

Active Nursery Projects at the Missoula Technology and Development Center

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Abstract: The USDA Forest Service Missoula Technology and Development Center (MTDC) provides technical expertise, new equipment prototypes, and technology transfer services to Federal, State, and cooperator forest tree seedling nursery managers. Current projects at MTDC include a nursery soil moisture meter, remote data collection systems, low cost weather stations, soil compaction tester, shielded herbicide sprayer, seedling wrap, copper treatment for Styroblocks™, and whitebark pine seed scarifier. Recently completed projects include nursery soil sterilization, hardwood cuttings preparation equipment, and seed orchard duff sweeper.

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Introduction

Missoula (MTDC) and San Dimas (SDTDC) Technology and Development Centers serve the USDA Forest Service by helping to solve problems identified by field employees. For nearly 40 years, MTDC and SDTDC have been evaluating existing technology and equipment, developing equipment prototypes, and conducting technology transfer through their reports, Web sites, videos, and DVDs.

The reforestation and nurseries program is located at MTDC in Missoula, Montana. The main focus of the nurseries program is to develop new equipment or technology to improve nursery operations and processes. The program is sponsored and funded by the Forest Management staff group at the Washington Office, and through State and Private Forestry.

Our focus at MTDC is on applied technology and technology transfer. We are not part of the Research and Development branch of the USDA Forest Service. Rather, we apply research findings to help solve on-the-ground problems.

Projects originate from ideas or concepts from field personnel. A national steering committee reviews the project proposals that typically come from employees at the Forest Service Federal nurseries, and from State and private cooperators. The steering committee selects the highest priority projects for MTDC to work on. In any given year, there are about 20 to 25 active reforestation and nurseries projects.

Projects typically last from 2 to 4 years, depending on their complexity. Equipment-based projects are field tested, and fabrication drawings are made so the equipment can be duplicated by other nurseries. We usually document our projects through printed reports or journal articles that are available from MTDC.

Current Nursery Projects at MTDC

Nursery Soil Moisture Meter

Recognizing the need for fast, accurate soil moisture readings, MTDC was asked to evaluate portable electronic moisture measuring devices to see if such instruments were an alternative to the oven drying method many nurseries use. Project Leader Ted Etter found that 2 instruments, Campbell Scientific TDR (time domain reflectometry) probes, models CSI-615 and CSI-616, looked most promising.

A formula converts electronic TDR signals to volumetric soil moisture content. However, Ted thinks that the “one size fits all” formula is not accurate enough for nursery work. He is looking into the feasibility of developing more accurate formulae customized to reflect soil characteristics at individual nurseries. We have lab tested the probes to see the effects of soil variables

on the TDR readings. The next step is to evaluate the probes at USDA Forest Service Coeur d'Alene Nursery in Idaho under field conditions and compare the results with the laboratory baking method.

Remote Data Collection Systems

Project Leader Gary Kees is evaluating remote sensors, monitored via satellite, which will tell silviculturists when distant sites are ready for outplanting. Satellite communication and the needed ground sensors are becoming much less expensive than in the past, and Gary believes it may be possible to measure snow depth and soil temperature remotely for approximately U.S. \$1,000 per setup. MTDC is testing 3 AXTracker satellite transmitters to determine if this is a practical, affordable, and dependable technology.

Low-Cost Weather Stations

Measuring weather at project locations is of interest to researchers, incident managers, and to anyone who needs to keep track of site-specific weather conditions. As part of the Remote Data Collection project, MTDC is evaluating low-cost weather instruments that have data logger capabilities (Figure 1). We purchased 2 different systems for U.S. \$600 and U.S. \$1,300, and plan to evaluate them.



Figure 1—Downloading data is relatively easy on these low-cost weather stations.

Project Leader Gary Kees hopes that if they work well, these less expensive systems will provide good alternatives to the more sophisticated RAWS weather stations that cost closer to U.S. \$15,000. It may also be possible to tie these weather stations into the AXTracker satellite system in order to monitor the readings remotely.

Soil Compaction Tester

A tree planting contract inspector approached MTDC with a proposal to develop a fool-proof, low-cost method to determine soil compaction around planted seedlings to determine whether contract specifications had been met. The traditional method for inspecting compaction is to dig a test hole alongside a sample of planted seedlings and determine compaction by visual inspection.

MTDC evaluated 3 electronic soil penetrometers on the Shasta-Trinity and Boise National Forests (Figure 2). Unfortunately, for tree contract inspection, the penetrometers gave inconsistent results and are not recommended. The electronic penetrometers do give consistent results for measuring soil compaction in other situations, are easy to use, and collect data that can be stored for later downloading and use. Project Leader Gary Kees plans to document his findings and the availability of this new generation of soil penetrometers. He plans to do further evaluation of the penetrometers at the Coeur d'Alene Nursery in 2004.

