

Seedbed Preparation and Sowing in Southern Hardwood Nurseries

R. Rentz

*Randy Rentz, retired Nursery Manager,
Louisiana Department of Agriculture and Forestry, Columbia, LA*

4b

Outline

Soil Tillage

- Objectives and Sequence
- Equipment
- Seedbed Preparation

Sowing

- Equipment
- Timing
- Field Handling of Seed
- Proper Depth and Distribution of Seed
 - Depth
 - Sowing rates

Mulching

- Living Mulches
- Adhesives
- Standard Mulches

References

Facing Page: *Seedbed preparation. (Photo by Randy Rentz.)*

Soil Tillage

Objectives and Sequence

The primary objective of soil tillage is to provide a stable seedbed with good external and internal drainage. Several factors affect the ways in which the soil is prepared for bedding. Soil type, whether a silt, sandy loam, or a deep sand, will determine the amount, type, and at what time of year many soil tillage operations are performed.

Cover crops are typically disked under in August and allowed to breakdown in preparation for fumigation in the fall or early spring. Most nurseries in the South prefer fall fumigation. Any cover crop needs to be incorporated into the soil well before fumigation. Fields may then be sub-soiled, harrowed, and lay fallow until time to fumigate. Many nursery managers prefer to work the soil into shallow beds ("hipping") during the fallow period between cover crop and fumigation, while other managers follow the field flat. Factors that may figure into this decision are soil type and external drainage. On fields with finer-textured soils, hipping allows equipment back in the field faster.

Subsoiling is performed with a two- or three-shank subsoiler designed to shatter any hardpan but not pull soil from lower zones up into the tillage zone. Subsoiling is performed before fumigation and when fields are dry so as to enhance the shattering of the lower zones and increase internal drainage. Fields are harrowed to the desired fumigation depth with a spring-tooth harrow fitted with a clod buster in the back. Harrowing depth after fumigation should not be greater than fumigated soil depth. This prevents unfumigated soil from being introduced into the bedding zone. Fields should not be disked before bedding in order to help retain soil structure.

The following is the general sequence of tillage operations.

1. Cover crop incorporated in mid-summer by disking, which could take multiple passes.
2. Subsoil or chisel plow and harrow
3. Lay-by awaiting fumigation (hipped or flat)
4. Fumigation (fall or spring)
5. Fertilize according to recommendations (fall or spring)
6. Prepare seedbeds
7. Sowing

Preplant fertilization can take many forms. Some managers apply phosphorous and potassium to fields in the cover crop area preceding the seedling crop and apply nitrogen after

fumigation when bedding. Others apply the complete regimen following fumigation and prior to bedding, while some prefer to fertilize at bedding prior to sowing. Many factors play into each scenario, such as soil type, organic matter, and pH. Perhaps the most common is the personal experience of the nursery manager and what seems to work best under the conditions at each site.

Equipment

Seedbed preparation is one aspect of nursery management that has changed considerably through the years. This is due in part to the sandier sites where most nurseries are now located and, more importantly, the advances in equipment availability. There are currently many different models of bed shapers on the market. These range from the Whitfield pull type, which hips and shapes beds, the rotary tiller types, and the combined rotary cultivator-fertilizer distributor-bed shaper. These are all used in bed preparation and provide satisfactory results. The Whitfield pull type (fig. 4b.1) must have a well-broken soil and requires disking and harrowing before shaping beds. Equipment that combines a rotary cultivator, fertilizer distributor, and bed shaper, such as the Fobro Kulti-Rotor (figs. 4b.2a and 4b.2b) can prepare beds with limited precultivation practices. This results in less soil compaction and substantial fuel savings by eliminating at least one pass over the field with a harrow or disc and one pass over the field when fertilizing. It also saves on fertilizer cost, as only the beds are fertilized, thus



Figure 4b.1—The Whitfield bed-shaper lifts and shapes to create a raised bed. (Photo by Doug Gillett, Louisiana Department of Agriculture and Forestry, 2001.)



