Southern Forest
Nursery Management Cooperative

RESEARCH REPORT 21-06

SUPPLEMENTARY TRIALS OF THREE POSTEMERGENT HERBICIDES IN LOBLOLLY AND SLASH PINE SEEDLING BEDS

by
Nina Payne, Elizabeth Bowersock, Tom Stokes, and Scott Enebak

INTRODUCTION

This study was initiated after results of testing 17 postemergent herbicides were summarized in the Southern Forest Nursery Research Management Cooperative (SFNMC) Report 20-03. In that report, five herbicide compounds were recommended for additional testing as few negative effects on loblolly or slash pine seedling growth had been quantified in previous studies. These five active ingredients, the products used in testing, years tested by the SFNMC, and the number of loblolly and slash pine studies conducted with each herbicide are listed below:

Active ingredient	Product tested	Years tested by SFNMC	# loblolly pine trials	# slash pine trials
mesotrione	Tenacity®	2019	4	1
orthosulfamuron	Strada®	2018, 2019	6	2
primisulfuron	Beacon®	2019	4	1
pyraflufen	Venue®	2018, 2019	6	2
tolpyralate	Shieldex®	2018, 2019	6	2

It should be noted that previous trials of these herbicides included seedlings ranging from nine to eleven weeks old, which should be considered in herbicide evaluations as older seedlings would typically exhibit more tolerance to a chemical application than younger seedlings. The appropriate sites of use and a partial list of controlled weeds from these product labels are listed in Table 1.

From recent bareroot nursery grower reports, one of the most problematic weeds found in SFNMC member bareroot pine seedling nurseries is nutsedge (both yellow and purple species). This weed is often incorrectly identified because its leaves resemble those of grasses; however, herbicides targeting grasses are not effective on nutsedge. There are currently no herbicides approved for nutsedge control in over-the-top spray applications on conifer seedlings in nursery beds. This inability to chemically control this weed once pine seedlings are established leaves few options for its control. Hand-weeding becomes necessary to salvage seedlings when infestations occur later in the growing season. Even if pulled weeds are removed from the field, remaining underground rhizomes and nutlets will sprout the following spring. Total removal of nutsedge plants is labor intensive, requiring digging

a hole of at least 10 inches beyond the edges of the nutsedge patch and at least ten inches deep to remove all rhizomes and nutlets (Clemson University 2021). This is impractical for operational nurseries unless used for small nutsedge patches in seedling growing areas.

To identify a postemergent herbicide that is labeled for nutsedge control and is safe for pine seedlings when applied over-the-top, three of the aforementioned products were tested in studies in 2020. One of the aforementioned products, Tenacity®, was selected for retesting because its label includes yellow nutsedge as a target weed. A second product, Strada®, was selected for retesting because it lists rice flatsedge (another problematic sedge in nurseries) as a target weed and yellow nutsedge as being suppressed. A third product, Shieldex®, was included in retesting because a sufficient quantity was readily available for use while the remaining two products had limited availability during the COVID-19 pandemic ongoing during this trial.

METHODOLOGY

Four SFNMC member bareroot nurseries provided bed space for this trial: the Georgia Forestry Commission's Flint River Nursery near Byromville, Georgia, IFCO's Pine Hill Nursery near Camden, Alabama, IFCO's White City Nursery near Verbena, Alabama, and the K & L Forest Nursery near Buena Vista, Georgia. Soil types of each of these are listed in Table 2. Loblolly pine trials were installed at all four nurseries; slash pine trials were also installed at the Georgia Forestry Commission Nursery and the Pine Hill Nursery. To avoid any complications arising from testing herbicides on multiple-aged seedlings, all spray applications were made when seedlings were nine weeks old, on the following dates:

Nursery	Date of postemergent spray application
Flint River Nursery (Georgia Forestry Commission)	June 29, 2020
Pine Hill Nursery (IFCO)	June 30, 2020
White City Nursery (IFCO)	July 1, 2020
K & L Forest Nursery	July 10, 2020

Each study was installed in a randomized block design on 200 feet of one bed with each treatment plot being one seedling bed wide and 10 feet in length. Five replications were used in each installation. The exception to this plot layout was the study at K & L Forest Nursery, where plots were located on three adjacent seedling beds due to bed orientation. Spray applications were made by SFNMC staff using handheld CO_2 spray equipment calibrated to apply the equivalent product amount of 25 gallons per acre. Rates of each herbicide applied were based on the lowest recommended label rate, with the following rates used:

Product	Quantity applied
Tenacity®	4 ounces per acre
Strada®	1.7 grams per acre
Shieldex®	1 ounce per acre

Operational nursery procedures were carried out on each installation during the remainder of the growing season, including applications of other herbicides if used operationally. Hand-weeding was also allowed if needed to control spot weed infestations in the trial areas.

