# Cool storage and freeze tolerance of longleaf pine

**David B. South**
**Auburn University**

**Bill Pickens**
**NC Forest Service**

**Effects of Extended Cold Storage on the Survival and Performance of Container Grown Longleaf Seedlings**

Bill Pickens

(Pine Silviculturist, N.C. Division of Forest Resources, Griffiths Forestry Center, Clayton, NC 27520)

**Abstract:** - Research has documented the survival of bareroot longleaf pine (*Pinus palustris*) is significantly reduced by extended cold storage. Similar research for container grown longleaf seedlings has not been conducted. This study evaluates the effects of extended cold storage (up to 10 weeks) on the survival and growth performance of container grown longleaf seedlings lifted on four different dates in October and November.


Pickens (2012)

# Seedlings grown in containers at the Goldsboro Nursery in 2001


Seedlings were lifted on October 5th, 16th, 30th, and November 13th. Of those lifted, 480 seedlings were then stored at 35 ºF for 0, 2, 4, 6, 8, 10 weeks.

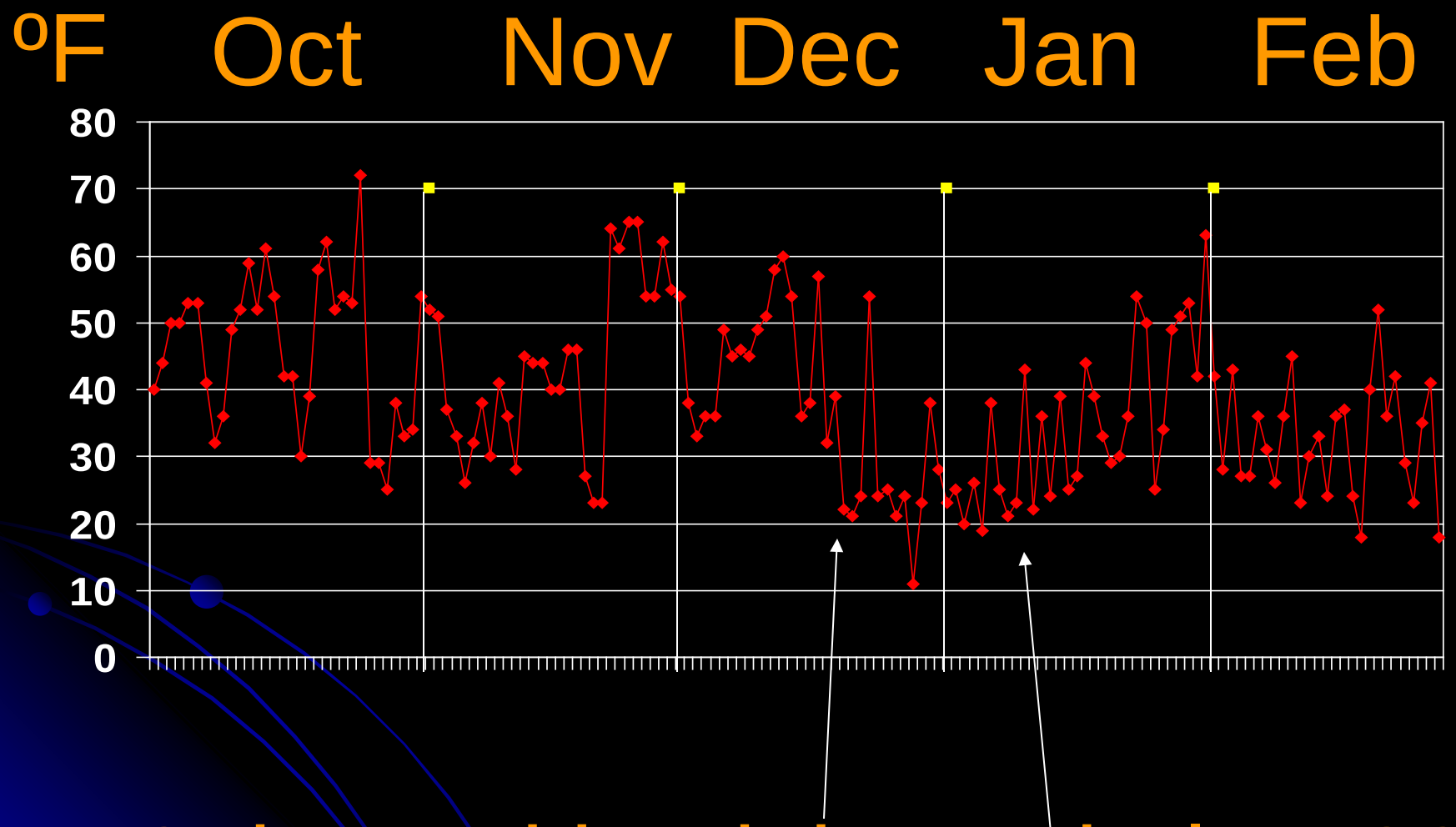
Four reps of 20 trees/tr/plot.

# Freeze events make the survival data interesting and informative

"It is suspected that minimum temperatures extremes after planting may have adversely impacted seedling survival. Several days with night time temperatures below freezing were recorded after the planting days with the poorest survival rates."

Pickens (2012)

# Minimum daily temps (ºF) Jones Lake Weather Station




16 days with minimum below 26 F

Percent Survival Age Two

| Planting Date | Lift Date 2-Oct (1) | 16-Oct (2) | 30-Oct (3) | 13-Nov (4) |
|---|---|---|---|---|
| 3-Oct-01 | 92 | . | . | . |
| 17-Oct-01 | 90 | 86 | . | . |
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| 22-Dec-01 | . | 38 | 50 | 91 |
| 8-Jan-02 | . | . | 66 | 92 |
| 22-Jan-02 | . | . | . | 92 |

Pickens (2012) Longleaf Alliance Report #16.

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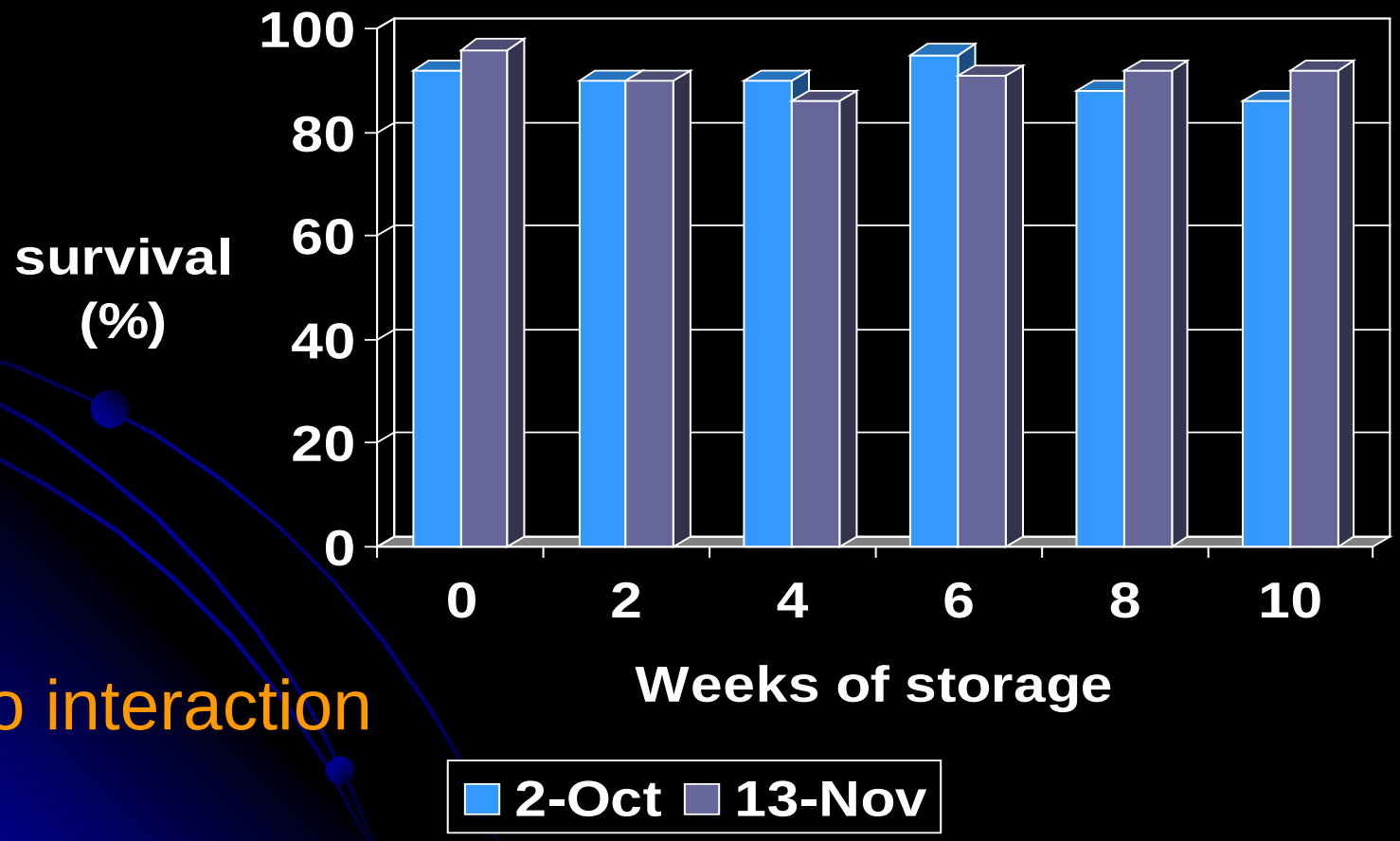
Pickens (2012) Longleaf Alliance Report #16.

