United States Department of Agriculture

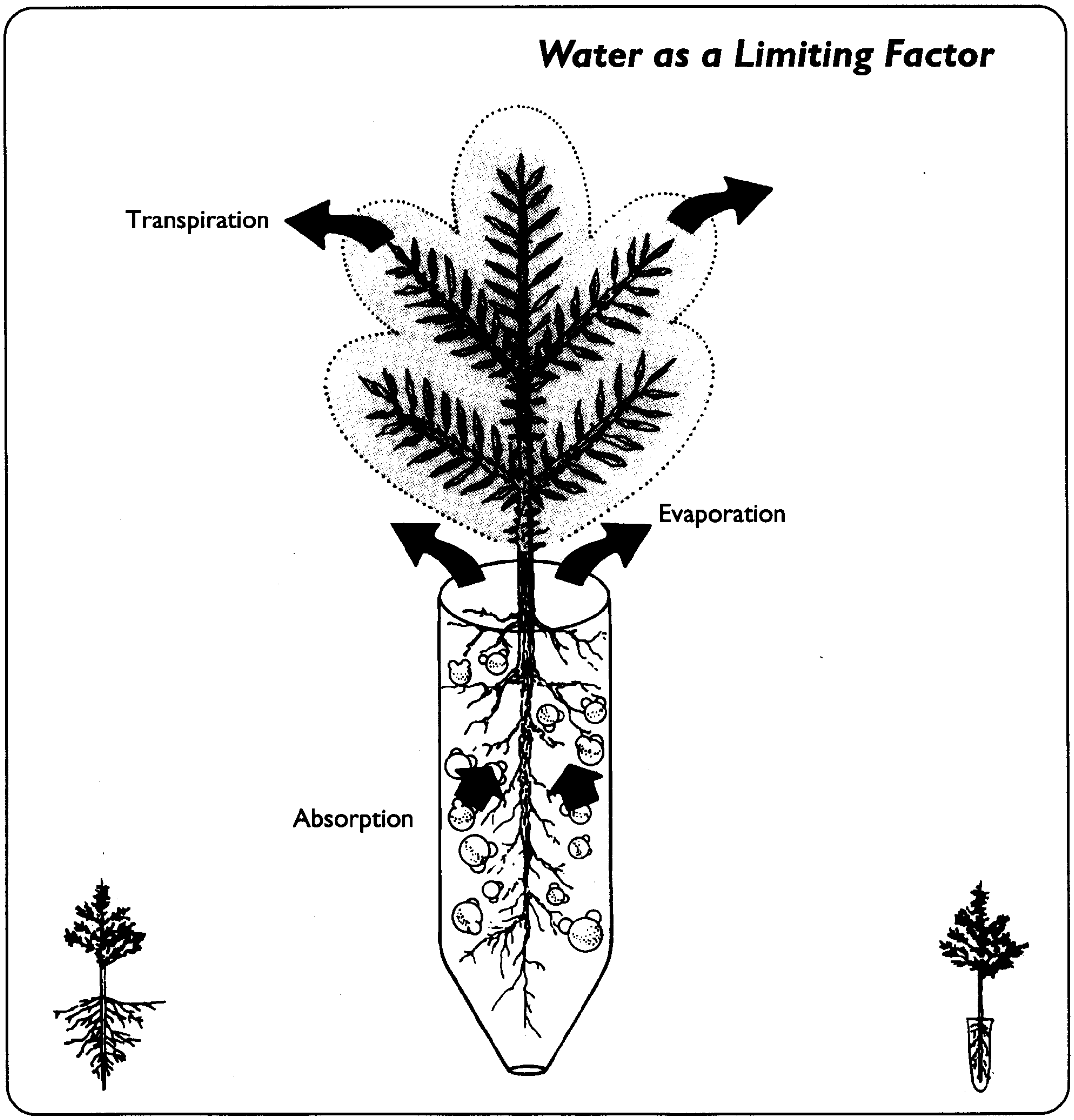
Pacific Northwest Region

State and Private Forestry

Cooperative Programs

Forest Nursery Notes

January 1994



This Technology Transfer Service is provided by:

USDA Forest Service
State & Private Forestry
Tom D. Landis
Western Nursery Specialist
PO Box 3623
Portland, OR 97208-3623
USA

Phone: (503) 326-6231 Fax: (503) 326-5569

FNN layout by Aleta Barthell

Forest Nursery Notes

January 1994

HOLIDAY PERSPECTIVES

"God put me on earth to accomplish a certain number of things.

Right now, I'm so far behind, I will never die."

Winter is a time of reflection, and the changing of the seasons is a comfortable reminder of the natural cycles that control our planet. Instead of being frustrated at all the things we have to do, let's take a different perspective. I think the key is to slow down and realize that we never are going to accomplish all the things that we wish we could. Instead, let's be thankful that we lead busy, productive lives in a profession that is having a positive effect on our world.

My best to you and yours during this Special Season.

TL

Contents

Forest Nursery Notes, January 1994

FNN Update Form

Well, the forms have been coming back steadily now for several months, and we are making the changes to the FNN mailing list. Apologies to you folks in British Columbia who received the wrong forms, and thanks for being patient with us. Matching up the letters with the mailing labels is more difficult than I anticipated, I guess. And thanks to all of you who included some kind words about the FNN service. The encouragement is certainly welcome.

New Official Look

As you can see on the cover, we now meet the official Forest Service Publication Design Criteria. In spite of these bureaucratic trappings, FNN will remain the same informative, yet slightly irreverent, technology transfer service.

FNN Literature Source

We have made new arrangements for copying and mailing the articles that you request on the Literature Order Form. Portland Habilitation, Inc. is a local handicapped workshop that does excellent work and I'm sure that you'll be satisfied with the quality of the copies and the speed of delivery. If you have any problems or questions about your orders, however, call or FAX me and we'll take care of it.

