

## Direct Seeding of Hardwoods in Wisconsin

By Greg Edge, WDNR - Division of Forestry (2004)

The direct seeding of hardwoods for reforestation plantings has grown in popularity across the Lake States. Although some locations, such as the lower Mississippi River valley, have been intensively hardwood seeding since the early 1980s, the practice is relatively new for most foresters and landowners within our region. During the past several years, Wisconsin foresters have been experimenting with a variety of seeding rates, species mixes, seeding methods, site preparation techniques, and follow-up weed control. In 2003, we began a survey of hardwood direct seeded plantings in Grant, Richland, Iowa, Lafayette, Sauk, and Manitowoc counties to learn more about the successes and failures of this reforestation method.



Manitowoc County 2003 – Direct seeded with oak in fall 1998.

### The Survey...

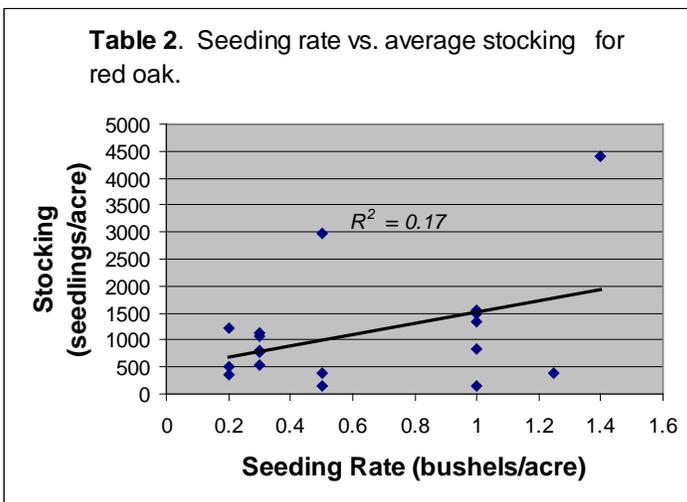
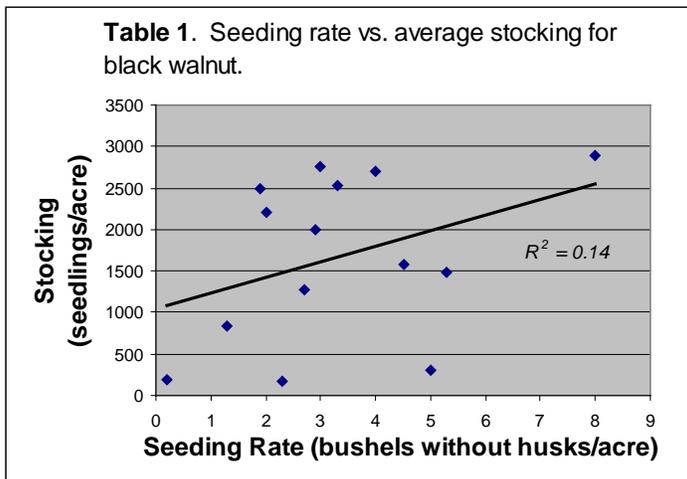
In the fall of 2003, Kristin Peterson (Tree Improvement Program Assistant) began collecting data on seeding method, weed competition level, site preparation, seeding rate, species composition, stand density, and seedling height for 31 direct seeded plantations. These plantations ranged in size from 1-7 acres and in age from 1-6 years old. We were fortunate to receive survey figures for Richland County that were previously collected by Adam Zirbel (Forester), Todd Kenefick (Forester Ranger), and Aaron Young (Forestry Team Leader). All surveying was done using 1/100<sup>th</sup>-acre circular plots. The tree species sown included black walnut, northern red oak, white oak, bur oak, swamp white oak, sugar maple, and shagbark hickory. All the plantings were high-density sowings on former agricultural fields. Stand density goals ranged from 3000 to 8000 stems per acre. Most sites were planted using a hardwood

seeder or drill. Occasionally, supplemental hand planting was used to introduce a light-seeded species that could not be run through the seeder, such as sugar maple. One site was entirely broadcast seeded by hand. Twenty-nine sites were fall planted and two were spring planted.

**The Findings...**

The average stocking level for the machine planted sites was 3359 stems per acre (range: 650 to 8833 stems per acre), including volunteer species. The hand broadcast site contained over 18,000 stems per acre. This level of stocking is not uncommon, considering all of the sites were designed to be “high density” hardwood plantings. The advantage of these high-density plantings is that the trees quickly occupy the site and tree form is improved by the intense competition. Volunteer species accounted for approximately 400 stems per acre on average, with elm and boxelder being by far the most common.

