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Wiregrass Tubeling Response to Postplant Herbicides[1]

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Abstract

Wiregrass (*Aristida beyrichiana* Trin. & Rupr.) seedlings were germinated and grown in trays of 96 medium-filled conical tubes. Four-month-old seedlings were treated with Aatrex 4L (atrazine), Factor 65WDG (prodiamine), or Ronstar 50WP (oxadiazon) (applied individually or in combination) in July 1998 and evaluated for phytotoxicity 2, 6, and 10 weeks after application. The experiment was conducted at two sites, one in Chiefland, FL (Florida Division of Forestry, Andrews Nursery), and the other at Monticello, FL (Univ. of Florida/IFAS, North Florida Research and Education Center). Although there was a site by treatment interaction, there was good agreement between sites as to treatments that caused acceptable and unacceptable injury. Ronstar at 2.2 kg ai·ha^{-1} (2 lb ai·A^{-1}), Aatrex at 2.2 kg ai·ha^{-1} (2 lb ai·A^{-1}), and Factor at 0.8 or 1.7 kg ai·ha^{-1} (0.75 or 1.5 lb ai·A^{-1}, resp.) ± Aatrex at 2.2 kg ai·ha^{-1} (2 lb ai·A^{-1}) caused slight but acceptable foliar injury when applied to 4-month-old (13-cm [5-in] tall) wiregrass seedlings, with either rate of Factor alone causing the least amount of injury. There was an apparent synergistic interaction between Aatrex (either rate) and Ronstar at 4.5 kg ai·ha^{-1} (4 lb ai·A^{-1}) 2 weeks after application but this effect was no longer consistently apparent by 10 weeks after application. There were no apparent interactions between Aatrex and Factor.

Index words: herbicide tolerance, nursery crop, pineland threeawn, preemergence, postemergence, *Aristida stricta*.

Species used in this study: wiregrass (*Aristida beyrichiana* Trin. & Rupr.).

Herbicides used in this study: Aatrex (atrazine), 2-chloro-4-ethylamino-6-isopropylamino-S-triazine; Factor (prodiamine), N^3,N^3-di-*n*-propyl-2,4-dintro-6-(trifluoromethyl)-*m*-phenylenediamine; Ronstar (oxadiazon), 2-tert-butyl-4-(2,4-dichloro-5-isopropoxphenyl)-Δ-1,3,4-oxadiazolin-5-one.

Significance to the Nursery Industry

There is a substantial demand for wiregrass tubelings (tubelings is a term commonly used to describe plants grown in trays of conical tubes) for use in restoration and reclamation efforts in the lower southeastern portion of the United States. Since there are no pre- or postemergence herbicides labelled for use on wiregrass, mass production of high quality wiregrass tubelings can be hindered because of weeds that can easily infest wiregrass tubelings and interfere with their growth. Moreover, manual weeding can interfere with growth because of the substantial root disturbance that can occur when weeds are removed, especially established weeds. In this study, Ronstar 50WP (oxadiazon) at 2.2 kg ai·ha^{-1} (2 lb ai·A^{-1}), Aatrex 4L (atrazine) at 2.2 kg ai·ha^{-1} (2 lb ai·A^{-1}), and Factor 65WDG (prodiamine) at 0.8 or 1.7 kg ai·ha^{-1} (0.75 or 1.5 lb ai·A^{-1}, resp.) ± Aatrex 4L at 2.2 kg ai·ha^{-1} (2 lb ai·A^{-1}) only caused minimal injury to 4-month-old wiregrass tubelings and hence could be considered for use in production.

Introduction

Wiregrass (*Aristida beyrichiana* Trin. & Rupr. [formerly synonymous with *Aristida stricta* Michx. but now classified as two species]) is a warm season native grass that is a primary understory species in longleaf pine-wiregrass forests of the Atlantic coastal plain. It is an essential component of this ecosystem because it will carry the periodic fires that are necessary to maintain the integrity of this ecosystem. The longleaf pine-wiregrass forest was once ubiquitous in the southeastern United States but has now declined to less than 5% of its original range (7, 14) and hence is considered one of the most endangered ecosystems worldwide (8, 12). Given the status of this ecosystem, there has been a growing demand for wiregrass seedlings for use in restoration and reclamation projects.

