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Spring Establishment of Four Warm-Season Turfgrasses After Fall Indaziflam Applications

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Indaziflam is an effective PRE herbicide for annual bluegrass control, but soil residual effects could inhibit spring turf establishment in treated areas. To test this hypothesis, field experiments were conducted to evaluate establishment of bermudagrass, centipedegrass, St. Augustinegrass, and zoysiagrass after fall indaziflam applications. Lateral spread of turfgrasses from plugs in summer generally had no meaningful differences from treatments. However, high indaziflam rates (70 and 140 g ai ha^{-1}) had approximately two-fold more nonrooted stolons than the nontreated control while low rates (17.5 and 35 g ha^{-1}), oxadiazon at 3360 g ai ha^{-1}, and prodiamine at 840 g ai ha^{-1} were similar to the nontreated. Indaziflam at 70 g ha^{-1} and prodiamine applications in fall reduced sprig establishment of the four turf species from the nontreated control, but oxadiazon and low rates of indaziflam were similar. Bermudagrass establishment from seed was significantly reduced (20 to 50%) by indaziflam at 35 to 140 g ha^{-1}, prodiamine, and oxadiazon, on several dates, but the low rate of indaziflam was similar to the nontreated at 10 wk after seeding. Overall, fall indaziflam applications at 17.5 to 35 g ha^{-1} appear safe on vegetative establishment of four warm-season turfgrasses in spring but reseeding bermudagrass in areas treated with rates $>$ 17.5 g ha^{-1} may cause unacceptable delays in growth.
Nomenclature: Bermudagrass, *Cynodon dactylon* x *C. transvaalensis* Burtt-Davy 'Tifway'; centipedegrass, *Eremochloa ophiuroides* (Munro) Hack. 'TifBlair'; St. Augustinegrass, *Stenotaphrum secundatum* (Walter) Kuntze 'Palmetto'; zoysiagrass, *Zoysia matrella* (L.) Merr. 'Jamur'.
Key words: Injury, residual, turfgrass.

Indaziflam es un herbicida PRE efectivo para el control de *Poa annua*, pero los efectos residuales en el suelo en áreas tratadas podrían inhibir el establecimiento del césped en la primavera. Para evaluar esta hipótesis, se realizaron experimentos de campo para evaluar el establecimiento de los céspedes *Cynodon dactylon* x *C. transvaalensis* (bermuda), *Eremochloa ophiuroides* (centipede), *Stenotaphrum secundatum* (St. Augustine), y *Zoysia matrella* (zoysia) después de aplicaciones de indaziflam en el otoño anterior. En el verano, el crecimiento lateral a partir de los estolones sembrados generalmente no tuvo diferencias importantes producto de los tratamientos. Sin embargo, las dosis altas de indaziflam (70 y 140 g ai ha^{-1}) tuvieron aproximadamente dos veces más estolones sin enraizar que el testigo sin tratar, mientras que las dosis bajas (17.5 y 35 g ha^{-1}), oxadiazon a 3360 g ai ha^{-1}, y prodiamine a 840 g ai ha^{-1} fueron similares al testigo sin tratar. Las aplicaciones de indaziflam a 70 g ha^{-1} y prodiamine en el otoño redujeron el establecimiento de los estolones recién sembrados de las cuatro especies de césped en comparación con el control no tratado, pero oxadiazon y las dosis bajas de indaziflam fueron similares. El establecimiento del césped bermuda a partir de semilla fue reducido significativamente (20 a 50%) por indaziflam a 35 y 140 g ha^{-1}, prodiamine, y oxadiazon, en varias fechas, pero la dosis baja de indaziflam fue similar el testigo sin tratar a 10 semanas después de la siembra. En general, las aplicaciones de indaziflam en el otoño a 17.5 a 35 g ha^{-1} parecen seguras para el establecimiento vegetativo en la primavera de cuatro especies de césped de clima cálido, pero el césped bermuda de resiembra en áreas tratadas con dosis $>$17.5 g ha^{-1} podría causar retrasos inaceptables en el crecimiento.

Annual bluegrass (*Poa annua* L.) is a problematic winter annual weed in turfgrass management. Infestations of annual bluegrass reduce turf because of to its light green color, coarser leaf texture, and unsightly seedhead production (Beard et al. 1978). Moreover, annual bluegrass has poor disease, drought, and wear tolerances and decline of populations in spring may predispose turfgrasses to germination of summer annual weeds (Lush 1989). Thus, practitioners often apply PRE herbicides in fall to prevent establishment of annual bluegrass in turfgrass swards.

