Controlling Bermudagrass in Zoysiagrass and Tall Fescue Turf

Subtitle: Research indicates that triclopyr safens the use of fluazifop and fenoxaprop on zoysiagrass and tall fescue turf while maintaining or improving bermudagrass control.

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Key Points:

- Fluazifop (Fusilade II) and fenoxaprop (Acclaim Extra) are two effective products for bermudagrass control in tall fescue and zoysiagrass.
- When applied alone for selective bermudagrass control in established turfgrass, fluazifop, and fenoxaprop can be injurious to tall fescue and zoysiagrass.
- Triclopyr (Turflon Ester) safens the use of fluazifop and fenoxaprop while improving or providing similar bermudagrass control compared to the same products applied alone.

Introduction: Bermudagrass (*Cynodon* spp.) is one of the most difficult to control species in turfgrass systems. Its extensive rhizomes and stolons, tolerance to environmental and management stresses and aggressive nature make it an excellent turfgrass, but also make it difficult to eradicate. Bermudagrass is problematic in warm-season grasses such as zoysiagrass (*Zoysia* spp.), centipedegrass (*Eremochloa ophiuroides*), and St. Augustinegrass (*Stenotaphrum secumdatum*), in addition to cool-season grasses such as tall fescue (*Lolium arundinaceum*), Kentucky bluegrass (*Poa pratensis*), and bentgrass (*Agrostis* spp.). Bermudagrass is especially problematic in zoysiagrass turf because they are both C-4 warm-season grasses with similar herbicide tolerances.

Fenoxaprop and fluazifop have been the primary herbicides evaluated for bermudagrass control in zoysiagrass and tall fescue turf. Four sequential monthly applications of fenoxaprop controlled bermudagrass 97 to 99%, but caused yellowing of Korean zoysiagrass (*Zoysia japonica* Steud.) (4). Others have reported that five sequential applications of fenoxaprop at 0.56 lb/acre controlled bermudagrass up to 80% (6). Fluazifop has been reported to injure and reduce stand quality of 'Emerald' zoysiagrass (*Zoysia japonica* Steud. X *Zoysia tenuifolia* Willd ex. Thiele); however, the turf eventually recovered (5).

Triclopyr has been reported to significantly injure both common bermudagrass and 'hybrid' bermudagrass [*Cynodon dactylon* (L.) Pers. X *C. transvaalensis* Burtt-Davy] when applied at twice the labeled rate (4.3 lb/acre; 1). Multiple applications of triclopyr (0.45 lb/a) or triclopyr + clopyralid (0.45 + 0.56 lb/acre) have been reported to injure bermudagrass $\leq$30%, and seashore paspalum (*Paspalum vaginatum* Swarz.) $\geq$40% (7). Injury is so significant that attempts have been made to use triclopyr to control bermudagrass. Sequential applications of fenoxaprop (0.47 lb/acre) or fenoxaprop + triclopyr (0.47 +1.25 lb/acre) have been reported to decrease bermudagrass ground coverage similarly (2). Multiple applications of triclopyr have also been utilized to control kikuyugrass in perennial ryegrass and Kentucky bluegrass (3).

Research Goal: Evaluate the use of triclopyr in combination with fluazifop and fenoxaprop for bermudagrass suppression in tall fescue and zoysiagrass turf.

Research Justification: Limited information is available regarding triclopyr tank-mixtures with fluazifop or fenoxaprop on tall fescue and zoysiagrass. In addition, fluroxypyr was also evaluated in this research because of its similar chemistry to triclopyr and its recent registration for turfgrass use.