In Florida, wiregrass is frequently germinated and grown in trays of conical tubes (plants grown in these trays are commonly referred to as 'tubelings'). The tubelings are usually sold 3 to 6 months after the seed are sown. Wiregrass tubeling production has reached upwards of 600,000 per year at Florida's Division of Forestry's Andrews Nursery in Chiefland. During production, wiregrass tubelings are quite susceptible to weed infestations because 1) native grasses like wiregrass generally are poor competitors (13), 2) individual wiregrass seedlings only cover about 2/3 to 3/4 of the medium surface, even though tubeling density in tubeling trays is high (~430·m^{-2}), 3) wiregrass seedlings are thin-bladed and initially slow growing, and 4) no pre- or postemergent herbicides are labelled for use on wiregrass. Moreover, manual weeding can be difficult, especially when seedlings are more than 3 or 4 months old, because it results in substantial root disturbance to wiregrass seedlings.

While there are no herbicides labelled for use on wiregrass, Atrazine, Ronstar, and Factor are labelled or have been shown to be safe on other warm season and ornamental grasses. Atrazine is tolerated by blue grama [*Bouteloua gracilis* (H.B.K.) Lag. Ex. Steud.] (9), and by big bluestem (*Andropogon gerardii* Vitman) and switchgrass (*Panicum virgatum* L.) (13). It also caused shifts in species composition away from forbs and annual grasses in favor of warm season perennial grasses such as big bluestem (3). Ronstar 2G at 4.5 kg ai·ha^{-1} (4 lb ai·A^{-1}) did not injure either pampas grass (*Cortaderia selloana* [Schult. & Schult. f.] Aschers. & Graebn.) (5, 10), or four other ornamental grasses (10) but temporarily injured blue fescue (*Festuca ovina* cv *glauca*

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(Lam.) W.D.J. Koch) (10), a cool season grass. Factor at 1.1 and 2.2 kg ai·ha^{-1} (1 and 2 lb ai·A^{-1}, respectively) caused no injury to container-grown pampas grass or five other ornamental grasses (10) but in another study Factor at 1.7 kg ai·ha^{-1} (1.5 lb ai·A^{-1}) reduced height and inhibited root development of container-grown pampas grass (5). Both Factor and Ronstar applied twice, 60 days apart, reduced sea oats (*Uniola paniculata* L.) shoot fresh weight (4).

In a recent study by Norcini et al. (11), Image (imazaquin), Plateau (imazapic), Gallery (isoxaben), Snapshot TG (isoxaben + trifluralin), Surflan (oryzalin), and Ronstar 2G applied before emergence of wiregrass and hairy bittercress (*Cardamine hirsuta* L.) caused moderate to severe injury to wiregrass 2 and 3 months after application; Plateau also injured wiregrass when applied to young seedlings (2.5 to 5 cm [1 to 2 in] tall). However, in a follow-up non-replicated study (unpublished results), labelled rates of Atrazine, Image, or Weed-B-Gon for Southern Lawns Formula II (MCPP + 2,4-D + dicamba) applied to 3-month-old wiregrass tubelings reduced hairy bittercress coverage by 75 to 100% without injuring wiregrass. Based on the results of these studies, it seems that older wiregrass seedlings may be less sensitive to herbicides than younger seedlings.

The objective of this study was to determine if label rates of Atrazine (a post- and preemergence herbicide), or Ronstar 50WP or Factor (two preemergence herbicides) applied alone or in various combinations were suitable for use on 4-month-old wiregrass seedlings in tubeling production.