At the end of the growing season, samples from each plot were collected and taken to the SFNMC laboratory for analysis. The field sampling procedure included collecting all seedlings within one 9-inch by 4-foot counting frame placed in a representative location in each plot. Seedlings from both outside rows were bundled separately from seedlings from interior rows within the counting frame, then these seedlings were placed in a plastic bag labeled with nursery name, pine species, herbicide product, and replication number. At the SFNMC greenhouse, all seedlings from each counting frame were counted to measure seedbed density. Exterior row seedlings were discarded, and a subsample of 25 seedlings from interior rows was randomly selected for measurements of density, seedling height, root collar diameter, and root and shoot dry weights. Measurements of non-treated control seedlings were compared to those of the three herbicide-treated seedlings in order to quantify seedling tolerance. Data was analyzed using Duncan's Multiple Range test and Dunnett's t-test at alpha = 0.05.

DISCUSSION AND RESULTS

Results of each product trial in loblolly and slash pine are included in Tables 3 through 8. Mesotrione (tested as Tenacity®) had no negative effect on loblolly pine seedling growth when applied over-the-top of 9-week-old bareroot loblolly pine seedlings in four nurseries. These results are similar to what was observed and reported in 2019 in four SFNMC member nurseries. In that trial, seedling height of treated seedlings in one nursery was significantly smaller than that of non-treated control seedlings (1.1 centimeters shorter). Three of the nurseries used in the 2019 study were also used in this 2020 study.

The effect of mesotrione on slash pine seedlings differed from that observed when applied over loblolly pine. In the two 2020 installations, smaller seedling characteristics of treated seedlings were recorded from those of non-treated control seedlings. These included smaller RCDs, root and shoot weights, as well as stem length. Therefore, the effects of mesotrione on pine seedlings is species-dependent with slash pine more sensitive to the active ingredient than loblolly pine. Unfortunately, these results are in conflict with the 2019 trial of mesotrione where no negative effects were observed and underscores the importance of repeating trials of a single product.

Orthosulfamuron (tested as Strada®) had no deleterious effects on the growth of either loblolly or slash pine seedlings in the 2020 study. This herbicide was also tested in 2018 and 2019. Of the 8 pine installations in those two years, the only seedling characteristic showing significantly lower measurements of treated seedlings when compared to non-treated control seedlings was that of seedling height in 4 of the 8 installations. However, these differences should be viewed with care

since all seedlings had been top-clipped to a standard height multiple times during the growing season, and the numerical values for the lower heights of treated seedlings ranged from only 0.5 to 1.5 centimeters shorter.

Tolpyralate (tested as Shieldex®) likewise showed no negative effects on either loblolly or slash pine in this 2020 study with the single exception of lower root weight in treated plots of slash pine in one nursery (0.05 grams less than root weights of non-treated control seedlings). This herbicide was also tested in 2018 and 2019 and showed no negative effects on either pine species in those trials.

MANAGEMENT IMPLICATIONS

The three herbicide active ingredients tested in this study, mesotrione, orthosulfamuron, and tolpyralate, show promising results in that they caused little to no negative effects on seedling growth in loblolly pine, and continued this same trend observed in previous studies. Mesotrione is the only herbicide of the three tested that resulted in negative effects of slash pine seedling growth in this 2020 trial. In order to pursue possible Special Use labeling for each product, additional testing needs to be done using higher rates of each product in multiple trials. Also, the two compounds not included in this 2020 study, primisulfuron and pyraflufen, should be retested in future trials.

Because nutsedge is a weed of high concern to many SFNMC member bareroot nurseries, it is recommended that the search for and investigation of non-conifer nursery labeled herbicides specifically targeting yellow and/or purple nutsedge be continued.

