

# **Linking Seedling Quality and Sapling Vertical Stability via the Root System Architecture of Container Stock Longleaf Pine**

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# Artificial Regeneration of Longleaf Pine Forests

	Container	Bareroot
Cold storage / Planting window	1 month	1 week
First year field survival	50 – 95 %	5 – 95 %
Sapling physical instability	Yes	No
Stock culling based on root system	No	Yes

## Two Issues

1. Duration of seedlings remaining at grass stage
2. Sapling instability

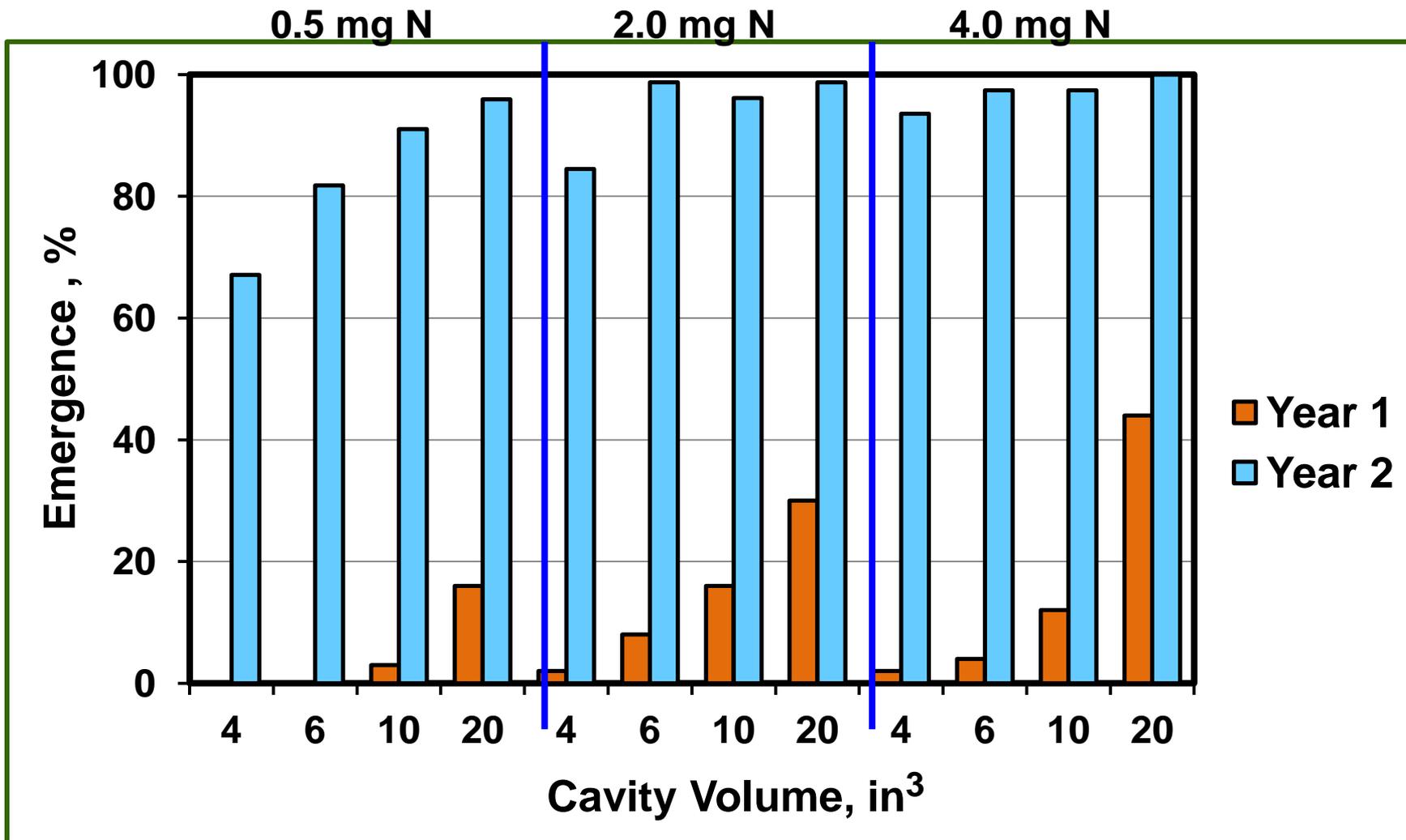


Studies at the US Forest Service's Palustris Experimental Forest in central Louisiana testing factors associated with longleaf pine stock quality, growth and sapling stability:

- ✓ container cavity volume, length, diameter
- ✓ cavity type (chemical root pruning)
- ✓ nursery and field fertility