Materials and Methods

Wiregrass seed plus chaff collected from Wekiwa Springs State Park, Apopka, FL in late 1997 was sown on April 1, 1998. The soilless medium was comprised of 50% Canadian sphagnum peat, 30% polystyrofoam beads, and 20% vermiculite (by vol) (Verlite Forestry Mix; Verlite Corp., Tampa, FL) amended with Osmocote 17N–2.6P–8.3K + minor elements (1.5Ca–1.0Mg–4.0S–0.02B–0.05Cu–0.4Fe–0.1Mn–0.001Mo–0.05Zn) (17–6–10 with minors; 8 to 9 month formulation at 21C [70F], Scotts Co., Marysville, OH) at 2.7 kg·m^{-3} (4.6 lb·yd^{-3}) and pelletized soil acidifier (90% sulfur; So. Agr. Insecticides Inc., Palmetto, FL) at 1.3 kg·m^{-3} (2.2 lb·yd^{-3}). Substrate filled the 96-tube tray (CAN AM tray #3; 35.6 × 60.3 × 11.4 cm [14 × 24 × 4.5 in]; each tube—12.2 cm deep, 3.8 cm diameter, vol 98 ml [3.3 oz]; Stuewe & Sons, Inc., Corvallis, OR) to within 1.25 cm (0.5 in) of the top. Wiregrass seed plus chaff (298 g [10.5 oz]) was mixed with a 0.11 m^3 (0.15 yd^3) bag of coarse vermiculite for 3 to 5 min in a ribbon blender (Twister I; Bouldin & Lawson, McMinnville, TN). This mixture was then used to fill the remaining 1.25 cm (0.5 in) of each tube of approximately 85 trays. This provided an estimated 60 seeds per tube. The germination rate was about 24%, resulting in about 14 seedlings per tubeling. Tubeling trays were maintained at the Chiefland site until July 27.

On July 27, 14 herbicide treatments (Table 1) were applied over-the-top to approximately 12.7-cm (5-in) tall wiregrass plants at Chiefland; nontreated, weed-free trays of wiregrass tubelings were controls. Herbicides were applied using a compressed air backpack sprayer that delivered 468 liters·ha^{-1} (50 GPA) at 138 kPa (20 psi) through a single flat fan spray tip (Teejet XR8004VH; Spraying Systems Co., St. Petersburg, FL). Conditions at application were: 90% relative humidity; 26.1C (79F) air temperature; 25.5C (78F) substrate temperature; calm wind; moist substrate; slightly damp foliage. Overhead irrigation (1.25 cm [0.5 in]) was applied within 30 min after application.

A nontreated set of wiregrass tubeling trays from Chiefland was brought to the North Florida Research and Education Center, Monticello, FL, on July 27. On July 28, the same treatments were applied with the same equipment described above to the second set of wiregrass tubelings. Conditions at application were: 78% relative humidity; 24.4C (76F) air temperature; 22.2C (72F) substrate temperature; calm wind; moist substrate; slightly damp foliage. Overhead irrigation (1.25 cm [0.5 in]) was applied within 30 min after application.

At each site, tubeling trays were arranged in a randomized complete block design with five replications. The trays at Chiefland were placed on wire supports 40.6 cm (16 in) above ground level; Roundup (glyphosate) was used to control weeds underneath the trays. The trays at Monticello were placed on a black polyethylene covered bed. Both sites were in full sun and overhead irrigated daily with 0.85 cm (0.33 in) at Monticello and 1.25 cm (0.5 in) at Chiefland. On September 9 (6 weeks after treatment application) at the Monticello site, each tray was fertilized with 3.8 liter (1 gal) of 50 mg·liter^{-1} (0.67 oz·100 gal^{-1}) N, 44 mg·liter^{-1} (1.33 oz·100 gal^{-1}) P, and 42 mg·liter^{-1} (0.67 oz·100 gal^{-1}) K (Peters 15–30–15; Scotts Co.). Rainfall amounts at Chiefland were 7.8 cm (3.0 in) from application to 2 weeks after treatment (WAT), 25.3 cm (10 in) from 2 to 6 WAT, and 27.0 cm (10.6 in) from 6 to 10 WAT. Rainfall at Monticello was 10.5 cm (4.1 in) from 0 to 2 WAT, 25.2 cm (9.9 inches) from 2 to 6 WAT, and 28.6 cm (11.2 in) from 6 to 10 WAT.

