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# Cold Weather Injury to Southern Yellow Pine Seedlings

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An extended winter freeze event occurred from December 27, 2017 through January 9, 2018 across North Carolina. During this time much of the state recorded low temperatures in the teens and several single digit nights. Daytime highs were below or barely above freezing for most of the period. For example, the Sandhills logged 7 consecutive days with low temperatures ≤ 10°F and daytime highs ≤ 33°F (Table 1).

| | Temperature° F | |
|---|---|---|
| | High | Low |
| Dec 27 | 44 | 30 |
| 28 | 32 | 21 |
| 29 | 44 | 19 |
| 30 | 52 | 23 |
| 31 | 34 | 25 |
| Jan 1 | 28 | 16 |
| 2 | 30 | 8 |
| 3 | 30 | 6 |
| 4 | 33 | 10 |
| 5 | 33 | 6 |
| 6 | 27 | 3 |
| 7 | 27 | 1 |
| 8 | 46 | 10 |
| 9 | 66 | 30 |

*Table 1. High and low temperatures recorded in Southern Pines, NC from Dec..27 2017 – Jan. 9, 2018.*

When temperatures drop this low and for this long, there is a risk of freeze injury to southern yellow pines. Pines typically acclimate to cold temperatures gradually as days get shorter and colder, developing a level of cold hardiness; however, pine roots never become fully dormant and are more sensitive to cold temperatures.

Susceptibility to cold injury varies by species and seed sources. Shortleaf is the most cold-hardy southern yellow pine species, followed by loblolly then longleaf. Pines from coastal sources are more sensitive than piedmont sources and southern sources more sensitive than northern. Planted longleaf is particularly at risk due to the practice of shallow planting container seedlings, leading to increased root exposure.

Unseasonably warm weather can deacclimate seedlings and increase susceptibility to cold damage. A warm spell followed by a sudden and extreme cold period is the most damaging winter weather situation. The risk of damage also increases if the freeze is accompanied by high winds.

**Indicators of winter damage** to pine seedlings include:

- winter burn to the needles;
- brown discoloration under the bark of the stem or root;
- frost heave where the seedling is pushed out of ground.

*Figure 1. Winter burn to longleaf seedling needles is a result of desiccation. In most cases the root system is not injured and the seedling will bud out in the spring.*

**Needle Injury -Winter-burn**

Newly planted seedlings initially have poor soil-to-root contact reducing the amount of moisture the roots can take up. In frozen or dry soils, winter-burn occurs when the needles dry out because the foliage loses water faster than is replaced from the roots. This "burn" isn't actually cold injury to the needles, but needle browning due to desiccation. Pine needles damaged by winter-burn turn brown or reddish and have a dry scorched appearance. High winds and low humidity speed up needle desiccation. Seedlings can usually recover from winter-burn once new root growth occurs as soil temperatures increase.

**Root and Stem Injury**

Pine root and stem tissue is susceptible to injury when temperatures fall below 25°F. The certainty of injury increases as the temperature decreases and the longer the seedlings are exposed. Exposed root tissue is more easily damaged then stem tissue. However, since soils insulate and hold heat longer, the root is protected from damaging cold. The stem just above the ground-line, where the coldest air often settles, is unprotected and particularly vulnerable.

Freeze damage to the stem or root is identified by a brown discoloration to the cambium or wood just under the bark (Figure 2). A dark brown pith in the stem is another indicator of injury. Above-ground symptoms of root or stem damage typically begin to appear as the trees initiate spring growth in March or April, and varies by both year and location. Shallow planted longleaf seedlings are particularly vulnerable to root damage since the sensitive root tissue is more exposed to damaging cold temperatures.

*Figure 2. Freeze damage is seen as a brown discoloration on the stem or root just under the bark.*

*Figure 3. This longleaf seedling was pushed out of the ground during an extreme cold event. The heavy texture and wet nature of the site increased the risk.*

**Frost Heave**

Frost heaved seedlings are pushed out of the ground when soils thaw and freeze (Figure 3). Newly planted container seedlings in wet, heavy textured soils are most at risk. Deeply planting loblolly pine seedlings, both container and bare-root, lessen the likelihood of frost heave. Unfortunately, this is not possible with longleaf seedlings. Planting longleaf seedlings deep buries the terminal bud, resulting in slow growth and potential death.

**Container seedlings in nurseries are at risk.**

The use of container pine seedlings has increased because of improved survival and early growth. This especially true for longleaf. Container seedlings are typically grown in the open on elevated benches to allow the trays to drain and roots to air prune. Without the insulating protection of the soil, the roots of elevated container seedlings are exposed to damaging cold that bare-root seedlings grown in the ground do not face. Damage can occur at temperatures below 25°F and is almost certain at 15°F or lower.

While on the nursery bench, consecutive cold days can weaken or kill the seedlings unless measures are taken to protect them from the extreme cold. Container seedlings can be packed and stored in refrigerated coolers or the container trays can be placed on the ground and covered with plastic for insulation. Unfortunately, many nurseries do not have refrigerated storage or lack capacity to store seedlings for many weeks. Covering with plastic requires daily removal and is cost prohibitive. Without additional projection, the seedlings may look fine following a freeze event, only to die a few weeks later after being shipped or planted.

Before you plant after a freeze event, ask the nursery what measures they took to protect their seedlings and if they checked for cold damage after the freeze. Unprotected container seedlings should not be planted without evaluating their condition. In the future, the best solution is to plant container seedlings in the fall, as soon as there is adequate soil moisture.

**Monitor your seedlings.**

Newly planted seedlings are at risk for injury when they are exposed to extreme cold, especially if they have not acclimated or became de-acclimated to cold. Damage may not show up for a few weeks so check your seedlings soon after a freeze and then again in a couple weeks. Even though the seedlings may not initially die, they may be weakened and at risk to other stressors like drought, pests, or vegetative competition. Continue to keep an eye on the seedlings until warm weather arrives and new growth is evident.

Following a freeze event, remember to also check unplanted container seedlings for damage before they go in the ground. Seedlings in question should not be planted without evaluating their condition.

**How to Check Seedlings for Injury**

- With your fingernail or a knife scrap off just the bark from the stem above the root collar and down into the tap root.
- Look for any brown tissue (Figure 2). Healthy tissue will be whitish or green (Figure 4).
- Cut the seedling stem and root lengthwise to expose the pith. A dark brown pith indicates cold damage.
- Check seedlings whose foliage has winter burn for stem/root damage.
- Cold damage to the stem is most common just above the ground, but also check the root area too, as roots are more sensitive.

**Summary**

- Pines acclimate to cold temperatures gradually as days get shorter and colder, developing a level of cold hardiness.
- Unseasonably warm weather can deacclimate seedlings and increase susceptibility.
- Pine roots, especially longleaf roots, never become fully dormant and are more sensitive to cold temperatures.
- Susceptibility to cold injury varies by seed source and species. Longleaf is more sensitive than loblolly, which is more sensitive than shortleaf.
- Cold damage to the stem is usually located just above the ground line. Cold damage to the more sensitive roots is typically seen in the first few inches of the taproot just below the surface.
- Freeze damage can weaken seedlings. Weakened seedlings are more likely to succumb to other stresses such as drought or competition.
- Seedlings can recover from minor freeze damage injury if other stresses are minimal.
- Container seedlings in the open on elevated benches are extremely vulnerable to temperatures below 25°F.
- Plant container seedlings in the fall, as soon as there is adequate soil moisture, to avoid cold exposure in the nursery.

*Figure 4. The white or green color of the root just under the bark is an indicator of a healthy seedling*

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