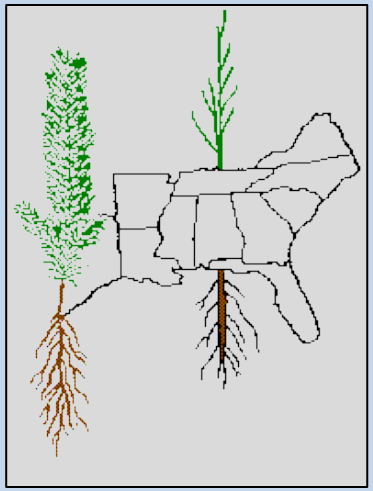
Pendimethalin Herbicide Galls on Pine and Hardwood Seedlings



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Results from six *Pinus taeda* nursery trials with the herbicide pendimethalin in the USA

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The formation of herbicide galls is most likely dependant on three factors:

1. Specific nursery (possibly climate, soils, OM, etc?)

2. Timing of application
   (at sowing; 2, 4, or 8 weeks post-sowing)

3. Rate applied
(34 or 68 oz of product per acre)

Historically: Herbicide Galls by Nursery and Application Timing

Nursery	Timing	Galls	Total
A	pre	0	6
	post	6	
B	post	13	13
C	pre	1	71
	post	70	
D	pre	0	174
	post	174	
E	pre	13	481
	post	468	

Total Number of Herbicide Galls
Timing of Application

- Applied over seed at sowing:

14

- Applied over emerged seedlings:

731

Historically: Herbicide Galls by Amount of PAC Applied to Emerged Seedlings

Nurseries	# Trials	PAC Amount	Galls	Nursery E
4	5	34	85	100% (2)
	5	34 + 34	184	95% (2)
	10	68	231	77% (3)
	5	68 + 68	159	19% (1)

Nursery D accounted for 79%

Some hardwoods are also affected by pendimethalin.

- Stem galls/swellings or hypocotyl constriction has been observed (to our knowledge) on:
  - Sugarberry
  - Maple
  - Common apple ???

In 2011, pendimethalin (Pendulum AquaCap) was tested on hardwoods:

Nursery	Tree Species	Timing	Rate (oz/acre)
Chatsworth, GA	Sycamore	Seed	34 & 68
Chatsworth, GA	Black oak	Seedling	34 & 68
East TN	Cherrybark oak	Seedling	34 & 68
East TN	Sawtooth oak	Seedling	34 & 68

- Measurements: heights, root collar diameter, shoot dry weight, and seedling density (sycamore only)
- Seedlings were evaluated for herbicide galls.

Sycamore Seedling Density

Treatment	Rep	# trees	Mean
Control	1	43	45.0 a
	2	65	
	3	27	
PAC-34 oz/ac	1	12	18.0 b
	2	23	
	3	19	
PAC-68 oz/ac	1	9	3.7 b
	2	0	
	3	2	

