Southern Forest Nursery Management Cooperative™

RESEARCH REPORT 25-03

A TRIAL of ISOXABEN in CONTAINERIZED SEEDLINGS for CONTROL of CARPETWEED and OTHER BROADLEAF WEEDS

by
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INTRODUCTION

As containerized seedling production has increased in the southern U.S. over the past ten years (Enebak 2013; Newell and Bowersock 2023), so has the demand for higher quality seedlings, and the pressures on growers to produce these. One detrimental effect of growing seedlings in the open and in packaged media is the potential introduction of weeds into the growing trays. Few, if any, herbicides have been tested by their manufacturers in forest-tree containerized growing systems for control of specific weeds. This lack of herbicide producer testing has been filled by the Southern Forest Nursery Management Cooperative (SFNMC) herbicide testing program beginning in 2014 with trials of Marengo® (indaziflam) (Enebak et al 2014).

Of the herbicides tested in containerized growing systems by the SFNMC since that time, Ronstar®Flo (oxadiazon) was found to control black willow and other weeds when applied at the time of sowing without harming seedlings (Payne, N. et al 2020). However, the use of this one herbicide to provide sufficient weed control over the entire growing season has been ineffective in some nurseries. Increased weed pressure later in the growing season and an increased variety of weed species necessitated continued testing of other herbicides in containers.

Because the pesticide labeling process for a new herbicide in container conifer nurseries can be lengthy (Fishel 2023), the opportunity to test a herbicide currently labeled in Canada for conifer container growing operations was taken in 2024. Gallery™ 75 DF (isoxaben) has been used in PRT container nurseries in Canada with success in controlling weeds in growing trays (N. Green, personal communication, February 8, 2024). Another PRT container nursery in the U.S. (Atmore, Alabama) provided for the installation of a SFNMC trial in 2024 on longleaf pine (*Pinus palustris*), loblolly pine (*Pinus taeda*), and slash pine (*Pinus elliottii*) grown in containers. The specific weed desired to be controlled at this nursery was identified as carpetweed (*Mollugo verticillata*), which is listed on the Gallery® 75 DF U.S. label as partially controlled or suppressed.

METHODOLOGY

This isoxaben trial was installed at PRT-IFCO's Atmore, Alabama container nursery in April, May, and June of 2024 in longleaf pine, loblolly pine, and slash pine seedlings. Two rates were tested in the trial: a low rate of 0.66 pounds per acre and a high rate of 1.33 pounds per acre. These rates were selected from page 3 of the U.S. herbicide label. SFNMC staff applied the herbicide with a CO_2 hand sprayer calibrated to broadcast a spray volume of 25 gallons of water per acre. Within each pine species, seedlings were treated at three different application timings: (1) one-week post-sowing, (2) six weeks post-sowing, and (3) one week plus six weeks post-sowing. Selection of the one week post-

sowing application timing was based on the Gallery® 75 DF label recommendation on page 5: *"Do not apply Gallery® 75 Dry Flowable to newly transplanted ornamentals, nursery stock, groundcovers, ornamental bulbs, non-bearing fruit and nut trees or non-bearing vineyards until soil or potting media has been settled by packing and irrigation or rainfall and no cracks are present, or plant injury may occur."* The six weeks post-sowing application timing was selected based on seedling damage experienced when herbicides were applied prior to the six week mark in pine nurseries.

For each species and application timing combination, ten trays were designated as non-treated control trays, ten trays were sprayed with the low rate of herbicide, and ten trays were sprayed with the high rate of herbicide. Each tray represented a replication in the study design and statistical analysis. A total of 270 trays of seedlings were used in the trial. Prior to herbicide applications at six weeks post-sowing, counts of pine seedlings per tray were made to determine percent fill at the initiation of the study. Percent fill of trays sprayed at one week post-sowing only and at one week plus six weeks post-sowing were based on the total number of cells sown with seed in each tray (128).

In November and December of 2024, seedling counts were made in each of the 270 trays and recorded to calculate percent fill of trays at the end of the growing season. These were compared to original counts of seedlings made in April, May, and June. After counting each tray, random samples of ten seedlings per tray were collected. These were processed at the SFNMC greenhouse and laboratory in Auburn, Alabama for measurements of shoot height, root collar diameter, shoot dry weight, and plug dry weight. Data was analyzed using R Statistical Software (v4.1.2; R Core Team 2021) with Tukey's Honest Significant Difference (HSD) post hoc test. A significance level at alpha = 0.05 was used.