ACKNOWLEDGEMENTS

The authors thank staff at the Georgia Forestry Commission nursery, the IFCO Pine Hill and White City nurseries, and the K & L Forest nursery for their willingness to participate in this trial, and for their assistance in seedling collection at the conclusion of the trial.

REFERENCES

Clemson University Cooperative Extension Service. 2021. Nutsedge. [Fact sheet]. https://hgic.clemson.edu/factsheet/nutsedge.

Nichino America. Strada® label. Retrieved from: http://www.cdms.net/ldat/ldC37006.pdf.

Payne N., Nadel R., and Enebak S. 2020. Postemergent herbicide screenings on bareroot pine seedbeds: a summary of multiple product trials 2016-2019. Auburn University, Southern Forest Nursery Management Cooperative. Research Report 20-03: 21 pp.

Payne N., Nadel R., and Enebak S. 2019. Postemergent herbicide screening trials on loblolly and slash pine seedbeds II. Auburn University, Southern Forest Nursery Management Cooperative. Research Report 19-04: 19 pp.

Summit Agro USA. Shieldex®400SC label. Retrieved from: https://summitagro-usa.com/wp-content/uploads/2019/09/SHIELDEX-400SC-Herbicide-Label.pdf.

Syngenta. Tenacity® label. Retrieved from: https://www.greencastonline.com/current-label/tenacity.

Table 1. Five herbicide products from SFNMC Research Report 20-03, their appropriate sites of use, and a partial list of controlled weeds from product labels.

Product tested	Site of use	Partial list of weeds controlled
Tenacity®	turf	yellow nutsedge, pigweed, crabgrass, goosegrass, lovegrass, carpetweed, horseweed, annual bluegrass, chickweed, clover, curly dock, dandelion, Florida pusley, henbit, marestail, oxalis, purslane
Strada®	rice	eclipta, rice flatsedge, gooseweed, morningglory, redstem, prickly sida, smartweed, waterhyssop (suppresses yellow nutsedge, alligatorweed)
Beacon®	corn	beggarweed, wild mustard, ragweed, sicklepod, smartweed, prickly sida (partial control of yellow nutsedge, sandbur, Johnsongrass, horseweed, morningglory, pigweed)
Venue®	hops, various fruit and nut trees, fallow land, pastureland, rangeland, non-cropland, uncultivated agricultural land	bedstraw, Florida beggarweed, field bindweed, carpetweed, chickweed, dandelion, curly dock, dollarweed, eclipta, henbit, lambsquarters, morningglory, white clover, pigweed, prickly sida, wild radish, ragweed, smartweed, leafy spurge
Shieldex®	corn	carpetweed, dandelion, henbit, horseweed, morningglory, pigweed, ragweed, smartweed, crabgrass, goosegrass

Table 2. Soil types at each nursery in the 2020 postemergent herbicide trial.

Nursery	Soil type
Flint River Nursery (Georgia Forestry Commission)	Eustis loamy sand
Pine Hill Nursery (IFCO)	Lenoir silt loam
White City Nursery (IFCO)	Troup loamy sand
K & L Forest Nursery	Lucy loamy sand

Table 3. Bareroot loblolly pine seedling characteristics treated with mesotrione (Tenacity®) in over-the-top applications at 9 weeks post-sowing at four nurseries.

Nursery	Treatment	Density/ ft^2	Shoot Height (cm)	RCD (mm)	Root Weight (g)	Shoot Weight (g)	Root Weight Ratio
Georgia Forestry Commission, GA	Control	26.9	25.5	4.45	0.46	2.19	0.18
	Tenacity®	27.3	25.1	4.39	0.47	2.21	0.17
IFCO Pine Hill, AL	Control	29.6	30.6	4.82	0.45	2.91	0.13
	Tenacity®	28.5	30.7	4.80	0.45	2.94	0.13
IFCO White City, AL	Control	26.7	29.1	5.24	0.55	3.01	0.15
	Tenacity®	25.2	28.4	5.34	0.56	3.06	0.16
K & L Nursery, GA	Control	31.9	25.0	4.89	0.58	2.49	0.19
	Tenacity®	30.5	24.7	4.86	0.57	2.44	0.19

Table 4. Bareroot slash pine seedling characteristics treated with mesotrione (Tenacity®) in over-the top applications at 9 weeks post-sowing at two nurseries.

