FREEZE DAMAGE TO SOUTHERN PINE SEEDLINGS IN THE NURSERY

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Abstract.--The December 1983 sudden temperature drop with prolonged freezing temperatures damaged significant numbers of pine seedlings in southern nurseries. Seedlings from southeastern Oklahoma and east Texas to north Florida and south Georgia were affected by freezing temperatures damaging non-frost-hardy tissues.

The primary tissue affected was the cambium. Damage extended from the root collar well into the root system. Symptoms included reddish-brown bark and brown cambium. Effective diagnosis required cutting through the root bark to expose the discolored cambium and cortex.

Additional keywords: Dormancy, dessication, Pinus elliottii, P. taeda, P. palustris, P. clausa, P. virginiana.

THE WEATHER

The fall of 1983 was unusually warm and wet for the South. In southern Alabama very little frost had occurred by mid December (Figure 1).

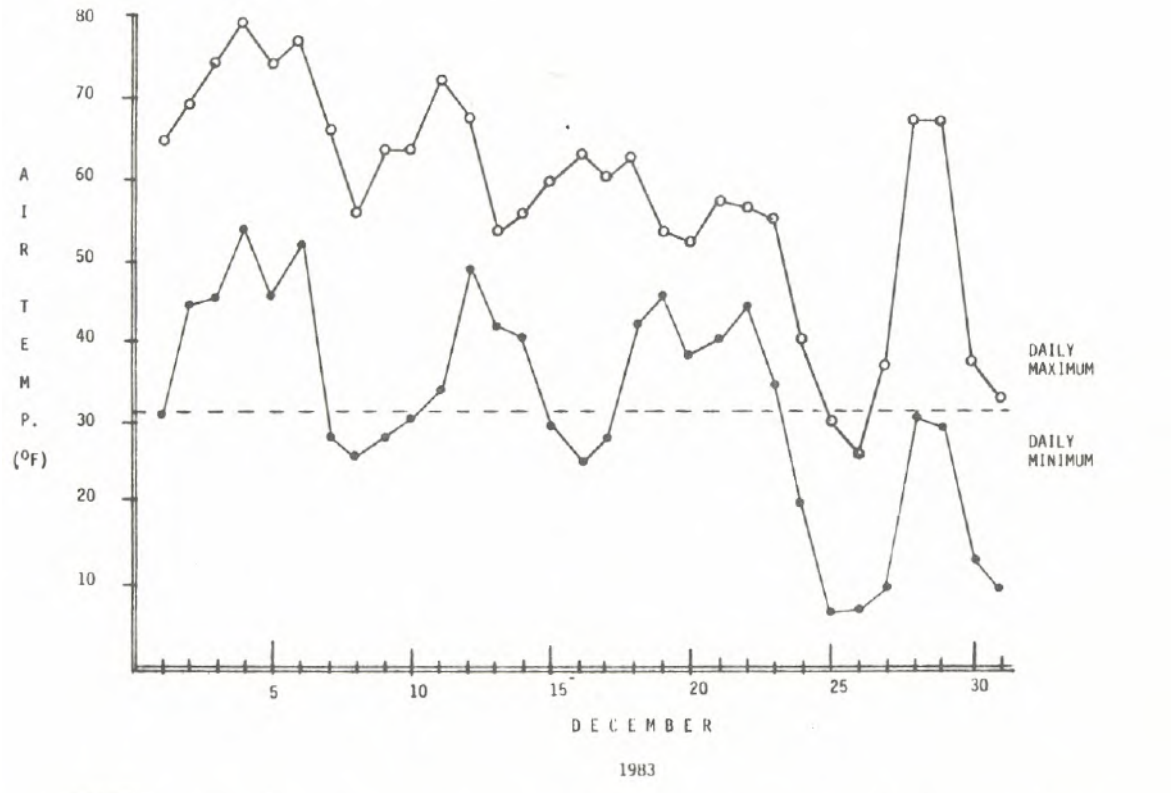

Figure 1: Maximum and minimum air temperatures for Brewton, Alabama; December 1983.