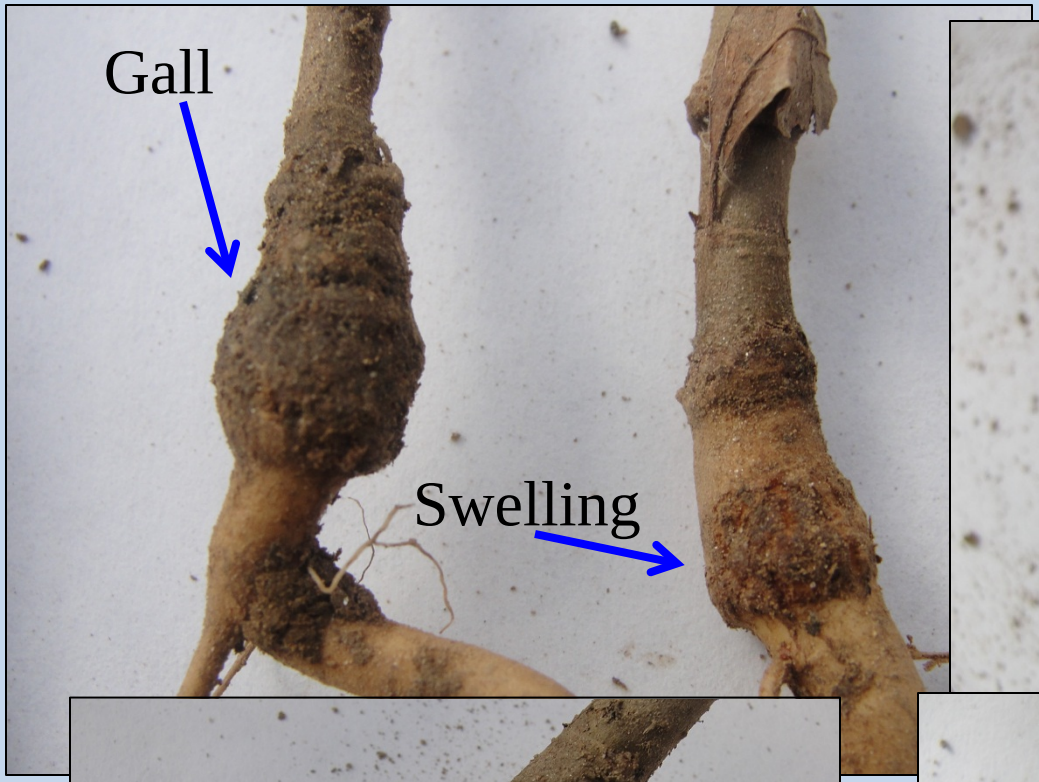
LSD = 26.9

Non-treated Control

PAC-34 oz/acre

PAC-68 oz/acre

Galls/Swellings on Sycamore



Galls/Swellings on Sycamore

Treatment	N	Swellings	Galls	%
Control	30	0	0	0
PAC-34 oz/ac	31	6	8	45
PAC-68 oz/ac	12	4	4	67

Cherrybark Oak

Cherrybark Oak-Seedling Morphology

Treatment	RCD (mm)	Height (cm)
Control	8.89 a	111.4 a
PAC-34 oz/ac	8.28 a	104.1 ab
PAC-68 oz/ac	7.36 a	97.3 b
LSD	*(2.23)*	*(11.0)*

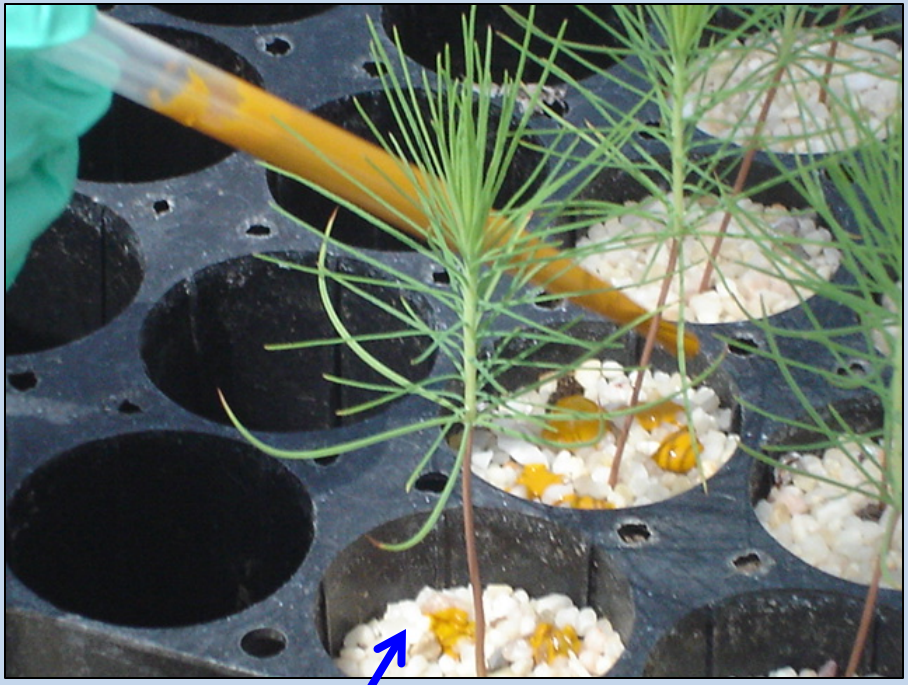
The height difference would not have been detected if seedlings were top-pruned.