Materials and Methods: Research was conducted to investigate the use of triclopyr as a selective bermudagrass suppression agent when utilized with fenoxaprop and fluazifop in tall fescue and zoysiagrass turf. Research was conducted in 2004 and 2005 at the Little Course at Conner Lane (Little Course), Franklin, TN, and in 2005 at the West Tennessee Research and Education Center (WTREC), Jackson, TN. In total, three zoysiagrass tolerance experiments, two bermudagrass control experiments, and one tall fescue tolerance experiment were conducted. Zoysiagrass tolerance studies at the Little Course were conducted on a 'Meyer' (*Zoysia japonica* Steud) and 'Cavalier' [*Zoysia matrella* (L.) Merr.] zoysiagrass fairways in 2004 and 2005, respectively. Tall fescue tolerance study was conducted at the Little Course on 'Rebel Jr.' tall fescue managed as a golf course rough. Fairways were mowed at a 0.5 in (1.2 cm) height and managed with 1.5 to 2.0 lb N/ 1000 ft^2/ year. Tall fescue rough areas were fertilized once in October at 1.0 lb N/ 1000 ft^2. Golf course fairway area soil at the Little Course was a Maury silt loam (fine, mixed, semiactive, mesic Typic Paleudalf) with pH 6.3 and 0.9% organic matter. Golf course rough area soil at the Little Course was pH 5.8 and 0.8% organic matter. The zoysiagrass tolerance study at WTREC was conducted on 'Meyer' zoysiagrass mowed at ~2 in (~5 cm) height and had not been fertilized or irrigated for the three years prior to research initiation. Soil at WTREC was a Loring silt loam (fine-silty, mixed, active,

thermic Oxyaquic Fragiudalf) with pH 6.4 and 1.1% organic matter. Common bermudagrass control was evaluated in 2004 and 2005 at the Little Course and WTREC, respectively. At both locations, common bermudagrass was mowed at 3 in (~7.5 cm) mowing height, with no fertility or irrigation for the three years prior to research initiation.

Herbicides evaluated were fenoxaprop, fluazifop, fluroxypyr, and triclopyr applied alone and in combination treatments at the rates listed in Table 1. Combination treatments included fenoxaprop + fluroxypyr, fenoxaprop + triclopyr, fluazifop + fluroxypyr, and fluazifop + triclopyr. To reiterate, fluroxypyr is similar in chemistry to triclopyr and was included as a comparison to triclopyr. Treatments were initiated June 14, 2004 and June 6, 2005 at the Little Course, and May 22, 2005 at WTREC. Three applications were made of each herbicide treatment on 28 day intervals. Herbicide applications were made with a CO_2 pressurized spray system calibrated to deliver 30 gal/acre (280 L/ha). The spray boom utilized four flat fan nozzles (Model 8002XR, Spraying Systems Co., Wheaton, Ill.) with 10 in (25 cm) spacing. Plots were not mowed the day before or the day after application. Experiments were arranged in a randomized complete block design with four replicates. Experimental units were 50 ft^2 (4.6 m^2) in size.

Visual ratings of tall fescue and zoysiagrass injury, and bermudagrass suppression were made two weeks after the third herbicide application. Tall fescue and zoysiagrass injury was visually rated for both experiments using a 0 to 100 scale, where 0% equals no visual injury and 100% equals complete plant death. To facilitate discussion, $\geq$20% injury to the treated area was deemed as unacceptable visual injury. Mild phytotoxic

bronzing of the leaf tissue is representative of a 20% injury rating. Bermudagrass control was rated on a similar scale of 0 to 100, where 0% equals no visual phytotoxicity and 100% equals complete plant browning of the aboveground vegetation. The authors wish to point out that while control was rated in these trials, bermudagrass began to regrow in year two due to the discontinuation of treatments. Data were subjected to analysis of variance (P = 0.05). Means were separated using Fisher's Protected LSD (P = 0.05).

Results and Discussion: While injury differences were observed between locations, some similar data trends were observed. Fluazifop + triclopyr injured zoysiagrass less in each experiment than fluazifop alone or fluazifop + fluroxypyr (Table 2; Figure 1). Fluazifop injured zoysiagrass 9 to 38% in each experiment, however no injury from fluazifop + triclopyr was observed in any experiment. Fluazifop + fluroxypyr injured zoysiagrass similar t`o fluazifop alone in each experiment.