Figure 4b.2a—The Fobro Kulti-Rotor, front view. (Photo by Denise Barnette, Louisiana Department of Agriculture and Forestry, 2011.)



Figure 4b.2b—The Fobro Kulti-Rotor, side view. (Photo by Denise Barnette, Louisiana Department of Agriculture and Forestry, 2011.)

reducing the amount used over the entire field. All of these bed shapers are suited to a wide range of soils.

Seedbed Preparation

Seedbeds are typically laid out in compartments consisting of nine beds per compartment. Beds are 48 to 54 inches (in) (1.22 to 1.37 meters [m]) across the top and middles are at 6 ft centers. Most nursery equipment is

manufactured to accommodate 6 ft centers. The seedbed should be raised to a height of 4 to 6 in (10 to 15 cm) and flat across the top to allow for uniform sowing depth across the entire bed width. Lighter, very sandy soils do not need to be raised as long as they have good internal drainage. Generally, a raised bed is needed to facilitate good drainage and bed aeration, especially in finer-textured soils or soils with a clay subsoil (fig. 4b.3).



Figure 4b.3—The finished product—prepared and sown beds. (Photo by Denise Barnette, Louisiana Department of Agriculture and Forestry, 2005.)



Figure 4b.4—A Love seeder showing drop tubes and rear packing wheels. The seeder accommodates up to eight drills and can be precision adjusted. (Photo courtesy of Louisiana Department of Agriculture and Forestry, 2005.)

Sowing

Equipment

With the various seeders and planters on the market, one can be found to meet the needs of just about any hardwood nursery operation. Planters such as the Love Oyjord (fig. 4b.4) have been modified to accommodate a wide variety of small- and light-seeded hardwood species. Planters such as the Whitfield (fig. 4b.5) are capable of sowing seed ranging from sweetgum (*Liquidambar styraciflua* L.) to black walnut (*Juglans nigra* L.). Planters or sowers consist of a feeder hopper (a device to regulate the rate of seed drop), drop tubes (a form of drill to open the ground and regulate depth), and some form of covering apparatus. Many are fitted with front and rear drum rollers. The front rollers help prepare the bed just ahead of the drills and the rear rollers assist in packing and closing the drills after sowing. Metering devices used to regulate seed drop are either ground-driven and gear-calibrated, or hydraulic driven. Seed plates or adjustable openings accommodate different seed sizes. Adjustments regulate the seed density.

All of these planters require a relatively low level of maintenance. All bearings, gears, and chains need to be lubricated daily when in use. At the end of the day, all dust should be blown out and drop tubes inspected. Regularly check drop

tubes for blockage and proper seed flow. The planter's drum roller needs to be kept clean and free of buildup to assure a smooth, flat bed. Inspect coulters regularly to remove any soil buildup and ensure proper rotation. If coulters are not rotating properly, this will affect seed drop and proper sowing depth.

At completion of sowing, thoroughly clean the entire unit and properly lubricate all moving parts. Cover the drum



Figure 4b.5—A Whitfield planter designed specifically for sowing hardwood seed. (Photo by Doug Gillett, Louisiana Department of Agriculture and Forestry, 2001.)

roller and coulter with a light coating of grease or oil. Inspect seed plates and drop tubes for warpage, cracking, and general wear. Check all belts, chains, bearings, and gears for excessive wear and replace as needed before placing the unit in storage awaiting another sowing season.