Summary-PAC on Hardwood Seedlings

- Galls/swellings on sycamore at sowing (PAC applied over sawdust)
- Sycamore seedling density decreased as PAC rate increased.
- Cherrybark oaks were shorter as PAC rate increased.
- Heights of sawtooth oak, black oak, and sycamore were not affected by PAC.
- RCD was not affected on any species.

Painting Pendimethalin on Loblolly Pine Seedlings

Null hypothesis: Applying concentrated Pendulum AquaCap (PAC) directly to the seedling stem, needles, and container media does not affect the formation of herbicide galls.

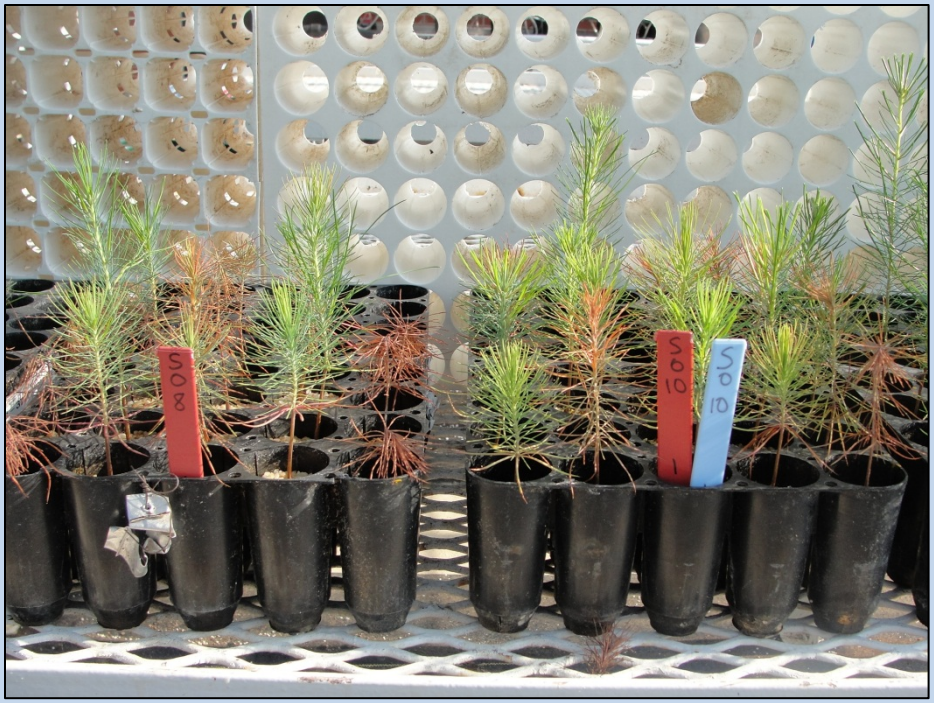


Media

Stem

Needle

- PAC was applied 8 weeks after germination (8).
- PAC was applied again to half of the treated seedlings 10 weeks after germination (8+10).
- PAC was used straight from the bottle and not diluted.



Media Treatment

Treatment	Container Survival (%)
Media 8	38
Media 8+10	38
Needle 8	100
Needle 8+10	96
Stem 8	96
Stem 8+10	89
Control	100


Controls-No galls
Media treatment-Galls occurred without PAC touching the seedlings

Media Treatment-Measurements

- Seedlings were broken up into 4 categories:
  1) Healthy control seedlings.
  2) Healthy looking seedlings from each media treatment (8 wks & 8 + 10 wks applications).
  3) Stressed seedlings from each media treatment.
  4) Dead seedlings from each media treatment.