Nursery Meetings

"So Many Meetings, So Little Time"

The ***Southwestern Container Growers'*** are holding an organizational meeting at the Holiday Inn in Gallup, NM on ***Feb. 8-9,1994***. The Navaho Nation Forest Nursery and New Mexico State University are hosting this meeting, and anyone interested in growing forest and conservation seedlings in containers is invited to attend. In addition to a tour of the Navaho nursery in Ft. Defiance, we will be having an informal discussion on mineral nutrition and fertilization. For more information, contact me or John Harrington:

John Harrington
New Mexico State University
Mora Research Center 359
Mora, NM 87732

PHONE: 505-387-2319
FAX:505-387-9012

The annual ***Western Nursery Pathology Workshop*** will be held on ***March 21-24, 1994*** at the Salishan Lodge in Gleneden Beach, OR. This meeting consists of an informal mixture of technical presentations and discussions, and anyone interested in seedling pathology is invited to attend. The agenda is still being developed, so if you'd like to give a presentation or just simply want more information, contact:

Diane Hildebrand
USDA Forest Service, FPM
P.O. Box 3623
Portland, OR 97208-3623

PHONE: 503-326-6697
FAX:503-326-5569

The Virginia Department of Forestry will be hosting the ***Southern Forest Nursery Association Meeting*** in Williamsburg, VA on ***July 11-14, 1994***. The meeting will include technical sessions on Reforestation, Fumigation, Pine Culture, Hardwood Culture, and Safety and Environment in addition to field trips to local nurseries. The meeting will be in the heart of Colonial Williamsburg and you can literally walk to many local historical landmarks, making this meeting ideal for a family vacation. For the latest information, contact:

Ron Jenkins or Doris Madison
Virginia Dept. of Forestry
P.O. Box 3758
Charlottesville, VA 22903

PHONE: 804-966-2201
FAX: 804-966-9801

Agroforestry and Sustainable Systems, a symposium designed for researchers, practitioners, technical specialists, and educators, will be held on ***August 7-10, 1994*** in Ft. Collins, CO. Invited speakers will focus on how trees can be integrated into sustainable agricultural systems in the semiarid West, as well as how they can enhance agricultural productivity, natural resource conservation, and human environments. Volunteer posters are being accepted until April 15, 1994, and will also be included in the Proceedings. For more information, contact:

Kim Isaacson
USDA Forest Service
Center for Semiarid Forestry
University of Nebraska, East Campus
Lincoln, NE 68583-0822

PHONE: 402-437-5178 ext. 13
FAX: 402-437-5178

A joint meeting of the ***Western Forest Nursery Council*** and the ***Forest Nursery Association of British Columbia*** will be held at the Best Western University Inn in Moscow, ID on ***August 15-19, 1994.*** Morning technical sessions on innovative methods for growing seedlings for reforestation, conservation, and biodiversity will be balanced by afternoon field trips to local nurseries. We will also be boating on Lake Coeur d'Alene and picnicking in the Snake River Canyon. We need to get an estimate of attendance; so, if you didn't receive an announcement or forgot to mail it back, please contact Kas Dumroese by February 1. If you're interested in presenting a poster or paper, please indicate that as well:

Kas Dumroese
Forest Research Nursery
University of Idaho
Moscow, ID 83844-1137

PHONE: 208-885-7017
FAX: 208-885-6226

This year the ***Intermountain Container Seedling Growers'*** will get together in Moscow, ID on ***Aug. 15, 1994*** in conjunction with the ***Western Forest Nursery Council*** meeting mentioned above. This will give us a chance to have our usual informal yet informative meeting, and save the cost of going to another meeting. The agenda is still being developed, but for more information, contact me or Kas.

"Making the Grade" will be the theme of an international symposium on planting stock performance and quality assessment which will be held in Sault Ste. Marie, ON on ***Sept. 11-15, 1994.*** The meeting is being arranged by the Ontario Forest Research Institute and is co-sponsored by IUFRO Working Parties on Characterization of Plant Material, Physiology, and Nursery Operations (See International Nursery Section for membership details). Invited presentations by world leaders in plant quality assessment will be supplemented by volunteer papers and posters which will make this meeting a must for researchers, reforestation specialists, and nursery workers. Tours to the Research Institute and local nurseries will round out the meeting. If you would like more information, contact:

Tom Noland or Peter Menes
Ontario Forest Research Institute
P.O. Box 969, 1235 Queen Street E.
Sault Ste. Marie, ON
CANADA P6A SNS

PHONE: 705-946-2981
FAX:705-946-2030

The 35th annual meeting of the ***Western Region of the International Plant Propagators' Society*** will be held at the Red Lion Hotel in Costa Mesa, CA on ***Sept. 29-Oct. 1, 1994.*** The society motto "To Seek and To Share" reflects the objectives of the annual meeting in which members share their knowledge and experience in the propagation of a wide variety of plants. This year's meeting will feature technical presentations and field trips to local nurseries, and is an excellent opportunity to expand your horticultural horizons. I hope to see you there. Additional information can be obtained from:

IPPS Membership
Wilbur Bluhm
IPPS, Western Region
743 Linda Avenue NE
Salem, OR 97303
PHONE: 503-393-2934

Program Chairman
Mike Evans
Tree of Life Nursery
P.O. Box 736
San Juan Capistrano, CA 92693
PHONE: 714-728-0685

National Nursery Issues

Methyl Bromide Update

The US Environmental Protection Agency (EPA) recently announced that the phaseout of methyl bromide (MBC) will be extended one year to Jan. 1, 2001. Beginning in 1994, MBC production will be held at 1991 levels and so availability will become an increasingly serious problem. The latest research has shown that a small amount of MBC used in agriculture reaches the stratosphere where some "fraction of it" participates in the destruction of the ozone layer (See last several issues of FNN for more information). Therefore, the proposed listing of MBC as a "Class I Ozone Depletor" under the *Clean Air Act* will probably occur this coming year. Following that, Congress may be assigning special excise taxes which are designed to make it less economical and reduce its use. I couldn't find any mention of specific amounts; however, because soil fumigation is already one of the most expensive treatments in bareroot nursery operations, any price increase will have a significant effect.

The Southern Forest Nursery Management Cooperative at Auburn University is screening alternative fumigants alone and in combination, including Basimid®, Sectagon® and Triform®. Basimid is already in wide use in the Western US and several nurseries have already completely switched over from MBC. I'll try to keep you informed as this saga continues, so stay tuned!

Source: Auburn University Southern Forest Nursery Management Cooperative Newsletter, Fall 1993. Auburn University, AL. 8 p.

