Bareroot Hardwood Seedling Lifting, Packing, and Storage at the Wilson State Nursery in Southern Wisconsin

11a

J.M. Vande Hey

Joseph M. Vande Hey is reforestation team leader and nursery superintendent,
Wisconsin Department of Natural Resources
F.G. Wilson State Nursery, Boscobel, WI

Outline

Facing Page: *Lifting and packing. (Photo by R. Overton.)*

Brief Description of Nursery Location and Crop

The Wilson State Nursery is located in Grant County in southwest Wisconsin in the Wisconsin River Valley. The soil is a deep Sparta loamy fine sand. There are about 70 acres of nursery beds under irrigation. The nursery annually distributes 2 to 8 million seedlings from a crop that consists of 35 to 40 species of Wisconsin native conifers, hardwoods, and shrubs. Stock is grown as 1-, 2-, and/or 3-year-old seedlings. Hardwoods generally make up about one-third of the annual distribution. Seedlings are used for reforestation/afforestation, conservation, and wildlife habitat. The minimum order size is a packet containing 300 tree seedlings, 500 wildlife shrubs, or 1,000 tree seedlings. Multiple species may be ordered to make up the 500 wildlife shrubs or 1,000 tree seedlings, with individual species requested in increments of 100.

Timing of Lifting and Outplanting

Hardwoods are primarily spring lifted, although if the projected workload is greater than what can be completed in the spring, then some hardwoods are lifted in the fall.

Spring Lifting

Spring lifting generally begins in mid- to late March, as the ground thaws. Sandy soils allow for a quicker thaw and entry into the fields. Sandy soils also allow for quick entry back into the fields following heavy rain. This is important because hardwoods generally provide a smaller window of opportunity to lift in the spring than do most conifers, but that will vary with species. Species like black cherry (*Prunus serotina* Ehrh.) begin to break dormancy in as little as 2 weeks after the ground thaws, while other species like the oaks (*Quercus* spp.) and black walnut (*Juglans nigra* L.) provide about 4 to 5 weeks of opportunity. As individual species reach the point of breaking dormancy, an effort is made to lift all the seedlings of that species. Most hardwood lifting is completed by mid- to late April.

Fall Lifting

When fall lifting occurs, it is usually done in very late October to mid-November, after the seedlings have been exposed to a few frosts or cold temperatures and the leaves have fallen off. Stock does not store well over winter with any leaves still present, especially when lifted wet. Leaves can be removed during the grading process but this is very labor intensive. As long as time and weather conditions allow, it is more cost-effective to let leaves fall naturally.

Outplanting

The outplanting season in southern Wisconsin generally starts in early April and progresses north over the next week or two. Most planting in southern Wisconsin is completed by early May, while continuing later into May in the north. Very little fall reforestation planting is done in Wisconsin due to the risk of frost heaving.

Seedling Preparation for Lifting – Activities and Timing

Undercutting

Hardwood seedlings that are being carried into their second growing season are generally undercut in early May of the second year. This is done for cultural reasons to get better root development and reduce top growth in the second growing season. The seedlings are undercut at a depth of about 8 inches (in) (20 centimeters [cm]) to encourage lateral root development within the 9 in (23 cm) lifting zone depth.

Top Pruning

Top pruning prepares the seedlings for distribution and outplanting. Seedlings are top cut in the fall or in the spring ahead of lifting. Seedlings are typically cut back to between 12 and 16 in (30.5 and 41 cm). Top cutting creates a more balanced seedling and prepares the seedlings for the planting site. Top cutting also allows larger quantities of seedlings to be handled and shipped more economically. Top cutting is avoided when possible for species with an opposite branching pattern such as the maples (*Acer* spp.) and ash (*Fraxinus* spp.) as this can lead to forked trees.

Leaf Removal

A dense layer of leaves can build up in some of the seedling beds, primarily the oaks (*Quercus* spp.). A leaf blower is used ahead of the lifter to blow the leaves out of the beds. This is especially helpful when the soils are wet. Removing the leaves seems to allow the lifter to do a better and faster job of getting the seedlings up on the soil surface, making it much easier for the crew to gather the seedlings.

