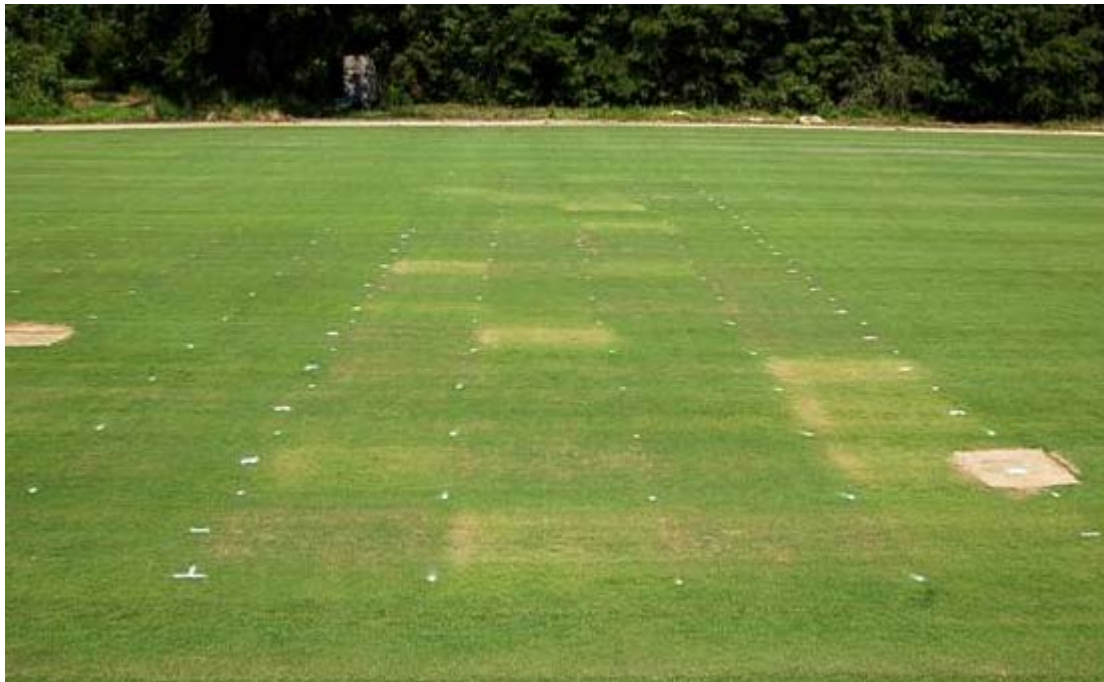




Turfgrass and Environmental Research Online

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Research at the University of Tennessee has been investigating postemergence herbicide applications for selective bermudagrass control in several varieties of zoysiagrass turf. Results indicate 'Tifway' bermudagrass control increases when fluazifop (Trade name: Fusilade II) is tank-mixed with triclopyr (Trade name: Turflon Ester) on 4-week application intervals, and triclopyr safens the application of fluazifop on 'Compadre', 'Meyer', 'Palisades', and 'Zeon' zoysiagrass. Shown above is Diamond zoysiagrass injury at New Life Turf in Norway, SC.

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PURPOSE

The purpose of *USGA Turfgrass and Environmental Research Online* is to effectively communicate the results of research projects funded under USGA's Turfgrass and Environmental Research Program to all who can benefit from such knowledge. Since 1983, the USGA has funded more than 400 projects at a cost of \$34 million. The private, non-profit research program provides funding opportunities to university faculty interested in working on environmental and turf management problems affecting golf courses. The outstanding playing conditions of today's golf courses are a direct result of ***using science to benefit golf***.

