Tall Fescue Seedling Growth as Affected by Postemergence Herbicides

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Abstract. The objective of this greenhouse study was to evaluate tall fescue (*Festuca arundinacea*) seedling growth when seeded after herbicide application. Herbicide treatments included a nontreated control; 1.19 lb/acre 2,4-dichlorophenoxyacetic acid (2,4-D) + 0.32 lb/acre methylchlorophenoxypropionic acid (MCPP) + 0.32 lb/acre dicamba; 0.75 lb/acre quinclorac; and 0.06 lb/acre halosulfuron-methyl. Seeding was done at 0, 3, 7, or 14 days after herbicide application to soil media. Two identical experiments were conducted in the greenhouse: Expt. 1 seedling growth from January to March and Expt. 2 from May to July (temperatures higher). Seeding dates after herbicide application did not influence growth. Average dry shoot weight reductions and dry root weight reductions caused by postemergence herbicides were 2,4-D + MCPP + dicamba (33% shoot and 27% root in Expt. 2), quinclorac (30% shoot and 37% root in Expt. 2), and halosulfuron-methyl (51% shoot in Expt. 2; 81% root in Expts. 1 and 2). Although application of these herbicides before seeding in the field may result in no visual impact, they can impact seedling shoot and root growth, particularly under higher growth temperatures.

When turfgrass swards are under renovation, a common problem is controlling weeds before seeding because seedlings do not compete well with weeds that are present (McCalla et al. 2004). Many products used for postemergence weed control such as 2,4-dichlorophenoxyacetic acid (2,4-D), dicamba, triclopyr, or methylchlorophenoxypropionic acid (MCPP) are only recommended for application after turfgrass seedlings have emerged and tillered (Willis et al. 2006).

Most herbicide labels recommend waiting for a defined period after application before seeding. If seeding is done before herbicide label recommendations, field establishment may be inhibited (Johnston et al. 2016; McElroy and Breeden 2007; McFadden et al. 2023). Research in Kansas, USA, indicated that tall fescue [*Festuca arundinacea* (synonyms, *Schedonorus arundinaceus* and *Lolium arundinaceum*)] cover was not significantly impacted when seeding was done 0 to 14 d after herbicide treatment (DAT) in soil treated with 2,4-D + MCPP + dicamba (Trimec Classic; PBI-Gordon Corp., Shawnee, KS, USA) or quinclorac (Drive 75 DF; BASF Corp., Florham Park, NJ, USA) (McFadden et al. 2022). However, cover was reduced by 6% to 32% at 6 weeks after planting by seeding into plots treated with halosulfuron-methyl at 0 or 3 DAT. In addition, tall fescue establishment in the field has been shown to be inhibited by 2,4-D + dicamba + penoxsulam + sulfentrazone (Avenue South, PBI-Gordon Corp.) when seeding was done after application (McFadden et al. 2023).

Although research has been done to evaluate establishment of tall fescue when postemergence herbicides are applied before seeding (McFadden et al. 2022, 2023) or shortly after seedling emergence (McElroy and Breeden 2007), no information has been published on the impact of postemergence herbicides on growth of shoots and roots when seed is planted shortly after herbicide application. Therefore, the objective of this greenhouse study was to evaluate herbicide effects on tall fescue shoot and root growth following application to the soil surface before seeding.

Materials and methods

A greenhouse study was conducted in the Throckmorton Plant Science Center at Kansas State University, Manhattan, KS, USA, from Jan to Mar 2020 (Expt. 1) and May to Jul 2020 (Expt. 2) to determine the effects of herbicides and seeding time after application on seedling growth. The greenhouse was climate controlled (Step50A; Wadsworth Control Systems, Arvada, CO, USA) with a day and night setpoint of 80 and 64 °F, respectively. In Expt. 1, greenhouse temperatures were consistent with these settings. In Expt. 2, late spring and summer outdoor temperatures raised daytime greenhouse temperatures above 85 °F and nighttime temperatures above 70 °F for several weeks. Supplemental lighting (T101M; Intermatic Inc., Spring Grove, IL, USA) was used to mimic an early fall daylength when turf professionals are most commonly seeding. One coffee filter was placed at the bottom of each thermoplastic greenhouse container (4 inches diameter, 4 inches deep), then filled with a 1:1 ratio of unpasteurized field soil and sand to a height of 3 1/2 inches. Each pot was filled with ~20 oz of media and then compressed to 1/2 inch from the top of the container.