Lifting

Lifting Equipment

Mechanical lifters are used to harvest the seedlings. We utilize both a power take-off-driven Fobro Super HD and a hydraulic-driven Lundaby Plant Lifter 60, depending on the stock being lifted. White oak (*Quercus alba* L.), bur oak (*Quercus macrocarpa* Michx.), and shagbark hickory (*Carya ovata* [Mill] K. Koch) tend to lift better with the Fobro. Most other hardwoods are more efficiently lifted in our soils with the Lundaby. The lifters are pulled with John Deere model 6330s. These are 85-horsepower tractors with four-wheel drive and infinitely variable hydrostatic transmissions. This allows for exceptional speed control. Equipment is well maintained to reduce breakdowns in the field. Lifters are inspected and greased daily.

Lifting Operations

Once the seedlings are lifted, a 6- to 10-member crew gathers the seedlings into bundles and hands them off to the packer on the wagon. The seedlings are packed into large field crates that sit on wagons alongside the lifting crew. Four crates fit on each wagon and one or two packers are on that wagon. Each lifting crew generally needs two or three wagons to shuttle seedlings to the coolers. Six crates would be better when lifting large hardwoods but a larger wagon would make entry into the field much more difficult. The crates are about 48 in by 45 in by 24 in deep (1.2 meters [m] by 1.1m by 0.6 m). Wet wool or burlap blankets are placed in each crate prior to going to the field and are placed on top of the stock once a crate has been filled. Once the field crates on a wagon are full, they are transported to the distribution building where they are wetted down with water, unloaded with a forklift, and moved into cold storage. Seedlings are packed for distribution in the seedling distribution building. This building was designed to accommodate grading, packing, cold storage, and distribution.

Packing

Material Used

Seedlings are packed into wax-impregnated white boxes that measure 30 in long by 12 in wide by 18 in high (76 cm by 30 cm by 46 cm). The bottom and top flaps are stapled to keep them closed. There is a box-making station where the box is opened up and the bottom is stapled on a pneumatic pedestal stapler. A 2-millimeter plastic liner is placed inside the box and is used to seal the seedlings. When it comes time to close the boxes at the end of the packing lines, there are handheld pneumatic staplers hanging from the ceiling on stretch cords.

Where and how seedlings are packed depends on the type of order. The nursery offers customers ungraded (bulk) and graded (counted) orders. In all cases, the seedlings are misted as they are packed in the boxes to ensure the roots are moist. Hose reels are located above the packing station so water is easily accessible.

Bulk Order Packing

A bulk order consists of 3,000 or more of a single species and age. The number of trees shipped in a bulk order is based on bed-run inventory and may contain 10 percent more or less than the number of seedlings ordered. A determined number of seedlings are lifted from the beds, placed in the large plastic field crates, and transported to the cooler. When the bulk packing crew is ready to pack that species, seedlings are moved out of the cooler, still in the large field crates, to the end of their packing line. The packing line is a roller-type conveyor. The crew takes the entire lift and packs it as evenly as possible into the white seedling boxes. As boxes are being packed, they are placed on wood pallets that are 44 in wide by 60 in deep (1.1 m by 1.5 m). The boxes are stacked on pallets seven boxes per layer and three layers high. The pallet is then placed in the cooler until it is needed to fill bulk orders. Once all the seedlings are packed, the total number of boxes is determined for that lift, along with an estimated number of seedlings per box. This information is then recorded as bulk inventory. To complete a bulk order, the calculated number of boxes is taken from inventory and the customer labels are placed on the side of the boxes.

