Storage of shortleaf pine seedlings: myths or facts?

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FORESTRY AND WILDLIFE SCIENCES

What do we know about storage of bareroot shortleaf pine?

Two schools of thought regarding storage of shortleaf pine seedlings

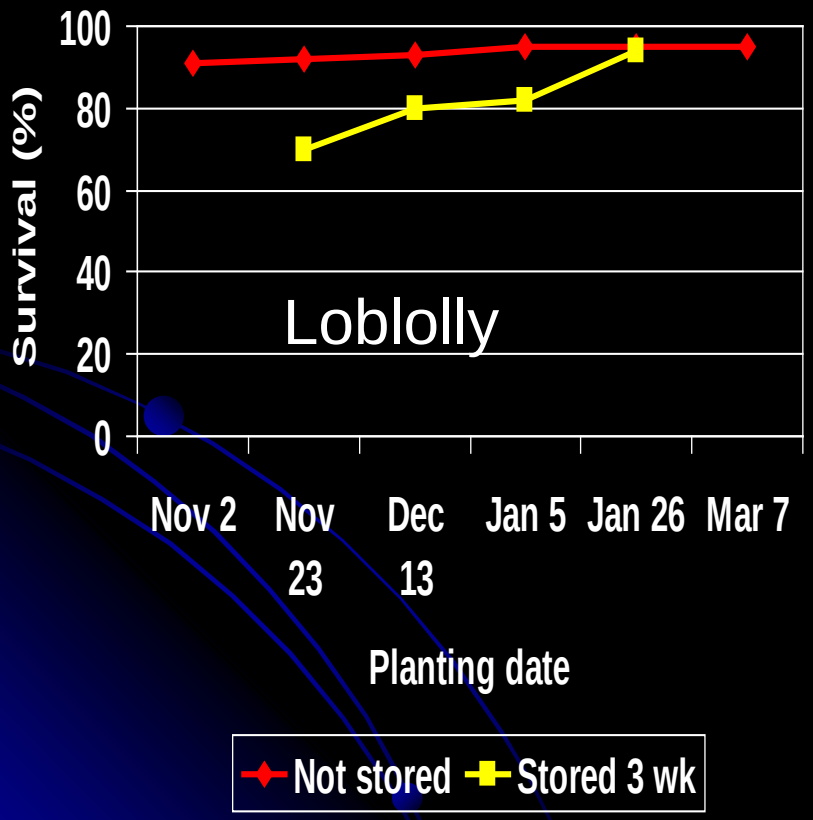
- “No difference” School

  Lift and store shortleaf pine the same as loblolly pine

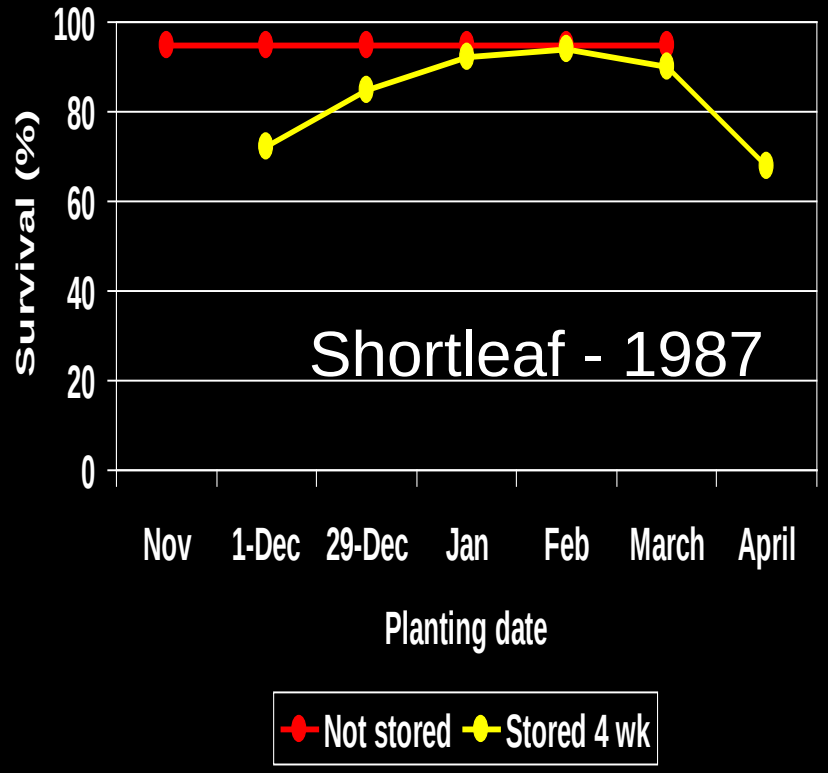
- “Less tolerant” School

  Bareroot shortleaf pine does not store as well as loblolly pine…and should be “hot planted” or stored no longer than 3 weeks.

“No difference” school says loblolly and shortleaf pine store the same

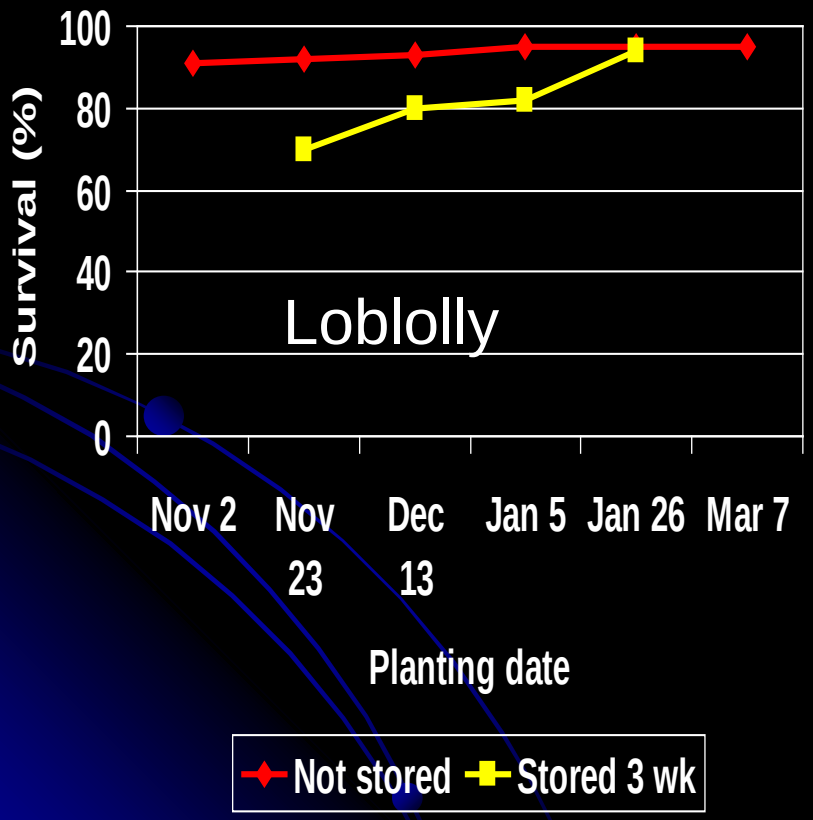


Mexal and Garber (1980)



Hallgren (1992)

“Less tolerant” school says loblolly and shortleaf pine do not store the same



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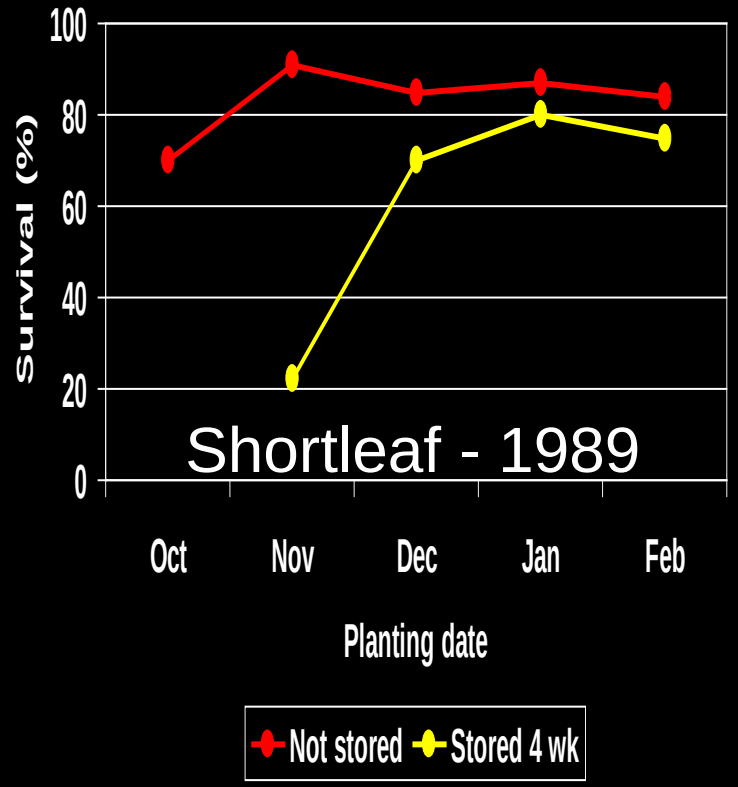


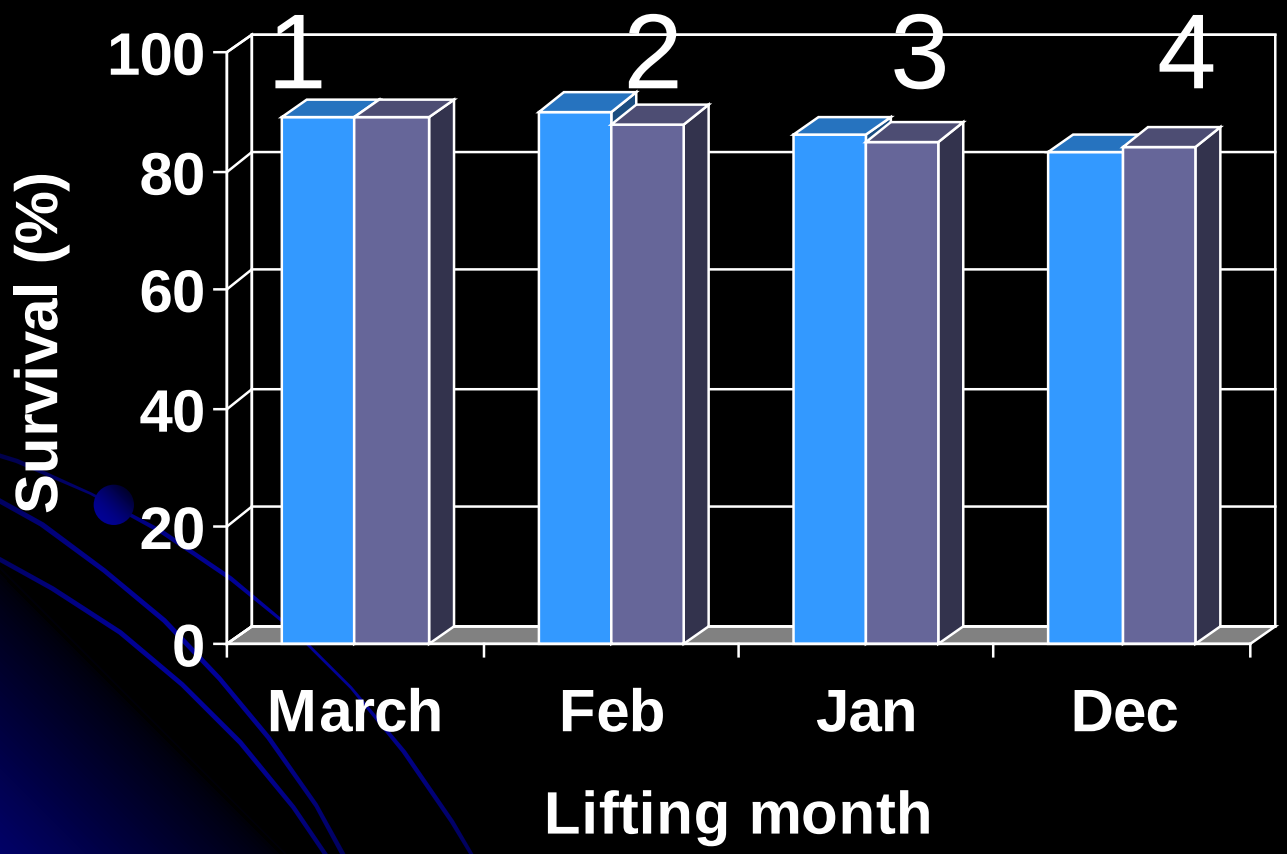
Hallgren and Ferris (1995)

