Southern Forest Nursery Management Cooperative™

RESEARCH REPORT 24-01

A THIRD YEAR OF VEXIS® (PYRIMISULFAN) TRIALS FOR NUTSEDGE CONTROL IN BAREROOT PINE SEEDLING BEDS

by
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INTRODUCTION

A provision of FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) is Section 24(c), which permits states to register "additional uses of federally registered pesticides" to meet special local needs within a state. Earlier Southern Forest Nursery Management Cooperative (SFNMC) herbicide trials with Reflex® (fomesafen) resulted in its successful 24(c) labeling for use in pine seedling nurseries in several southern states. Applications are made by the herbicide manufacturer to individual states for approval and to the EPA for review. These applications contain information on the scope of the problem being addressed, other possible herbicides currently labeled for the site and target pest, support from potential users of the herbicide, data and analyses from multiple trials, and proposed label information. The application must show that there is a pest problem present (in this case, nutsedge) in the state with no federally registered herbicide available that provides sufficient control in the crop (in this case, pine seedlings grown in beds).

When Vexis® was approved by the EPA in 2018 for use in turf sites, sod production areas, and other nonproduction sites, bareroot conifer nurseries were not listed as approved sites of use. Because its label lists annual sedge and purple and yellow nutsedge as controlled, the SFNMC chose this herbicide for testing in bareroot pine seedling beds in 2021 to control nutsedge and reduce its impact on seedling production costs, quantity, and quality each year. Following successful Vexis® trials in 2021 (Research Report 22-03) and 2022 (Research Report 23-05) in SFNMC member nurseries, additional field studies were installed in 2023. The purpose of this further testing was to provide data on seedling tolerance to the Vexis® manufacturer, PBI-Gordon, for use in 24(c) labeling applications to individual state's pesticide regulatory organizations.

METHODOLOGY

Modifications to previous Vexis® study plans were made in 2023 on the recommendation of the manufacturer to focus on the appropriate rates and timing of applications in bareroot pine seedling beds. Two rates of Vexis® were tested: 1) the current label rate of 2 pounds/500 square feet and 2) twice the current label rate (4 pounds/500 square feet). Two different timing schemes were tested to imitate projected use in seedling beds during the growing season: 1) a single application made at 7 weeks after seeds were sown and 2) two applications made at 7 and 12 weeks after seeds were sown. This double application testing was done to provide seedling tolerance information should an additional second application be needed in the nursery. All applications were made at the noted number of weeks post-sowing, between early June and late July of 2023.

Individual plots were measured and flagged for identification prior to herbicide application. A PVC pipe frame (4' X 5') was placed at each plot to identify the application area. Hand applications of premeasured Vexis® samples were

made by SFNMC staff on plots in both loblolly and slash pine seedling beds. Five replications were installed, for a total of 125 feet per seedling bed used. Field plot layouts are shown in Figure 1. If rainfall did not occur, the herbicide was watered in within 48 hours of application as recommended on its label.

Three nursery sites of varying soil types were selected for testing. These nurseries and soil types are listed below:

Nursery	Soil type
ArborGen Nursery, Shellman, GA	Lucy loamy sand, 0-5% slopes (0-24 inches loamy sand, 24-35 inches sandy loam, 35-70 inches sandy clay loam)
PRT-IFCO Pine Hill Nursery, Pine Hill, AL	Lenoir silt loam, 0-2% slopes (0-2 inches silt loam, 2-6 inches loam, 6-12 inches clay loam, 12-80 inches clay)
Weyerhaeuser Quail Ridge Nursery, Aiken, SC	Lakeland sand, 0-6% slopes (0-80 inches sand)

Treatment information is listed below:

Treatment No.	Description	Rate/Timing
1	control	no treatment
2	1X rate @ 7 weeks	2 lbs/500 ft^2 at 7-weeks post-sow
3	1X rate @ 7 weeks + 12 weeks	2 lbs/500 ft^2 at 7- and 12-weeks post-sow
4	2X rate @ 7 weeks	4 lbs/500 ft^2 at 7-weeks post-sow
5	2X rate @ 7 weeks + 12 weeks	4 lbs/500 ft^2 at 7- and 12-weeks post-sow

At the end of the growing season, seedling samples were collected from each plot in each installation. All seedlings within a 9-inch by 4-foot counting frame placed in each plot were lifted by hand, with outside rows' seedlings marked and separated from inside rows' seedlings. These were taken to the SFNMC laboratory in Auburn, Alabama for measurements. Notes of nutsedge populations in each plot were made.

