United States Department of Agriculture

Forest Service

Pacific Northwest Region

State and Private Forestry

Cooperative Programs

R6-CP-TP-11-95

Forest Nursery Notes

July 1995

Forest Nursery Notes
Production Team

Tom D. Landis, Principal Author and Editor
USDA Forest Service
Cooperative Programs
P.O. Box 3623
Portland, OR
Phone: 503-326-6231
Fax: 503-326-5569

Aleta Barthell, Design Layout and Printing
USDA Forest Service
Cooperative Programs
P.O. Box 3623
Portland, OR
Phone: 503-326-6665
Fax: 503-326-5569

Donna Loucks, Library Services
Weyerhaeuser Research Center
505 N. Pearl St.
Centralia, WA
Phone: 206-330-1740
Fax: 206-330-1742

Cheryl Ullrich, Mailing and Publications Distribution
Portland Habilitation Center, Inc.
3829 SE 74th Avenue
Portland, OR 97206
Phone: 503-777-2215
Fax:503-771-6820

This technology transfer service is funded by:
USDA Forest Service, State and Private Forestry

Cover Photo: This badly rootbound pine seedling which was grown in a polybag container was unstable after outplanting (see corresponding article on page 6).

Table of Contents

Thought for the day...

"More and more Americans feel threatened by runaway technology, by large-scale organization, by overcrowding. More and more Americans are appalled by the ravages of industrial progress, by the defacement of nature, by man-made ugliness. If our society continues at its present rate to become less livable as it becomes more affluent, we promise all to end up in sumptuous misery"

-John W. Gardner

At first glance, this little quote is rather depressing, but then you have to realize that we in the nursery business are twice blessed. First, most of us are lucky enough to live in the few remaining parts of the country where we can still enjoy the beauty and peace of nature. Second, as nursery workers, we have a unique ability to change this rather glum prediction. By propagating trees and other native species, we are providing the resources to restore plant communities, increase species diversity, and buffer the consequences of our industrial civilization. Growing and planting trees demonstrates that each of us can make a difference, however small.

Downsizing

As seems to be the case with state, provincial, and federal governments everywhere, the USDA Forest Service is reducing its work force and cutting budgets. For example, the latest prognostication is that the Washington, DC office staffing will be reduced by 25% over the next few years, whereas the headquarters offices (where we work) will have to eliminate 600 jobs. On top of all that, we've been told to expect a 10% funding reduction for each of the next 2 years. But hey, it's not that bad! I've been through these things before and have come to believe that if you just keep trying to do a good job, that things will all work out. So, the FNN Team will just keep plugging along-believing that good things happen to good people.

Spanish Version of FNN Now Available

In cooperation with CEFORA-The Center for the Reforstation of the Americas-we arranged to have the January, 1995 issue of FNN translated into Spanish. This July, 1995, issue will also be translated and should be ready in about a month. Copies of "Notas Sobre Viveros Forestales" can be ordered from:

CEFORA
PO Box 30003, Dept. 3Q
New Mexico State University
Las Cruces, NM 88003-0003 USA
Tel: 505-646-5485
Fax:505-646-6041

Nursery Meetings

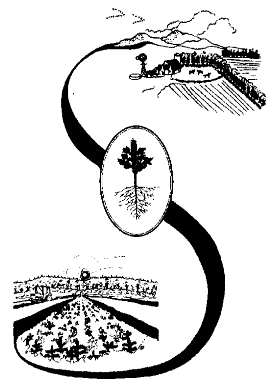
The USDA Forest Service has organized a Forest Nursery Training Session to be conducted on July 31 to August 2, 1995 at the Gulf Park Campus of the University of Southern Mississippi in Long Beach, MS. The agenda includes a variety of nursery management topics and a field trip to the Forest Service Ashe Nursery near Brooklyn, MS. For more information, contact:

Charlie Affeltranger
USDA Forest Service, S&PF
2500 Shreveport Highway
Pineville, LA 71360 USA
Tel: 318-473-7292
Fax: 318-473-7117

Afforestation of First Rotation Sites-Production of Appropriate Seedlings, Seedling Establishment, and Stand Treatment is the title of a pre-IUFRO World Congress meeting that will be held on August 1-6,1995 in Garpenberg, Sweden and Helsinki, Finland. The meeting is being sponsored by several IUFRO Working Groups including IUFRO S3.02-03 Nursery Operations, and will consist of both technical sessions and field trips in Sweden and Finland. Contact Anders Mattsson for more specifics:

Anders Mattsson
Swedish University of Ag. Sciences
Faculty of Forestry
Dept. of Forest Yield Research
S-776 98 Garpenberg SWEDEN
Tel: 46-225-26000
Fax: 46-225-26100

The Western Forest and Conservation Nursery Association will be holding their annual meeting at the Ramada Inn in Kearney, NE on August 7-10,1995. Following the successful format of last year's meeting, the agenda for the three day meeting will consist of morning technical sessions followed by afternoon field trips. Focus topics include nursery safety, soil fumigation and alternatives, marketing and customer service, propagation of junipers, and general nursery topics. The afternoon field trips will include: Bessey Nursery and the Nebraska National Forest, Great Plains outplantings, and a tour of local historical and recreational attractions. You should contact our host, Clark Fleege, for more information:



Clark Fleege
USDA Forest Service
Bessey Nursery
P.O. Box 38
Halsey, NE 69142 USA
Tel: 308-533-2257
Fax:308-533-2213

The **Northeastern Forest Nursery Conference** will be holding their annual meeting at the Spring Mill Inn near Mitchell, IN (about 80 miles south of Indianapolis) on **August 14- 17, 1995.** Jim Wichman of the Vallonia State Nursery will be our host. The agenda includes a wide variety of interesting topics including Relating Stock Quality to Field Performance, Seed Testing and Sowing, and Nursery Data Management. Tours of the Vallonia Nursery and local outplantings will round-out the agenda. The Spring Mill State Park features old-growth hardwood stands and historical attractions making this an ideal summer vacation for the family. If you would like more information, contact:

Jim Wichman
Indiana Div. of Forestry
Vallonia State Nursery
2782 W. County Road 540 S.
Vallonia, IN 47281 USA
Phone/Fax: 812-358-3621

The 36th annual meeting of the Western Region of the International Plant Propagators' Society will be held at the Red Lion Columbia River Hotel in Portland. OR on Sent. 14-**16, 1995.** The meeting theme is "Propagating Plants for the World: Seek, Share, and Grow" and will include technical sessions that will stress basic plant propagation concepts and techniques. The Portland area has many ornamental nurseries as well as those growing forest and conservation species, and 2 half-day tours are scheduled. These IPPS meetings are an excellent opportunity to expand your horticultural horizons and I hope to see you there. Additional information can be obtained from:

IPPS Membership	Program Chairman
Wilbur Bluhm	Allan Elliott
IPPS, Western Region	Canton Plants
743 Linda Avenue NE	P.O. Box 398
Salem, OR 97303 USA	Dayton, OR 97114 USA
Tel: 503-393-2934	Te1:800-398-8733
Fax: 503-868-7503	Fax:503-868-7503

The annual meeting of the **Forest Nursery Association of British Columbia** will be held at the Harrison Hot Springs Hotel on **Sept. 18-20, 1995.** The tentative agenda includes technical sessions on a variety of nursery topics and a field trip to the Chilliwack Valley. The dates for the meeting were chosen so that attendees could travel to the Western Canadian Horticultural Trade Show which opens in Vancouver on Sept. 20th. If you would like more information, contact:

Bruce Morton
Hybrid Nurseries, Ltd.
12682 Woolridge Road
Pitt Meadows, BC V3Y 1Z1 CANADA
Tel: 604-465-6276
Fax:604-465-9829

Meeting Cancellation: The University of Montana and Bitterroot Native Growers, Inc. regret to announce that the symposium entitled **"The Restoration of Disturbed Sites: An Ecological Approach"** that was scheduled for **Oct. 31 to Nov. 2,1995** has been cancelled.

The annual **International Research Conference of Methyl Bromide Alternatives** will be held in San Diego, CA on **Nov. 6-8, 1995.** Jenny Juzwik and Steve Fraedich are organizing a forestry symposium as part of this conference which would include pest management issues for forest and conservation nurseries. If you would like to present a paper or poster, or are considering attending, contact:

Jennifer Juzwik	Steve Fraedrich
USDA Forest Service	USDA Forest
Service	
North Central Research Stn.	Southern Research
Stn.	
1992 Folwell Ave.	320 Green Street St.
Paul, MN 55108	Athens, GA 30602
USA	USA
Te1:612-649-5114	Te1:706-546-2455
Fax:612-649-5285	Fax:706-546-2454

The XIVth Meeting of the North American Forest Biology Workshop will be held on **June 16-20, 1996** at Laval University in Quebec City, QC, CANADA. The meeting theme is Forest Management Impacts on Ecosystems Processes, and the specific agenda is still being developed. For the latest information, check the World Wide Web site (http://forestgeomat.for.ulaval.ca/) or contact:

Dominique Houde
Agora Communication
2600 boul. Laurier (#2680)
Sainte-Foy, QC G1V 4M6
CANADA
Tel: 418-658-6755
Fax: 418-658-8850

The 3rd meeting of the **IUFRO Working Party S2.07-09 (Diseases and Insects in Forest Nurseries)** will be held in Gainesville, FL during the **Summer of 1996.** They are still in the initial planning stages for this meeting, and so would like your input. Please contact Steve Fraedrich or Ed Barnard and give them your ideas:

Steve Fraedrich	Ed Barnard
USDA Forest Service	Florida Div. of Forestry
320 Green Street	PO Box 147100
Athens, GA 30602	Gainesville, FL
32614-7100	
USA	USA
Te1:706-546-2455	Te1:904-372-3505
Fax:706-546-2454	Fax:904-955-2301

The College of Forestry at Oregon State University is surveying interest in a **Reforestation Training Course** for the **Summer of 1996.** This manager's level course will focus on the integration of issues, such as: nursery culture, site preparation, planting, monitoring, logistics, personnel training, and operational trials for both temperate and tropical countries. The three week intensive training will consist of discussions, homework, and field trips. A $3,000 attendance fee includes tuition, course materials, living expenses, and transportation. For more details, contact:

Conference Assistant
College of Forestry
Oregon State University
Peavy Hall 202
Corvallis, OR 97331 USA
Tel: 503-737-2329
Fax: 503-737-4966

Improving Polybag Culture for Sustainable Nurseries

Bags made of polyethylene plastic sheeting are the most commonly-used nursery containers in the world because they are inexpensive and easy to ship and store. Unfortunately, polybags generally produce seedlings with poorly formed root systems that spiral around the sides and the bottom of the smooth walled containers **(Figure A).** This problem becomes much worse when seedlings are not outplanted at the proper time and are held-over in the container. Polybags are typically grown side-by-side on the ground, which allows aggressive roots to grow into the soil. Thus, by the time of harvest, many seedlings are seriously rootbound, and do not survive or grow well after outplanting.

Because of this problem with poor root form, many people have advocated that all polybag nurseries should convert to more "high-tech" hard plastic containers that control root spiraling. But, changing only the type of container without adjusting the entire nursery system is just asking for problems. Hard plastic containers are meant to be used with artificial growing media, which is very uniform in quality. This is not the case in developing countries where nurseries typically use forest soil or some type of soil mix for growing media. Peat moss-based growing media are too expensive and difficult to obtain in developing countries, especially in the tropics or semi-tropics. Soil-based mixes are notoriously variable in their ability to supply water, oxygen and mineral nutrients. This variability makes uniform irrigation and fertilization difficult, if not impossible. Irrigation of smaller-volume hard plastic containers must also be frequent and uniform. Most polybag nurseries do not have modern irrigation systems that apply water evenly, and so the containers must be watered by hand. In spite of the common perception, hand watering of small volume containers is more variable than automated irrigation systems. Finally, hard plastic containers must be placed on raised benches that are designed to promote root pruning. All of these restrictions mean that converting to a hard plastic containers is usually not sustainable after the initial development funding and technical support stop.

Figure A: Polybag containers do not control root spiralling, and so seedlings often become unstable after outplanting.

Rather than insist that nurseries stop using polybags, I suggest that we work at improving the existing container propagation system wherever converting to hard plastic containers would be operationally or financially impractical. In the last few years, I have been working with nurseries in Mexico in association with CEFORA (Center for Reforestation of the Americas) at New Mexico State University. We have decided to try to develop a "low-tech" sustainable nursery system based around the polybag for nurseries where it is impossible to convert to a modern nursery system. In greenhouse trials, Rich Phillips and John Mexal have demonstrated that high quality seedlings can be grown in polybag containers filled with soil mixes, if everything is done properly. Some of these cultural modifications include:

- Soil-based growing media should be amended with other components to promote aeration and drainage while maintaining a high water-holding ability. Bark, sawdust, and pumice are potential components that are both inexpensive and readily available. CEFORA is doing research into affordable and practical soil-based growing media for developing countries.

✍✍ Growing media made from forest soils cannot provide the amount and range of mineral nutrients that is needed for rapid seedling growth. Although most nurseries attempt to correct this problem with fertilizer amendments, these attempts are usually thwarted because the native soils immobilize the nutrients. Fertilizer trials, in combination with the proper growing media, have demonstrated remarkable results, even when the seedlings have been severely stunted for several months **(Figure B).**

Figure B: The pine seedlings on the left half of the container were stunted and chloratic, like those on the right half, until they received proper fertilization.

✍✍ Poly tube containers should be used instead of polybags, if at all possible, because they eliminate much of the root spiraling. Poly tubes will hold soil if they are properly filled and placed on screen-bottomed trays, which can either be homemade or purchased commercially. The tray of containers should be elevated above the ground to promote air pruning of roots.

✍✍ The widespread technique of transplanting newly-emerged seedlings from germination trays to polybags often results in root deformation. Transplanting the emergents at the proper time and improving the transplanting technique will improve the situation, but switching to planting germinants would be a better option. Ideally, seed quality can be improved to the point where direct seeding would be feasible with many species.

✍✍ Where root spiraling has already occurred, the adverse effects can be managed by root pruning prior to outplanting. Either the bottom layer of the polybags can be cut off, or the seedling can be removed from the container, graded, and pruned. The now bareroot seedlings can then dipped into super absorbent polymer or other water-holding material, and the roots "jelly-rolled" into wet cloth for shipment to the outplanting site.

✍✍ Finally, container seedlings must be managed as a perishable commodity with a limited "shelf life". This is particularly critical in tropical nurseries where seedlings grow year-round. If seedlings cannot be outplanted when their roots fill the container, then they must be transplanted into a larger container or bareroot bed. Holding-over polybag seedlings is not an option.

The polybag nursery system is not likely to change in the near future, and it's unrealistic to think that we can make the entire world change over to hard plastic containers and artificial growing media. However, by incorporating these few recommendations into the polybag system and working on other improvements, seedling quality and resultant outplanting performance can increase dramatically.

Volunteer Nursery Assignments

Volunteers in Overseas Cooperative Assistance (VOCA), an international people-to-people organization, is seeking volunteers with forest and conservation nursery experience to serve on assignment with local community-based organizations. VOCA is committed to conserving the natural resource base while improving the economic livelihood of rural-based communities. Projects develop from requests for technical assistance submitted by local organizations to VOCA's 24 offices worldwide. The use of VOCA volunteers brings technical expertise into the community thus enhancing stewardship of available resources. Assignments last from two weeks to three months, averaging one month each. Volunteers contribute their time and expertise while VOCA covers all related expenses including travel, lodging, meals, and work-related costs. To receive an application, call or write Mark Zinsky who is their natural resource specialist:

VOCA
50 F Street, Suite 1075
Washington, DC 20001
USA
Tel: 202-383-9760

Cultural Perspectives

What is a Soil Management Plan, and Why Would You Want One? -Part II

The first part of this article appeared in the January, 1995, issue; it covered the parts of a Soil Management Plan and how to organize the soil survey. This second part discusses how to conduct the survey and then analyze the results. The third and final part of this series will appear in the January, 1996, issue of FNN, and will show how to assess the production potential of your nursery soil and implement the Management Plan.

Conducting the survey. Because the soil sampling process causes considerable disturbance, it is usually best to only sample blocks that are in the fallow year of the crop rotation. The location of the sample points is established by laying out the sampling grid in a block based on the detailed soil map that you developed **(Figure C)** - see January, 1995, issue of FNN for details.