Media- 10 R1
Healthy-
No herbicide
Healthy-
Herbicide
Stressed-
Herbicide
Dead-
Herbicide

PAC Media Treatment: Seedling Morphology

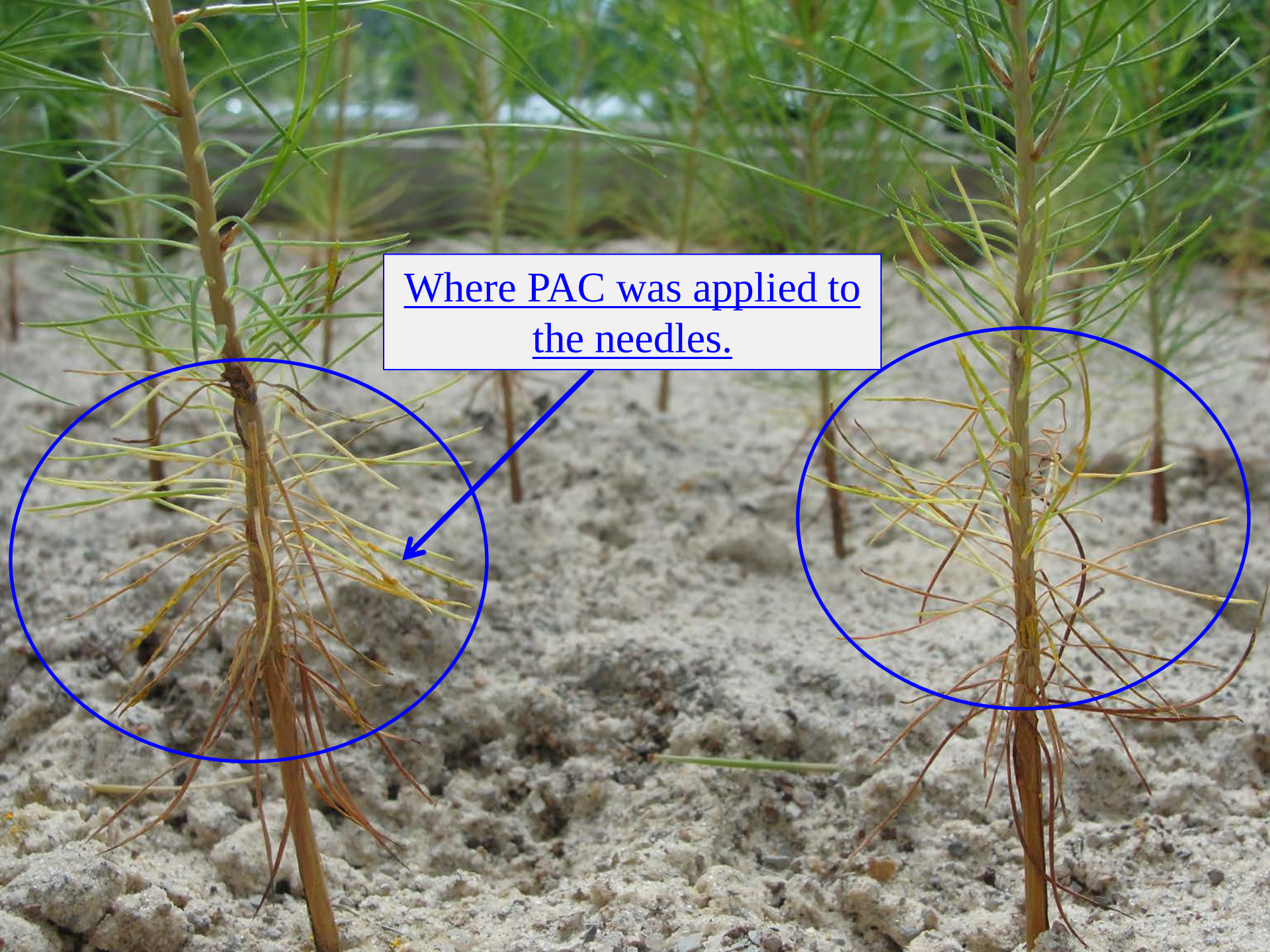
PAC Treatment (wks)	Quality	N	RCD (mm)	Height (cm)	Root Tips (#)
8	healthy	16	3.17 b	15.8 b	90.9 b
8 + 10	healthy	14	3.79 a	13.6 c	65.6 bc
Control	healthy	20	2.11 d	18.8 a	224.2 a
LSD			*(0.31)*	*(1.5)*	*(26.2)*

- Healthy control seedlings had a similar RCD as dead seedlings in treated media.
- The presence of stem galls increased the RCD of seedlings grown in treated media.
- Healthy control seedlings were taller than all other seedlings grown in treated media.

