

Seedling Care and Handling

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Nursery workers, foresters, land owners, and tree planters often overlook the need for care in handling seedlings between lifting and planting. Successful reforestation depends on maintaining the life support systems of the seedling while it is removed from its natural environment; *all* persons handling the seedling must share responsibility for its health.

Maintaining a seedling out of the ground is somewhat like maintaining a fish out of water—improper care and handling translates into mortality. Many planting failures thought to be caused by receiving damaged or dead stock from the nursery can be traced to poor handling procedures between the nursery and the planting site. You must protect seedlings from temperature and moisture extremes and from physical damage at all times.

Water

You must keep out-of-soil seedlings moist, either by restricting water loss with a water vapor barrier or by adding water to the roots at regular intervals. A shipping bag or box should contain an effective vapor barrier made of either polyethylene or wax. A water-proof planting bag also can restrict water loss from the roots, although the open top of the bag allows substantial amounts of water to be lost, particularly in relatively warm, dry conditions.



Under such conditions, anything that you can do to reduce temperature, slow air movement around the seedling, and increase the water supply is helpful. For example, adding moist peat moss to the bag provides a water supply, and an insulated planting bag reduces seedling temperatures. Reduced temperature decreases water lost to the air, as does keeping seedlings covered

during transportation or when planting on a windy day.

Although both seedling shoots and roots lose water to the air, the roots require more protection. Root tips are most susceptible to drying because, unlike leaves, they do not have stomata (closeable openings in the leaf surface) or a waxy coating to reduce water loss. If roots appear dry, the finer root hairs are probably already damaged or dead. Make every effort to keep roots moist while the seedling is out of the ground.

Insufficient water damages seedlings, but complete submersion in water can be damaging, also, because of a lack of oxygen in the water. This lack of oxygen is the same reason that most conifers will not grow where soil is flooded for any length of time.

If there is any doubt about seedling water status, add water to the seedlings, but don't completely submerge them in water for more than a few minutes at a time. A good way to be sure that the roots are completely moist is

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to dip them in water for about 1 minute (Figure 1). A good time for dipping is when you remove seedlings from the packing bag, before you transfer them to the planting bag.

Temperature

Live seedlings burn food reserves (respire) to survive the winter. You must reduce the amount of food the seedling uses while it's out of its natural environment, so that it will have sufficient reserves to support growth and avoid transplant shock when you plant it.

Respiration is the conversion of food reserves to energy. In this process, 60 percent of the energy is available for work, but the remaining 40 percent is given off as heat. Respiration rate is a function of temperature: as temperature increases, so do respiration and the amount of heat generated.

As temperatures approach 32°F (0°C), respiration rates decrease to a low level; food reserves are conserved, and the seedlings give off little heat. Seedlings packed in seedling bags or boxes can produce considerable respiratory heat if containers are exposed to warm air or direct sunlight. This heat does not dissipate readily; as a result, temperature can become high enough to injure seedlings.

For this reason, keep seedlings as cool as practical during handling, as long as they are

not frozen. Subfreezing storage is possible, but not unless conditions are carefully controlled. For practical field storage, prevent both freezing and high temperatures. Table 1 gives a temperature guide for seedlings.

Several principles are important in maintaining the seedlings at low temperatures and preventing damage.

1. Seedling temperatures are affected by air temperature, air circulation around the container, sunlight, and the time of year you lift the seedlings. Since you can't measure all these components easily, it is important to have a small thermometer to measure seedling temperature. A pocket dial thermometer is ideal for measuring the temperature of seedlings in a container. (Consult Table 1 to identify acceptable temperatures.)
2. Keep seedlings out of direct sunlight; solar radiation heats seedlings even on cool days (Figure 2).
3. Seedlings lifted during midwinter (when they are dormant) are less susceptible to heating problems.
4. The best way to protect trees is to store them under refrigeration with precise temperature control until they are ready for planting. All good nurseries have such facilities. Don't take a chance on storing them in uncontrolled conditions (such as a shed).

