

# Seedbed Preparation and Sowing: A Northern Hardwood Nursery Perspective

R. A. Hawkins

*Robert A. Hawkins is nursery section supervisor,  
Indiana Department of Natural Resources, Vallonia Nursery, Vallonia, IN*

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## Outline

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**Facing Page:** *Operation of a large acorn seeder. (Photo by Jeanie Redicker, Indiana Department of Natural Resources, 2013.)*



**Figure 4a.1**—Flail mower used to cut cover crop prior to soil preparation. Mowing is followed by incorporation (disking), fumigation, and bed preparation. (Photo by Jeanie Redicker, Indiana Department of Natural Resources, 2013.)

## Seedbed Preparation

The majority of seed planting in a typical northern hardwood nursery takes place in the fall (September to December) before soil freezes up. Due to the various species of hardwood seed handled in the North, their requirements of cold stratification and the lack of adequate seed storage facilities, most seed need to be fall sown for optimal germination. Seedbed preparation is mainly done just before planting. Species that can be spring sown will have their seedbeds formed before sowing but the actual field tillage and soil preparation for these areas will be done in the fall, with soil management extremely important for subsequent seed germination and seedling survival.

Most northern nurseries start with some type of soil-injected gas for fumigation in late summer or early fall before seeding. For the fumigation equipment and the chemical to work properly, mowing, chopping, and disking of any cover crops are required. Various cover crops are raised in many areas to increase soil organic matter, maintain high soil fertility, and assist with minimizing weed seed buildup. However, cover crops must be well incorporated into the soil. Flail mowers and rotary cutters chop these cover crops in very small pieces that can then be easily incorporated into the soil (fig. 4a.1). This is the first step in preparing the seedbeds for tillage and bedding. Disking and plowing the soil to help bury the cover

crop remnants and facilitate decomposition are also necessary. The process may also include deep rippers to break up soil hardpans and chisel plows to assist with clod breakup and cover crop burial. The tools and equipment used to ready the fields for fumigation vary and depend on the individual nursery and the type and amount of cover crop residue.

The type of cover crop will determine the extent of field preparations needed, and plenty of preparation time should be allowed to properly prepare fields for fumigation. Up to 4 to 6 weeks of soil preparation, including weekly disking of cover crop residues, may be necessary to ready the ground for fumigation and eventually bedding (bedforming). A good indication that fields are ready to fumigate is the ability to run a spring-tooth harrow over the fields without dragging up piles of the cover crop residue.

After soil tillage operations and fumigation, seedbed building can begin, within 1 or 2 days of fumigation tarp removal. The benefit to early seedbed preparation is to set the beds and install paths for proper water drainage in the fields. The drier weather typical of the fall results in lower soil moisture and is favorable to seedbed preparation conditions. Various types of seedbed formers or shapers (bedformers) are used to make a raised seedbed to allow equipment access to these seedbeds for various cultural practices. These bedformers also make paths for water to travel away from the sown seed to reduce the potential for germination problems from extremely wet





**Figure 4a.2**—Bedformers have soil rototilling functions in addition to the formation of a specific bed width. (Photo by Jeanie Redicker, Indiana Department of Natural Resources, 2013.)

soil conditions. Bedformers have changed over the years to better produce a bed for seed sowing (fig. 4a.2). They are now equipped with roto-tiller capabilities as well as rollers to firm up the seedbed. This tilling of the seedbed will assist with the incorporation of all organic matter remnants into the soil, just prior to sowing. A firm, level bed free of clods and large woody materials will allow seed to be planted uniformly at the correct depth over the entire bed and help ensure optimal seed germination. Bedformers are available in varying widths to fit individual nursery requirements. Each seedbed width should match the wheel spacing of tractors and other equipment used in the various cultural practices that are applied to the seedbeds of the individual nursery.

## Sowing

### Mechanical Hardwood Seeders

Mechanical seeders for hardwood tree seeds are very specialized. Unfortunately, there aren't enough nurseries across the United States to warrant their commercialized mass production, and as a result they tend to be very expensive. Also, while commercially available seeders do an exceptional job, they only handle limited seed sizes: hardwood seed sizes range from smaller than a BB to baseball size and require different sowing depths and

densities. (Individual seed depth and density guidelines can be found in *The Woody Seed Plant Manual*, Bonner and Karrfalt 2008). Typically, local nursery operators fabricate hardwood seeders to fit the needs of their nursery. Often each nursery has several homemade seeders that incorporate certain mechanisms from a variety of planters to meet all planting objectives.