The actual survey will consist of two parts: on-site sampling, and collecting samples for laboratory analysis. Readily apparent soil characteristics, such as depth and texture, can be determined during the on-site sampling, whereas other characteristics, such as pH and mineral nutrient levels, must be measured later in a soils laboratory. Using the sampling criteria that you have identified as potentially limiting factors, decide whether they can be measured during the on-site sampling or laboratory analysis. When we surveyed the Colorado State Nursery in Ft. Collins, CO we identified 5 factors as most important:

1. *Soil depth*—measured during on-site sampling

2. *Soil texture*—measured during on-site sampling

3. *Soil reaction (pH)*—samples collected for laboratory analysis

4. *Electrical conductivity* (*EC)*—samples collected for laboratory analysis

5. *Calcium carbonate* ($CaC0_3$)-samples collected for laboratory analysis

The on-site sampling will require technical soils expertise, and unless the nursery has a person skilled in soil analysis on staff, it will be necessary to obtain assistance from a nursery soils consultant or soil survey personnel from the National Resource Conservation Service or State University Extension Service. The sampling procedure consists of digging a soil pit or auger hole at each location on the soil sampling grid. The soil pits

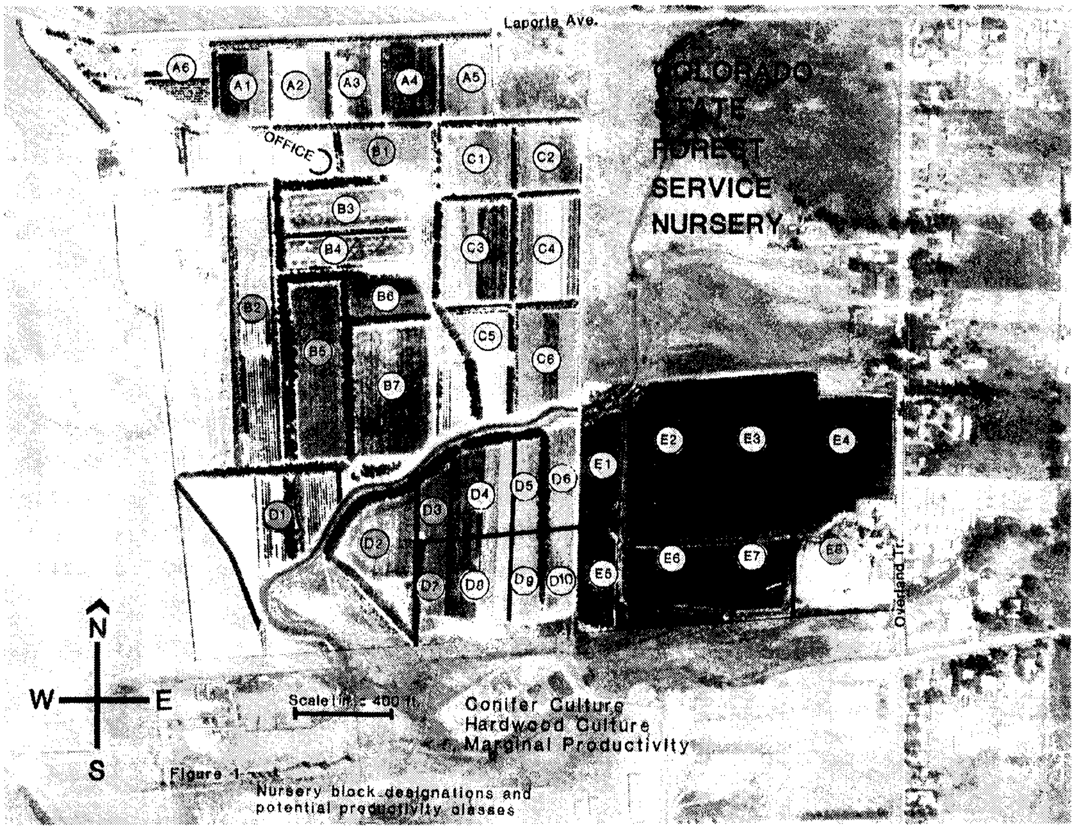


Figure C: A detailed map of the nursery blocks is the first step in the soil survey

must be deep and large enough to allow the manual determination of physical soil properties, such as texture and presence of compacted soil layers **(Figure D).** This information is recorded on a survey sheet for each location in the sampling grid.

After the on-site measurements have been made, soil samples are collected from the plow in each pit. Depending on your sampling criteria, subsoil sampling may also be required. A composite soil sample is recommended to provide an average for each sampling location, and to keep down the costs of laboratory analysis. Collect five separate samples from around the pit, place them in a bucket, mix the soil thoroughly, and then draw one soil sample and place it in a sack. Make sure that the sample bags are properly labeled with the proper pit location and use pencil or indelible ink, so that the labels do not fade or smear. The samples should be stored in a safe location until they can be shipped to the laboratory. One handy procedure is to place the samples in an insulated cooler; this both protects them and allows them to be easily carried around the field.

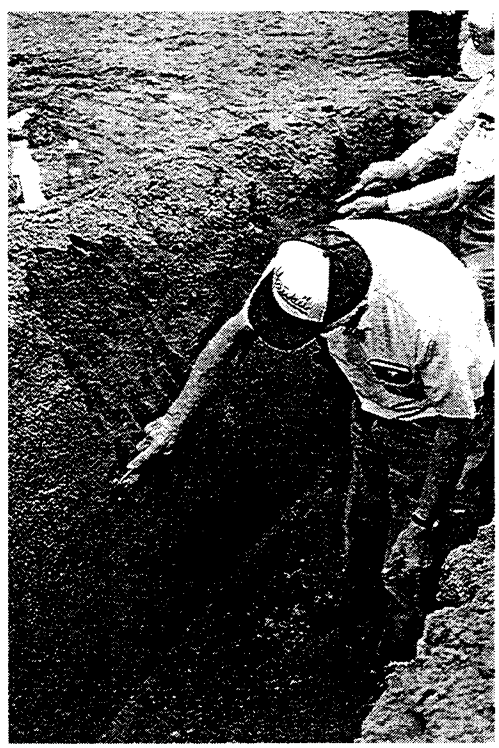


Figure D: Large soil pits made with a post-hole auger or backhoe make close examination much easier.

Laboratory Soil Analysis. There are many soil testing laboratories that do agricultural soil testing, but only a few that are experienced with forest nursery soils. Each laboratory has its own analytical procedures for testing soils and the results of some of the tests vary with the type of procedure (e.g. organic matter) or extracting solution (e.g. phosphorus) that is used. A set of standard laboratory procedures for testing forest nursery soils has been developed by a panel of experts (Bickelhaupt and others 1983). When contacting analytical laboratories, nursery managers should insist that these standard soil tests are used. Otherwise, it is impossible to compare tests results with published standards and those of different nurseries. The exact cost per sample will vary with the specific soil tests that are requested, but can range from $5 for a simple pH test, to $50 or more for a complete mineral nutrient analysis.

Analyzing Soil Survey Results. The next step is to analyze the data collected during the on-site survey, along with the results of the laboratory analysis, and determine how they affect seedling growth (Table 1). Each of these factors is analyzed against some set of ideal standards, which must be

Table 1. The results of the on-site sampling and laboratory analysis, such as these for the Colorado State Forest Service Nursery (CSFS) in Ft. Collins, CO, should be tabulated by nursery block for detailed analysis.

Nursery Block	Gross Acres	Depth (in)	Textural[1] Class	pH (units)	E.C. (mmhos)	$CaC0_3$ (%)	O.M. (%)	C.E.C (m.e.)
A-1	1.7	18+	Fi Sa Lo	6.2	1.0	---	1.7	11.4
A-2	1.6	12-18	Fi Sa Lo	7.4	1.3	---	1.7	10.6
A-3	1.7	10-11;	Fi Sa Lo	8.0	1.2	5.6	1.9	15.4
A-4	1.7	10-16	Lo	7.8	1.4	2.5	1.9	13.5
A-5	1.6	8-18	Lo	8.0	1.4	6.1	2.0	15.7
A-6	1.0	18+	Sa Lo	6.6	0.8	---	1.2	9.6
B-1	1.5	16-18	Gr Lo	8.0	0.8	1.9	1.7	9.6
B-2	2.2	Stool Blocks-Out of Production						
B-3	3.7	16-18	Fi Sa Lo	6.3	1.3	---	1.7	11.9
B-4	1.4	14-18	Lo	7.0	0.8	---	1.8	12.5
B-5	3.1	Stool Blocks-Out of Production						
B-6	1.2	10-18	Sa Lo	6.6	0.8	---	2.0	11.()
B-7	3.9	12-16	Lo	7.4	1.0	---	2.1	14.2
C-1	1.7	18+	Fi Sa Lo	7.0	1.1	---	2.0	11.5
C-2	1.4	10-16	Lo	7.8	1.3	3.1	2.1	13.4
C-3	2.4	14-18	Sa Lo	7.0	0.5	---	2.1	11.6
C-4	2.4	10-18	Sa Lo	6.6	0.6	---	1.6	11.1
C-5	1.5	16-18	Fi Sa Lo	7.2	0.6	---	2.2	11.5
C-6	2.2	18+	Fi Sa Lo	7.3	0.7	---	2.4	13.4

[1]Textural Class Code: Sa Lo=Sandy loam; Fi Sa Lo = Fine sandy loam; Lo = Loam; Cl Lo= Clay loam; Gr Lo = Gravelly loam

appropriate for the local climatic and edaphic conditions. The standards in **Table 2** were developed for soils in the Interior Western US, where the dry climate causes soluble salts to accumulate in the surface soil horizons; this results in higher pH and EC values than would be found in soils with higher rainfall. Other soil standards should be used for nurseries with more acidic soils-for an example, see Youngberg (1984) and van den Driessche (1984)

For the purposes of discussion, let's look at one physical factor (soil depth) and one chemical factor (pH) for the CSFS nursery:

Soil Depth—Arable soil depth is important for the development of a good root system, as well as for standard soil tillage. Seedling size specifications typically call for a root system that is 8-10 inches long; therefore, the surface soil must be at least 12 inches deep to permit proper seedling culturing and lifting. Ideally, nursery soils should be from 1-2 feet deep **(Table 2),** which allows good soil tillage without the possibility of bringing up undesirable material from the subsoil. Soils at the Colorado State nursery are typically high in $CaC0_3$ **(Table 1),** which raises the pH to 7.0 or above, and causes mineral nutrient availability problems with many forest species. The presence of free $CaC0_3$ in surface soils is a unique characteristic of nurseries in semi-arid climates where evapotranspiration exceeds precipitation, and calcium is recurrently wicked to the soil surface by the strong evapotranspirative forces. In wetter climates, $CaC0_3$ is dissolved by rainfall, and is leached from surface soils along with other bases, resulting in more acidic soil conditions. Subsoils are even higher in $CaC0_3$ under arid conditions, so problems can result where calcareous subsoils are mixed with surface soils during deep cultivation or land leveling. Unfortunately, this often occurs during nursery soil development, and subsequently, nursery mangers have difficulty understanding and managing the wide variation of soil properties between different blocks **(Table 1).**

Table 2. Soil productivity targets for forest and conservation nurseries in the Interior West of the US

Physical and Chemical Properties	**Range**	**Units**
Soil Depth		
minimum	>12	inches
optimum	12-24	inches
Texture - loamy sands or sandy loams		
conifers	20-25	% silt + clay
hardwoods	25-35	% silt + clay
pH		
most conifers	5.5-6.5	-
hardwoods and junipers	6.5-7.5	-
Electrical Conductivity (E.C.)		
conifers	<2.0	mmhos/cm
hardwoods	<4.0	mmhos/cm
Organic Matter (O.M.)[1/]	2.0-5.0	
Cation Exchange Capacity (C.E.C.)	7-12	m.e./100g
Calcium Carbonate Equivalent ($CaC0_3$)	0	

The CSFS soil survey revealed that surface soil depth should not be a serious problem in most of the nursery blocks, although Block A-6 shows a minimum 8 inches, and several others are only 10 inches deep **(Table 1).** Therefore, ripping or deep plowing should be avoided in these blocks whenever possible.

Soil Reaction (pH) - The ideal soil pH for tree seedling nurseries varies with species from 5.5 to 6.5 for most conifer seedlings, to a 6.5 to 7.5 range for hardwoods and junipers **(Table 2).** Although most nursery managers are quite concerned about soil pH levels, soil pH is not as critical as some other chemical indexes, because the actual acidity or alkalinity in most nursery soils is not extreme enough to be directly damaging to tree seedlings. The actual pH reading merely gives an indication of the chemical action of other ions or minerals in the soil, such as CaC03 in alkaline soils. From a management standpoint, the indirect effect of pH on mineral nutrient availability and soil pathogens is most important.

At the Colorado State Nursery, the soil pH varies widely between different nursery blocks, ranging from a low of 6.2 in A-1 to a high of 8.0 in blocks A-3 and others **(Table 1).** This extreme variation of almost 2 pH units within one field emphasizes the need for a good soil management plan. The overall objective of pH management at the Colorado State Nursery is to gradually lower soil pH to the desired range over a long period of time. This gradual acidification should increase the availability of most nutrients, particularly phosphorus and iron, and also decrease the incidence of damping-off disease.

The management of soil pH should be done by nursery block, taking into consideration the planned use for that block. Blocks with lower pH values (less than 7.0) should be reserved for conifer seedling production. Most hardwoods and the junipers are more tolerant of alkaline soils, and they can be produced on soils of pH 7.0-8.0. For maximum nutrient availability, these nursery soils will require some degree of acidification. Lowering soil pH is a very slow process; however, it usually requires several crop rotations for any significant change. Acidification should be done in two phases: acidifying fertilizers should be used during seedling production, and flaked or prilled sulfur can be added during the fallow period. In nursery blocks that contain free $CaC0_3$ **(Table 1),** soil pH cannot be appreciably lowered until the $CaC0_3$ is oxidized to gypsum (Ca $S0_4$), which is soluble enough to be leached from the soil profile.

The presence of $CaC0_3$ emphasizes the need for a site specific soil survey that identifies potentially limiting factors that can be used as critical sampling criteria. If soil pH was surveyed without any attention to this often underappreciated soil factor, it would be impossible to develop an effective soil management plan.

In the January, 1996, issue, we will further discuss how to use this survey data to assess the production potential of your nursery soil block-by-block, and implement a comprehensive Soil Management Plan.

Sources:

Bickelhaupt, D.H.; Davey, C.B.; White, E. H. 1983. Laboratory Methods for Forest Tree Nursery Soil Analysis. Misc. Publ. No. 2. Syracuse, NY: State University of New York, College of Environmental Science and Forestry. 16 p.

Landis, T.D.; Boyer, D.S. What is a soil management plan and why wouldyou want one? Escanaba, MI: Northeastern Area Nurseryman's Conference and Nursery Soil Workshop; 1992 July 29-30. Portland, OR: USDA Forest Service, Cooperative Forestry. 12 p.

Meinert, D.; Viele, D.; Knoernschild, T.; Moore, M. 1994. Soil management plan for the G.O. White State Forest Nursery. In: Landis, T.D. tech. coord. Proceedings: Northeastern and Intermountain Forest and Conservation Nursery Associations. 1993 August 2-5; St. Louis, MO. General Technical Report RM-243. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station: 9-18.

van den Driessche, R. 1984. Soil fertility in forest nurseries. IN: Duryea, M.L.; Landis, T.D. eds. Forest Nursery Manual: Production of Bareroot Seedlings. Boston: Martinus-Nijhoff/Dr. W. Junk Publ. 75-80.

Youngberg, C.T. 1984. Soil and tissue analysis: tools for maintaining soil fertility. IN: Duryea, M.L.; Landis, T.D. eds. Forest Nursery Manual: Production of Bareroot Seedlings. Boston: Martinus-Nijhoff/Dr. W. Junk Publ. 75-80.

Botrytis-New Management Strategies for an Old Pest

Grey mold caused by the fungus (Botrytis cinerea) is one of the most common and destructive pests of forest and conservation nurseries. Although it can also be a serious problem in bareroot nurseries in wetter climates, Botrytis blight is best known as a foliage blight and stem canker of container seedlings (Figure E). If left untreated, the fungus thrive at cold temperatures, and can develop into a serious storage mold. Botrytis is a common fungus, so spores are always present in the nursery environment. The fungus typically infect weak or damaged foliar tissue when free moisture is present. In fully-enclosed propagation structures, these conditions develop during the late summer and fall when seedling crown canopies close, and the lower foliage is shaded out and begins to senesce. At the same time, night temperatures are lowered for the Hardening Period, which results in moisture condensation on the foliage, especially after irrigation.

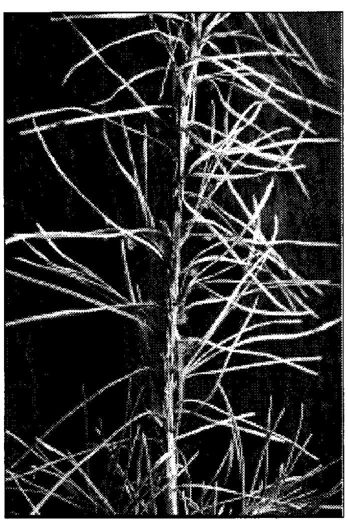
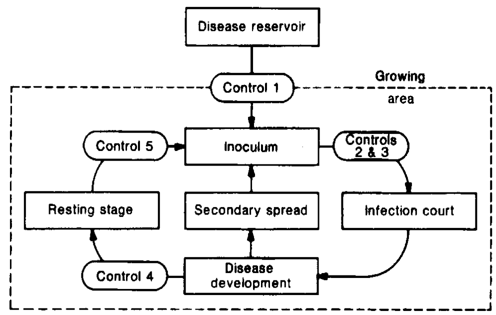


Figure E: The grey mold fungus (Botrytis cinerea) produces abundant airborne spores that can quickly spread the disease.

The disease cycle of Botrytis is very short, and inoculum levels can build up quickly in the favorable container nursery environment. The secret to successfully controlling Botrytis is to develop an integrated program of both cultural and chemical control measures (Figure F).

Many growers have found that if they use preventative cultural controls and are vigilant, they can almost eliminate the need for chemicals.



Disease Control Techniques

1. Keep surroundings clean of weeds
2. Apply protectant fungicides
3. Use cultural techniques to keep foliage dry
4. Rogue out diseased seedlings
5. Clean and disinfect growing area between crops

Figure F: An integrated pest management (IPM) program for grey mold consists of both cultural (1,3,4,5) and chemical (2,5) control measures

Cultural Management - The first level of defense is to keep the inoculum level of Botrytis spores low by removing dead and dying seedlings from the propagation area, and eliminating weeds from around the nursery **(Figure F-Control 1)**. The second phase is to use protectant fungicides when warranted **(Figure F-Control 2)**. The next step is to keep the seedling foliage dry, as much as is possible, by irrigating early in the day and venting immediately after irrigation. Injecting surfactants into the irrigation water causes the foliage to drip dry faster. Under the bench heating, ventilation is very effective, but horizontal airflow (HAF) systems, and even portable fans, will help. Some innovative growers use portable leaf blowers **(Figure F-Control 3)**. The fourth level of defense is to teach your crew to constantly keep an eye open for any evidence of the grey, cottony markings of Botrytis **(Figure E)**, which often develops on suppressed foliage or dead seedlings. As soon as they find a disease pocket, then the infected seedling should be removed and the area spot-treated with a fungicide **(Figure F-Control 4).** The final phase of the control program is to keep the propagation environment clean between crops and to sterilize used containers **(Figure F-Control 5).**

Chemical controls—Fungicides can be used as either protectants or eradicants for controlling Botrytis; of the latter group, the chlorothalonil products are the most effective. Recent research has shown that a tank mix of half-strength chlorothalonil and half-strength mancozeb provides both good protection and effective eradication (Powell 1995). Unfortunately, the Botrytis fungus has developed resistance to many common fungicides, so the best plan is to rotate fungicides between applications. Although they have the longest Restricted Entry Intervals, the mancozeb, copper, and chlorothalonil fungicides are less likely to promote the development of resistance strains **(Table 3).**

Sources:

Landis, T.D.; Tinus, R.W.; McDonald, S.E.; Barnett, J.P. 1990. The Biological Component: Nursery Pests and Mycorrhizae, Vol. 5, The Container Tree Nursery Manual. Agric. Handbk. 674. Washington, DC: USDA Forest Service. 171 p.