Indaziflam is an alkylazine herbicide that inhibits cellulose synthesis in susceptible species, and PRE applications may provide effective control of annual bluegrass in warm-season turfgrass species (Brosnan et al. 2012; Perry et al. 2011; Tompkins 2010). Indaziflam has approximately 10 to 15 times lower use rates than most PRE herbicides, but has significant residual activity that may extend duration of annual weed control from fall to spring. Annual bluegrass resistance to dinitroaniline (DNA) herbicides has been reported in turfgrass, and indaziflam offers practitioners a new mode of action for PRE grassy weed control (Isgrigg et al. 2002; Tompkins 2010). Fall PRE applications of indaziflam effectively control annual bluegrass, but early POST activity may provide greater application flexibility than other PRE herbicides (Brosnan et al. 2012; Perry et al. 2011).

Despite potential uses of indaziflam in warm-season turf, residual activity of PRE herbicides in fall may concern practitioners that need to establish turf in treated areas in spring. For example, fall applications of dithiopyr, pendimethalin, and prodiamine have shown to reduce bermudagrass

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and zoysiagrass sprig establishment in spring up to 25% (Fagerness et al. 2002). The researchers noted however that benefin + trifluralin and oryzalin did not inhibit sprig establishment suggesting injurious effects of DNA herbicides in fall could vary across active ingredients. Similar to DNAs, indaziflam could damage roots of immature grasses resulting in failure of warm-season turfgrass to establish in treated areas. Residual effects of indaziflam in soil may concern practitioners who encounter disease, winterkill, or other damage to warm-season turf and research is needed to evaluate turfgrass establishment potential after applications. The objective of this research was to evaluate effects of fall indaziflam applications on spring establishment of (1) four warm-season turfgrasses from plugs; (2) four warm-season turfgrasses from sprigs; and (3) common bermudagrass from seed.

Materials and Methods

Plug Experiments. Experiments were conducted on two separate fields at the University of Georgia in Griffin, GA from 2010 to 2012. Soil was a Cecil sandy clay loam with a pH 6.1 and 2.2% organic matter. Fields were prepared by killing existing vegetation with two applications of glyphosate (Roundup Pro, Monsanto Co., St. Louis, MO 63167) at 6 kg ae ha^{-1} in September of both years. Fields were scalped with a rotary mower and clippings were removed with blowers. Treatments were applied to bareground October 18, 2010 and October 17, 2011 for the first and second experiment, respectively. This application timing in fall was effective for annual bluegrass control in previous research with indaziflam in Griffin, GA (Bronsnan et al. 2012). Treatments included indaziflam (Specticle 20WSP, Bayer Environmental Sciences, Research Triangle Park, NC 27709) at 0, 17.5, 35, 70, or 140 g ai ha^{-1}; oxadiazon (Ronstar Flo 3.2SL, Bayer Environmental Sciences, Research Triangle Park, NC 27709) at 3360 g ai ha^{-1}; and prodiamine (Barricade 65WG, Syngenta Crop Protection Inc., Greensboro, NC 27409) at 840 g ai ha^{-1}. Applications were made with CO_2 pressured sprayers calibrated to deliver 234 L ha^{-1} with a three-nozzle boom and 8004 flat-fan nozzles (Tee Jet, Spraying Systems Co., Roswell, GA 30075). Fields were irrigated to 0.6-cm depth within 24 hours after applications. Fields were sprayed with glyphosate and metsulfuron (Manor 60DF, Nufarm Americas Inc., Burr Ridge, IL 60527) during winter months to control weeds.

Experiment design was a split-plot with four replications. Whole plots were herbicide applications measuring 1.5 by 6-m and subplots, measuring 1.5 by 1.5-m, were four grasses planted from plugs. Plugs measuring 79-cm^2 by 9-cm depth were taken from mature fields of 'Tifway' bermudagrass, 'TifBlair' centipedegrass, 'Palmetto' St. Augustinegrass, and 'Jamur' zoysiagrass on campus grown on the aforementioned soil. Plugs were planted on June 2, 2011 and June 1, 2012 in the first and second experiments, respectively, by removing three plugs of soil from each subplot with similar dimensions to turf samples. The three grass plugs were planted approximately 30 cm apart in each subplot and fields were irrigated as needed to prevent wilting. Broadleaf weeds were controlled as needed with metsulfuron and 2,4-D + dicamba + MCPP (Trimec Classic 2.7SL, PBI Gordon Corp., Kansas City, MO 64101) beginning 4 wk after planting and grassy weeds were removed by hand. Fields were mowed weekly with a rotary mower at a 5.1-cm height with clippings returned.

