Moss, Marengo®, and Miles

Update on Herbicide Trials

2015 SFNMC Contact Meeting
St. Simons Island, GA
July 28, 2015

Nina Dowling Payne
SFNMC Staff
Auburn University

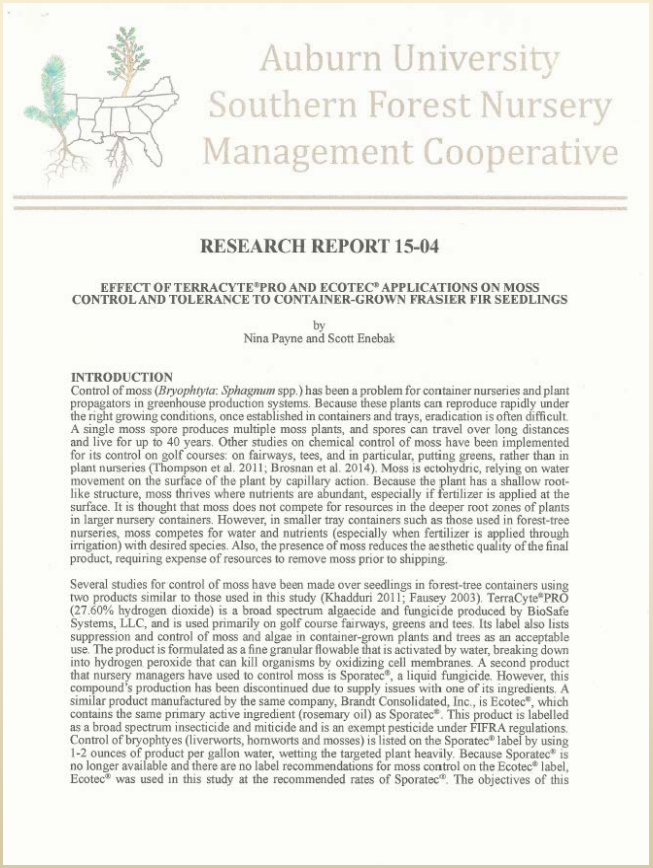
Herbicide trials results and updates:

- 2 trials conducted in 2014
- 7 trials currently in progress in 2015
- Preview of field tour stops at Jesup Nursery

2 container trials conducted in 2014

1. Moss control trial
2. Black willow control trial

TerraCyte® PRO and EcoTec® Trial



Auburn University
Southern Forest Nursery
Management Cooperative

RESEARCH REPORT 15-04

EFFECT OF TERRACYTE® PRO AND ECOTEC® APPLICATIONS ON MOSS CONTROL AND TOLERANCE TO CONTAINER-GROWN FRASIER FIR SEEDLINGS

by
Nina Payne and Scott Enebak

INTRODUCTION

Control of moss (*Bryophyta*: *Sphagnum* spp.) has been a problem for container nurseries and plant propagators in greenhouse production systems. Because these plants can reproduce rapidly under the right growing conditions, once established in containers and trays, eradication is often difficult. A single moss spore produces multiple moss plants, and spores can travel over long distances and live for up to 40 years. Other studies on chemical control of moss have been implemented for its control on golf courses: on fairways, tees, and in particular, putting greens, rather than in plant nurseries (Thompson et al. 2011; Brosnan et al. 2014). Moss is ectohydric, relying on water movement on the surface of the plant by capillary action. Because the plant has a shallow root-like structure, moss thrives where nutrients are abundant, especially if fertilizer is applied at the surface. It is thought that moss does not compete for resources in the deeper root zones of plants in larger nursery containers. However, in smaller tray containers such as those used in forest-tree nurseries, moss competes for water and nutrients (especially when fertilizer is applied through irrigation) with desired species. Also, the presence of moss reduces the aesthetic quality of the final product, requiring expense of resources to remove moss prior to shipping.

