Auburn University
Southern Forest Nursery
Management Cooperative

RESEARCH REPORT 17-01

EFFECT OF RATE OF OVER-THE-TOP APPLICATIONS OF MARENGO® (INDAZIFLAM) ON SEEDLING TOLERANCE AND CONTROL OF BLACK WILLOW AND OTHER WEEDS IN CONTAINER-GROWN PINE SEEDLINGS

by
Nina Payne, Scott Enebak and Barry Brooks

INTRODUCTION

The pre-emergent herbicide Marengo® (7.4% indaziflam) was introduced to the ornamental horticulture and turf market in 2013 by OHP, Inc. The herbicide reduces weed development by inhibiting the formation of cell walls in the growing tips of roots, stems and cambium. Now manufactured by Bayer CropScience, LP, the compound is marketed as providing long-term (up to 8-mos) residual control of grass, sedge and broadleaf weeds, including difficult-to-control weeds such as spurge, eclipta and crabgrass. Marengo® is the only pre-emergent herbicide labelled for use inside greenhouses under benches.

Conifer nurseries are listed on the Marengo® label as an acceptable use location as a directed spray to soil, and not on seedlings or seedling beds. Since it became commercially available, the SFNMC has tested Marengo® on both bareroot and containerized seedlings at various rates, times of application and conifer species. Results of these studies in 2013, 2014 and 2015 are reported in Research Reports 14-04, 15-01 and 16-04 and include weed control and seedling characteristic information from both bareroot and container nursery trials.

The first of these studies (2013) showed that the use of Marengo® at the time of sowing in bareroot loblolly pine nursery beds significantly reduced seedling density. However, applications at 6 or 12 weeks post-sowing had no effect on seedling densities and root-weight ratios (RR 14-04). The second of these studies (2014) was installed to evaluate the effect of Marengo® on conifer species in container production systems as there was no information on the interaction of indaziflam and organic media (RR 15-01). The 2014 study was also intended to evaluate the effectiveness of the herbicide in controlling black willow (*Salix nigra*), a troublesome weed in container plugs that requires significant labor to control. Results of the 2014 trials of Marengo® on loblolly, longleaf, shortleaf and slash pine seedlings sprayed at 7+ weeks post-sowing indicated that seedling tolerance to Marengo® in containers was species-dependent. Longleaf pine was the least tolerant, with the herbicide detrimental to RCD, seedling shoot height, shoot weight and root weight. The remaining three conifer species in the 2014 trial had none of these detrimental effects on seedling quality, except for the presence of stem swelling on slash pine seedlings being the least tolerant. The number of willow seedlings in treated container sets were significantly less than in untreated container sets. Thus, the herbicide did reduce willow populations.

The third study, conducted in 2015, was installed in both bareroot and container nurseries (RR 16-04) to confirm the 2014 results of bareroot loblolly and slash pine tolerance to applications of Marengo® at least 6 weeks post-sowing. Results from trials established at three container nurseries showed mixed results, with significant contrasts to the 2014 container study. In the 2015 study, longleaf pine showed greater tolerance to Marengo® as fewer differences in survival, shoot height, shoot weight, root weight and production of new white root tips were observed when compared to untreated seedlings. Treated loblolly and slash pine seedlings showed tolerance to the herbicide as seedling characteristics were measured, but with a tendency to lower root (plug) weights than untreated seedlings. Although no negative effects of the herbicide were observed in the production of new white root tips, two outplanting studies of loblolly pine were established to determine any carryover effect of the herbicide in container plugs.

Because of the observed negative effect on root (plug) weights and the inconclusive results of the two years' of Marengo® studies in container production systems, a third-year study was installed in a container nursery in 2016. It was agreed that this would be the final study as to whether or not Marengo® had a place for weed control in bareroot and container seedling production systems. Therefore, the objectives of this study were to 1) evaluate the tolerance of container-grown loblolly, longleaf, shortleaf and slash pine to single, multiple rate post-sowing applications of Marengo®, and 2) evaluate its effectiveness in controlling black willow and other weeds in container plugs.

