Reforestation Tech Tips

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Improved Whitebark Pine Seed Scarifier

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Nurseries scarify (nick or sand) whitebark pine seed to make it more likely to germinate. The U.S. Department of Agriculture Forest Service, Missoula Technology and Development Center (MTDC) has developed a new scarifier (figure 1) that lightly sands whitebark pine seed.

Figure 1—The new sanding scarifier for whitebark pine seed. The seeds swirl across sandpaper lining each of the four cans.

Highlights...

- Whitebark pine seeds need to be scarified (nicked or sanded) to increase their germination rate.
- Nicking seed by hand is tedious and somewhat dangerous.
- The original scarifier developed by MTDC had problems.
- A new scarifier appears to be just as effective, more reliable, less expensive, and requires almost no attention by the operator, a big labor savings.

The new scarifier can handle all sizes and shapes of seed, is more reliable, and doesn't have to be tended while it is operating, all big improvements over the original scarifier developed by MTDC. For information about the original scarifier, see the tech tip *Whitebark Pine Seed Scarifier* (0224–2332–MTDC, *http://www.fs.fed.us/eng/t-d.php?link=pubs*).

Before these scarifiers were invented, nursery workers used scalpels to nick the seed by hand (figure 2). Workers could nick no more than 400 seeds an hour and sometimes nicked themselves rather than the seeds. The original MTDC scarifier (figure 3) could nick 1,500 seeds per hour, was easier for workers to use, and was safer than nicking seed by hand.

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Figure 2—A scalpel is used to nick (scarify) whitebark pine seed by hand. The inset photo shows a seed that was nicked by hand.

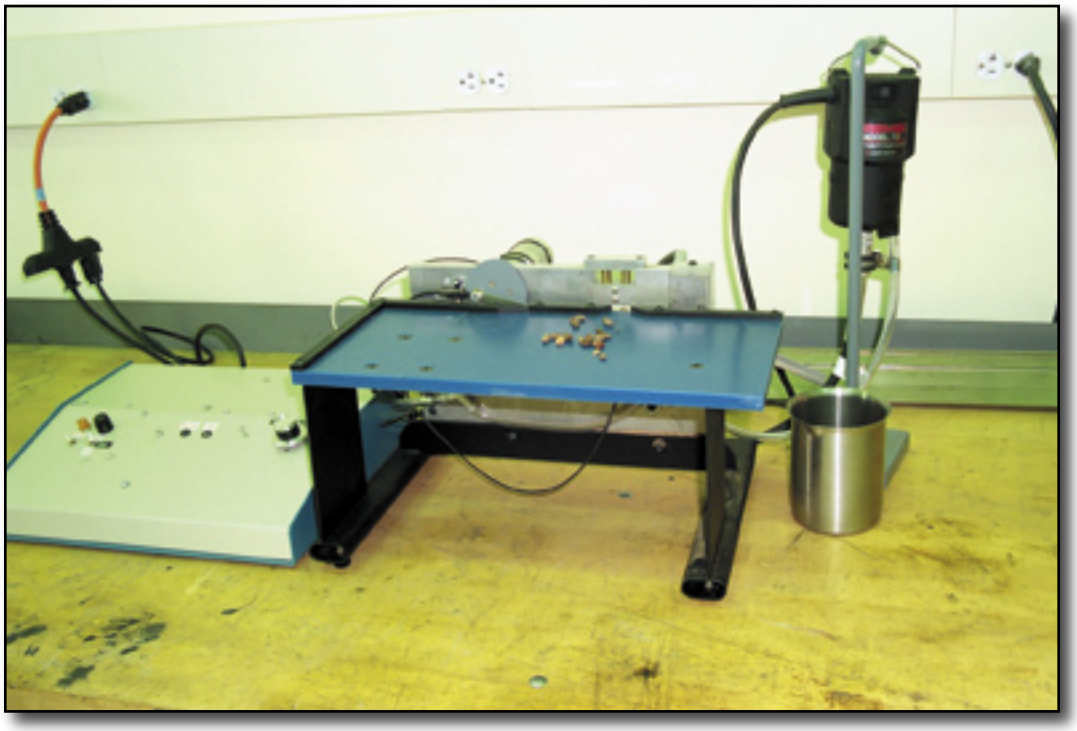

Figure 3—The original whitebark pine scarifier developed by MTDC.

Whitebark pine seed is a favorite food of the grizzly bear, a threatened species protected by the Endangered Species Act. Whitebark pine has declined over the past century because of white pine blister rust, insect infestations, and fire suppression. Scarifiers should reduce the cost of growing whitebark pine seedlings, allowing more whitebark pines to be planted.

Problems with the Original Scarifier

Whitebark pine seeds vary considerably in size and shape. During a production run of whitebark pine seed at the Forest Service's Coeur d'Alene Nursery in 2003, the original scarifier ran into problems nicking very round large seeds. Those seeds were not being nicked deeply enough or were not being nicked at all. The original scarifier also had to be repaired periodically.