**Drill sown seeders.** This type of seeder usually handles all small-seeded hardwood species, shrubs, and conifer seeds (fig. 4a.3). Seed drills are "ground-driven" so the rate of travel across the seedbeds will have no ill effect on sowing rates. The rate of speed across the field depends greatly on soil conditions. The planter can handle seeds that vary in size from a grain of salt, such as ninebark (*Physocarpus opulifolius* L. Maxim.), to winged seeds like river birch (*Betula nigra* L.), to small stone fruits, like blackgum (*Nyssa sylvatica* Marsh.). Seed drills commonly have double disk openers to create the furrow into which the seed is placed. Individual row coverers cover the seed with the correct amount of soil once it has been placed in the furrow. The openers adjust to varying depths (1/8 to 1/4 inch [in]) (3 to 6 millimeter [mm]), based on the sowing requirements of each species.

Seeds are usually sown in five to eight rows across the prepared seedbed. Distribution of seed through this drill ensures equal amounts are sown in all rows. The planter is





**Figure 4a.3**—Operation of the Love seed drill, used for small-seeded hardwood sowing. (Photo by Jeanie Redicker, Indiana Department of Natural Resources, 2013.)

calibrated by catching all seed in one revolution of the drive wheel, which is a known distance of travel, and weighing it. Individual seed data, specifically “pure live seed” (PLS) per pound, can be used in determining number of seeds sown per linear foot. The drill can be adjusted to dispense the appropriate weight of seed to meet the desired sowing rate. This type of hardwood seeder can easily achieve the desired sowing depth and density for each species. This drill takes two people to operate. The first drives the tractor and focuses on alignment within the seedbed, while the second rides and operates the seeder.

**Seeders for large acorns.** This type of seeder handles acorns ranging in size from white oak (*Quercus alba* L.) to chestnut oak (*Quercus prinus* L.) or  $\frac{3}{4}$  to  $1\frac{1}{2}$  in (19 to 38 mm) diameter. The majority of acorns collected in the North will fall within this range. Nurseries fabricate this type of seeder in-house to meet their specific needs, so the equipment varies based on each nursery manager's ideas and expertise. Most of these seeders are operated from tractor power take-off (PTO) units and are not ground driven. Each tractor must travel a steady speed across the seedbeds (usually 1 mile per hour [mph]) in order to distribute seed at the desired rate (fig. 4a.4). Some type of furrow opener is used to create trenches, usually five or six across the width of the bed, for seed to be placed in as the seeder is pulled over the seedbed. Furrows are made much deeper (1 to 2 in) (25 to 50

mm) when sowing this size of seed, compared to drill-sown hardwood seeders. Double disk openers do not perform well on this type of seeder because of the large seed size and the depth required. Normally, a chain mechanism with attached cups moving through the seed hopper transports seed to the drop tubes and into the furrows. The chain drive operates by hydraulics from the tractor PTO unit. The hydraulic system can be adjusted to increase or decrease the pace of the chains in order to drop the desired amount of seed based on the desired sowing rate for each species. A slight change to the chain speed enables more or less seed to drop while keeping the tractor at a constant speed over the seedbeds.

The furrow opener can also be connected to the hydraulic system, allowing the seed trenches to be deepened or made shallower, depending upon the needs of the seed. The furrow opener can be raised or lowered while the tractor is in motion and seeding is taking place to ensure proper sowing depth when the seedbed level varies. A small-grain drop-type seeder is often incorporated into the hardwood seed planter in order to sow a living mulch cover crop while sowing the hardwood seed. The acorn seeder will also pull some type of drag system to lightly cover the sown seed with soil.

The seeder can be calibrated by collecting seed from the seeder for a set amount of time, such as 1 minute. At 1 mph the tractor will travel a known distance across the seedbed





**Figure 4a.4**—Operation of a large acorn seeder. This seeder was built at the Vallonia State Nursery in Indiana. A living mulch seed sower attached to the back of the acorn sower sows wheat, rye, or oats simultaneous to acorns. (Photo by Jeanie Redicker, Indiana Department of Natural Resources, 2013.)

(88 feet [ft]) (27 meters [m]). The weight of this collected seed can then be checked against the PLS per pound data estimates. Calculating the number of PLS collected in 1 minute divided by the distance covered provides the sowing rate per unit of linear distance. The speed of the chain drive system can be adjusted to produce the desired sowing rate. This seeder takes two people to operate—one to drive the tractor and monitor speed and straightness and a second to ride and operate the seeder.