- Healthy control seedlings had significantly more roots than healthy seedlings grown in treated media and the decrease in the number of roots was more severe with two PAC applications.

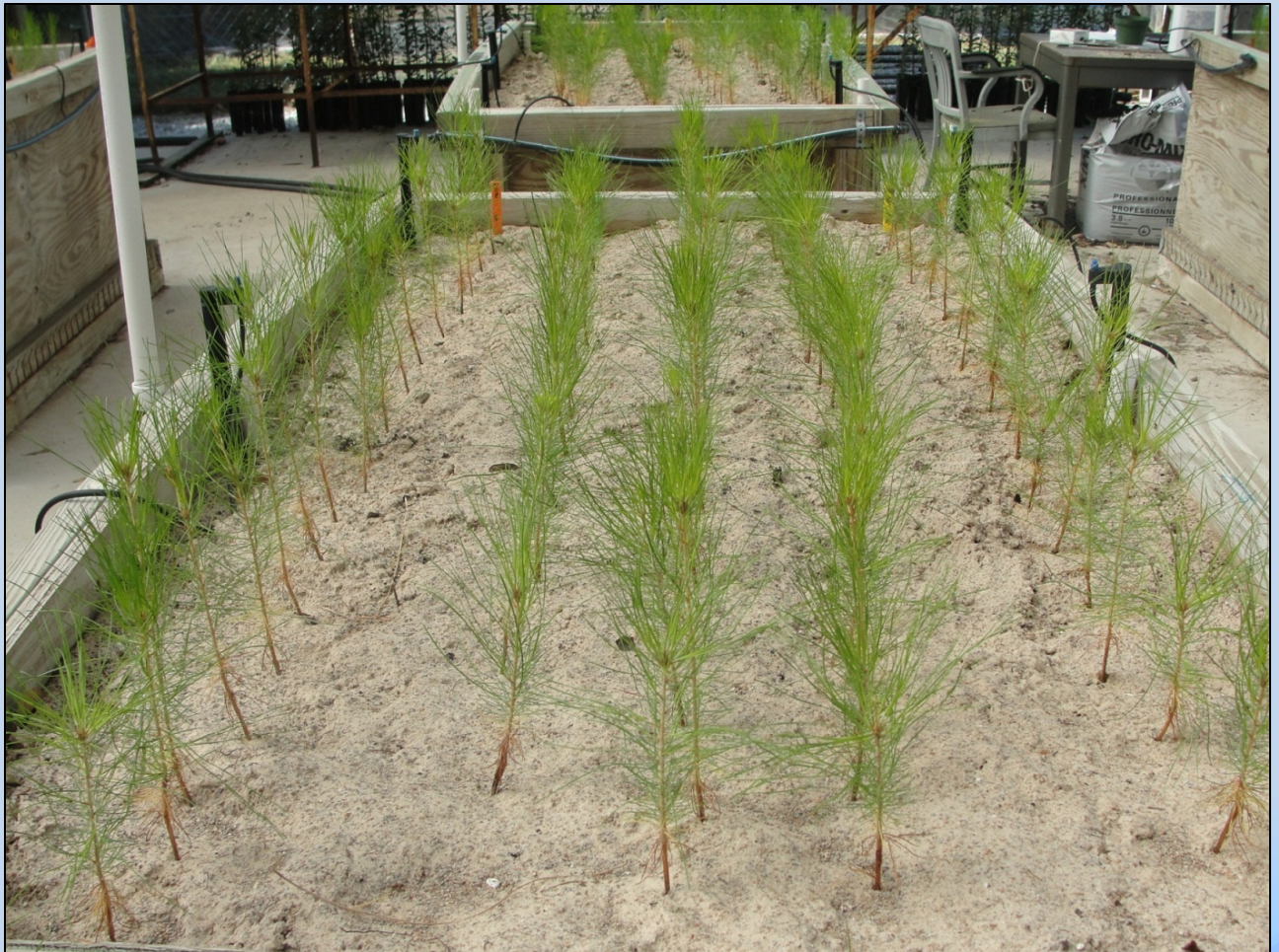

Control
Stem- treated


Control


Where PAC was applied to the needles.