RESULTS and DISCUSSION

Longleaf pine treated at 1 week post-sowing: There were no statistically significant **negative** effects of the herbicide application at either rate on any seedling characteristic when compared to the non-treated control seedlings (Table 1). Shoot heights of treated seedlings were significantly larger by up to 1.8 centimeters; however, all seedlings are top-clipped multiple times during the growing season, so this quantity is not considered to be important.

Longleaf pine treated at 6 weeks post-sowing: As in the one week post-sowing installation, no **negative** statistical differences were found between seedlings from non-treated control trays and those from treated trays, at either rate in any seedling characteristic measured (Table 2).

Longleaf pine treated at 1 and 6 weeks post-sowing: The single instance of a statistically significant **negative** effect of the herbicide on seedlings in this set of trays was in lower plug dry weights of seedlings sprayed at the high rate. Treated plug weights were 0.34 grams less than non-treated control seedlings' plug weights. There were no other **negative** statistical differences in any seedling characteristic (Table 3).

Loblolly pine treated at 1 week post-sowing: With the exception of two characteristics of loblolly seedlings sprayed at the low rate, there were no statistically significant **negative** effects of the herbicide application on any seedling characteristic when compared to the non-treated control seedlings (Table 4). Of seedlings measured from the low rate samples, root collar diameters were 0.24 millimeters smaller and plug dry weights were 0.6 grams less than those of non-treated control seedlings. These two small quantities are generally not of concern to container conifer growers.

Loblolly pine treated at 6 weeks post-sowing: There were no statistically significant **negative** effects of the herbicide application at either rate on any seedling characteristic when compared to the non-treated control seedlings (Table 5).

Loblolly pine treated at 1 and 6 weeks post-sowing: At the high rate of herbicide application, this set showed a statistically significant lower tray fill compared to non-treated seedlings, which averaged 87.9% fill while seedlings treated with the high rate of the herbicide averaged 83.7%. This difference equates to five fewer seedlings per tray. There were no other statistically significant **negative** effects of the herbicide application at either rate on any seedling characteristic when compared to the non-treated control seedlings (Table 6).

Slash pine treated at 1 week post-sowing: In slash pine trays treated one week after sowing, there were no statistically significant **negative** effects of the herbicide application at either rate on any seedling characteristic when compared to the non-treated control seedlings (Table 7).

Slash pine treated at 6 weeks post-sowing: Except for two characteristics of slash pine seedlings sprayed at the low rate, there were no statistically significant **negative** effects of the herbicide application at either rate on any seedling characteristic when compared to the non-treated control seedlings (Table 8). Both shoot and plug dry weights of

seedlings treated with the low rate of Gallery® 75 DF were significantly lower than non-treated seedlings. However, these quantities were less than one gram lower than those of control seedlings. These amounts are generally not concerning to container conifer growers. Increased percent fill over two time periods were quantified in both rates of treated trees, ranging from 2.5% (3 seedlings) to 7.2% (9 seedlings) to when compared to non-treated seedlings during those same time periods.

Slash pine treated at 1 and 6 weeks post-sowing: There were no statistically significant **negative** effects of the herbicide application at either rate on any seedling characteristic when compared to the non-treated control seedlings in these slash pine seedlings (Table 9).

MANAGEMENT IMPLICATIONS

These trials show that Gallery® 75 DF may be a suitable herbicide to apply in longleaf, loblolly, and slash pine containers for weed control. Double applications or a single later application could provide weed control longer into the growing season than early (one week post-sowing) applications without damage to seedlings, according to this initial trial.

The Gallery®75 DF labels for Canada and the U.S. are slightly different. The Canadian label reads *"Gallery™ 75 DF herbicide is a preemergent herbicide for control of certain broadleaved weeds in bareroot and container grown nursery stock" on page 6.* The herbicide's label for U.S. use reads *"Gallery® 75 Dry Flowable specialty herbicide is a preemergence product for control of certain broadleaf weeds in established turfgrass, landscape ornamentals, container grown ornamentals, field grown ornamentals, groundcovers/perennials, ornamental bulbs, non-bearing fruit and nut trees and non-bearing vineyards, Christmas tree/conifer plantations and non-cropland areas."* Note that the wording on the Canadian label lists 'container grown nursery stock' without the added verbiage on the U.S. label of 'container grown ornamentals. The SFNMC staff is currently in contact with Corteva, the manufacturer of this herbicide, to clarify if Nursery Cooperative member nurseries that grow pine seedlings in containers can be considered as an allowable site of use in order to legally use the herbicide in the U.S., or if additional labeling measures must be taken.