Plug diameters were measured biweekly by averaging two perpendicular measurements for each plug. Nonrooted stolons were counted 12 wk after planting (WAP) for the three samples per subplot. For each species, data were pooled over three subsamples per plot and subjected to analysis of variance. Significance of main effects, treatments and species, and interactions were determined at the 0.05 probability level. Means were separated with Fisher's Protected LSD test at $\alpha = 0.05$.

Sprig Experiments. Two experiments were conducted on the aforementioned fields in Griffin, GA from October to August in 2010 to 2012. Field preparation, herbicide treatments, application dates, and application equipment used were similar to the plug experiments. Experimental design was a split-plot with four replications. Whole plots measuring 1.5 by 6 m, were given herbicide applications and subplots, measuring 1.5 by 1.5 m, consisted of four grasses planted from plugs. Plugs measuring 79 cm^2 by 9 cm depth were taken from mature fields of 'Tifway' bermudagrass, 'TifBlair' centipedegrass, 'Palmetto' St. Augustinegrass, and of 'Jamur' zoysiagrass, campus grown on the aforementioned soil. Plugs were planted on June 2, 2011 and June 1, 2012 in the first and second experiments, respectively, by removing three plugs of soil from each subplot with similar dimensions to turf samples. The three grass plugs were planted approximately 30 cm apart in each subplot and fields were irrigated as needed to prevent wilting. Broadleaf weeds were controlled as needed with metsulfuron and 2,4-D + dicamba + MCPP (Trimec Classic 2.7SL, PBI Gordon Corp., Kansas City, MO 64101) beginning four weeks after planting and grassy weeds were removed by hand. Fields were mowed weekly with a rotary mower at a 5.1-cm height with clippings returned.

Turfgrass density was visually measured 4, 6, 8, 10, and 12 WAP on a percent scale, where 0 equaled bareground and 100 equaled complete subplot cover for each grass. Significance of main effects, treatments and species, and interactions were determined at the 0.05 probability level. Means were separated with Fisher's Protected LSD test at $\alpha = 0.05$. Year by treatment interactions were not detected and thus years were combined.

Bermudagrass Seed Establishment. Experiments were conducted from October to August in 2010 and 2012 in Griffin, GA. Soil in the first experiment was clay with a pH 5.8 over a native sandy loam. Soil in the second experiment, was a Cecil sandy clay loam with a pH 6.1 and 2.2% organic matter. Fields were prepared by killing existing vegetation with two applications of glyphosate at 6 kg ae ha^{-1} in September of both years. Fields were scalped with a rotary mower and clippings were removed with blowers.

Experimental design was a randomized complete block with four replications of plots measuring 1.5 by 6 m and 1.5 by 2.7 m in the first and second experiment, respectively. Treatments and equipment used were similar to the aforementioned experiments and application dates were

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Table 1. Diameters and production of nonrooted stolons of four warm-season turfgrass species planted by plugs in spring following fall applications of PRE herbicides in two combined field experiments, 2010 to 2012, Griffin, GA.

	Rate	Diameter (2011)			Diameter (2012)			Nonrooted stolons[a]
		4 WAP[c]	8 WAP	12 WAP	4 WAP	8 WAP	12 WAP	12 WAS
	g ai ha^{-1}	cm						# m^{-2}
Herbicide[b]								
indaziflam	17.5	18	39	44	11	38	58	1.0
	35	17	46	53	12	46	68	1.3
	70	17	43	53	12	37	63	2.2
	140	18	40	50	12	44	71	1.6
oxadiazon	3360	18	43	45	14	46	73	0.5
prodiamine	840	19	41	51	12	42	66	1.2
nontreated	0	19	47	49	12	41	67	0.7
$LSD_{0.05}$		2	6	9	NS	9	8	0.8
Species[d]								
Bermudagrass		21	76	91	14	67	90	0.3
Centipedegrass		18	22	29	12	33	66	1.5
St. Augustinegrass		20	40	43	13	48	68	1.9
Zoysiagrass		13	26	30	10	19	37	1.3
$LSD_{0.05}$		2	5	7	1	7	6	0.6

[a] Nonrooted stolons were counted per plot and results are averaged over 2011 and 2012.