**Seeder for small acorns and larger stone fruits.** Seed sizes for this seeder fall between pin oak (*Quercus palustris* Munchh.) and American plum (*Prunus americana* L.), or between 3/8 in to 5/8 in (9.5 to 16 mm) diameter. This seeder combines the functions of the seed drill with those of the large acorn seeder. The small acorn seeder itself operates by hydraulics from the tractor PTO unit. It is not ground driven but operates through a hydraulic chain drive system with adjustable speed controls. The tractor pulling this seeder is driven at a constant speed (1 mph) over each seedbed. Double disk openers (five to six rows) create the furrows into which the seed is placed. Double disk openers will work with these seeds due to their smaller size. Furrow openers are set fairly deep (1/2 in to 1 in) (13 to 25 mm) to accommodate the depth requirements of the seed. Finger pickup units designed for soybeans have been slightly modified to allow for the seed size. This enables each individual seed to be picked up and

dropped into the furrow, achieving a very uniform seed placement. Individual seed hoppers are used for each row or finger pickup unit. Press wheels follow behind each trench, pressing the seed into the soil and ensuring good soil contact.

A type of wheat/rye dispenser can be incorporated into the seeder to sow a living mulch cover crop while sowing the hardwood seed, or it can be done separately using a different machine. A drag system lightly pulls soil into the trenches and covers the sown seed. This system is separate from the seeder shown but helps incorporate living mulch seed into the trench while lightly covering all seed. Calibration for this type of seeder is identical to that of the large acorn seeders. Personnel requirements and operation are also the same.

As with all mechanical equipment, a good maintenance schedule is needed to assure proper operation. Each piece of equipment should be inspected for proper function every summer, prior to fall use. This includes checking fluid levels and hydraulic systems. Disk openers should move freely and not bind up. Inspect seed metering systems for accurate seed flow. Lubricate chain drive systems regularly to assure that individual seeds will be picked up in the correct manner. All sowing must be completed in a timely manner within a relatively short period, especially when adverse weather and soil conditions are taken into account. When seeding time arrives, mechanical breakdowns can

cause havoc, so it is best to ensure proper operation of all equipment before the critical time arrives.

## Timing of Sowing

Timing of sowing is crucial for proper germination and is closely tied to the availability of seed in the fall. The fruit of most northern tree species begin to ripen in September or October. Some small seeded hardwoods ripen even earlier. For example, black cherry (*Prunus serotina* Ehrh.) ripens and should be harvested in July and August, while other northern hardwood species, such as cherrybark oak (*Quercus pagoda* Raf.), ripen and fall much later in October and November. The time for seed collection tends to be relatively short, so collection needs to begin when seed ripen and begin to fall. As seed is harvested, a testing procedure must be in place to determine the amount of good seed collected for sowing purposes. Without this knowledge, the accuracy of seeder calibration is very limited.

Seed collected or purchased must be properly cared for until sowing takes place. It must be kept in cold storage to ensure that it does not begin to heat. Some seeds can be cleaned of their fleshy pulp to allow better flow through the seeder (black cherry, for example) and then placed in cold storage until sowing begins. Other large seed—i.e., black walnut (*Juglans nigra* L.)—can have their husk removed to allow seed to be sown by a mechanical seeder. This seed would otherwise have to be sown by another means that may lead to difficulty controlling sowing density.

Fumigation is completed in most northern nurseries in late September, then seeding can commence after the necessary waiting period. Hardwood seed must not be sown too early because of possible early germination if temperatures remain high in late fall. Seeding should begin after a typical fall cool-down has begun. Seedbeds are formed and various species are sown based upon seed availability. Seed can be sown as quickly as it can be harvested and seeders calibrated. This timing of seeding will assure cold stratification periods will be met by the various hardwood seed species. Larger seed, such as acorns, require a large space to store the sheer volume needed to be sown to meet production goals. Sowing this seed as it is harvested eliminates the need to store this large volume of seed any longer than necessary.

The majority of species raised in northern hardwood nurseries are fall sown, but species such as American sycamore (*Platanus occidentalis* L.), which grow quickly to shippable size and do not require a large seed storage space, can be stratified in cold storage for spring sowing. Very small seeded species, such as ninebark, can be held and stratified in cold storage to ensure seed is not lost during winter field

conditions. Frost heaving, bird predation, and soil and wind erosion can all affect the availability of this seed to remain sown at the correct depth to germinate in the spring. Spring sowing of this stratified seed gives some assurance that this small seed will be in the seedbeds and found at the correct depth to germinate a few weeks later.