# Effect of lifting date and storage length on survival (2-yr).




No interaction

Percent Survival Age Two

| Planting Date | Lift Date 2-Oct (1) | 16-Oct (2) | 30-Oct (3) | 13-Nov (4) |
|---|---|---|---|---|
| 3-Oct-01 | | . | . | . |
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Pickens (2012) Longleaf Alliance Report #16.

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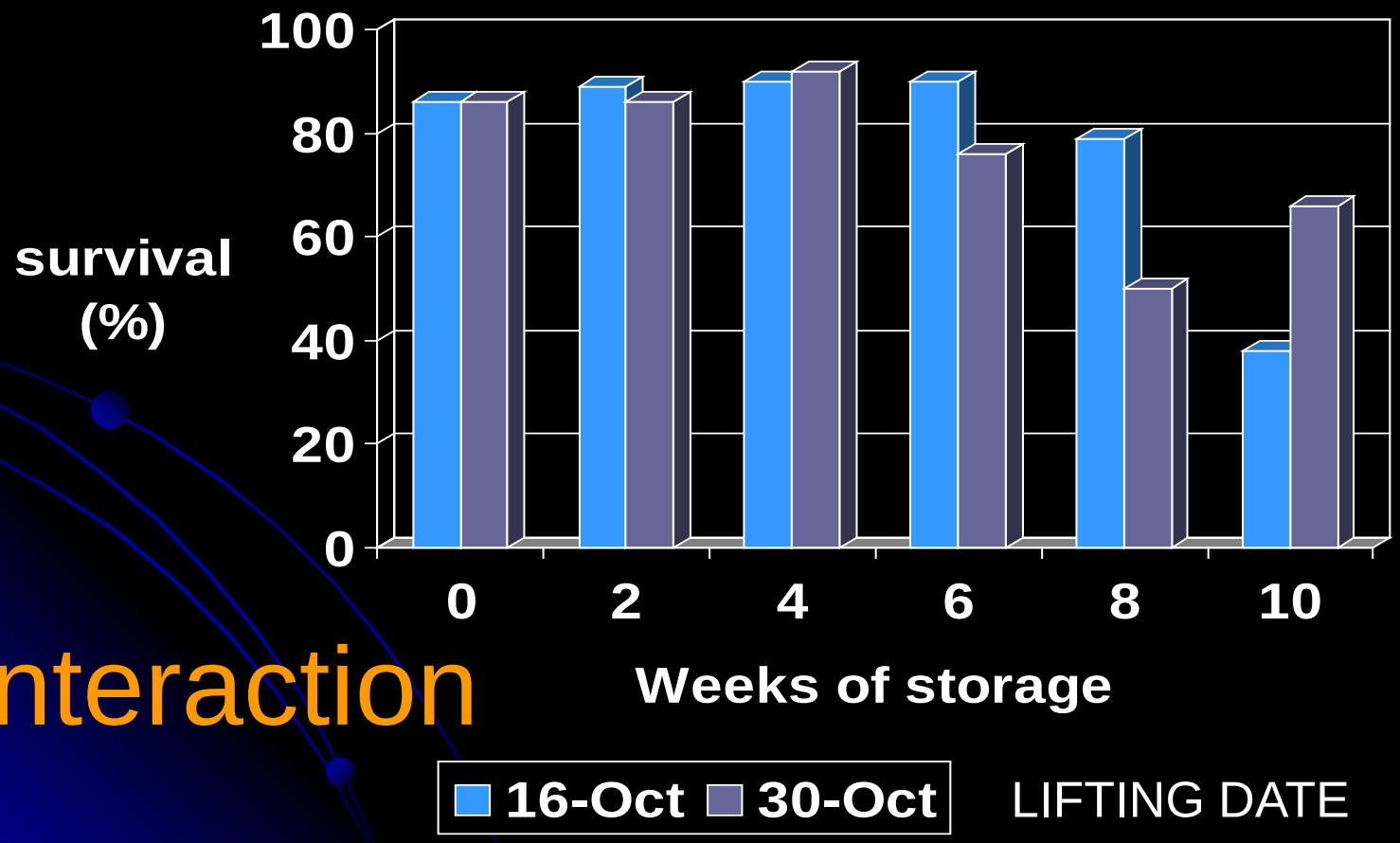
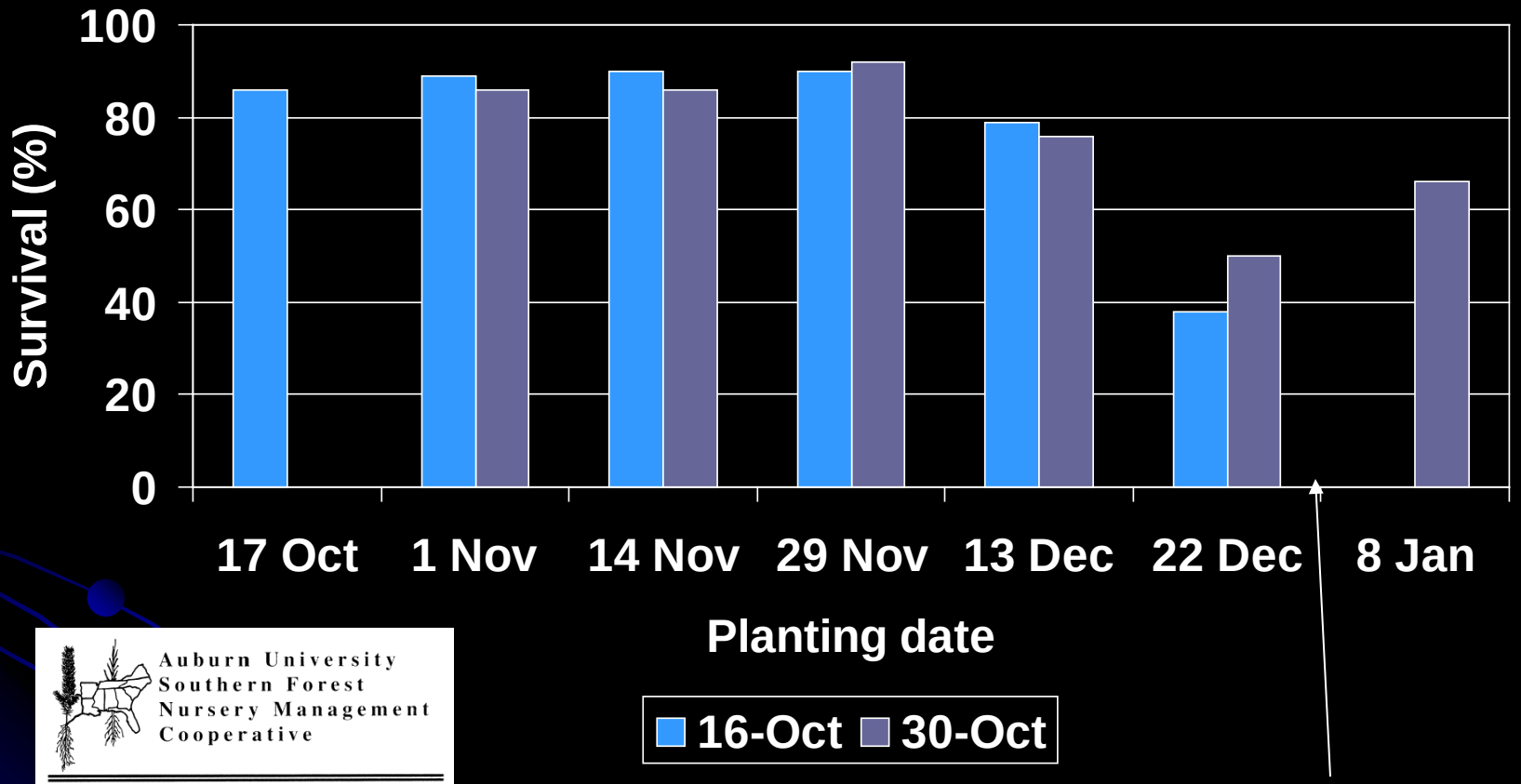
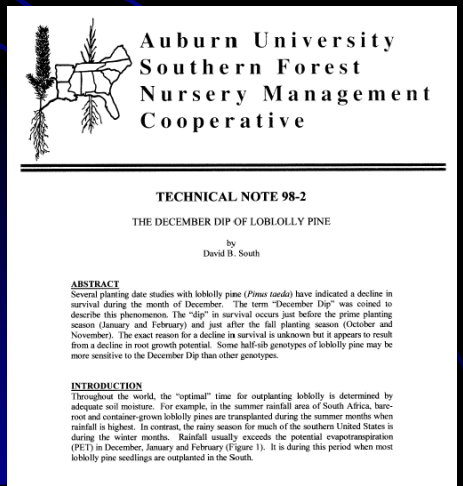