“No difference” school before 1980

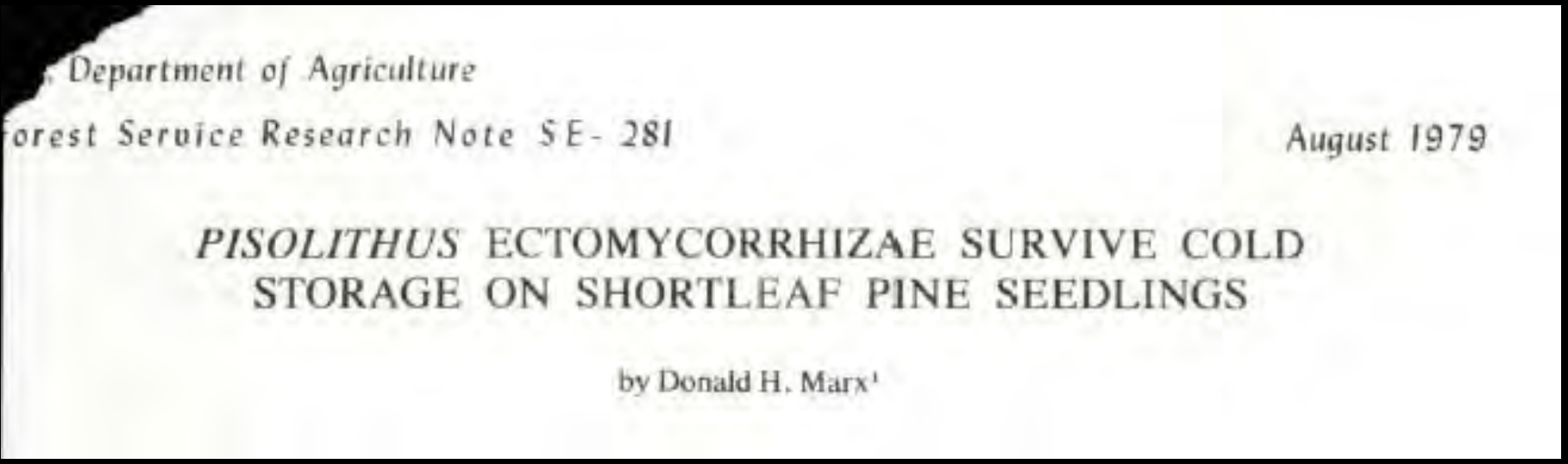
- Researchers and nursery managers assumed shortleaf pine could be lifted in December and safely stored for 3 months.

  No one was suggesting shortleaf pine seedlings could not tolerate long-term storage.

Survival of stored bareroot shortleaf pine seedlings (months of storage)



Marx (1979)



. Department of Agriculture

orest Service Research Note SE- 281 August 1979

PISOLITHUS ECTOMYCORRHIZAE SURVIVE COLD STORAGE ON SHORTLEAF PINE SEEDLINGS

by Donald H. Marx[1]

- For some reason, researchers in the “less tolerant” school do not cite the results of Dr. Don Marx’s long-term storage study.

Shortleaf pine myth

- We can’t store bareroot shortleaf pine for 4 months without killing the seedlings.

Two schools after 1980

- After a study conducted in the 1980-81 lifting season (Venator 1985), several authorities began to say that shortleaf pine was less tolerant to storage than loblolly pine.

“Less tolerant” School

- “Early indications were that seedlings could be stored for long periods of time and 30 days of storage should cause no significant problems. This indication was not correct. Seedlings that were stored for less than three weeks had better survival than those stored for a longer period of time.”

  William Walker (1992)

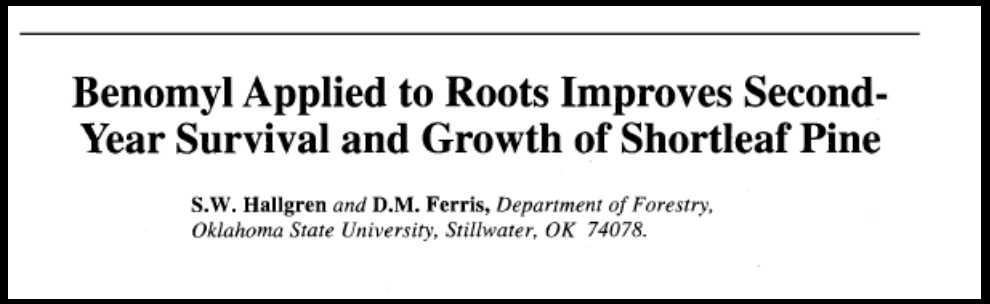
“Less tolerant” School

- “Shortleaf pine seedlings apparently do not store as well as expected from data on loblolly pine.”

- “Until additional studies establish optimum times for lifting and storing shortleaf pine seedlings, lengthy storage should be avoided.”

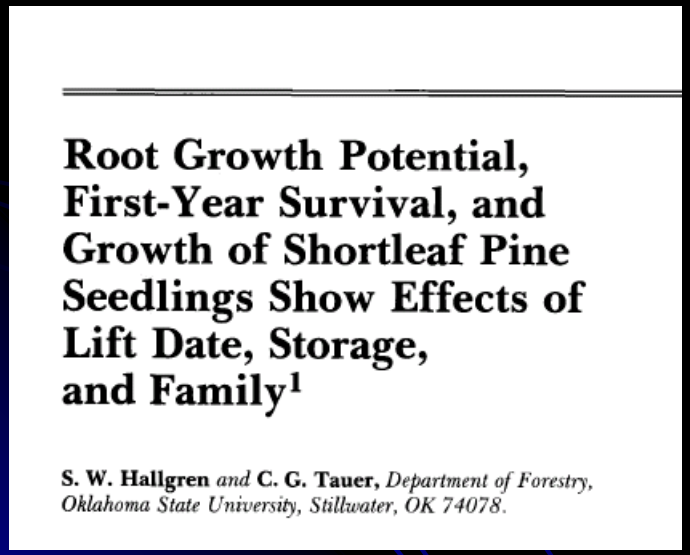
  Charles Venator (1985)

Additional studies were established to determine the optimum times for lifting and storing bareroot shortleaf pine stock. Storage trials (replicated in time) were conducted by Dr. Steven Hallgren. Results from trials replicated in time are superior to single-study trials.



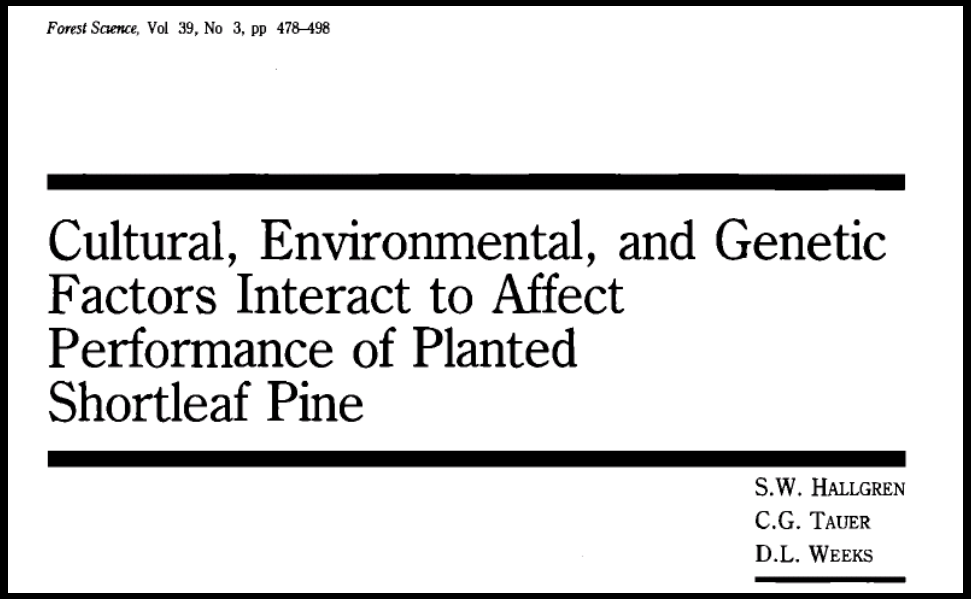
Benomyl Applied to Roots Improves Second-Year Survival and Growth of Shortleaf Pine

S.W. Hallgren *and* **D.M. Ferris,** *Department of Forestry, Oklahoma State University, Stillwater, OK 74078.*



Root Growth Potential, First-Year Survival, and Growth of Shortleaf Pine Seedlings Show Effects of Lift Date, Storage, and Family[1]