Several studies for control of moss have been made over seedlings in forest-tree containers using two products similar to those used in this study (Khadduri 2011; Fausey 2003). TerraCyte® PRO (27.60% hydrogen dioxide) is a broad spectrum algaecide and fungicide produced by BioSafe Systems, LLC, and is used primarily on golf course fairways, greens and tees. Its label also lists suppression and control of moss and algae in container-grown plants and trees as an acceptable use. The product is formulated as a fine granular flowable that is activated by water, breaking down into hydrogen peroxide that can kill organisms by oxidizing cell membranes. A second product that nursery managers have used to control moss is Sporatec®, a liquid fungicide. However, this compound's production has been discontinued due to supply issues with one of its ingredients. A similar product manufactured by the same company, Brandt Consolidated, Inc., is Ecotec®, which contains the same primary active ingredient (rosemary oil) as Sporatec®. This product is labelled as a broad spectrum insecticide and miticide and is an exempt pesticide under FIFRA regulations. Control of bryophtyes (liverworts, hornworts and mosses) is listed on the Sporatec® label by using 1-2 ounces of product per gallon water, wetting the targeted plant heavily. Because Sporatec® is no longer available and there are no label recommendations for moss control on the Ecotec® label, Ecotec® was used in this study at the recommended rates of Sporatec®. The objectives of this

Moss in containers:

- shallow-rooted plant that grows at the surface of container
- competes for water and nutrients
- spreads rapidly with water and fertilizer
- increases weeding costs
- reduces aesthetic quality
- most studies on moss control conducted on golf course turf

2 objectives of the study:

1. What is the tolerance of Frasier fir in containers to different rates and times of application of TerraCyte®PRO and Ecotec®?

2. What is the effectiveness of TerraCyte®PRO and Ecotec® on moss control in containers at different rates and times of application?

one species

Frasier fir

two products

TerraCyte®PRO

- algaecide/fungicide
- wettable powder
- 'nursery container plants and trees'
- cost $50/15 lb.
- golf courses

Ecotec®

- insecticide/miticide
- Liquid/rosemary and peppermint oils
- FIFRA exempt (min. risk)
- cost $300/5 gal.
- agriculture and ornamental nurseries
- replacement for Sporatec®

two rates

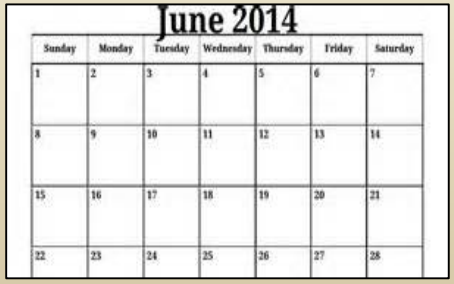
low rate of 10.5 g/gal

high rate of 21.0 g/gal

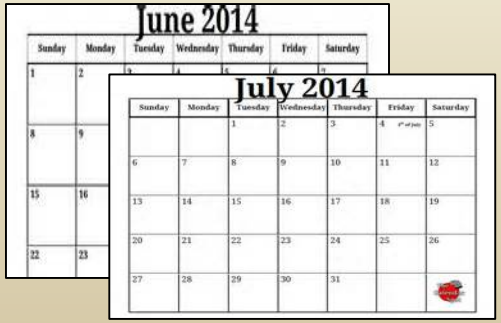
low rate of 2.5 mL/gal

high rate of 5 mL/gal

two timings



June only



June and July

To install this study:

- 45 trays (5 replications of each of the 9 treatments) were removed from benches and labeled
- seedlings in each tray were counted and initial moss coverage was evaluated

- 5 trays of each treatment were sprayed (except control), allowed to dry, then randomly placed back on benches

- process repeated in July for 20 trays receiving sprays twice

At the end of the growing season:

- Made seedling counts in each tray for each treatment
- Evaluated moss coverage in each tray for each treatment
- On samples from each tray for each treatment, measured seedling shoot height, RCD, and root and shoot dry weights

Results on moss control

- Total quantity of moss not controlled by either product, at either rate, by single or multiple applications
- *However,* multiple applications showed a *smaller increase* in moss coverage than single applications (slowed the spread of moss)

Results on Frasier fir tolerance

Frasier fir appeared to tolerate both compounds; however, since we had no moss control, it's hard to determine whether Frasier fir would tolerate these compounds at a higher rate needed to control moss