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Selective Control Options for Bermudagrass Contamination in Zoysiagrass Turf

Dustin F. Lewis, J. Scott McElroy, John C. Sorochan, and Greg K. Breeden

SUMMARY

Research at the University of Tennessee has been investigating postemergence herbicide applications for selective bermudagrass control in several varieties of zoysiagrass turf. Overall results from this study indicate:

- 'Tifway' bermudagrass control increases when fluzifop (Trade name: Fusilade II) is tank-mixed with triclopyr (Trade name: Turflon Ester) on 4-week application intervals.
- Triclopyr safens the application of fluzifop on 'Compadre', 'Meyer', 'Palisades', and 'Zeon' zoysiagrass.
- Applying fluzifop tank-mixed with triclopyr increases injury and cover reduction to 'Diamond' zoysiagrass compared to fluzifop applied alone.
- Two-week application intervals increase zoysiagrass injury and cover reduction compared to four-week application intervals.

Zoysiagrass (*Zoysia spp.*) and bermudagrass (*Cynodon dactylon* (L.) Pers.) are both used as highly maintained turf on golf course settings throughout the transition zone and southern United States. However, bermudagrass can become a weed once it contaminates an area of zoysiagrass turf. When grown under the identical edaphic and environmental conditions, bermudagrass will commonly outcompete zoysiagrass.

Zoysiagrass can easily be invaded by bermudagrass as many zoysiagrass fairways and tee boxes are surrounded by common or hybrid bermudagrass rough. This situation provides bermudagrass with an easy opportunity to encroach into the fairways from the rough and invade weak or thin zoysiagrass areas. Once

infested, bermudagrass will disrupt zoysiagrass uniformity, most easily seen by variations in morning dew pattern and by entering dormancy earlier than zoysiagrass (12).

There are few effective measures for bermudagrass control in zoysiagrass turf. Physically removing the contaminated area and replacing with sod is only applicable if the infected area is relatively small. Chemically removing bermudagrass takes multiple applications of glyphosate. However, non-selective options are impractical because they result in the death of the weed and desired turf. These large dead areas can actually promote bermudagrass regrowth which



Bermudagrass encroachment from the rough/ intermediate rough into a 'Meyer' zoysiagrass fairway. Notice the dew pattern on the bermudagrass is much more prevalent than on the zoysiagrass.

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Location	City/State	Plant Material	Species	Initiation Date
Atlanta Athletic Club	Duluth, GA	Diamond zoysiagrass	<i>Z. matrella</i>	June 2008
		Zeon zoysiagrass	<i>Z. matrella</i>	June 2008
East Tennessee ERC	Knoxville, TN	Tifway bermudagrass	<i>Cynodon</i> hybrid	May 2007-08
		Compadre zoysiagrass	<i>Z. japonica</i>	May 2007-08
Honors Course	Ooltewah, TN	Meyer zoysiagrass	<i>Z. japonica</i>	June 2008
Little Course	Franklin, TN	Palisades zoysiagrass	<i>Z. japonica</i>	May 2008
New Life Turf	Norway, SC	Diamond zoysiagrass	<i>Z. matrella</i>	June 2008
		Palisades zoysiagrass	<i>Z. japonica</i>	June 2008

Table 1. Experimental locations, plant materials, and initiation dates for research trials.

will reinvade from its extensive rhizomatous network (2). Selective herbicides often fail since both bermudagrass and zoysiagrass are C₄ turfgrasses that react similar to herbicide treatments.

Due to the needs of zoysiagrass managers, the University of Tennessee, Auburn University, and the USGA partnered with turfgrass managers across the Southeast to evaluate selective post-emergence herbicide treatments for bermudagrass

control in various zoysiagrasses. Many products registered for selective bermudagrass control belong to the aryloxyphenoxy-propionate (AOPP) herbicide family. Research has shown that these materials can cause injury to zoysiagrass (3, 4, 7, 6, 10).

Other research has indicated that the AOPP herbicide fluazifop tank-mixed with the synthetic auxin herbicide triclopyr could be safely



Patches of dormant bermudagrass in a 'still-green' 'Meyer' zoysiagrass fairway. Photo credit to David Stone, Superintendent of the Honors Course in Ooltewah, TN.