## Seed Handling

Field handling of seed to be sown is also important for seed viability. Keep seed out of direct sunlight so it will not dry to the point that it would inhibit germination. Once the seed has been sown, irrigation can be used to moisten the seed if rainfall is not sufficient. This will also help secure the soil around the seed so loose soil will not be lost in a heavy downpour shortly after seeding. Various types of mulches can also be used to protect seed from drying out and inhibit seedbed erosion.

## Mulching

Mulches are commonly used in northern hardwood nurseries as they provide several benefits to both seed and seedbed. Sawdust, wood chips, hydro-mulch, and wheat straw are common mulches used in northern hardwood nurseries. The primary benefit for using mulch is to hold the seed in place on the seedbed during the winter months. The mulch also provides secondary benefits such as covering seed at the proper depth, reducing seed predation, and protecting it from extreme cold temperatures. Typically, hardwood seed germinates up through this mulch layer in the spring.

Living mulches are also commonly used in northern hardwood nurseries. Common living mulches are rye, winter wheat, and oats. Each mulch species has its benefits and nursery personnel have to determine what works best in their environment. Living mulch seed is sown along with the tree seed during fall seeding. Rye and wheat seed will fall into the furrows made with the seeder and are covered along with the tree seed (fig. 4a.4). Seeders with this ability can plant crop and living mulch seeds with one pass over the seedbeds. Irrigation after sowing will assist with quick germination of the living mulch seed. This enables the mulch to grow in size to hold the seedbed in place as well as provide winter protection to the seed. In late February or early March, living mulches are sprayed with a grass herbicide to kill the vegetation. Several types of chemical are available to kill this living vegetation; selection and use depends on the condition of hardwood seed germination. If hardwood seedlings have not emerged at the time of herbicide application, an over-the-top application of a glyphosate-based product may be used. On the other hand, if hardwood seedlings have emerged, then the



herbicide choice is limited to products that are not soil active and affect only grasses (see chapter 8).

Soil protection continues as the mulch begins to die. Shading the seedbed lowers soil temperatures and helps to avoid early hardwood seed germination, which may result in seedling damage caused by a late spring frost. Germinating hardwood seed has the ability to shoot up through this dying vegetation and continue normal development. Oats are usually killed by cold temperatures, which is a benefit over the use of wheat or rye. This could save time and money by not having to spray this vegetation in early spring. However, oat seed typically does not have sufficient time in the fall to germinate and grow due to the short degree days remaining after seeding. This is a definite disadvantage when using oats as a living mulch because hardwood seed will not be protected from wind and water erosion to the degree necessary throughout the winter months. Also, soils may warm early and possibly result in early seed germination.

The use of a living mulch and wheat straw combination provides excellent protection from extreme cold temperatures, seed predation, and soil erosion (fig. 4a.5). This unique combination may be used over seedbeds sown to large hardwood seeds such as oaks (*Quercus* spp.), hickory (*Carya* spp.), and walnut (*Juglans* spp.). Wheat or rye seed is sown at the time of seeding and covered along with the large hardwood seed. At completion of the seeding, a layer of clean wheat straw is applied, 2 to 3 in thick, over



**Figure 4a.5**—A living mulch of rye growing over seedbeds. (Photo by Bob Hawkins, Indiana Department of Natural Resources, 2014.)



**Figure 4a.6**—Hardwood seedbeds covered with wheat straw after sowing of both hardwood and living mulch seed. The combination of a living mulch and wheat straw provides excellent protection for hardwood seed against cold temperatures, erosion, and animal predation. At the appropriate time both mulches are removed by a combination of herbicide application and fire. (Photo by Bob Hawkins, Indiana Department of Natural Resources, 2014.)

these seedbeds (fig. 4a.6). Wheat or rye seed will germinate and grow up through the wheat straw, creating a very thick mat over the seedbed. This not only provides excellent protection from extreme cold temperatures, but also creates a layer that animals have a difficult time pawing through. This virtually eliminates seed predation in these seedbeds. As with the other living mulches, this must be sprayed with herbicide in late winter. Chemical choice will depend on the degree of crop seed development. After the living mulch is killed and before hardwood seed emergence, a prescribed burn can be used as a relatively easy way to remove the majority of the wheat straw layer and allow for the large hardwood seed to germinate in a normal manner. A prescribed burn also reduces annual weeds and their seed.

## Reference

Bonner, F.T.; Karrfalt, R.P. 2008. The woody plant seed manual. Agric. Handb. 727. Washington DC: U.S. Department of Agriculture, Forest Service. 1,223 p.