From seedlings collected in each plot, total seedlings were counted to measure bed density. From each plot's inside rows, a random selection of 25 seedlings were measured for shoot height, root collar diameter, shoot dry weight, and root dry weight. Data was analyzed using R Statistical Software (v4.1.2; R Core Team 2021) to identify significant differences between the means of each measured characteristic with Tukey's Honest Significant Difference (HSD) post hoc test. A significance level at alpha = 0.05 was used for comparisons.

RESULTS

Loblolly pine: No statistically significant negative effects of Vexis® (pyrimisulfan) were quantified in any seedling characteristic in any application. Data and analyses from loblolly pine installations are reported in Tables 1, 2, and 3.

Slash pine: Of seedling characteristics measured, no statistically significant negative effects of Vexis® were quantified with the exception of shoot height in each of the three nurseries (Tables 4, 5, and 6). Similar results were seen in the 2022 trials (RR 23-05). Treated seedling shoot heights were shorter by 1.2 cm (Weyerhaeuser Quail Ridge Nursery), 2.4 cm to 3.4 cm (PRT-IFCO Pine Hill Nursery), and 1.0 cm (ArborGen Shellman Nursery). The determination of herbicidal effect on height of conifer seedlings grown in the southern U.S. is problematic because these seedlings have been top-clipped several times during a growing season. It is practical to identify these differences as biologically insignificant.

Nutsedge: Not all beds included in these trials contained nutsedge. For those that did have patches of nutsedge during the growing season, the presence of healthy nutsedge in nontreated control plots and dead or dying nutsedge in treated plots was seen. The boundary lines between control and treated plots were evident in those beds with nutsedge.

MANAGEMENT IMPLICATIONS

With the submission of this data from 6 new Vexis® trial installations to PBI-Gordon, it is our expectation that the 24(c) label application process for its use in loblolly and slash pine seedling beds will proceed. Should SFNMC member nurseries wish to conduct individual trials of Vexis®, we recommend following the guidelines for testing contained in "How To Test Herbicides In Forest Tree Nurseries", USFS General Technical Report PNW- 127, accessible at https://research.fs.usda.gov/treesearch/7521.

ACKNOWLEDGEMENTS

Our gratitude goes to the managers and staff of the ArborGen's Shellman Nursery, PRT-IFCO's Pine Hill Nursery, and Weyerhaeuser's Quail Ridge Nursery for their provision of bed space and, more importantly, their time and help in trial installation and seedling sample collections. Our thanks also go to Dr. Eric Reasor of PBI-Gordon, for his recommendations on modifications to previous SFNMC Vexis® trials, for providing product samples, and for his guidance on SFNMC efforts in the 24(c) label process. Dr. Wheeler Foshee of Auburn University's College of Agriculture has provided invaluable experience and expertise to streamline our efforts to contribute to the 24(c) label application process.