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On December 21 a cold front from the west had extended into Oklahoma and northwest Texas pushed by strong northwest winds. (Figure 2). As this cold air mass moved eastward, temperatures suddenly dropped well below freezing throughout most of the South. Some Gulf Coast locations dropped 38° in one day.

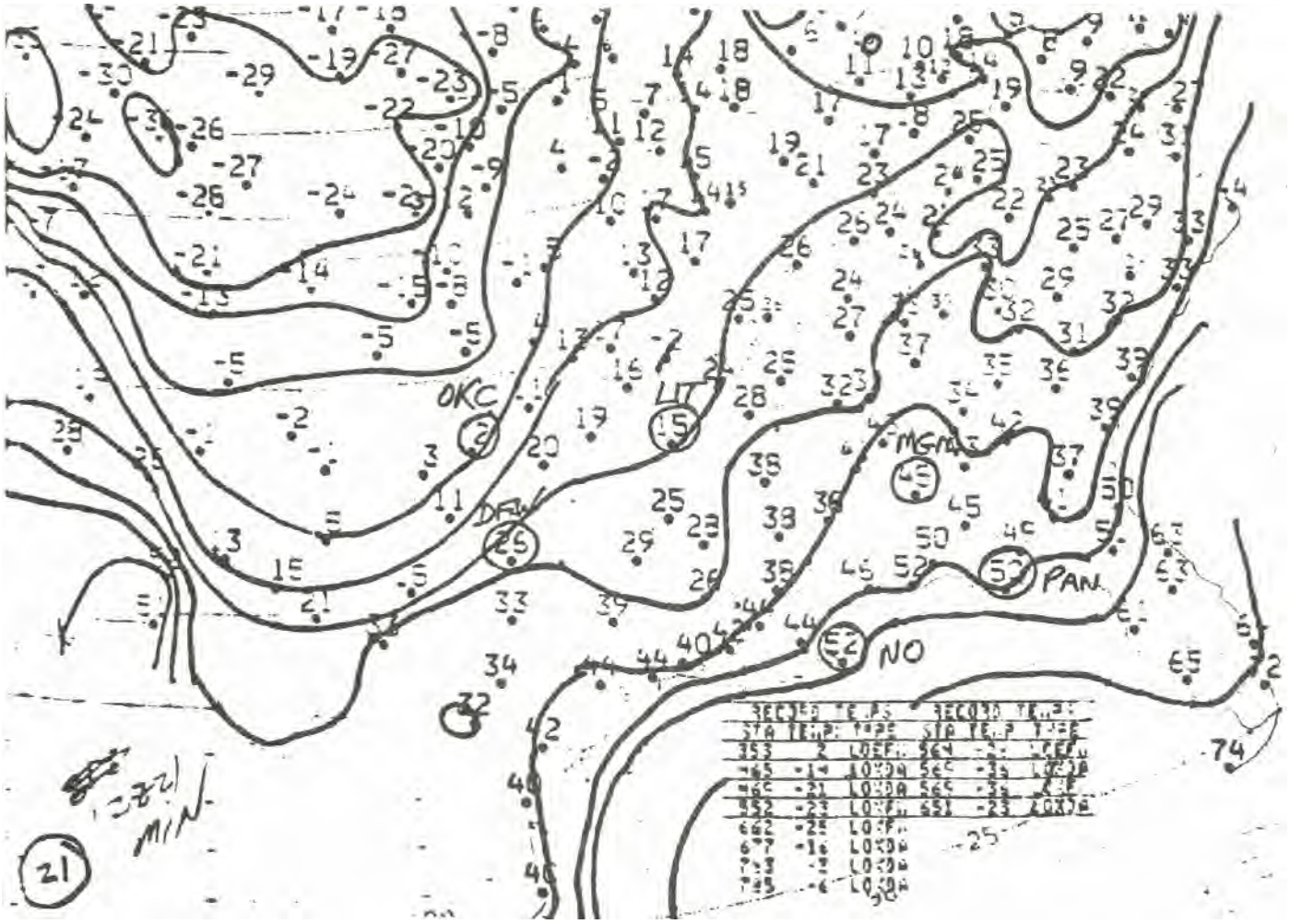

Figure 2: Minimum air temperatures on 12/21/84.