Nursery	Treatment	Density/ ft^2	Shoot Height (cm)	RCD (mm)	Root Weight (g)	Shoot Weight (g)	Root Weight Ratio
Georgia Forestry Commission, GA	Control	20.0	26.2	4.38	0.54	2.70	0.17
	Tenacity®	20.8	25.8	4.19	0.48	2.17	0.18
IFCO Pine Hill, AL	Control	31.5	27.6	4.49	0.40	2.57	0.13
	Tenacity®	33.6	25.2	4.23	0.37	2.10	0.15

Single underlined means within a seedling characteristic indicate significant treatment difference from that of the non-treated control at that rate according to Dunnett's T-test at alpha = 0.05.

Table 5. Bareroot loblolly pine seedling characteristics treated with orthosulfamuron (Strada®) in over-the-top applications at 9 weeks post-sowing at four nurseries.

Nursery	Treatment	Density/ ft^2	Shoot Height (cm)	RCD (mm)	Root Weight (g)	Shoot Weight (g)	Root Weight Ratio
Georgia Forestry Commission, GA	Control	26.9	25.5	4.45	0.46	2.19	0.18
	Strada®	25.7	25.3	4.39	0.47	2.17	0.18
IFCO Pine Hill, AL	Control	29.6	30.6	4.82	0.45	2.91	0.13
	Strada®	28.8	30.9	4.82	0.45	2.87	0.14
IFCO White City, AL	Control	26.7	29.1	5.24	0.55	3.01	0.15
	Strada®	25.6	29.5	5.30	0.56	3.20	0.15
K & L Nursery, GA	Control	31.9	25.0	4.89	0.58	2.49	0.19
	Strada®	29.4	24.3	4.91	0.60	2.61	0.19

Table 6. Bareroot slash pine seedling characteristics treated with orthosulfamuron (Strada®) in over-the-top applications at 9 weeks post-sowing at two nurseries.

Nursery	Treatment	Density/ ft^2	Shoot Height (cm)	RCD (mm)	Root Weight (g)	Shoot Weight (g)	Root Weight Ratio
Georgia Forestry Commission, GA	Control	20.0	26.2	4.38	0.54	2.70	0.17
	Strada®	19.5	27.0	4.54	0.58	2.87	0.17
IFCO Pine Hill, AL	Control	31.5	27.6	4.49	0.40	2.57	0.13
	Strada®	34.2	25.6	4.20	0.35	2.19	0.14

Table 7. Bareroot loblolly pine seedling characteristics treated with tolpyralate (Shieldex®) in over-the-top applications at 9 weeks post-sowing at four nurseries.

Nursery	Treatment	Density/ ft^2	Shoot Height (cm)	RCD (mm)	Root Weight (g)	Shoot Weight (g)	Root Weight Ratio
Georgia Forestry Commission, GA	Control	26.9	25.5	4.45	0.46	2.19	0.18
	Shieldex®	27.6	25.2	4.37	0.44	2.20	0.17
IFCO Pine Hill, AL	Control	29.6	30.6	4.82	0.45	2.91	0.13
	Shieldex®	31.3	31.0	4.76	0.45	2.79	0.14
IFCO White City, AL	Control	26.7	29.1	5.24	0.55	3.01	0.15
	Shieldex®	26.8	28.5	5.33	0.56	3.06	0.15
K & L Nursery, GA	Control	31.9	25.0	4.89	0.58	2.49	0.19
	Shieldex®	30.3	24.7	4.85	0.56	2.51	0.18

Table 8. Bareroot slash pine seedling characteristics treated with tolpyralate (Shieldex®) in over-the-top applications at 9 weeks post-sowing at two nurseries.

Nursery	Treatment	Density/ ft^2	Shoot Height (cm)	RCD (mm)	Root Weight (g)	Shoot Weight (g)	Root Weight Ratio
Georgia Forestry Commission, GA	Control	20.0	26.2	4.38	0.54	2.70	0.17
	Shieldex®	23.5	26.4	4.24	0.49	2.54	0.16
IFCO Pine Hill, AL	Control	31.5	27.6	4.49	0.40	2.57	0.13
	Shieldex®	33.5	26.1	4.34	0.38	2.34	0.14

Single underlined means within a seedling characteristic indicate significant treatment difference from that of the non-treated control at that rate according to Dunnett's T-test at alpha = 0.05.