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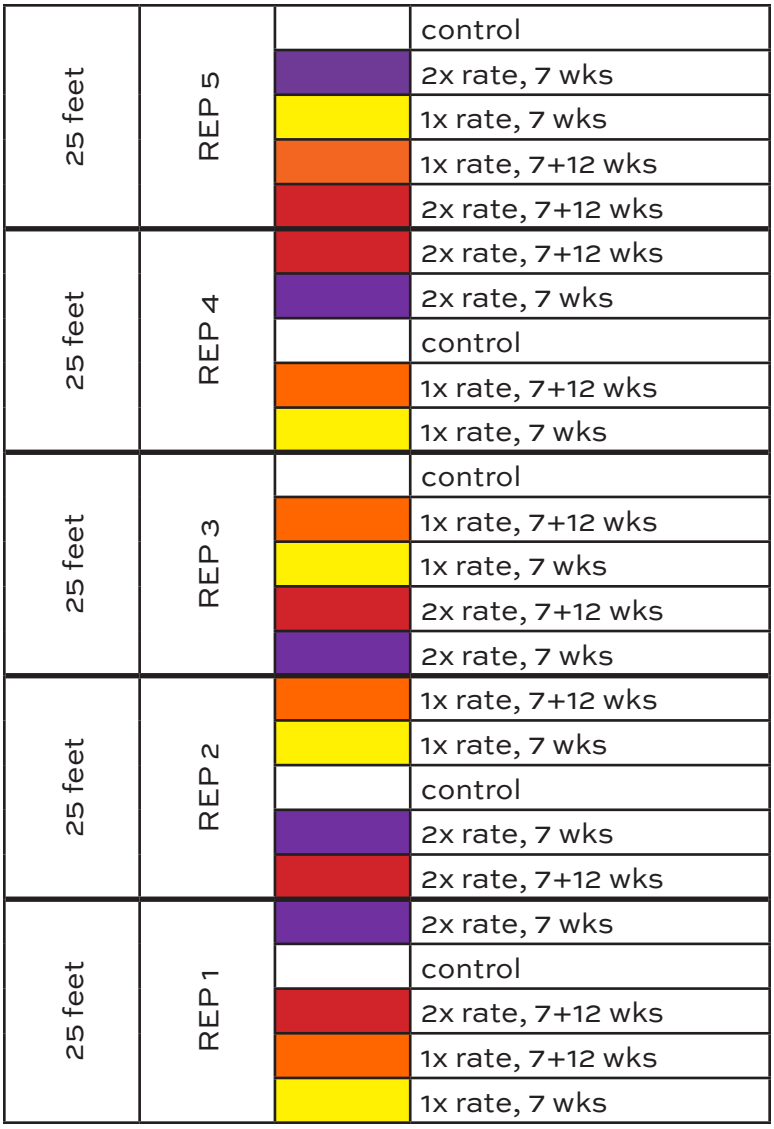

Figure 1. Field layout of plots in pyrimisulfan (Vexis®) trials conducted by the SFNMC in 2023.

Table 1. Bareroot loblolly pine seedling characteristics treated with pyrimisulfan (Vexis®) at 7 weeks and 12 weeks post-sowing on June 2 and July 6, 2023, at Weyerhaeuser Quail Ridge Nursery, Aiken, SC.

Treatment	Rate (lbs./500 ft²)	Density (seedlings/ft²)	Shoot height (cm)	Root collar diameter (mm)	Shoot dry weight (g)	Root dry weight (g)[1,2]
Control	0.0	30.3 ± 2.05	27.9 ± 0.22	4.55 ± 0.04	2.18 ± 0.07	0.41 ± 0.02 a
1X label rate 7 wks	2.0	31.7 ± 1.46	28.0 ± 0.22	4.45 ± 0.04	2.19 ± 0.08	0.41 ± 0.02 a
1X label rate 7 + 12 wks	2.0 + 2.0	29.9 ± 1.38	28.0 ± 0.26	4.71 ± 0.14	2.31 ± 0.07	0.44 ± 0.002 ab
2X label rate 7 wks	4.0	31.9 ± 0.33	27.8 ± 0.22	4.43 ± 0.04	2.17 ± 0.08	0.41 ± 0.01 a
2X label rate 7 + 12 wks	4.0 + 4.0	31.5 ± 1.05	27.2 ± 0.28	4.88 ± 0.31	2.33 ± 0.07	**0.49 ± 0.01** b
p>f		*0.777*	*0.093*	*0.193*	*0.406*	*<0.001*

[1]Bold within a seedling characteristic indicates significant difference between that rate and control.
[2]Different letters within a seedling characteristic indicate significant differences in rates.