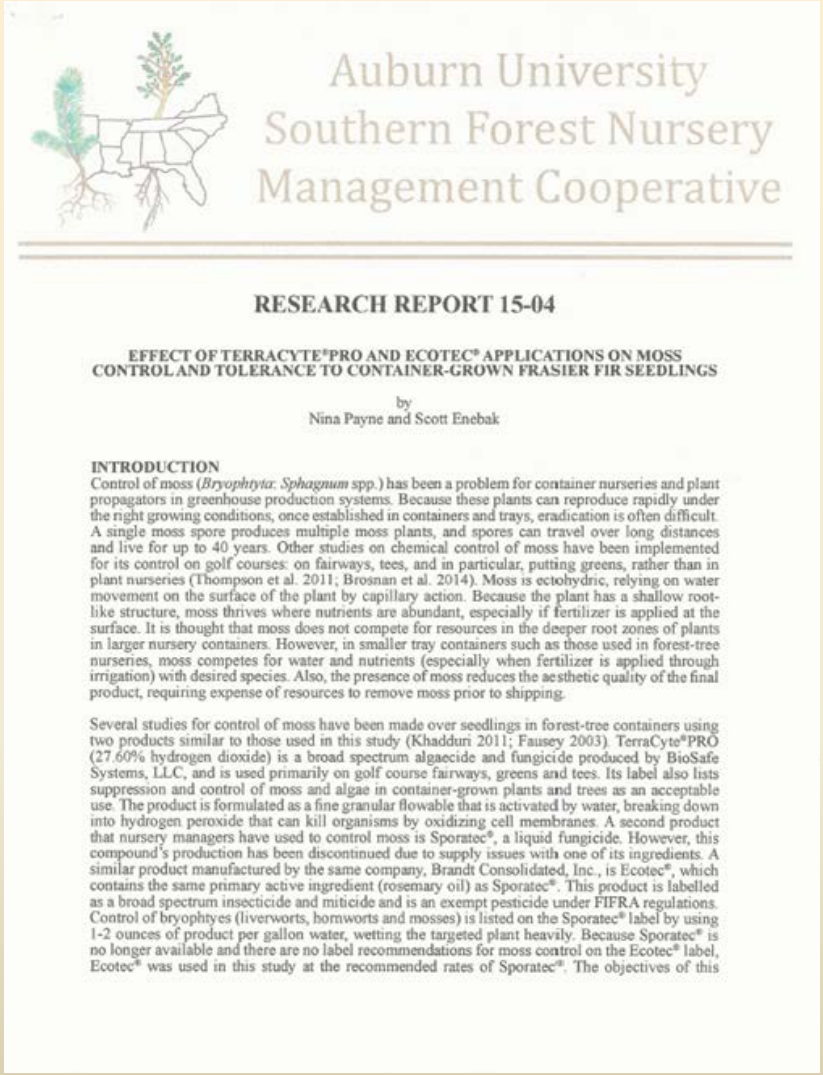
Lessons learned:

- Take preventive measures in greenhouse when possible. Most literature on moss control refers to watering, air circulation and fertilization as cultural practices that may be changed to control moss.

- Initial moss coverage may have been too high at first treatment date (13 weeks post-sowing) to be effective = *treat earlier in season*

- Insufficient number of applications may have been made (at 13 weeks and 19 weeks post-sowing) = *treat more frequently*

Comments and Questions



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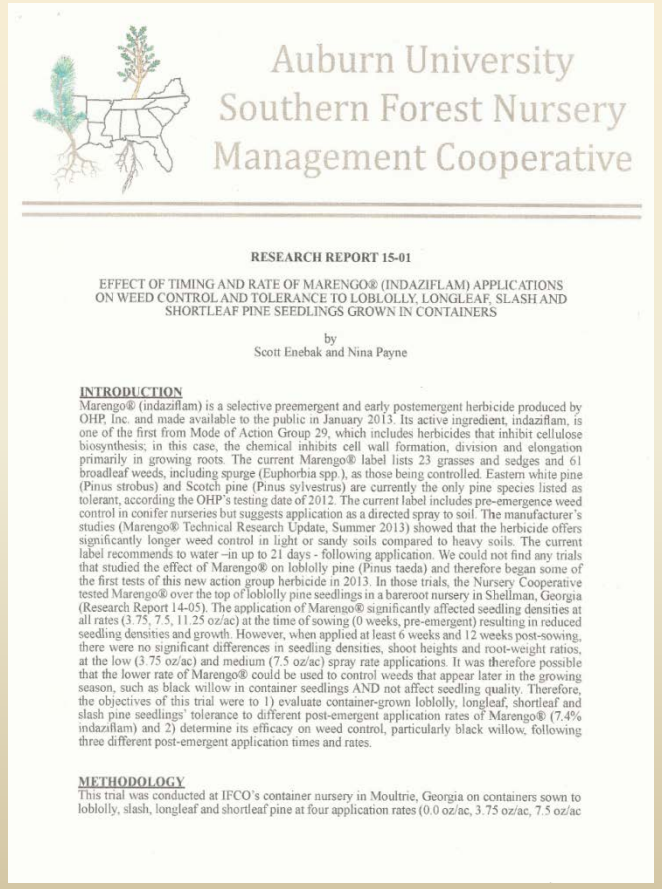
RR 15-04