The Worker Protection Standard: You Must Comply by Aril 15, 1994

In 1992, the EPA issued a new regulation called the *Worker Protection Standard (WPS)* which is designed to protect agricultural employees from occupational exposure to pesticides or their residues. Who must comply? You do if you own or manage a farm, forest, nursery or greenhouse where pesticides are used in the production of agricultural plants. This not only includes typical bareroot and container seedlings but also Christmas trees, hedges used as a source of cuttings, and even research plants. Some provisions of the *WPS* are already in place, and you'll have to comply with the rest of the law by April 15, 1994.

At first glance the *WPS* may seem complicated, especially if you try and decipher it from the Federal Register. The provisions are relatively straight-forward and so, if you use common sense and get a little help, complying with the law should not be difficult. You should first contact your local cooperative extension service and state pesticide regulatory agency and find out what materials and training sessions they are planning to help you comply with *WPS*. As part of their training and information sessions they may provide as handouts, or for a nominal charge, all of the publications described below. Watch local agricultural supply companies for posters, signs, personal protective equipment, and other items you'll need to comply with the *WPS*.

There are several publications available from the EPA and other organizations which are very informative and make WPS compliance much simpler. All of the following materials are available through the Government Printing Office (GPO), but you can also get them from your local regulatory agencies, and private companies. The phone number of the Washington, DC office of the GPO is 202-783-3238, or you can contact the distribution center here in Portland. Prices include shipping and handling, and you can order by mail, phone, or FAX. All orders must be prepaid in cash, check payable to "Superintendent of Documents", or can be charged to Visa or MasterCard:

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

Federal Register

The August 21, 1992 issue of the Federal Register contains the actual law. You don't have to read this to become savvy with WPS, you may also find it repetitive and with too much legalese. It is useful as a reference, however. You can check it out at our local library, or you can obtain a copy from:

US Environmental Protection Agency/OPP
Mail Code 7506C
Washington, DC 20460
PHONE: 703-305-7666
FAX: 703-305-5884

WPS Compliance Manual

You should definitely order an EPA compliance manual as this is the "bible" for the WPS. The manual is handy, easy-to-read, and includes a quick reference guide that boils all the requirements of the WPS down to two pages. It should be available from your local cooperative extension service office, state pesticide regulatory office, or your EPA Regional Office. Private companies such as Gempler's Agricultural Supplies are also printing the manual. EPA requires they copy the manual verbatim, so you don't have to worry about not getting all the facts. They'll send you a complimentary copy, additional copies are $1 each, and volume discounts are available with larger orders. If you have particular questions about the WPS, Trisha Cox is their specialist:

Gempler's
PHONE: 800-3 82-8473
FAX:800-551-1128

Compliance Manuals can also be purchased for $8.50 each from the GPO, with a 25% discount if you order over 100. Ask for publication number 055-000-00442-1.

Quick Reference Guide Poster

This is a 17 in. x 22 in. poster of the quick reference guide found in the compliance manual. The GPO offers copies for only $1.00 with a 25% discount for orders of 100 or more--ask for publication number 055-000-00445-5.

"Protect Yourself from Pesticides" Poster

One of the requirements of the WPS is that you must display a safety poster at your nursery by April 15, 1994. You may make your own poster as long as it contains all the information and requirements specified in the compliance manual, or they are also available from private suppliers. The GPO has the EPA-developed version which is 24 in. x 36 in., illustrated in color, and has both English and Spanish text. It is publication number 055-000-00444-7 and sells for $1.50, with a 25% discount if you order more than 100.

"Protect Yourself from Pesticides: Guide for Agricultural Workers" Booklet

Employee training is mandated by the WPS. This Worker Training Booklet can be used for training your employees and is written in both English and Spanish. They cost only $3 - again with the 25% discount if you order more than 100 - ask for publication number 055-000-00443-9:

Finally, some states, tribes, or local governments with jurisdiction over pesticide enforcement may have additional worker protection requirements beyond those mandated by the federal WPS. Check with these agencies to obtain all the information you need to comply with their specific requirements.

Source: This information was graciously supplied by cub reporter Kas Dumroese of the Forest Research Nursery, University of Idaho, Moscow, ID.

International Nursery Items

International Union of Forest Research Organizations (IUFRO)

As announced in the Nursery Meetings and Workshops section, the "Making the Grade" seedling quality workshop will be held in Sault Ste. Marie, Ontario this coming September. This meeting is being jointed sponsored by 3 different IUFRO Working Parties, and I encourage you to consider joining one of them. Membership in international organizations is an excellent opportunity to share information and learn what nursery folks are doing in other countries. Contact one of the following group leaders for more information on IUFRO organization and membership:

Working Group S1.05-04: Characterization of Plant Material

Dr. Pasi Puttonen
B.C. Ministry of Forests
Research Branch
31 Bastion Square
Victoria, BC
CANADA V8W 3E7

PHONE: 604-387-3041
FAX: 604-3 87-0046

Working Group 53.02-03 Nursery Operations

Dr. Mike Menzies
New Zealand Forest Research Institute
Dept. of Biotechnology
Private Bag 302
Rotorua
NEW ZEALAND

PHONE: 64-73-475-899
FAX:64-73-479-3 80

Subject Group 52.01-00: Physiology

Dr. Melvin Cannell
Natural Environment Research Council
Institute of Terrestrial Ecology
Bush Estate
Penicuik, Midlothian
UNITED KINGDOM EH26 OQB

PHONE: 44-31-445-4343
FAX: 44-31-445-3943

Ecological Alternatives

The Production and Use of Organic Composts

Composting is a term that has been most recently associated with organic gardening but, in reality, has been around for thousands of years. Few forest and conservation nurseries use composts at the present time, although several nurseries have made small composting trials in recent years. However, there are new reason why both bareroot and container nurseries should take another look at the benefits of composts:

Container Nurseries

Organic Component in Growing Media. Peat moss, the standard organic component of most artificial growing media, is already too expensive in some regions. Composting offers tremendous opportunities for generating locally-made organic materials for use in growing media.

Suppressive Media. Growing media that contain composted organic materials can help control soilborne diseases. While all composts have some suppressive benefits, it may soon be possible to custom-inoculate growing media to combat specific pests.

Bareroot nurseries

Soil Amendments. Propagation of bareroot seedlings is hard on soils, and even the best nursery soil loses some of its original productivity after several crops. Organic composts can improve soils in several ways but one of the most important is its positive effect on soil structure. The composting process increases soil porosity because gums, which result from the decomposition of organic matter, and fungal mycelia bind soil particles together into crumbs *(Figure A).* Composts are superior to raw organic soil amendments because they do not cause the severe nitrogen tie-up that so often results after application.