Shielded Herbicide Sprayer

Weeds are difficult to control in hardwood nursery beds. Chemicals such as Roundup™ kill the weeds, but also kill the seedlings if the spray is misdirected. Several nurseries have fabricated shielded sprayers to prevent herbicides from being applied to the hardwood seedlings. MTDC was asked to review this existing equipment, select the best features, and incorporate those features into a new prototype model.



Figure 2—New-generation soil penetrometers are easy to use, and save readings for further analysis back at the office.

Project Leader Keith Windell worked with machinery developed by several Southern nurseries. He developed a prototype spraying system, had it fabricated, and field tested it in May 2002. The MTDC prototype sprayer is mounted on a 3-point tractor hitch. It is a fully contained system with up to 9 nozzles. The shields are adjustable, and the sprayer can be steered for perfect alignment as it is pulled down the rows. The spray pump is run off the tractor's power take-off and is calibrated before spraying (see South, this proceedings; Stallard, this proceedings).

Field testing was done at the Virginia Department of Forestry New Kent and Augusta nurseries. Two deficiencies became evident. Steering was blocking the view of the ground, making it difficult to precisely steer the machine. Also, the shields were digging into soft ground. MTDC modified the sprayer by redesigning the steering, adding height gauge wheels, and adding a more precise hood width adjustment (Figure 3). The Virginia nurseries are retesting the sprayer, and MTDC has construction drawings available upon request for the improved prototype.

Seedling Wrap

Jelly-rolling bareroot seedlings in wet burlap is a traditional way to protect and carry seedlings in planting bags just prior to planting. Over the past several years, many National Forests have used a synthetic fabric, Kimtex[®], as an alternative to burlap. Kimtex[®] is no longer available in the sizes needed for tree wrapping, so we were asked to find another fabric that would work.

The Bitterroot and Idaho Panhandle National Forests evaluated several synthetic fabrics in 2004. DuPont Sontara[™] absorbent fabric worked the best, and MTDC located a supplier, American Supply Corporation, that agreed to custom cut the fabric into 22 in (56 cm) wide rolls, 200 yd (183 m) long, for tree wrapping applications. Contact Brian Vachowski for more information.



Figure 3—MTDC's improved shielded herbicide sprayer is being evaluated in Virginia.

Copper Treatment for Styroblocks[™]

Copper-coated Styroblocks[™] are the containers of choice for some nurseries as the benefits of the containers become better understood. These benefits include ease of seedling extraction, reduced root spiraling, improved seedling development, reduced buildup of root disease inoculum, and longer usable container life.

Copper-coated Styroblocks[™] can be purchased from Styrobloc[™] manufacturers, but the coating wears off after about 2 growing cycles. MTDC was asked to look at methods and equipment to recoat the containers with the copper treatment, assuming it is feasible to do so.

After evaluating the economic and environmental feasibility of the recoating process, MTDC determined that it would not be in the government's best interest to further pursue developing a recoating machine. We do not plan any further development work on this project. There may be some private-sector potential to developing a recoating machine. Gary Kees is the contact for more information.

Styrofoam[™] Container Sterilizer

The MTDC is looking at methods and equipment to sterilize Styroblocks[™] before filling them with media and sowing seeds. Certain pathogens like *Pythium* spp. and *Fusarium* spp. remain in the residual media and in some roots that may remain after the seedlings have been extracted.

Many nurseries dip their used containers into hot vats of water (160 to 180 °F [71 to 82 °C]) and hold them there for at least 2 minutes. This method works, but is slow and labor intensive. A typical nursery can dip only about 25 to 30 containers at a time, but must sterilize thousands of containers each year.

The MTDC has been looking at alternative methods of sterilization. We first looked at infrared heat, but we could not provide enough heat to the inner cavities without melting the tops of the containers.

Next, we looked at using microwave or radio frequency waves, using a large radio frequency oven made for drying. The MTDC tested several Styroblocks[™] at various exposure durations and found that the oven was effective at reducing pathogen levels to acceptable levels, but the equipment costs were excessive.

We also evaluated steam heat, like that in a sauna, and found that it will effectively sterilize the containers. The concept is that a large room could be constructed where pallet loads of containers could be treated at one time. The containers could be left in the oven for a specific period of time, then removed. Preliminary testing indicates that the Styroblocks[™] must be wetted or sprayed down before heating.

Project Leader Andy Trent is currently working with the USDA Forest Service Lucky Peak Nursery near Boise, Idaho, to install a steam boiler and distribution system to test this concept on an operational level.

Whitebark Pine Seed Scarifier

Whitebark pine is being planted for restoration projects because its seeds are an important food source for grizzly

bears. Scarifying the seed coat increases germination dramatically at the nursery, from about 1 to 2% natural germination, to more than 60% germination if there is a 1-mm cut in the seed coat. Now each seed is being cut manually with an Exacto knife, a tedious process that presents its own set of safety concerns.