Powell, C.C. 1995. Botrytis: new management strategies for an old blight. Nursery Management & Production 11(5): 58-59.

Table 3. Comparison of current Botrytis fungicides (Powell 1995)

Class/Type	Fungicide	Restricted Entry Interval (hrs)	Resistance Likely?
chlorothalonil	Daconil2787®	48	No
	Thalonil®	48	No
mancozeb	Protect T/O®	24	No
	Dithane T/O®	24	No
	Fore®	24	No
copper	Phyton-27®	24	No
	Kocide®	48	No
thiophanate	Cleary's 3336®	12	Yes
	Domain®	12	Yes
dicarboximide	Chipco 26019®	12	Yes
	Ornalin®	12	Yes
	Botran®	12	Yes

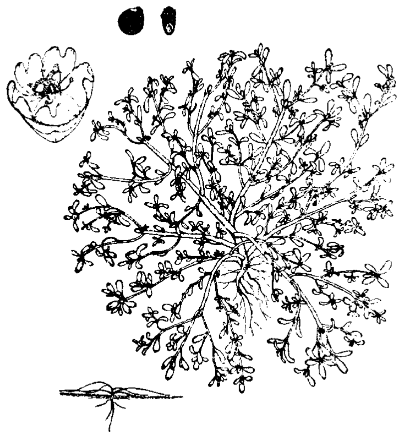
If You Can't Beat Them, Eat Them

Weeds are a continual headache to nursery managers, and some species seem to defy all attempts at control. Common purslane (*Protulaca oleracea*—Figure G) is persistent in nurseries because it flowers quickly, produces billions of tiny seeds, and each leaf segment can root if not removed from the seedbed. A new weapon in the IPM arsenal could be consumption. Nutritionists report that the leaves of purslane have more vitamin C than spinach, and is rich in omega-3 fatty acids and antioxidants, making it an attractive health food.

Source:

Anonymous. 1994. Abstract 8780. Horticultural Abstracts 64(11):1162.

Figure G: Purslane (Portulaca oleracea) is a persistent weed that reproduces both vegetatively and by seed.



Eco-friendly herbicides

The phenomenal success of Roundup® (glyphosate) herbicide can be traced to the fact that it is not only very effective, but it safe to use and not a threat to the environment. Even some organic farmers who normally shun all chemical pesticides have begun to experiment with it as part of an IPM program. Now, another eco-friendly herbicide has hit the market. Finale® (WipeOut® in Canada) has very similar properties to Roundup®-acting by disrupting the metabolism of weeds, not poisoning them. The active ingredient is glufosinate-ammonium, which inhibits the production of an enzyme leading to toxic accumulation of ammonium within treated plants. When Finale® is applied to the leaves, browning becomes visible within 2 days and the weed is dead in a week. It acts fastest in full sunlight, and becomes resistant to rain only four hours after application; but more importantly, for IPM reasons, is its advertised safety for humans and the environment. Glufosinate-ammonium has fairly low toxicity rating for humans and animals, and becomes inactive when it hits the soil, where it biodegrades rapidly, leaching only 15 cm (6 in). This means that it can be used as a preplant, with wick applicators, or with shielded sprayers between the rows. I'm not sure about the status of EPA registration for nursery crops, but it sounds like it's worth looking into.

Source:

Anonymous. 1995. HortIdeas 12(2): 22-23

New Natural IPM Products

Gro-Mate® is a natural humate formed from the decomposition of organic matter, which helps plants resist attack by the *Pythium* fungus. Humate Canada Ltd. lists the following associated advantages: increases the canon exchange capacity of the growing medium and stimulates beneficial microbe activity in the rhizosphere, resulting in more and larger roots. Research at the Alberta Tree Nursery and Horticultural Centre in Edmonton found that seedlings of 6 conifers showed increased height, caliper, and shoot-to-root ratio compared to a control. For more information, contact Bob Cantwell at Tel: 403-246-1688.

Yuccah® Concentrate is derived from the *Yucca schidigera* plant which grows in the deserts of western North America and is advertised as a "safe, natural surfactant and biological catalyst". Yuccah® is a water soluble liquid that, when injected in standard irrigation or added to spay mixes, improves the spray coverage of aqueous solutions and aids in the penetration of soluble fertilizers and pesticides. Being completely nonphytotoxic to plants, even when overapplied or applied in hot weather, it provides an alternative to inorganic chemical surfactants which can burn sensitive seedling foliage, especially when applied under high stress conditions. Yuccah® is compatible with all soluble fertilizes and pesticides, and stays in solution without agitation, but requires a antifoam agent. This product would be a welcome to IPM programs, because it is advertised as being nontoxic to humans and animals; therefore, it is exempt from worker safety and pesticide regulations. For more information, contact:

Plant Health Care, Inc.
440 William Pitt Way
Pittsburg, PA 15238
Tel: 412-826-5448
Fax: 412-826-5445

Environmental Control Equipment

One of the greatest advantages of growing seedlings in a container nursery, is the ability to control all the environmental factors that are potentially limiting to growth. In fully-controlled propagation. structures, such as greenhouses, growers rely on environmental control systems to monitor and regulate all the climatic variables. There are three different types of environmental controls that vary considerably in sophistication and price **(Table 4).**

Discrete and dedicated controls. These single-function controllers (e.g. thermostats) regulate one piece of equipment with a simple ON/OFF switch. Currently, around 90% of existing greenhouses still rely on mechanical thermostats (Greenhouse Manager 1994a). One common thermostat contains a bimetallic strip that is sensitive to changes in temperature and activates a switch when it senses a change. Thermostats are used to regulate temperature control equipment, such as: heaters, fans, and vents **(Table 4).** Other types of discrete and dedicated controls do not sense the propagation environment at all, but use time clocks to regulate irrigation solenoids, photoperiod lights, or carbon dioxide generators. They can operate independently or be linked in sequence. This redundancy of function means that if one device fails, the rest of the system keeps working. Discrete and dedicated controls are inexpensive, but must be calibrated routinely. Thermostats are particularly unreliable, and response varies from instrument to instrument, and can also change over time.

Analog and integrated controllers. A wide variety of controllers are available that can regulate many different environmental variables **(Table 4).** They use proportioning thermostats and other electric sensors to gather information from the propagation environment, and then rely on electronic logic circuitry to process this information, make decisions, and operate a single piece of environmental control equipment. Analog controllers are limited to a single sensor, and can control only one propagation environment (Ball 1991). Many are "hardwired systems", which means that they are not directly programmable, whereas others have limited programmability. Analog controllers can also be wired to activate alarm systems, such as when the temperature decreases past a set point.

Environmental controllers are commonly linked to provide multiple functions, and operate in stages to maintain the desired temperature by switching an increasing sequence of heating or cooling. For example, consider a situation in a greenhouse early in the morning. Neither the heating nor cooling is operating; the house is in "neutral". As the greenhouse heats up, the temperature reaches the first cooling setpoint and one of several fans comes on. If that gives sufficient cooling, nothing further happens, but if the temperature continues to rise and reaches the second cooling setpoint, a second fan comes on. If all of the fans are on, and cooling is still not adequate, then the pump comes on and begins circulating water through the wetwall and evaporative cooling-the third stage of cooling. As the greenhouse cools down, the sequence reverses. Heating stages consist of a sequence of burners and heat distribution fans.

Climate control computers. The computer revolution has radically changed the way in which the environment in propagation structures is controlled. Climate control computers use microprocessors to combine information from a variety of sensors and provide an integrated view of all factors in the propagation environment. Computers can sense and record climatic information from an outside weather station, as well as atmospheric or growing medium conditions within the propagation structure **(Figure H).** Climatic indexes, such as vapor pressure deficit, used to be difficult to monitor in operational nurseries, but this task is now possible with computers **(Table 4).**

Computers are essential in high-tech greenhouses to integrate all the various environmental control equipment. Instead of only switching a single piece of equipment on or off, climate control computers can modulate, which produces an infinite number of adjustments. They also compile and analyze the full complement of environmental data to make "intelligent" decisions. For example, during the winter, light sensors tell the climate computer that

Table 4. Features of the 3 types of environmental controls

	Type of environmental controls		
	Discrete/ dedicated	Analog/ integrated	Computer system
Functions			
Multiple sensors	No	No	Yes
Multiple structures	No	No	Yes
Proportional switching	No	Yes	Yes
Seasonal adjustments			
Clock time	Maybe	Maybe	Yes
Solar time	No	Maybe	Yes
Weather stations	No	Maybe	Yes
Record and store data	No	No	Yes
Programmable	No	Limited	Yes
Price range	$50-250	$800-1,600	$3,000-50,000+
Environmental factors*			
Temperature	Heaters	Heaters	Heaters
	Vents	Vents	Vents
	Fans	Fans	Fans
		Wet Wall	Wet Wall
		Heat Curtain	Heat Curtain
Humidity	Humidistat	Heat	Heat
		Vents	Vents
		Mist Nozzles	Mist nozzles
Light	Time Clock	Lights	Lights
		Shade curtain	Shade curtain
		Blackout curtain	Blackout curtain
Carbon dioxide	Time Clock	Yes	Yes
Water	Time Clock	Irrigation	Irrigation
		Mist nozzles	Mist nozzles
Mineral nutrients	Ratiometric	pH	pH
	Injector	Salinity	Salinity
			Nutrients

*Note that each environmental factor requires a separate piece of discrete/dedicated equipment or a separate type of analog control and these must be integrated. Source: Ball (1991), Mackenzie (1993).

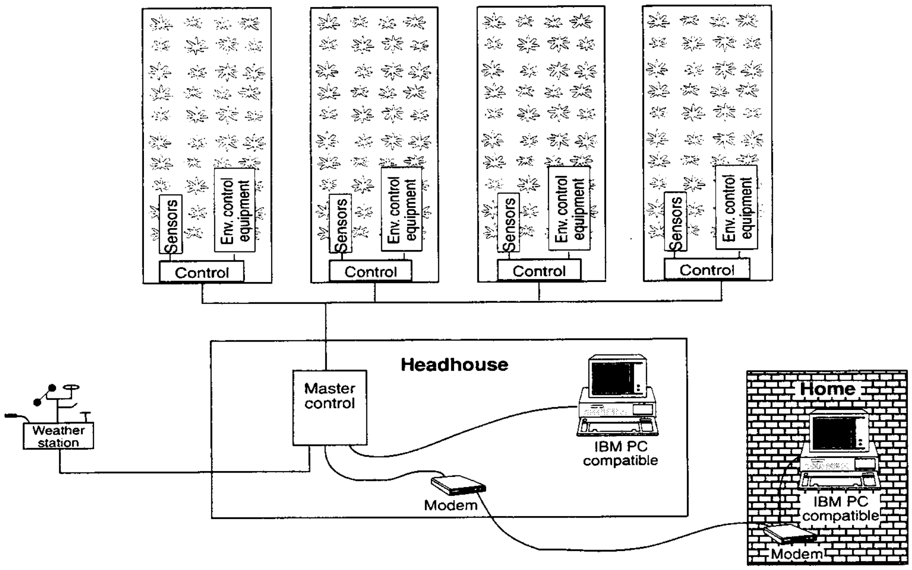


Figure H: Climate control computers monitor environmental conditions both inside and outside the propagation structures, and permanently record the data, and can be accessed from remote locations.

the sun is setting, therefore, the demand for heat can be anticipated before the temperature actually begins to drop. Increasing energy costs and concern about excess fertilizer runoff make computer control systems even more attractive. Documented energy savings can range from 15 to 30% for typical nurseries, and as high as 40 to 60% for high-tech greenhouses with all the latest equipment (Whitesides 1991).

A typical system consists of a central computer terminal, and individual controllers and alarms at different locations throughout the various propagation environments **(Figure H).** One terminal should be located in the headhouse so that personnel can instantaneously monitor all environmental factors in each propagation environment, as well as analyze stored data to compute trends and detect problems. Many growers also install computer terminals in their homes so that they can respond to potential problems without having to go to the nursery. One of the greatest advantages of climate control computers is that they are able to accurately record what really happens in the nursery so that this information can be used for troubleshooting and fine-tuning environmental control equipment. Computers also can be linked to a more sophisticated alarm system that can be redundantly programmed. With this technology, computers can often identify the location and nature of a problem, so that the grower is not needlessly bothered.

Nurseries with propagation structures larger than 2,000 m^2 (21,500 square feet) can usually justify computer control systems, which pay for themselves in 3 to 5 years (Mackenzie 1993). Computer systems come in many different models, offering a wide variety of different features. Developers should consult with other nurseries and suppliers to make sure that the system is well matched to their requirements. Maintenance is rarely a problem because replacement parts can usually be obtained by overnight courier, and companies offer specialist support by telephone.

Sources:

Argus Control Systems. 1990. Argus Control System Brochure, Sept. 19, 1990. White Rock, BC. 9 p.

Ball, G. J. 1991. Ball Redbook. 15th ed. West Chicago, IL: George Ball Publishing. 802 p.

Bartok, 1.W. Jr. 1993. Computers may help you determine your ideal greenhouse environment. Greenhouse Manager 12(4): 139.

Greenhouse Manager. 1994a. First step: electronic thermostats. Greenhouse Manager 12(11): 64-67.

Greenhouse Manager. 1994b. A look at environmental computers. Greenhouse Manager 12(11):69-71.

Landis, T.D.; Tinus, R.W.; McDonald, S.E.; Barnett, J.P. 1994. Nursery planning, development, and management, Vol. 1, The Container Tree Nursery Manual. Agric. Handbk. 674. Washington, DC: USDA, Forest Service. 188 p.

Mackenzie, A.J.G. 1993. Personal communication. White Rock, BC: Argus Control systems, Ltd.

Whitesides, R. 1991. Computers are a cost-effective way to maintain your competitive edge. Greenhouse Manager 10(2): 56-58,60,62,64.

Incorporating Basamid Fumigant

Dazomet, also known as Basamid Granular®, is a unique formulation for a soil fumigant. It is applied to the soil as a very fine white granule that converts to a gas when it encounters water. The fumigant activity results from the interaction of a mixture of different gases, the most common being methyl isothiocyanate. With the proposed ban of methyl bromide by the year 2001, many bareroot nurseries are testing alternative fumigants and basamid is a popular choice because it is already labeled for forest nurseries.

The basamid "micro-granules" are normally applied through drop-type spreaders, immediately incorporated into the soil, and physically contained with a roller, or water-sealed with irrigation. The depth of incorporation is critical to get a complete sterilization of the root zone because the fumigant gas only moves up. BASF, the manufacturer of basamid, recommends an incorporation depth of 12 inches to control root disease and states that application rates of 392 kg/ha (350 lbs/acre) are necessary to obtain a 95°lo kill of *Fusarium oxysporum,* one of the major soil pathogens in forest nurseries in the US.

Kelpsas and Campbell (1994) tested four farm implements to determine how well they mixed basamid into the soil: a standard double-gang disc, a harrow roller called Brillion cultipak, a disk and cultipak combination, and a Lely Roterra®, which is a power harrow. The disc, disk and cultipack, and Roterra treatments gave complete control of *Fusarium* and *Pythium* down to 10 cm (4 in), but only partial control down to 20 cm (8 in).

Another field trial in a Wisconsin state nursery compared three different rotary tillers and one spading machine to a 12 inch depth (Juzwik 1995). In preliminary trials using inert tracers, the average maximum incorporation depth was 7 inches for two tillers, and 9 inches for the third. The spading machine **(Figure I)** resulted in much more uniform distribution of tracers through the depth profile than the tillers, and also achieved deeper incorporation to 25 cm (10 inches). Dazomet trials were then conducted using two rates, 286 and 571 kg/ha (255 and

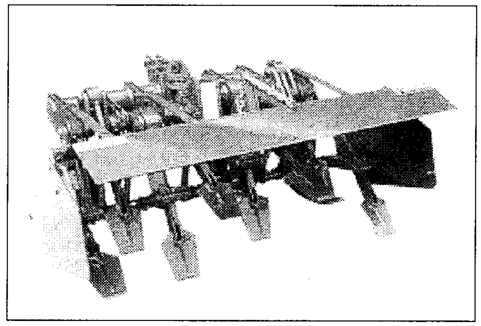


Figure I: Spading machines have provided the best incorporation of Basamid micro-granules (courtesy of J. Juzwik)

510 lbs/acre), and fumigant activity was evaluated through the soil depth profile to a depth of 30 cm (12 in). Fungal populations of *Fusarium* and *Cylindrocladium* and lettuce seed germination bioassays confirmed the tracer results proving that the spading machine gave biocidal activity to the greatest depth. A second chemical/tracer trial is scheduled for another nursery for August 1995 to confirm these preliminary tests.

Sources:

Juzwik, J. Personal communication. St. Paul, MN: USDA Forest Service, NCFES.

Kelpsas, B.R.; Campbell, S.J. 1994. Influence of mechanical incorporation method on dazomet distribution in conifer nursery soil. Tree Planters' Notes 45(2): 53-57.

Landis, T.D.; Campbell, S.J. 1989. Soil fumigation in bareroot tree nurseries. IN: Landis, T.D. tech. coord. Proceedings, Intermountain Forest Nursery Association. General Technical Report RM-184. Ft. Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station: 13-28.