Marengo® Timing and Rate Trial



Auburn University
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Management Cooperative

RESEARCH REPORT 15-01

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

by
Scott Enebak and Nina Payne

INTRODUCTION

Marengo® (indaziflam) is a selective preemergent and early postemergent herbicide produced by OHP, Inc. and made available to the public in January 2013. Its active ingredient, indaziflam, is one of the first from Mode of Action Group 29, which includes herbicides that inhibit cellulose biosynthesis; in this case, the chemical inhibits cell wall formation, division and elongation primarily in growing roots. The current Marengo® label lists 23 grasses and sedges and 61 broadleaf weeds, including spurge (Euphorbia spp.), as those being controlled. Eastern white pine (Pinus strobus) and Scotch pine (Pinus sylvestrus) are currently the only pine species listed as tolerant, according the OHP's testing date of 2012. The current label includes pre-emergence weed control in conifer nurseries but suggests application as a directed spray to soil. The manufacturer's studies (Marengo® Technical Research Update, Summer 2013) showed that the herbicide offers significantly longer weed control in light or sandy soils compared to heavy soils. The current label recommends to water –in up to 21 days - following application. We could not find any trials that studied the effect of Marengo® on loblolly pine (Pinus taeda) and therefore began some of the first tests of this new action group herbicide in 2013. In those trials, the Nursery Cooperative tested Marengo® over the top of loblolly pine seedlings in a bareroot nursery in Shellman, Georgia (Research Report 14-05). The application of Marengo® significantly affected seedling densities at all rates (3.75, 7.5, 11.25 oz/ac) at the time of sowing (0 weeks, pre-emergent) resulting in reduced seedling densities and growth. However, when applied at least 6 weeks and 12 weeks post-sowing, there were no significant differences in seedling densities, shoot heights and root-weight ratios, at the low (3.75 oz/ac) and medium (7.5 oz/ac) spray rate applications. It was therefore possible that the lower rate of Marengo® could be used to control weeds that appear later in the growing season, such as black willow in container seedlings AND not affect seedling quality. Therefore, the objectives of this trial were to 1) evaluate container-grown loblolly, longleaf, shortleaf and slash pine seedlings' tolerance to different post-emergent application rates of Marengo® (7.4% indaziflam) and 2) determine its efficacy on weed control, particularly black willow, following three different post-emergent application times and rates.

METHODOLOGY

This trial was conducted at IFCO's container nursery in Moultrie, Georgia on containers sown to loblolly, slash, longleaf and shortleaf pine at four application rates (0.0 oz/ac, 3.75 oz/ac, 7.5 oz/ac

Follow-up to 2013 trial using Marengo® (indaziflam) in bareroot nursery *RR 14-04*

1. DO NOT apply Marengo® at sowing

2. Marengo® application at 6 weeks post-sowing at low or medium rates can provide effective weed control without reducing seedling density or height

Willows in containers:

- compete for water and nutrients
- can be unpredictable in seeding rates and coverage
- increase weeding costs

2 objectives of the study:

1. What is the tolerance of four pine species in containers to different rates and times of application of Marengo®?

2. What is the effectiveness of Marengo® on black willow control at different rates and times of application in containers?