[b] Herbicides applied were Specticle 20WSP (indaziflam), Bayer Environmental Sciences, Research Triangle Park, NC 27709; Ronstar Flo 3.2SL (oxadiazon), Bayer Environmental Sciences, Research Triangle Park, NC 27709; Barricade 65WG (prodiamine), Syngenta Crop Protection Inc., Greensboro, NC 27409. Treatments were applied October 18, 2010 and October 17, 2011 for the first and second experiment, respectively.

[c] WAP = weeks after planting. Plugs were planted on June 2, 2011 and June 1, 2012

[d] Grasses planted were 'Tifway' bermudagrass, 'TifBlair' centipedegrass, 'Palmetto' St. Augustinegrass, and 'Jamur' zoysiagrass.

October 21, 2010 and October 17, 2011 in the first and second experiment, respectively. Fields were sprayed with glyphosate, metsulfuron, and 2,4-D + dicamba + MCPP for POST weed control in winter and spring months.

Common bermudagrass ('Mowhawk', Sultan', and 'Sydney' blend, Bermuda Triangle, Pennington Seed Inc., Madison, GA) was seeded on June 14, 2011 and June 1, 2012 in the first and second experiments, respectively. Fields were prepared on the day of seeding with a vertical mower to slice the ground in two directions at a 1.3-cm depth. Bermudagrass was seeded in a 6 : 1 mixture by weight of 5-2-0 (N–P–K) fertilizer (Milorganite, Milwaukee, WI 53204) with a drop spreader calibrated to deliver 49 kg ha^{-1} of seed. Fields were irrigated to promote establishment and mowed weekly after emergence with a rotary mower at a 5.1-cm height with clippings returned.

Bermudagrass cover was measured biweekly from 2 to 12 wk after seeding (WAS), with the exception of 4 WAS in 2012, on a percent scale where 0 equaled no bermudagrass cover and 100 equaled complete plot cover. Data were subjected to analysis of variance at the 0.05 probability level. Means were separated with Fisher's Protected LSD test at $\alpha = 0.05$. Year by treatment interactions were not detected and thus years were combined.

Results and Discussion

Plug Establishment. Treatment by species interaction was not detected for plug diameters, and thus, results are presented by main effect (Table 1). Plug diameters generally increased from 4 to 12 WAP for all grasses but the effects of herbicides were inconsistent over years. In 2011, herbicide treated grasses had similar diameters to the nontreated control at 4 WAP, but indaziflam treatments at 17.5 and 140 g ha^{-1} had measurements reduced 15% at 8 WAP. However, these effects were inconsistent across rates and grasses planted in treated plots had similar diameters to the nontreated control at 12 WAP. In 2012, herbicides did not reduce plug diameters from the nontreated, except indaziflam at 17.5 g ha^{-1} on one date, and there were no meaningful differences detected among other treatments. Reductions in diameter measurements from the low rate of indaziflam appear to have been an anomaly and likely do not have meaningful implications relative to other rates evaluated.

Although plug diameters were generally comparable to the nontreated at 12 WAP in both years, herbicides affected rooting of stolons for all grasses (Table 1). Turf established in areas receiving high indaziflam rates (70 and 140 g ha^{-1}) averaged $\approx$ 2.5 times more nonrooted stolons than the nontreated at 12 WAP. Grasses planted after treatments with lower rates of indaziflam, oxadiazon, and prodiamine were similar to the nontreated control. Centipedegrass and St. Augustinegrass averaged $\approx$ 2 and 4 times more nonrooted stolons than zoysiagrass and bermudagrass, respectively.

Effects of several PRE herbicides have been reported to inhibit rooting and lateral growth of warm-season grasses during vegetative establishment. McCarty et al. (1995) noted dithiopyr, isoxaben, and pendimethalin applications after sod cutting reduced the number of rooted stolons of St. Augustinegrass by 5 to 24%. Bingham (1967) reported DCPA inhibited rooting of bermudagrass from stolon nodes for 12 wk and effects were attributed to herbicide placement depth in soil. However, established root systems of bermudagrass were not affected by treatments suggesting direct contact of juvenile roots on lateral stems have greater potential for

Table 2. Density of four warm-season turfgrasses sprigged in spring following fall applications of PRE herbicides in two combined field experiments, 2010–2012, Griffin, GA.