Fenoxaprop tank-mixtures with triclopyr or fluroxypyr were similar to the fluazifop treatments (Table 2; Figure 1). Fenoxaprop and fenoxaprop + fluroxypyr injured zoysiagrass greater than fenoxaprop + triclopyr at the Little Course in 2004 and Jackson in 2005. While fenoxaprop and fenoxaprop + fluroxypyr injured zoysiagrass 18 and 16%, respectively, 5% injury from fenoxaprop + triclopyr was statistically equivalent in Jackson in 2005. These data indicate triclopyr safens the use of fenoxaprop on zoysiagrass, but others have reported triclopyr + fenoxaprop applied at similar rates injured perennial ryegrass more than either herbicide applied alone (2). Across experiments, triclopyr and fluroxypyr alone injured zoysiagrass $\leq$10%.

Fluazifop injured tall fescue greater than fluazifop + triclopyr or fluazifop + fluroxypyr (Table 2). Fenoxaprop alone or fenoxaprop + fluroxypyr injured tall fescue minimally. Fenoxaprop + triclopyr injured tall fescue greater than fenoxaprop + fluroxypyr, but less than fenoxaprop alone. This difference is attributed to greater than expected injury from triclopyr alone (11%). Despite the observed injury only fluazifop alone exceeded the allowable injury level of 20%.

While triclopyr reduced fluazifop injury to tall fescue and zoysiagrass, fluazifop, fluazifop + fluroxypyr, and fluazifop + triclopyr controlled bermudagrass 74, 76, and 69%, respectively (Table 3). Fenoxaprop + triclopyr controlled bermudagrass (67%) greater than fenoxaprop or fenoxaprop + fluroxypyr (39 and 35%, respectively). Triclopyr alone controlled bermudagrass (47%) greater than fluroxypyr alone. These data indicate that triclopyr is a necessary component for bermudagrass control with fenoxaprop, but no affect on bermudagrass control was observed when tank-mixed with fluazifop.

Conclusions: While triclopyr is a pyridinyloxyacetic acid herbicide primarily active on dicotyledenous weeds species, it is a beneficial herbicide for suppression of bermudagrass in tall fescue and zoysiagrass turf for two primary reasons. First, triclopyr safens the use of both fenoxaprop and fluazifop on tall fescue and zoysiagrass turf. Secondly, injury or quality reduction of tall fescue or zoysiagrass turf from multiple fenoxaprop or fluazifop applications have been previously reported (4, 5), decreasing the potential use of these herbicides due to intolerance of turfgrass managers to potential phytotoxicity. However, with the addition of triclopyr, injury from fenoxaprop or

fluazifop disappeared or decreased to tolerable levels. Second, multiple applications of triclopyr are phytotoxic to bermudagrass turf, thus improving suppression with fenoxaprop tank-mixtures and fluazifop tank-mixtures maintaining similar levels of suppression to fluazifop alone.

Strategies for bermudagrass control in tall fescue and zoysiagrass

Products label summaries are presented in Table 4. Presented below are potential strategies for selective bermudagrass control. These strategies should be maintained for two years to achieve maximum control. It is imperative that once the management strategy starts, no applications are missed. Delaying an application interval beyond four weeks will allow bermudagrass to recover and will decrease long term control.

- In tall fescue, apply Fusilade II at 6 fl oz/a or Acclaim Extra at 28 fl oz/a plus Turflon Ester at 1 qt/a beginning mid-May. Apply sequential applications every 4 weeks throughout the growing season ending August 15. Reseed tall fescue into the controlled or killed areas. Increase mowing height to $\geq$ 3 inches. Fertilize September 15, November 1, and March 1 with 1 lb/N/ 1000 ft^2 to encourage vigorous tall fescue growth. Do not fertilize tall fescue after April 1 or before September 1.
- In zoysiagrass, apply Fusilade II at 6 fl oz/a or Acclaim Extra at 28 fl oz/a plus Turflon Ester at 1 qt/a beginning mid-May. Apply sequential applications every 4 weeks throughout the growing season ending September 15. Limit N fertility to only maintain desirable green color. Re-seed, sprig or sod zoysiagrass in year two between May 15 and June 15

as needed. Control applications can resume two to three months following reseeding.