The MTDC has developed a machine that may replace the Exacto knife operation. Our first attempt produced a sophisticated instrument that uses a laser-guided rotary-head cutting tool to make a 1-mm cut through the seed coat. The prototype worked in limited testing, but was not adaptable enough to the large variability found in later seed lots.

We are currently testing a less complex prototype, which consists of sandpaper-lined cans that rotate in an orbiting pattern (Figure 4). Coeur d'Alene Nursery staff are currently evaluating it to see if it meets the need. Andy Trent is Project Leader.

Recently Completed Nursery Projects

Nursery Soil Sterilization

Methyl bromide has been the preferred method at most nurseries for fumigating soil to combat soil pathogens. However, methyl bromide has been found to be environmentally harmful, and its use may be banned or severely restricted. The MTDC was asked to look at alternatives to chemical fumigation for tree seedling nurseries.

Looking at an older technology still used in Europe in agricultural applications, MTDC built a prototype steam treatment machine for treating nursery beds. If soil is heated to at least 160 °F (71 °C) for 20 minutes, tree seedling pathogens are killed, while desirable microorganisms survive. The MTDC's steamer featured a 1-million BTU boiler that has been outfitted to inject steam into the soil at about 8 in (20 cm) deep. Field testing of the steamer concluded that it effectively controlled the pathogens, but



Figure 4—This whitebark pine seed scarifier is being evaluated at the USDA Forest Service Coeur d'Alene Nursery, Idaho.

the prototype machine was too slow for field production use. Test results are documented in *Nursery Soil Steam Fumigation* (9724-2833-MTDC), available from MTDC.

A British firm, UK Sterilizers, reportedly had a mobile soil sterilizing machine that they were hoping to test in the United States in late 2003. We have not heard from that company for over a year, but will continue to try to make contact to see whether their machine works.

As another alternative, we are evaluating infrared heat for sterilizing the soil. In theory, infrared or radiant burners should be much more efficient in heating the soil than steam. The idea is to lift soil from the soil bed onto a conveyor belt where infrared burners mounted 12 in (30.5 cm) above the conveyor will heat the soil. Project Leader Gary Kees is conducting preliminary tests to determine if this concept warrants full field testing.

Hardwood Cuttings Preparation Equipment

The MTDC was asked to develop equipment to prepare hardwood cuttings for planting. The current practice at many nurseries is to cut long whips from stumps, then use table saws to cut the whips into 6- to 8-in (15- to 20-cm) cuttings. This work is time consuming and raises safety concerns because of the close proximity of the operator's hands to the saw.

Project Leader Gary Kees developed a prototype saw that made the job of preparing the cuttings easier and safer. The electric miter saw has a brake that stops the blade once the cut is made and a foot-operated clamp that holds a bundle of whips as they are cut (Figure 5). The saw was tested at the USDA Forest Service Bessey Nursery in Halsey, NE, early in 2003, and MTDC has drawings and a report available.

Seed Orchard Duff Sweeper

Duff in seed orchards harbors insect larvae over winter. Starting with a machine designed to sweep golf courses, the

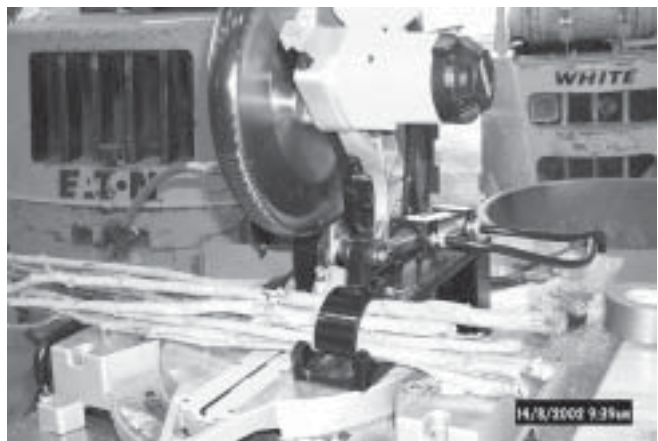


Figure 5—This miter saw features a foot-operated clamp to safely and securely hold bundles of tree whips being prepared as cuttings.

Project Leader Keith Windell developed a prototype duff sweeper that removes the infected duff from the seed orchard floor. He also developed a collection device for the duff. The project was funded through MTDC's Forest Health Program and State and Private Cooperators in the Northwest.

Contacts for More Information _____

A complete listing of the nursery projects completed over many years is available electronically to Forest Service and BLM employees at the MTDC intranet site, <http://fsweb.mtdc.wo.fs.fed.us/programs/ref/>. The list is also included in the printed report, *Reforestation & Nurseries*

(0224-2805-MTDC), available on request by calling 406.329.3978. Drawings and reports that are available in electronic form are available to the public at:

<http://www.fs.fed.us/eng/t-d.php>.

Paper copies of MTDC reports and drawings are available from:

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