ACKNOWLEDGEMENTS

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Table 1. Container longleaf pine seedling characteristics treated with isoxaben (Gallery®75 DF) at 1 week post-sowing on April 1, 2024, at PRT-IFCO Atmore Nursery, Atmore, AL.

Treatment	Timing	Rate (lbs/ac)	Percent fill of tray from sowing[1]	Shoot height (cm) [2,3]	Root collar diameter (mm)	Shoot dry weight (g)	Plug dry weight (g)
Control	none	0.0	68.8 ± 1.27	30.0 ± 0.31 b	8.01 ± 0.14	3.61 ± 0.11	13.0 ± 0.13
low label rate	1 week post-sowing	0.66	67.9 ± 0.75	**31.0 ± 0.23** a	8.16 ± 0.13	3.70 ± 0.86	12.9 ± 0.09
1X label rate	1 week post-sowing	1.00	68.6 ± 2.20	**31.8 ± 0.21** a	8.30 ± 0.12	3.60 ± 0.86	13.1 ± 0.15
p-value			*0.910*	*<0.001*	*0.269*	*0.694*	*0.349*

[1] Calculated from difference in cells containing seeds at sowing (March 25) to cells containing seedlings at collection (November 20).
[2] Bold within a seedling characteristic indicates significant difference between that rate and control (p>0.05).
[3] Different letters within a seedling characteristic indicate significant differences in rates (p>0.05).

Table 2. Container longleaf pine seedling characteristics treated with isoxaben (Gallery®75 DF) at 6 weeks post-sowing on May 6, 2024, at PRT-IFCO Atmore Nursery, Atmore, AL.

Treatment	Timing	Rate (lbs /ac)	Percent fill of tray from sowing[1]	Percent fill of tray from 6 weeks post-sowing[2]	Shoot height (cm)	Root collar diameter (mm)	Shoot dry weight (g)	Plug dry weight (g)[3]
Control	none	0.0	69.3 ± 1.17	97.7 ± 0.81	31.9 ± 0.27	7.86 ± 0.14	3.56 ± 0.14	12.2 ± 0.08 ab
low label rate	6 weeks post-sowing	0.66	68.7 ± 1.22	96.8 ± 1.06	32.2 ± 0.24	7.54 ± 0.12	3.32 ± 0.08	12.1 ± 0.08 b
1X label rate	6 weeks post-sowing	1.00	70.6 ± 1.45	98.6 ± 0.57	32.0 ± 0.24	7.93 ± 0.13	3.55 ± 0.06	12.5 ± 0.09 a
p-value			*0.556*	*0.350*	*0.751*	*0.0764*	*0.151*	*0.027*

[1] Calculated from difference in cells containing seeds at sowing (March 25) to cells containing seedlings at collection (November 20).
[2] Calculated from difference in cells containing seedlings at 6 weeks post-sowing (May 6) to cells containing seedlings at collection (November 20).
[3] Different letters within a seedling characteristic indicate significant differences in rates (p>0.05).

Table 3. Container longleaf pine seedling characteristics treated with isoxaben (Gallery® 75 DF) at 1 and 6 weeks post-sowing on April 1 and May 6, 2024, at PRT-IFCO Atmore Nursery, Atmore, AL.

Treatment	Timing	Rate (lbs/ ac)	Percent fill of tray from sowing[1]	Shoot height (cm)[3]	Root collar diameter (mm)	Shoot dry weight (g)[2, 3]	Plug dry weight (g)
Control	none	0.0	70.3 ± 1.32	32.9 ± 0.23 ab	8.18 ± 0.12	3.73 ± 0.11 a	12.9 ± 0.21
low label rate	1 and 6 weeks post-sowing	0.66	68.7 ± 0.96	32.2 ± 0.23 b	8.21 ± 0.12	3.55 ± 0.08 ab	12.8 ± 0.15
1X label rate	1 and 6 weeks post-sowing	1.00	70.4 ± 1.48	33.1 ± 0.22 a	7.96 ± 0.12	**3.39 ± 0.07 b**	12.9 ± 0.10
p-value			*0.569*	*0.020*	*0.290*	*0.042*	*0.812*

[1] Calculated from difference in cells containing seeds at sowing (March 25) to cells containing seedlings at collection (November 20).
[2] Bold within a seedling characteristic indicates significant difference between that rate and control (p>0.05).
[3] Different letters within a seedling characteristic indicate significant differences in rates (p>0.05).