Shutterbox Feeders

The simplest and least expensive seeder for containers is the shutterbox, a rectangular box with a seed reservoir at one end and a seeding frame at the other **(Figure J).** The seeding frame corresponds to the outside dimensions of the container block or tray, and contains a bottom plate with a grid of holes that correspond to the pattern of cavities in the container. This means that a shutterbox is custom built for a specific type of container and if different container types need to be sown, then a shutterbox will have to be constructed for each. The top layer of the seeding frame is a shutter with holes of the same pattern as the bottom plate, but offset to the side. The holes in the shutter are drilled just large enough to hold the number of seeds to be sown, usually two to six. Different shutters are needed to sow a different number of seeds per cavity or for another type of seed.

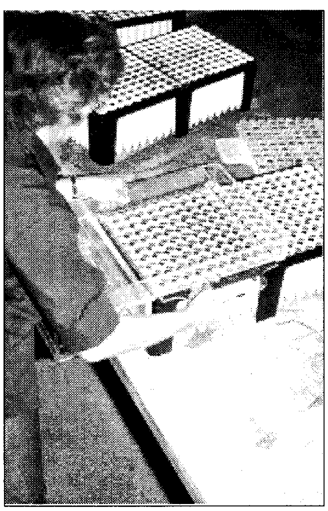


Figure J: Shutterboxes are an inexpensive and easy way to sow seeds into bock containers

To operate the shutterbox, the operator hand-sweeps seed from the reservoir onto the shutter, making certain that each hole is filled. Excess seed is swept back into the reservoir. When the shutter is moved laterally so that its holes are aligned with

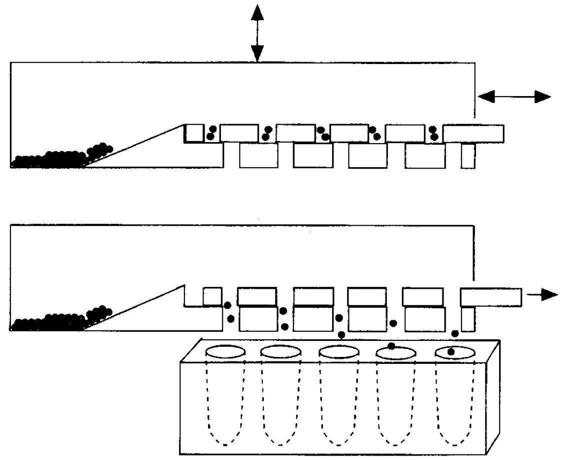


Figure K: Shutterboxes are custom-made for each type of container and sow multiple seeds when the shutter is moved laterally.

those in the bottom plate, the seeds drop into the container **(Figure K).** Operation of a shutterbox requires practice, but experienced workers can achieve acceptable seeding rates with this simple device. They work best with roughly spherical seeds, like those of pine species, and will jam if seeds are dirty.

Shutterboxes can be custom-made of wood, metal, or plastic, and also are available commercially. In fact, Eric Stuewe is looking for some growers who would like to test a shutterbox that he is thinking of marketing. If interested, contact Eric at:

Stuewe and Sons, Inc.
2290 SE Kiger Island Drive
Corvallis, OR 97333-9461 USA
Tel: 503-757-7798
Fax: 503-754-6617

Source:

Landis, T.D.; Tinus, R.W.; McDonald, S.E.; Barnett, J.P. 1994. Nursery planning, development, and management, Vol. 1, The Container Tree Nursery Manual. Agric. Handbk. 674. Washington, DC: USDA, Forest Service. 188 p.

Machine Vision

The wages paid for grading, counting, and handling seedlings during the harvesting operation can account for about one-third of the total production cost in a bareroot nursery. It has been documented that a worker on the packing line can grade a seedling every 1 to 3 seconds with an error rate of 7 to 8 %. Machine vision is a new technology that is being widely used to count and grade other types of agricultural products. Since the late 1980's, the Missoula Technology and Development Center has been working with researchers at Oklahoma State University to develop a Machine Vision System for counting and measuring bareroot seedlings on the grading belt **(Figure L).** This system has been operationally tested at the J. Herbert Stone Nursery in Medford, Oregon, and the results show that variation in seedling dimension measurements was better than manual grading for most attributes, and also allowed the calculations of other useful morphological indices **(Table 5).** The process should work even better for container seedlings. The next step is to expand the capability of Machine Vision to include color into the grading evaluation, so that insect and disease damage, and other types of injury can be detected. In the near future, nursery workers may only have to separate the bareroot seedlings, or extract the container seedlings and place them on the grading belt where machine vision can do the rest. The potential for this new technology is exciting and the latest developments will be reported at the regional nursery meetings.

Source:

Rigney, M.P.; Kranzler, G.A. 1994. Machine vision inspection system for packing house quality control. IN: Landis, T.D.; Dumorese, R,K. tech. coords. National Proceedings, Forest and Conservation Nursery Associations. Gen. Tech. Rep. RM-257. Ft. Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station: 182-191.

Lowman, B.J. 1995. Seedling Grading Machine Project, No. XE52E62. Missoula, MT: USDA Forest Service, FY1995 Technology & Development Project Status Mid-Year Report.

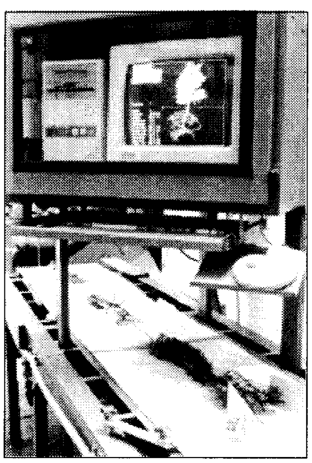


Figure L: Machine vision equipment can count and measure seedlings as they pass on the grading belt (courtesy of Rigney and Kranzler)

Table 5 - Comparison of the precision of machine vision to manual grading (modified from Rigney and Kranzler)

Morphological Attribute	Units	Machine Vision CV (%)	Manual Grading CV (%)
Stem Diameter	mm	1.4	6.6
Shoot Height cm	2.7	3.0	
Root Length	cm	6.6	4.8
Sturdiness	ratio	3.9	7.3
Shoot: Root	ratio	3.5	Not Done
Fine Roots	%	6.0	Not Done
Root Area	cm^2	2.5	Not Done
Shoot Area	cm^2	1.8	Not Done

CV = Coefficient of variation which is the standard error of the mean divided by the treatment mean.

Health and Safety

You know you've been at it too long when you start repeating yourself. Checking back through past issues of FNN, I found sections on sporotrichosis and carpal tunnel syndrome back in January and July of 1988. Well, these health and safety issues haven't gone away, but I'm not sure that they've gotten any worse either. What has gotten worse, and much more expensive, is the cost of managing them—primarily due to a recent flurry of Workers' Compensation Claims.

Sporotrichosis

This rather rare skin disease, which is caused by the fungus *(Sporothrix schenckii),* has been around since the turn of the century, but has recently been causing an increasing number of problems in forest and conservation nurseries. One epidemic of sporotrichosis cost over $11,000 in Worker's Compensation claims and associated expenses, and a recent outbreak among tree planters in Nebraska lead to a Natural Resource District being faced with a $75 million lawsuit. Many nursery managers have, or are considering, eliminating the use of sphagnum peat moss in their nurseries. A recent national directive from the USDA Forest Service Health and Safety Code Handbook stated that Forest Service nurseries should "not use soil amendments containing pathogenic microorganisms. This prohibition applies especially to fresh, nondecomposed sphagnum moss that is often infested with *S. schenckii.*

Is all this concern justified? Is the sporotrichosis fungus becoming more virulent, or is this just one more symptom of our litigious society?

The fungus causing sporotrichosis has been identified in many different types of organic matter that can normally be found around a nursery. Unfortunately, peat moss of the *Sphagnum* genus has been identified as the causal agent in several recent nursery-related cases of this disease. Although *S. schenckii* has never been isolated directly from a peat bog, it has been cultured from bales of bulk peat moss used for packing bareroot seedlings, and one study found the fungus in 2 out of 12 brands of commercial growing media. It has been reported that *S. schenckii is* most common in peat moss from the Lake States and Wisconsin in particular.

The fungus develops and spreads after the moss is processed. Storage of moss under warm, moist conditions allows the fungus to proliferate, and it apparently thrives in the moist environment that exists in nursery packing sheds. Clinical cases of sporotrichosis are relatively uncommon considering the number of people that are regularly exposed to sphagnum moss, but epidemics of sporotrichosis have been documented in several states including Mississippi, Florida, Vermont, and Oregon.

The most common form of sporotrichosis develops after the spores of the fungus are introduced into skin wounds. Punctures involving organic materials, such as thorns or splinters, are particularly . suspect. The hands or arms are most commonly affected first, and small painless skin blisters develop after several weeks **(Figure M).** *Many different things, including allergic reactions, can cause these symptoms, so you should only become concerned if the blisters are persistent, and do not respond to normal therapy.* The lesions may turn into a firm, movable subcutaneous nodule, and skin color often becomes pink or purplish. If left untreated, the disease can spread throughout the lymph system causing glands in the elbow or armpit to become swollen and sore.

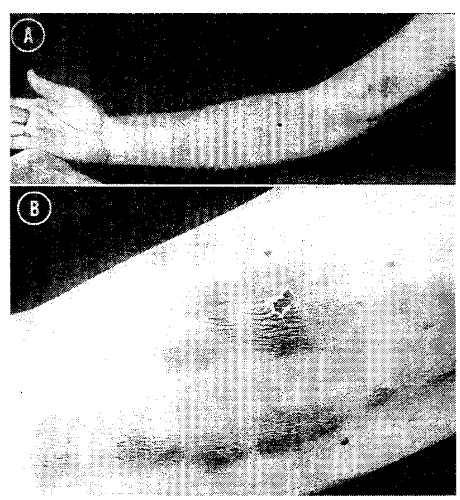


Figure M: The fungus causing sporotrichosis enters the skin through wounds and causes small blisters that do not respond to normal antibiotics (from Emmons and others 1970)

Regardless of these striking symptoms, sporotrichosis is not a serious disease if promptly diagnosed and treated. The problem is that many physicians are unfamiliar with the disease and may misdiagnose it. And, the longer the disease remains untreated, the longer and more complicated the treatment becomes. Sporotrichosis can be cured with oral doses of potassium iodide or antibiotics for advanced cases, and the treatment must continue well past the time that all symptoms have disappeared.

Both nursery workers and tree planters must be aware of sporotrichosis, because many of the most recent cases involved people handling seedlings after they left the nursery. This incidence, and especially the severity of this disease, can be eliminated by some rather simple precautions:

- Make discussions about sporotrichosis a regular part of nursery safety sessions, especially before lifting and packing season, container filling operations, and other times when workers will be in frequent contact with peat moss and other organic materials.

- Buy peat moss in waterproof bags, and only order enough for immediate needs, storing it under dry conditions. Keep all moss storage and work areas as clean and dry as possible.

- Workers in contact with peat moss should wear clothing that minimizes the chances of skin punctures and subsequent infection. Gloves and long-sleeved shirts are recommended. Basic hygiene will greatly minimize the chances of infection, so wash hands and arms thoroughly after exposure to peat moss and treat any skin wound with a disinfectant. Exposed workers should inspect their hands and arms daily and report any suspicious infections immediately.

- Information about the risk of sporotrichosis also should be provided to nursery customers, perhaps as part of seedling handling instructions.

I personally believe that there is little justification to ban the use of *Sphagnum* peat moss since nursery workers are regularly exposed to soil and a wide number of other organic materials which could harbor the sporotrichosis fungus. Fresh *Sphagnum* moss has many desirable properties for packing bareroot seedlings (low pH, high water-holding capacity, good aeration), and processed *Sphagnum* peat is the principal component of growing media for container seedlings. Serious cases of sporotrichosis could be greatly reduced if a few simple precautions are followed.

Sources:

Anonymous. 1987. Sporotrichosis, a skin disease caused by the fungus Sporotrichum schenckii. Ornamentals Northwest Newsletter 11(3): 8.

Emmons, C.W.; Binford, C.H.; Utz, J.P. 1970. Medical mycology. Philadelphia: Lea and Febiger. 508 p.

Kenyon, E.M.; Russell, L.H.; McMurray, D.N. 1984. Isolation of Sporothrix schenckii from potting soil. Mycopathologia 87: 128.

McDonough, E.S.; Lewis, A.L.; Meister, M. 1970. Sporothrix (Sporotrichum) schenckii in a nursery barn containing Sphagnum. Public Health Reports 85(7): 579-584.

Padhye, A.A.; Ajello, L. 1990. Sporotrichosis - an occupational hazard for nursery workers, tree planters, and orchid growers. American Orchid Society Bulletin 59(6): 613-616.

Powell, K.E.; Taylor, A.; Phillips, B.J.; Blakey, D.L.; Campbell, G.D.; Kaufman, L.; Kaplan, W. 1978. Cutaneous sporotrichosis in forestry workers: epidemic due to contaminated Sphagnum moss. Journal of the American Medical Association 240(3): 232-235.

Scholtes, JR. 1994. Letter to Forest Supervisor, Rogue River National Forest about Health and Safety Code Handbook (Oct. 14, 1994: File 6700). Central Point, OR: USDA Forest Service, J. Herbert Stone Nursery. 3 p.

Skilling, D.D. 1983. Sporotrichosis - a disease hazard for nursery personnel and tree planters. Tree Planters' Notes 34(4): 8-9.

Carpal Tunnel Syndrome

Repetitive strain injuries, of which carpal tunnel syndrome (CTS) and tennis elbow are the best known, afflict athletes, musicians, computer users, and workers who perform the same motion for extended periods of time. Unfortunately, some common nursery tasks, such as extracting container seedlings or grading bareroot seedlings, have lead to an outbreak of repetitive strain incidents in forest and conservation nurseries in recent years. CTS in particular has been the cause for many injuries and resultant Worker's Compensation Claims. In fact, these claims have been so numerous and costly that some nurseries have had to convert from salaried employees to contract workers in the packing shed.

Exactly what is carpal tunnel syndrome? The carpal tunnel is a 2-3 cm long canal through the wrist through which 9 finger tendons and the median nerve pass **(Figure N).** CTS is a repetitive strain injury caused by compression of the median nerve. Symptoms include a numbness and/or burning pain in the hand and wrist, as well as the thumb and first three forgers. These symptoms are most noticeable at night. In extreme cases, permanent nerve damage occurs, causing irreversible muscular weakness and wasting.

Everyone seems to agree on what the symptoms for CTS are, and what causes them; but that's where the agreement ends. Specialists disagree on the best way to diagnose CTS, what causes it, and how to treat it.

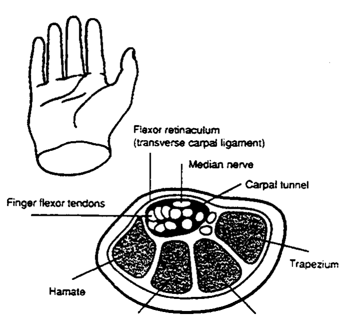


Figure N: Carpal tunnel syndrome results from pressure on the median nerve which passes through the wrist (from Oliver and Rickards)

Diagnosis—Diagnosis of CTS is made by a combination of symptoms, patient history, and diagnostic testing. Nerve conduction studies (NCS) can detect a slowing of the sensory conduction velocity through the median nerve, and these tests are considered by many specialists to be the best single diagnostic factor. Unfortunately, the National Institute for Occupational Safety and Health (NIOSH) of the US Department of Health and Human Services does not require an abnormal NCS for a compensable diagnosis, and some researchers have concluded that many CTS cases have been misdiagnosed in the past. They point out that many doctors rely too much on subjective symptoms, rather than objective test results, and therefore misdiagnose transient muscoskeletal aches and pains as CTS. In studies of Workers' Compensation Claims, they found a major discrepancy between subjective CTS symptoms and NCS tests-50% of the patients in one study did not have an abnormal NCS.

Causes and Risk Factors—There is also controversy over the causes of CTS and the associated risk factors. One study found that up to 47% of all CTS cases could be attributed to workplace factors. Some of these risk factors include doing tasks involving hand and wrist movement which have high repetition and force, those that require awkward wrist positions or exposure to vibration. Other researchers conclude that starting a new job or using hands vigorously can cause CTS symptoms, but question whether the occupation actually causes the compression of the median nerve. They have found that individual patient factors, such as body mass index (obesity), lack of avocational physical exercise, age, and the wrist depth-to-width ratio are the strongest predictors of who will develop CTS.

Prevention and Treatment—Finally, CTS specialists and researchers disagree over how to prevent and treat this disorder. Many doctors traditionally have recommended workplace modification programs and splinting of the arm or wrist. For example, work stations should be adjusted so that the elbows aren't elevated above mid-torso height, and the shoulders should not be flexed or abducted more than 60 degrees. Workers also are told to use a power grip instead of a pinch grip when performing tasks. Other specialists state that "there is no electrophysiologic evidence indicating that these ergognomic interventions reverse the disease process which leads to CTS". They have concluded that the most effective way to prevent CTS is to encourage workers to reduce their risk factors by health education and workplace wellness programs. In particular, they recommend regular aerobic exercise, weight loss, and good nutrition.

Sources:

Nathan, P.A. 1994. Carpal tunnel syndrome: is it caused by work? Portland, OR Portland Hand Surgery and Rehabilitation Center. 2 p.

Nathan, P.A.; Keniston, R.C. 1993. Carpal tunnel syndrome and its relation to general physical condition. Hand Clinics 9(2): 253-261.

Oliver, M.L. Rickards, J. 1995. Carpal tunnel syndrome -identifying the risk factors in forest industry operations. Journal of Forest Engineering 6(2): 51-58.

Follow-Up:

Both of these health and safety concerns will be addressed at the Wesern Forest and Conservation Nursery Association meeting in Kearney, Nebraska, this coming August. Dr. Arvind Padhye, a mycologist at the Centers for Disease Control in Atlanta, Georgia, will talk about sporotrichosis; and Dr. Deborah Mowry, a local physiatrist, will present the very latest information on CTS and other repetitive motion injuries. See page three of this issue for meeting contacts. For those unable to attend, the presentations will be captured in the National Nursery Proceedings.