four species

loblolly

longleaf

shortleaf

slash

three rates

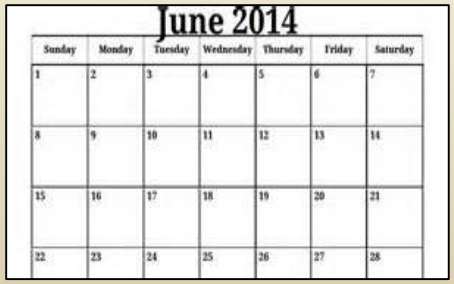
low rate of 3.75 oz/ac

medium rate of 7.5 oz/ac

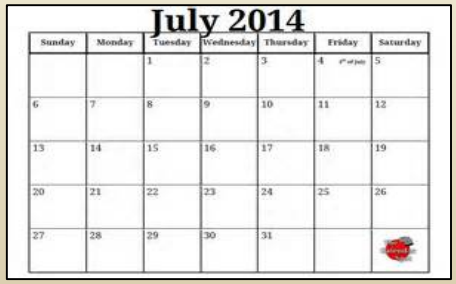
high rate of 11.25 oz/ac

cost is $750-$825/0.5 gal

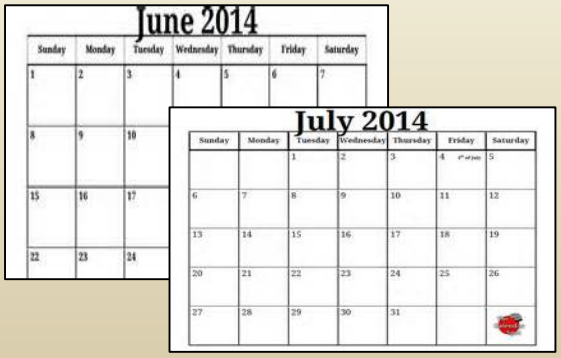
three timings



June only



July only



June and July

To install this study on each of 4 species:

- 50 trays (5 replications of each of the 10 treatments) were removed from benches and labeled
- seedlings and willow in each tray were counted

- 5 trays of each ‘June’ and ‘June and July’ treatment were sprayed (except control), allowed to dry, then randomly placed back on benches

- process repeated in July for trays receiving ‘July’ and ‘June and July’ sprays

As we were preparing to do our July spray (3 weeks after June spray), we saw evidence of Marengo® providing weed control and affecting height growth in loblolly pine.

Untreated (left side) and treated (right side) loblolly pine

High rate (11.25 oz/ac) June only application

As we were preparing to do our July spray (3 weeks after June spray), we saw evidence of Marengo® providing weed control and affecting height growth in longleaf pine.

Untreated (left side) and treated (right side) longleaf pine

Medium rate (7.5 oz/ac) June only application

While at the nursery in August, we saw evidence of Marengo® providing willow control

Loblolly low rate
twice sprayed

Loblolly medium rate
twice sprayed

Loblolly high rate
twice sprayed

At the end of the growing season:

- Made seedling counts in each tray for each treatment
- Counted and evaluated willow and other weeds in each tray for each treatment
- On samples from each tray for each treatment, measured seedling shoot height, RCD, stem swelling, root and shoot dry weights, and root growth potential

As we took the study down, we observed two things:

- Integrity of root plug was not consistent across species

- Some stems had swelling at the ground line

Results on willow control

- Only two of four species had willow present in trays
- Use of Marengo® reduced the number of willow per tray compared to control, for all rates and times of application
- *Timing effect*: early treatment (June) provided better willow control than later season treatments
- *Rate effect*: highest rate of Marengo® produced fewer willows than low and medium rate
- Marengo® is a herbicide than could be used to control willows; however, there is a species difference in tolerance that will limit its use in container nurseries

Results on pine tolerance

Dependent on pine species tested:

- Loblolly – the use of Marengo® had no effect on shoot height, root or shoot biomass compared to control
- Slash – the use of Marengo® had no effect on shoot height, root or shoot biomass compared to control
- Shortleaf – the use of Marengo® had no effect on shoot height or shoot biomass compared to control; however, a trend of lower root biomass compared to control was observed (not statistically significant)
- Longleaf – the use of Marengo® had an inconsistent effect on shoot height, but had effect of lower shoot and root biomass compared to control

Results on pine tolerance, continued

Root collar diameter measurements:

- 3 species exhibited **stem swelling** which increased RCD artificially, so RCD not considered in measuring the effect of herbicide
- Longleaf is the exception – significantly smaller RCD than non-treated control trays

Results on pine tolerance, continued

Stem swelling:

- amount of stem swelling on seedlings was recorded as
  0 = no swelling
  1 = slight swelling
  2 = moderate swelling
  3 = obvious swelling

- Loblolly and shortleaf exhibited lowest stem swelling observations
- Slash exhibited greater amount of stem swelling than loblolly or shortleaf
- Longleaf was not evaluated for stem swelling due to unique growth habit - difficult to quantify if stem swelling had occurred

In a method to determine any long-term effects of the herbicide, we examined Root Growth Potential (RGP) of the seedling

Samples from twice-treated trays of each species were placed in tanks of aerated water for one month to measure root growth potential (RGP)

Root Growth Potential is measured by the number of new white root tips as shown here

This is commonly what is observed in RGP tanks with new white root tips

Our RGP test results, for all species and treatments including control, showed very few white root tips and no differences between treatments or control ???