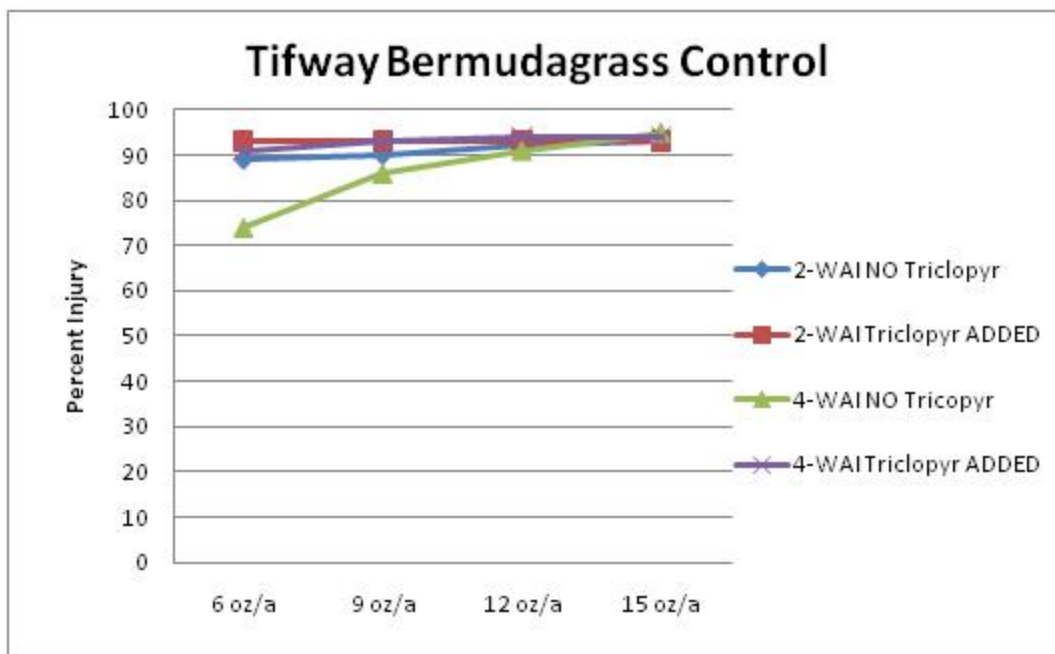


Figure 1. 'Tifway' bermudagrass injury taken 2 weeks after final application.

applied to 'Cavalier' and 'Meyer' zoysiagrass (1, 10). Turfgrasses are known to have differences in herbicide tolerance among cultivars (5, 8); therefore, we tested these products independently and combined across several zoysiagrass varieties.

The objective of this study was to determine the optimal timing and rate of fluzifop (Trade Name: Fusilade II) with or without triclopyr (Trade Name: Turflon Ester) for bermudagrass control in zoysiagrass turf.

Materials and Methods

Research was conducted to evaluate 'Tifway' bermudagrass [*C. dactylon* (L.) Pers. X *C. transvaalensis* Burt-Davy] control and *Zoysia spp.* tolerance to various timings and rates of fluzifop applied alone or tank-mixed with triclopyr. At all locations (Table 1), experimental units were managed and maintained as a golf course fairway. Plots were arranged in a randomized complete