By Christmas day, freezing temperatures were reported as far South as central Florida. (Figure 3). Oklahoma City and Little Rock recorded lows of -1°F and Dallas-Fort Worth 6°F. Panama City reported 15°F.

This bitter cold lasted for 7-10 days in many areas. Many nurseries were "frozen-up" and seedlings could not be lifted.

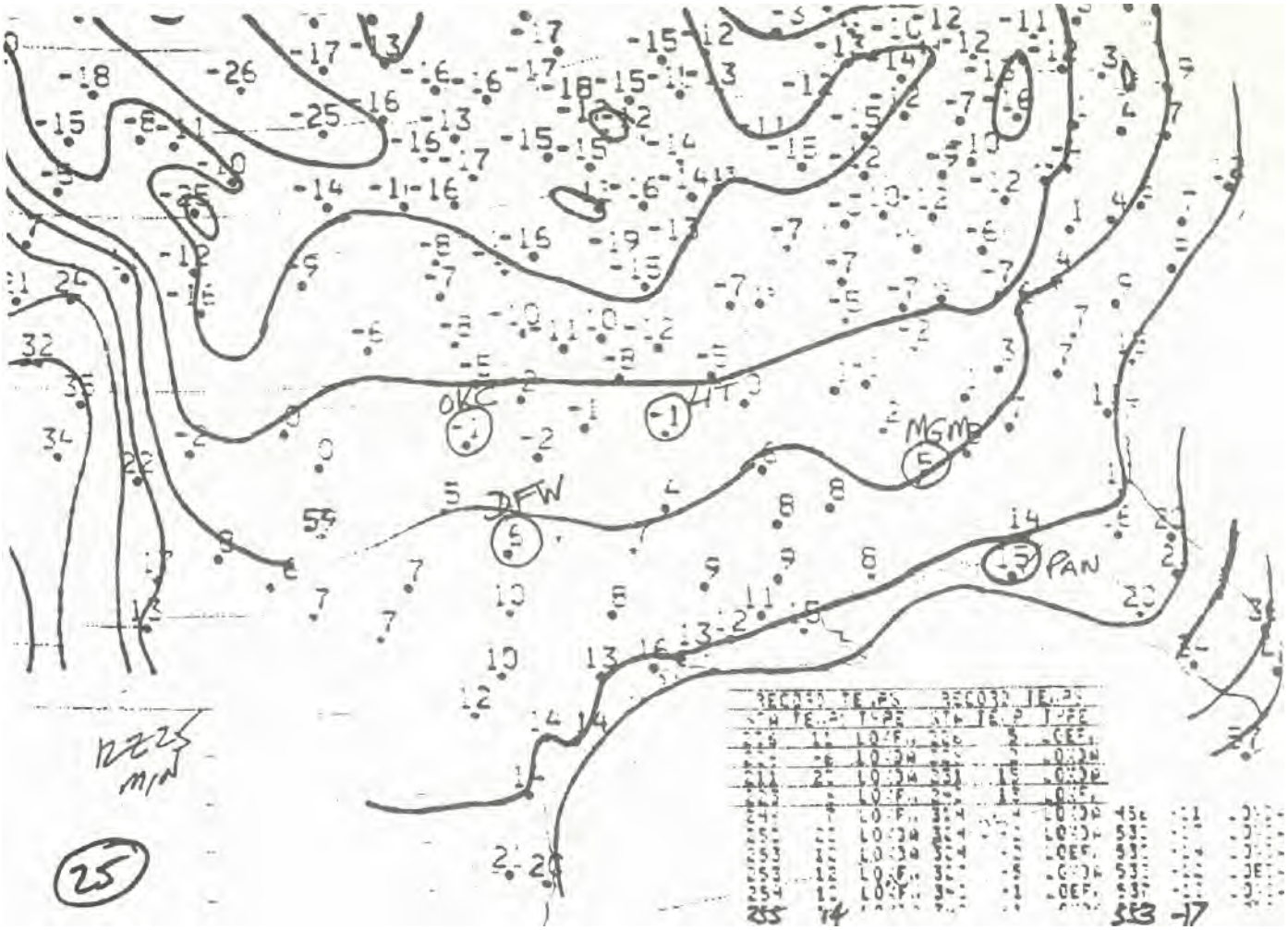

Figure 3: Minimum air temperatures on 12/25/84.

SEEDLING DAMAGE

The first symptoms of seedling damage were observed in nurseries in southern Alabama and northwest Florida. Longleaf pine seedlings were observed with reddish-brown roots when they were lifted. These damaged seedlings were particularly evident on the north and west (exposed) sides of the seedbeds.

By the middle of January it was apparent that seedling damage was both serious and widespread. A letter was sent to Southern Forest Nursery personnel in an effort to alert everyone to recognize the damage symptoms. (Appendix A). Suggestions for handling damaged seedlings were included.

Freeze damage to other pine species (loblolly, slash, shortleaf and sand pine) was more difficult to detect than with longleaf. In some cases sections through the root cortex were required to find damaged tissues.

Most of the damage observed was not similar to the typical "winter drying" damage. Winter drying can be recognized by reddish-brown needles caused by dessication when the soil is frozen and lost moisture cannot be replaced. Symptoms of winter drying are usually apparent very soon after the injury occurs. In contrast, the freeze damage did not result in visible needle symptoms until several weeks after the damage happened.