Experiments were arranged in a completely randomized design with four

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Units

To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
9.3540	gal/acre	$L\cdot ha^{-1}$	0.1069
2.54	inch(es)	cm	0.3937
6.4516	$inch^2$	cm^2	0.1550
48.8243	lb/1000 ft^2	$kg\cdot ha^{-1}$	0.0205
1.1209	lb/acre	$kg\cdot ha^{-1}$	0.8922
28.3495	oz	g	0.0353
(°F − 32) ÷ 1.8	°F	°C	(°C × 1.8) + 32

Table 1. Main effects of herbicide treatment on tall fescue dry shoot and root weights 42 d after herbicide application. Herbicides were applied on 20 Jan 2020 (Expt. 1) and 18 May 2020 (Expt. 2). Means are averages over seeding intervals (n = 16).

	Shoot dry wt (g)[i]		Root dry wt (g)[i]	
Treatment	Expt. 1	Expt. 2	Expt. 1	Expt. 2
Nontreated	0.93 a[ii]	1.07 a	5.49 a	1.67 a
2,4-dichlorophenoxyacetic acid + methylchlorophenoxypropionic acid + dicamba	0.92 a	0.83 b	6.18 a	1.15 b
Quinclorac	0.92 a	0.75 b	5.09 a	1.06 b
Halosulfuron-methyl	1.00 a	0.63 b	0.98 b	0.33 c
P value	0.64	<0.001	0.002	<0.001

[i] Shoots and roots harvested 42 d after seeding and dried for 48 h at 150 °F (65.6 °C); 1 g = 0.0353 oz.

[ii] Means followed by the same letter in a column are not statistically different according to Tukey's honest significant difference test at $P \leq 0.05$.

replicates and a two-way factorial treatment structure to evaluate the effect of herbicide and seeding interval. Herbicide treatments included a nontreated control and four herbicides. Pots were placed on the floor, and herbicides were applied using a carbon dioxide (CO_2)-pressurized, handheld spray boom (R&D Sprayers, Opelousas, LA, USA) equipped with four flat-fan nozzles (8003; TeeJet Technologies, Springfield, IL, USA) on 25-cm spacing calibrated to deliver 43 gal/acre.

Herbicides applied were 1.19 lb/acre 2,4-D + 0.32 lb/acre MCPP + 0.13 lb/acre dicamba (Trimec Classic); 0.75 lb/acre quinclorac (Drive 75 DF); and 0.06 lb/acre halosulfuron-methyl (Sedgehammer; Gowan Corp., Yuma, AZ, USA). Application rates were selected by label recommendations for highest rate on cool-season turfgrass.

The four seeding intervals included 0, 3, 7, and 14 DAT. Tall fescue [36.8% 'Copious', 31.1% 'Technique', 30.9% 'Leonardo' (Kansas Excalibur Tall Fescue Blend; Lesco Inc., Cleveland, OH, USA)] was seeded at 10 lb/1000 ft^2 pure live seed. Before seed was sown into each pot, a 1-mm-diameter dowel rod was used to prepare the top 1/2 inch of the seedbed by pressing 12 holes/$inch^2$. A starter fertilizer (14N–8.8P–3.3K) was applied to deliver a nitrogen rate equivalent to 1 lb/1000 ft^2 to each pot. Isofetamid + tebuconazole (Tekken Broad Spectrum Fungicide, PBI-Gordon Corp.) was applied at 21 and 35 DAT at 1.8 lb/acre to prevent fungal diseases.

Tall fescue was harvested 42 d after each seeding interval. Treatments were maintained at 2 3/4 inches height of cut throughout the duration of the experiments for acceptable growth. At harvest, shoots were collected by cutting off at the soil surface. After shoot harvest, root zone material was placed on a sieve and soil was washed from roots. Shoots and roots were then placed in individual paper bags and dried for ~48 h in an electric drying oven (model 2185632; Hamilton Industries, Two Rivers, WI, USA) at 150 °F. After 48 h, dried shoots and roots were weighed. Because the experiment was repeated, data for each experiment were analyzed with experiment number as a factor to determine whether data could be combined from the two experiments. There were treatment by experiment interactions for both dry shoot and dry root weight data. Therefore, dry weight data for Expts. 1 and 2 are presented separately. All data for each of the harvest weights were subjected to analysis of variance in statistical software (SAS ver. 9.4; SAS Institute Inc., Cary, NC, USA) using the GLIMMIX procedure and means were separated according to Tukey's honest significant difference (HSD) test ($P \leq 0.05$).

Results and discussion

Postemergence herbicide treatments resulted in an average of 20% higher shoot weights in Expt. 1 compared with Expt. 2. Likewise, root weights were 3 to 5 times greater in Expt. 1 compared with Expt. 2. This was likely the result of higher greenhouse temperatures experienced in Expt. 2.

Dry shoot weights were comparable to nontreated tall fescue for all postemergence herbicides in Expt. 1 (Table 1). In Expt. 2, tall fescue seeded into all postemergence herbicide-treated soil resulted in 30% to 51% lower shoot weights compared with nontreated tall fescue.