- treated and non-treated seedlings were placed in the same tank
- if any active ingredient remained in plug at the time seedlings were placed in the tank, then it would have been distributed to all seedlings in the tank where roots were continually being ‘washed’ in the active ingredient

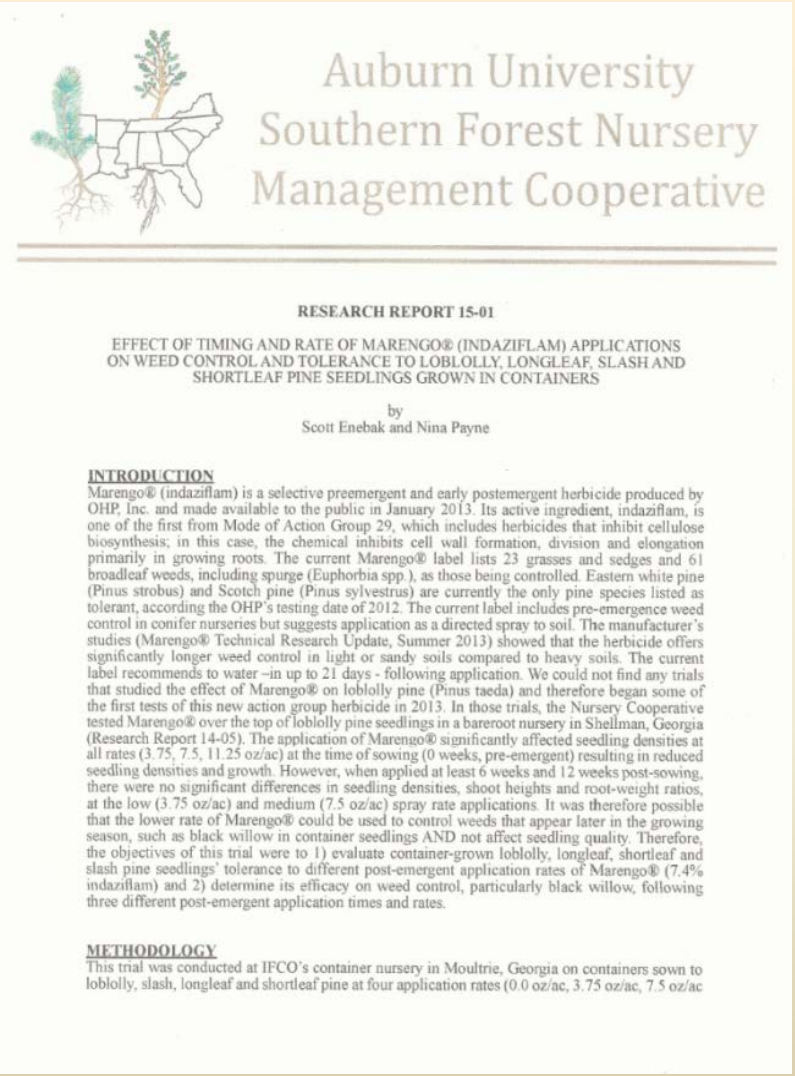
RGP test results were inconclusive and tests should be repeated

Lessons learned:

- *Weeds*: it is possible to control weeds in container loblolly, slash, and shortleaf pine using Marengo® at lower rates early in the season (at least 6 weeks after sowing)
- *Stem swelling*: the use of Marengo® causes stem swelling on loblolly, shortleaf, and slash pine (slash is least tolerant); more outplanting studies should be conducted to determine effect of stem swelling on survival and growth if Marengo® is to be used for willow control
- *Herbicide carryover*: additional RGP and outplanting studies are needed to evaluate possibility of carry-over of Marengo® in container media (as seen in this study's RGP tests) if Marengo® is to be used for willow control
- *Longleaf:* Marengo® is not a good option in longleaf due to significantly lower root biomass, shoot height, shoot biomass and root collar diameter

At the end of the growing season, this was commonly seen in longleaf plugs sprayed at the high rate

Comments and Questions



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RR 15-01

Summary of 7 trials currently in progress:

Marengo®:

- container trial
- bareroot trial
- directed spray trial

Pendulum® AquaCap™:

- container trial
- bareroot trial
- hardwood trial
- soil type trial

Marengo® container trial

- follow-up to 2014 container trial (*RR 15-01*)
- installed at 3 nurseries on 4 species in 2 container types
- each species sprayed at 3 rates with single application made between 6 - 8 weeks post-sowing

The objectives of the study:

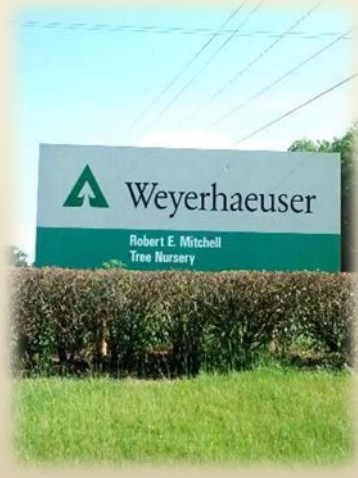
1. To determine the tolerance of four pine species in containers to different rates of Marengo®

2. To determine the effectiveness of Marengo® on black willow control at different rates in containers

3. To determine the effect of Marengo® on pine in plastic and Styroblock containers

Marengo® bareroot trial

- follow-up to 2013 bareroot trial (*RR 14-04 – 1 nursery)*
- installed at 5 nurseries on 3 species (loblolly, slash, eastern red cedar)
- pine sprayed at 3 rates with single application made between 6 - 8 weeks post-sowing; cedar sprayed at 3 rates on same date (winter sown - 20 weeks)



The objectives of the study:

1. To determine the tolerance of two pine species and eastern red cedar to different rates of Marengo®

2. To determine the effectiveness of Marengo® on spurge and weed control at different rates

Marengo® directed spray trial

- further development of 2 trials for morning glory control in hardwoods (*RR 13-05* and *RR 14-05* used broadcast spray applications)
- installed at East Tennessee Nursery (TN DOF) on one species (pin oak)
- directed sprayer used to apply one rate at single and multiple applications

The objectives of the study:

1. To determine the tolerance of pin oak to Marengo® with multiple applications

2. To determine the effectiveness of Marengo® on morning glory and weed control with multiple applications

Pendulum® AquaCap™ container trial

- to consider alternative herbicide in containers for willow control
- PAC controls weeds in bareroot nurseries with no detrimental effect to pine when sprayed at sowing (*RR 08-05, 09-01, 10-14, 11-05, 12-01, 12-05, 13-04, 14-01, 14-02, 14-03, 14-06)*
- despite previous SFNMC studies with PAC, it has not tested in containers with organic matter

Pendulum® AquaCap™ container trial, *continued*

- installed at 2 nurseries on 2 species
- sprayed with 2 rates
- sprays made weekly for up to 6 weeks (on newly-sown trays each week) in order to coordinate spray with pine sowing and willow seed dispersal

The objectives of the study:

1. To determine the tolerance of four pine species to Pendulum® AquaCap™ in containers

2. To determine the effectiveness of Pendulum® AquaCap™ on willow and weed control in containers

Pendulum® AquaCap™ bareroot trial

- follow-up to PAC bareroot trials
- installed at 1 nursery on 2 species
- each species sprayed with 2 rates at sowing

The objectives of the study:

1. To determine the tolerance of two pine species to Pendulum® AquaCap™

2. To determine the effectiveness of Pendulum® AquaCap™ on weed control

Pendulum® AquaCap™ hardwood trial

- further development of PAC hardwood studies (*RR 12-03*, *13-05*) and PAC study on small-seeded species (*RR 13-03*)
- installed at 1 nursery on 1 species (buttonbush)
- sprayed with 2 rates at 6 weeks post-sowing; all weeds removed from test area to simulate ‘at sowing’ bed conditions

The objectives of the study:

1. To determine the tolerance of buttonbush to Pendulum® AquaCap™

2. To determine the effectiveness of Pendulum® AquaCap™ on weed control (primarily morning glory)

Pendulum® AquaCap™ soil type trial

- to determine effect of soil type on herbicide gall formation after PAC application, at controlled temperature
- installed in SFNMC greenhouse on AU campus
- one species sown in 2 soil types sprayed with PAC at 6 weeks post-sowing in order to induce herbicide gall formation

The objective of the study:

1. To determine the effect of soil type on herbicide gall formation when temperature variable is removed

These are current herbicide trials:

Marengo®:
- container trial
- bareroot trial
- directed spray trial

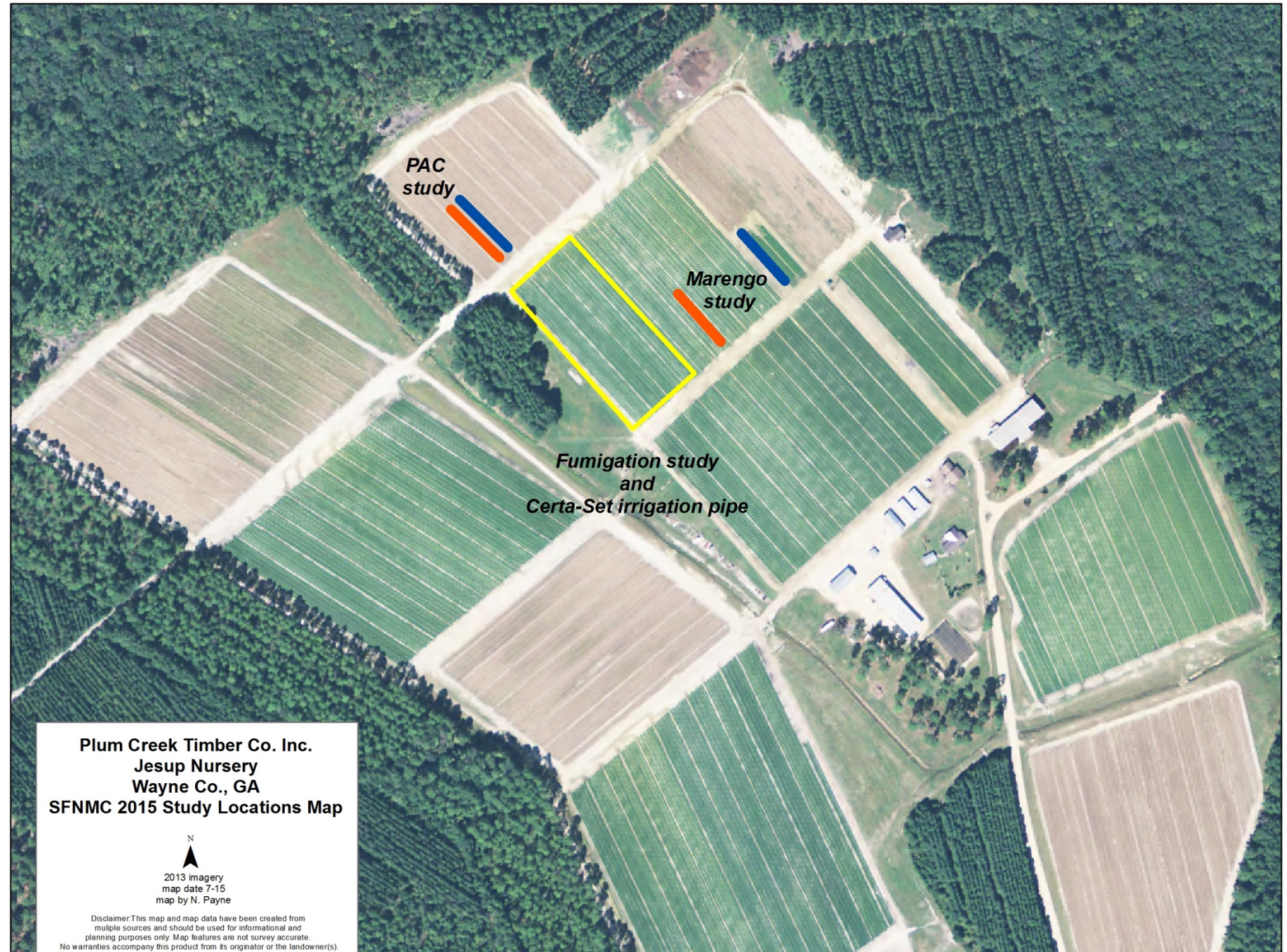
Pendulum® AquaCap™:
- container trial
- bareroot trial
- hardwood trial
- soil type trial

These trials will be completed this season, with results in research reports.

Comments and Questions

Preview of field tour stops at Jesup Nursery:

- Fumigation study
- Marengo® trial - 2 species sprayed 6 weeks post-sowing
- Pendulum® AquaCap™ trial - 2 species sprayed at sowing



Plum Creek Timber Co. Inc.
Jesup Nursery
Wayne Co., GA
SFNMC 2015 Study Locations Map

N

2013 imagery
map date 7-15
map by N. Payne

Disclaimer:This map and map data have been created from muliple sources and should be used for informational and planning purposes only. Map features are not survey accurate. No warranties accompany this product from its originator or the landowner(s).

Recap

- 2 trials conducted in 2014
- 7 trials currently in progress in 2015
- Preview of field tour stops at Jesup Nursery

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