbicide tolerance of two cold-resistant bermudagrass (*Cynodon spp.*) cultivars determined by visual assessment and vehicle-mounted optical sensing. *Weed Technol.* 14:635-641. (TGIF Record 108918)

3. Boyd, J. 2000. Kill off bermudagrass with one less spraying: Replacing obsolete turf requires freedom from old bermudagrass. *Golf Course Management* 68(5):68-71. (TGIF Record 64769)

4. Christians, N. E. 2004. Fundamentals of turfgrass management. 2nd edition. John Wiley & Sons, Inc. Hoboken, NJ. (TGIF Record 91849)

5. Dernoeden, P. H. 1989. Bermudagrass suppression and zoysiagrass tolerance to fenoxaprop. Pages 285-290. *In* H. Takatoh (ed.). Proceedings of the Sixth International Turfgrass Research Conference. Intl. Turfgrass Soc. and the Japanesese Soc. of Turfgrass Sci. Tokyo. (TGIF Record 17106)

6. Fry, J., R. Taylor, B. Wolf., D. Stuntz, and A. Zuk. 2007. Strip seeding: A new approach for converting cool-season turf to warm-season grasses. *USGA Turfgrass and Environmental Research Online* 6(4):1-6. (TGIF Record 123335)

7. Johnson, B. J., and R.N. Carrow. 1993. Common bermudagrass control in tall fescue with fenoxaprop. *International Turfgrass Society Research Journal* 7:303-309 (TGIF Record 20972)

8. Johnson, B. J. 1992. Common bermudagrass (*Cynodon dactylon*) suppression in *Zoysia spp.* with herbicides. *Weed Technology* 6:813-819. (TGIF Record 29899)

9. McElroy, J. S., and G. K. Breeden. 2006. Triclopyr safens the use of fluazifop and fenoxaprop on zoysiagrass while maintaining bermudagrass suppression. *Applied Turfgrass Science* [online] May 2. pp. 1-5. (TGIF Record 111517)

10. Patton, A. J., Z.J. Reicher, A.J. Zuk, J.D. Fry, M.D. Richardson, and D.W. Williams. 2006. A guide to establishing seeded zoysiagrass in the transition zone. *Applied Turfgrass Science* [online] October 4. pp.1-16. (TGIF Record 116274)

11. Senseman, S. A. (ed.) 2007. Herbicide handbook. 9th Edition. Weed Science Society of America, Lawrence, KS.

12. Turgeon, A. J. 1996. Turfgrass management. 4th edition. Prentice Hall, Upper Saddle River, NJ. (TGIF Record 37186)

13. Vargas, J. M. Jr. 2005. Management of turfgrass diseases. 3rd edition. John Wiley, New York. (TGIF Record 98813)