	Rate	Turfgrass density (WAP)[a]				
		4	6	8	10	12
	g ai ha^{-1}	%				
Herbicide[b]						
indaziflam	17.5	17	28	43	55	62
	35	16	23	41	48	55
	70	13	20	32	39	47
	140	15	19	33	42	52
oxadiazon	3360	17	29	47	48	56
prodiamine	840	12	19	38	41	52
nontreated	0	13	25	41	53	61
$LSD_{0.05}$		NS	NS	11	10	9
Species[c]						
Bermudagrass		42	59	83	94	96
Centipedegrass		5	9	21	30	38
St. Augustinegrass		5	12	18	18	19
Zoysiagrass		6	13	34	44	56
$LSD_{0.05}$		6	7	9	7	8

[a] WAP = weeks after planting.

[b] Herbicides applied were Specticle 20WSP (indaziflam), Bayer Environmental Sciences, Research Triangle Park, NC 27709; Ronstar Flo 3.2SL (oxadiazon), Bayer Environmental Sciences, Research Triangle Park, NC 27709; Barricade 65WG (prodiamine), Syngenta Crop Protection Inc., Greensboro, NC 27409. Treatments were applied October 18, 2010 and October 17, 2011 for the first and second experiment, respectively.

[c] Grasses sprigged were 'Tifway' bermudagrass, 'TifBlair' centipedegrass, 'Palmetto' St. Augustinegrass, and 'Jamur' zoysiagrass.

injury from residual herbicides. In other experiments, Fishel and Coats (1994) noted dithiopyr and prodiamine reduced root weights compared to nontreated bermudagrass plugs, and injury was attributed to malformed roots.

Fall applications of oxadiazon did not inhibit lateral growth or stolon rooting of the four turf species planted from plugs in spring and is similar to previous research. Fry et al. (1986) noted oxadiazon effectively controlled smooth crabgrass (*Digitaria ischaemum* Schreb.) without affecting zoysiagrass establishment from plugs. Solon and Turgeon (1975) noted oxadiazon did not reduce Kentucky bluegrass (*Poa pratensis* L.) establishment from plugs suggesting treatments may be safe and effective for controlling grassy weeds without deleterious effects on turf.

Although PRE herbicides that affect rooting have potential to inhibit plug establishment, application rate and timing will be critical for minimizing lateral root growth inhibition on newly planted turfgrass plugs. Labeled rates of indaziflam (17.5 to 35 g ha^{-1}) do not appear to consistently inhibit lateral spread or rooting of warm-season turfgrasses. However, excessive rates of indaziflam (70 to 140 g ha^{-1}) from overdose or sprayer overlaps in fall could restrict lateral rooting of turf planted in the following spring. Results suggest practitioners may not have a 2 times margin of safety with labeled application rates and thorough soil preparation or herbicide inactivation may be necessary at these rates. Further work is needed to evaluate how cultural practices and fertility could modify the effect of indaziflam on stolon rooting on plugs in spring after fall applications.

Sprig Establishment. Species by herbicide interactions were not detected on any date, and results are presented by main effect (Table 2). Fall herbicide applications generally did not reduce sprig establishment from the nontreated control. Turf density in plots treated with indaziflam at 70 and 140 g ha^{-1} and prodiamine in fall was reduced 10 to 12% at 10 and 12 WAP. Fall applications of oxadiazon and low rates of indaziflam (17.5 and 35 g ha^{-1}) had similar density to the nontreated control on all dates. Bermudagrass had the quickest establishment from sprigs compared to centipedegrass, St. Augustinegrass, and zoysiagrass and final turf density at 12 WAP measured 96, 38, 19, and 56%, respectively.

Researchers have reported potential of PRE herbicides to injure warm-season turfgrass establishment from sprigs. Fagerness et al. (2002) noted fall applications of oxadiazon, benefin + trifluralin, and oryzalin at labeled rates did not inhibit bermudagrass and zoysiagrass sprig establishment, but prodiamine and dithiopyr caused up to 25% growth suppression from the nontreated control. It was also reported that fall applications of pendimethalin inhibited sprig establishment of both species in spring but effects were less substantial than dithiopyr and prodiamine.