In a study of cold damage (winter drying) in a Virginia Nursery, Dierauf and Olinger (1977) found that seedlings on the southwest side of the seedbeds suffered much less mortality than those in other bed positions. These seedlings on the southwest side replaced lost moisture when the soil thawed. Other seedlings were unable to replace their lost moisture.

In January 1984 seedlings with external symptoms of freeze injury were lifted and "forced" into growth in several locations. In most of these trials very few seedlings deteriorated visibly: most seedlings maintained "Status Quo." In one study of Georgia Forestry Commission seedlings, only 10 seedlings died of 1,000 planted 1/.

Freeze damaged seedlings from the Alabama Forestry Commission were examined by Peter Feret at Virginia Polytechnic Institute. Some of the damaged seedlings showed a reduced root growth potential when compared with non-damaged seedlings:

	Mean number of new roots	Mean length of new roots (cm)
Damaged Seedlings	1.1	1.6
Undamaged Seedlings	3.7	6.6

Other samples did not show any association between damage symptoms and root regeneration.

[I]/ Personal communication from David Bramlett, SEFES, Macon, GA.

Southern pine seedlings normally respond to decreasing temperature and shorter day length in the fall by a gradual decrease in shoot growth. Many of the more northern nurseries (e.g. those in Kentucky, Tennessee, and Virginia) exhibit winter needle coloration by mid-November. Nurseries near the Gulf and south Atlantic coasts may never turn color. Root growth continues through the winter as soil temperatures permit.

Apparently the degree of both dormancy and cold hardiness varies with the seed source of the seedlings and the location of the nursery. Garber and Mexal (1980) estimated that loblolly pine from southeastern Oklahoma (McCurtain County) needs about 7 weeks of cold temperatures during November and December to complete it cold requirements.