Editorial

Making Meetings Efficient

Meetings are a valuable management tool for improving work productivity and increasing networking between nursery workers. Like everything, however, you can have too much of a good thing, and meetings must be managed or they can quickly get out of hand. Kehoe (1993) states that meetings are "the most abused form of company communications".

Here are a few tip from the pros:

✍✍**Scheduling**—Keep meetings as short as possible. Weekly staff meetings should take only 15-30 minutes, and single topics at decision-making meetings can be solved in less than an hour. In general, meetings are most effective when they are no more than 1.5 hours in length.

✍✍**Purpose**—Every meeting should have a well--stated purpose, or maybe you don't need one. There are many good reasons for meetings, such as information exchange, plans for the next crop,

"What's this about your refusing to attend another meeting today because you want to "get some work done" ??

BERRY'S WORLD reprinted by permission of Newspaper Enterprise Association.

assignment of responsibilities, so just make sure that the purpose is stated and understood.

✍✍**Attendance**—A general rule is "the smaller the better". The experts say that meetings of more than 10 people become difficult to manage. Not everybody has to attend every meeting. Use the meeting objectives to make up a list of who really has to be there.

✍✍**Structure**—Good meetings require preparation and so an outline with a list of objectives is a good idea. Use a facilitator if appropriate, and document the results in writing.

✍✍**Accountability**—There are forms that are designed to improve the efficiency and document the cost: benefit ratio of meetings. They have listings for the purpose of the meeting, the starting and stopping time, and the total time expended.

You can list everyone who attends, their hourly salary, and management code that their time is going to be charged to. By multiplying the total personnel cost of the meeting by the time of the meeting, you can calculate the true cost of the meeting. Comparing the costs to the tangible benefits of the meeting is an easy and quick way to measure their true value and charge the costs to the appropriate cost center.

Meetings are powerful tools and a necessary part of nursery management, but they must be properly planned and executed.

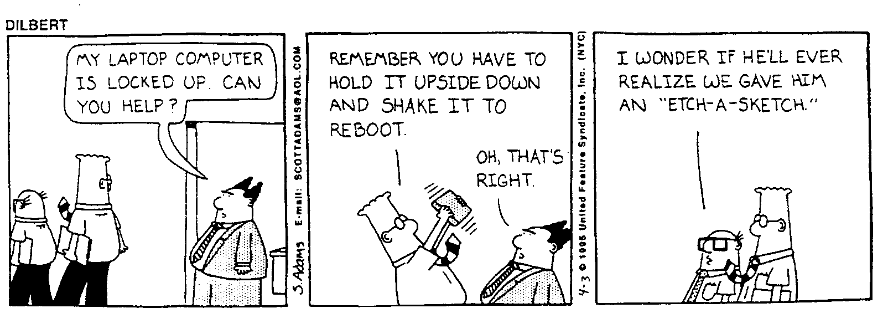
Sources:

Hosey, T.; Percival, B. 1984. Motivate employees for effective staff meetings. American Nurseryman 160(9): 51-54.

Kehoe, K.R. 1993. Maximize your meetings. American Nurseryman 178(10): 64-66, 68-69.

DILBERT reprinted by permission of United Feature syndicate, Inc.

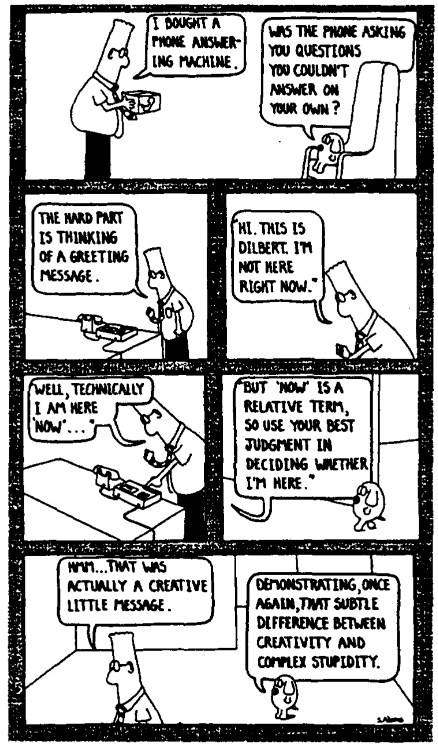
Horticultural Humor

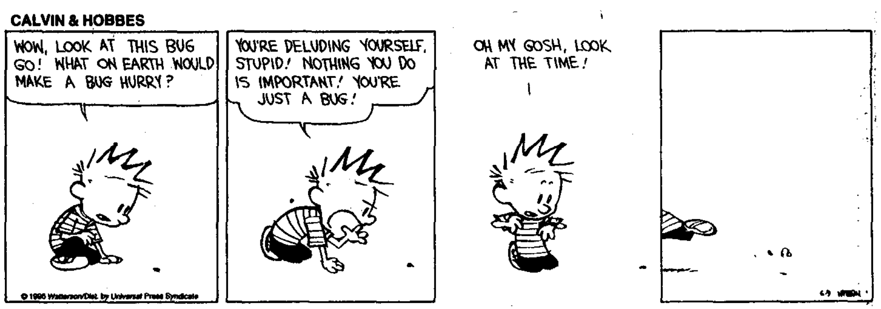


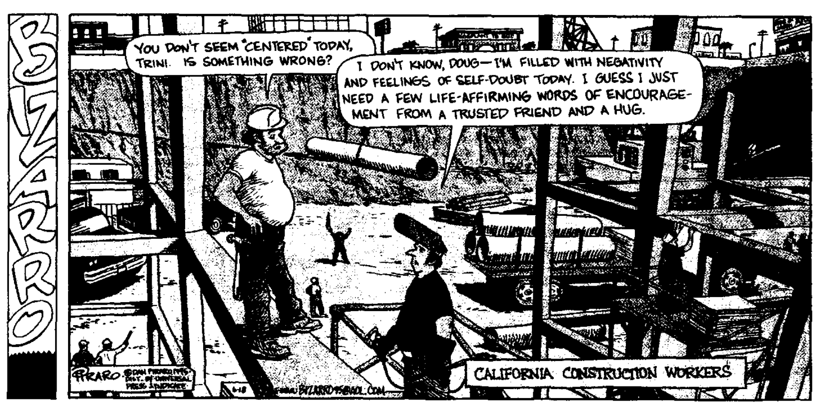
DILBERT reprinted by permission of United Feature syndicate, Inc.

Another Good Argument for IPM

A man trying to rid his apartment of cockroaches set off 25 pesticide bombs that blew out the windows and set his furniture ablaze, according to fire officials. One or two canisters should have done the job, but the guy wanted to "really do it good" when he decided to fumigate his Southern California home. The man and his wife set off the bug bombs and were heading out the door when the explosion occurred. Fortunately, no one was injured, but damage was estimated at $10,000. Ironically, the incident does not seem to have killed all the cockroaches because when the fire officials arrived there were some still running around.







New Nursery Literature

Many of the journals that are listed in Forest Nursery Notes are copyrighted and some charge a copyright fee. So, to comply with copyright laws, there are three categories of publications listed in the New Nursery Literature section:

1. Numbered or lettered articles can be ordered using the Literature Order Form on the last page. Subscribers circle the appropriate number or letter and return the form to me.

2. Items with © are copyrighted and require a fee for each copy, and so only the title page and abstract will be provided through this service. If subscribers desire the entire article, they can order a copy from Donna Loucks (See FNN Database on p. 30) or a private literature service.

3. **Special Order (SO)** articles or publications are either too long or too expensive for us to provide free copies, but prices and ordering instructions are provided here and following the individual listings in the New Nursery Literature section. Numbered or Lettered publications can be requested by circling the appropriate listing on the Literature Order Form and returning it to me.

Special Publications

SO. Bonner, F.T.; Vozzo, J.A.; Elam, W.W.; Land, S.B. Jr. 1994. Tree Seed **Technology Training Course—Instructor's Manual.** General Technical Report SO-106. New Orleans, LA: USDA Forest Service, Southern Forest Experiment Station. 160 p.

This softbound publication contains chapters on seed biology, collection, and handling; evaluation of seed-quality; seed protection; basic seed propagation; and seed programs as well as a practical laboratory exercises for students and a course evaluation. It is well illustrated with black-andwhite drawins and notably, contains information on both temperate and tropical tree species. The Manual could be used to train seed collectors, seed-plant workers, seed analysts, nursery crews, as well as regeneration specialists. It is the companion publication for GTR SO-107 - see next listing.

SO. Bonner, F.T.; Vozzo, J.A.; Elam, W.W.; Land, S.B. Jr. 1994. **Tree Seed Technology Training Course—Student Outline.** General Technical Report SO-107. New Orleans, LA: USDA Forest Service, Southern Forest Experiment Station. 81 p.

This softbound publication is the companion for the Instructor's Manual (GTR SO106) - see previous listing. As such, it contains the same chapters but with less detail as well as some of the same illustrations. This book is intended as a take-home reference for students taking the training course.

Ordering information for both publications of the Tree Seed Technology Training Course are as follows:

Cost: Free

Order From:
USDA Forest Service
Southern Forest Experiment Stn.
Publications Distribution701
Loyola Ave. Rm. T-10210
New Orleans, LA 70113-1920
Tel: 504-589-6800
Fax: 504-589-3961

SO. Moulton, R.J.; Lockhart, F.; Snellgrove, J.D. 1995. **Tree Planting in the United States, 1994.** Washington, DC: USDA Forest Service, Cooperative Forestry. 18 p.

This annual report summarized tree planting, tree improvement, and nursery production for the United States, and is a must for anyone interested in long-term trends **(Figure O)**. The data is organized by both State-by-State and land ownership, and presented in tables and pie charts. Of particular interest to nursery managers are the statistics on nursery production by ownership category **(Figure P)** and a table of production by state. Those of you who were always confused by the acronyms of the various types of USDA Tree Planting Assistance Programs, such as FIP, ACP, and SIP will appreciate the section explaining how they work.

Cost:
Free

Order From:
Robert Moulton
USDA Forest Service
Cooperative Forestry
PO Box 96090
Washington, DC 20090-6090
USA
Tel: 202-205-1376
Fax: 202-205-1271

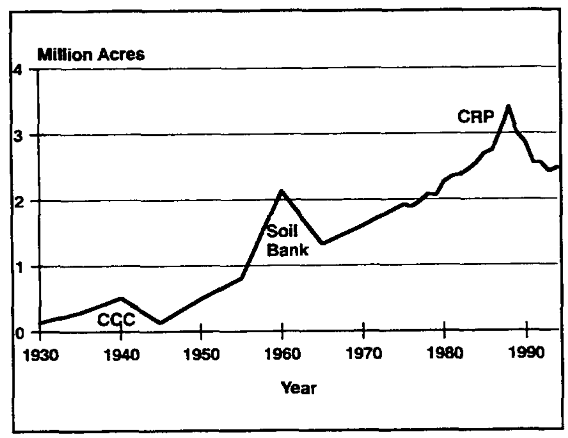


Figure O: National Tree Planting Trends in the US show peaks caused by national programs including the Civilian Conservation Corps, the Soil Bank, and the Conservation Reserve Program (from Moulton and others).

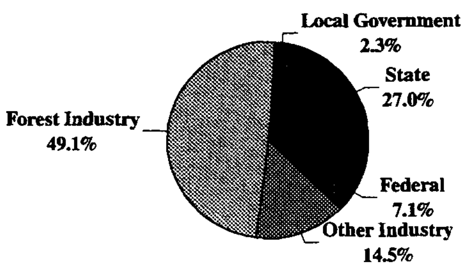


Figure P: US Nursery Production by Ownership Class (from Moulton and others)

SO. Odlum K.D.; Ng, P. 1995. Selecting greenhouse temperatures to control black spruce and jack pine seedling growth: pocket guide. Saint Ste. Marie, ON: Ontario Forest Research Institute. 36 p.

This small format, full color book presents seedling growth information and 3-dimensional response curves for the day and night temperatures for black spruce and jack pine seedlings. Growth parameters include shoot length; root collar diameter; shoot, root, and total biomass; shoot-to-root ratio; and height-to-diameter ratio. This will be valuable not only to growers raising these species but also to plant physiologists and others interested in seedling development.

Cost:
Free

Order From:
Technology Transfer Department
Ontario Forest Research Institute
PO Box 969, 1235 Queen St. East
Sault Ste. Marie, ON P6A 6J8
CANADA
Tel: 705-946-2981
Fax: 705-946-2030

Surplus Publications

We have extras of the following publications, and will send you a free copy if you circle the corresponding letter on the Literature Order Form on the back page and return it to us. Supplies vary, so orders will be filled on a first-come, first-served basis.

A) Lantz, C.W. ed. 1984. Southern pine nursery handbook. USDA Forest Service, Southern Region. 289 p+Appendices

This classic book contains 18 different chapters on all phases of bareroot production of southern pine seedlings. It contains the accumulated knowledge of Jack May and Earl Belcher, as well as other nursery specialists. The format is loose-leaf, 3-hole punched and ready for your binder.

B) Tree Planter's Notes, Volume 45, Number 2 (Spring 1994)

C) Tree Planter's Notes, Volume 45, Number 2 (Summer 1994)

Container Tree Nursery Manual Update

The publication of *Volume One: Nursery Planning, Development, and Management* was announced in the January, 1995, issue of FNN, along with instructions for ordering a free copy (#B on the Literature Order Form for that issue). In case you had ordered one and were wondering where it was, the actual publication took about 5 months longer than we had anticipated. Nothing moves very fast in Washington, DC! Anyway, we finally received our supply of Volume One in mid-June and mailed a copy out to everyone who had ordered one by the end of the month. If you haven't received yours by the time you receive this FNN issue, then let us know and we'll see that you get one. Sorry for the delay!

We have also been trying to keep the other volumes of the CTNM in stock, but it hasn't been easy. The current status is given on the table on the opposite page, along with letters for ordering copies.

FNN Database

The technical references that are listed in each issue of *Forest Nursery Notes* are also entered into a computer database using a software package called Pro-Cite©, which currently contains over 7,500 listings. The database is maintained by a private librarian, Donna Loucks, who can provide copies of the database on a fee basis to people who have the computer software. She can also do computer searches and provide hard copies of articles for people who do not want to buy the software. For more information on any of these services, contact:

Donna M. Loucks
Forestry Information Specialist
P.O. Box 638
Centralia, WA 98531
Tel: 360-736-2147

Availability and Projected Publication Schedule of the Container Tree Nursery Manual

One free copy of available volumes of the Manual will be sent to cooperators. If you need more than one copy, then you must purchase them from the US Government Bookstore:

Volume Number	Title	Publication Date	Stock Number And Price
D) Volume One	Container Nursery Planning, Development, and Management	1995	001-001-00654-8 $24.00?
E) Volume Two	Containers and Growing Media	1990	001-001-00644-1 $9.50?
F) Volume Three	Atmospheric Environment	1992	001-001-00648-3 $16.00?
G) Volume Four	Seedling Nutrition and Irrigation	1989	001-001-00635-1 $15.00?
H) Volume Five	Biological Influences: Nursery Pests and Mycorrhizae	1990	001-001-00633-5 $30.00?
Volume Six	Seedling Propagation	(1996)	
Volume Seven	Seedling Processing, Storage, and Outplanting	(1998)	

( ) = Estimated Publication Date

? = There is a 25% Surcharge for foreign orders

Order From:

U.S. Government Printing Office
1305 S.W. First Avenue
Portland, OR 97201-5801
USA
PHONE: 503-221-6217
FAX: 503-225-0563

New Nursery Literature

Please obtain these articles from your local forestry library or literature service if at all possible. Numbered articles can also be ordered directly, using the Literature Order Form on the last page—just circle the appropriate number and return form to me. These free copies are a technology transfer service of USDA Forest Service, State and Private Forestry. Items bordered with © are copyrighted and require a fee for each copy, so you will only be sent the title page and abstract. If you desire the entire article, follow the ordering instructions that follow the abstract.

Special Order (SO) articles or publications must be ordered directly from the publisher. Prices and ordering instructions follow each listing.

Bareroot Production

1. **Additional tests of root pruning loblolly pine seedlings in the seedbed.** Dierauf, T. A.; Scrivani, J. A.; Chandler, L. Virginia Department of Forestry, Occasional Report 115. 14 p. 1995.

2. **Bed density alters stem density of loblolly pine seedlings.** Zwolinski, J.; Ferreira, M. Auburn University, Southern Forest Nursery Management Cooperative, Research Note 952. 3 p. 1995.

3. **Root pruning white pine seedlings in the seedbed.** Dierauf, T. A.; Scrivanik J.A.; Chandler, L. Virginia Department of Forestry, Occasional Report 116. 17 p. 1995.

4. **Transplanting time controls size and balance of 1-1 Douglas-fir.** Nelson, J. A.; Jenkinson, J. L. Humboldt Nursery Diverse Species Culture Unit report to Pacific Southwest Region, Pacific Northwest Region and USDI Bureau of Land Management. 17 p. 1992.

Business Management

5. **Get on the information superhighway.** Rhodus, T. Greenhouse Grower 12(10):22, 24. 1994.

6. **Get profits on line with computer software.** Aylsworth, J. D. Greenhouse Grower 12(13):24, 26-27, 29-30. 1994.

7. **Horticulture zooms onto the information superhighway.** Erwin, J. E. Greenhouse Management and Production 13(11):84-86. 1995.

8. **How to impress the inspector.** Kren, L. A. Greenhouse Grower 12(8):103- 104. 1994. Awareness of health, safety, and environmental issues is the best way to prepare for inspections.

9. **Labor savings around the clock.** Ohofrey, D. Greenhouse Grower 13(4):27- 28, 30,32. 1995. Computer program tracks time required for different tasks.

10. **NAHSA releases bar code standards.** Greenhouse Grower 11(12):56-57. 1993.

11. **The networking edge.** Eppler, M. T. American Nurseryman 181(1):53-59. 1995. An experienced business consultant tells how to benefit from the experience of others.

12. **Recycling's bottom line.** Firt, K. M. Greenhouse Grower 12(8):122, 124. 1994. Let your wallet be your guide as to whether the benefits of recycling are worth the extra effort of handling and storage.