S. W. Hallgren *and* **C. G. Tauer,** *Department of Forestry, Oklahoma State University, Stillwater, OK 74078.*



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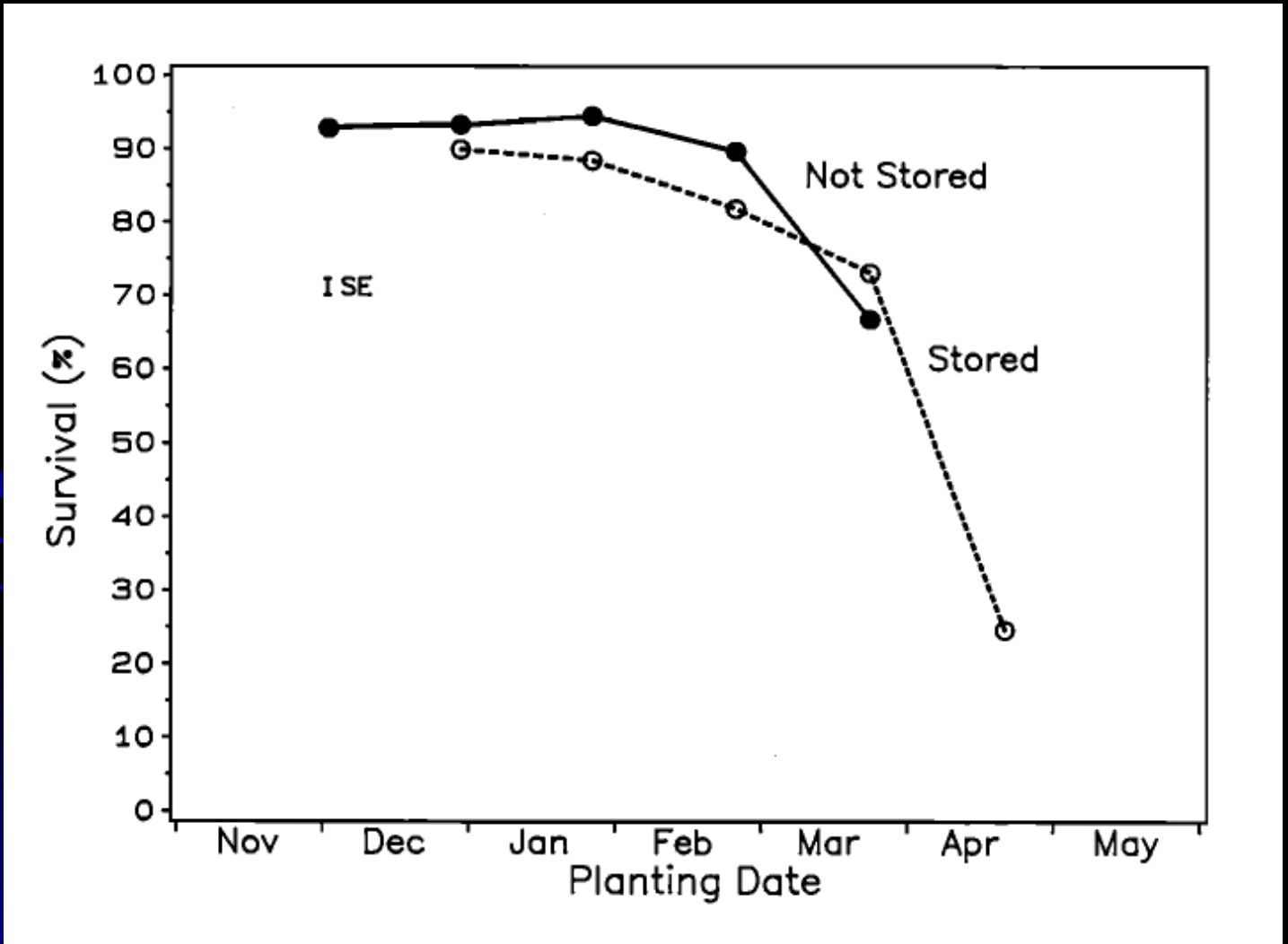
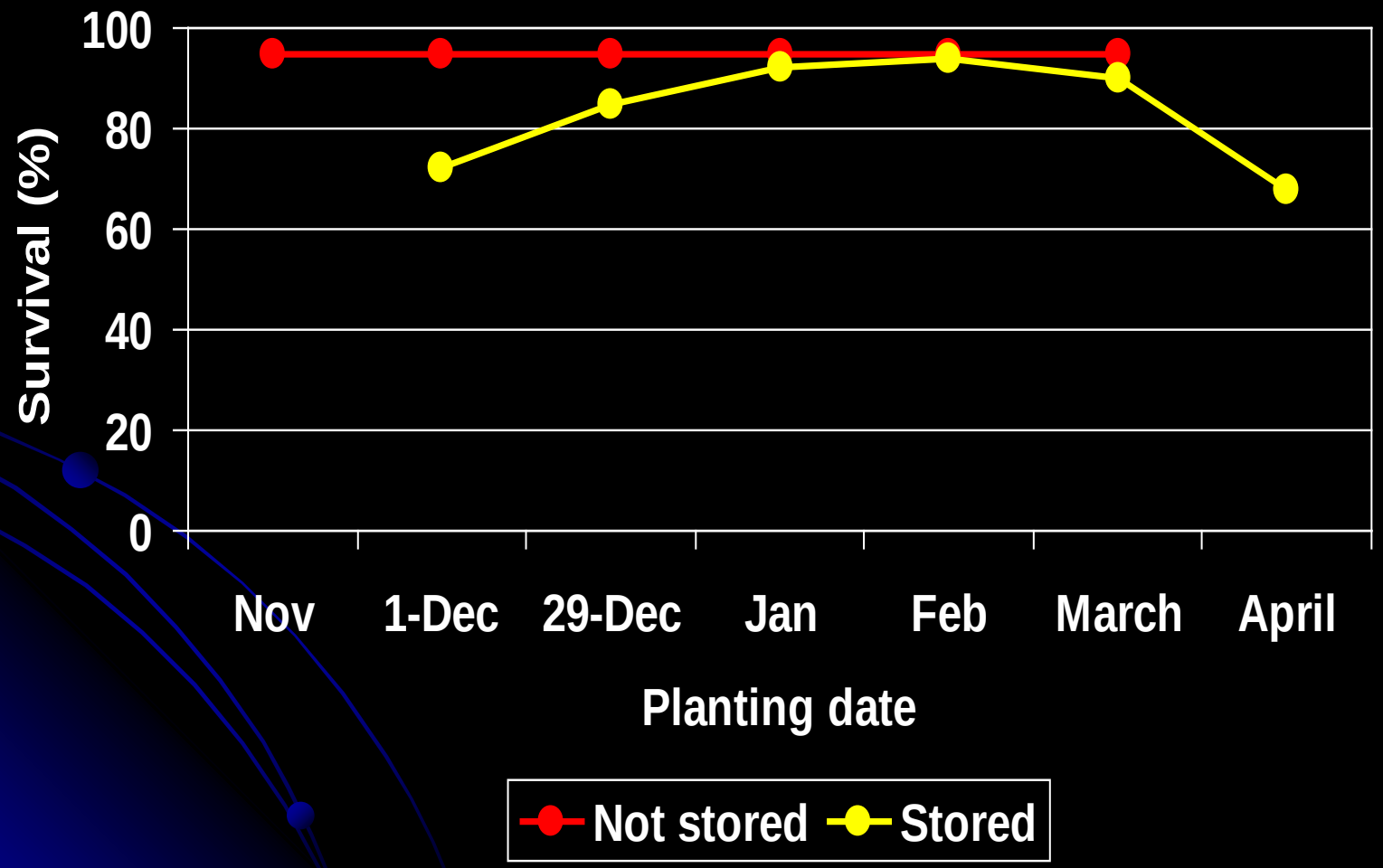
Cultural, Environmental, and Genetic Factors Interact to Affect Performance of Planted Shortleaf Pine

S.W. HALLGREN
C.G. TAUER
D.L. WEEKS

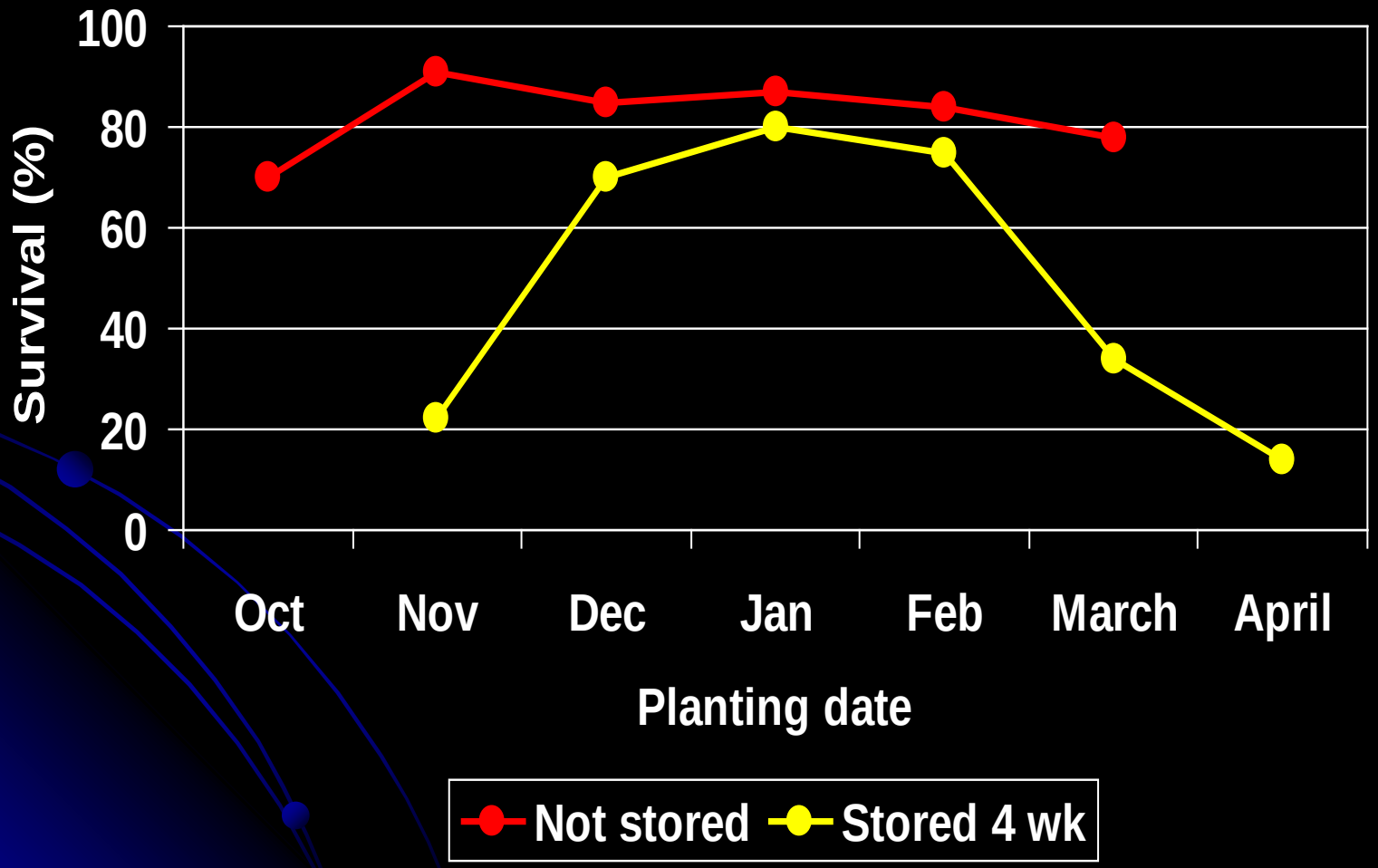
The first study (Hallgren and Tauer 1989) found that four weeks of storage reduced survival by 3% when seedlings were lifted on Dec 1 (with 314 chilling hr) and there was an 8% reduction when lifted on Jan 26 (with 950 chilling hr).



The second study (Hallgren et al. 1993) found that four weeks of storage had no effect on survival when seedlings were lifted on Dec 28 (758 chilling hr).



Third study (Hallgren and Ferris 1995) found that four weeks of storage reduced survival by at least 7%. Seedlings lifted on December 26 (442 chilling hr) had the highest survival for seedlings stored 4-weeks.