Table 2. Bareroot loblolly pine seedling characteristics treated with pyrimisulfan (Vexis®) at 7 weeks and 12 weeks post-sowing on June 17 and July 28, 2023, at PRT-IFCO Pine Hill Nursery, Camden, AL.

Treatment	Rate (lbs./500 ft²)	Density (seedlings/ft²) [1,2]	Shoot height (cm) [1,2]	Root collar diameter (mm) [1,2]	Shoot dry weight (g)	Root dry weight (g)
Control	0.0	17.8 ± 2.72 a	30.0 ± 0.44 a	5.35 ± 0.08 a	3.62 ± 0.27	0.77 ± 0.05
1X label rate 7 wks	2.0	23.5 ± 1.75 ab	**31.6 ± 0.30** b	**6.03 ± 0.34** b	4.45 ± 0.15	0.90 ± 0.03
1X label rate 7 + 12 wks	2.0 + 2.0	**25.9 ± 0.92** b	30.7 ± 0.34 ab	5.67 ± 0.09 ab	4.47 ± 0.36	0.94 ± 0.08
2X label rate 7 wks	4.0	24.6 ± 0.59 ab	30.0 ± 0.30 a	5.41 ± 0.08 ab	3.95 ± 0.28	0.83 ± 0.02
2X label rate 7 + 12 wks	4.0 + 4.0	24.6 ± 1.11 ab	30.8 ± 0.30 ab	5.74 ± 0.07 ab	4.36 ± 0.20	0.95 ± 0.03
p>f		*0.036*	*0.003*	*0.040*	*0.164*	*0.090*

[1]Bold within a seedling characteristic indicates significant difference between that rate and control.
[2]Different letters within a seedling characteristic indicate significant differences in rates.

Table 3. Bareroot loblolly pine seedling characteristics treated with pyrimisulfan (Vexis®) at 7 weeks and 12 weeks post-sowing on June 8 and July 13, 2023, at ArborGen Nursery, Shellman, GA.

Treatment	Rate (lbs./500 ft²)	Density (seedlings/ft²)	Shoot height (cm)	Root collar diameter (mm)[1]	Shoot dry weight (g)	Root dry weight (g)
Control	0.0	17.1 ± 0.65	30.9 ± 0.39	6.70 ± 0.16 ab	5.14 ± 0.14	1.07 ± 0.01
1X label rate 7 wks	2.0	17.4 ± 0.61	30.0 ± 0.46	6.89 ± 0.28 a	5.23 ± 0.18	1.16 ± 0.04
1X label rate 7 + 12 wks	2.0 + 2.0	17.1 ± 0.83	30.6 ± 0.39	6.58 ± 0.10 ab	5.23 ± 0.24	1.18 ± 0.04
2X label rate 7 wks	4.0	17.5 ± 0.56	28.7 ± 0.38	6.36 ± 0.09 ab	4.85 ± 0.19	1.06 ± 0.05
2X label rate 7 + 12 wks	4.0 + 4.0	17.9 ± 0.51	29.5 ± 1.68	6.25 ± 0.09 b	4.60 ± 0.15	1.09 ± 0.06
p>f		*0.878*	*0.349*	*0.042*	*0.092*	*0.271*

[1]Different letters within a seedling characteristic indicate significant differences in rates.

Table 4. Bareroot slash pine seedling characteristics treated with pyrimisulfan (Vexis®) at 7 weeks and 12 weeks post-sowing on June 2 and July 6, 2023, at Weyerhaeuser Quail Ridge Nursery, Aiken, SC.