Furthermore, there are important differences in cold hardiness between shoots and roots. Roots are not as cold tolerant as shoots, and the roots do not become cold hardy unless the soil is frozen. (Glerum 1982).

Observations in several southern nurseries indicated that where the soil was frozen, seedling damage was reduced or not present (table 1).

Table 1: Observations on Seedling Freeze Damage:

STATE	NURSERY LOCATION	CHILLING HOURS	LOW TEMP.	WIND VEL.	LOSS
AR	LITTLE ROCK GROUND FROZEN 12/19-1/28				0
TX	JASPER	58	8°		NEEDLE BURN NO ROOT OR CAMBIUM DAMAGE
OK	NORMAN				0
MS	BROOKLYN	361	7°	HIGH	5-15%
AL	BREWTON		10°	63 MW	1/2 MM
	EUTAW				LOB FAMILY LOSS 7-70%
	ATMORE		7°		STATE NURSERIES LOST 11 MM $ 1/4 MM
FL	MUNSON CHIEFLAND				ALL FALL-SOWN SAND, S FL SLASH, VA, LONGLEAF: 60% S FL SLASH: 78% CONTRACT LONGLEAF
SC	SWANSEA [LAST N ON 8/17 [LAST K ON 8/23	409	6° (GROUND FROZEN 3-4" 4 DAYS)		0
GA	BELLVILLE BYRON				LONGLEAF, SAND, SLASH (EXPOSED DRILLS)

On the basis of these limited observations it appears that soil temperatures may have an important influence on the cold hardiness of southern pine roots. Additional research is needed to understand this relationship.

CONCLUSIONS

The greatest amount of freeze damage was observed in exposed seedbeds in gulf coast nurseries. Seedling drills on the north and west sides of seedbeds were injured more than interior drills. Longleaf pine seedlings were damaged more severely than other species. The total value of damaged seedlings southwide is estimated at several million dollars.

Greenhouse studies and root regeneration studies have indicated a relationship between damage symptoms and seedling performance in only a few cases.

Several studies have been installed to compare visible damage with field survival. The results of these studies will not be available until winter 1984-85.

RECOMMENDATIONS TO AVOID DAMAGE IN THE FUTURE

The following procedures are recommended to reduce the amount of freeze damage in the future:

1. Install wind breaks to shield exposed seedbeds in the nursery.

2. Plant longleaf pine in protected seedbeds.

3. Maintain a continuous cover of mulch through the winter for fall-sown species.

4. Schedule cultural practices to "harden-off" seedlings in the fall:

   -do not fertilize after August
   -do not irrigate after September unless moisture stress will cause seedling mortality.
   -root and top prune during the summer and early fall to control growth and morphology.
   -examine root wrenching techniques to "condition" seedlings.

LITERATURE CITED

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Appendix A: Maximum and minimum temperatures for Brewton, Alabama, December 1983.

DATE	AIR TEMP.		SOIL TEMP.	
	MAX	MIN	MAX	MIN
12/ 1	64	31	60	44
12/ 2	69	44	62	51
12/ 3	74	45	66	51
12/ 4	79	54	71	60
12/ 5	73	45	70	57
12/ 6	77	52	67	57
12/ 7	65	27	66	45
12/ 8	55	25	60	44
12/ 9	63	27	61	42
12/10	63	30	62	44
12/11	72	33	63	45
12/12	67	49	62	55
12/13	53	41	55	50
12/14	55	40	56	50
12/15	59	29	59	45
12/16	62	24	58	42
12/17	60	28	57	41
12/18	62	42	57	47
12/19	53	45	53	49
12/20	52	38	53	47
12/21	57	40	56	47
12/22	56	44	57	49
12/23	55	34	55	46
12/24	40	20	48	38
12/25	30	6	44	32
12/26	25	7	32	31
12/27	36	9	39	31
12/28	67	31	55	37
12/29	67	29	59	44
12/30	37	13	40	34
12/31	32	10	38	33

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Freeze Damage to Seedlings in the Nursery

Southern Forest Nursery Personnel

The recent low temperatures experienced in the South have damaged many seedlings in the nursery. Observations of nursery beds in Alabama, Arkansas, Florida, Georgia, and Texas have indicated freeze damage to both pine and hardwood seedlings.

