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This publication includes lecture notes of papers presented at the 2019 GREEN EXPO Turf and Landscape Conference. Publication of these lectures provides a readily available source of information covering a wide range of topics and includes technical and popular presentations of importance to the turfgrass industry.

This proceedings also includes research papers that contain original research findings and reviews of selected subjects in turfgrass science. These papers are presented primarily to facilitate the timely dissemination of original turfgrass research for use by the turfgrass industry.

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GLYPHOSATE ALTERNATIVES FOR TALL FESCUE AND WHITE CLOVER CONTROL, 2019

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The objective of this experiment was to evaluate various herbicides for post-emergence tall fescue *(Schedonorus arundinaceus)* and white clover *(Trifolium repens)* control.

MATERIALS AND METHODS

This experiment was conducted at the Rutgers Horticulture Research Farm No. 2 in North Brunswick, NJ on a simulated lawn with a Nixon sandy loam soil. The site was a mature stand of 'Falcon V' tall fescue and white clover. Green cover was 100% at the start of the experiment and the white clover infestation was uniform comprising ~30% of the total green cover. The site was fertilized with 0.75 lbs N/1000 ft^2 on 25 April 2019. No plant protectants or other fertilizers were applied at any time during the experiment. Mowing was suspended from 2 weeks after treatment (WAT) until the conclusion of the trial at 6 WAT to evaluate growth suppression.

Treatments (Table 1) were arranged in a randomized block design and replicated four times. The treatments were applied to 4 by 7-ft plots using a CO_2-powered sprayer calibrated to apply 44 GPA through a single 9504EVS nozzle at 40 PSI on 1 July 2019. A 12-in wide non-treated buffer strip was maintained between each plot providing a 3 by 7-ft treated area.

Tall fescue and white clover control were evaluated visually on a 0 (no injury or control) to 100 (complete control) percent scale relative to the non-treated control. Tall fescue percent growth suppression was evaluated by visually estimating the clipping yield reduction at a 2.5-in height of cut in each plot relative to the non-treated control. Data were analyzed subjected to ANOVA in ARM (v2019) and Fisher's Protected LSD ($p \leq 0.05$) was used to separate means.

RESULTS

Tall Fescue Control

Manuscript applied alone provided more tall fescue control than Fusilade II (hereafter Fusilade) applied alone from 2 to 6 WAT (Table 2). At the conclusion of the experiment 6 WAT, Fusilade provided 58% tall fescue control compared to 94% control provided by Manuscript. Control provided by Manuscript was statistically similar to that provided by Finale and Finale + Reward from 4 to 6 WAT.

Manuscript + dicamba provided similar tall fescue control to Manuscript alone. Fusilade + dicamba tended to provide less control than Fusilade alone at 4 and 5 WAT. By 6 WAT this difference was statistically significant as Fusilade alone provided 58% tall fescue control while Fusilade + dicamba provided 14% control.

Manuscript alone provided more tall fescue control than Manuscript + Primo Maxx at 2 WAT, but control was similar from 4 to 6 WAT. Fusilade alone provided more tall fescue control than Fusilade + Primo Maxx from 2 to 5 WAT but these treatments provided similar tall fescue control at 6 WAT.

Fusilade + Reward provided more tall fescue control than Fusilade alone on all rating dates. Fusilade + Reward provided >85% tall fescue control from 1 to 6 WAT. Control provided by Reward alone was similar to Fusilade + Reward at 1 and 2 WAT, but not from 4 to 6 WAT when Reward alone provided ≤35% control compared to >85% control provided by Fusilade + Reward.

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Finale + Reward provided statistically greater tall fescue control than Finale alone at 1 and 2 WAT. This tank-mixture also tended to provide more control than Finale alone from 4 to 6 WAT although the difference was not statistically significant.

Finale + Reward, Fusilade + Reward, and all Manuscript-containing treatments provided >90% tall fescue control at the conclusion of the experiment.