**Accelerating seedling emergence from the grass stage can be accomplished by increasing container cavity volume and nursery fertility, site preparation, vegetation control, and prescribed burning.**



# 2008 Interim Guidelines for Nursery Production of Longleaf Pine Seedlings in Container Nurseries

(Dumroese, Barnett, Jackson, and Hains)

**Roots** Root-collar diameter should be no less than 0.2 inches. Plugs should be **firm** and moist and stay intact during extraction and outplanting.  
**Avoid “floppy” seedlings.**

**Container size** Diameter  $\geq 1$  in, with  $\geq 1.5$  in desired.  
Depth  $\geq 3.5$  in, with  $\geq 4.5$  inches preferred.  
Volume  $\geq 5.5$  in<sup>3</sup>, with  $\geq 6$  in<sup>3</sup> recommended.  
**Avoid multiple seedlings within a single cavity.**

(<http://www.treesearch.fs.fed.us/pubs/32949>)

# Root Systems of Natural Longleaf Pine



- a deep and large-diameter taproot;
- lateral roots extending horizontally and distributing evenly around the taproot circumference;
- lateral roots rarely spiraling or strangulating each other or the taproot.

# Root Systems of Container-grown Longleaf Pine Seedlings

Regular

Copper

6 weeks



Taproot Visible



Regular

Copper

28 weeks



# Root Systems of Container Seedlings (15 months in field)

**Cage-like lateral roots**



**20 in<sup>3</sup>-4N-R**

**Spiraling lateral roots**



**6 in<sup>3</sup>-2N-R**

**Normal lateral roots**



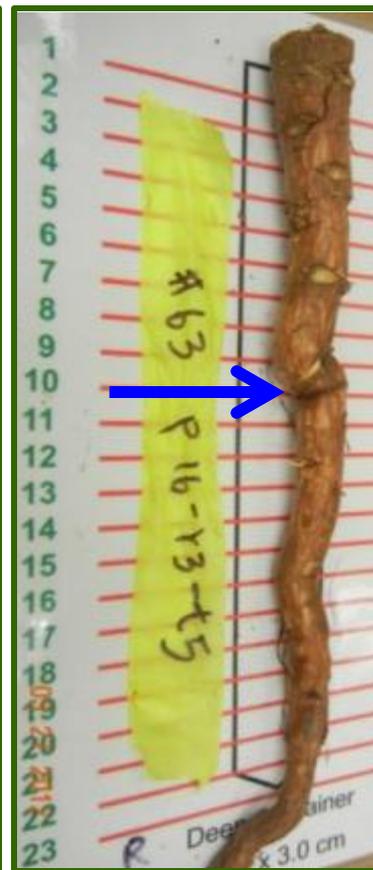
**10 in<sup>3</sup>-4N-Cu**

**One-sided lateral roots**



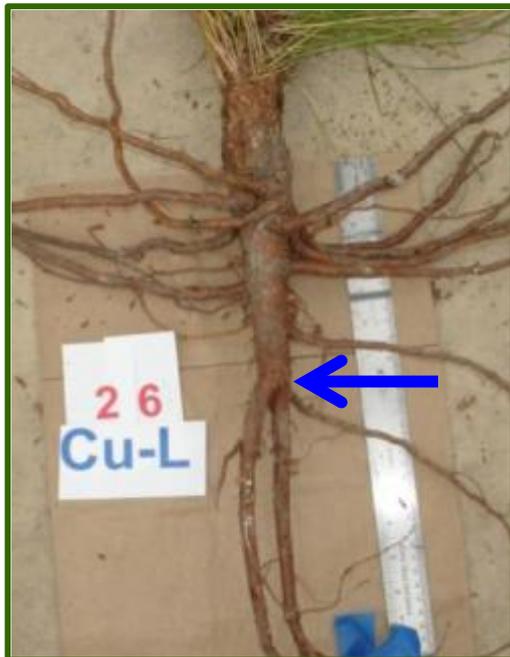
Small Container  
11.7 x 3.6 cm

# Taproots and Sinkers of Container Seedlings (15 months in field)

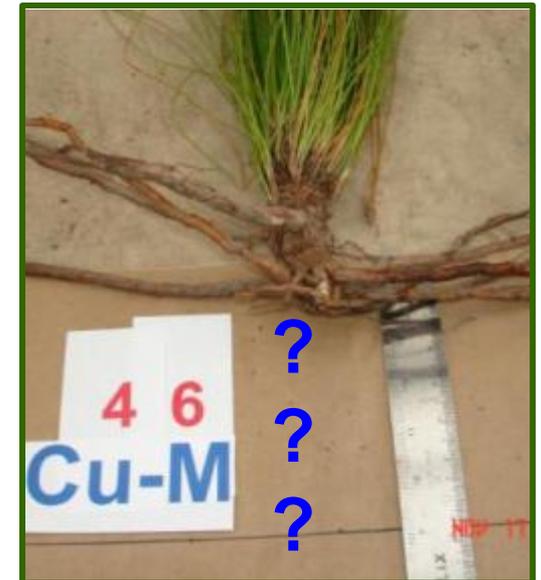
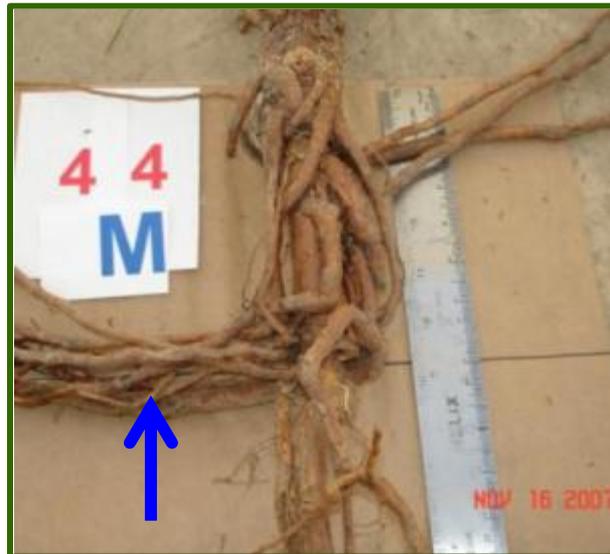


# Attributes of the root system architecture persist for years after planting for container longleaf pine.

- Seedlings cultured in copper-lined container cavities have less lateral root deformity than seedlings from non-copper-lined cavities after nursery culture and up to 6 years in field.