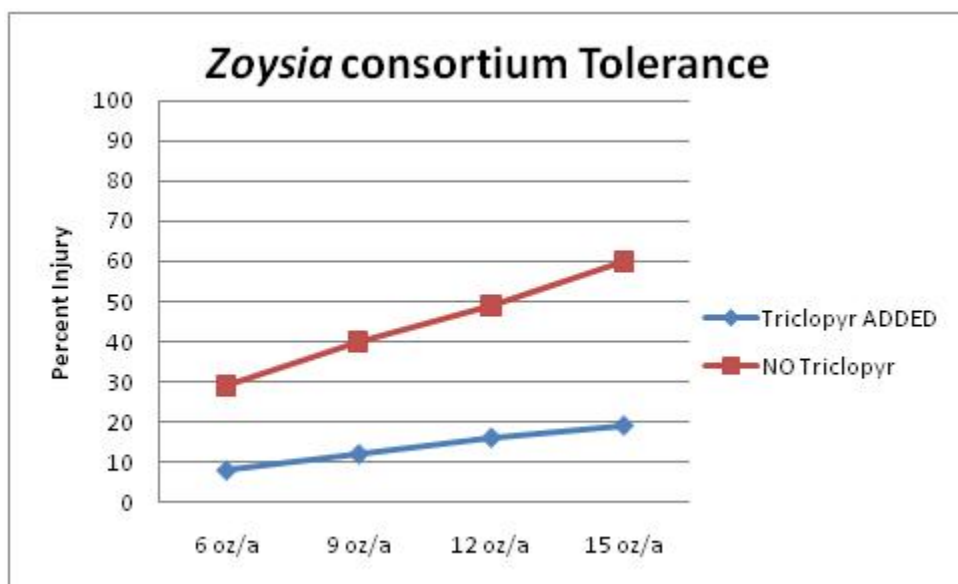


Figure 2. Zoysia consortium tolerance affected by fluzifop rate by triclopyr rate interaction taken two weeks after final application.

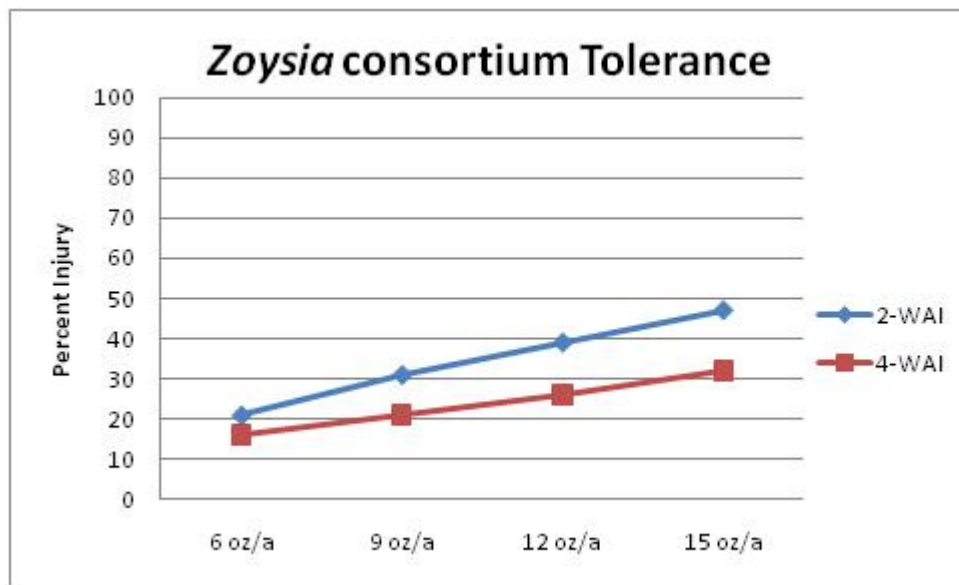


Figure 3. Zoysia consortium tolerance affected by fluazifop rate by application timing interaction taken two weeks after final application.

block design with four replications. Herbicide applications were made with a CO₂ pressurized pesticide applicator equipped with four 11002 XR flat fan TeeJet nozzles calibrated to deliver 30 gallons per acre. All treatments included a non-ionic surfactant (0.25%, v/v).