Seedbed Mulches. Composted organic materials make ideal mulches for covering fall-sown seed, overwintering seedlings, or protecting young

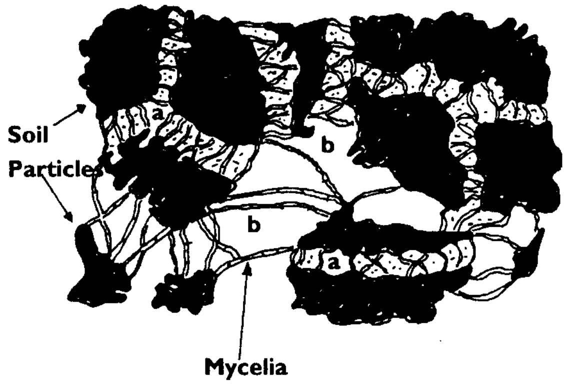


Figure A. Soil particles bound together by mycelia and gums. The smaller cavities (a) are filled with retained water, the larger ones (b) with air.

IPM Substitute for Methyl Bromide. In recent years, bareroot nurseries have been searching for ways to deal with the probable loss of methyl bromide fumigants. Although they cannot directly control pathogens, organic soil supplements can contribute in several way to an overall IPM program. Experiments and small field trials have shown that creating a suppressive soil with organic amendments can help control disease organisms and reduce the need for fumigants and other pesticides. The challenge will be to accomplish this on an large-scale operational basis.

Both Container& Bareroot Nurseries

Eco-friendly Waste Disposal. Composting is an ideal way to dispose of cull seedlings and other organic refuse that accumulate around the nursery. Disposal of all types of waste is becoming more difficult and expensive, and many landfills are putting restrictions on the dumping of organic materials. Nurseries are viewed as "green" industries, and should provide a good example by recycling all their organic wastes.

Source of mineral nutrients. Composts are an ideal way to supply mineral nutrients in a safe organically-bound form. Although they alone cannot maintain the high macronutrient levels needed for intensive nursery culture, organic forms of nutrients resist leaching and are therefore more available to plants. This makes organic composts particularly attractive for micronutrients, because providing the proper level and balance of micronutrients can be challenging.

Improved Community Relations. Nurseries can become local composting centers. Even if they don't offer plants for retail sales, forest nurseries can provide a valuable public service by accepting municipal organic wastes for composting. Although this may not be cost effective, it's impossible to put a dollar value on these types of good community relations.

The Composting Process

Okay, you want to give composting a try but don't know much about it. The process is really quite simple. Composting is the controlled decomposition of organic matter by microorganisms in a warm moist, aerated environment *(Figure B).* Organic decomposition will take place all by itself but the objective is to accelerate the process by carefully management and end-up with a useful product.

Organic wastes. Although any organic material can be composted, decomposition will be hastened by having a mixture of materials that will result in the proper carbon:nitrogen (C:N) ratio. The microorganisms which drive the composting process require a C source to provide energy and materials for new cells, along with N to manufacture cellular proteins. The C:N of the original mixture should be in the range of 25:1 to 35:1 *(Figure B).* The simplest and most economical way to adjust the C:N is to use of mixture of materials with different carbon and nitrogen contents. Municipal waste composters recommend a mixture of "green" and "brown" materials. Green materials have a high proportion of nitrogen compared to brown materials which have relatively more carbon. You should know the C:N ratio of the materials that you want to use in your compost. For example, sawdust with a C:N of 500:1 should be mixed with manure with a C:N of 25:1. Otherwise, the nitrogen to help breakdown the sawdust will have to be supplied with inorganic fertilizer at a rate of 0.25 lb/ft3 (4 kg/ m3), which can make the entire composting process uneconomic.

Particle size. The individual pieces of organic material must be small enough so that they have a greater surface area for microbial attack. On the other hand, small particles of the same size tend to pack tightly together, reducing the supply of oxygen, and hindering the release of carbon dioxide. Therefore, a mixture of particle sizes in the 0.4 to 2.0 in. (1 to 5 cm) range is recommended. For aerated compost piles, particles can be at the smaller end of the range.

Moisture content. Microorganisms require water to breakdown the organic matter and reproduce *(Figure B).* However, if the moisture content is too high, the pores become waterlogged which prevents good air exchange. The optimum moisture content in the compost pile should be between 50-60%. Very dry components may need to be moistened to start the composting process, and additional watering may be required in dry climates or in aerated composted systems.

Aeration. The microorganisms that breakdown organic matter are aerobic, but the necessity of supplying enough air during composting is probably the least understood aspect of the process. All areas of a compost pile must have good aeration to supply oxygen for microbial respiration and flush out the carbon dioxide that is produced *(Figure B).* Poor aeration favors

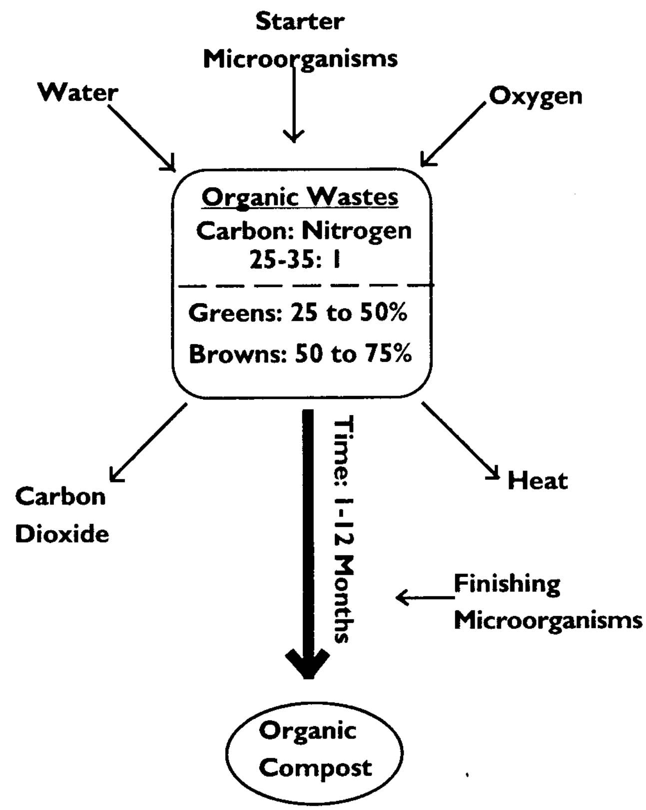


Figure B. The Composting Process

anaerobic microorganisms which can lead to acidic conditions, leaving you with silage instead of compost. Proper air exchange can be achieved by either turning the compost heap or providing natural or forced ventilation. Regular agitation will insure that no part of the compost heap will be more than 30 in. (75 cm) from an air source for an extended period. With natural aeration, compost should be piled no more than 8 ft high and 5 ft wide (2.5 m x 1.5 m). In addition to releasing the carbon dioxide and water that is produced by decomposition, providing a regular source of air also removes heat which can be very important in large-scale composting operations.