interaction

# Example of the “December dip”




freeze



Auburn University
Southern Forest
Nursery Management
Cooperative

**TECHNICAL NOTE 98-2**

THE DECEMBER DIP OF LOBLOLLY PINE

by
David B. South

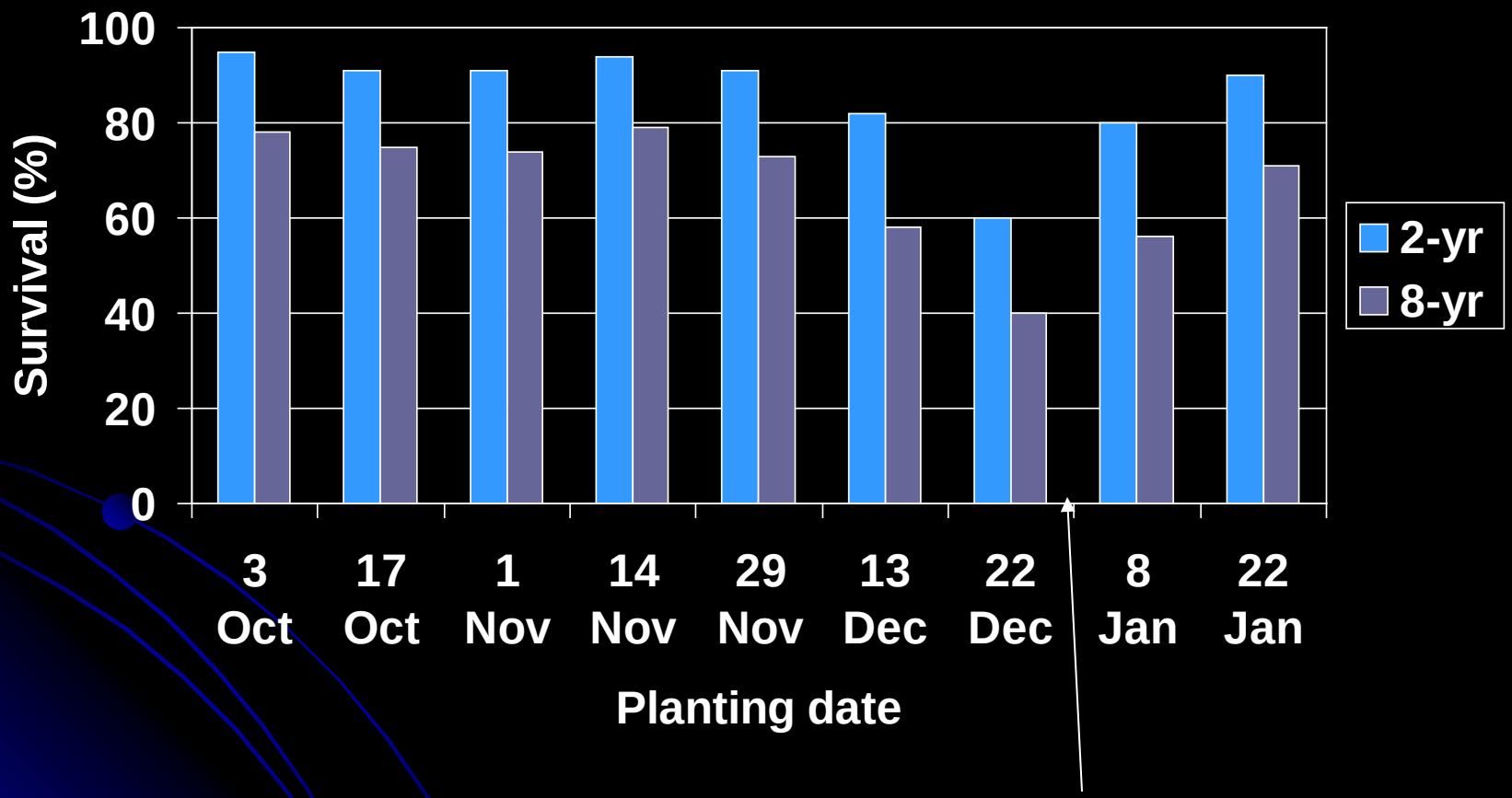
**ABSTRACT**

Several planting date studies with loblolly pine (*Pinus taeda*) have indicated a decline in survival during the month of December. The term “December Dip” was coined to describe this phenomenon. The “dip” in survival occurs just before the prime planting season (January and February) and just after the fall planting season (October and November). The exact reason for a decline in survival is unknown but it appears to result from a decline in root growth potential. Some half-sib genotypes of loblolly pine may be more sensitive to the December Dip than other genotypes.