13. **Test your environmental I.Q., part 1: Can you pass an environmental exam?** Firth, K. M. Greenhouse Grower 12(10):61-64. 1994. Guidance for conducting your own environmental audit.

14. **Test your environmental I.Q., part 4: Wrap-up.** Firth, K. M. Greenhouse Grower 12(14):47-50. 1994. Reviews waste reduction, underground storage tanks, emergency planning, recordkeeping, worker protection standard, and special greenhouse rules.

15. **Your expert on call.** Shipp, L.; Papadopoulos, T.; Jarvis, B.; Jewett, T.; Clarke, N. Greenhouse Grower 12(13):18-20, 22. 1994.

Container Production

16. **Copper hydroxide affects root distribution of *Ilex cassine* in plastic containers.** Gilman, E. F.; Beeson, R. J. HortTechnology 5(1):4849. 1995.

17. **Gutless and atrimmec for controlling growth of woody landscape plants in containers.** Banko, T. J.; Stefani, M. A. Journal of Environmental Horticulture 13(1):22-26. 1995.

18.© **Irrigation regime affects water and aeration conditions in peat growth medium and the growth of containerized Scots pine seedlings.** Heiskanen, J. New Forests 9(3):181-195. 1995.

19. **Nursery production: growing western white pine and western redcedar in greenhouses.** Wenny, D. L.; Dumroese, R. K. IN: Interior cedar - hemlock - white pine forests: ecology and management, p. 261-266. Held March 24, 1993, Spokane, Washington. Washington State University, Department of Natural Resource Sciences. 1994.

20. **Shoot and root responses of eight subtropical species grown in cupric hydroxide-treated containers.** Svenson, S. E.; Johnston, D. L.; Coy, B. L. HortScience 30(2):249-251. 1995.

Diverse Species

21. **Collecting, processing, and storing desert seeds: notes from an innocent abroad.** Bainbridge, D. A. IN: Proceedings of the joint meeting of the B.C. Seed Dealers' Association and the Western Forest and Range Seed Council, p.9-12. Held June 2-4, 1993, Vernon, B.C., Canada. Forestry Canada and British Columbia Ministry of Forests. 1993.

22. **The effect of containerless transport on desert shrubs.** Fidelibus, M. W.; Bainbridge, D. A. Tree Planters' Notes 45(3):82-85. 1994.

23. **The establishment of *Scirpus tabernaemontani* (formerly Scirpus *validus)* from large and small rhizomes as a function of water depth.** Garbisch, E. W.; McIninch, S. M. Wetland Journal 6(4):17-21. 1994.

24.© **Interactions between native prairie grasses and indigenous arbuscular mycorrhizal fungi: implications for reclamation of taconite iron ore tailing.** Noyd, R. K.; Pfleger, F. L.; Russelle, M. P. New Phytologist 129(4):651-660. 1995.

25. **Osmotic priming or chilling stratification improves seed germination of purple coneflower.** Wartidiningsih, N.; Geneve, R. L.; Kester, S. T. HortScience 29(12):1445-1448. 1994.

26. **Seed source and quality influence germination in purple coneflower *[Echinacea purpurea (L.)* Moench.].** Wartidiningsih, N.; Geneve, R. L. HortScience 29(12):14431444. 1994.

SO. **Complete garden guide to the native shrubs of California.** Keator, G. Chronicle Books. 314 p. 1994. Chapters: The habitats of native shrubs; Techniques for native shrub planting and care; Management of soil and water; Sources of native shrubs; Propagation of native shrubs; Significant features of shrubs in the garden; Landscapes using native shrubs; Encyclopedia of native shrubs. ORDER FROM: Chronicle Books, 275 Fifth St., San Francisco, CA 94103. Phone (415) 777-7240 or 800-722-6657.

Fertilization and Nutrition

27.© **Calcium and pH interaction on root modulation of nursery-grown red alder (Alnus rubra Bong.)** seedlings by Frankia. Crannell, W. K.; Tanaka, Y.; Myrold, D. D. Soil Biology and Biochemistry 26(5):607614. 1994.

28.© **Copper nutrition of Eucalyptus maculata Hook.** seedlings: Requirements for growth, distribution of copper and the diagnosis of copper deficiency. Dell, B. Plant and Soil 167(2):181-187. 1994.

29.© **Does nitrogen fertilization have an impact on the trade-off between willow growth and defensive secondary metabolism?** Hakulinen, J.; Julkunen-Tiitto, R.; Tahvanainen, J. Trees: Structure and Function 9(4):235- 2420. 1995.

30. **Don't leach out profits.** Steinkamp, R. Greenhouse Grower 13(1):136-138, 140. 1995. By monitoring crops using an EC meter, you can grow quality plants with reduced fertility.

31. **Effect of nitrogen fertilization rate in the seedbed on growth in the field.** Dierauf, T. A.; Chandler, L. Virginia Department of Forestry, Occasional Report 121.6 p. 1995.

32. **The effect of nitrogen supply on root growth and development in sycamore and Sitka spruce trees.** Mackie-Dawson, L. A.; Millard, P.; Proe, M. F. Forestry 68(2):107114. 1995.

33.© **Effects of a catch crop on leaching of nitrogen from a sandy soil: simulations and measurements.** Lewan, E. Plant and Soil 166(1):137-152. 1994.

34.© **Growth and nutrition of birch seedlings at varied relative addition rates of magnesium.** Ericsson, T.; Kahr, M. Tree Physiology 15(2):85-93. 1995.

35.© **Iron availability in plant tissues - iron chlorosis on calcareous soils.** Mengel, K. Plant and Soil 165(2):275-283. 1994.

36. **Nitrate leaching at a coastal plain nursery in Alabama.** McNabb, K. Auburn University, Southern Forest Nursery Management Cooperative, Research Note 95-4. 5 p. 1995.

37.© **Nitrate reductase and glutamine synthetase activities in relation to growth and nitrogen assimilation in red oak and red ash seedlings: effects of N-forms, N concentration and light intensity.** Truax, B.; Lambert, F.; Gagnon, D.; Cheerier, N. Trees: Structure and Function 9(1):12-18. 1994.

38. **Variation in the electrical conductivity and acidity of preculture peat growth media used in Finnish tree nurseries.** Rikala, R.; Heiskanen, J. Scandinavian Journal of Forest Research 10(2):161-166. 1995.

General and Miscellaneous

39. **Carpal tunnel syndrome - identifying the risk factors in forest industry operations.** Oliver, M. L.; Rickards, J. Journal of Forest Engineering 6(2):51-58. 1995.

40. **Ecologically responsible restoration and ecoforestry.** Drengson, A.; Stevens, V. International Journal of Ecoforestry 10(4):206-210. 1994.

41.**© Revised NIOSH equation for the design and evaluation of manual lifting tasks.** Waters, T. R.; Putz-Anderson, V.; Garg, A.; Fine, L. J. Ergonomics 37(7):749-776. 1993.

42. ***Taxus* populations and clippings yields at commercial nurseries.** Hansen, R. C.; Cochran, K. D.; Keener, H. M.; Croom, E. M. Jr. HortTechnology 4(4):372-377. 1994.

SO. **NIOSH pocket guide to chemical hazards.** Department of Health and Human Services, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 94-116. 398 p. 1994. Lists chemical name, structure, exposure limits, chemical and physical properties, reactivities, health hazards. ORDER FROM: Government Printing Office, Superintendent of Documents, Washington, DC 20402. Phone (202) 783-3238. Stock No. 017-033-00473-1. Also available in electronic format.

SO. **Workplace use of back belts: review and recommendations.** Department of Health and Human Services, National Institute for Occupational Safety and Health, Back Belt Working Group. DHHS(NIOSH) Number 94-122. 25 p. 1994. ORDER FROM: Publications Dissemination, DSDTT, NIOSH, 4676 Columbia Parkway, Cincinnati, OH 45226-1998. Fax (513) 533-8573.

Genetics and Tree Improvement

43. **Characterization of *Pinus pinaster* seedling growth in different photo- and thermoperiods in a phytotron as a basis for early selection.** Nguyen, A.; Dorn-fling, L; Kremer, A. Scandinavian Journal of Forest Research 10(2):129- 139. 1995.

44.© **Intraspecific variation in the response of *Taxodium distichum* seedlings to salinity.** Allen, J. A.; Chambers, J. L.; McKinney, D. Forest Ecology and Management 70(1-30:203-214. 1994.

Mycorrhizae and Beneficial Microorganisms

45.© **Arbuscular mycorrhizal induced changes to plant growth and root system morphology in *Prunus cerasifera.*** Berta, G.; Trotta, A.; Fusconi, A.; Hooker, J. E. Munro, M.; Atkinson, D.; Giovannetti, M.; Morini, S.; Fortuna, P.; Tisserant, B.; GianinazziPearson, V.; Gianinazzi, S. Tree Physiology 15(5):281- 293. 1995.

46.© **Contribution of ectomycorrhiza to the potential nutrient-absorbing surface of pine.** Rousseau, J. V. D.; Sylvia, D. M.; Fox, A. J. New Phytologist 128(4):639-644. 1994.

47.© **The effect of ectomycorrhizal fungi on Zn uptake and distribution in seedlings of *Pinus sylvesfris*** L. Bucking, H.; Heyser, W. Plant and Soil 167(2):203-212. 1994.

48.© **Effect of elevated CO_2 on mycorrhizal colonization of loblolly pine *(Pinus taeda* L.) seedlings.** Lewis, J. D.; Thomas, R. B.; Strain, B. R. Plant and Soil 165(1):81-88. 1994.

49.© **The effect of soil phosphorus on the external mycelium growth of arbuscular mycorrhizal fungi during the early states of mycorrhiza formation.** de Miranda, J. C. C.; Harris, P. J. Plant and Soil 166(2):271280. 1994.

50.© **Effects of high nitrogen concentrations on ectomycorrhizal structure and growth of seedlings of *Picea abies* (L.) Karst.** Brunner, L; Scheidegger, C. New Phytologist 129(1):83-95. 1995.

51.© **Enhancement of growth and establishment of oak seedlings *(Quercus ithaburensis* Decaisne) by inoculation with *Azospirillum brasilense.*** Zaady, E.; Perevolotsky, A. Forest Ecology and Management 72(1):8183. 1995.

52. **Fungi lend a hand: rooting out mycorrhizae's place in the nursery.** Cuny, H. Nursery Management and Production 11(4):44-46, 48-50. 1995.

53.© **Growth and assimilation of NH_4+ and $N0_3$- by *Paxillus involutus* in association with *Betula pendula*** and ***Picea abies* as affected by substrate pH.** Ek, H.; Andersson, S.; Arnebrant, K.; Soderstrom, B. New Phytologist 128(4):629-637. 1994.

54.© **How to monitor released rhizobia.** Selenska-Pobell, S. Plant and Soil 166(2):187-191. 1994.

55. **The influence of fertilization on ectomycorrhizal colonization of *Pinus patina* roots.** Carlson, C. A. South African Forestry Journal 171:1-6. 1994.

56. **Methyl bromide soil fumigation alters plant element concentrations.** Ellis, J. R.; Watson, D. M. H.; Varvel, G. E.; Jawson, M. D. Soil Science Society of America Journal 59(3):848-852. 1995.

57.© **A new hypothesis to explain allocation of dry matter between mycorrhizal fungi and pine seedlings in relation to nutrient supply.** Wallander, H. Plant and Soil 168-169:243-248. 1995.

58.© **Structure and function of the ectomycorrhizal association between *Paxillus involutus* (Batsch) Fr.** and ***Belula pendula* Roth. I. Dynamics of mycorrhiza formation.** Brun, A.; Chalot, M.; Finlay, R. D.; Soderstrom, B. New Phytologist 129(3):487-493. 1995.

59. **Vesicular-arbuscular mycorrhizal inoculation of micropropagated fruit trees.** Rapparini, F.; Baraldi, R.; Bertazza, G.; Branzanti, B.; Predieri, S. Journal of Horticultural Science 69(6):1101-1109. 1994.

Nursery Structures and Equipment

60. **The bottom line on heating.** Hopkins, M. T. Greenhouse Grower 12(14):26, 28, 30. 1994. Basics on bench or floor heating systems.

61. **Choose the fan that fits.** Greenhouse Grower 12(4):18-19. 1994.

62. **Choose the right microscreening.** Gill, S. A.; Ross, D. S. Greenhouse Grower 12(6):72-74. 1994.

63. **Cool off: vent your hot air frustrations with these basic guidelines to effective cooling.** Hopkins, M. T. Greenhouse Grower 13(4):18-20. 1995.

64. **Coverings: how they rate.** Papadopoulos, A. P. Greenhouse Grower 12(8):19. 1994. Double polyethylene, glass, and acrylic -which is better?

65.© **Development and field evaluation of a hydropneumatic planter for primed vegetable seeds.** Far, J. J.; Upadhyaya, S. K.; Shafii, S. Transactions of the American Society of Agricultural Engineers 37(4):1069-1075. 1994.

66. **Dispose of old ideas about plastics.** Aylsworth, J. D. Greenhouse Grower 13(1):63-65. 1995. Use greenhouse films for fuel?

67. **Durability and efficiency of recycled multi-layer plastic covering in the production of greenhouse-grown tomatoes.** Kasrawi, M. A.; Khraishi, N.; Tabaza, Y. HortTechnology 4(4):394-398. 1994.

68. **Expanding your greenhouses.** Davis, T. Greenhouse Management and Production 14(4):22-24. 1995.

69. **The heat is off.** Martinez, H. Greenhouse Management and Production 13(11):67, 71-74. 1995. Heater corrosion proves to be costly experience for Georgia grower.

70. **The heat is on.** Ibarbia, E. A. Greenhouse Grower 12(14):22, 24-25. 1994.

71. **How to select the proper ventilation system.** Bartok, J. W., Jr. Greenhouse Management and Production 14(3):71-72. 1995.

72. **Insect microscreening: its time has come.** Gill, S. A.; Ross, D. S. Greenhouse Grower 12(5):77, 80-82. 1995.

73. **It's time to check your equipment.** Carlson, W. Greenhouse Grower 12(14):17-18, 20-21. 1994. Heating equipment and injection equipment are the two most likely to malfunction.

74. **A look at: polyethylene film fasteners.** Roskens, L. Greenhouse Management and Production 14(3):48-50. 1995.

75. **A look at: Quonset greenhouses.** McLean, J. Greenhouse Management and Production 14(4):54-58, 60. 1995.

76. **Low-temperature exotherm measurement using infrared thermography.** Ceccardi, T. L.; Heath, R. L.; Ting, I. P. HortScience 30(1):140-142. 1995.

77. **Manufactured shade: Choosing the right material won't leave you—or your plants—in the dark.** Davis, T. Nursery Management and Production 11(4):41-43. 1995.

78. **Microscreening: putting it to work.** Gill, S. A.; Ross, D. S. Greenhouse Grower 12(8):5354, 57-58. 1994.

79. **On target with low volume sprayers.** Getting, R. D. Greenhouse Grower 13(1):176-178. 1995.

80. **Remodeling greenhouses: consider a 10-year plan.** Bartok, J. W. , Jr. Greenhouse Management and Production 14(4):72-73. 1995.

81. **Shades of summer.** Onofrey, D. Greenhouse Grower 12(4):20-22. 1994.

82.© **Sorting cut roses with machine vision.** Steinmetz, V.; Delwiche, M. J.; Giles, D. K.; Evans, R. Transactions of the American Society of Agricultural Engineers 37(4):1347-1353. 1994.

83. **Transplanting: is the choice automatic?** Bartok, J., Jr. Greenhouse Grower 12(8):46, 48. 1994. Conveyor transplanting systems can help grower increase production efficiency.

84. **Wind-protected sprayer for single- and multiple-row field plot nurseries.** Jolliff, G. D.; Seddigh, M.; Crane, J. M. Agronomy Journal 87(2):278-279. 1995.

Outplanting Performance

85. **Comparing methods of artificially regenerating loblolly and slash pines: container planting, bareroot planting, and spot seeding.** Haywood, J. D.; Barnett, J. P. Tree Planters' Notes 45(2):63-67. 1994.

86. **Effects of pocket gophers, bracken fern, and western coneflower on survival and growth of planted conifers.** Ferguson, D. E.; Adams, D. L. Northwest Science 68(4):241-249. 1994.

87. **Establishment of white oak seedlings with three post-plant handling methods on deep-tilled minesoil during reclamation.** Kjelgren, R.; Cleveland, B.; Foutch, M. Journal of Environmental Horticulture 12(2):100-103. 1994.

88. **Field performance of grade 1 and 2 loblolly seedlings from a top clipping study.** Dierauf, T. A.; Chandler, L. A. Virginia Department of Forestry, Occasional Report 120. 5 p. 1995.

89.© **Frost heaving of forest tree seedlings: a review.** Goulet, F. New Forests 9(1):67-94. 1995.

90.© **Gas exchange, water relations and morphology of yellow-cedar seedlings and stecklings before planting and during field establishment.** Folk, R. S.; Grossnickle, S. C.; Russell, J. H. New Forests 9(1):1-20. 1995.

91.© **Heat damage in boxed white spruce (Picea glauca [Moench.] Voss) seedlings: its preplanting detection and effect on field performance.** Binder, W. D.; Fielder, P. New Forests 9(3):237-259. 1995.

92. **In-fill planting with large planting stock.** Cormier, D. Forest Engineering Research Institute of Canada, Field Note: Silviculture -62. 2 p. 1994.

93. **Mulching to regenerate a harsh site: effect on Douglas-fir seedlings, forbs, grasses, and ferns.** McDonald, P. M.; Fiddler, G. O.; Harrison, H. R. USDA Forest Service, Pacific Southwest Research Station, Research Paper PSW-RP-222. 10 p. 1994.

94. **Planting 1-0 white pine seedlings.** Dierauf, T. A.; Chandler, L. Virginia Department of Forestry, Occasional Report 117. 6 p. 1995.