METHODOLOGY

The study was installed at the IFCO Moultrie, Georgia production facility in containers sown to loblolly, longleaf, shortleaf and slash pine. Prior to herbicide applications, seedling and weed counts and weed ID were collected from each tray to determine herbicide effect on seedling survival and weed control at the end of the growing season. Single application rates of 3.75 oz/ac (low rate), 7.5 oz/ac (medium rate) and 11.25 oz/ac (high rate) of Marengo® were used. Depending on time of sowing (age of seedlings), herbicide applications were made in April, May or June 2016 by SFNMC personnel with a CO_2 sprayer calibrated to broadcast spray 25 gallons per acre. Studies used 40 trays per pine species.

In October 2016, at the end of the growing season prior to seedling packing, all study trays were removed from pivots and seedling and weed counts along with weed ID were collected from each container set. A random sample of 10 seedlings from each tray of each treatment were removed for measurements of seedling characteristics at the SFNMC laboratory in Auburn. In addition, 30 seedlings of each treatment of each species were placed in aerated tanks for a minimum of 30 days in the SFNMC greenhouse for RGP evaluation. 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.

In December 2016 and January 2017, seedling measurements were made on the two outplanting studies established with loblolly pine seedlings that were treated with Marengo® in the 2015 study. This included ground line diameter, seedling height and seedling survival.

RESULTS AND DISCUSSION

Like the previous trials using this herbicide, the effect of Marengo® over the top of containerized pine was shown to be species dependent. Longleaf pine was most sensitive to the herbicide as lower plug weights and fewer new white root tips were measured in treated seedlings. Plug weights in loblolly and shortleaf were also negatively affected in this trial. Although slash pine plug weights were not available, results from the 2015 study showed that slash pine plug weights were lower in treated than untreated seedlings. Results for other seedling characteristics are similar to observations on these species in both the 2014 and 2015 container pine studies.

As in previous years' experiments, the use of Marengo® had no effect on seedling survival. Seedling inventory at the time of treatment and end of season were similar across all rates and all species. In addition, Marengo® did not affect biomass as shoot dry weights were similar in treated containers and non-treated containers.

Because Marengo® inhibits root growth in plants, two important indicators of the effect of the herbicide on root production in container plugs are measurements of dry root (plug) weight and number of new white root tips produced (to quantify root growth potential). Results in this third year of study showed that longleaf pine is the least tolerant of applications of Marengo as quantified by root (plug) weights and the production of white root tips (Table 1). Loblolly pine exhibited mixed results, with root (plug) dry weights unaffected except measuring lower only at the medium rate of application. Production of white root tips in loblolly pine was unaffected by the herbicide. There was no negative effect of the herbicide on root (plug) dry weights and new white root tip production in shortleaf pine. In slash pine, root (plug) dry weights were not used in this study due to discrepancies in plug weights. Root growth potential (production of white root tips) was not affected by the application of Marengo® in slash pine.

Control of willow using herbicides is an operational solution often requested by container nursery managers. Removal of willow seedlings by hand proves to be labor-intensive and costly. Willow counts and other weeds (and identification of these weeds) were made at the time of herbicide application and again at the conclusion of the study. Significant reduction of willow and other weeds was observed in the longleaf and loblolly trays. The application reduced weeds in treated trays over non-treated trays. However, no effect was seen on these weeds in the shortleaf and slash trays (Table 1). The tree species sown should have no effect on weed control, therefore the "statistical" lack of effect on willow control in the latter two species should not be interpreted as lack of herbicidal effect but rather, weed levels were too low in untreated and treated trays of these two species to allow for a statistical difference. Most likely, since both shortleaf and slash pine are the final species sown at this facility, the timing of their placement on the irrigation pivots missed the willow flowering and seed dispersal process to adequately populate these trays with willow seed.

To determine if herbicide carryover in the plugs of container seedlings occurs, outplanting studies were established in 2015 at two locations using loblolly pine seedlings from the 2015 studies. At the end of one-year after outplanting, measurements of survival, height and root collar diameter were made. No differences were seen when comparing the different rates of treated seedlings to untreated seedlings (Table 2). In hindsight, a better choice to assess the long-term effect of Marengo® on growth of container seedlings will be the utilization of longleaf pine in outplantings,

as the herbicide has been shown to have a detrimental effect on root (plug) weights and on root growth potential in this species.