Four conclusions…

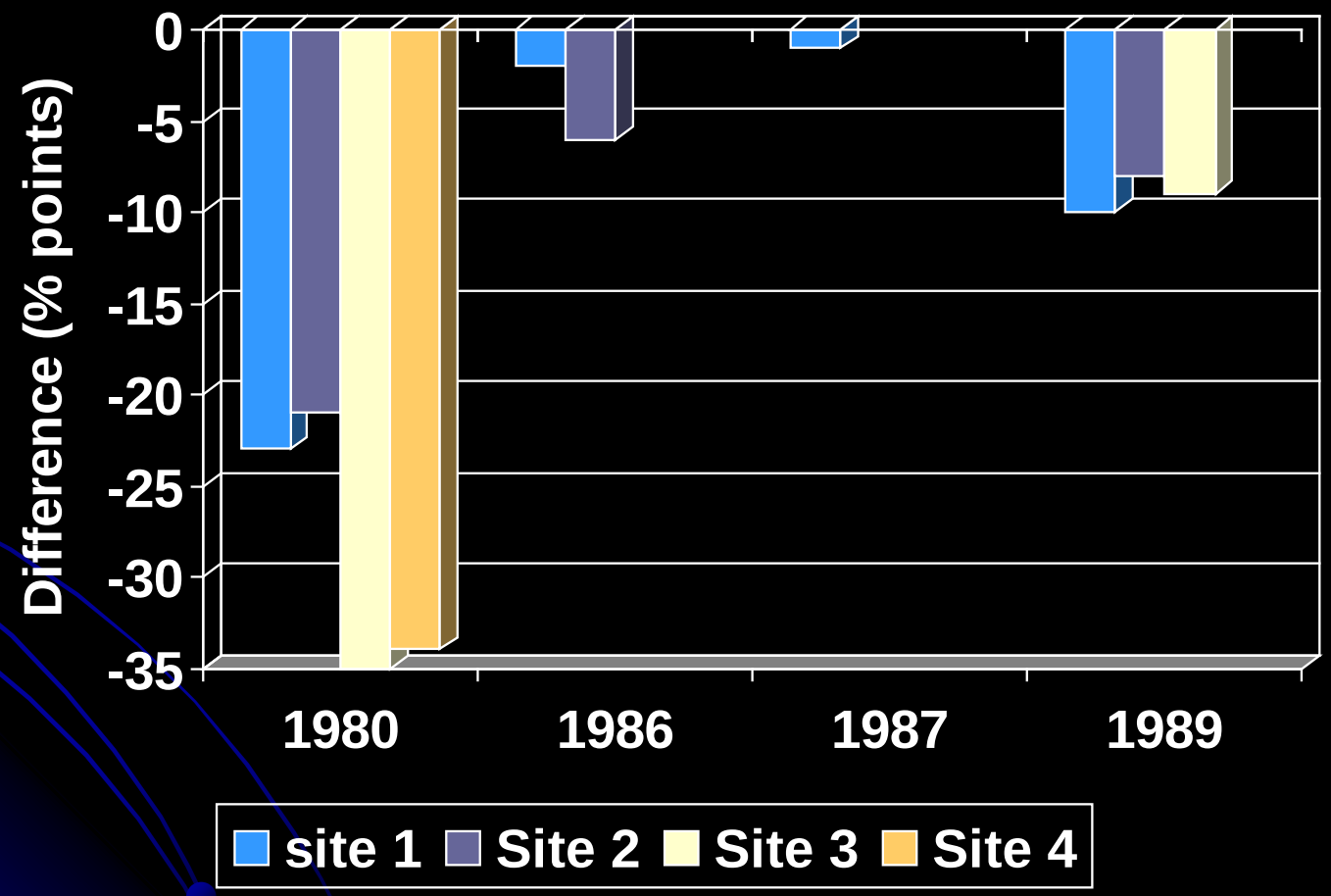
- Best time to store shortleaf pine is Dec 1st (first study) Survival of stored seedlings was >90% from early Dec to late Feb.
- Best time for storage is late December (second study)
- No best time since storage reduced survival on all lift dates (third study).
- Making universal planting recommendations base on a single study with shortleaf pine is dangerous and potentially misleading.

Storage myth

- Universal conclusions about storage of shortleaf pine can be obtained by a single study conducted in one year.

For Example

Decline in survival when lifting in Jan and planting in Feb



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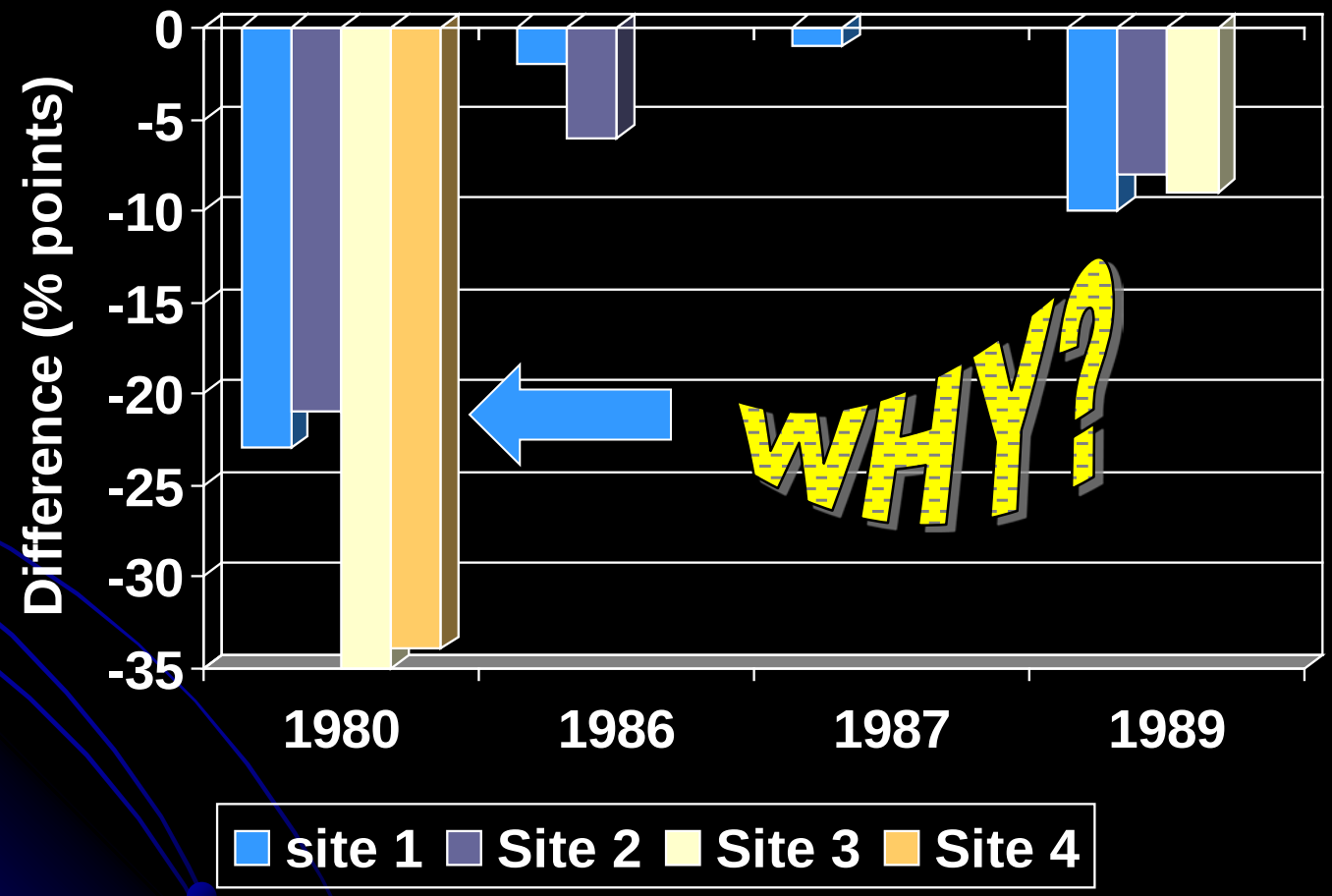
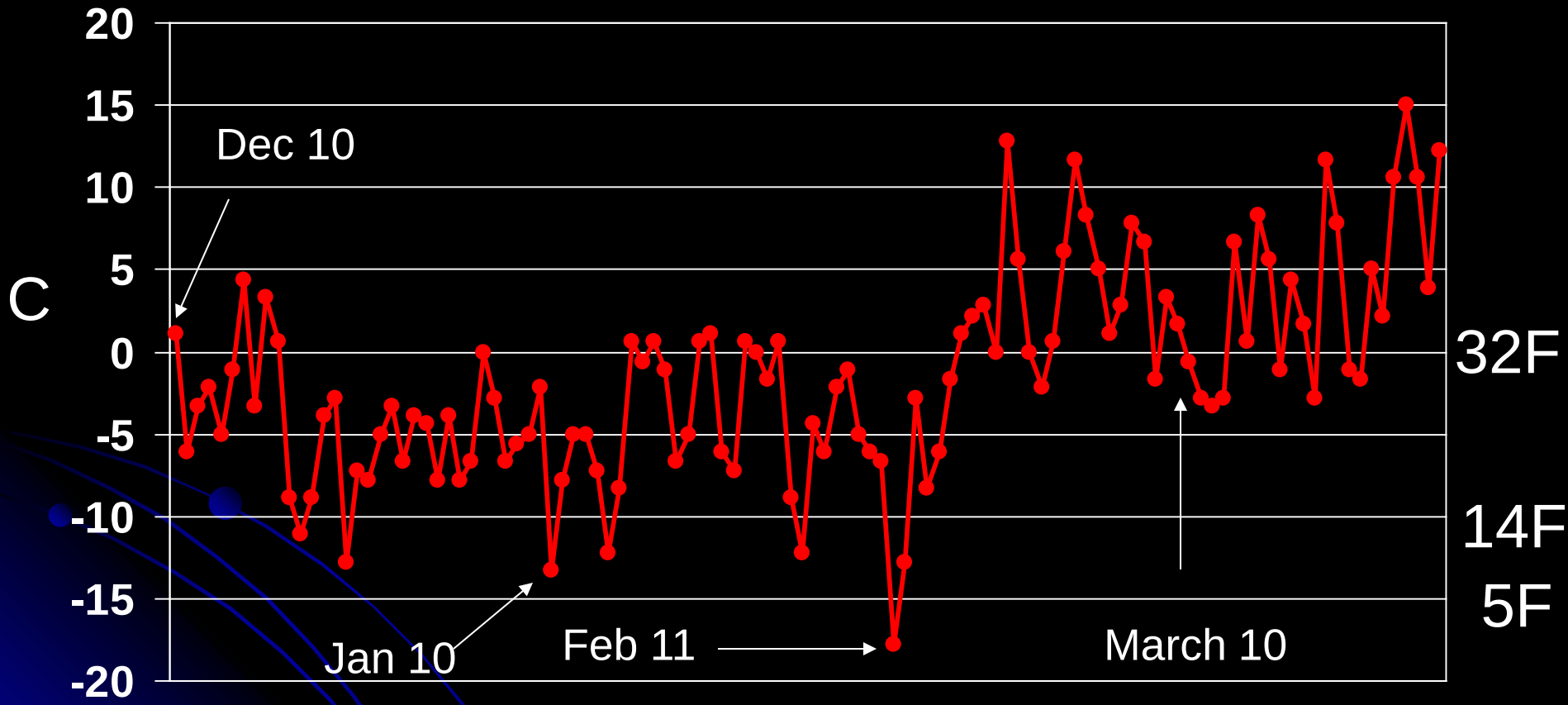
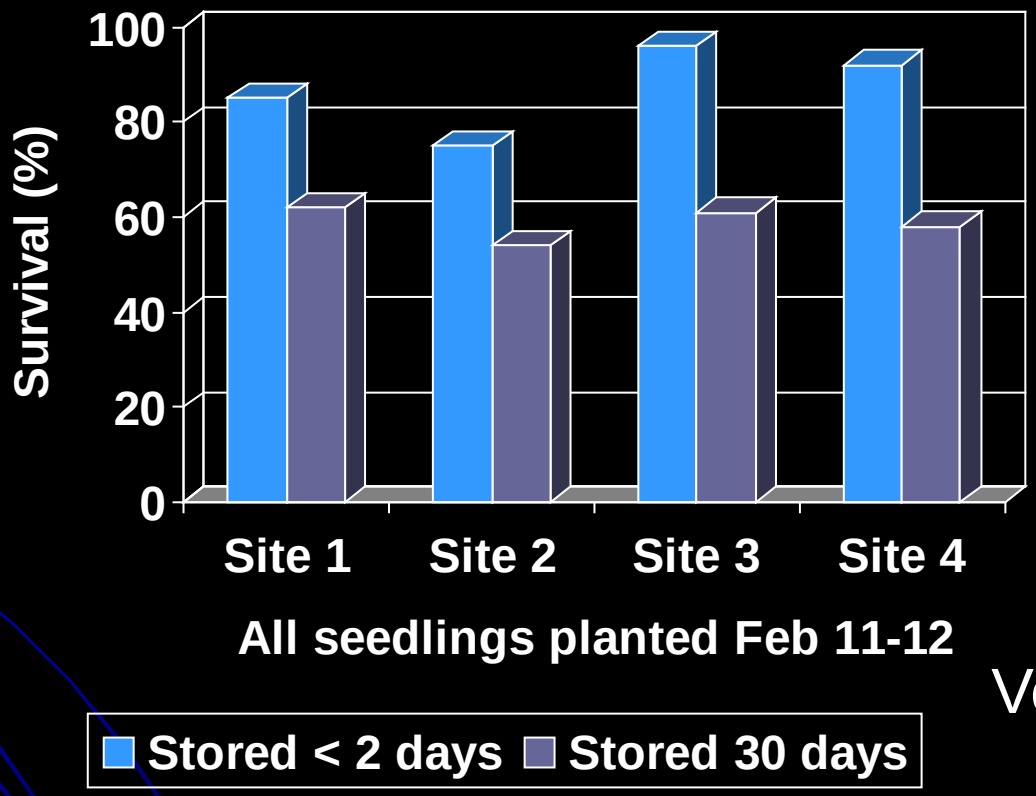


Low temperatures at Waldron, AR (1980-81)



Seedlings lifted on Jan 10 were stored and planted on Feb 11-12. Hard freezes on those dates at Waldron, AR.