Applications of PRE herbicides at appropriate rates and timings can enhance bermudagrass establishment from the nontreated but safety is influenced by herbicide chemistry. Bingham and Hall (1985) noted oxadiazon applications after sprigging 'Tifway' bermudagrass did not inhibit root development from the nontreated during establishment. Similar results with oxadiazon were noted by McCarty and Weinbrecht (1997), but applications of pendimethalin inhibited bermudagrass sprig establishment for 30 wk. Carroll et al. (1996) also reported that oxadiazon enhanced establishment by controlling smooth crabgrass without affecting turf rooting.

Similar to DNAs, indaziflam has potential to inhibit sprig establishment of warm-season turfgrasses but fall applications at rates tested appear to not compromise final establishment in summer. High rates of indaziflam in fall reduced turf density in summer but measurements were similar to the

Table 3. Common bermudagrass cover after seeding in June following fall applications of PRE herbicides in two combined field experiments, 2010–2012, Griffin, GA.

	Rate	Bermudagrass cover (WAS)[a]				
		2	4[c]	6	8	10
	g ai ha^{-1}	%				
Herbicide[b]						
indaziflam	17.5	3	25	59	74	75
	35	5	13	32	54	66
	70	2	4	31	26	33
	140	1	4	15	11	20
oxadiazon	3360	3	11	39	52	66
prodiamine	840	4	10	36	53	64
nontreated	0	9	45	66	82	89
$LSD_{0.05}$		5	15	24	20	22

[a] WAS = week after seeding. Common bermudagrass seeded was a blend of 'Mowhawk', Sultan', and 'Sydney', Bermuda Triangle, Pennington Seed Inc., Madison, GA. Seeding dates were June 14, 2011 and June 4, 2012 in the first and second experiment, respectively.

[b] Herbicides applied were Specticle 20WSP (indaziflam), Bayer Environmental Sciences, Research Triangle Park, NC 27709; Ronstar Flo 3.2SL (oxadiazon), Bayer Environmental Sciences, Research Triangle Park, NC 27709; Barricade 65WG (prodiamine), Syngenta Crop Protection Inc., Greensboro, NC 27409. Application dates were October 21, 2010 and October 17, 2011 in the first and second experiment, respectively.

[c] Ratings presented for 4 wk after seeding are from 2011 only.

nontreated at 12 WAP. Further work is needed to evaluate indaziflam application timing before sprigging to develop recommendations intervals safe for warm-season turf establishment at labeled use rates.

Bermudagrass Seed Establishment. Bermudagrass cover in nontreated control plots increased from 2 to 10 WAP, ranging 9 to 89% (Table 3). Fall applications of indaziflam at 17.5 g ha^{-1} reduced bermudagrass cover at 2 and 4 wk after seeding (WAS) but was similar from 6 to 10 WAS. However, bermudagrass cover was reduced on every evaluation from 2 WAS from indaziflam rates > 17.5 g ha^{-1} and final bermudagrass ground cover ranged 20 to 66% from 35 to 140 g ha^{-1}. Oxadiazon and prodiamine also reduced bermudagrass cover, but were generally comparable to indaziflam at ≤ 35 g ha^{-1} on most dates. Reductions in bermudagrass cover by indaziflam at 70 and 140 g ha^{-1} were greater than oxadiazon and prodiamine at 8 and 10 WAS. Bermudagrass seeded in plots treated with high indaziflam rates (70 and 140 g ha^{-1}) in fall averaged 26% cover at 10 WAS while plots seeded after oxadiazon and prodiamine treatments averaged 65% cover.

Fall applications of all PRE herbicides reduced establishment of spring-seeded bermudagrass except indaziflam at 17.5 g ha^{-1}. Reductions in bermudagrass ground cover were exacerbated by increased rates of indaziflam from 35 to 140 g ha^{-1}, ranging 20 to 50% on most dates. However, fall applications of indaziflam at 35 g ha^{-1} may effectively control annual bluegrass and practitioners could potentially seed bermudagrass if establishment inhibition is acceptable. Applications of PRE herbicides may inhibit turfgrass seed establishment but appropriate reseeding intervals vary by rate, timing, and properties affecting soil residual activity (Bingham and Schmidt 1983; Juska 1961).

Modifications in establishment practices, such as increasing sowing rate, fertilization, cultivar selection, or more intense soil preparation could influence bermudagrass seed establishment and warrant further investigation in spring following fall indaziflam applications. Despite treatments eight months before seeding, indaziflam at rates > 35 g ha^{-1} appear to cause substantial reductions in bermudagrass establishment and may warrant deactivation in soil or delayed planting dates in treated areas.

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