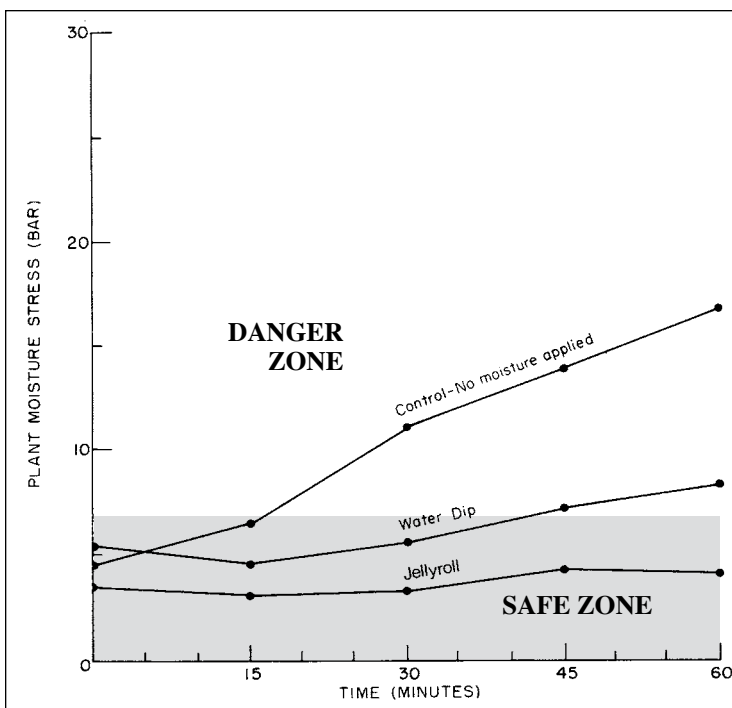


Figure 1.—Moisture stress in exposed seedlings: desiccation of water-dipped, jellyrolled, and undipped seedlings during a 1-hour exposure to room temperatures. Water-dipped seedlings were soaked for 1 minute before the 1-hour exposure. Jellyrolled seedlings were dipped in a slurry of water, peat moss, and vermiculite, and the roots then were wrapped in wet burlap.

Plant moisture stress (PMS) measures the tension that develops in the seedling water column when the leaf stomata lose water faster than the roots can take it up. The water column is continuous from the root tip–soil water interface (source of water) to the leaf stomata–atmosphere interface (point of water evaporation); hence, when water loss (at leaf) exceeds gain (at roots), the water column is stretched, much like a rubber band, creating tension. Tension force is measured in bars. When tension is low—normally 2 to 7 bars for healthy seedlings—water is sufficient to prevent cell damage. As the seedling dries out (water loss continues, but water is not available for uptake), the tension increases, as does the potential for cell damage. Note that undipped and dipped seedlings entered the danger zone within 20 minutes and 45 minutes, respectively.

- You can store seedlings received from cold storage at nurseries for a few days if you keep them shaded and cool (less than 50°F). If you can't plant all seedlings within a few days, find a cold-storage facility to keep them at 34 to 40°F. Avoid freezing them.

Physical damage

Preventing physical damage to seedlings should be an obvious concern, but it's often overlooked. A seedling can be damaged by physical pressure caused by crushing, dropping, or excessive vibration in much the same way as people are bruised when hit by an object. The seedling often can repair the damage in the same way that humans recover from injury—but only at a loss in ability to survive and grow. In the extreme case of complete girdling or removing part of the seedling, recovery is not possible.

Handle seedlings carefully. Research indicates that merely rubbing roots between your hands or dropping a box of seedlings reduces survival and growth. Analyze your handling process and, if necessary, change it to minimize handling while still ensuring the best possible environment for the seedlings.

If you must keep seedlings for several weeks, consider “heeling in”—storing them outdoors with their roots in a moist mulch of soil or organic matter. This is an old practice that's still used in some regions.

“Heeling in” must be done cautiously to avoid damage, as trees are subjected to an extra handling step. Even if done carefully, some root damage is likely. More important, heeling in means control of the seedling environment either is lost or difficult to maintain. Seedlings may be subjected to subfreezing or excessively high temperatures and/or loss of water. Unless you take extra precautions to prevent freeze damage by protecting the seedlings, and to replace water loss through a regular irrigation program, your seedlings are likely to suffer a significant decline in vigor while they are heeled in.

Seedlings also lose dormancy and become active if temperatures are warm enough. Seedlings planted after dormancy is lost have lower survival and growth because the active growing roots or buds are damaged easily. Because of these problems, it's best to store seedlings in a refrigerated facility at 34 to 36°F, in order to slow respiration to a very low level, and allow the seedlings to remain dormant and at an ideal moisture.