In order to determine season-long control and tolerance, trials were rated both visual and digitally. Visual assessments were taken two weeks after the initial application (2 WAIA) and continued until two weeks after the final application (2 WAFA). Control and tolerance were rated

on a 0-100% scale (0%= no visible injury; 100% = complete plant death) with greater than or equal to 90% injury considered acceptable bermudagrass control and less than or equal to 20% injury considered acceptable zoysiagrass tolerance. Digital image analysis (DIA) was taken to determine percent zoysiagrass cover using Sigma Scan Pro software (9).

Analysis of variance (P=0.05) was conducted using MIXED model methodology in SAS (12) and analyzed as a randomized complete block design with 4x2x2 factorial (four fluazifop rates by two triclopyr rates x two application tim-

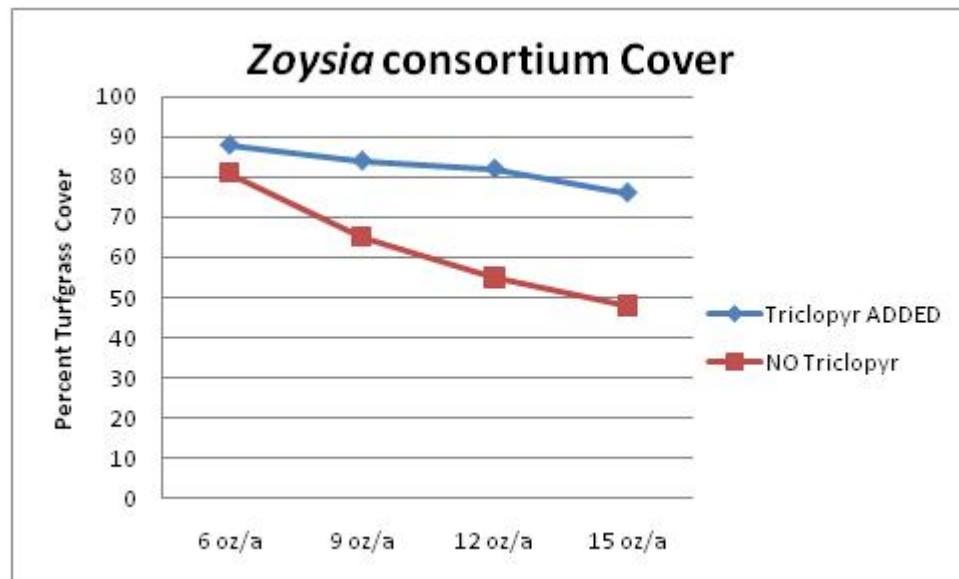


Figure 4. Zoysia consortium cover affected by fluazifop rate by triclopyr rate interaction taken 2 weeks after final application.