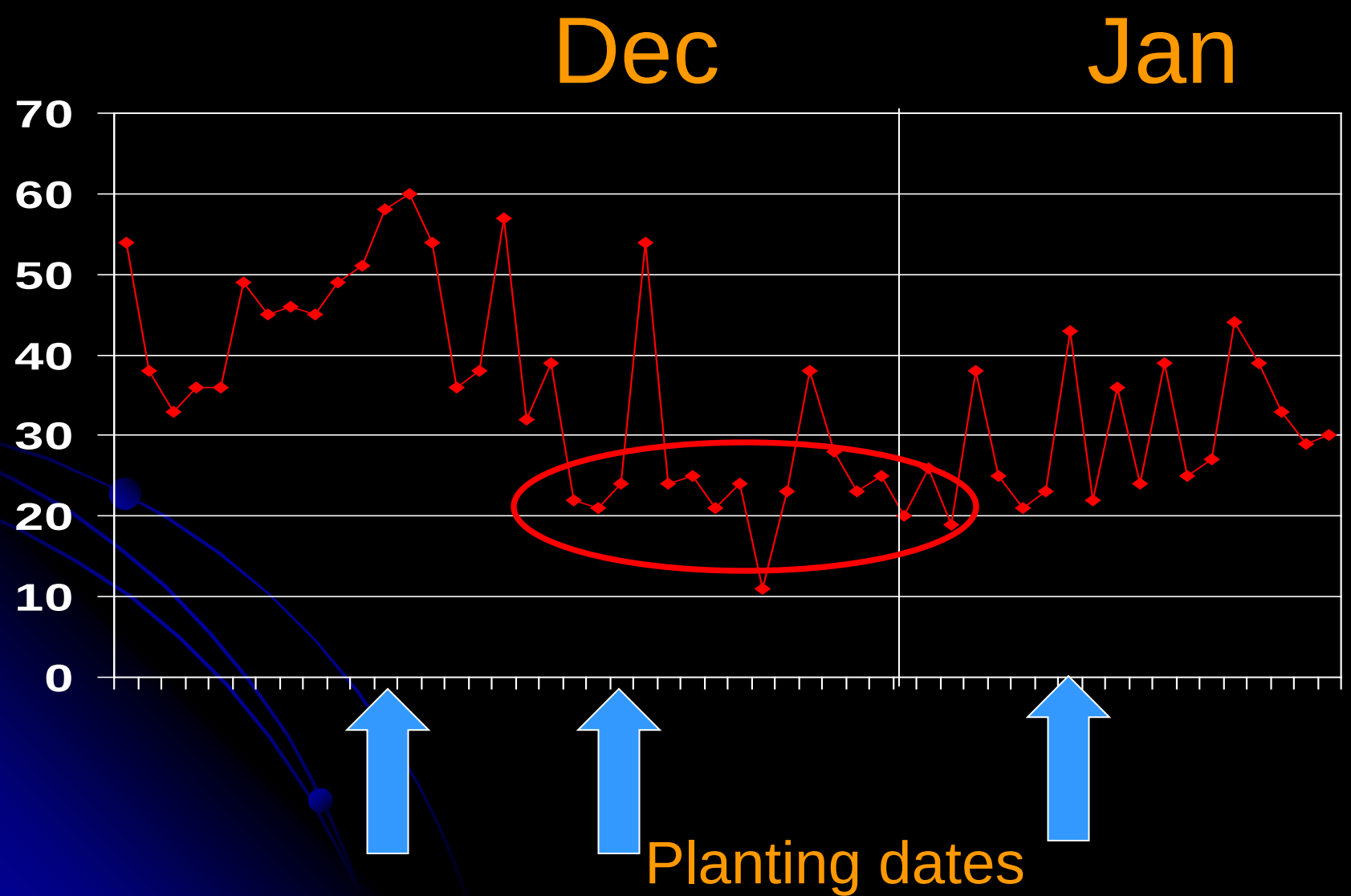
**INTRODUCTION**

Throughout the world, the “optimal” time for outplanting loblolly is determined by adequate soil moisture. For example, in the summer rainfall area of South Africa, bare-root and container-grown loblolly pines are transplanted during the summer months when rainfall is highest. In contrast, the rainy season for much of the southern United States is during the winter months. Rainfall usually exceeds the potential evapotranspiration (PET) in December, January and February (Figure 1). It is during this period when most loblolly pine seedlings are outplanted in the South.

# Example of the “December dip”



# 5 days with minimum < 22 F
# Dec 21 to Jan 5



# Short review of freeze tolerance

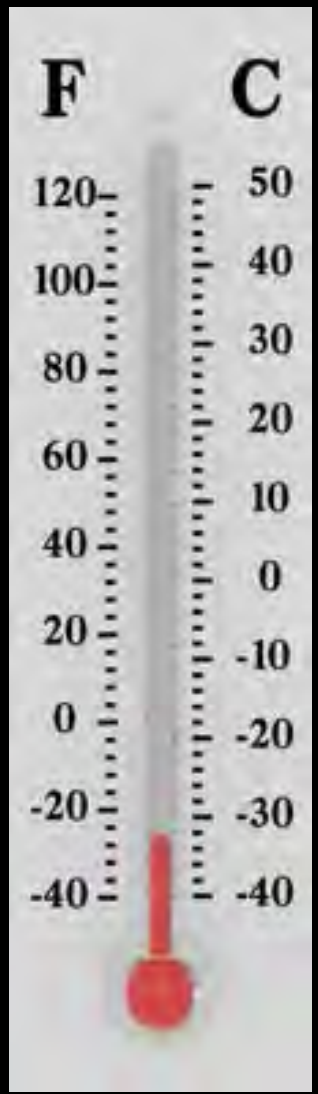
11 ºF temp injured half of bareroot longleaf pine at the Lee nursery in Florida 25 Dec, 1983

# Short review of freeze tolerance

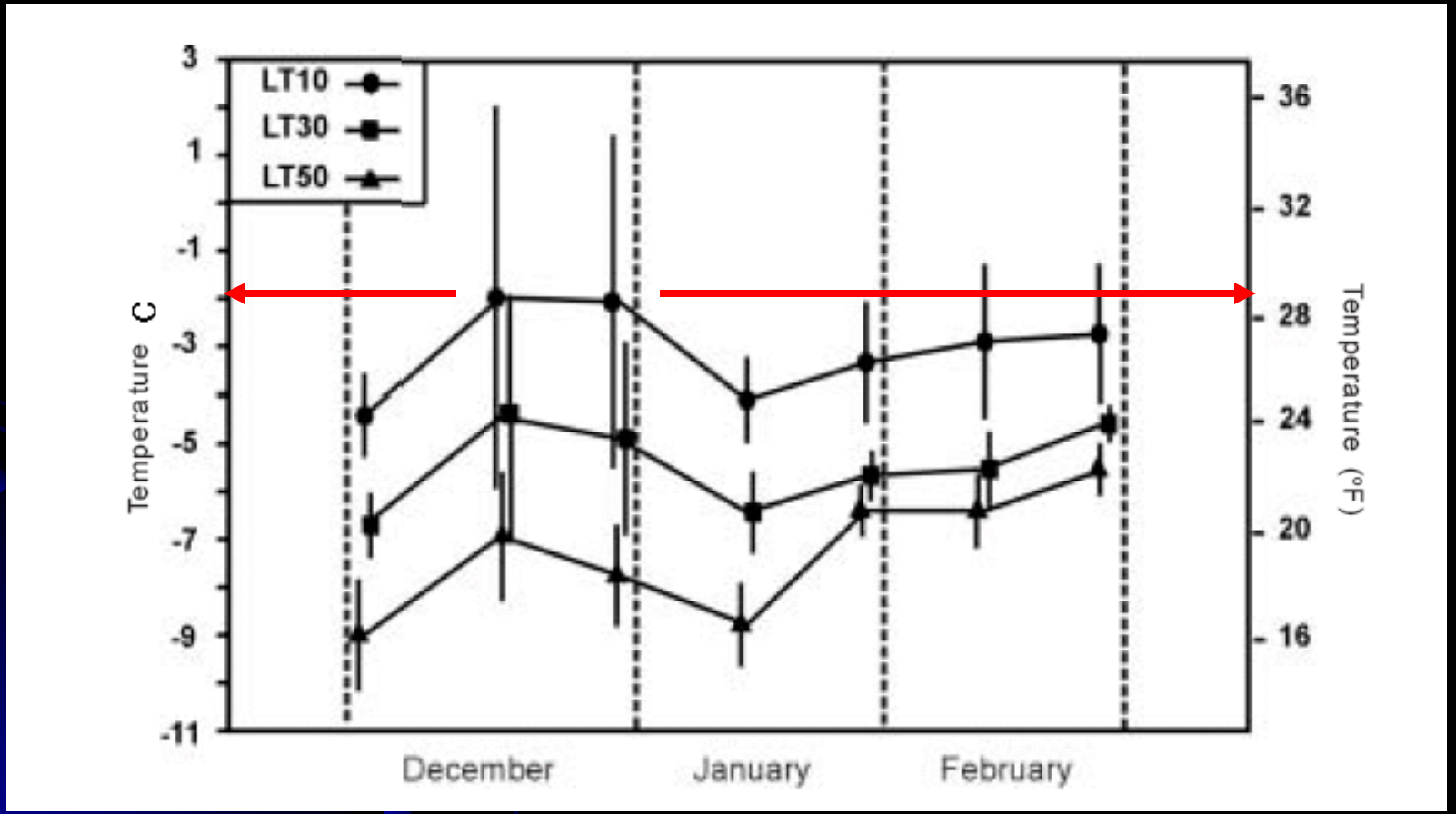
10 ºF freeze killed
400,000 container
longleaf pine
at the Ashe Nursery
5-6 Feb, 1996

Based on electrolyte leakage (EL) studies, Tinus and others (2002) suggest that container longleaf pine roots should not be exposed to temperatures below 26 F (-3 C).

26 F




# Electrolyte leakage (EL) test container longleaf pine




Tinus et al. 2002

# Fact: Natural chilling increases freeze tolerance of some pines

The Christmas 1983 freeze injured pine seedlings in Alabama and Georgia.

But not in Kentucky or Tennessee where seedlings were exposed to more chilling.

South (2007) Southern Hemisphere For. J. 69 (3):151-156.