Outplanting Performance

- Seedlings were outplanted into stress boxes on October 6, 2011.
- They were not watered from February 1 to May 3, 2012.
- After May 3, seedlings were watered twice per week.
- Seedling survival, RCD, and height were recorded on July 2, 2012.



Outplanting Results-Root Collar Diameter

PAC Treatment (weeks post-sow)	RCD (mm) Oct 6, 2011	RCD (mm) July 2, 2012	RCD growth (mm)
Stem 8	3.09 ab	3.90 a	0.81 a
Stem 8+10	3.17 ab	3.87 a	0.71 a
Needle 8	3.54 a	3.63 b	0.09 b
Needle 8+10	3.27 ab	3.40 c	0.12 b
Control	2.76 b	3.21 c	0.45 ab
LSD	*0.53*	*0.20*	*0.55*

Outplanting Results-Height

PAC Treatment (weeks post-sow)	Height (cm) Oct 6, 2011	Height (cm) July 2, 2012	Height growth (cm)
Stem 8	18.3 b	23.1 b	4.9 b
Stem 8+10	16.9 c	21.3 c	4.5 b
Needle 8	20.7 a	26.8 a	6.1 a
Needle 8+10	18.3 b	23.5 b	5.2 ab
Control	18.8 b	22.7 bc	4.0 b
LSD	*1.0*	*1.4*	*1.2*

Outplanting Results-Survival

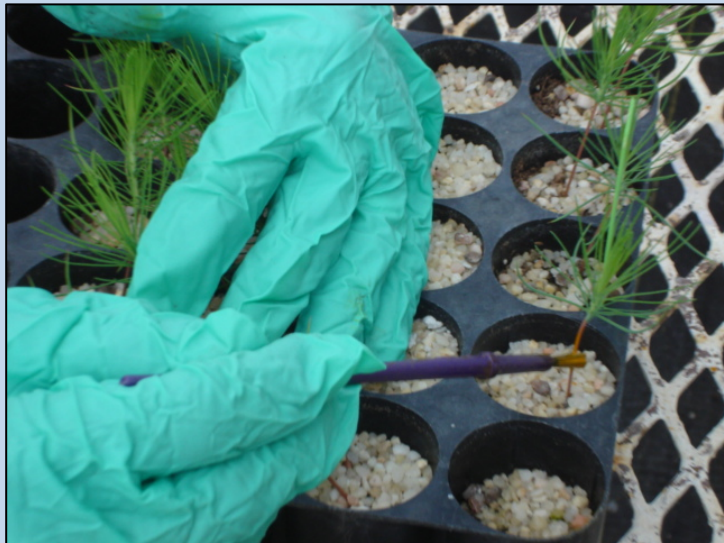
PAC Treatment (weeks post-sow)	Survival (%)
Stem 8	100
Stem 8+10	100
Needle 8	99
Needle 8+10	99
Control	98

Summary-PAC Media Treatment (PAC did not touch seedlings)

- Stem swellings
- Poor survival in greenhouse (38%)
- Dead seedling RCD = Control seedling RCD
- Healthy seedlings with PAC media were shorter and had fewer root tips than control seedlings.
  - (especially with double app.)

Summary-PAC Stem Treatment (PAC touched seedlings)

- Stem swellings/galls
- Larger RCD (numerically) than controls (due to swellings)
- Good survival in greenhouse (93%)
- Shorter seedlings with 2 applications



Summary-PAC Needle Treatment (PAC touched seedlings)

- No stem swellings/galls
- Good survival in greenhouse (98%)
- Larger RCD and taller than controls with one application of PAC

Summary-Outplanting Performance (in stress boxes)

- More RCD growth with PAC on stem (increased RCD due to galls)
- Most height growth for PAC applied to needles at 8 weeks
- Stem galled seedlings = 100% survival

2012 Pendulum AquaCap Trials Underway

- PAC applied to either loblolly pine seed at sowing or seedlings 8 weeks post-sowing at three rates: 17, 34, and 68 oz/acre.

- PAC applied to various sized hardwood seed at sowing: green ash, red maple, black gum, pear, silver maple, and sweet gum.

- PAC included as a treatment to control morningglory over-the-top of swamp chestnut oak, willow oak, water oak, persimmon, plum, and hazelnut.

QUESTIONS?