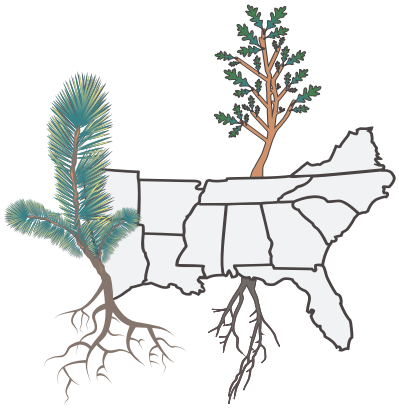

Auburn University Southern Forest Nursery Management Cooperative

RESEARCH REPORT 17-03

PENDULUM® AQUACAP™ (PENDIMETHALIN) APPLICATIONS ON TOLERANCE OF CONTAINER-GROWN LOBLOLLY, LONGLEAF, SHORTLEAF AND SLASH PINE AND ON BLACK WILLOW AND WEED POPULATIONS IN CONTAINERIZED GROWING SYSTEMS

by
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INTRODUCTION

Following numerous successful trials conducted by the Southern Forest Nursey Management Cooperative of pendimethalin applied as Pendulum® AquaCap™ (PAC) in bareroot forest tree nurseries, the operational use of PAC is increasing in Cooperative members' bareroot nurseries. If **applied at sowing**, the use of PAC has decreased the incidence of prostrate spurge (*Chamaesyce maculate*) and other weeds while preventing gall formation that may occur with the use of this herbicide post-sowing.

Although hand-weeding is performed in both bareroot and container forest tree nurseries, the use of this weed control practice in container nurseries is more common in order to produce weed-free seedlings for shipment. Herbicide applications that could control both black willow (*Salix nigra*) and other weeds found in containers could decrease the time and expense of hand-weeding. The quantity and coverage of willow seed in an area is unpredictable year to year so the timing of a PAC application is crucial. The herbicide should be applied **at the time of sowing** the containers and prior to willow seed dispersal if possible. Applications made after willow seed flight could provide control of other weeds.

Because of the positive results of PAC use in bareroot nurseries yet limited information available about the interaction of pendimethalin and organic media, the SFNMC began testing of the herbicide in container nurseries in 2015. Trials of two rates (34 and 68 oz/ac) of PAC were installed at two member nurseries on two pine species to gauge seedling tolerance and the effectiveness of PAC on willow and weed control and tolerance **at sowing**. Results (RR16-03) showed that most growth characteristics of containerized loblolly and slash pine were not affected by applications of PAC. However, lower plug weights in slash pine and smaller root collar diameters (at the high rate only) in loblolly pine suggested the possibility of diminished root production of treated seedlings. Although total willow populations were lower in 2015 than previous years, the quantity of willows in treated trays was statistically less than in non-treated trays. Significant decreases in the number of weeds other than willow were also recorded. The results of the 2015 trials indicated the need for further studies that would include additional pine species and an increase in willow populations (to test for treatment significance) if available.

Therefore, the objectives of this trial were 1) to evaluate the tolerance of container loblolly, longleaf, slash and shortleaf pine to pre-emergent applications of PAC and 2) to assess willow and

METHODOLOGY

Six separate installations of this experimental study were made at IFCO's container nursery in Moultrie, Georgia. The weekly herbicide applications on the containers were scheduled to coincide with black willow seed dispersal with the intent to maximize the numbers of black willow in the study areas. Loblolly, longleaf, shortleaf and slash pine seedlings were included in the study with each weekly application made on the same day that trays were sown. Pendulum® AquaCap™ (PAC) was applied at standard rates of 34 oz/ac or 68 oz/ac over the top of trays sown then capped with sawdust. An additional set of non-treated trays was included each week as controls. Each weekly installation was placed on a different pivot at the nursery to increase the area of opportunity for willow seed dispersal. All herbicide applications were made by SFNMC personnel using a CO_2 hand sprayer calibrated to apply 25 gallons per acre.

Each treatment was one container tray for each tree species that was replicated 25 times for each rate and week of application. Of the 6 weekly installations of this trial, 4 applications (1 per species) were examined in October for seedling tolerance to PAC and weed control. Because two installations each were made for loblolly and slash pine due to the timing of sowing/willow flowering, one installation from each of these species containing the highest willow populations was selected for evaluation. In October, the number of seedlings, willow plants and other weeds were counted in the 300 trays (3 treatments x 25 trays per treatment x 4 species) included in this study. Random samples of 10 seedlings from each tray were removed and transported to the SFNMC laboratory in Auburn, where they were evaluated for seedling shoot height, root collar diameter, presence or absence of stem galls, root dry weight and shoot dry weight. In addition, 10 plugs (media only) were removed from each of the treatments by species and the dry weights of these plugs were used as tare weights for root biomass. Seedling characteristics of treated seedlings (34 oz/ac or 68 oz/ac) were compared to non-treated (0 oz/ac) seedlings to determine tolerance to the rates of PAC applied. Significant differences among them would indicated seedling intolerance to PAC. The seedling and weed data was analyzed using Analysis of Variance (ANOVA). Treatment means were compared at alpha=0.05. Significant differences in treatments were noted if p-values fell below 0.05.

To assess any long-term effects of PAC after outplanting, in December 2016 and January 2017, seedling measurements were made on two 2015 outplanting studies established with containerized loblolly pine seedlings that were treated with Pendulum® AquaCap™ in the 2015 study. These measurements included ground line diameter, seedling height and seedling survival.