# For loblolly pine, 2 weeks outdoors could increase survival by 60 percentage points

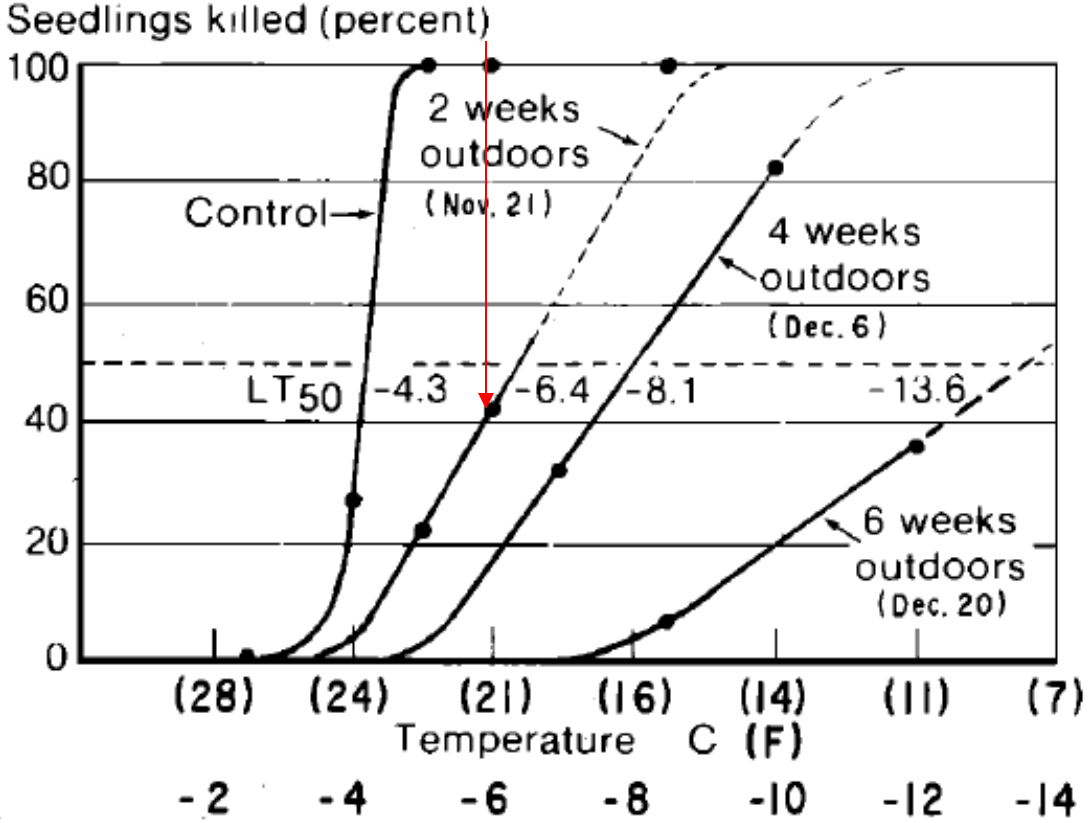



*Figure 2. Mortality-temperature curves for loblolly pine seedlings exposed to different hardening periods (Experiment 1).*

Mexal et al. (1979) South. J. Appl. For. 3:15-19.

# For loblolly pine, 4 weeks outdoors
# Could increase survival by 90 percentage points

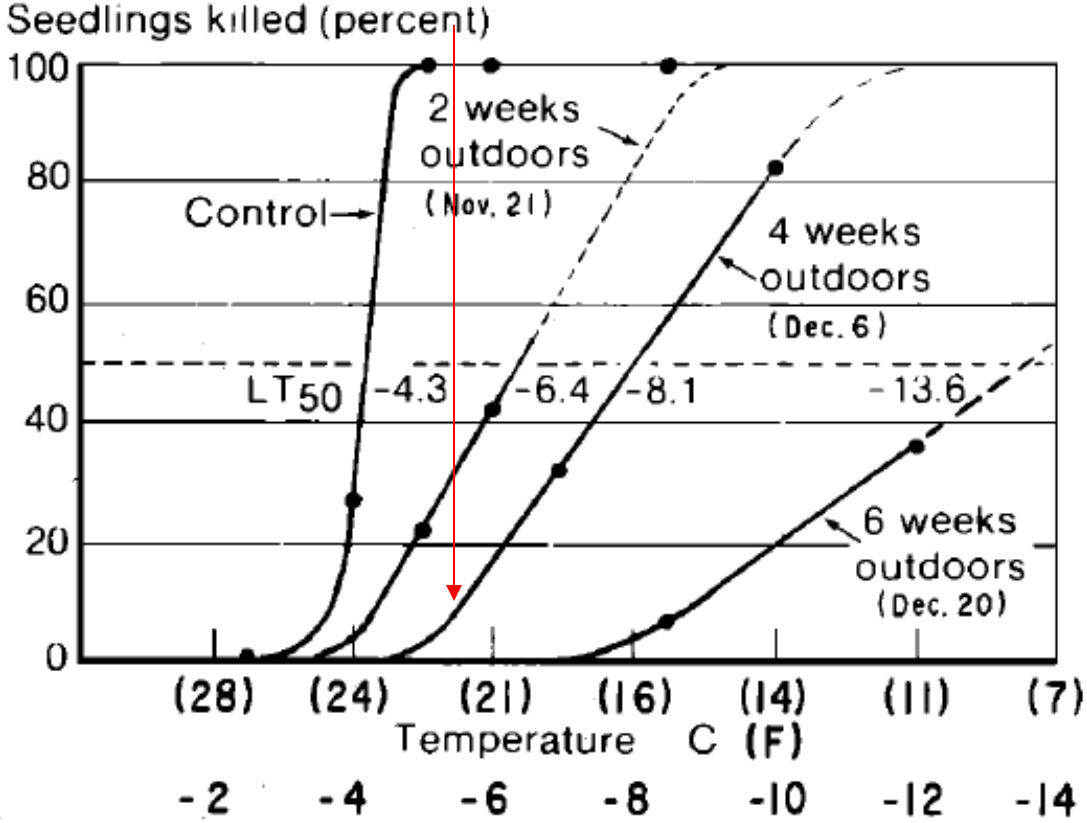
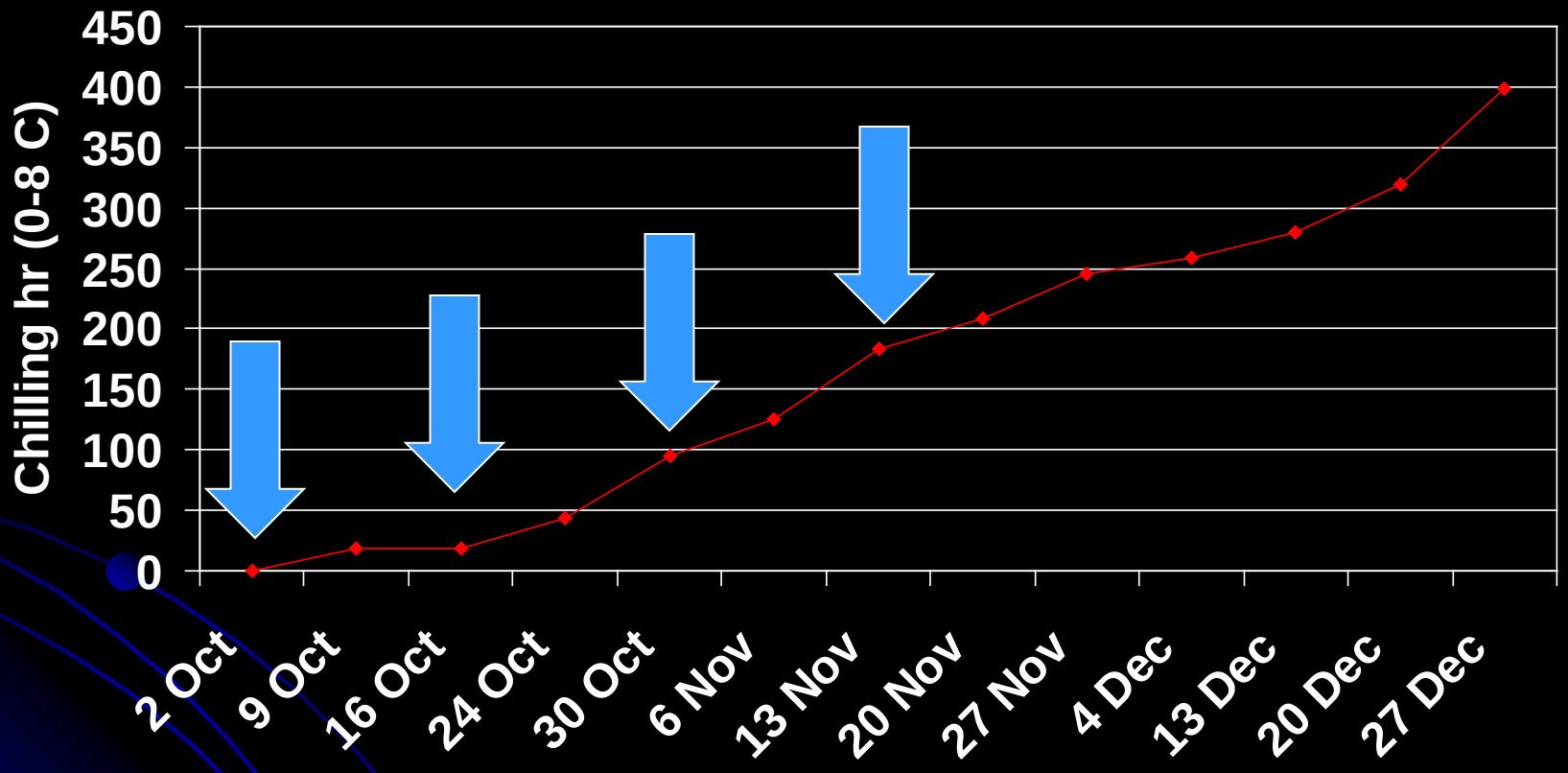



*Figure 2. Mortality-temperature curves for loblolly pine seedlings exposed to different hardening periods (Experiment 1).*

Mexal et al. (1979) South. J. Appl. For. 3:15-19.