Table 4. Container loblolly pine seedling characteristics treated with isoxaben (Gallery®75 DF) at 1 week post-sowing on May 6, 2024, at PRT-IFCO Atmore Nursery, Atmore, AL.

Treatment	Timing	Rate (lbs/ac)	Percent fill of tray from sowing[1]	Shoot height (cm)	Root collar diameter (mm)[3]	Shoot dry weight (g)	Plug dry weight (g)[2, 3]
Control	none	0.0	88.3 ± 0.77 ab	29.3 ± 0.34	4.83 ± 0.05 a	2.76 ± 0.08	12.5 ± 0.09 a
low label rate	1 week post-sowing	0.66	92.2 ± 1.02 a	29.9 ± 0.33	**4.59 ± 0.05** b	2.60 ± 0.04	**11.9 ± 0.10** b
1X label rate	1 week post-sowing	1.00	85.6 ± 1.90 b	30.2 ± 0.30	4.84 ± 0.05 a	2.74 ± 0.09	12.2 ± 0.15 ab
p-value			*0.006*	*0.109*	*0.001*	*0.25*	*0.003*

[1] Calculated from difference in cells containing seeds at sowing (April 30) to cells containing seedlings at collection (November 26).
[2] Bold within a seedling characteristic indicates significant difference between that rate and control (p>0.05).
[3] Different letters within a seedling characteristic indicate significant differences in rates (p>0.05).

Table 5. Container loblolly pine seedling characteristics treated with isoxaben (Gallery®75 DF) at 6 weeks post-sowing on June 10, 2024, at PRT-IFCO Atmore Nursery, Atmore, AL.

Treatment	Timing	Rate (lbs/ ac)	Percent fill of tray from sowing[1, 3, 4]	Percent fill of tray from 6 weeks post-sowing[2, 4]	Shoot height (cm)	Root collar diameter (mm)	Shoot dry weight (g)	Plug dry weight (g)
Control	none	0.0	90.1 ± 0.45 b	98.8 ± 0.26 ab	32.0 ± 0.32	5.03 ± 0.24	2.89 ± 0.07	12.2 ± 0.08
low label rate	6 weeks post-sowing	0.66	90.9 ± 0.71 ab	99.6 ± 0.29 a	31.6 ± 0.31	4.84 ± 0.06	2.82 ± 0.07	12.4 ± 0.07
1X label rate	6 weeks post-sowing	1.00	**92.2 ± 0.56** a	98.3 ± 0.43 b	31.2 ± 0.30	4.76 ± 0.06	2.77 ± 0.07	12.0 ± 0.10
p-value			*0.046*	*0.049*	*0.174*	*0.404*	*0.513*	*0.051*

[1] Calculated from difference in cells containing seeds at sowing (April 30) to cells containing seedlings at collection (November 26).
[2] Calculated from difference in cells containing seedlings at 6 weeks post-sowing (June 10) to cells containing seedlings at collection (November 26).
[3] Bold within a seedling characteristic indicates significant difference between that rate and control (p>0.05).
[4] Different letters within a seedling characteristic indicate significant differences in rates (p>0.05).

Table 6. Container loblolly pine seedling characteristics treated with isoxaben (Gallery®75 DF) at 1 and 6 weeks post-sowing on May 6 and June 10, 2024, at PRT-IFCO Atmore Nursery, Atmore, AL.

Treatment	Timing	Rate (lbs/ac)	Percent fill of tray from sowing[1, 2, 3]	Shoot height (cm)	Root collar diameter (mm)	Shoot dry weight (g)	Plug dry weight (g)[3]
Control	none	0.0	87.9 ± 1.00 a	33.2 ± 0.29	4.77 ± 0.05	2.90 ± 0.10	12.4 ± 0.13 ab
low label rate	1 and 6 weeks post-sowing	0.66	88.6 ± 0.92 a	32.5 ± 0.33	4.78 ± 0.06	2.84 ± 0.06	12.2 ± 0.12 b
1X label rate	1 and 6 weeks post-sowing	1.00	**83.7 ± 1.54** b	32.6 ± 0.30	4.79 ± 0.07	2.89 ± 0.11	12.8 ± 0.13 a
p-value			*0.014*	*0.264*	*0.972*	*0.901*	*0.018*

[1] Calculated from difference in cells containing seeds at sowing (April 30) to cells containing seedlings at collection (November 26).
[2] Bold within a seedling characteristic indicates significant difference between that rate and control (p>0.05).
[3] Different letters within a seedling characteristic indicate significant differences in rates (p>0.05).