95. **Potential of two tree shelters to aid the early establishment and growth of three Australian tree species on the Darling Downs, south-east Queensland.** Dunn, G. M.; Cant, M. S.; Nester, M. R. Australian Forestry 57(3):95-97. 1994.

96. **Protecting red oak seedlings with tree shelters in northwestern Pennsylvania.** Walters, R. S. USDA Forest Service, Northeastern Forest Experiment Station, Research Paper NE-679. 5 p. 1993.

97. **Ripping to improve loblolly seedling survival and growth.** Dierauf, T. A.; Scrivani, J. A. Virginia Department of Forestry, Occasional Report 119. 3 p. 1995.

98.© **Root system morphology of *Quercus rubra* L. planting stock and 3- year field performance in Iowa.** Thompson, J. R.; Schultz, R. C. New Forests 9(3):225-236. 1995.

SO. **Main causes of mortality and height growth of containerized seedlings following four reforestation tests.** Delisle, C. Canadian Forest Service, Laurentian Forestry Centre, Information Report LAU-X-106E. 44 p. 1993. ORDER FROM: Canadian Forest Service - Quebec Region, Laurentian Forestry Centre, 1055 du P.E.P.S., P.O. Box 3800, Sainte-Foy, Quebec G1V 4C7 Canada. Free.

Pest Management

99. **ABCs of IPM, part 1.** Matteoni, J.; Elliot, D. Greenhouse Grower 12(13):38, 40-41. 1994. Outlines initial phase for implementing your own IPM program.

100. **ABCs of IPM, part 2.** Matteoni, J.; Elliot, D. Greenhouse Grower 12(14):56-57. 1994. Here's what you need to know to get an integrated pest management program up and running in your greenhouse.

101. **Alternatives to methyl bromide: assessment of research needs and priorities for forestry, nursery, and ornamental crops.** Linderman, R.; Dixon, W.; Fraedrich, S.; Smith, R. S., Jr. Tree Planters' Notes 45(2):43-47. 1994.

102. ***Botrytis*: new management strategies for an old blight.** Powell, C. C. Nursery Management and Production 11(5):58-59. 1995.

103.© **Cytopathological responses in roots of *Picea abies* seedlings infected with *Pythium dimorphum.*** Borja, L; Sharma, P.; Krekling, T.; Lonneborg, A. Phytopathology 85(4):495501. 1995.

104.© **Effects of soil solarization and fumigation on survival of soilborne pathogens of tomato in northern Florida.** Chellemi, D. O.; Olson, S. M.; Mitchell, D. J. Plant Disease 78(12):1167-1172. 1994.

105. **Engineer the environment: how environmental control helps plants and hinders pathogens.** Curry, H. Greenhouse Management and Production 13(12):30-32, 38-39. 1995.

106. **Environmental controls leave fungi dry.** Onofrey, D. Greenhouse Grower 12(13):32-33, 36. 1994. Experiments are underway to control disease by preventing condensation on the leaves by adding bursts of heat to plants to slow the cooling process.

107. **An evaluation of dazomet and metam-sodium soil fumigants for control of *Macrophomina phaseolina* in a Florida forest nursery.** Barnard, E. L.; Gilly, S. P.; Ash, E. C. Tree Planters' Notes 45(3):91-95. 1994.

108. **Evaluation of eight species of Cornus for resistance to dogwood *Anthracnose.*** Sherald, J.L. Stidham, T.M.; Roberts, L.E. Journal of Environmental Horticulture 12(2):61-64. 1994.

109. **Forecasting diseases.** Hausbeck, M. K. Greenhouse Grower 13(3):43-44, 46. 1995. A disease forecasting system can identify when environmental conditions are favorable for a disease epidemic in your greenhouse.

110. **Fundamentals of fumigation.** Ibarbia, E. A. Greenhouse Grower 13(1):141-142, 144. 1995.

111. **IGRs for IPM.** Getting, R. D. Greenhouse Grower 12(12):28-31. 1994. Insect growth regulators are compatible with integrated pest management principles.

112. **Influence of mechanical incorporation method on dazomet distribution in conifer nursery soil.** Kelpsas, B. R.; Campbell, S. J. Tree Planters' Notes 45(2):53-57. 1994.

113. **Insects and diseases of oak seedlings grown in tree shelters.** Allen, K. Tree Planters' Notes 45(3):88-90. 1994.

114. **IPM ... does it mean integrated pest management or "I pay more"?** Lindquist, R. K. Greenhouse Grower 11(12):73-74, 76. 1993.

115. **Metalaxyl-resistant *Pythium sp.*: you can still fight it.** Roberts, D. L. Greenhouse Grower 12(8):59, 62. 1994.

116. **Mix it up.** Kren, L. A. Greenhouse Grower 12(12):24-26. 1994. Disease and insect suppressive biological controls are incorporated in growing mixes.

117. **Mixing, matching may give best results on root rots.** Powell, C. C. Nursery Management and Production 11(3):68, 71. 1995. Suggests products for root drenching.

118. **Nantucket pine tip moth infests longleaf pine seedlings in a North Carolina nursery.** Doggett, C.; Langston, F. W.; Worley, W. L. Tree Planters' Notes 45(3):86-87. 1994.

119.© **A phomopsis canker associated with branch dieback of Colorado blue spruce in Michigan.** Igoe, M. J.; Peterson, N. C.; Roberts, D. L. Plant Disease 79(2):202-205. 1995.

120. ***Pythium* plan of action.** Hausbeck, M. Greenhouse Grower 12(6):67-70. 1994.

121. **Recognizing and eliminating fungus gnats and shore flies.** Robb, K. Greenhouse Management and Production 14(4):70-71. 1995.

122. **Scalping reduces impact of soilborne pests and improves survival and growth of slash pine seedlings on converted agricultural croplands.** Barnard, E. L.; Dixon, W. N.; Ash, E. C.; Fraedrich, S. W.; Cordell, C. E. Southern Journal of Applied Forestry 19(2):49-59. 1995.

123.© **Seedborne *Fusarium* on Douglas-fir: pathogenicity and seed stratification method to decrease *Fusarium* contamination.** Axelrood, P. E.; Neumann, M.; Trotter, D.; Radley, R.; Shrimpton, G.; Dennis, J. New Forests 9(1):35-51. 1995.

124.© **Soil solarization in an Italian forest nursery.** Annesi, T.; Motta, E. European Journal of Forest Pathology 24(4):203-209. 1994.

125.© **Soluble silicon: its role in crop and disease management of greenhouse crops.** Belanger, R. R.; Bowen, P. A.; Ehret, D. L.; Menzies, J. G. Plant Disease 79(4):329-336. 1995.

126. **Spider mites...** rearing their resistant heads again. Smitley, D. Greenhouse Grower 13(2):20, 22, 24-26. 1995.

127. **Susceptibility of redbuds (Cercis) to root-knot nematodes.** Santamour, F. S., Jr.; Riedel, L. G. H. Journal of Arboriculture 21(1):37-40. 1995.

128. **Testing alternatives to methyl bromide fumigation at New Kent Nursery.** Carey, B. Auburn University, Southern Forest Nursery Management Cooperative, Research Note 95-1. 4 p. 1995.

129. **Urban and agricultural wastes for use as mulches on avocado and citrus and for delivery of microbial biocontrol agents.** Casale, W. L.; Minassian, V.; Menge, J. A.; Lovatt, C. J.; Pond, E.; Johnson, E.; Guillemet, F. Journal of Horticultural Science 70(2):315-332. 1995.

130. **Wipe out algae.** Milgate, H. B. Greenhouse Grower 12(8):20. 1994.

Pesticides

131. **Enhance your pesticide applications with adjuvants.** Robb, K. Greenhouse Management and Production 13(12):67-68. 1995.

132. **Science and policy in regulating pesticides: will they collide or merge?** Andersen, J. L. Weed Technology 8(4):883-886. 1994.

133. **Tank mixing: a two-in-one punch.** Hopkins, M. T. Greenhouse Grower 13(2):32-33. 1995.

134. **Test your environmental I.Q., part 3: Managing pesticides - grow safe, grow smart.** Firth, K. M. Greenhouse Grower 12(13):47-50. 1994.

135. **Worker protection's new dress code.** Hopkins, M. T. Greenhouse Grower 13(1):59-60, 62. 1995.

Seedling Harvesting and Storage

136. **Benomyl applied to roots improves second-year survival and growth of shortleaf pine.** Hallgren, S. W.; Ferris, D. M. Southern Journal of Applied Forestry 19(1):36-41. 1995.

137. **Overwintering black spruce container stock under a Styrofoam SM insulating blanket.** Whaley, R. E.; Buse, L. J. Tree Planters' Notes 45(2):47-52. 1994.

138.© **Physiological recovery of freezer-stored white and Engelmann spruce seedlings planted following different thawing regimes.** Camm, E. L.; Guy, R. D.; Kubien, D. S.; Goetze, D. C.; Silim, S. N.; Burton, P. J. New Forests 10(1):55-77. 1995.

139. **Ship-shape shipping.** Kren, L. A. Greenhouse Grower 12(14):64, 66-67. 1994.

Seedling Physiology and Morphology

140. **Anti-stress 2000 fails to protect pine seedlings against frost.** Zwolinski, J. Auburn University, Southern Forest Nursery Management Cooperative, Research Note 95-3. 4 p. 1995.

141. **Assessment of frost damage to leafless stem tissues of *Quercus petraea:* a reappraisal of the method of relative conductivity.** Deans, J. D.; Billington, H. L.; Harvey, F. J. Forestry 68(1):25-34. 1995.

142.© **The effect of flurprimidol on bud flush, shoot growth, and on endogenous gibberellins and abscisic acid of Douglas-fir seedlings.** Graham, J. S.; Hobbs, S. D.; Zaerr, J. B. Journal of Plant Growth Regulation 13(3):131-136. 1994.

143.© **Effects of ambient ozone on seedlings of *Fagus sylvatica* L. and *Picea abies* (L.) Karst.** Braun, S.; Fluckiger, W. New Phytologist 129(1):33-44. 1995.

144.© **Effects of cold storage and water stress on water relations and gas exchange of white spruce *(Picea glauca)* seedlings.** Jiang, Y.; Macdonald, S. E.; Zwiazek, J. J. Tree Physiology 15(4):267-273. 1995.

145.© **Effects of "near-lethal" stress on bud dormancy and stem cold hardiness in red-osier dogwood.** Shirazi, A. M.; Fuchigami, L. H. Tree Physiology 15(4):275-279. 1995.

146.© **Effects of ozone on growth and gas exchange of *Eucalyptus globulus* seedlings.** Pearson, M. Tree Physiology 15(3):207-210. 1995.

147.© **Effects of shade on the morphology and physiology of amabilis fir and western hemlock seedlings.** Mitchell, A. K.; Arnott, J. T. New Forests 10(1):79-98. 1995.

148.© **Frost hardiness and winter photosynthesis of *Thuja plicata* and *Pseudotsuga menziesii* seedlings grown at three rates of nitrogen and phosphorus supply.** Hawkins, B. J.; Davradou, M.; Pier, D.; Shorn, R. Canadian Journal of Forest Research 25(1):18-28. 1995.

149. **Frost hardiness gradients in shoots and roots of *Picea mariana* seedlings.** Colombo, S. J.; Zhao, S.; Blumwald, E. Scandinavian Journal of Forest Research 10(1):32-36. 1995.

150.© **Growth and dry matter partitioning in loblolly and ponderosa pine seedlings in response to carbon and nitrogen availability.** Griffin, K. L.; Winner, W. E.; Strain, B. R. New Phytologist 129(4):547-556. 1995.

151.© **Growth and morphology of rhizome cuttings and seedlings of salal *(Gaultheria shallop):* effects of four light intensities.** Huffman, D. W.; Zasada, J. C.; Tappeiner, J. C. II. Canadian Journal of Botany 72(11):1702- 1708. 1994.

152. **Handwarmers benefit young citrus trees during freezes.** Parsons, L. R.; Wheaton, T. A.; Yelenosky, G. HortScience 30(2):231233. 1995.

153.© **The induction of freezing tolerance in jack pine seedlings: the role of root plasma membrane H+-ATPase and redox activities.** Zhao, S.; Colombo, S. J.; Blumwald, E. Physiologia Plantarum 93(1):55-60. 1995.

154.© **Influence of copper on root growth and morphology of *Pinus pinea* L. and *Pinus pinaster* Ait. seedlings.** Arduini, L; Godbold, D. L.; Onnis, A. Tree Physiology 15(6):411-415. 1995.

155.© **Influence of root temperature on growth of *Pinus sylvestris*, *Fagus sylvatica*, *Tilia cordata* and *Quercus* robur.** Lyr, H.; Garbe, V. Trees: Structure and Function 9(4):220-223. 1995.

156.© **Interactions between drought and elevated CO_2 on growth and gas exchange of seedlings of three deciduous tree species.** Tschaplinski, T. J.; Stewart, D. B.; Hanson, P. J.; Norby, R. J. New Phytologist 129(1):63-71. 1995.

157. **Problems of reporting spectral quality and interpreting phytochrome- mediated responses.** Rajapakse, N. C.; Kelly, J. W. HortScience 29(12):1404- 1407. 1994.

158. **Reduced water supply induces fall acclimation of evergreen azaleas.** Anisko, T.; Lindstrom, O. M. Journal of the American Society for Horticultural Science 120(3):429-434. 1995.

159.© **Relationship between net photosynthesis and nitrogen in Scots pine: seasonal variation in seedlings and shoots.** Vapaavuori, E. M.; Vuorinen, A. H.; Aphalo, P. J.; Smolander, H. Plant and Soil 168-169:263-270. 1995.

160.© **Response of red alder seedlings to CO_2 enrichment and water stress.** Hibbs, D. E.; Chan, S. S.; Castellano, M.; Niu, C. H. New Phytologist 129(4):569- 577. 1995.

161. **The role of photoinhibitation during tree seedling establishment at low temperatures.** Ball, M. C. Photoinhibition of photosynthesis for molecular mechanisms to the field, p. 365-376. N.R. Baker, ed. BIOS Scientific Publishers. 1994.

162.© **Root freezing tolerance and vitality of Norway spruce and Scots pine seedlings; influence of storage duration, storage temperature, and prestorage root freezing.** Lindstrom, A.; Stattin, E. Canadian Journal of Forest Research 24(12):2477-2484. 1994.

163.© **Root response to CO_2 enrichment and nitrogen supply in loblolly pine.** Larigauderie, A.; Reynolds, J. F.; Strain, B. R. Plant and Soil 165(1):21-32. 1994.

164. **Seedling roots and forest floor: Misplaced and neglected aspects of British Columbia's reforestation effort?** Balisky, A. C.; Salonius, P.; Walli, C.; Brinkman, D. Forestry Chronicle 71(1):59-65. 1995. Unnatural root morphology, coupled with planting techniques that emphasize vertical orientation of roots, may exacerbate harsh microenvironmental site conditions.

165. **Take your plants' temperature.** Faust, J. E.; Heins, R. D. Greenhouse Grower 13(5):68-69. 1995. Knowing shoot tip temperature can improve grower's control of greenhouse crops.

166.© **Temperature control of the development of frost hardiness in two populations of *Leptospermum scoparium*.** Green D. H.; Robinson, L. A. Tree Physiology 15(4):399-404. 1995.

167.© **The use of mitotic index in seedling assessments.** Krasowski, M. J.; Owens, J. N. Canadian Journal of Forest Research 24(11):2222-2234. 1994.

168. **Validity of screening for foliage cold hardiness in the laboratory.** Johnson, G. R.; Hirsh, A. G. Journal of Environmental Horticulture 13(1):26-30. 1995.

169.© **Water stress preconditioning of black spruce seedlings from lowland and upland sites.** Zinc El Abidine, A.; Bernier, P. Y.; Stewart, J. D.; Plamondon, A. P. Canadian Journal of Botany 72(10):1511-1518. 1994.

SO. **Containerized spruce seedlings: relative importance of measured morphological and physiological variables in characterizing seedlings for reforestation.** D'Aoust, A. L.; Delisle, C.; Girouard, R.; Gonzalez, A.; Bernier-Cardou, M. Canadian Forest Service, Laurentian Forestry Centre, Information Report LAU-X-110E. 27 p. 1994. ORDER FROM: Canadian Forest Service - Quebec Region, Laurentian Forestry Centre, 1055 du P.E.P.S., P.O. Box 3800, Sainte-Foy, Quebec G IV 4C7 Canada. Free.

Seeds

170. **Atlantic white-cedar propagation by seed and cuttings in New Jersey.** Boyle, E. D.; Kuser, J. E. Tree Planters' Notes 45(3):104111. 1994.

171.© **Effects of artificial environmental conditions on anatomical and physiological ripening of *Pinus sylvesfris* L. seeds.** Sahlen, K.; Abbing, K. New Forests 9(3):205-224. 1995.

172. **Effects of temperature on germination of stratified seeds of three ash species.** Piotto, B. Seed Science and Technology 22(3):519529. 1994.

173.© **Estimating acorn crops using visual surveys.** Koenig, W. D.; Knops, J. M. H.; Carmen, W. J.; Stanback, M. T.; Mumme, R. L. Canadian Journal of Forest Research 24(10):2105-2112. 1994.

174. **Field and laboratory investigations of seed dormancy in red maple *(Acer rubrum* L.) from the North Carolina piedmont.** Peroni, P. A. Forest Science 41(2):378-386. 1995.

175. **A historical overview of seed upgrading techniques and on to new roads of discovery.** Edwards, D. G. W. IN: Proceedings of the joint meeting of the B.C. Seed Dealers' Association and the Western Forest and Range Seed Council, p.21-24. Held June 2-4, 1993, Vernon, B.C., Canada. Forestry Canada and British Columbia Ministry of Forests. 1993.

176.© **Interactive effects of light and stratification on the germination of some British Columbia conifers.** Li, X. J.; Burton, P. J.; Leadem, C. L. Canadian Journal of Botany 72(I I):1635-1646. 1994.

177. **Introduction to collecting quality seeds.** Pigott, D. IN: Proceedings of the joint meeting of the B.C. Seed Dealers' Association and the Western Forest and Range Seed Council, p. 13-17. Held June 2-4, 1993, Vernon, B.C., Canada. Forestry Canada and British Columbia Ministry of Forests. 1993.