Tall Fescue Growth Suppression

Fusilade alone provided >50% growth suppression from 4 to 6 weeks after treatment (Table 3). Suppression provided by Fusilade + dicamba was <50% on all rating dates although it was statistically similar to Fusilade alone.

Primo Maxx provided 45 to 54% suppression from 4 to 6 WAT. Suppression provided by Fusilade + Primo Maxx tended to be greater than Primo Maxx alone although this difference was not statistically significant. Suppression provided by Fusilade + Primo Maxx and Fusilade alone was similar on all dates. Similarly, suppression provided by Manuscript + Primo Maxx and Manuscript alone was similar on all dates.

White Clover Control

Treatments containing dicamba or Finale provided 85 to 100% clover control from 2 to 6 WAT (Table 4). All dicamba treatments provided similar control regardless of tank-mix partner. All other treatments, including Reward, provided poor (<20%) white clover control from 2 to 6 WAT.

CONCLUSIONS

This experiment demonstrates that Manuscript + dicamba could be investigated further as a replacement for glyphosate where broadleaf and grassy weeds are present. Dicamba may antagonize Fusilade and this tank-mixture should be investigated further. Fusilide antagonism by phenoxy herbicides such as 2,4-D and MCPA is well documented, but antagonism by dicamba, a pyridine herbicide, was not expected.

Fusilade + Reward or Manuscript alone are good candidates for glyphosate replacement if only tall fescue is present. Primo Maxx generally did not enhance tall fescue suppression or control provided by Fusilade or Manuscript.

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Table 1. Herbicide treatments applied singly at Hort. Farm No. 2 in North Brunswick, New Jersey for post-emergence tall fescue and white clover control. Treatments were applied on 1 July 2019.

Treatment	Product	Active ingredient	Rate (per acre)
1	Non-treated	–	–
2	Fusilade II[1]	fluazifop-p-butyl	24 fl oz
3	Fusilade II + dicamba	fluazifop + dicamba	24 fl oz + 0.5 lb ai
4	Fusilade II + Reward	fluazifop + diquat	24 + 16 fl oz
5	Reward	diquat	32 fl oz
6	Manuscript[2]	pinoxaden	19.2 fl oz
7	Manuscript + dicamba	pinoxaden + dicamba	19.2 fl oz + 0.5 lb ai
8	Primo Maxx	trinexapac-ethyl	88 fl oz
9	Fusilade II + Primo Maxx	fluazifop + trinexapac-ethyl	24 + 88 fl oz
10	Manuscript + Primo Maxx	pinoxaden + trinexapac-ethyl	19.2 + 88 fl oz
11	Finale	glufosinate	3 qt
12	Finale + Reward	glufosinate + diquat	3 qt + 16 fl oz

[1]Treatments containing Fusilade II, Reward, and Finale were tank-mixed with non-ionic surfactant (Activator 90) at 0.5% volume/volume.
[2]Treatments containing Manuscript were tank-mixed with Adigor surfactant at 0.5% volume/volume.

Table 2. Tall fescue control following herbicide treatments applied singly on 1 July 2019 in North Brunswick, NJ.

		Tall fescue control (%)[1]									
		7 July		15 July		29 July		5 Aug.		12 Aug	
Treatment	Product	1 WAT[2]		2 WAT		4 WAT		5 WAT		6 WAT	
1	Non-treated	0	d	0	f	0	d	0	c	0	e
2	Fusilade[3]	0	d	20	e	43	b	38	b	58	bc
3	Fusilade + dicamba	3	d	19	e	25	bc	15	bc	14	de
4	Fusilade + Reward	88	ab	94	ab	90	a	89	a	91	a
5	Reward	85	b	84	c	34	b	35	b	35	cd
6	Manuscript[4]	0	d	24	e	76	a	73	a	94	a
7	Manuscript + dicamba	1	d	38	d	80	a	80	a	97	a
8	Primo Maxx	1	d	4	f	0	d	0	c	0	e
9	Fusilade + Primo Maxx	3	d	5	f	9	cd	5	c	38	cd
10	Manuscript + Primo Maxx	1	d	35	d	81	a	73	a	100	a
11	Finale	14	c	89	bc	88	a	73	a	81	ab
12	Finale + Reward	90	a	98	a	95	a	94	a	94	a