Phytotoxicity was rated 2, 6, and 10 WAT at each site. The phytotoxicity rating scale (2) was: 0 = no crop reduction; 10 = slight crop discoloration or stunting; 20 = some crop discoloration, stunting, or stunt loss; 30 = crop injury more pronounced, but not lasting; 40 = moderate injury, crop usually recovers; 50 = crop injury more lasting, recovery doubtful; 60 = lasting crop injury, no recovery; 70 = heavy crop injury and stand loss; 80 = crop nearly destroyed—a few surviving plants; 90 = only occasional live crop plants left; and 100 = complete plant destruction. Acceptable injury was based on injury ratings at 10 WAT. Within a site, treatments with a mean rating of <20, with no individual rating >20 was considered commercially acceptable. A treatment that caused an injury rating >20 to any tray of seedlings by 10 WAT was not considered commercially acceptable because any tray of seedlings with an injury rating >20 would not be marketable.

Ratings were ranked from low (rank = 1) to high with the average rank assigned to ties. Ranks were transformed to expected normal scores (1). The expected normal scores were subjected to analysis of variance using SAS. For ease of interpretation, average ratings are reported in the tables. Mean separation was by the Waller-Duncan procedure of SAS.

Results and Discussion

All herbicide treatments caused some degree of foliar injury (Table 1). Ronstar and Aatrex caused chlorosis and necrosis, with moderately to severely damaged seedlings being visibly smaller by 10 WAT. Seedlings injured by Factor alone had slightly more dead foliage than nontreated plants, but Factor alone did not visibly inhibit growth. Injury generally occurred by 2 WAT.

There was a significant site by treatment interaction therefore data for each site are presented separately. Only injury

Table 1. Phytotoxic response of 4-month-old wiregrass *(Aristida beyrichiana)* tubelings to 14 postplant herbicide treatments 10 weeks after application at Chiefland and Monticello, FL.[z]

Herbicide/ Formulation	Rate		Phytotoxicity at 10 weeks after application	
	kg ai·ha^{-1}	lb ai·A^{-1}	Chiefland	Monticello
Nontreated control	—	—	0g	0h
Factor 65WDG	0.8	0.7	12ef	2gh
Factor 65WDG	1.7	1.5	2g	2gh
Aatrex 4L	2.2	2.0	8f	10ef
Aatrex 4L + Factor 65WDG	2.2 + 0.8	2.0 + 0.7	10ef	14e
Aatrex 4L + Factor 65WDG	2.2 + 1.7	2.0 + 1.5	12ef	12e
Aatrex 4L	4.5	4.0	52b	44bc
Aatrex 4L + Factor 65WDG	4.5 + 0.8	4.0 + 0.7	52b	50bc
Aatrex 4L + Factor 65WDG	4.5 + 1.7	4.0 + 1.5	36bc	60ab
Ronstar 50WP	2.2	2.0	8f	0h
Ronstar 50WP	4.5	4.0	18de	6fg
Aatrex 4L + Ronstar 50WP	2.2 + 2.2	2.0 + 2.0	32cd	14e
Aatrex 4L + Ronstar 50WP	2.2 + 4.5	2.0 + 4.0	48bc	30d
Aatrex 4L + Ronstar 50WP	4.5 + 2.2	4.0 + 2.0	70a	32cd
Aatrex 4L + Ronstar 50WP	4.5 + 4.5	4.0 + 4.0	74a	74a

[z]Phytotoxicity rating scale of 0 to 100, increments of 10, with 0 = no injury or stand loss to 100 = complete stand loss or plant death.

[y]Weeks after treatment (WAT).

[x]Statistical analysis performed on expected normal scores; average scores are presented. Means within columns followed by the same letter are not significantly different by Waller-Duncan (*k*-ratio = 100).