- Taproot length can be affected by cavity length and other factors during culture.



3 years in field



# Lateral root deformity still visible after 6 years in field

- spiraling, strangulating
- uneven egress from the root plug



# Comparing root system architecture between straight and stem-displaced container longleaf pine saplings in year 6.



Displaced



Straight

# A longleaf pine sapling can recover from the stem displacement AS LONG AS .....



Jan 2010



May 2010



# A longleaf pine sapling can recover from the stem displacement AS LONG AS .....



**Bumped by a trackhoe during root excavation in May 2010 (defoliated for viewing)**

## No vertical anchorage

\* Sinkers provide vertical anchorage to longleaf pine.



**A longleaf pine sapling can recover, at least partially, from stem displacement  
AS LONG AS**

**its root system has the vertical anchorage provided by the taproot and/or sinkers and the horizontal anchorage provided by non-deformed lateral roots.**

# Sapling Vertical Instability of Container Longleaf Pine in Central Louisiana



11 months after Hurricane Gustav (Aug 2009, year 5)



Horses (Aug 2010, year 6)



Icy rain (Feb 2011, year 7)



Tropical Storm Lee (Oct 2011, year 7)

# Visited three longleaf plantations in South Miss which were impacted by Heavy Rain from Hurricane Isaac





**No vertical anchorage**



**straight sapling**

# Staking immediately after toppling may help—if sapling root systems were not damaged



spiraling lateral roots



natural longleaf pine





Toppled @734 lb force

2 sinkers  
uneven distribution of laterals  
some laterals spiraling





**Toppled @344 lb force**

**taproot broke**  
**uneven distribution of laterals**



**Toppled @1054 lb force**

**taproot broke 1 ft below soil surface  
even distribution of laterals  
some laterals spiraling**





**Toppled @354 lb force**

**taproot broke where spiraling laterals  
constricting the tap  
even distribution of laterals  
some laterals spiraling**