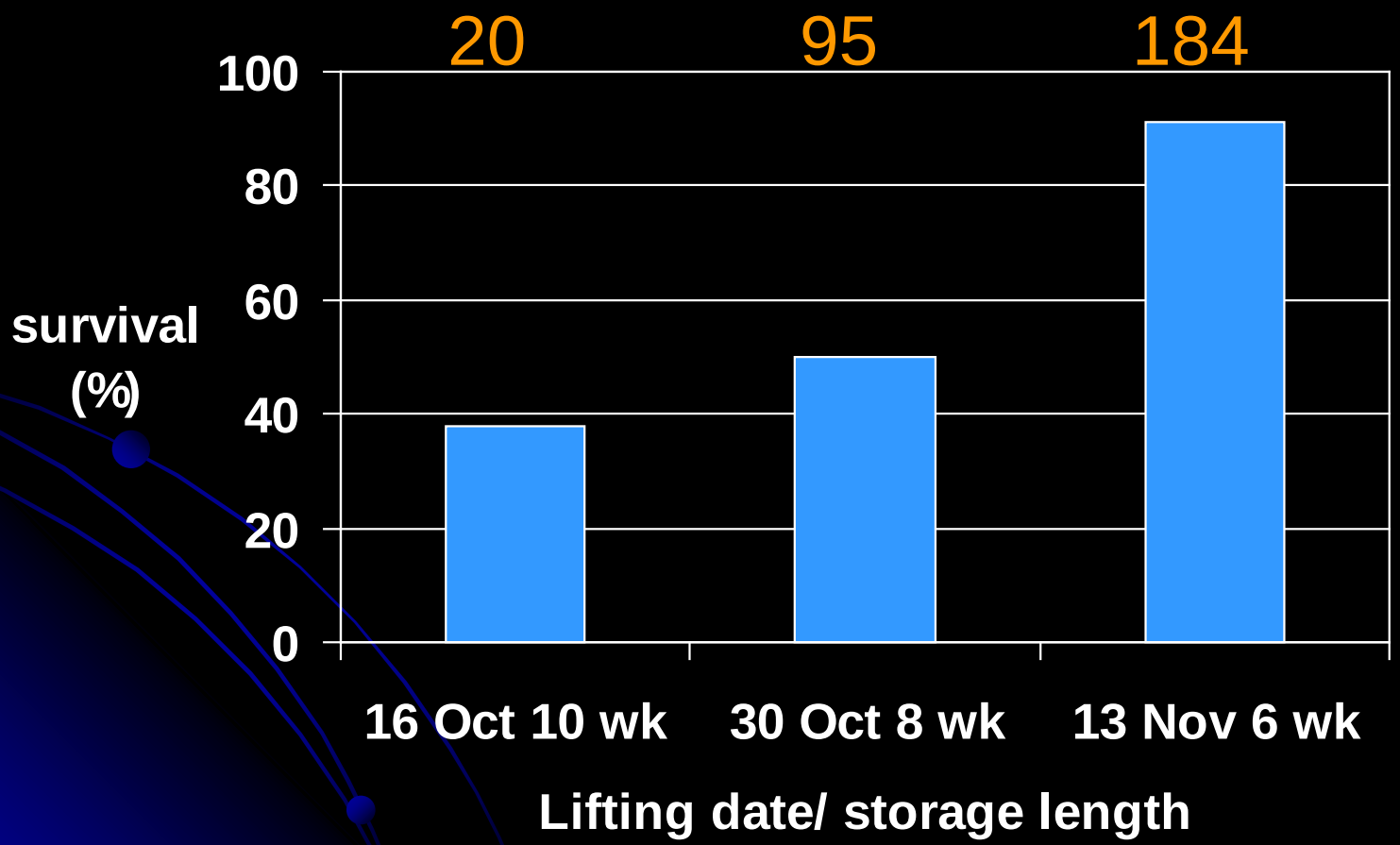
# Chilling hrs (2001) at Seymour-Johnson AFB Wayne Co, NC (near Nursery)




Blue arrows = lifting dates

# Dark cool storage reduces natural chilling and therefore may reduce freeze tolerance

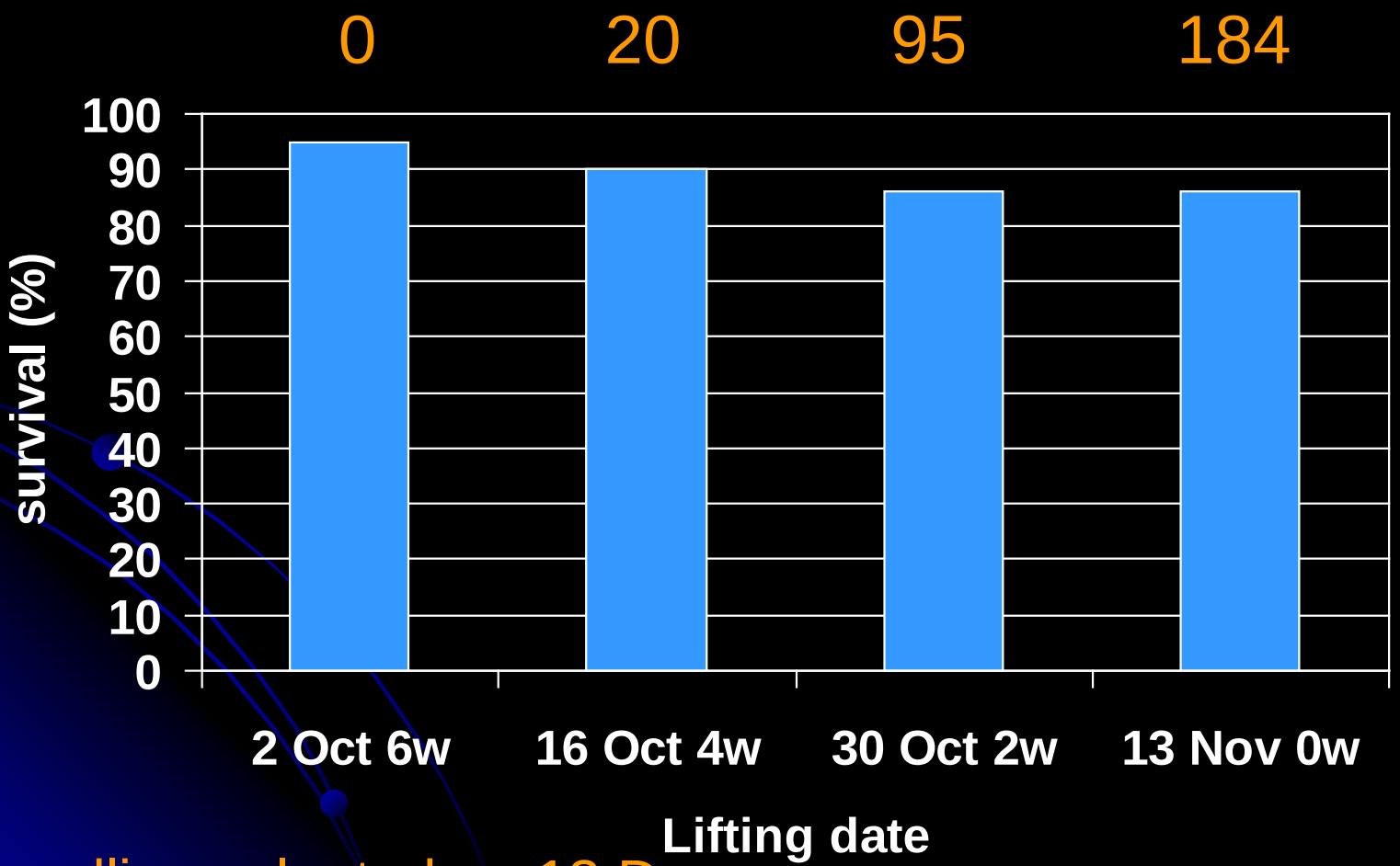
Nursery chill hours (0-8 ºC)