In Expt. 1, tall fescue seeded in nontreated soil had 82% higher root weight compared with that treated with halosulfuron-methyl, whereas other herbicides did not impact root weight. In Expt. 2, root weights in herbicide-treated soil were all significantly lower than those in nontreated soil: 31% lower for 2,4-D + MCPP + dicamba; 37% lower for quinclorac; and 80% lower for halosulfuron-methyl. Root weights in halosulfuron-methyl treated soil were significantly lower than those in soil treated with 2,4-D + MCPP + dicamba or quinclorac (Fig. 1).

Although coverage of tall fescue seeded into soil treated with 2,4-D + MCPP + dicamba or quinclorac between 0 and 14 DAT was not reduced in US field research at Manhattan, KS, and Wooster, OH (McFadden et al. 2022), it is clear that tall fescue seedling shoot and root growth can still be impacted by postemergence herbicides applied before seeding. In this greenhouse study, all herbicides caused some reduction in shoot growth (Expt. 2) and root growth (Expt. 2). Only halosulfuron-methyl caused root weight reduction in Expt. 1. Reductions in root weights caused by 2,4-D + MCPP + dicamba and quinclorac were minor; those caused by halosulfuron-methyl were moderate. Under seeding conditions with higher temperatures, seeding 0 to 14 d after quinclorac application can have some effect on shoot and root growth. Research in Tennessee, USA, on tall fescue showed that a quinclorac single application (1.5 lb/acre, 14 d after emergence) or sequential applications (0.75 lb/acre, 14 and 28 d after emergence) reduced cover up to 9% 42 d after emergence and up to 17% 63 d after emergence (McElroy and Breeden 2007).

Little past research has been conducted to evaluate the impact of postemergence herbicides in this study on

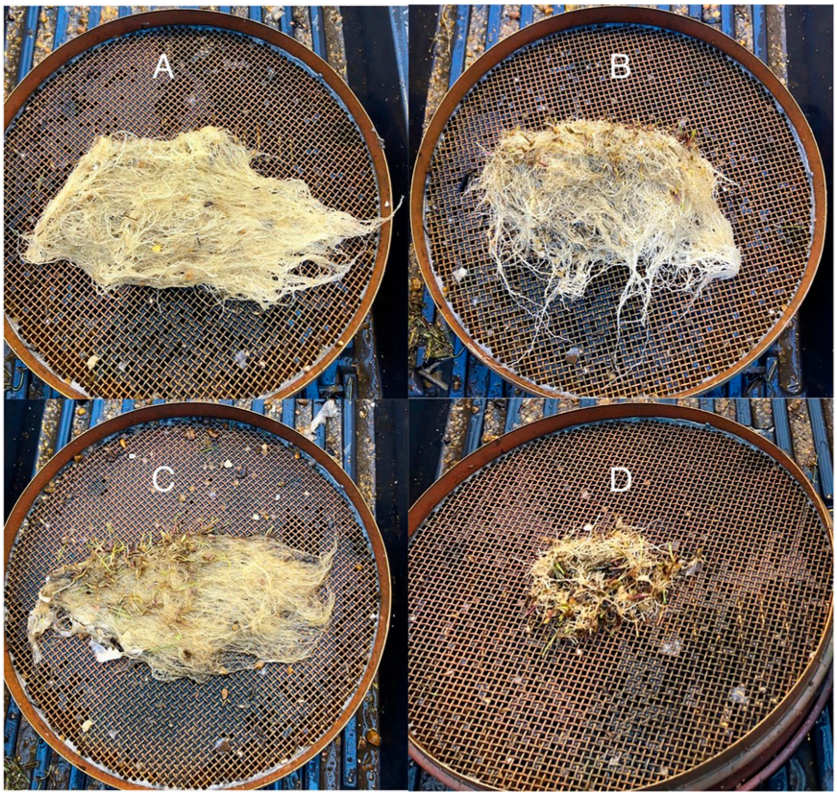

Fig. 1. Differences in rooting of tall fescue 42 d after seeding into nontreated soil (A) and soil treated with 1.19 lb/acre 2,4-dichlorophenoxyacetic acid + 0.32 lb/acre methylchlorophenoxypropionic acid + 0.13 lb/acre dicamba (B), 0.75 lb/acre quinclorac (C), or 0.06 lb/acre halosulfuron-methyl (D) in a greenhouse experiment conducted Jan to Mar 2020; 1 lb/acre = 1.1209 kg·ha^{-1}.

growth of tall fescue roots and shoots. As shown herein, tall fescue root and shoot growth can be impacted by halosulfuron-methyl regardless of seedling temperature growth and by 2,4-D + MCPP + dicamba and quinclorac when seedlings are growing during relatively high temperatures.

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