Table 7. Container slash pine seedling characteristics treated with isoxaben (Gallery®75 DF) at 1 week post-sowing on May 1, 2024, at PRT-IFCO Atmore Nursery, Atmore, AL.

Treatment	Timing	Rate (lbs/ac)	Percent fill of tray from sowing[1]	Shoot height (cm)[2]	Root collar diameter (mm)	Shoot dry weight (g)	Plug dry weight (g)
Control	none	0.0	80.9 ± 1.57	25.2 ± 0.34	4.64 ± 0.07	3.08 ± 0.10	11.8 ± 0.14
low label rate	1 week post-sowing	0.66	83.5 ± 1.40	24.1 ± 0.34	4.59 ± 0.08	2.87 ± 0.14	11.6 ± 0.18
1X label rate	1 week post-sowing	1.00	78.4 ± 2.15	24.7 ± 0.33	4.98 ± 0.18	3.17 ± 0.06	12.0 ± 0.12
p-value			*0.128*	*0.058*	*0.052*	*0.138*	*0.151*

[1] Calculated from difference in cells containing seeds at sowing (April 25) to cells containing seedlings at collection (December 4).

Table 8. Container slash pine seedling characteristics treated with isoxaben (Gallery®75 DF) at 6 weeks post-sowing on June 5, 2024, at PRT-IFCO Atmore Nursery, Atmore, AL.

Treatment	Timing	Rate (lbs/ ac)	Percent fill of tray from sowing[1, 3, 4]	Percent fill of tray from 6 weeks post-sowing[2, 3, 4]	Shoot height (cm)	Root collar diameter (mm)	Shoot dry weight (g)[3, 4]	Plug dry weight (g)[3, 4]
Control	none	0.0	76.9 ± 1.02 b	96.4 ± 0.74 b	26.3 ± 0.37	5.00 ± 0.08	3.48 ± 0.11 a	12.5 ± 0.12 a
low label rate	6 weeks post-sowing	0.66	**84.1 ± 0.88** a	**98.7 ± 0.44** a	26.3 ± 0.37	4.78 ± 0.07	**3.12 ± 0.10** b	**11.8 ± 0.12** b
1X label rate	6 weeks post-sowing	1.00	**81.0 ± 1.08** a	**98.9 ± 0.31** a	26.2± 0.37	4.98 ± 0.08	3.37 ± 0.08 ab	12.4 ± 0.06 a
p-value			*<0.001*	*0.003*	*0.936*	*0.078*	*0.041*	*<0.001*

[1] Calculated from difference in cells containing seeds at sowing (April 25) to cells containing seedlings at collection (December 4).
[2] Calculated from difference in cells containing seedlings at 6 weeks post-sowing (June 5) to cells containing seedlings at collection (December 4).
[3] Bold within a seedling characteristic indicates significant difference between that rate and control (p>0.05).
[4] Different letters within a seedling characteristic indicate significant differences in rates (p>0.05).

Table 9. Container slash pine seedling characteristics treated with isoxaben (Gallery®75 DF) at 1 and 6 weeks post-sowing on May 1 and June 5, 2024, at PRT-IFCO Atmore Nursery, Atmore, AL.

Treatment	Timing	Rate (lbs/ac)	Percent fill of tray from sowing[1]	Shoot height (cm)	Root collar diameter (mm)	Shoot dry weight (g)	Plug dry weight (g)
Control	none	0.0	82.3 ± 1.07	24.5 ± 0.32	4.88 ± 0.08	3.23 ± 0.15	12.0 ± 0.14
low label rate	1 and 6 weeks post-sowing	0.66	83.1 ± 1.11	24.7 ± 0.37	4.80 ± 0.07	3.12 ± 0.12	11.9 ± 0.10
1X label rate	1 and 6 weeks post-sowing	1.00	82.6 ± 0.97	24.3 ± 0.33	4.80 ± 0.07	2.99 ± 0.12	12.0 ± 0.09
p-value			*0.847*	*0.695*	*0.693*	*0.442*	*0.77*

[1] Calculated from difference in cells containing seeds at sowing (April 25) to cells containing seedlings at collection (December 4).