Nursery personnel suggested another method of scarification: sanding the seed. Researchers who had studied whitebark pine seed found they could improve germination percentages by swirling small lots of seed in a can lined with sandpaper. This method is different than nicking, but the seedcoat gets scraped or sanded enough to help the seed germinate.

New Prototype Whitebark Pine Seed Scarifier

MTDC developed a new prototype whitebark pine seed scarifier that swirls the seeds in sandpaper-lined cans. Four 5-pound coffee cans, lined with 60-grit sandpaper, are attached to an 18-inch-diameter disk. An electric motor rotates the disk, while a chain-and-sprocket system keeps the orientation of the cans fixed relative to their starting position. The seed slides across the sandpaper, which is attached to the bottom and sides of the cans. A motor controller can adjust the speed of the disk's rotation from 0 to 140 revolutions per minute. Lids may be placed on the coffee cans to reduce the noise and keep the seeds from bouncing out.

If the new scarifier is proven effective, it will be much more efficient than nicking seed by hand or with a machine. Although a worker can feed about 1,500 whitebark pine seeds per hour into the original scarifier, doing so requires constantly feeding the machine. With the new scarifier, the operator can place seed into the cans, turn the machine on, and leave to handle other work. Even if it takes several hours to scarify the seed, the new scarifier will save labor, lowering production costs. Although each can could hold several thousand seeds, no more than several hundred at a time can be sanded effectively.

Test Procedures

Tests were conducted to determine how long the seeds need to be sanded and how fast the cans need to be rotated.

Speed Tests

A digital high-speed video camera recorded the motion of the seeds in the coffee cans while the disk was rotated at different speeds. The goal was to determine the speed that would move the seeds back and forth across the bottom of the can without sending them into the side so hard that the seeds could be damaged. Starting at 10 revolutions per minute, the speed was increased by 10 revolutions per minute up to 140 revolutions per minute. The high-speed video showed that 110 revolutions per minute provided the best motion to scarify the seed. This speed corresponds to a setting of 80 on the motor's speed controller.

Duration and Germination Tests

Once the scarifier's developers had determined the best rotational speed, they had to determine how long to sand the whitebark pine seeds. Tests were conducted with seed from the Coeur d'Alene Nursery. A sample from a lot of whitebark pine seed was stratified (soaked in running water for 48 hours, followed by 30 days of warm [70 degrees Fahrenheit] moist conditions, then 60 days of cold [34 degrees Fahrenheit] moist conditions). The seeds were scarified after they had been stratified. The seeds were placed in germination boxes (figure 4) that were put in an environmental chamber at about 70 degrees Fahrenheit. Comparison tests included:

- No scarification—200 seeds were removed from the lot as a control sample.

Figure 4—Scarified seeds are placed in germination boxes during testing.

- Hand-nicking scarification—600 seeds were nicked by hand.
- Sanding scarification—400 seeds were sanded for either 5, 10, 15, 20, 30, 45, 60, 90, 120, 180, or 480 minutes.

Test Results

Figure 5 shows the results of the duration tests. The germination rate for the seed that was neither sanded nor nicked was 43 percent. Seed nicked by hand had a germination rate of 73 percent. Seed sanded for 3 hours had a germination rate of 72 percent, slightly lower than that of hand-nicked seed. The hand-nicked seed reached full germination in 8 days, while the sanded seeds took about 15 days.

One problem was solved during testing. During the 30-minute tests, some seeds got underneath the sandpaper, possibly damaging them. A Styrofoam ring was placed underneath the sandpaper near the perimeter of each can. This compensated for the uneven surfaces on the bottom of these cans. Seeds did not get underneath the sandpaper during the 120-, 180-, and 480-minute tests.