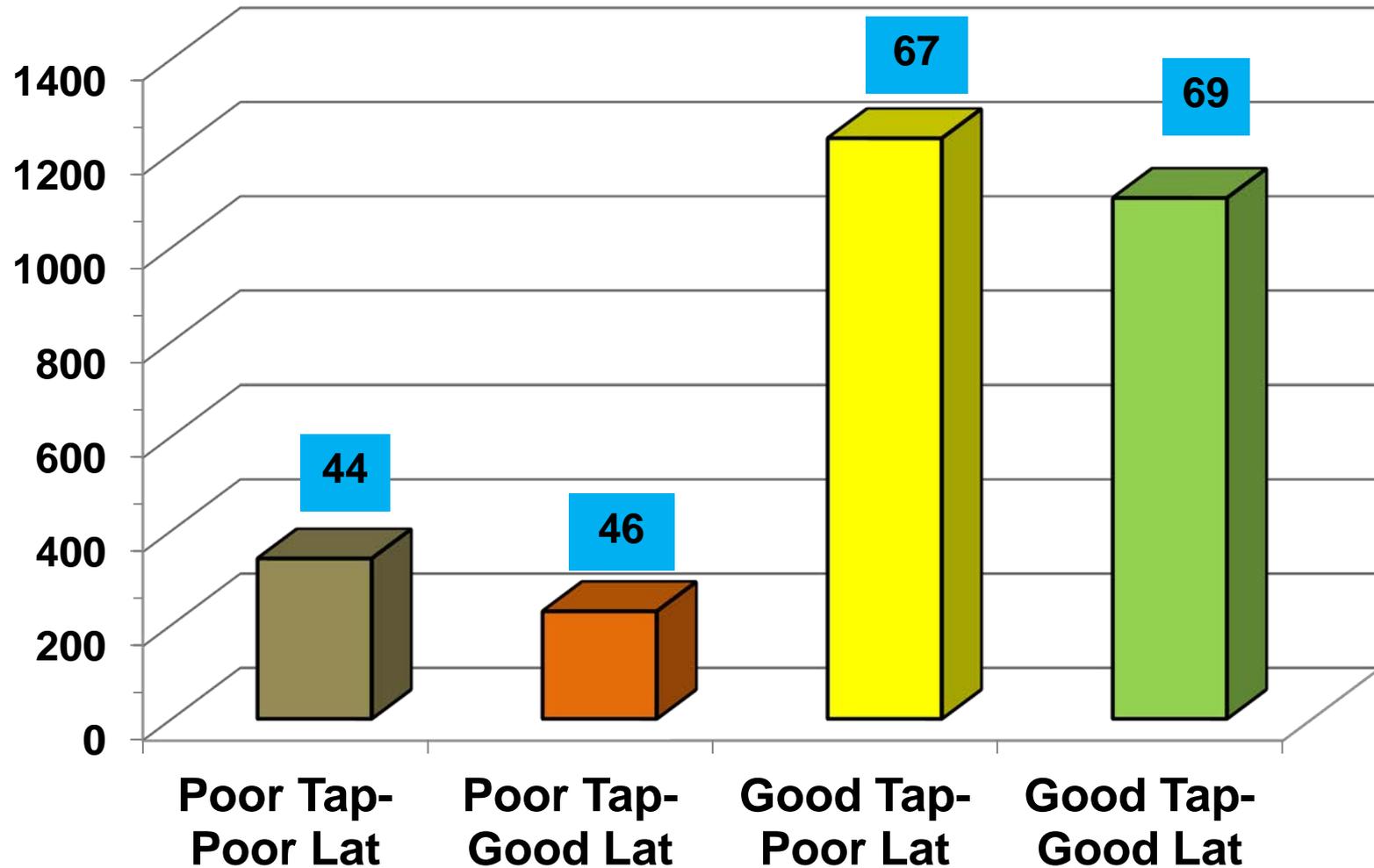
**Toppled @498 lb force due to stem failure**

**3 sinker  
even distribution of laterals**





## Toppling Force (lb) & Est Wind Speed (mph)



# What We Know

- **Longleaf pine tree toppling is of particular concern for private landowners.**
- **Longleaf pine trees with a poorly developed taproot or sinker roots, or asymmetrical or spiraled lateral roots often topple in high winds.**
- **Vertical instability increased particularly when the lateral roots were poorly developed on the leeward side of the tree, or the lateral roots had spiraled tightly around the taproot or sinker roots.**
- **Heavy rain coupled with high wind makes tree toppling more likely.**
- **Root system development in the nursery affects root system architecture after planting, which is correlated with vertical stability throughout the tree's life.**

# What We Propose to Do

**Soil physical properties and site quality affect root system development and growth relative to shoot growth. Root system architecture and container type also impact vertical stability of longleaf pine trees. Because vulnerability may be variable depending on soil type, we want to broaden our experimentation by**

- **Conducting tree toppling work in natural longleaf pine stands on sandy soils**
- **Conducting additional tree toppling work in a longleaf pine plantation that was established by planting container nursery stock in sandy soils**
- **The outcome of this proposed work will either confirm that current longleaf pine cultural practices are adequate for artificial regeneration on sandy sites, or accelerate the improvement of nursery practices for seedlings planted where high wind is probable.**