Timing

Sowing of hardwood seed in the Southeastern United States ranges from September to November for fall sowing and February to June 1 for spring sowing. This is species-dependent as some species can be readily sown in fall and spring, while others must be spring planted after the chance of heavy frost has past. In either case, the South is blessed with a relatively long growing season and a wide window of opportunity for sowing. Species whose seed mature in the spring, such as red maple (*Acer rubrum* L. var. *drummondii* Hook. & Arn. ex Nutt.) and American elm (*Ulmus americana* L.), generally do better if sown as soon as possible after seed is collected. Other species, like yaupon (*Ilex vomitoria* Ait.) and fringe tree (*Chionanthus virginicus* L.), which show dual dormancy as a result of two or more factors such as seedcoat and embryo dormancy, require special handling to break dormancy. Still others that show a light dormancy of some type will be handled in different ways.

The oaks (*Quercus* spp.) may be planted in either fall or spring, depending upon species. White oak species fare better if fall planted immediately after collection as they do not store well and much seed viability is lost if stored until spring sowing. The red oak species, which show signs of light dormancy, may be fall or spring planted. These store well and under proper conditions may be kept at a temperature of 36 °F (2.2 °C) for up to a year before any appreciable loss of viability. When spring sowing oaks, the order of sowing is determined by how readily each species germinates. Some species such as Shumard oak (*Quercus shumardii* Buckl.) and cherrybark oak (*Quercus pagoda* Raf.) readily germinate while others take longer. Most nursery managers plant the slower germinating species first, followed by the faster germinators. Spring sowing in the South can start as early as the middle of February and last until the end of May. It is usually too hot by June 1 for adequate germination and growth of many hardwood species.

Consideration must also be given to the growth patterns of individual species. Red mulberry (*Morus rubra* L.), sycamore (*Platanus occidentalis* L.), and green ash (*Fraxinus pennsylvanica* Marsh.) are usually sown later in the season, due in part to the accelerated growth they show in the nursery bed. Species that exhibit slower patterns of growth perform better when planted earlier in the growing season. Other factors that affect timing of sowing are length of stratification, soil

type, weather patterns, and weed pressure. Recommended guidelines for sowing order may be found in table 4b.1, recognizing the order may be subject to change at different sites and based on the experience of each nursery manager.

Field Handling of Seed

Proper care in seed stratification is essential to ensure a quality stand of hardwood seedlings. Stratification times usually range from 30 to 120 days. Proper care and types of stratification of each species may be found in *The Woody Plant Seed Manual* (Bonner and Karrfalt 2008).

Table 4b.1—General guideline for the sowing order of spring-sown hardwoods.

1. Native sweet pecan, *Carya illinoensis* (wangenh.) K. Koch
2. Bitter pecan, *Carya aquatica* (Michx.) Nutt.
3. Black walnut, *Juglans nigra* L.
4. Water oak, *Quercus nigra* L.
5. Any white oak species left over from fall Sowing
6. Willow oak, *Quercus phellos* L.
7. Laurel oak, *Quercus laurifolia* Michx.
8. Post oak, *Quercus stellata* Wangenh.
9. Overcup oak, *Quercus lyrata* Walt.
10. Nuttall oak, *Quercus nuttallii* Palmer
11. Shumard oak, *Quercus shumardii* Buckl.
12. Cherrybark oak, *Quercus pagoda* Raf.
13. Southern Red oak, *Quercus falcata* Michx.
14. Red Maple, *Acer rubrum* var. *drummondii* Hook. & Arn. ex Nutt.
15. Sweetgum, *Liquidambar styraciflua* L.
16. Hawthorn, *Crataegus* Spp.
17. Elm, *Ulmus* Spp.
18. Persimmon, *Diospyros virginiana* L.
19. Plums, *Prunus* spp.
20. Tupelo gum, *Nyssa aquatic* L.
21. Blackgum, *Nyssa sylvatica* Marsh
22. Yellow poplar, *Liriodendron tulipifera* L.
23. Red mulberry, *Morus rubra* L.
24. Sycamore, *Platanus occidentalis* L.
25. Baldcypress, *Taxodium distichum* (L.) Rich.
26. Green ash, *Fraxinus pennsylvanica* Marsh.