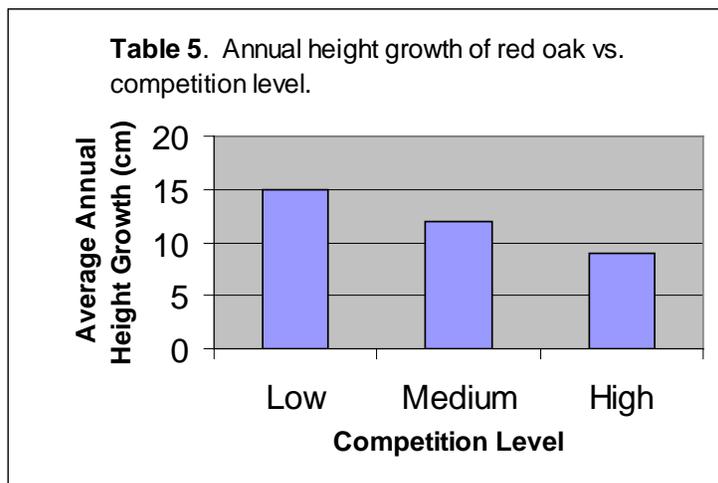
Tables 1-3 plot the seeding rate in bushels per acre verses the corresponding stocking rate for black walnut, red oak, and the white oak group. Unfortunately, data on seeding rates were not available for all plantations.



Not all species germinated and established seedlings equally well. In general, black walnut had the most consistent stocking with most sites developing more than 500 stems per acre (Table 1). Assuming 1000 walnuts per bushel (without husks), field germination rates averaged around 60-70%. Red oak germination was more variable with several sites having very low germination rates (Table 2). Assuming 4500 red oak acorns per bushel, field germination rates averaged around 30-40%. Finally, the white oak group was the most variable with at least two total germination failures (Table 3). Table 3 includes white oak, bur oak, and swamp white oak as a grouping, since individual species data was not always available. It is interesting to note that the two complete germination failures were white oak (*Quercus alba*).



evaluate sites beyond age five in order to determine the composition of the final stand (Johnson and Krinard 1987).



**Competing Vegetation:** All plantations, whether established from seedlings or seed, require adequate site preparation and weed control. Perhaps initial site preparation is even more critical for direct seeding given the delicate nature of newly germinated seed. The level of grass and broadleaf competition was evaluated at each plantation and given a low, medium, and high rating.

Table 5 illustrates the average annual height growth for red oak at each plantation in relation to the competition level found at each site.

Many of the foresters we talked to were drilling seed directly into untreated grass or other vegetation, and then killing that vegetation with glyphosate prior to tree seed germination in the spring (alternatively, grass could be killed prior to seeding). These plantations would then be treated in subsequent years with typical pre-emergent herbicides such as simazine or Oust. This method seemed to result in adequate seed germination on most sites. Hand broadcast seeding requires that the field be tilled to allow for the incorporation of the seed by disking or dragging.

### **Important Considerations...**

The results of this survey indicate that direct seeding of hardwoods can be done successfully, at least with black walnut and to a lesser degree with red, bur, and swamp white oak. However, the results of direct seeding are often more variable than planting seedlings. Direct seeding also presents several challenges in terms of collecting adequate amounts of seed and proper storage of seed. Most hardwood direct seeding efforts have been with heavy-seeded species and much less work has been done with light-seeded hardwoods, such as ash, maple, birch, etc. Direct seeding with light-seeded hardwoods should be considered experimental and more field research is needed. As for the heavy seeded species, here are some important considerations before you proceed:

**Plantation Size** – Keep it manageable. Collecting, transporting, and storing large amounts of seed is not easy. Especially in years with a poor acorn crop, oak seed is often in limited supply for growing nursery stock and direct seeding projects. All of the plantations we examined were less than 10 acres in size. For large plantings, consider doing part with seed and the rest with seedlings or establish the plantation over several seasons. On the other hand, be cautious with very small plantings. Research with southern oak species has found the greatest nut predation by mice, squirrels, and deer within plantings of less than

two acres in size, especially plantings within existing forest cover (Pope 1992). Spring seeding may be an option to help avoid heavy seed predation in these small, forested plantings.