RESULTS AND DISCUSSION

Comparable results of this study and of those in conducted in bareroot nurseries show that when PAC is applied at the time of sowing (in containerized systems, applied on the day of sowing), it has no negative effect on shoot height, shoot weight or root collar diameter in any of the 4 species tested (Table 1). This trial is the second conducted by the SFNMC testing Pendulum® AquaCap™ (PAC) in a containerized nursery system. In this trial, loblolly seedlings treated at the high rate had a slightly lower survival rate that non-treated seedlings, although they were unaffected in the 2015 trial. The remaining 3 species showed no negative effects of PAC on survival (Table 1). Because of the outplanting advantages that the intact root plug of a containerized pine seedling offers, maintaining root growth and structure in herbicide-treated plugs is crucial. This study showed that the application of PAC at either low or high rates in loblolly, longleaf, and slash pine did not negatively affect plug weights. Shortleaf pine had lower plug weights at the high rate of PAC (Table 1). The 2015 study showed lower plug weights in slash pine at both rates of PAC. Limited literature on the effect of pendimethalin on plant growth in organic media is available. Most studies on the interaction and activity of pendimethalin in different soil types typically involve silt loam, loamy sand or clay more commonly found in agricultural fields. Because organic media has more binding sites than lighter agricultural soils, it will adsorb more herbicide. While this is a positive aspect in that less leaching is expected, higher quantities of pendimethalin may be needed in order to increase the amount available in soil water for weed uptake.

The 6-week time span of this study coincided with the flowering and seed dispersal of black willow in the vicinity of the nursery, particularly during the time when longleaf and loblolly pine were sown. In trays of these 2 species treated with the high rate of PAC, populations of willow were significantly lower than in untreated trays. Shortleaf and slash pine containers had no difference in the quantities of willow in treated and untreated trays (Table 1), which may be attributed to the time of sowing of these species later in the spring after willow seed had dispersed. There was also a significant decrease in the number of other weeds in loblolly and shortleaf containers treated at the high rate of PAC, although longleaf and slash containers showed no differences (Table 1). These weeds were identified in the trays in October and included annual sedge, prostrate spurge and grass.

As far as any carry-over or long-term effect from container treated PAC, one year after containerized loblolly seedlings from the 2015 study (RR16-03), there was no difference in seedling growth or survival between treated and non-treated seedlings (Table 2).

MANAGEMENT IMPLICATIONS

- The majority of seedling characteristics of containerized loblolly, longleaf, shortleaf and slash pine were unaffected by applications of Pendulum® AquaCap™ (PAC). Plug weights, as a measure of root growth or inhibition, of treated seedlings of **loblolly**, **longleaf** and **slash** pine showed no negative effects of applications of PAC. In the SFNMC 2015 study, slash pine had lower plug weights. In this study, **shortleaf** pine had lower plug weights at the high rate of PAC application, signaling a possible negative impact on root production.
- As in the 2015 study, willow populations were significantly lower in trays of those species whose sowing dates and placement in the nursery coincided with willow seed dispersal.
- When prostrate spurge, annual sedge and grasses are present in a containerized nursery system, Pendulum® AquaCap™ could be an option for control.
- Because pendimethalin may adsorb to organic soils and reduce the amount of herbicide available for weed control, a higher rate may be required for longer control. The inclusion of the highest labelled rate for Pendulum® AquaCap™ needs to be tested.
- The outplanting study using seedlings from the 2015 trial will be continued for one additional year so that second-year measurements can be made to determine any outplanting effects on loblolly seedlings treated with Pendulum® AquaCap™.

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Table 1. Container pine seedling characteristics treated with Pendulum® AquaCap™, IFCO Nursery, Moultrie, GA.

Species	Rate	Survival[1] (% Fill)	Shoot Height (cm)	RCD (mm)	Shoot Weight (g)	Plug Weight[2] (g)	Willow[3] (no./tray)	Other Weeds[3] (no./tray)
Loblolly	Control	97.6 a	28.2	3.83 a	2.42	13.31 a	2.4 a	1.0 a
	Low	97.7 a	28.3	3.71 b	2.43	13.40 a	1.6 ab	1.0 a
	High	96.1 b	28.2	3.87 a	2.48	13.67 b	0.6 b	0.2 b
Longleaf	Control	65.8 ab	24.6	7.28	3.41	12.22	1.6 a	4.4
	Low	67.0 a	25.6	7.23	3.48	12.16	0.3 b	3.0
	High	62.9 b	24.8	7.40	3.51	12.08	0.2 b	2.9
Shortleaf	Control	86.5	23.1	3.66	1.74	10.90 a	0.1	4.0 a
	Low	89.2	23.2	3.72	1.76	10.86 ab	0.0	3.2 a
	High	89.6	23.9	3.80	1.72	10.70 b	0.0	1.9 b
Slash	Control	94.0	27.9	3.94 a	2.35 a	11.56	0.1	2.3
	Low	93.5	28.1	3.97 a	2.45 ab	11.45	0.0	3.0
	High	90.9	28.1	4.12 b	2.54 b	11.44	0.0	1.8

Different letters (a, b) within a seedling characteristic column indicate significant treatment difference in rates according to Duncan's Multiple Range test at alpha = 0.05. 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.

[1] Percent survival based on tray seedling count made in October compared to total number of cells initially sown.

[2] Plug weight includes both media and root dry weight.

[3] Counts of willow or other weeds per tray were made in October at the conclusion of the study.

Table 2. Year 1 measurements of container loblolly pine seedlings treated with Pendulum® AquaCap™ outplanted at two locations.

Location	Rate	Survival (%)	Ht (cm)	RCD (mm)
Nursery A	Control	98	56.1	10.32
	Low	98	58.8	11.03
	High	100	55.1	10.26
Nursery B	Control	92	62.0	12.51
	Low	96	58.9	11.87
	High	94	66.5	12.35

Different letters (a, b) within a seedling characteristic column indicate significant treatment difference in rates according to Duncan's Multiple Range test at alpha = 0.05.

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