Seed need to be readied for sowing once it has been properly stratified. Hard mast seed such as pecan (*Carya illinoensis* Wangen. K. Koch) and oak need little to no preparation before sowing, while most of the soft mast species such as green ash and sweetgum need some form of preparation. Soft mast and smaller seeded hardwood are often treated with some type of bird repellent or other treatment. Afterwards, the seed is carefully surface-dried on screens or in a blower. During the drying process, it is very important not to overdry seed and reverse the stratification process. Seed may then be treated with talcum powder or some other material that allows the seed to more uniformly flow through the planter.

Proper Depth and Distribution of Seed

Depth. All mechanical sowers are fitted with some type of sowing depth adjustment. Some, like the Oyjord, have coulters that can be adjusted up or down and can sow as shallow as 1/8 in (3 mm) to as deep as 2 in (51 mm). Others, such as the Whitfield, are fitted with rollers or shanks just ahead of drop tubes that open the drills to varying depths and cover and roll seed with devices located on the seeder. The texture of the bed must allow for proper sowing depth and covering of seed.

The desired sowing depth will be affected by the type of mulch used, soil texture, and time of year. Sowing depth will be shallower if heavy mulch is used to cover the beds. The seed may be planted a little deeper where a soil-binding agent is used. Seed will need to be planted shallower in heavier soils than in light, sandy soils, where seedlings can emerge easier. When fall sowing, it is usually desirable to plant a little deeper to compensate for overwinter washing of seedbeds. The old rule of sowing depth being 1 to 1 ½ times the diameter of the seed is still a good one to follow.

Seed is sown in drills in most bareroot nurseries with four or five drills per bed with drills 6 to 10 in (15 to 25 cm) apart (depending upon the number of drills sown). Some lighter seeded species may not require as much bed area to reach desired seedling specifications. In these cases, as many as eight drills may be sown per bed. The number of seedlings grown per square foot of bed space is determined by growth characteristics of each species and the desired product. Most species are sown to produce 8 to 10 seedlings per ft² (86 to 108 seedlings per m²), although several species can be grown 15 to 20 seedlings per ft² of bed space (161 to 215 per m²). The desired caliper, height, and root mass of seedling to be produced will initially determine bed density.

Sowing rates. The following formula (Stoekeler and Jones 1957, Williams and Hanks 1994) can be used to calculate the total amount of seed needed for each species or seedlot.

$$P = \frac{A \times D}{G \times S \times Y} \quad \text{[Equation 1]}$$

Where P is the total pounds of seed needed for sowing. The term A x D equals the total number of seedlings desired, where A is the area of bed space in square feet and D is the target density expressed as the desired number of seedlings per square foot. G is percent seed germination expressed as a decimal. S is the number of seeds per pound as they come from the container. Y is a "survival factor" that varies by species and is an experience-based estimate of the percentage of viable seed that will produce plantable seedlings at the end of the growing season, expressed as a decimal.

As an example, Williams and Hanks (1994) assume a nursery production target of 100,000 yellow poplar seedlings and a nursery target density of 10 plantable trees per square foot. Meeting these targets will require 10,000 square feet of seedbed. The percent germination of the seed is 8 percent and there are 14,000 seeds per pound. Based on the nursery manager's experience with this species and seedlot, the "survival factor" is estimated at 50 percent.

$$P = \frac{10,000 \times 10}{.08 \times 14,000 \times .50} \quad \text{[Equation 2]}$$

$$P = \frac{10,000}{560} = 178.57 \text{ pounds.}$$

Seed counts must be made periodically to ensure the number of seeds dropped from the sower is on target. The number of seeds to sow per linear foot of drill can be computed using the formula of Williams and Hanks (1994):

$$N = \frac{D}{GY} \quad \text{[Equation 3]}$$

N is the number of seeds to sow per linear foot. D is the desired number of seedlings per linear foot. G is the seed germination percent expressed as a decimal. Y is a "survival factor" that varies by species and is an experience-based estimate of the percentage of viable seed that will produce plantable seedlings at the end of the growing season, expressed as a decimal.