178. **Keep your cool during germination.** Faust, J. E.; Shimizu, H.; Heins, R. D. Greenhouse Grower 12(11):52, 55, 58. 1994.

179.© **The morphological background to imbibition in seeds of *Pinus sylvesfris* L. of different provenances.** Tillman-Sutela, E.; Kauppi, A. Trees: Structure and Function 9(3):123-133. 1995. Describes the surface structure of the seed coat of Scots pine, its basic anatomy and color, any differences between provenances and their contribution to differences in imbibition.

180. **Nursery experience with seed orchard seed - spruce.** Kooistra, C. M. IN: Proceedings of the joint meeting of the B.C. Seed Dealers' Association and the Western Forest and Range Seed Council, p.5-8. Held June 2-4, 1993, Vernon, B.C., Canada. Forestry Canada and British Columbia Ministry of Forests. 1993.

181. **Operational density separation processing (DSP) at the BCFS tree centre (TSC) -1993.** Kolotelo, D. IN: Proceedings of the joint meeting of the B.C. Seed Dealers' Association and the Western Forest and Range Seed Council, p. 25-35. Held June 24, 1993, Vernon, B.C., Canada. Forestry Canada and British Columbia Ministry of Forests. 1993.

182. **pH of seed exudate as a rapid physiological quality test.** Peske, S. T.; Amaral, A. S. Seed Science and Technology 22(3):641-644. 1994.

183.© **Presowing seed priming.** Parera, C. A.; Cantliffe Horticultural Reviews 16:109-141. 1994.

184. **Seed drying fundamentals and practical considerations.** Furber, R. A. IN: Proceedings of the joint meeting of the B.C. Seed Dealers' Association and the Western Forest and Range Seed Council, p.36-39. Held June 2-4, 1993, Vernon, B.C., Canada. Forestry Canada and British Columbia Ministry of Forests. 1993.

185. **Seed for thought.** Kren, L. A. Greenhouse Grower 12(11):48-49. 1994. Reviews seed coating, seed pelleting, mufti-seeding, and seed priming.

186. **Seed lot potential: viability, vigour and field performance.** McDonald, M. B., Jr. Seed Science and Technology 22(3):421-425. 1994.

187. **Seedcoat structure related to germination in eastern redbud *(Cercis canadensis L.).*** Jones, R. O.; Geneve, R. L. Journal of the American Society for Horticultural Science 120(1):123-127. 1995.

188. **Using seed orchard seed in the nursery; the growers point of view.** Hale, T. IN: Proceedings of the joint meeting of the B.C. Seed Dealers' Association and the Western Forest and Range Seed Council, p.3-4. Held June 2-4, 1993, Vernon, B.C., Canada. Forestry Canada and British Columbia Ministry of Forests. 1993.

SO. **Tree seed technology training course: instructor's manual.** Bonner, F. T.; Vozzo, J. A.; Elam, W. W.; Land, S. B., Jr. USDA Forest Service, Southern Forest Experiment Station, General Technical Report SO-106. 160 p. 1994. ORDER FROM: USDA Forest Service, Southern Forest Experiment Station, 701 Loyola Avenue, New Orleans, LA 70113. Free.

SO. **Tree seed technology training course: student outline.** Bonner, F. T.; Vozzo, J. A.; Elam, W. W.; Land, S. B., Jr. USDA Forest Service, Southern Forest Experiment Station, General Technical Report SO-107. 81 p. 1994. ORDER FROM: USDA Forest Service, Southern Forest Experiment Station, 701 Loyola Avenue, New Orleans, LA 70113. Free.

Soil Management and Growing Media

189. **Canadian sphagnum peat moss ... a sustainable natural resource.** Steinkamp, R. Greenhouse Grower 11(12):28-29. 1993.

190. **Development of a polyethylene mulch system that changes color in the field.** Graham, H. A. H.; Decoteau, D. R.; Linvill, D. E. HortScience 30(2):265-269. 1995.

191. **Effects of the physical properties of *Sphagnum* peat on the nursery growth of containerized *Picea mariana* and *Picea glauca* seedlings.** Bernier, P. Y.; Gonzalez, A. Scandinavian Journal of Forest Research 10(2):176- 183. 1995.

192. **Effects of the physical properties of *Sphagnum* peat on water stress in containerized *Picea mariana* seedlings** under simulated field conditions. Bernier, P. Y.; Stewart, J. D.; Gonzalez, G. Scandinavian Journal of Forest Research 10(2):184-189. 1995.

193. **Growth of two subtropical ornamentals using coir (coconut mesocarp pith) as a peat substitute.** Meerow, A. W. HortScience 29(12):1484-1486. 1994.

194. **Kenaf: New growing medium component produces quality crops in quicker time—for less.** Wang, Y. T. Greenhouse Management and Production 13(11):53-54, 56-58. 1995.

195. **Looking for growth media?** Greenhouse Grower 11(12):30-31. 1993. List of various brands with their main ingredients and additives.

196.© **Measuring the saturated hydraulic conductivity of peat substrates in nursery containers.** Allaire, S. E.; Carom J.; Gallichand, J. Canadian Journal of Soil Science 74(4):431-437. 1994.

197. **Suitability of composted bluegrass residues as an amendment in container media.** Manning, L. K.; Tripepi, R. R.; Campbell, A. G. HortScience 30(2):277-280. 1995.

198. **What to expect from your substrate.** Fonteno, W. C. Greenhouse Grower 11(12):22-23. 1993. More important than what's in your mix is how its properties combine to affect water and air availability to plant roots.

Tropical Forestry and Agroforestry

199. **Amelioration of degraded rain forest soils by plantations of native trees.** Fisher, R. F. Soil Science Society of America Journal 59(2):544-549. 1995.

200.© **Effect of indole butyric acid (IBA) on stem cuttings of *Shorea leprosula.*** Aminah, H.; Dick, J. McP; Leakey, R. R. B.; Grace, J.; Smith, R. I. Forest Ecology and Management 72(2-3):199-206. 1995.

201. **Effect of inoculation of VAM fungi and *Rhizobium* on growth and biomass production in *Acacia nilotica* in nursery.** Verma, R. K.; Gupta, J.; Gupta, B. N. Indian Forester 120(12):1989-1094. 1994.

202.© **Effects of sodium chloride on growth, tissue elasticity and solute adjustment in two *Acacia nilotica* subspecies.** Nabil, M.; Coudret, A. Physiologia Plantarum 93(2):217-224. 1995.

203. **Forest rehabilitation in the Asia-Pacific region: past lessons and present uncertainties.** Lamb, D. Journal of Tropical Forest Science 7(1):157- 170. 1994.

204. **Genotypic variations in germination and potential in *Acacia nilotica* (L.) seeds.** Dhillon, G. P. S.; Khajuria, H. N. Indian Journal of Forestry 17(4):345-347. 1994.

205. **Increasing nursery efficiency by use of presprouted seeds in *Hardwickia binata* Roxb.** Suresh, K. K.; Swaminathan, C.; Vinaya Rai, R. S. Indian Journal of Forestry 17(4):356-358. 1994.

206. **Microbial technology for raising seedlings of fast growing trees.** Meshram, S. U.; Joshi, S. N.; Pande, S. S.; Gaikwad, S. J.; Juwarkar, A. S. Indian Journal of Forestry 17(3):243248. 1994.

207. **A note on in vitro screening of fungicides on *Fusarium solani* and *F. oxysporum* isolated from *Pterocarpus indicus* (Angsana).** Philip, E. Journal of Tropical Forest Science 7(2):332-225. 1994.

208. **Nutrition of *Robinia pseudacacia* L. as influenced by phosphorus and molybdenum.** Sharma, K.; Joshi, N. K.; Verma, K. S. Indian Forester 120(12):1080-1083. 1994.

209. **Provenance variation in rooting ability of juvenile stem cuttings from *Racosperma auriculiforme* and *R. mangium.*** Khasa, P. D.; Vallee, G.; Bousquet, J. Forest Science 41(2):306-320. 1995.

210. **Reforestation of degraded tropical forest lands in the Asia-Pacific region.** Lamb, D. Journal of Tropical Forest Science 7(1):1-7. 1994.

211.© **Selection of efficient VA mycorrhizal fungi for *Casuarina equisetcfolia - second* screening.** Vasanthakrishna, M.; Bagyaraj, J. D.; Nirmalnath, J. P. New Forests 9(2):157-162. 1995.

212. **Sowing of pelletized seed: a technique to simplify eucalypt raising in tropical nurseries.** Piotto, B. Tree Planters' Notes 45(2):58-62. 1994.

213. **Vegetative propagation of *Casuarina junghuhniana* by rooted sprigs.** Ravichandran, V. K.; Balasubramanian, T. N.; Rajasekaran, S. Indian Journal of Forestry 17(4):361-362. 1994.

214. **Wrenching and fertilization of *Acacia catechu* Willd. stock - effect on morphology of seedlings.** Chauhan, P. S.; Gupta, S. K. Indian Journal of Forestry 17(3):201-204. 1994.

Vegetative Propagation and Tissue Culture

215. **Automobile radiator antifreeze and windshield washer fluid as IBA carriers for rooting woody cuttings.** Chong, C.; Hamersma, B. HortScience 30(2):363-365. 1995.

216. **Contributions of the leaves and axillary shoots to rooting in *Eucalyptus grandis* Hill ex Maid. stem cuttings.** Wilson, P. J. Journal of Horticultural Science 69(6):999-1007. 1994.

217. **Contributions of the stem to rooting in *Eucalyptus grandis* Hill ex Maid. stem cuttings.** Wilson, P. J. Journal of Horticultural Science 69(6):1009- 1017. 1994.

218.© **Cutting propagation of common cypress *(Cupressus sempervirens L.).*** Capuana, M.; Lambardi, M. New Forests 9(2):111-122. 1995.

219. **Development of a computer database for vegetative propagation of trees and shrubs.** Burger, D. W.; Lee, C. I. Journal of Environmental Horticulture 12(2):87-89. 1994.

220. **Effect of vesicular-arbuscular mycorrhizal fungi on rooting of *Sciadopitys verticillata* Sieb & Zucc. cuttings.** Douds, D. D., Jr.; Becard, G.; Pfeffer, P. E.; Doner, L. W.; Dymant, T. J.; Kayser, W. M. HortScience 30(1):133- 134. 1995.

221. **Fungicide treatment increases sprouting percentage and sprout growth for *Paulownia tomentosa* root cuttings.** Stringer, J. W. Tree Planters' Notes 45(3):101-103. 1994.

222.© **Genetic variation in rooting ability of loblolly pine cuttings: effects of auxin and family on rooting by hypocotyl cuttings.** Greenwood, M. S.; Weir, R. J. Tree Physiology 15(1):41-45. 1995.

223.© **Influence of environment, fertilizer and genotype on shoot morphology and subsequent rooting of birch cuttings.** Welander, M. Tree Physiology 15(1):11-18. 1995.

224. **Light quality of the in vitro stage affects the subsequent rooting and field performance of *Betula pendula* (Roth).** Saebo, A.; Skjeseth, G.; Appelgren, M. Scandinavian Journal of Forest Research 10(2):155-160. 1995.

225. **Propagating cuttings, part I: water.** Read, P. E. American Nurseryman 181(3):80-85. 1995. Enclosures, intermittent mist systems, fog systems and antitranspirants can be used to reduce plant water loss.

226. **Propagating cuttings, part II: temperature.** Preece, J. E. American Nurseryman 181(4):38-41. 1995. Proper control of air and root zone temperatures is critical when rooting stem cuttings.

227. **Propagating cuttings, part IV. How stock plant age affects the root formation of cuttings.** Geneve, R. L. American Nurseryman 181(6):56-61. 1995.

228. **Propagation of fraser fir.** Blazich, F. A.; Hinesley, L. E. Journal of Environmental Horticulture 12(2):112-117. 1994.

229. **Rooting cuttings in cupric hydroxide treated pots affects root length and number of flowers after transplanting.** Svenson, S. E.; Johnston, D. L. HortScience 30(2):247-248. 1995.

230. **Setting of uprooted cuttings in the field: a shortcut in radiata pine plantation establishment?** Klomp, B.; Holden, G.; Faulds, T.; Dibley, M. New Zealand Forest Research Institute, What's New in Forest Research 236. 4 p. 1995.

231. **Sprouting and growth of *Paulownia tomentosa* root cuttings.** Stringer, J. W. Tree Planters' Notes 45(3):95-100. 1994.

232. **Towards a protocol for the micropropagation of *Pinus patula.*** McKellar, D. S.; Herman, B.; Watt, M. P. South African Forestry Journal 171:33- 41. 1994.

Water Management and Irrigation

233. **Adoption of nitrogen and water management practices to improve water quality.** Supalla, R. J.; Selley, R. A.; Bredeweg, S.; Watts, D. Journal of Soil and Water Conservation 50(1):77-82. 1995.

234. **Application technology and best management practices for minimizing herbicide runoff.** Baker, J. L.; Mickelson, S. K. Weed Technology 8(4):862-869. 1994.

235. **Backflow devices key to contamination prevention.** Pagliasotti, S. The Digger 39(3):29-30. 1995.

236. **Cyclic irrigation reduces container leachate nitrate-nitrogen concentration.** Fare, D. C.; Gilliam, C. H.; Keever, G. J.; Olive, J. W. HortScience 29(12):1514-1517. 1994.

237. **Five ways to sterilize your irrigation water.** Martinez, H. Greenhouse Management and Production 13(12):26-29. 1995. Using ozone treatment, ultraviolot light, chlorination, ultrafiltration or heat treatment.

238. **Irrigation primer.** Moore, J. Greenhouse Grower 13(3):28, 30-31. 1995. A look at the benefits and costs of different irrigation methods: hand watering, stationary sprinklers, watering boom, irrigation robot, ebb and flow.

239. **A look at: super absorbent polymers.** Roskens, L. Greenhouse Management and Production 13(11):97-100. 1995.

240. **Potential regulatory problems associated with atrazine, cyanazine, and alachlor in surface water source drinking water.** Nelson, H.; Jones, R. D. Weed Technology 8(4):852-861. 1994.

241. **Sources for greenhouse irrigation.** Biernbaum, J. A. Greenhouse Grower 11(12):32-34, 36. 1993. First in a four part series about water quality in the greenhouse and why it's important.

242. **Take control of your water quality.** Martinez, H. Greenhouse Management and Production 14(4):34-36. 1995.

243. **Test your environmental I.Q., part 2: Managing water and fertilizer - a little goes a long way.** Firth, K. M. Greenhouse Grower 12(12):55-58. 1994.

244. **Water status of sphagnum peat and a peat-perlite mixture in containers subjected to irrigation regimes.** Heiskanen, J. HortScience 30(2):281-284. 1995.

Weed Control

245. **A comparison of six glyphosate (360 g/1) generics for weed management.** Eccles, N.; Little, K. Institute for Commercial Forestry Research, South Africa, ICFR Newsletter, November 1994, p.2-3. 1994.

246.© **Comparison of the weedy vegetation in old-fields and crop fields on the same site reveals that fallowing crop fields does not result in seedbank buildup of agricultural weeds.** Odum, E. P.; Park, T. Y.; Hutcheson, K. Agriculture, Ecosystems and Environment 49(3):247-252. 1994.

247. **Effect of MON-12037 on purple *(Cyperus rotundus)* and yellow *(Cyperus esculentus)* nutsedge.** Vencill, W. K.; Richburg, J. S. III; Wilcut, J. W.; Hawf, L. R. Weed Technology 9(1):148-152. 1995.

248.© **Field survival of *Phoma proboscis* and synergism with herbicides for control of field bindweed.** Heiny, D. K. Plant Disease 78(12):1156-1164. 1994.

249. **Innovative herbicide application methods and their potential for use in the nursery and landscape industry.** Derr, J. F. HortTechnology 4(4):345-350. 1994. Methods described include: slow release tablets, herbicide collar, herbicide treated paper, herbicide treated mulch, and herbicide hand pruners.

Literature Order Form—July 1995

Please fill out a separate order form for each person ordering literature (copy this form). Circle the articles in which you are interested. For items that require a copyright fee, you will receive the title page with the abstract and ordering instructions. If you have questions about your literature orders, please contact "FSINFO Northwest": Tel: 206-553-1076; Fax: 206-553-1190.

Name ______________________ *Position* ______________________

Department ______________________ *Nursery/Company* ______________________

Mailing Address ______________________

Street Address ______________________

City ______________________ *State/Province* ______________________

State/Province ______________________

Country ______________________ *Zip/Postal Code* ______________________

Phone ______________________ *Fax* ______________________

1	2	3	4	5	6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25	26	27	28
29	30	31	32	33	34	35	36	37	38	39	40	41	42
43	44	45	46	47	48	49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	94	95	96	97	98
99	100	101	102	103	104	105	106	107	108	109	110	111	112
113	114	115	116	117	118	119	120	121	122	123	124	125	126
127	128	129	130	131	132	133	134	135	136	137	138	139	140
141	142	143	144	145	146	147	148	149	150	151	152	153	154
155	156	157	158	159	160	161	162	163	164	165	166	167	168
169	170	171	172	173	174	175	176	177	178	179	180	181	182
183	184	185	186	187	188	189	190	191	192	193	194	195	196
197	198	199	200	201	202	203	204	205	206	207	208	209	210
211	212	213	214	215	216	217	218	219	220	221	222	223	224
225	226	227	228	229	230	231	232	233	234	235	236	237	238
239	240	241	242	243	244	245	246	247	248	249			
A	B	C	D	E	F	G	H						

Return to:

Tom D. Landis, Western Nursery Specialist
USDA-Forest Service, CF
P.O. Box 3623
Portland, OR 97208-3623 USA
Fax: 503-326-5569

From: ______________________________

____

____

____

Place
Postage
Stamp
Here

Attn: Tom Landis
USDA Forest Service
Cooperative Forestry
PO Box 3623
Portland, OR 97208-3623 USA

This publication reports research involving pesticides. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.