All seedlings planted on 22 Dec

# Longleaf pine planted 11 days before 23 ºF freeze survived well (75 field chill hrs?)

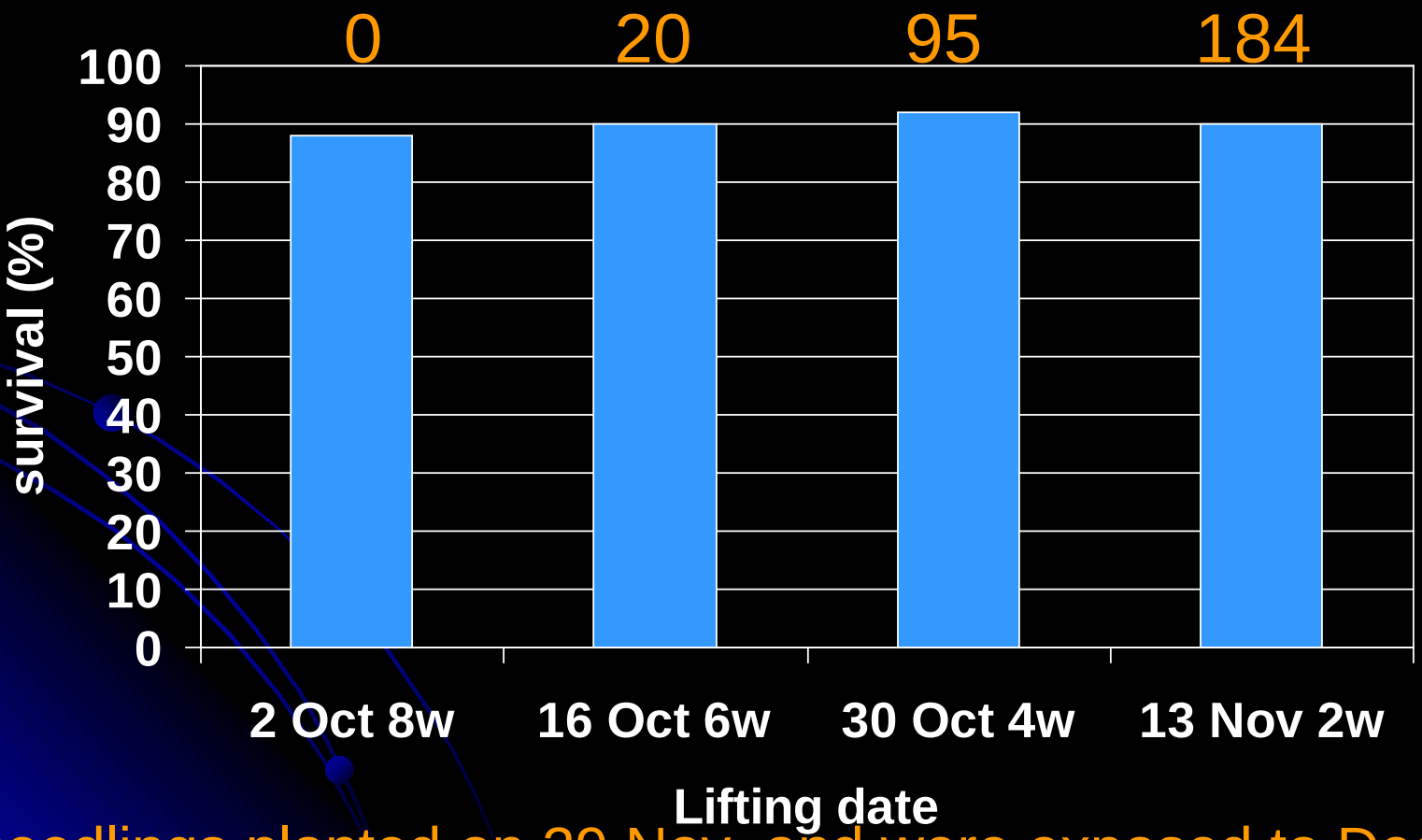
Nursery chill hours (0-8 ºC)




All seedlings planted on 13 Dec

# Four weeks of natural chilling (140 chilling hr?) in the field ( from 29 Nov to 24 Dec) likely increased freeze tolerance

Nursery chill hours (0-8 ºC)




All seedlings planted on 29 Nov and were exposed to Dec temps

Percent Survival Age Two

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|---|---|---|---|---|
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| 22-Jan-02 | . | . | . | 92 |

Freeze Dec 24-29

4 additional weeks outdoors

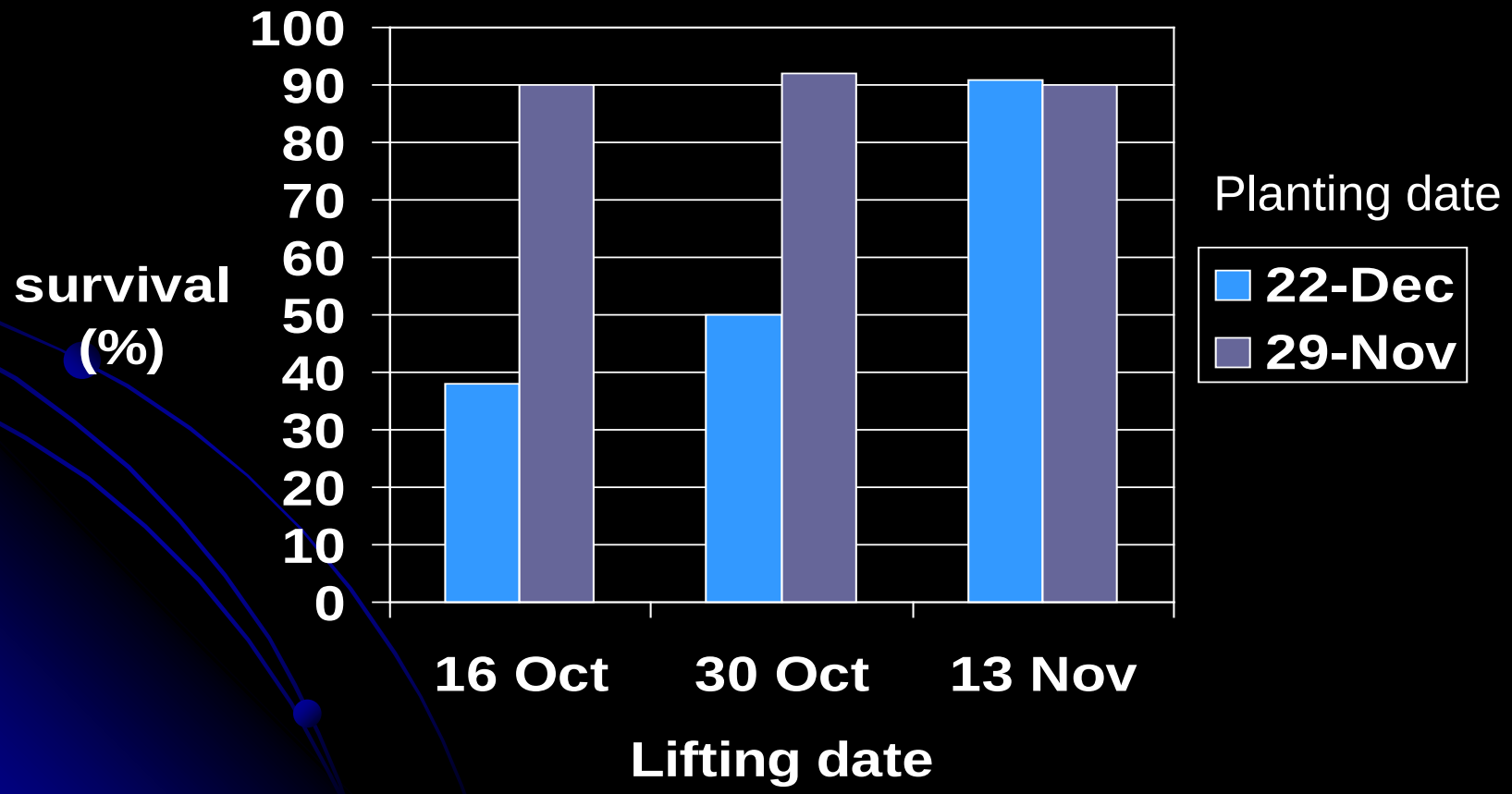
4 additional weeks in a cooler

- 4 additional weeks of chilling outdoors increases freeze tolerance of longleaf pine seedlings but 4 additional weeks in a cooler does not!

- It does not appear that placing longleaf pine seedlings in a cooler increases seedling quality (in contrast to theory proposed by a few PNW researchers).