MANAGEMENT IMPLICATIONS

- For control of willow and other weeds in container production systems, the application of Marengo at lower rates made early enough in the growing season during willow seed dispersal may provide good control.

- Three years of studies of Marengo® in container production systems has shown that root (plug) weights in containerized longleaf, loblolly, slash and shortleaf pine can be negatively affected by the herbicide. In addition, new root growth (as measured by white root tip production) in longleaf pine can be negatively affected by the herbicide application.

REFERENCES

Anonymous. 2016. Marengo® product label. Bayer Environmental Science, Research Triangle Park, NC.

Enebak, S. and N. Payne. 2015. Effect of timing and rate of Marengo® (indaziflam) applications on weed control and tolerance to loblolly, longleaf, slash and shortleaf pine seedlings grown in containers. Southern Forest Nursery Management Cooperative, Auburn University. Research Report 15-01. 15 pp.

Enebak, S., N. Payne and B. Brooks. 2014. Effect of timing and rate of Marengo® (indaziflam) applications on weed control and loblolly characteristics at the ArborGen SuperTree Nursery in Shellman, GA. Southern Forest Nursery Management Cooperative, Auburn University. Research Report 14-04. 8 pp.

Myers, D., R. Hanrahan, J. Michel, B. Monke, L. Mudge, L. Norton, C. Olsen, A. Parker, J.. Smith, and D. Spak. 2009. Indaziflam/BCS-AA10717: A new herbicide for pre-emergent control of grasses and broadleaf weeds for turf and ornamentals. Proc. South. Weed Sci. Soc. 62:394.

Payne, N., B. Brooks, and S. Enebak. 2016. Effect of rate of over-the-top applications of Marengo® (indaziflam) on weed control and tolerance in bareroot and container-grown pine seedlings and timing of directed spray Marengo® (indaziflam) applications on weed control and tolerance in pin oak. Southern Forest Nursery Management Cooperative, Auburn University. Research Report 16-04. 18 pp.

Table 1. Container pine seedling characteristics treated with Marengo®, IFCO Nursery, Moultrie, GA.

Species	Rate	Plug weight[1] (g)	No. White Root Tips	Change in number of willow per tray	Change in number of other weeds per tray
Longleaf	Control	0.96 a	33.9 a	2.8 a	5.1 a
	Low	0.91 a	21.2 b	-0.1 b	0.4 b
	Medium	0.94 a	27.0 b	-0.1 b	-0.8 b
	High	0.35 b	24.6 b	-0.1 b	0.1 b
Loblolly	Control	2.14 b	37.8 a	-0.2 a	0.8 a
	Low	2.50 a	35.4 a	-2.8 b	-0.3 b
	Medium	1.24 c	32.4 a	-3.3 b	-0.3 b
	High	2.17 b	33.5 a	-3.3 b	-0.3 b
Shortleaf	Control	2.11 a	46.1 b	0.0 a	-0.7 a
	Low	2.36 a	55.8 ab	0.0 a	-0.5 a
	Medium	2.14 a	49.3 ab	-0.1 a	-2.2 a
	High	2.42 a	63.8 a	-0.1 a	-2.1 a
Slash	Control	.	29.5 ab	-0.1 a	1.2 a
	Low	.	35.9 a	-0.2 a	-0.4 a
	Medium	.	24.6 b	-0.2 a	-0.1 a
	High	.	30.4 ab	0.1 a	1.3 a

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] Plug weight includes both media and root dry weight.

[2]Counts of willow or other weeds per tray were made in April, May or June and October. Negative numbers indicate decrease in number of willows or weeds per tray from spring to October count. Positive numbers indicate increase in same.

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

Location	Rate	Survival (%)	Ht (cm)	RCD (mm)
Nursery A	Control	98	47.4	9.83
	Low	100	43.5	8.73
	Medium	100	46.4	9.53
	High	98	41.4	8.71
Nursery B	Control	90	57.1	11.17
	Low	94	54.9	11.86
	Medium	98	58.6	10.40
	High	90	61.7	11.66