Bigtooth and Quaking Aspen Propagation From Roots Versus Seed

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Abstract

With increased demand for trembling or quaking aspen (*Populus tremuloides* Michx.) and bigtooth aspen (*P. grandidentata* Michx.), the Wisconsin Department of Natural Resources, F.G. Wilson State Nursery has been conducting operational trials to determine the most efficient and effective way to propagate these plants for reforestation and afforestation activities. Seed propagation trials have been mostly unsuccessful because of the nursery's coarse, sandy soils. Root propagation trials with varying cutting sizes and with hand and machine planting has resulted in better success than seed propagation, with maximum yields to date of 8 to 9 salable trees per ft^2 (86 to 97 per m^2). The nursery continues to refine both seed and root propagation techniques to improve efficiency and quality. This paper was presented at a joint meeting of the Northeast Forest and Conservation Nursery Association and Southern Forest Nursery Association (Kent Island, MD, July 20–23, 2015).

Background

The Wisconsin Department of Natural Resources, F.G. Wilson State Nursery is located along the Wisconsin River in southwestern Wisconsin and has been producing seedlings since 1952. In recent years, there has been an increased demand for trembling or quaking aspen (*Populus tremuloides* Michx.) and bigtooth aspen (*P. grandidentata* Michx.). The nursery has had little demand for these species until recently, mainly because of their common presence on the landscape and the fact that they easily regenerate following a harvest by root sprouting. The forests of Wisconsin have been maturing, however, and aspen now make up a smaller percentage of the forest than in the past. Landowners' objectives are also changing. For many landowners, timber production is a secondary goal, and wildlife habitat is the primary goal, especially for whitetail deer. Wildlife biologists are recognizing the decline in aspen and its impact on ruffed grouse habitat. All these factors lead to an increased demand for aspen for both afforestation and reforestation. At the F.G. Wilson State Nursery, the demand for aspen is estimated to be 50,000 to 100,000 seedlings annually.

Seed Propagation Trials

Our first attempts to grow aspen were from seed. Because aspen number about 3 million seed per pound (6.6 million seed per kg), we added wheat germ, corn meal, or a similar carrier to the seed so it would flow better through the LOVE/Oyjord seeder (J.E. Love Company, Garfield, WA). The seed was planted just below the surface (less than 0.15 in [0.38 mm] deep). Several cultural treatments were used, including shading, straw mulch, frequent misting, and hydromulching. Efforts to propagate by seed continued for 5 years, with results ranging from total failure to mediocre success. The best results came from spreading a 0.5- to 1.0-in (12- to 25-mm) straw layer over the seedbed and then watering up to four times daily to maintain moisture. The nursery's coarse, sandy soil with low organic matter made maintaining moisture on the surface difficult, even with the straw. Keeping the straw in place was also a challenge with the wind blowing the straw off the seedbed.

Root Propagation Trials

After talking with staff at the Iowa State Forest Nursery in Ames, Iowa, we learned they were successful at propagating aspen from root cuttings harvested from aspen stands, but it was cost prohibitive to get enough cuttings from wild aspen stands. So our challenge

was how to make root propagation cost effective and acquire sufficient quantities of root cuttings. We had plenty of questions to work through.

- Stool beds work well for producing cottonwood cutting, but would they work for aspen?
- We had a supply of both quaking aspen and bigtooth aspen seeding into our oak seedbeds that we considered weeds. Could we harvest these seedlings when the oak seedlings were lifted and produce enough roots from these seedlings?
- How would we care for these seedlings until we could prepare the cuttings?
- How were we going to section the roots?
- What size roots did we need?
- How would we store the roots until we planted?
- How and when would we need to plant?

Year 1

We started our first year of aspen root propagation by lifting the aspen seedlings with the oak seedlings in early April to mid-April 2013 and separating those on the grading belt. We were able to gather about 1,000 aspen seedlings. The seedlings were then stored in the cooler for 3 to 4 weeks. In early May, we began to process the aspen roots. To make the operation more efficient, we bundled the seedlings with aligned root collars, and cut the roots using paper cutters (figure 1). Not knowing which root cuttings would produce sprouts, we saved all the roots and cut them into approximately 4-in (10-cm) lengths, with most root cuttings having diameters ranging from fine hair roots (<0.04 in [<1mm]) to 0.2 in (5 mm) and a few with diameters between 0.2 and 0.4 in (5 and 10 mm). The root cuttings were then placed into seedling boxes and stored in the cooler until planting in early May to mid-May.

Figure 1. Root cuttings from bundles of aspen seedlings were created using a paper cutter. (Photo by Joseph Vande Hey, 2016)

To plant the seedlings, we used the Whitfield hardwood seeder (R.A. Whitfield Manufacturing Co., Mableton, GA) to produce five furrows across the 48-in-wide (1.2-m-wide) bed that had been prepped the same as if we were going to seed. The furrows were about 1-in (2.5-cm) deep. The roots were then placed into the furrows by hand and covered with 0.25 to 0.50 in (6 to 13 mm) of soil. Bundles of root cuttings were placed lengthwise down the row with each bundle against the previous one. Bundle diameters were approximately 0.50 to 0.75 in (13 to 19 mm), with varying numbers of roots in each. With this method, we had enough roots to plant about a 400-ft (122-m) bed. The target density was about 8 to 10 salable trees per ft^2 (86 to 108 per m2). After planting was complete, the bed was watered well.