**Seed Quality** – Proper collection and storage of nuts is critical for success. Collect from trees that have desirable growth and vigor characteristics. Native stands (forests, parks, cemeteries, etc.) and thinned plantations are good collecting locations. Street trees are not desirable because their genetic origin may not be appropriate for Wisconsin. As a rule of thumb, try not to move oak and walnut seed more than 150 miles north or south of its origin. The percent of sound seed can be estimated by performing a “cut test” on a sample of your seed. Viable nuts will be white and sound in appearance. Non-viable nuts will be brown or shriveled and may have a rancid odor. Do not pick red oak acorns with the cap still attached, as this often means the nuts are not viable. Acorns will still germinate with a relatively minor amount of weevil damage. Acorns and walnuts (without husks) can be tested by floating them in water. The empty seed will float and the sound seed will sink. Occasionally sound acorns will float with this method if the nuts have low moisture content. All nuts should be stored in a cooler at 34-36° F with high relative humidity (e.g., 90%) and planted as soon as possible. Store nuts in small quantities or in seed bags to reduce heating.

**Timing** – Walnuts and red oak acorns require a period of cold and moist stratification before they will germinate. Most direct seeded plantings in Wisconsin have been fall sown, so the seed naturally stratifies over winter in the soil. Fall sowing is the best method to avoid potential storage problems and maintain high seed viability. Red oak acorns and walnuts have been successfully stored over the winter in a cooler at 34-36° F in sealed 4 mil plastic bags. Acorns from the white oak group do not require cold stratification. White oak acorns, for example, will begin germinating soon after they ripen, making quick collection and fall planting a necessity.

**Species Selection** – As with all reforestation planting, select only species that are well adapted to the site. Be cautious with white oak, since direct seeding success rates have been very low with this species. Also, be aware of the species mixture. As we saw with the walnut and oak mixed plantations, species with very different juvenile growth rates may not be compatible. This problem can be overcome by group planting or by delaying the planting of the fastest growing species.

**Seeding Rate** – Base your seeding rate on the estimated percent germination and survival and on the desired number of trees per acre. For the machine planted sites we examined; 1-2 bushels of acorns per acre or 4-6 bushels of walnuts (without husks) per acre appeared adequate to reach a density of approximately 3000 or more stems per acre.

**Site Preparation and Release** – There are many effective methods of site preparation, but the basic principle is to reduce the competing vegetation just enough to give the tree seedlings adequate sunlight, water, and nutrients. Grass competition is especially hard on newly germinated seed and it can slow

seedling growth for years. Heavy disking or tillage of idle agriculture fields is an excellent way to eliminate a sod layer and create soil conditions that are good for seed germination. Be aware that this type of site preparation alone sometimes creates technical problems. Operating machinery may be more difficult on freshly tilled soil. A variety of weeds may become established from the seed bank or get blown in from adjacent areas. Cover crops can help this problem, however, in this survey, the germination and survival rates appeared to be no better in the plantations with a cover crop. As stated above, many foresters have preferred to drill seed directly into mowed grass stubble, then kill the grass with glyphosate prior to tree seed germination in the spring. This method leaves a layer of dead grass to limit soil erosion and suppress weed growth.

Pre-emergent herbicide must be used with caution during the first growing season in order to avoid chemically killing or damaging germinating tree seed. Many foresters have preferred to apply nothing beyond good site preparation and monitor the planting during the first growing season. Pendulum, a pre-emergent for grasses and some broadleaf weeds, has been commonly used over hardwood seed. Simazine has also been used on an experimental basis over oak and walnut seed, but we could find no data measuring its effects on germination rates. After the first growing season, typical pre-emergent herbicides such as Simazine or Oust can be used for release.

During the growing season release options are limited to mowing or a few registered post emergent herbicides, such as Vantage or Transline.

**Seeding Method** – Mechanical or spot seeding is a much more efficient use of seed than broadcast methods. Mechanical seeding allows better control over the final stand density and keeps planting costs lower. The advantages of broadcast seeding include the ability to achieve very high stand densities and more options for incorporating light-seeded species. Seed supply is often the most limiting factor for direct seeding, so mechanical seeding makes great sense.

**Depth of sowing** – Acorns and walnuts are usually sown 1-3 inches deep. Johnson and Krinard (1987) recommended sowing at a depth of 2-4 inches for southern oak species to take advantage of more constant soil temperatures and moisture. If using a mechanical seeder, make sure that the furrow gets properly closed to protect the seed.