# After planting, 4 weeks of outside chilling environment likely increased survival of Oct lifted stock

+62% +42% --



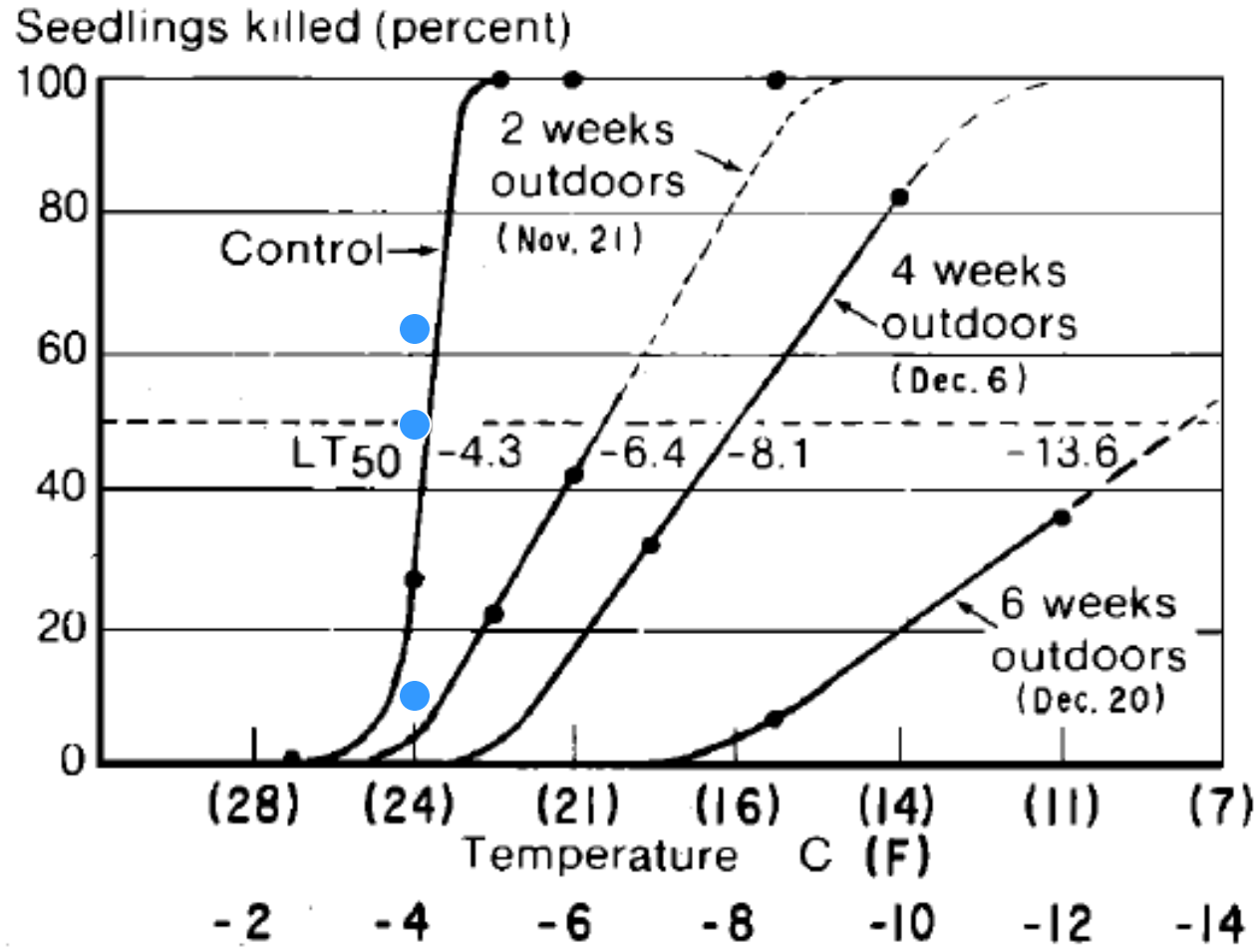
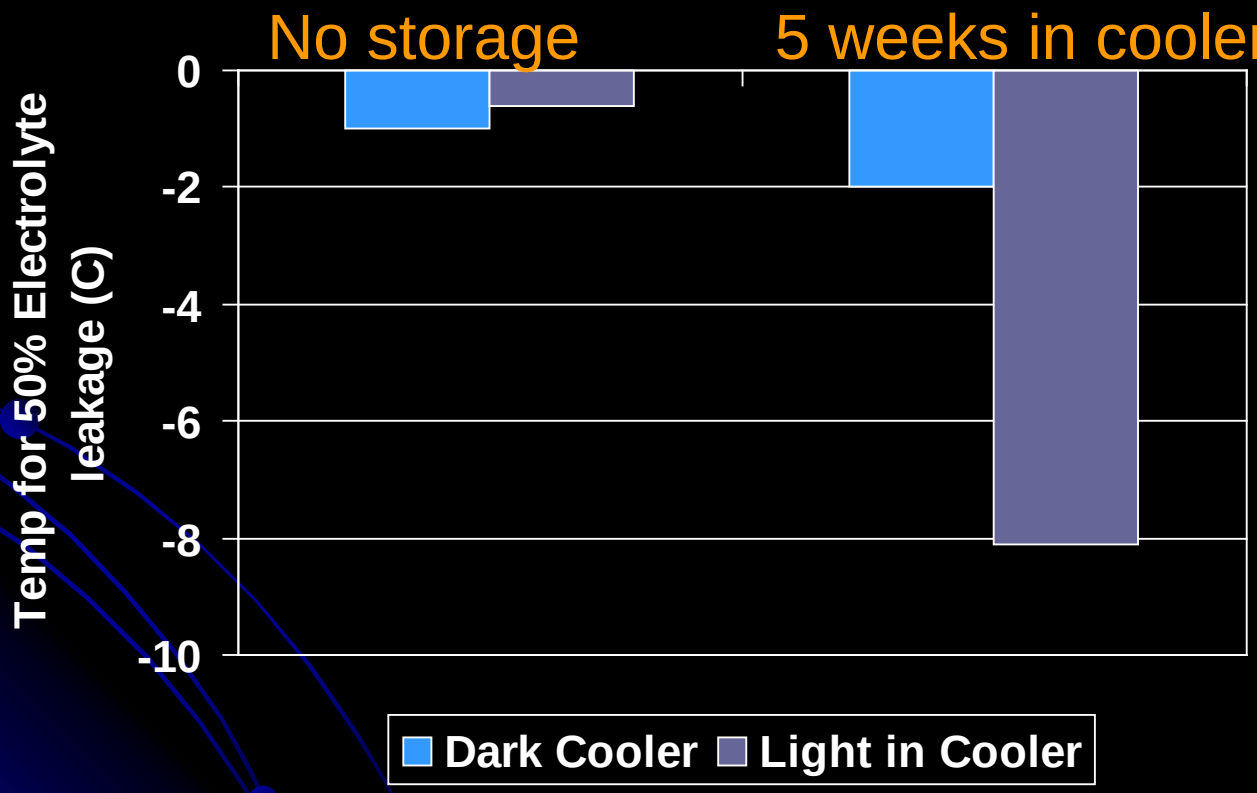



*Figure 2. Mortality-temperature curves for loblolly pine seedlings exposed to different hardening periods (Experiment 1).*

24 F low temp occurred on Dec 22, 24, 26, 27, 28 and 29
Blue dots represent data for longleaf pine planted on Dec 22

# Important Facts

- Chilling seedlings in a dark cooler (4 ºC) does not increase freeze tolerance of container-grown loblolly pine. Pine seedlings need light to achieve freeze tolerance. (15 µmol $m^{-2}$/sec)




Steve Grossnickle (unpublished)

# Important Facts

- Chilling seedlings in a dark cooler does not increase freeze tolerance of pines and it does not count as chilling hours for “long-term” storage
- Natural chilling increases freeze tolerance
- When container-grown pines are stored in October, they may survive well after 10 weeks of storage (even when planted about 4 weeks prior to 21 F freeze).
- Many storage studies confound storage length with planting date.

# Conclusion

- Natural chilling improves seedling quality of pine seedlings since chilling increases freeze tolerance.
- When dark, artificial chilling is applied to stored container-grown pine seedlings (lifted in October or November), seedling quality is not increased.
- Some assume chilling hours are required before storing container-grown longleaf pine seedlings for 6 weeks… but these data suggest nursery chilling is not required if seedlings are planted 4 weeks or more before a hard freeze.
- Natural chilling is required (for good survival) if seedlings are planted just before a hard freeze.

# Conclusion

- The “December Dip” can occur with longleaf pine and in 2001 the observed “Dip” was apparently caused by freezing temperatures just after planting.

# QUESTIONS?

Percent Survival Age Two

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