Seedlings planted on Feb 11-12
0 F freeze on Feb 11 (-18 C)
9 F freeze on Feb 12 (-13 C)



Venator 1985

Are stored seedlings more susceptible to freeze injury because they had a month less natural chilling?

Storage trial Fact

Seedling mortality can occur when seedlings are outplanted just prior to a -13 F freeze.

In some trials, outplanting dates are confounded with storage lengths. As a result, in some cases conclusions could be faulty.

Question…. How can we improve the survival of stored shortleaf pine seedlings?

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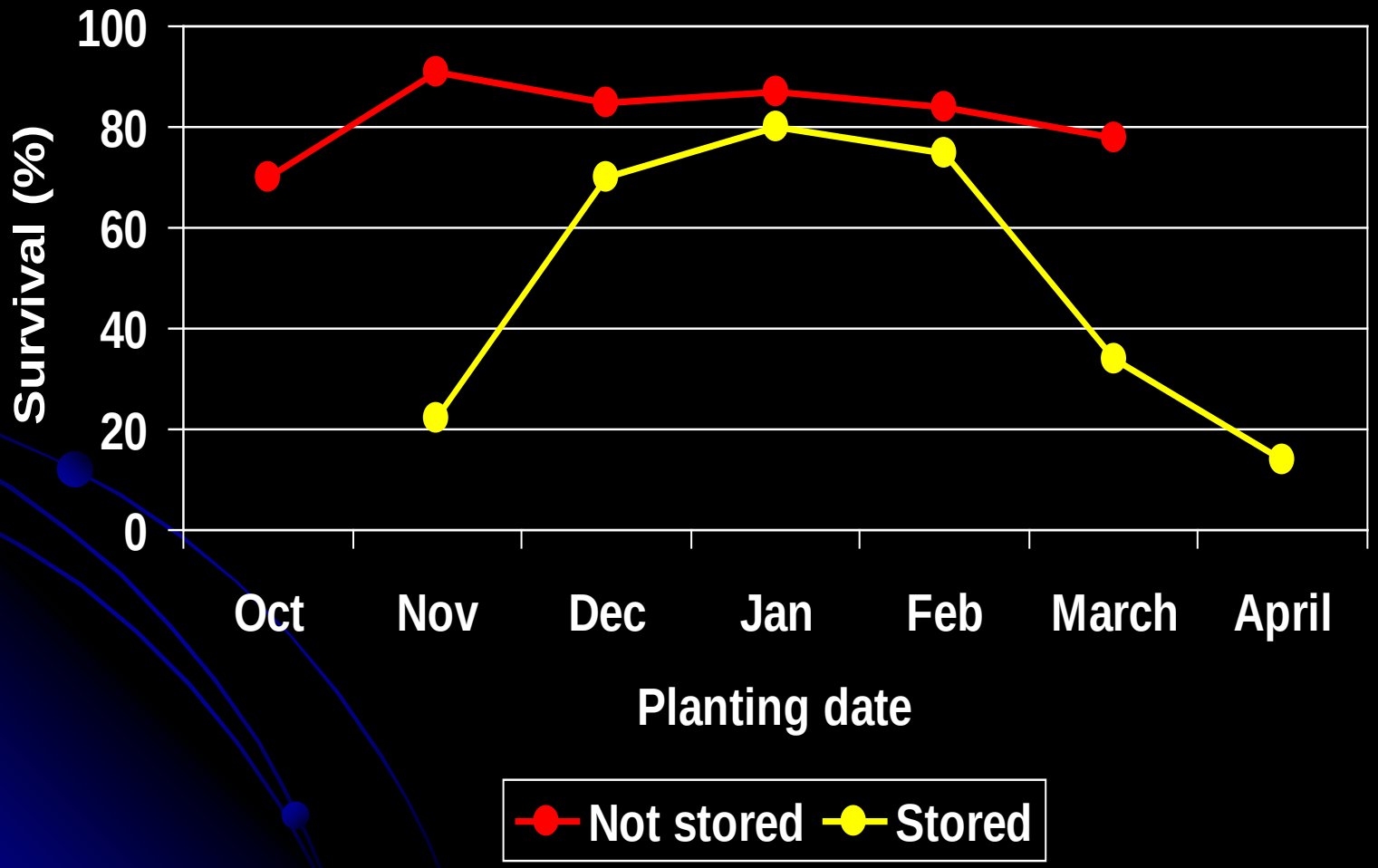
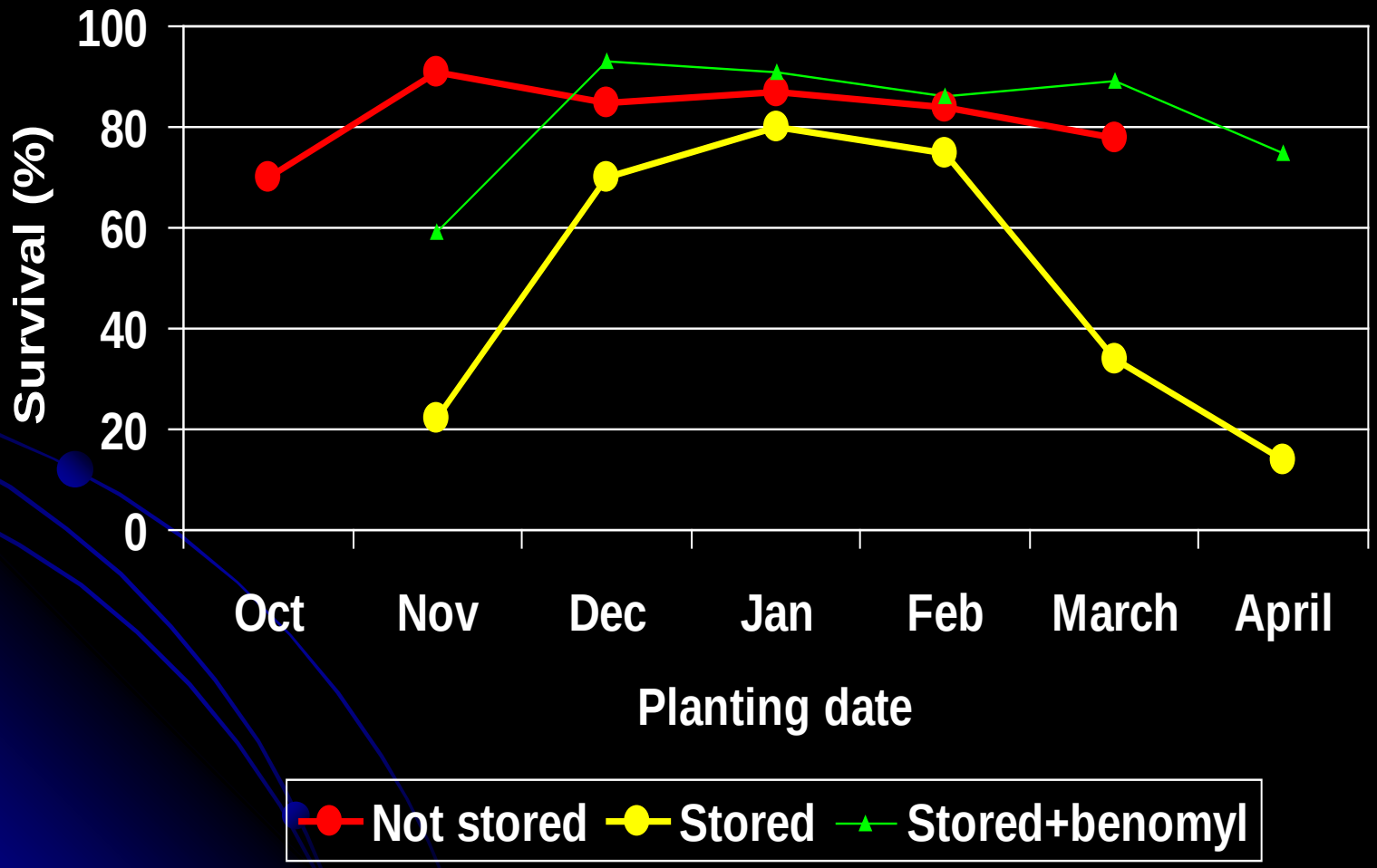


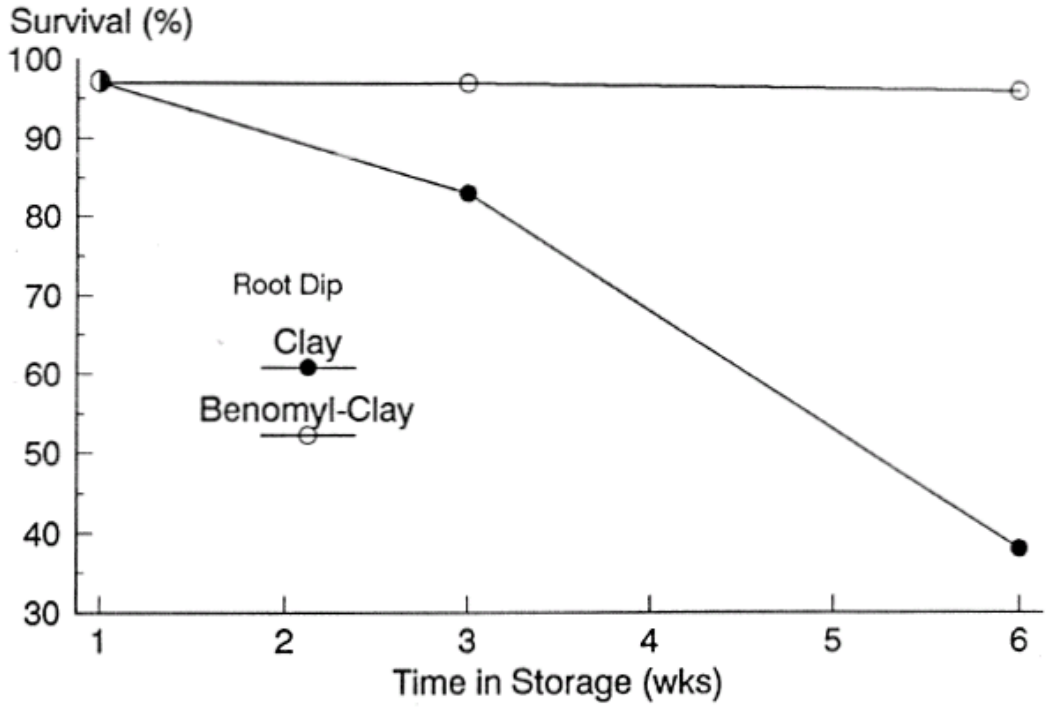
Hallgren and Ferris 1995

Question…. How can we improve the survival of stored shortleaf pine seedlings? Answer…. Treat roots with certain fungicides



Hallgren and Ferris 1995

Fungicides can significantly increase seedling survival



Improvement in survival of stored shortleaf pine seedlings following treatment with Benomyl^{R} (after Barnett et al. 1988).