Temperature. Some of the chemical energy in the organic matter is given off as heat during decomposition *(Figure B).* Compost must reach the proper temperature range to start the decomposition process and so, during cold weather, compost piles may need to be initially covered. Once conditions are optimum, however, the temperature follows a typical curve during the composting process *(Figure* C). The temperature rises rapidly as bacteria and fungi breakdown the easily decomposable green materials. When the temperature reaches approximately 140 °F (60 °C), the fungi and some of the initial bacteria die off and actinomycetes and rod-forming bacteria take over. This is the pasteurization phase in which most plant pathogens are killed but beneficial microbes survive. All parts of the compost heap should be kept in this temperature range for at least 3 days. After most of the easily decomposable organic material has been broken down, the compost pile begins to cool and then fungi and actinomycetes begin to work on the more resistant materials such as hemicellulose and cellulose. As the pile cools further, competition increases between microorganisms, antibiotics are released, and larger organisms like earthworms move in. The compost is ready for use when the temperature stabilizes.

Microbial additives. Supplementing composts with a special mixture of microorganisms is generally not needed if the proper mix of organic materials has been selected. The composting process can be accelerated, however, by adding aged manure or compost from a previous batch at a rate of about 3% by volume. Relatively sterile organic materials like fresh sawdust start composting much more rapidly if they are inoculated with special cellulose-decomposing fungi like Coprinus ephemerus.

Well, that's a brief introduction to composting. In the July, 1994 issue of FNN, we will look at the practical and economical aspects of composts in forest and conservation nurseries.

Sources:

Blumenthal, S.G.; Boyer, D.E. 1982. Organic amendments in forest nursery management in the Pacific Northwest. Administrative Report. Portland, OR: USDA Forest Service, Pacific Northwest Forest and Range Experiment Station. 73 p.

Dalzell, H.W.; Biddlestone, A.J.; Gray, K.R.; Thurairajan, K. 1987. Soil management: compost production and use in tropical and subtropical environments. FAO Soils Bulletin 56. Rome: Food and Agriculture Organization of the United Nations. 177 p.

Harmonious technologies. 1992. Backyard composting: your complete guide to recycling yard clippings. Ojai, CA: Harmonious Press. 62 p.

Martin, D.L.; Gershuny, G. eds. 1992. The Rodale book of compositn, Emmaus, PA: Rodale Press. 278 p.

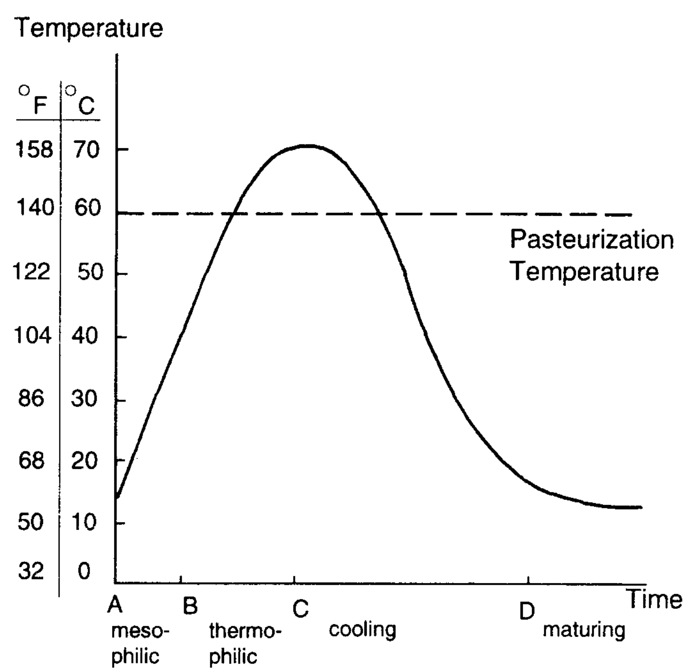


Figure C. Temperature variations in a compost heap.

Biocontrol of Botrytis

Peninsu-Lab, a private diagnostic and research laboratory in Washington State, is beginning a major business expansion to develop a wide range of non-chemical pesticides. One of their current projects is the biocontrol of gray mold disease of conifer seedlings, which is caused by **Botrytis cinerea.** This fungus is the major pathogen of container seedlings and also affects bareroot stock in the Pacific Northwest, costing the forest and ornamental nursery industry over $2.5 million per year. The research and development division of Peninsu-Lab has just been awarded a $220,000 grant from the USDA Small Business Innovative Research Program to complete this research which is expected to take about 2 years. Hopefully, the product will be commercially available by 1995. For the latest information, contact:

Linda Davis
Peninsu-Lab
5795 NE Minder Road
Poulsbo, WA 98370

PHONE: 206-297-3295
FAX: 206-297-7369

Special Publications

Ordering Information

The following publications are featured here because they are of special interest to nursery folks. If you would like a copy, there are two different ordering procedures. **Numbered** or **Lettered** publications can be requested by circling the appropriate listing on the Literature Order Form and returning it to me. Special Order (**SO**) 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.

SO. ***Seed Manual for Forest Trees.*** Gordon, A.G. Forestry Commission Bulletin 83. London, HMSO Publications. 132 p. 1992.

Somehow, I neglected to mention this book which was listed in the New Nursery Literature section of the January, 1993 issue of FNN. It is noteworthy, however, because it contains a good overall discussion of the collection, processing, treatment, and storage of forest tree seeds. The easy-to-read text is complemented by numerous tables and graphs as well as several color photographs of cone development.