ratings for 10 WAT are presented since there was little change in injury from 2 to 10 WAT within a treatment. Factor at 0.8 or 1.7 kg ai·ha^{-1} (0.75 or 1.5 lb ai·A^{-1}) ± Aatrex at 2.2 kg ai·ha^{-1} (2 lb ai·A^{-1}), Ronstar at 2.2 kg ai·ha^{-1} (2 lb ai·A^{-1}), and Aatrex at 2.2 kg ai·ha^{-1} (2 lb ai·A^{-1}) caused slight, but acceptable, foliar injury at both sites. Seedlings treated with Factor alone (either rate) exhibited the least amount of injury based on ratings and observations. By 10 WAT, no injury was observed on 80% of the trays of seedlings treated with Factor alone (either rate) at Monticello or 40% of those at Chiefland. Of the remaining trays of seedlings (both sites) treated with Factor alone, the injury rating was 10 for all but one tray of seedlings (rating = 20). Of all trays of seedlings (both sites) treated with Ronstar at 2.2 kg ai·ha^{-1} (2 lb ai·A^{-1}) injury was slight, with injury (rating = 10) observed on only four of the 10 trays (and none at Monticello). Ronstar at 4.5 kg ai·ha^{-1} (4 lb ai·A^{-1}) was not considered an acceptable treatment because one of the trays of seedlings at Chiefland had an injury rating of 30 at 10 WAT. Aatrex at 2.2 kg ai·ha^{-1} (2 lb ai·A^{-1}) caused slightly more injury than was noted above, but there was no injury observed on 30% of the trays of seedlings by 10 WAT; a rating of 20 was only observed on seedlings in two of the 10 trays.

Aatrex at 4.5 kg ai·ha^{-1} (4 lb ai·A^{-1}) produced significant injury to wiregrass tubelings when applied alone or in tank mixes. Tank mixing labelled rates of Aatrex and Factor generally caused less injury than when label rates of Aatrex and Ronstar were tank mixed. The phytotoxic effects of Aatrex and Factor were generally independent of each other (6). That is, the injury resulting from application of these tank mixes was no greater or worse than injury from either product when applied alone. There was some indication of a synergistic effect between Aatrex (either rate) and Ronstar at 4.5 kg ai·ha^{-1} (4 lb ai·A^{-1}) at 2 WAT (results not shown), but by 10 WAT there was no consistent evidence of this effect.

Four-month-old wiregrass seedlings (~13 cm [5 in] tall) displayed some tolerance to Aatrex, Factor, and Ronstar, unlike in a previous study in which all herbicides, including Ronstar 2G, applied prior to emergence of wiregrass caused substantial injury to wiregrass (11). Ronstar 2G at 4.5 kg ai·A^{-1} completely inhibited emergence of wiregrass seedlings (or may have killed all seedlings) by 2 months after application. In the current study, Ronstar 50WP at the same rate (with tubelings growing in the same medium as in the previous study) resulted in average injury ratings of 20 or less after 10 weeks. Increased tolerance of wiregrass to herbicides as seedlings get older has also been noted with Plateau (11). Plateau severely injured seedlings that were 2.5 to 5 cm (1 to 2 in) tall but Kluson (Robert Kluson, pers. comm.) observed no injury on older wiregrass plants treated with Plateau. A greater degree of herbicide tolerance as wiregrass gets older is not surprising given that the effectiveness of many postemergent herbicides on sensitive perennial weed species generally declines as those species get larger and older.

Variability in levels of phytotoxicity, as evidenced by the site by treatment interaction noted before, was not totally unexpected given that different observers rated injury at Monticello and Chiefland. While the injury tended to be rated more severe at Chiefland than at Monticello over the course of the expermiment, there was good agreement as to which treatments caused acceptable or unacceptable injury.

In conclusion, Factor at 0.8 or 1.7 kg ai·ha^{-1} (0.75 or 1.5 lb ai·A^{-1}) ± Aatrex at 2.2 kg ai·ha^{-1} (2 lb ai·A^{-1}), Ronstar at 2.2 kg ai·ha^{-1} (2 lb ai·A^{-1}), or Aatrex at 2.2 kg ai·ha^{-1} (2 lb ai·A^{-1}) could be used for postplant weed control in wiregrass tubeling production if slight injury could be tolerated. The slight damage on the 4-month-old seedlings observed in this study was considered acceptable, especially given the potential benefits. For example, tank mixing Aatrex with Factor could be used in situations where postemergence control (with residual activity) of a sensitive weed species is desired, and in areas where atrazine is not likely to contaminate ground water.

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