Barnett et al. 1988

Question

- If a fungicide was registered for use on pine seedlings to improve seedling survival, would we treat seedlings operationally prior to storage?

Question

- If an insecticide was registered for use on pine seedlings to improve seedling survival, would we treat seedlings prior to storage?

Question

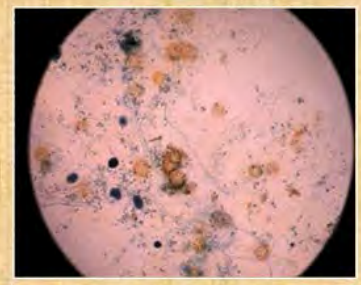
- If an insecticide was registered for use on pine seedlings to improve seedling survival, would nursery managers treat seedlings prior to storage?

Elite Pine Species			
Specie No.	Name	Price/1000	Price/500
70	Piedmont 3 Loblolly	$58.00	$34.00
91	Select Premium Slash	$58.00	$34.00
93	Pitch Canker Res. Slash	THIS SPECIES IS SOLD OUT	
160	Select RR3 Loblolly	$58.00	$34.00
254	Select Premium w/ Pounce	THIS SPECIES IS SOLD OUT	

Question…. How can we reduce growth of Pythium on seedlings in storage without using fungicides?

A Theory to Explain Poor Storability

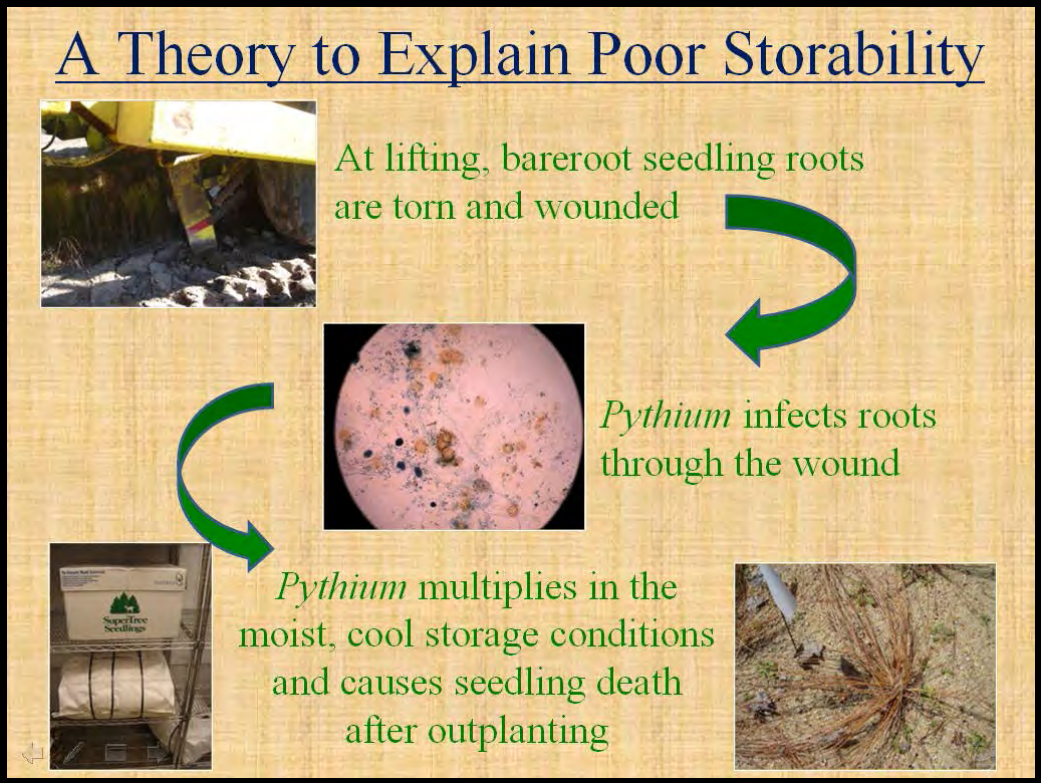
At lifting, bareroot seedling roots are torn and wounded



Pythium infects roots through the wound

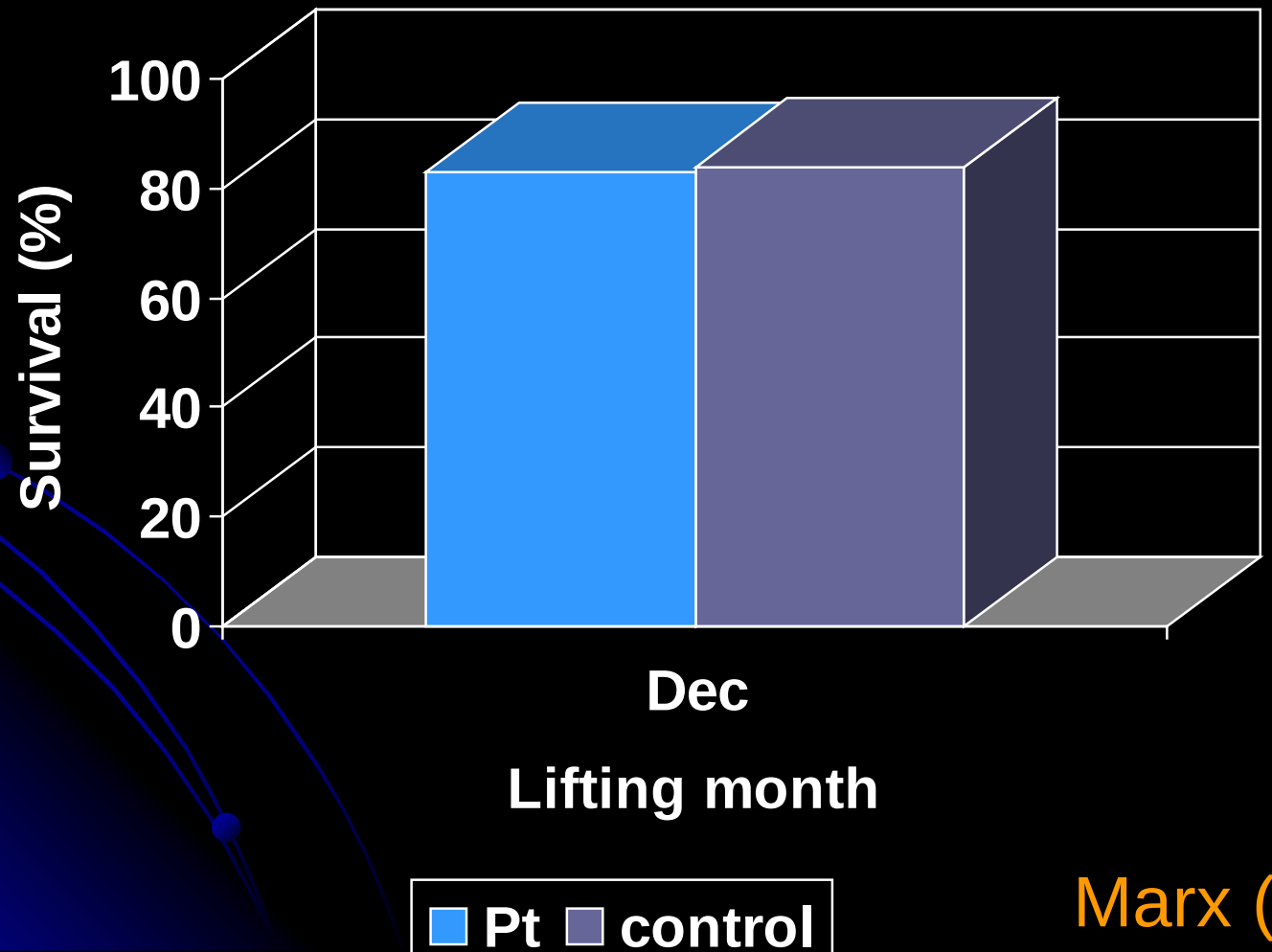
Pythium multiplies in the moist, cool storage conditions and causes seedling death after outplanting

Question…. How can we reduce growth of Pythium in storage without using fungicides?



How long could shortleaf pine be stored when cooler temp is set for 41 F (5 C) ??

Survival of stored bareroot shortleaf pine seedlings after 4 months of storage at 5 C



Marx (1979)

Storage temperatures

- 5 C Marx 1979 (4 months)
- 4-5 C Jackson et al. 2012 (1.5 months)

- 3 C Brissette and Chambers 1992
- 1-3 C Hallgren et al. 1993
- 2 C Venator 1985
- 1.5 C Barnett et al. 1988
- 1 C Bean 1963

Storage myth

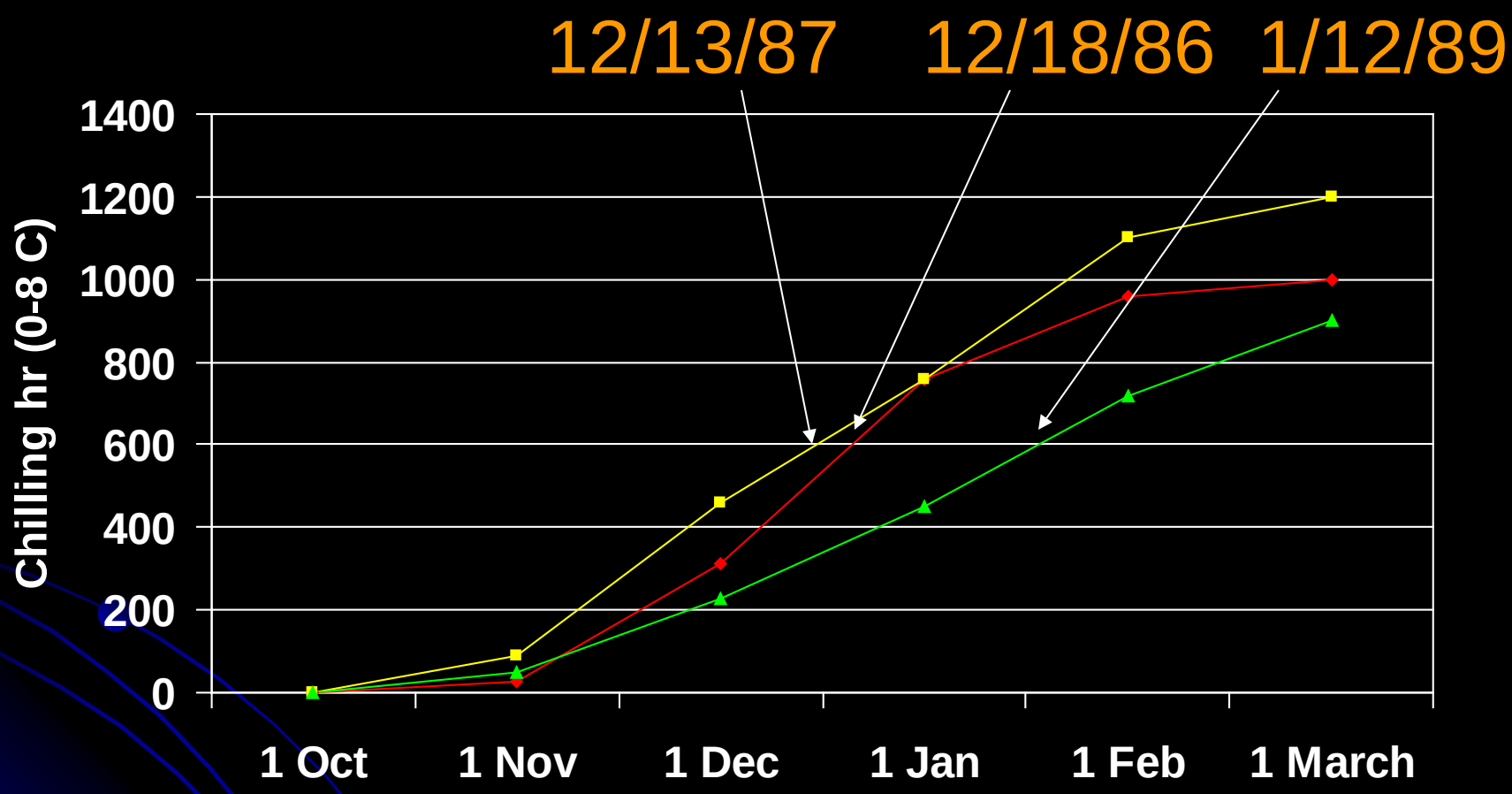
- Bareroot shortleaf pines cannot be stored for 4 weeks until the accumulation of 600 chilling hrs (0-8 C).