COST: L10.95 **ORDER FROM:** HMSO Publications Centre
P.O. Box 276
London SW8 SDT
UNITED KINGDOM

SO. ***Plantation Forestry in the Tropics.*** Evans, J. Second Edition. Oxford: Clarendon Press. 403 p. 1992.

Although the bulk of the book concerns other aspects of plantation management, the section on Plantation Silviculture contains chapters on What to Plant; Seed Collection, Supply, and Storage; and Forest Nurseries. Both seed and vegetative propagation are discussed along with many example of tropical nursery culture from around the world. Line drawings, B/W photographs, and tables illustrate the test.

COST: $47.50 +S & H

ORDER FROM:
Oxford University Press
2001 Evans Road
Cary, NC 27513
PHONE: 800-451-7556

SO. ***Tropical Containerized Nursery Manual.*** Josiah, S.J. Washington, DC: Pan American Development Foundation. 245 p. 1992.

The spiral-bound book is a good handbook for starting a container nursery in developing tropical countries. It is primarily oriented toward nursery technicians who work in forestry or agroforestry programs but lack extensive formal schooling and technical training. Scott developed this manual while helping produce over 50 million tropical tree seedlings in Haiti. Besides being well-organized and written, it contains excellent illustrations which increase its value as a teaching aid.

COST: $18.95 + S&H

ORDER FROM:
Spencer-Lemaire Industries Ltd.
11413 - 120 St.
Edmonton, AB
CANADA T5G 2Y3
PHONE: 403-451-4318
FAX: 403-452-0920

SO. ***Rootrainers in the tropics.*** Spencer, H.A. Edmonton, AB: Spencer-Lemaire Industries. 13 p. 1993.

The pamphlet is designed to show people how to raise seedlings in Rootrainer[R] containers. It is easy to read, contains helpful illustrations, and should serve as a good basic nursery manual.

COST: FREE

ORDER FROM:
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Tree Planters' Notes. For those of you who don't already subscribe, Tree Planters' Notes (TPN) is a technical journal published quarterly by the USDA Forest Service in Washington, DC. It contains a wide variety of volunteer and peer-reviewed articles about nursery science, tree improvement, and reforestation. We encourage everyone to subscribe because it costs only $5 per year ($6.25 foreign) -use order form at the bottom of this page. To give you an idea of the content, we are offering copies of back issues of TPN. Just check the box on the Literature Order Form for the issues in which you are interested. Copies are limited, so don't wait:

A. **Volume 42(3), Summer, 1991** - 5 copies.

B. **Volume 42(4), Fa11,1991** - 3 copies

C. **Volume 43(1), Winter, 1992** - 10 copies

D. **Volume 43(2), Spring, 1992** - 6 copies

E. **Volume 43(3), Summer, 1992** - 11 copies

F. **Volume 43(4), Fa11,1992** - 6 copies

G. **Volume 44(2), Spring, 1993** - 23 copies

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Health and Safety

Agriculture is a Dangerous Business

In 1991, the agricultural industry recorded more fatalities per capita than either mining or construction. According to Bradley Rein of the USDA, this is because agricultural workers perform a wide variety of tasks and often only do them one only once or twice a year. Some of the most serious problems include:

1. **Tractor-related accidents.** Tractor roll-over and accidents in power take-off attachments take the lives of about 132 growers each year, and many more are injured.

2. **Respiratory hazards.** Pesticide inhalation is an obvious hazard, but one of the most common respiratory problems is organic dust which causes a variety of maladies including pneumonitis, bronchitis and asthma.

3. **Electrocution.** Farmers are notorious for making on-the-spot repairs but jury rigged electrical wiring often results in injury or death.

4. **Hearing loss.** Although working around mechanical equipment without proper ear protection is dangerous, many growers like to listen to equipment to make sure that it is operating properly.

What makes farm-related accidents even more serious is that they typically happen in remote locations which delays the response time for emergency medical assistance. All nurseries should have someone that is up-to-date on the latest emergency medical procedures. Farmedic, an non-profit corporation has developed a system to train workers how to properly respond to farm emergencies. The course includes classroom sessions, videos, and modular demonstrations. For information, contact:

Farmedic
PHONE: 607-587-4734
FAX: 607-587-4737

Source: Occupational Health and Safety as cited in American Nurseryman 178(7): 9.

Of Mice and Men

When a mysterious illness began claiming the lives of young Navajos last spring, tribal elders blamed the deaths on the tendency of young generations to drift away from traditional beliefs. It looks like they were right.

After several months of exhaustive field research and laboratory analysis, the Center for Disease Control finally identified the cause of the disease as a previously unknown pathogen, called a hantavirus. These viruses are known to be earned by rodents and spread through their droppings, the dust of which becomes airborne in the arid Southwest. Unlike other infectious ailments, hantaviral diseases tend to strike young, healthy adults rather than small children and the elderly. Although hantavirus-caused diseases are common in Asia and parts of Europe, they were previously unknown in America - or were they?

Contact with mice has always been prohibited in Navajo culture because they are thought to have dangerous powers. They must be kept out of houses and away from food and, if a mouse so much as touches your clothes, the garments must be burned. "The mouse is the only rodent that Navajos have this thing about," says Ben Muneta, a doctor and CDC-trained epidemiologist who works for the Indian Health Service. From a medicine woman in Monument Valley, Muneta learned that mice must never be touched or allowed in the home because they are bearers of illness from ancient times. "The illness spreads in the air," the medicine woman told him. "In a closed room, the power of the mouse would take over and destroy you if it got in your eyes or nose or mouth." She also told him that "the mouse would choose the strongest and best person in the house."

"It was an incredible feeling of discovery," Muneta recalls. "She was describing quite subtle aspects of the hantaviral infection process." He concluded that Navajos could have encountered the hantavirus generations ago and, through observation, learned how to avoid it. "The traditional healers are also scientists with centuries of experience " he says. This fall, with his help, the Indian Health Service introduced a program that combines modern health education with traditional wisdom to teach people to protect themselves from the disease.

So, what does this mean to us - except not to inhale mouse droppings? The take-home lesson is to appreciate the value of direct observation and indirect experience. Those of us who are college-educated are taught not to trust our senses, and that all facts must be verified by controlled experiments. While we all acknowledge the value of formal research, much useful information can be gained by careful observation. So, keep your eyes open while walking around your nursery and don't discount the experiences of your long-time workers.