It took about 3 weeks for the first sprouts to break the soil surface and about 2 more weeks to complete sprouting. Sprout density ranged from 10 to 20 sprouts per square foot. All root-cutting sizes produced sprouts, with the most vigorous sprouts coming from the larger cuttings (0.13 to 0.19 in [3 to 5 mm] diameter range). Some of the roots had multiple sprouts, which we monitored to see what would happen. As the growing season went on, the sprouts grew slowly at first but, by mid-July, were growing well (figure 2), with most root cuttings having good root development and only one sprout left (figure 3). By fall, the sprouts were 16 to 24 in (40 to 60 cm) tall, with stem diameters of 0.13 in (3 mm) or larger. The density had thinned to about 3 to 4 trees per ft^2 (32 to 43 per m2). That bed density was less than the target, but it was still encouraging. Seedlings were lifted and graded the next spring for distribution. During grading, roots were pruned to 8 in (20 cm). The surplus roots were then saved to be used to produce the next crop, along with more aspen roots that were weeded out of the oak seedling beds.

Year 2

After evaluating year-1 production of aspen with root cuttings, we concluded that it was mostly successful. Objectives for the second year were to improve bed

Figure 2. By mid-July, aspen root cuttings were growing well in the nursery beds. (Photo by Joseph Vande Hey, 2015)

Figure 3. Aspen cuttings show good root development by mid-July. (Photo by Joseph Vande Hey, 2015)

densities and determine how short a root we could cut and still produce a salable tree. In year 2, we planted about 500 ft (152 m) of bed with 120 feet of the bed having root cuttings that were about 1 to 2 in (2.5 to 5.0 cm) long and the remainder having cuttings that were 3 to 4 in (7 to 10 cm) long. We also varied the number of roots by planting 0.5-in to 1.0-in-diameter [1.3- to 2.5-cm-diameter] bundles to determine the minimum needed to reach our target density. Planting was done similarly to the previous year.

The longer roots produced the most sprouts and the most saleable trees (4 to 7 per ft^2 [43 to 75 per m2]), but the shorter roots still had very good sprouting and also produced salable trees (3 to 4 per ft^2 [32 to 43 per m^2]). The best beds of salable trees and bed densities (5 to 7 per ft^2 [54 to 75 per m^2]) were grown from the 3- to 4-in (7- to 10-cm) long roots with root bundles of about 1-in (2.5-cm) in diameter at planting; this size is about the most root that can be packed into the furrow using the Whitfield hardwood seeder. These densities were still less than our target, but they were much closer and far better than any yields we had with seed propagation. Again, these seedlings were lifted, graded, and root pruned the next spring. The roots produced from root pruning were about 1.5 times more than in the previous year, resulting in a net gain on root cuttings each year.

Year 3

Hand-planting the root cuttings was labor intensive during the first 2 years, so staff looked at ways to allow for machine planting. They modified our Whitfield hardwood planter by removing the seed hopper and installing larger drop tubes. Each drop tube needed to have the root cuttings hand fed. All root cuttings were 2 to 4 in (5 to 10 cm) long. Two rows were planted using the modified Whitfield hardwood planter (figure 4.) It took four people to hand feed the roots down the drop tubes. A third row was hand-planted as in previous years, with about 1-in (2.5-cm) size root bundles. The machine planting required about the same amount of labor as did the hand-planting. The two rows that were machine planted had five to six salable trees per ft^2 (54 to 65 per m^2). In the hand-planted row, we reached the target bed density of eight to nine salable trees per ft^2 (86 to 97 per m^2).

Figure 4. The nursery's Whitfield hardwood tree planter was modified with drop tubes to hand-feed bundles of aspen roots for planting. (Photo by Joseph Vande Hey, 2015)

Lessons Learned

After producing three crops of aspen from root cuttings, we learned many lessons as we worked through determining if this propagation method could be a viable and cost-effective way to produce aspen.

- Root lengths of 2 to 4 in (5 to 10 cm) long work well.
- Best root-cutting diameters are 0.06 to 0.25 in (1.5 to 6.4 mm); larger cuttings result in too few roots in the ground to reach desired bed density.
- Beds need to be kept moist, similar to other seedlings during germination.
- Some exposed roots do not appear to be a problem.
- Planting depth is critical and should not exceed 1 in (2.5 cm) deep with 0.25 to 0.50 in (6.4 to 12.7 mm) of soil covering.
- Modified machine planting is possible and reduces planting time, but this technique still needs improvement to achieve adequate bed density.

Conclusions

The F.G. Wilson State Nursery will continue propagating aspen from root cuttings. After 3 years, we reached target salable bed densities by hand-planting the root cuttings. Staff believe it is possible to increase yield using the modified Whitfield hardwood planter, but it will require additional modifications to the planter to be able to feed more roots. The nursery also plans to do more aspen propagation from seed. Seed propagation is more cost effective if we can overcome the hurdles of keeping the seed and, ultimately, the small seedling moist in coarse, sandy soils.

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