Mulching

Many nurseries in the South use some form of bedding mulch in the form of living mulches or other organic materials. Other nurseries have opted to use a soil-binding adhesive sprayed directly over the bed. Each approach has advantages and disadvantages.

Living Mulches

Living mulches work well on fall-sown seedbeds, as they do not wash during the winter. After the beds are sown, they are seeded with rye, wheat, or some other form of winter cover. This provides cover for seed overwintering in the beds, as well as protection from freezing and animal depredation such as deer, crow, and feral hogs. The winter cover can be killed with glyphosate in late winter or early spring if seedlings have not begun germination. If seedlings have emerged, a postemergent grass herbicide such as fluazafop-p-butyl, or clethodim may be used to kill back the living mulch. It is important to kill mulch back before it gets too large and overpowers seedlings. One disadvantage of living mulches is that windblown seed and contaminated cover seed is introduced to beds. Therefore, after the mulch has been burned back, any preemergent and postemergent herbicides need to be applied as soon as possible to control weed pressure.

Adhesives

A second option is not a mulch at all, but to spray on an adhesive that acts as a soil-binding agent. Spray adhesives are applied by converted hydromulchers or tanks and tips designed to apply 250 to 500 gallons of mixed material per acre (2338 to 4677 liters [L] per hectares [ha]). Adhesives come in 50-gallon (189 L) drums and are usually applied with one drum mixed with enough water to properly cover and bind 1 acre (0.404 ha) of ground. How much mixed material is applied over a given area depends on soil types and the nursery manager's own experience.

Adhesives provide an easy, reliable, weed-free binding agent to maintain seedbed integrity. In addition, pre-emergent herbicides and fungicides may be mixed with adhesive agents and applied at the same time. Another advantage is that adhesives can be used with all seed types, large or small. This allows easier seed depth control while sowing and results in better overall germination. The drawback to adhesives is that they provide little, if any, moisture-holding capacity. More frequent watering and monitoring of soil moisture is needed to assure proper germination. The ease of adhesive application and ability to provide weed-free soil binding, along with its use on all types of seed, outweighs this drawback for many nursery managers (fig. 4b.6).

Standard Mulches

Most of the many types of standard mulches are byproducts of agriculture or forest product operations. Examples include wheat straw, oat straw, pine straw, sawdust, wood chips, pine bark, and grit. Each of these can effectively protect seed and seedbeds from the elements. These types of



Figure 4b.6—A converted hydro-mulcher applying a soil-binding agent. (Photo by Ginger Bonner, Louisiana Department of Agriculture and Forestry, 2001.)

mulches have a certain amount of moisture-retention capability and work well as a cover for seedbeds. These may also introduce unwanted weed seed to the beds. The straws may be fumigated before spreading, but many of the other forms are very difficult to fumigate adequately. Since these will be hauled and spread mechanically, time and expense are considerations. Added care must be taken with the spreading of mulch. If too thin, it may tend to float away and not provide adequate protection from washing. If too thick, it may hinder germination of some species. The nursery manager needs to determine which is the most economical and effective cover for their situation.

References

- Bonner, F.T.; Karrfalt, R.P. 2008. The woody plants seed manual. Agric. Handb. 727. Washington, DC: U.S. Department of Agriculture, Forest Service. 1,223 p.
- Stoeckeler, J.H; Jones, G.W. 1957. Forest nursery practice in the Lake States. Agric. Handb. 110. Washington, DC: U.S. Department of Agriculture, Forest Service. 123 p.
- Williams, R.D.; Hanks, S.H. 1976. Hardwood Nursery Guide (formerly Hardwood nurseryman's guide; slightly revised July 1994). Agric. Handb. 473. Washington, DC: U.S. Department of Agriculture, Forest Service. 78 p.