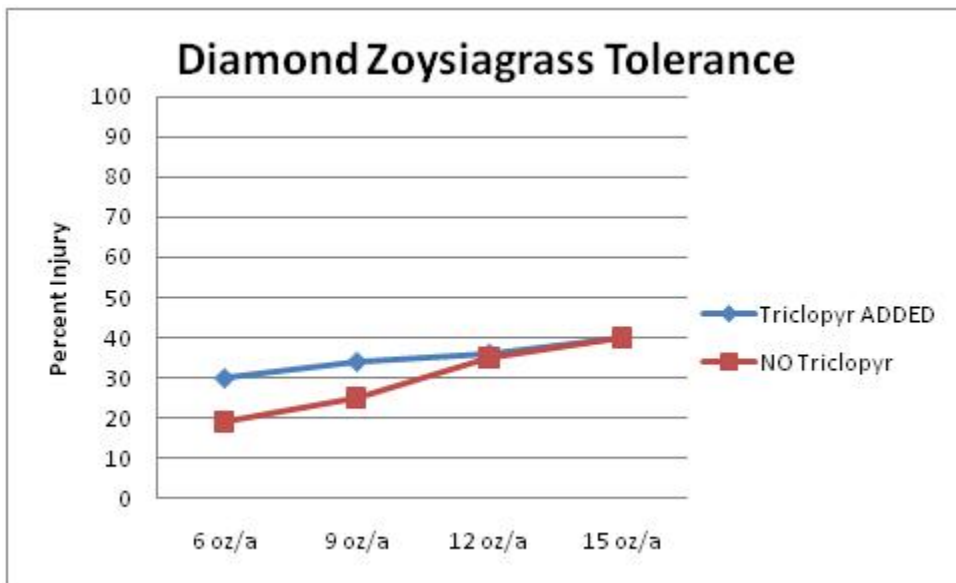


Figure 5. 'Diamond' zoysiagrass tolerance affected by fluazifop rate by triclopyr rate interaction taken two weeks after final application.

ings) arrangement of treatments. During statistical analysis, it was determined that 'Diamond' zoysiagrass responded differently than the other four tested zoysiagrasses, which corresponded to observations made in the field. Therefore, the data was arranged into three distinct groups: 'Tifway' bermudagrass; Zoysia consortium (combined analysis of 'Compadre', 'Meyer', 'Palisades', and 'Zeon' zoysiagrass); and 'Diamond' zoysiagrass. For discussion, only data from 2 WFA will be presented for 'Tifway' bermudagrass, Zoysia consortium, and 'Diamond' zoysiagrass.

Results

'Tifway' Bermudagrass

At two-week application intervals, four sequential applications of fluazifop at 6, 9, 12, and 15 fl oz/a applied alone or tank-mixed with triclopyr controlled bermudagrass (>89%) (Figure 1).

At four-week application intervals, less control was observed with lower fluazifop rates than equivalent rates applied with triclopyr

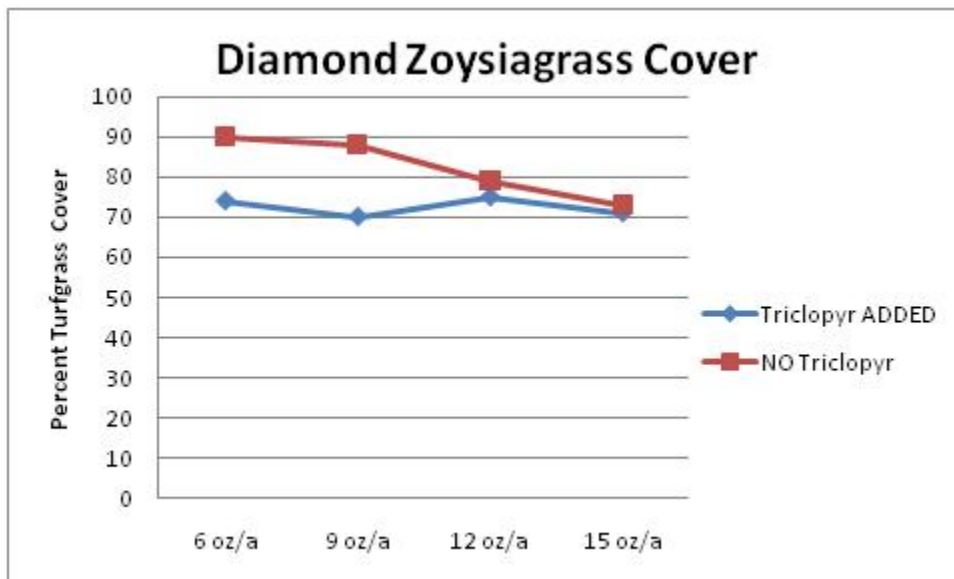


Figure 6. Diamond zoysiagrass cover affected by fluazifop rate by triclopyr rate interaction taken two weeks after final application.

Application Timing	Triclopyr Added	Zoysia Consortium	Diamond Zoysiagrass
	% Injury.....	
2-Week Intervals	NO	48	38
2-Week Intervals	YES	21	37
4-Week Intervals	NO	41	22
4-Week Intervals	YES	7	34

Table 2. Percent injury of zoysia consortium and 'Diamond' zoysiagrass when treated with fluzifop with and without triclopyr at 2- and 4-week intervals. Percent injury was recorded two weeks following final application.