Grade Order Packing

Grade orders make up the majority of the orders and are typically smaller in size. Once the seedlings have been graded and grouped into bundles of 25 seedlings, the bundle is wrapped with tape. A set quantity of seedlings is then placed into boxes, depending on the size of the seedlings, typically 150 to 500 seedlings per box. The boxes are then stacked 7 boxes per layer and 3 layers high on wood pallets that are 44 by 60 in (1.1 by 1.5 m). The pallets are placed in the cooler until needed in the grade order packing room. Grade orders are filled with a "grocery shopping" method. Pallets of each species are lined up in the room and the packers take the individual orders and go from one species to the next, gathering enough boxes to fill that order. Occasionally, it is necessary to open boxes if the quantity of seedlings ordered cannot be evenly divided by the number per box. In this case, the packer calculates the number of bundles required to complete the quantity needed and repacks those in a new box, often combining them with other species. If they are combined with other species in the same box, one of the bundles is labeled so the customer can identify them. Once an order has been packed for bulk or grade, it is determined if it is a "will call" (customer picking up at the nursery) or if it is being shipped in a refrigerated truck to a central location in each county (by county truck). "Will calls" are placed on a pallet or cart and stored in a designated area of the cooler. Orders shipped on a county truck are placed on the pallets with other orders going to that county. There are seven boxes per layer, but instead of three layers, the boxes are stacked four layers high. The pallet is then shrinkwrapped, labeled for the county, and placed into the cooler until shipped.

Fall Lift Packing

If seedlings are lifted in the fall for fall distribution, the procedures are the same as for spring-lifted stock. When stock is lifted in the fall for spring distribution, however, the procedures are somewhat different. Stock that is lifted in the fall and stored until spring is lifted in relatively dry conditions and stored dry. Leaves are removed during the grading process. There is a much greater occurrence of mold developing during storage when the stock is wet and/or the leaves are still attached at lifting. Instead of packing seedlings into waxed boxes after grading, the bundles are placed back into the large field crates with a plastic liner. After the crate is filled, a dry blanket is placed on top and then covered tightly with a piece of plastic. They are then placed in the cooler set at 25 to 28 °F (-3.8 to -2.2 °C) for storage until spring. The cooler temperature is raised in the spring to between 33 and 36 °F (0.5 to 2.2 °C) and the stock allowed to thaw. Once thawed, the seedlings are then misted as they are being packed into the waxed boxes and placed on pallets just as they would be coming off the grading belt.

Grading Procedures

Seedlings are graded in the packing building in a separate room specifically designed for grading seedlings. The floor is heated and set at about 50 °F (10 °C). This provides some comfort for the workers but is not too warm for the seedlings, given the short amount of time they will spend in this room. The building design incorporates in-floor heat because there is not the warm dry air movement associated with forced air or a unit heater. There are two conveyor belts 30 ft (9 m) long, with tables on each side of the belt. Each table is about 3 by 5 ft (91 by 152 cm). There is enough room for two workers to work at each table. Stools are available for staff to use while grading, although most prefer to stand, especially when working with the larger hardwoods. Seedlings in field crates are brought into the grading room with a forklift and placed alongside the tables, two on each side of the belt. As the graders sort the healthy seedlings that are within acceptable specifications (table 11a.1), the seedlings are sorted into bundles of 25 and placed on the conveyor belt. If the seedlings are being graded in the fall and stored until spring, any leaves that might still remain on the seedlings are also removed. The cull seedlings and other debris are dropped to the floor. Staff are assigned to keep supplies of seedlings on the tables for grading as well as sweep away the cull seedlings and other debris, which is loaded into a dump trailer parked at one end of the conveyor. Two people are stationed at the end of the conveyor. They will take 5 bundles of 5 seedlings to make a bundle of 25, and then, using a large produce tape dispenser, tape the bundles of 25 seedlings. Once the seedling bundle is taped, it is placed on a table at the end of the conveyor belt where the packers can place them in seedling boxes. Bundles of seedlings used to fill larger orders may not always be taped, but instead placed loosely into boxes.