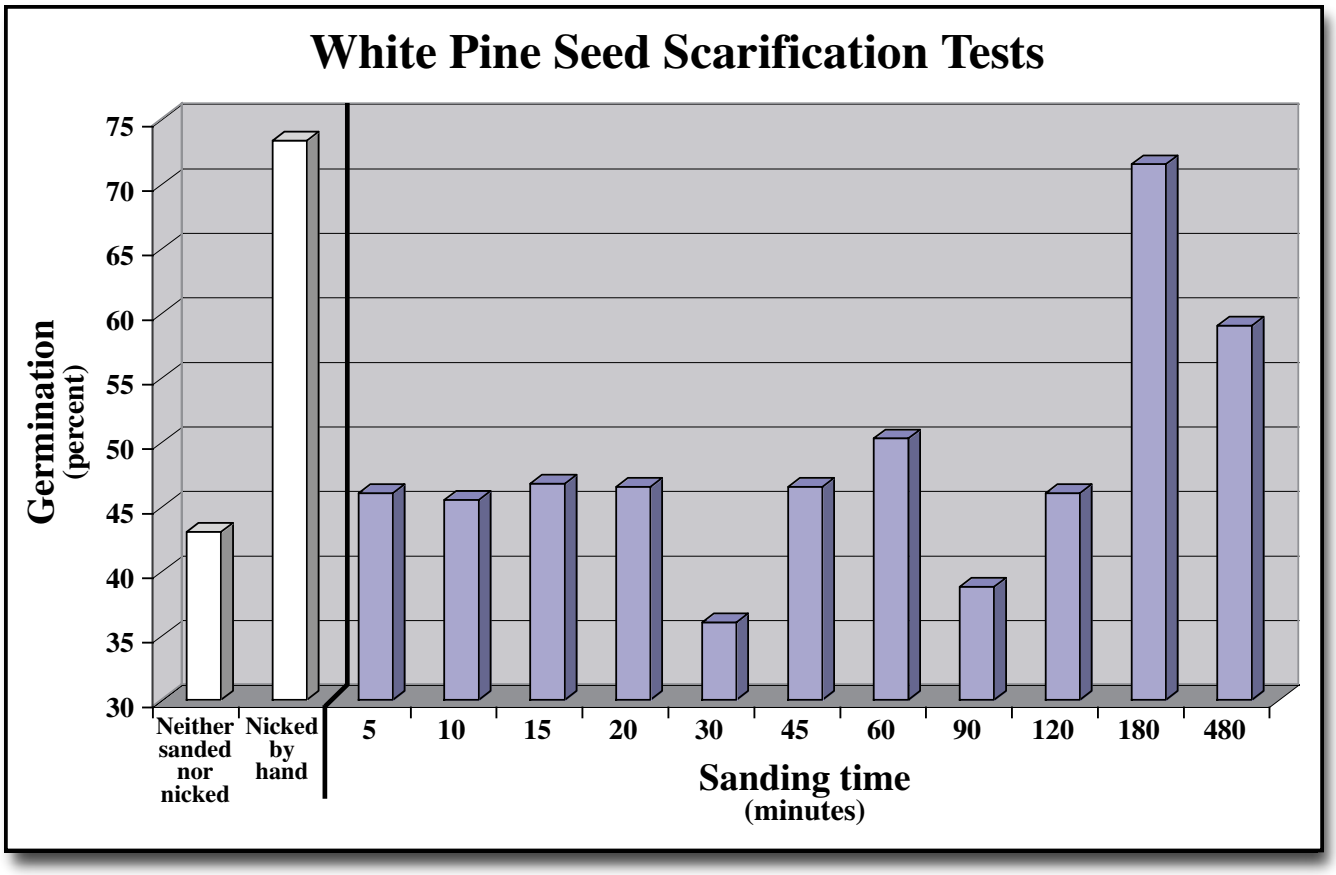

Figure 5—Germination rates of seed sanded for up to 480 minutes (8 hours) compared to rates for seed that was neither sanded nor nicked and seed that was nicked by hand.

Conclusions

MTDC has developed a new whitebark pine seed scarifier that appears to be nearly as effective as nicking seed by hand. The new scarifier uses four sandpaper-lined cans that are rotated by an electric motor to sand the seedcoat from whitebark pine seed. The new scarifier is far less complicated than the original scarifier developed by MTDC. The new scarifier costs $1,000 to manufacture, less than the original scarifier, and is more reliable. Fabrication drawings will be available from MTDC late in 2005.

One improvement that has been suggested is to incorporate a timer to stop the scarifier after a set period. This would prevent the seed from being sanded too long. Germination rates went down when seed was sanded for longer than 180 minutes (3 hours).

About the Authors

Andy Trent is a project engineer at MTDC. He received his bachelor's degree in mechanical engineering from Montana State University in 1989. Before coming to MTDC in 1996, he worked as a civilian engineer for the U.S. Navy. Andy works on projects in the nurseries and reforestation, forest health protection, and watershed, soil, and air programs.

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Karen Burr is a horticulturist at the USDA Forest Service's Coeur d'Alene Nursery in Coeur d'Alene, ID, where she oversees seed and seedling quality activities. Formerly, she was a research plant physiologist at the Rocky Mountain Research Station in Flagstaff, AZ. She received her Ph.D. in horticulture from Colorado State University.

Library Card

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Describes a new scarifier that can lightly sand whitebark pine seed to increase the germination rate. Whitebark pine seed that has not been scarified (sanded or nicked) is much less likely to germinate than seed that has been scarified. Traditionally, workers have nicked whitebark pine seed by hand. The original scarifier developed by the Missoula Technology and Development Center (see *Whitebark Pine Seed Scarifier*, 0224–2332–MTDC) nicked seeds about three times as fast as the fastest worker. However, the original scarifier had to be tended while it was running, broke down on occasion, and couldn't handle all sizes and shapes of seed. The new scarifier costs less to manufacture (about $1,000), can handle all sizes and shapes of seed, is more reliable, and doesn't have to be tended while it is operating, a big labor savings. The new scarifier sands the seed using sandpaper in the bottom of four coffee cans mounted on a rotating disc. Tests at the Forest Service's Coeur d'Alene Nursery showed that 72 percent of the seed sanded for 3 hours at 110 revolutions per minute germinated, slightly less than the 73 percent that germinated when seeds were nicked by hand, and dramatically more than the 43 percent that germinated when the seed was neither sanded nor nicked.

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