(Figure 1). Four sequential applications of fluzifop at 6 and 9 oz/a controlled bermudagrass 74 and 86%, respectively (Figure 1). Fluzifop at 12 and 15 oz/a rates provided 91 and 95% control, respectively. When tank-mixed with triclopyr, all fluzifop rates controlled bermudagrass greater or equal to 91%.

Zoysia Consortium

Zoysia consortium injury was reduced when all rates of fluzifop were tank-mixed with triclopyr. Triclopyr reduced fluzifop induced Zoysia consortium injury compared to equivalent

rates of fluzifop alone (Figure 2). Fluzifop alone at 6, 9, 12, and 15 oz/a injured zoysia consortium cultivars 29, 40, 49, and 60%, respectively. The addition of triclopyr reduced injury for increasing fluzifop rates to 8, 12, 16, and 19%, respectively.

Zoysia consortium injury increased as fluzifop rates increased and application intervals shortened (Figure 3). At two-week application intervals, fluzifop at 6, 9, 12, and 15 oz/a injured 21, 31, 39, and 47%, respectively. At four week intervals, increasing fluzifop rates injured 16, 21, 26, and 32%, respectively.

At both two- and four-week applications



'Zeon' zoysiagrass injury at the Atlanta Athletic Club in Duluth, GA.

intervals, treatments containing triclopyr reduced zoysia consortium injury (Table 2). Treatments without triclopyr at two- and four-week application intervals injured 48 and 41%, respectively; triclopyr reduced injury to 21 and 7%, respectively.

Digital image analysis of cover revealed fluazifop treatments tank-mixed with triclopyr increased total green turfgrass cover compared to fluazifop alone (Figure 4). Fluazifop alone at 6, 9, 12, and 15 oz/a reduced cover to 81, 65, 55, and 48%, respectively. Increasing fluazifop rates tank-mixed with triclopyr reduced turfgrass cover to 88, 84, 82, and 76%, respectively.

'Diamond' Zoysiagrass

Unlike the zoysia consortium, fluazifop tank-mixed with triclopyr increased 'Diamond' injury (Figure 5). Fluazifop applied alone at 6, 9, 12, and 15 oz/a injured 19, 25, 35, and 40%, respectively. Increasing fluazifop rates tank-mixed with triclopyr increased injury to 30, 34, 36, and 40%.

At both two- and four-week application intervals, treatments containing triclopyr increased 'Diamond' zoysiagrass injury (Table 2). Two- and four-week application intervals without triclopyr injured 38 and 22%, respectively; however, injury increased to 37 and 34% when triclopyr was added.

Digital image analysis showed that tank-mixtures of triclopyr reduced 'Diamond' zoysiagrass cover (Figure 6). Fluazifop alone a 6, 9, 12, and 15 oz/a retained 90, 88, 79, and 73% cover, respectively; however, the addition of triclopyr to the increasing fluazifop rates reduced cover to 74, 70, 75, and 71%, respectively.

Conclusion

These data indicate that sequential applications of fluazifop and triclopyr can provide selective bermudagrass control in many different zoysiagrass varieties. Based on these results, applications of fluazifop at 6 oz/a tank-mixed with triclopyr (32 oz/a) should be applied at 4-week

application intervals for selective bermudagrass control in 'Compadre', 'Meyer', 'Palisades', and 'Zeon' zoysiagrasses.

However, applications of these materials are not recommended for use on 'Diamond' zoysiagrass. Even though acceptable bermudagrass control was achieved in one year, it is advised that applications of fluazifop and triclopyr be made over several growing seasons to ensure that bermudagrass will not regenerate from rhizomes. With any new herbicide application, always be sure set up a small test area before applying on a large-scale basis.

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