Seedling Storage

Storage Facility Design

There are three independent coolers within the building complex. Cooler 1 is 50 by 60 ft (15 by 18 m) with 13 ½ ft (4 m) of clearance. This cooler is used primarily for storing seedlings that have been packed and are ready to be assigned to a customer or are ready to ship. Cooler 2 is 48 by 53 ft (14.5 by 16 m) with 14 ft (4 m) of clearance. This cooler is primarily used to store the large field crates of seedlings that come in from the field. They are stored there until ready to be graded and packed. This cooler is on the opposite end of the building from cooler 1 and allows for the "flow through" concept to move the stock through the distribution process. Cooler 3 is 24 by 48 ft (7.5 by 14.5 m) with 14 ft (4 m) of clearance, and it is attached to cooler 2. This is a small cooler and is used to handle small batches of miscellaneous stock that might get lost in the two larger coolers. A misting system is installed in each cooler so that stock, mainly in the field crates, can be misted. The coolers are designed to take temperatures below freezing for winter storage. Heaters are also installed in the coolers to prevent the temperature from getting too cold during winter storage.

Temperature

Seedlings are stored in coolers with thermostats set to maintain a temperature between 33 to 36 °F (0.5 to 2.2 °C). Coolers are set to maintain a temperature between 25 to 28 °F (-3.8 to -2.2 °C) during winter storage. Heaters are designed to keep temperatures above 23 °F (-5 °C).

Monitoring

Large probe-type thermometers are used to monitor seedling temperatures in both the field crates and the waxed boxes. Hardwoods typically cool down more quickly than conifers when in a cooler, so they are generally not of much concern, whereas much time is spent monitoring conifers. The cooler temperatures are checked each morning and again at the end of the work day. Small temperature measuring devices called "I-buttons" have been used. These small units are about the

Table 11a.1. Minimum specifications for culling seedlings at Wisconsin State Nurseries.

Species	Age	Caliper (in)	Height (in)	Root Length (in)
Populus tremuloides (Michx.)	1-0	1/8	8	8
Tilia americana (L.)	1-0	1/8	6	8
Betula nigra (L.)	1-0	1/8	8	8
Betula papyrifera (Marsh)	2-0	3/16	10	8
Betula alleghaniensis (Britton)	–	–	–	–
Juglans cinerea (L.)	1-0	1/2	10	8
Prunus serotina (Ehrh.)	1-0	1/8	8	8
Prunus serotina (Ehrh.)	2-0	3/16	10	8
Celtis occidentalis (L.)	1-0	1/8	6	8
Celtis occidentalis (L.)	2-0	3/16	10	8
Carya cordiformis (Wangenh.) K. Koch	2-0	3/16	5	8
Carya ovata (Mill.) K. Koch	3-0	1/4	8	8
Acer saccharum (Marsh.)	2-0	1/8	6	8
Acer saccharum (Marsh.)	3-0	3/16	10	8
Acer rubrum (L.)	2-0	1/8	6	8
Acer saccharinum (L.)	1-0	1/8	28	8
Acer saccharinum (L.)	2-0	3/16	10	8
Quercus macrocarpa (Michx.)	1-0	1/8	6	8
Quercus alba (L.)	2-0	3/16	10	8
Quercus rubra (L.)	1-0	1/8	8	8
Quercus bicolor (Willd.)	2-0	3/16	10	8
Juglans nigra (L.)	1-0	1/4	10	8

in = inches.

size of a quarter and can be placed in a seedling box. They can be programmed to record temperature at many different intervals, which is useful in determining how long it takes to chill seedlings to 34 °F (1 °C) during processing, especially with varying outside temperatures. This information helps to make necessary cooling adjustments.

Structures and Racking

There are no structures or racking in the coolers. The pallet system with shrinkwrap allows for stacking and gives the greatest flexibility for storage.

Maximum Recommended Seedling Storage

Seedling storage time varies by how the seedlings were prepared for storage. With typical spring packing procedures, storage longer than 3 to 6 weeks is undesirable. The earlier in the spring that seedlings are lifted, the longer they can be stored. As seedlings begin to break dormancy in the spring, storage time declines to about 3 weeks. Seedlings packed dry for winter storage may be stored for several months until they are ready to be outplanted in the spring.

Potential Problems During Storage

Not all species store well over winter. There are frequent problems with mold developing in sugar maple (*Acer Saccharum* Marsh.), black cherry, and white oak.


WISE EL SANTO
DEMAND
SAFE-T-WISE
GLOVES