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Figure 1. Caption: Tank-mixtures of triclopyr plus fluazifop or fenoxaprop caused less injury to ‘Cavalier’ zoysiagrass when compared to the fluazifop or fenoxaprop applied alone.

Table 1. Active ingredient and product names, along with equivalent active ingredient and product rates utilized in the studies.

Herbicide Active Ingredient	Herbicide Product	Active Ingredient Rate[1]	Product Rate
		lb ai or ae/ acre	oz/acre
fenoxaprop	Acclaim Extra	1.00	28
fluazifop	Fusilade II	0.09	6
fluroxypyr	Spotlight	0.23	20
triclopyr	Turflon Ester	0.12	32

[1]Due to differences in herbicide chemistry, fluroxypyr and triclopyr active ingredient rates are presented in acid equivalents per acre, while fenoxaprop and fluazifop are presented as active ingredient per acre. Abbreviations: ae, acid equivalents; ai, active ingredient.

Table 2. Response of 'Meyer' and 'Cavalier' zoysiagrass cultivars two weeks after three consecutive herbicide treatments.

Herbicide treatment	Rate	'Meyer' Zoysia[1] Little Course 2004		'Meyer' Zoysia[1] Jackson 2005		'Cavalier' Zoysia Little Course 2005		Rebel Jr.' Tall Fescue Little Course 2004	
	lb ai or ae/ acre	% Injury							
fenoxaprop	0.12	38	a	18	ab	42	a	3	c
fluazifop	0.09	9	c	23	a	38	b	29	a
fluroxypyr	0.23	0	d	0	c	0	c	0	c
triclopyr	1.00	1	d	10	abc	0	c	11	bc
fenoxaprop + fluroxypyr	0.12 + 0.23	18	b	16	ab	38	b	0	d
fenoxaprop + triclopyr	0.12 + 1.00	1	d	5	bc	0	c	13	bc
fluazifop + fluroxypyr	0.09 + 0.23	9	c	20	ab	39	ab	16	b
fluazifop + triclopyr	0.09 + 1.00	0	d	0	c	0	c	14	b

[1]Means within columns followed by the same letter are statistically equivalent according to least significant difference means separation (P = 0.05).

Table 3. Common bermudagrass suppression two weeks after three consecutive herbicide treatments.

Herbicide treatment	Rate	Bermudagrass Suppression[1]
	lb ai or ae/ acre	———%———
fenoxaprop	0.12	39 b
fluazifop	0.09	74 a
fluroxypyr	0.23	9 c
triclopyr	1.00	47 b
fenoxaprop + fluroxypyr	0.12 + 0.23	35 b
fenoxaprop + triclopyr	0.12 + 1.00	67 a
fluazifop + fluroxypyr	0.09 + 0.23	76 a
fluazifop + triclopyr	0.09 + 1.00	69 a

[1]Means within columns followed by the same letter are statistically equivalent according to least significant difference means separation (P = 0.05).

Table 4. Label information and limitation for fenoxaprop, fluazifop, and triclopyr products.

Generic name	Product name[1]	Maximum zoysiagrass label rate	Maximum tall fescue label rate	Yearly maximum	Select label comments
fenoxaprop	Acclaim Extra	28 fl oz/a	28 fl oz/a	120 fl oz/a	Applications should only be made when plants are vigorously growing. Avoid applications under conditions of drought stress.
fluazifop	Fusilade II Turf and Ornamental	5 fl oz/a	6 fl oz/a	not available	Add non-ionic surfactant to improve absorption. Droughty conditions can decrease efficacy. Do not reseed for 30 days following application.
triclopyr	Turflon Ester	1 qt/a	1 qt/a	not available	Do not apply more than 2 qt/a per application. Do not apply to golf course greens. Spray drift can injure desirable broadleaf crops

[1] The product names provided are the products evaluated in the aforementioned research. Other formulations and product names may exist but have not been tested for tall fescue and zoysiagrass tolerance or bermudagrass control by the University of Tennessee. Select label comments are restricted to the products listed and do not reflect other potential products that may exist.