Source: Grady, D. 1993. Death at the Corners. Discover 14(12): 83-91.

Cultural Perspectives

The "Nursery Effect"

Phenotype = Genotype x Environment

This equation is the mathematical expression of the fact that an individual's appearance is the result of it's genetic make-up, tempered by the environment in which it was raised. In the forest and conservation nursery business, the physical characteristics of a seedling are a function of its genotype, generally expressed as seed source, and the environment of the nursery in which it was grown. Actually, nursery environment is a composite of the location of the nursery and the cultural practices used to raise the seedling. Incorporating this information into our equation produces:

Seedling Morphology = Seed Source x [Nursery Location x Cultural Practices]

In bareroot nurseries, seedlings are grown under ambient climatic conditions and so become naturally acclimatized to the nursery environment. Because bareroot stock is acclimatized to the general climatic of a geographic region, they are not normally shipped outside that region. With the advent of container nurseries, however, it has became possible to grow seedlings in one geographic region and ship them to another. Theoretically, as long as the seed source is carefully selected and maintained during the nursery tenure, a container seedling can be grown almost anywhere as long as it is properly hardened prior to storage and shipment to the outplanting site. Seedling users need to know the biological implications of this practice to insure that they are receiving the highest quality stock for their reforestation projects.

This concept has immediate practical implications because container nurseries are beginning to expand their markets and bid on seedling growing contracts from vastly different environments. In recent years, for example, a container seedling grower in Colorado has produced tree seedlings for a timber company in British Columbia. Another contractor in Northern California has grown conifer stock for outplanting in New Mexico. Because of a tremendous reforestation backlog in Mexico and a shortage of local nursery stock, some people are advocating growing container seedlings of Mexican species in the US or Canada.

I hypothesize that seedlings of the same seed source grown in nurseries with significantly different environments will respond differently upon outplanting. This response has been called the nursery effect and is an example of environmental imprinting in which the seedlings "remember" the influence of nursery site conditions or cultural practices. Apparently, these "memories" can override normal genetic controls, at least temporarily.

Forest geneticists have written extensively about genotype X environment interactions and how they influence early genetic selection, but the nursery effect is not widely appreciated in the nursery community. However, nursery imprinting is evident in day-to-day nursery and reforestation activities. Foresters who have planted seedlings from the same seed source that were grown at different nurseries have noticed differences in survival and growth. Bareroot nurseries who transplant container or bareroot seedlings from other nurseries have observed similar differences. I remember one nursery trial that I established with fall-sown vs. spring-sown bareroot seedlings of the same source sown right next to one another. The fall-sown stock was of course larger at the end of the first year because it had germinated earlier. What surprised me was that the fall-sown seedlings also broke bud significantly earlier the following year, showing that it had been imprinted with its response from the l+p year.

The nursery effect is extremely hard to prove by experiment, however, because of the complexities in raising seedlings of exactly the same size, the larger sample sizes that would be necessary, and the problems in holding all other variables constant. Some formal experiments have shown that the nursery effect does exist and can be quantified in terms of seedling performance on the outplanting site. Ying and others (1989) concluded that, although the differences between nurseries were significant, the nursery effect is relatively shortterm (15 years). Another study in Alaska compared container seedlings from a local nursery vs. ones grown from the same seed source in Idaho (Zasada and others 1990). The Idaho trees suffered significantly more animal browsing and frost damage compared to the local stock. I am not aware of other research trials, however, probably because the nursery effect on seedling survival and outplanting is often hard to separate from the other stresses and complicating factors.

The nursery effect has some practical and economical implications, especially with seedling growing contracts:

* **Should local growing zones be established?** If so, who is going to do it and how large should they be?

* **Should nurseries be rated by past performance?** How can you separate true environmental imprinting from just poor culture or fluke weather events?

* **What about species differences?** Is the response the same with all species?

Well, there you have it. Is the nursery effect a legitimate concern or merely the product of another government bureaucrat with an overactive imagination and too much time on his hands? After all, ornamental nurseries have been growing their stock in nurseries in just a few selected geographical areas, including the Pacific Northwest, and then shipping then across the continent using only the Plant Hardiness Zones as their guide. Anyway, I'd like to hear from you and, if there is enough interest, I'll provide some follow-up in the next issue of FNN.

Source: Ying, C.C.; Thompson, C.; Herring, L. 1989. Geographic variation, nursery effect, and early selection in lodgepole pine. Canadian Journal of Forest Research 19(7): 832-841.

Campbell, R.K.; Sorensen, F.C. 1984. Genetic implications of nursery practices. IN: Duryea, M.L.; Landis, T.D. eds. Forest Nursery Manual: Production of Bareroot Seedlings: 183-191.

Zasada, J.C., Owston, P.W.; Murphy, D. 1990. Field performance in Southeast Alaska of Sitka spruce seedlings produced at two nurseries. Research Note PNW-RN-494. Corvallis, OR: USDA Forest Service, Pacific Northwest Research Station. 11 **p.**

Limiting Factors--Water

As we have been discussing in past issues of FNN, plants need six different "limiting" factors for good growth. Four are found in the ambient environment (light, temperature, humidity, and carbon dioxide) and two (mineral nutrients and water) are supplied from the soil or growing medium *(Figure A).* We have covered everything except water and so, in this issue, we will take a look at how seedlings use water and how growers supply it to their crops.

Water is one of the most important growth-limiting factors in natural terrestrial ecosystems.

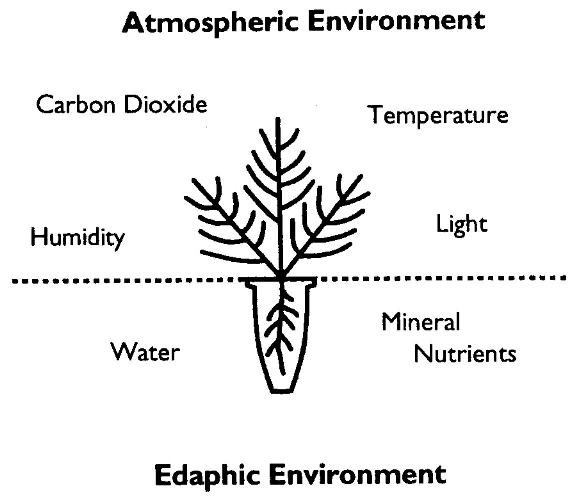

Figure A. Factors limiting seedling growth.