Table 1.—Temperature guidelines for storing dormant bare-root seedlings.

Guidelines	Temperature range
<i>Short-term storage guidelines (1–5 hrs)</i>	
Ideal	34 to 36°F
Tolerable (no damage likely)	36 to 40°F
Risk zone	40 to 68°F
Damage probable if heat builds up	68 to 86°F
Respiration damage occurring	86°F +
<i>Long-term storage guidelines (5+ hrs)</i>	
Subfreezing (rate of freezing and thawing critical—prevents molding)	26 to 28°F
Ideal	34 to 36°F
Tolerable	36 to 42°F
Risk zone—damage proportional to time in storage	42 to 50°F
Damage occurring from increased use of food reserves; greater risk from desiccation; respiration damage	50°F +

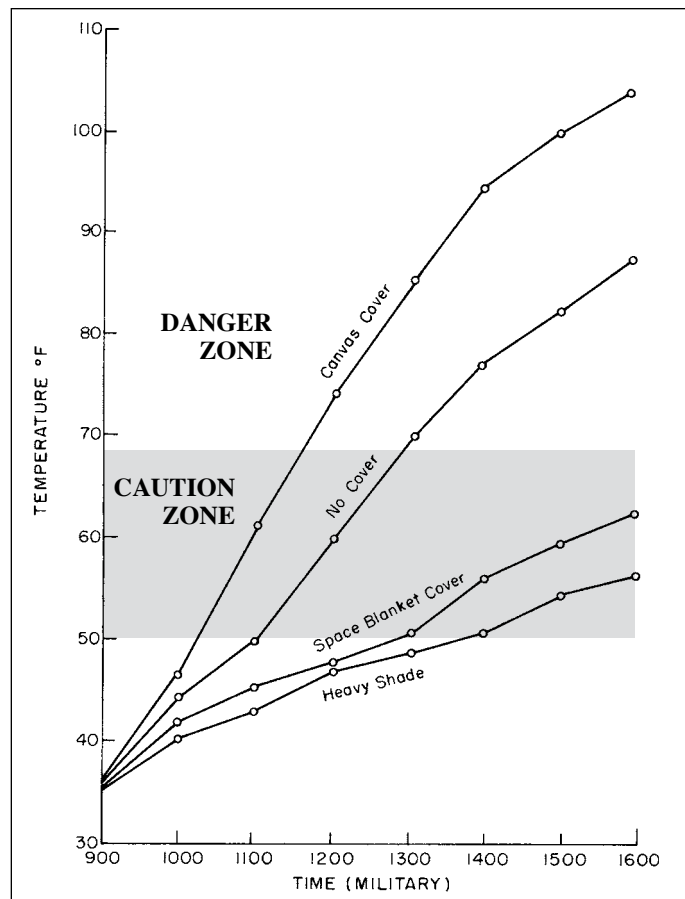


Figure 2.—Temperature increase in seedling containers. Radiant sunlight can cause large increases in seedling temperatures. Here are temperatures of four bags of seedlings over a 1.5-hour period. Note that: (1) seedlings in the deep shade had the slowest increase in temperatures; (2) seedlings with a canvas cover heated up the most and fastest; and (3) a “space” blanket (bright white or silver reflective cover) that reflects most of the sunlight was effective in slowing the heating process. Even seedlings stored under a space blanket or in heavy shade need to be cooled at night if they are not planted during the day.

Checklist

In summary, use this seedling-care checklist to improve reforestation success.

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| √ Handle seedlings carefully and as little as possible. | drying air and by adding water during the processing. If temperatures climb and humidity drops, quit planting. | planting bag. Consider using jellyrolled seedlings (see Figure 1 for definition) when you plant them in extremely hot and dry conditions. |
| √ Keep seedlings cool (34 to 36°F) and protect them from freezing. | | |
| √ At field sites, store seedlings in the shade or under a reflective “space” blanket. Do not use canvas to protect seedlings from solar heating. | √ Use bags and boxes that have a vapor barrier to restrict water loss during storage; keep these containers sealed (use tape for tears and rips). | √ Don’t cram too many seedlings into your planting bag, and plant them as soon as possible. |
| √ Protect seedlings from desiccation (water loss) by reducing exposure to the | √ Dip seedling roots in water for 1 minute before you place them in a moist | √ Keep seedling roots in the moist planting bag until you put them directly into the moist planting hole. |

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