[1]Tall fescue control evaluated on a 0 to 100% scale, where 0 = no control and 100 = complete control relative to the non-treated control. Means followed by the same letter are not significantly different according to Fisher's Protected LSD test ($p \leq 0.05$).
[2]WAT = weeks after treatment
[3]Treatments containing Fusilade II, Reward, and Finale were tank-mixed with non-ionic surfactant (Activator 90) at 0.5% volume/volume.
[4]Treatments containing Manuscript were tank-mixed with Adigor surfactant at 0.5% volume/volume.

Table 3. Tall fescue growth suppression following herbicide treatments applied singly on 1 July 2019 in North Brunswick, NJ.

Treatment	Product	Tall fescue growth suppression (%)[1]							
		15 July		29 July		5 Aug.		12 Aug	
		2 WAT[2]		4 WAT		5 WAT		6 WAT	
1	Non-treated	0	f	0	c	0	e	0	d
2	Fusilade[3]	35	de	56	b	63	cd	65	bc
3	Fusilade + dicamba	35	de	46	b	45	d	48	c
4	Fusilade + Reward	100	a	96	a	95	a	85	ab
5	Reward	70	bc	50	b	49	cd	48	c
6	Manuscript[4]	48	cde	84	a	92	ab	96	a
7	Manuscript + dicamba	58	cd	89	a	96	a	98	a
8	Primo Maxx	30	e	50	b	54	cd	45	c
9	Fusilade + Primo Maxx	53	cde	61	b	70	bc	64	bc
10	Manuscript + Primo Maxx	60	c	90	a	96	a	99	a
11	Finale	88	ab	93	a	88	ab	85	ab
12	Finale + Reward	100	a	94	a	95	a	97	a

[1]Tall fescue percent growth suppression was evaluated by visually estimating the clipping yield reduction at a 2.5-inch height of cut in each plot relative to the non-treated control. Suppression was evaluated visually on 0 to 100% scale, where 0 = no suppression and 100 = complete suppression. Means followed by the same letter are not significantly different according to Fisher's Protected LSD test ($p \leq 0.05$).
[2]WAT = weeks after treatment
[3]Treatments containing Fusilade II, Reward, and Finale were tank-mixed with non-ionic surfactant (Activator 90) at 0.5% volume/volume.
[4]Treatments containing Manuscript were tank-mixed with Adigor surfactant at 0.5% volume/volume.

Table 4. White clover *(Trifolium repens)* control following herbicide treatments applied singly on 1 July 2019 in North Brunswick, NJ.

		White clover control (%)[1]					
		15 July		29 July		12 Aug	
Treatment	Product	2 WAT[2]		4 WAT		6 WAT	
1	Non-treated	0	c	0	c	0	d
2	Fusilade[3]	0	c	0	c	0	d
3	Fusilade + dicamba	86	a	100	a	100	a
4	Fusilade + Reward	0	c	0	c	0	d
5	Reward	18	b	10	bc	0	d
6	Manuscript[4]	0	c	0	c	0	d
7	Manuscript + dicamba	90	a	100	a	100	a
8	Primo Maxx	5	c	18	b	0	d
9	Fusilade + Primo Maxx	0	c	13	bc	0	d
10	Manuscript + Primo Maxx	5	c	15	b	0	d
11	Finale	95	a	95	a	91	b
12	Finale + Reward	95	a	91	a	89	c

[1]White clover control evaluated on a 0 to 100% scale, where 0 = no control and 100 = complete control relative to the non-treated control. Means followed by the same letter are not significantly different according to Fisher's Protected LSD test ($p \leq 0.05$).
[2]WAT = weeks after treatment
[3]Treatments containing Fusilade II, Reward, and Finale were tank-mixed with non-ionic surfactant (Activator 90) at 0.5% volume/volume.
[4]Treatments containing Manuscript were tank-mixed with Adigor surfactant at 0.5% volume/volume.