600 chilling hours

"Brissette and others (1988) found root growth potential (RGP) of shortleaf pine sensitive to chilling hour accumulation (0 to 8 ºC at 200 mm above the ground). When lifting date was expressed in accumulated chilling hours, maximum RGP after lifting occurred after 610 hours, **but no strong interaction occurred with cold storage**. Hallgren (1992) did report maximum RGP following storage for seedlings lifted after 700 hours of chilling."

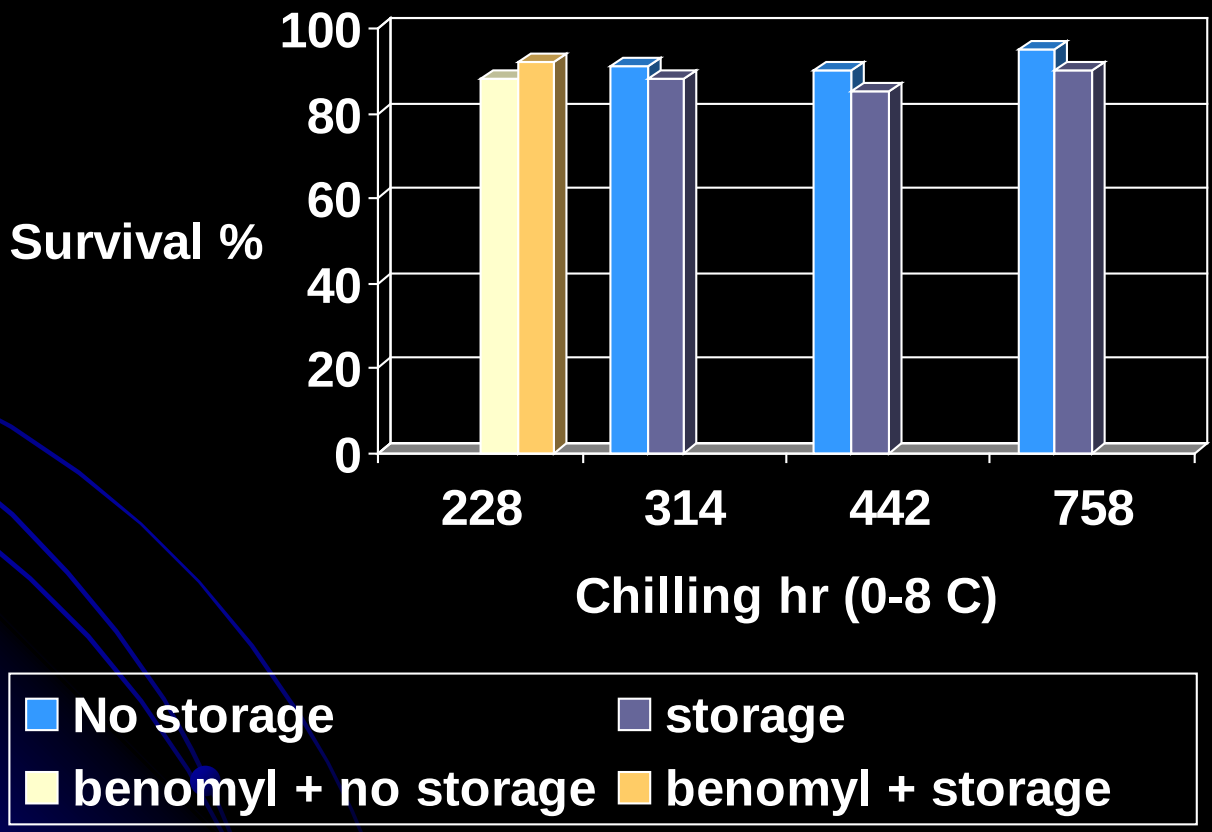
Barnett and Brissette 2007

Dates for 600 chilling hrs (0-8 C) Ft. Towson, OK



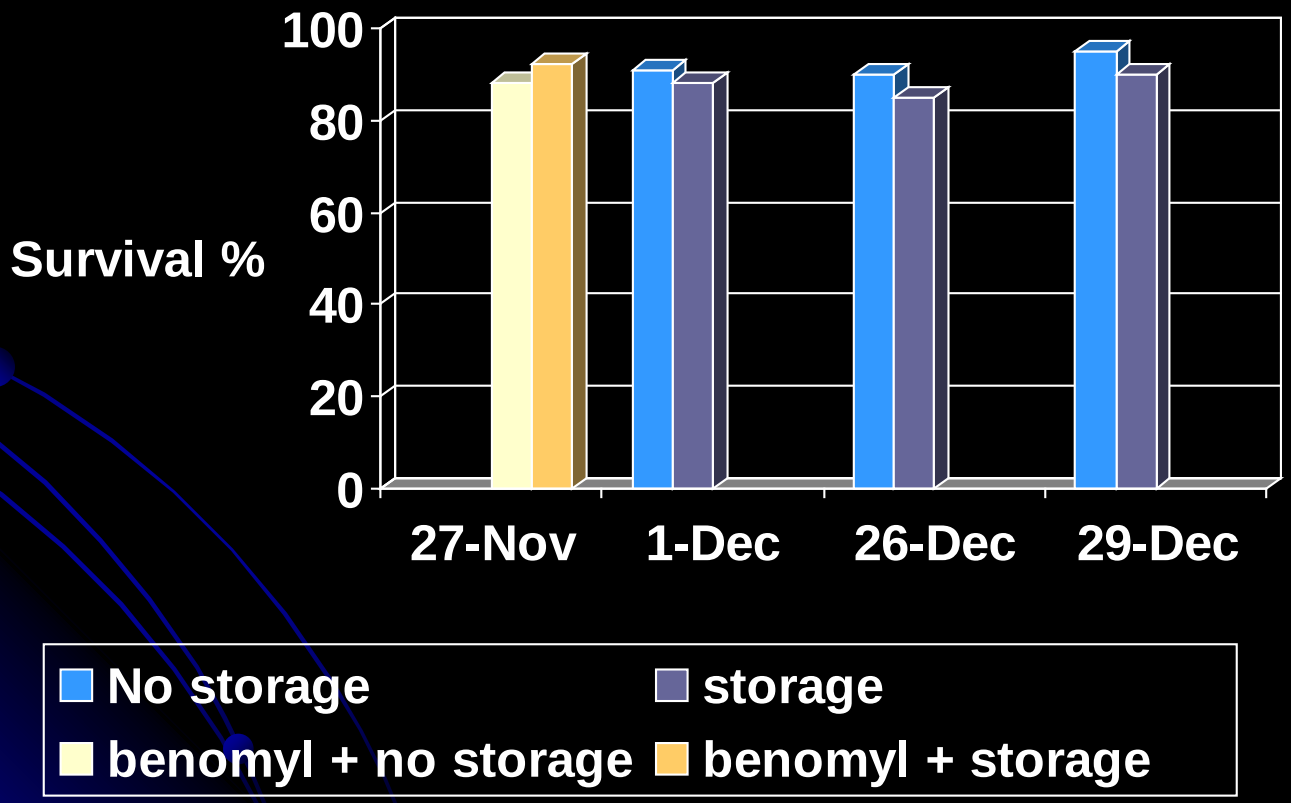
600 chilling hrs are not required before storing seedlings for 4 weeks

Dr. Hallgren trials



In some years, early Dec is OK (200-300 CH) and others late Dec is OK (400-750 CH) to start storing seedlings for 4 weeks

Dr. Hallgren trials



If storage of shortleaf pine depends on activity of *Pythium*, perhaps sensitivity to *Pythium* is not related to chilling hours.

A Theory to Explain Poor Storability

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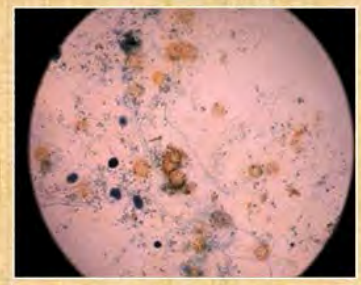
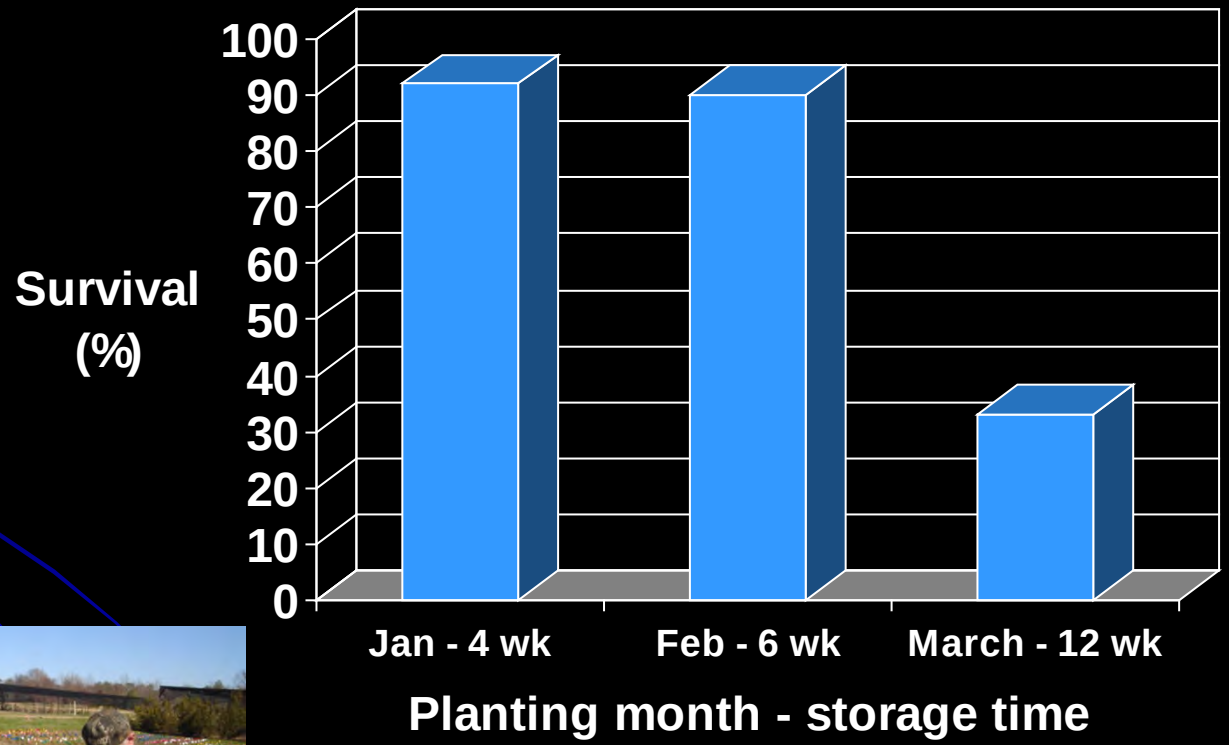