Longleaf seedlings appear to have suffered the most severe damage. Slash, loblolly, Virginia, and sand pines, plus sweetgum and black walnut seedlings have also been affected. Early damage estimates are already revealing probable seedling losses exceeding 50 million. This damage estimate will undoubtedly increase with further, more intensive observations.

In general, the most severe damage has been observed with one or more of the following conditions:

--Nurseries located in central and southern Alabama, north Florida and central and southern Georgia.

--Nursery beds oriented in an east-west direction or with a north aspect.

--Nursery beds with fine textured soil.

--Nursery beds with high soil moisture just prior to the freeze.

Damage appraisals to date in several affected nurseries have not revealed any correlations with seed source or degree of genetic improvement.

Symptoms of Damage

This is not just the typical "winter drying" damage which can be recognized by brown needles caused by desiccation. This damage appears to be the result of the sudden freezing (during the Christmas 1983 weekend) of plant tissues which were not cold-hardy. Easily-recognized symptoms have not become apparent for several weeks since the freeze occurred.

Look for:

--Discolored cambium near the root collar-may be spotted, gray or brown. In advanced cases, the bark will "slip" and may feel "spongy."

--Roots may be brown or black. They may appear watersoaked and feel "spongy."

--The bark on the roots may "slip."

--Sections cut through the roots may have a "wet sawdust" or fermented smell.

Note: Adequate damage detection requires removal of the root bark with a knife to reveal the brown or discolored tissues. These appear in longitudinal and cross sections in the inner root tissues and primarily occur from the ground line to a 3 to 4 inch depth.

This damage cannot be adequately diagnosed solely by external observations of the seedling roots. The interior discoloration is seldom visible on the root surface.

Suggestions for handling damaged seedlings

1. Since the identification of damage becomes easier with time, we suggest that the lifting of suspect seedlings he delayed as long as possible. Once seedlings are lifted, packed and placed in cold storage it will be very difficult to detect damage. However, present seedling lifting and field planting time schedules may limit the practicality of this procedure.

2. The damage appears to be related to wind exposure in some nurseries. Exposed seedbeds were damaged while sheltered beds were not. In some nurseries seedlings on the north or exposed end or side of the beds were damaged while those to the south escaped injury. In these beds the suspect seedlings can be marked and lifting can be delayed until a more positive diagnosis can be made.

3. Suspect seedlings can be lifted, potted and forced into growth (or decline) by moving them into a greenhouse, growth chamber or even a warm room. In 10-14 days the status of the damage should he apparent.

4. Some state forestry agencies are employing the following procedures to reduce the impact of this problem:

    a. Intensive seedling sampling and diagnostic procedures.

    h. Establishment of maximum damage levels for seedling sales.

    c. A coordinated public relations program to include the distribution of literature describing the seedling damage and alerting the public to the potential losses involved.

Send your observations to us

We plan to document this situation and publish the results. We will appreciate any information you can provide on the description and/or the degree of damage. There is no need for a formal report - just send us your handwritten notes.

Remember the Importance of Seed Source!

When seedlings are not available from the recommended seed source the temptation is strong to buy seedlings from wherever they are available, regardless of the seed source. If seedlings from a poorly-adapted seed source are planted, the losses can he devastating. Besides the possibility of complete plantation failure, growth reductions can occur which will adversely affect yields throughout the rotation.

Please impress upon your personnel the importance of planting seedlings of the proper geographic sources for their respective areas. The importance of seed source cannot be stressed enough; it is better to leave a site unplanted than to risk the catastrophic results of planting an ill-adapted source!

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