Treatment	Rate (lbs./500 ft²)	Density (seedlings/ft²)	Shoot height (cm)[1,2]	Root collar diameter (mm)	Shoot dry weight (g)	Root dry weight (g)
Control	0.0	15.9 ± 0.90	28.9 ± 0.24 a	5.80 ± 0.06	4.17 ± 0.18	0.79 ± 0.04
1X label rate 7 wks	2.0	15.7 ± 0.68	28.5 ± 0.22 ab	5.83 ± 0.06	4.18 ± 0.10	0.85 ± 0.03
1X label rate 7 + 12 wks	2.0 + 2.0	16.3 ± 0.57	28.5 ± 0.20 ab	5.93 ± 0.06	4.32 ± 0.11	0.95 ± 0.04
2X label rate 7 wks	4.0	15.9 ± 1.03	**27.7 ± 0.25** b	5.71 ± 0.07	4.17 ± 0.11	0.86 ± 0.04
2X label rate 7 + 12 wks	4.0 + 4.0	15.5 ± 0.93	28.0 ± 0.24 ab	5.79 ± 0.07	4.21 ± 0.20	0.94 ± 0.04
p>f		*0.972*	*0.004*	*0.203*	*0.938*	*0.050*

[1]Bold within a seedling characteristic indicates significant difference between that rate and control.
[2]Different letters within a seedling characteristic indicate significant differences in rates.

Table 5. Bareroot slash pine seedling characteristics treated with pyrimisulfan (Vexis®) at 7 weeks and 12 weeks post-sowing on June 17 and July 28, 2022, at PRT-IFCO Pine Hill Nursery, Camden, AL.

Treatment	Rate (lbs./500 ft²)	Density (seedlings/ft²)	Shoot height (cm)[1,2]	Root collar diameter (mm)	Shoot dry weight (g)	Root dry weight (g)
Control	0.0	20.7 ± 0.79	29.6 ± 0.86 a	6.18 ± 0.08	4.79 ± 0.08	1.02 ± 0.02
1X label rate 7 wks	2.0	20.1 ± 0.93	**26.6 ± 0.44** b	6.41 ± 0.26	4.65 ± 0.18	1.04 ± 0.03
1X label rate 7 + 12 wks	2.0 + 2.0	20.7 ± 0.20	**27.2 ± 0.39** b	6.07 ± 0.09	4.69 ± 0.16	1.08 ± 0.03
2X label rate 7 wks	4.0	19.4 ± 1.20	**26.7 ± 0.44** b	6.30 ± 0.22	4.92 ± 0.30	1.15 ± 0.08
2X label rate 7 + 12 wks	4.0 + 4.0	18.5 ± 0.73	**26.2 ± 0.39** b	6.10 ± 0.09	4.71 ± 0.27	1.15 ± 0.07
p>f		*0.313*	*<0.001*	*0.587*	*0.902*	*0.276*

[1]Bold within a seedling characteristic indicates significant difference between that rate and control.
[2]Different letters within a seedling characteristic indicate significant differences in rates.

Table 6. Bareroot slash pine seedling characteristics treated with pyrimisulfan (Vexis®) at 7 weeks and 12 weeks post-sowing on June 8 and July 13, 2023, at ArborGen Nursery, Shellman, GA.

Treatment	Rate (lbs./500 ft²)	Density (seedlings/ft²)	Shoot height (cm)[1,2]	Root collar diameter (mm)	Shoot dry weight (g)	Root dry weight (g)
Control	0.0	30.8 ± 0.44	24.8 ± 0.14 a	5.83 ± 0.06	3.22 ± 0.09	0.94 ± 0.05
1X label rate 7 wks	2.0	30.8 ± 0.58	24.7 ± 0.16 a	5.64 ± 0.06	3.10 ± 0.07	0.91 ± 0.03
1X label rate 7 + 12 wks	2.0 + 2.0	29.6 ± 0.60	24.3 ± 0.16 ab	5.74 ± 0.06	3.28 ± 0.03	1.03 ± 0.02
2X label rate 7 wks	4.0	29.9 ± 0.29	24.8 ± 0.17 a	5.51 ± 0.06	3.11 ± 0.07	0.91 ± 0.06
2X label rate 7 + 12 wks	4.0 + 4.0	30.1 ± 1.04	**23.8 ± 0.19** b	5.79 ± 0.20	3.23 ± 0.10	1.08 ± 0.04
p>f		*0.598*	*<0.001*	*0.211*	*0.361*	*0.025*

[1]Bold within a seedling characteristic indicates significant difference between that rate and control.

[2]Different letters within a seedling characteristic indicate significant differences in rates.