Pythium infects roots through the wound

Pythium multiplies in the moist, cool storage conditions and causes seedling death after outplanting

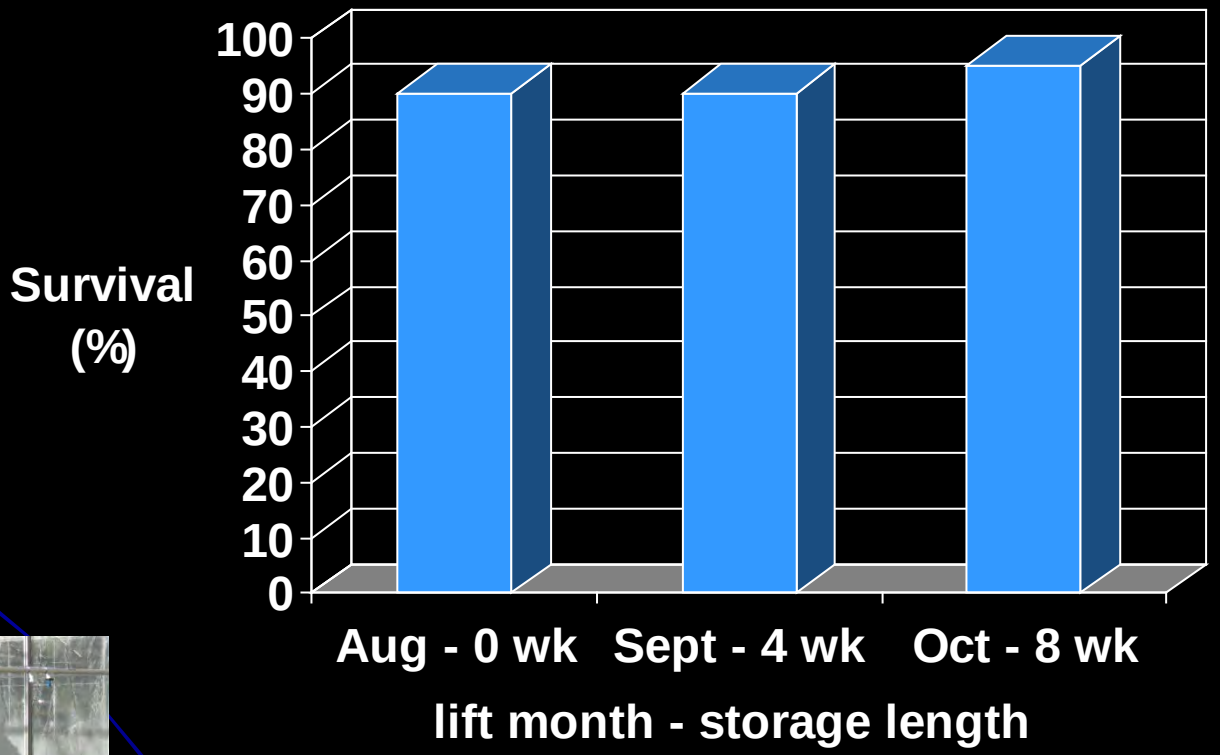
Effect of planting date/storage on survival of container-grown shortleaf pine

Low survival of container stock is caused by planting date? or combination with storage?



Jackson et al. (2012)

Container stock can be stored for 8 weeks (with no chilling)



Jackson et al. (2012)

Storage myth

- Container-grown shortleaf pine need chilling before they can be stored for 4 weeks

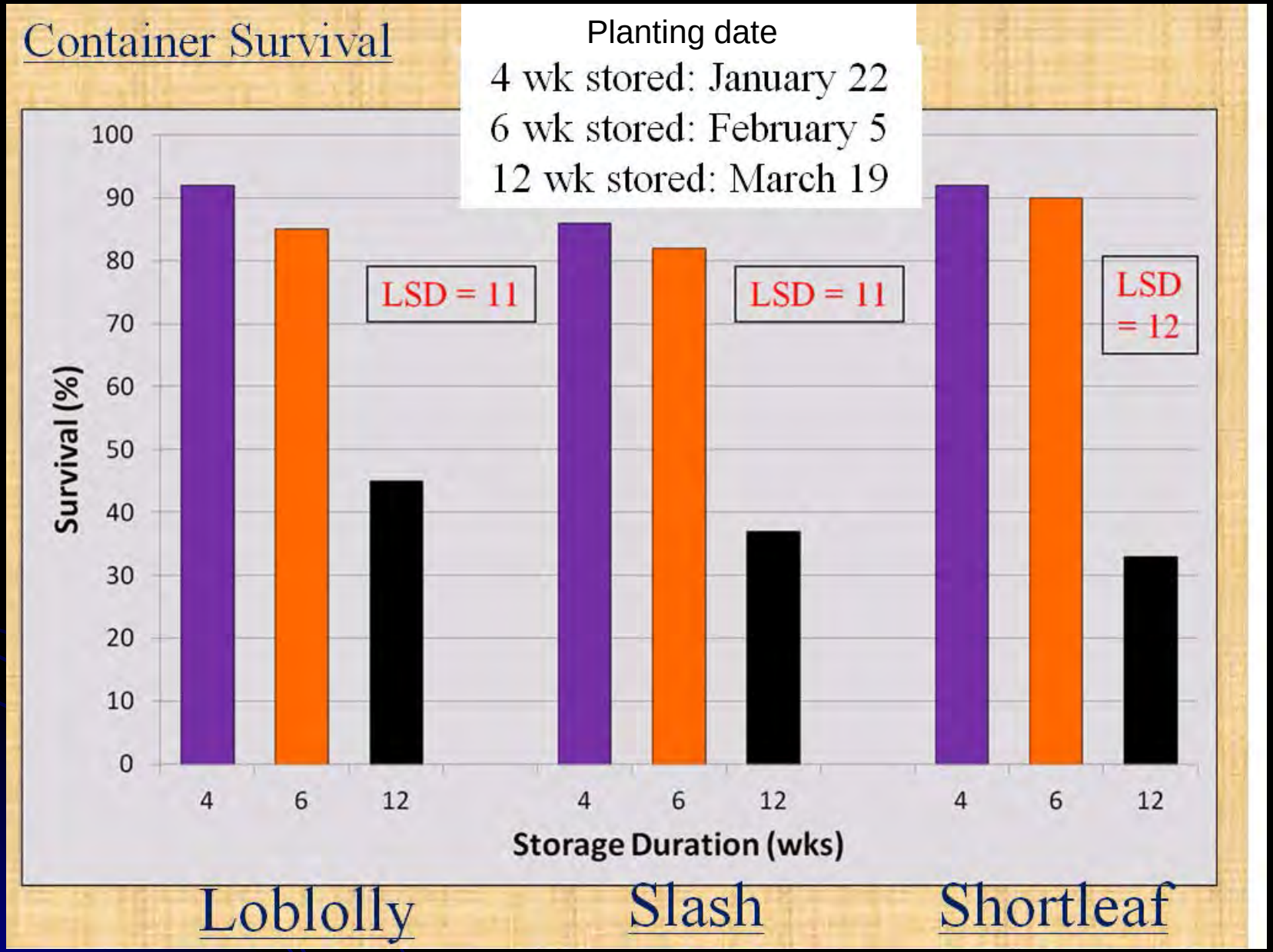
Is there an interaction between species and seedling storage?

- “Too few experiments have been made with cold storage of southern pine nursery stock to warrant recommendations concerning it”.

  Philip Wakeley (1954)

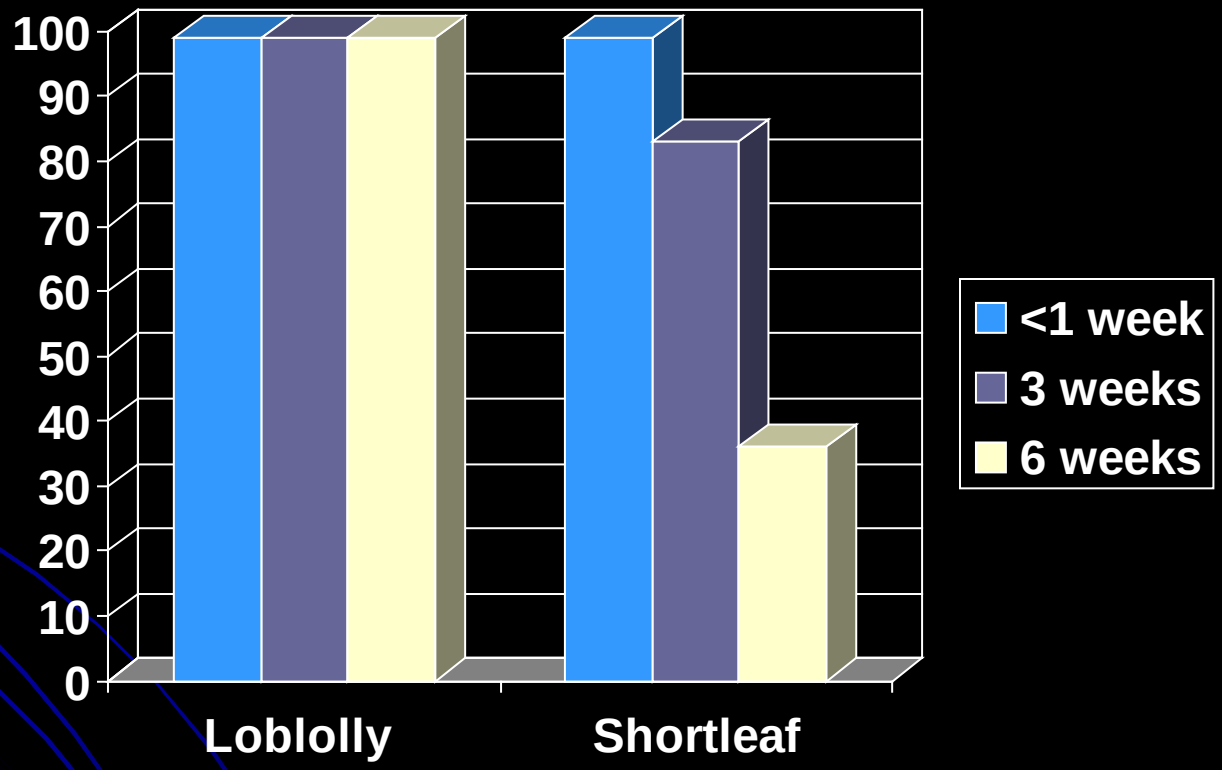
Is there an interaction between species and seedling storage?

- How many field species comparison experiments have reported tolerance to storage? Only two



Jackson et al. (2012)

Species x storage interaction for bareroot seedlings



Barnett et al. 1988

How long can shortleaf seedlings be stored?

- Depends on trial methodology (most trials are confounded)
- Depends on lifting date/ planting date
- Depends on year
- Depends on genotype
- Depends on stock type
- Depends on fungicide treatment
- Likely depends on storage temp/humidity

Questions???

- Example of care of shortleaf pine seedlings in Delaware.