The ecological importance of water is matched by its physiological importance because almost every process in plants is directly or indirectly affected by water:

1. Water is a major constituent of plants, composing 80-90 % of fresh weight.

2. Water is the "universal solvent", and the medium for mineral nutrient transport within the plant.

3. Water is a biochemical reactant in many critical physiological processes, including photosynthesis *(Figure B).*

4. Water is essential for maintaining turgidity in plant cells, promoting cell expansion and seedling growth.

Biophysics of water in containers

The best way to describe seedling water status is in terms of water potential because the basic principles and units remain the same throughout the nursery system. Water is drawn along a water potential gradient that is driven by

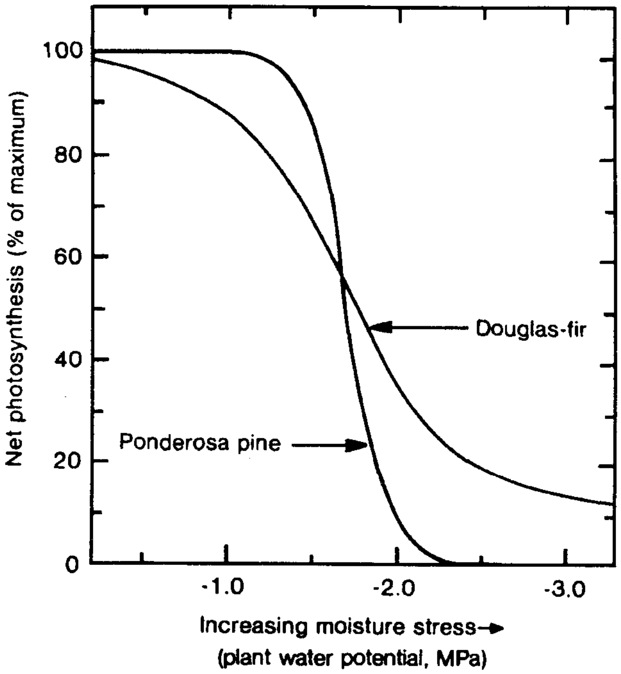

Figure B. Increasing moisture stress, as measured by more negative plant water potential, reduces photosynthesis of tree seedlings at different rates, depending on species characteristics.

evapotranspirational losses: from higher levels in the growing medium, through the seedling, and into the lower levels in the atmosphere.

Growing medium water potential is composed of two parts. The matric potential represents the energy with which water is held in the pores of the growing medium. The porosity of the growing medium affects water availability because seedlings are able to extract water easier from larger pores than from smaller ones. Water in containers behaves very differently than in an unconfined soil. Because of the air beneath a container, a layer of saturated growing medium always exists at the bottom *(Figure C).* Although the actual thickness of the layer is determined by the type of growing medium, the relative depth of this saturated layer is always greater in shorter containers.

The osmotic potential is the second component of the growing medium water potential and reflects the influence of dissolved salts, including fertilizers. The osmotic potential of the growing medium solution increases as the soil water content decreases due to evapotranspiration - a reduction of 50% water content will approximately double the salinity. Heavy fertilization produces a significant osmotic potential, which increases as the medium dries out. When the osmotic potential becomes significant, fertilizer "burn" results.

Seedling Water Relations

Plant water potential (PWP) also contains two components: osmotic potential and pressure potential, which change in relationship to one another as the seedling loses water from turgidity to the wilting point. PWP changes in a typical daily pattern, the absolute value of which depend on soil moisture levels and atmospheric demand. Nursery managers and foresters are more familiar with the term plant moisture stress (PMS). The two terms are identical in absolute value; PWP is always expressed in negative terms, whereas PMS is always a positive number (see Monitoring Seedling Water Use section for sample readings).

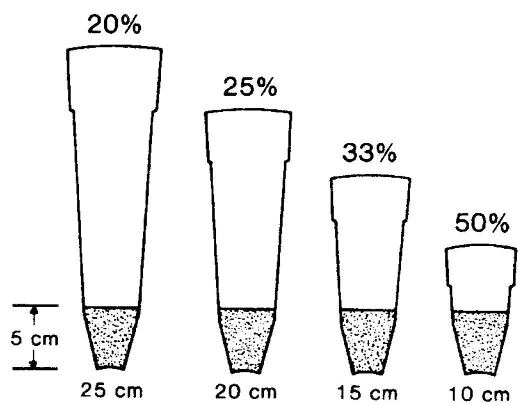

Figure C. The depth of the saturated growing medium layer at the bottom of the container is proportionately greater in shorter containers, given the same type of growin medium.

Water Quality

The definition of water quality is determined by its intended use. Water that would be entirely suitable for domestic or industrial purposes can be severely damaging to plants. For nursery purposes, irrigation water quality is determined by two factors: suspended sediments or pests, and dissolved salts.

Suspended sediments - Inorganic materials such as clay, silt, and even very fine sand particles are small enough to remain suspended in irrigation water. Suspended sediments are abrasive and can quickly wear out water pumps, fertilizer injectors, and sprinklers. The source of the irrigation water determines what types of suspended materials it may contain. Municipal water usually has been filtered to remove particulate matter, although this should be checked. Surface water often contains suspended silt or clay particles, especially after a heavy rain, and depending on the characteristics of the aquifer and type of casing, even well water may contain sand. Organic sediments can be harmless but pests, such as weed seeds and fungal or algal spores, are also be suspended in water. Water from surface sources, especially ponds in agricultural areas, can contain propagules of potential nursery pests, which include weed seeds and spores of fungi, algae, mosses, and liverworts.

Specially-designed filters can remove the larger waterborne pests including weed seeds, algae, and some fungal spores, but the cost of the filters increases as the minimum pore size decreases. Domestic water sources are normally well-filtered and so these pests should not be a problem. Chlorination is the traditional way to eliminate pathogenic fungi, bacteria, algae, and liverworts in irrigation water.

Dissolved salts - Many different mineral ions can be dissolved in potential irrigation water, but even perfectly clear water can contain harmful salts. In coastal areas, potential nursery sites can have

Table 1 - Salinity standards for forest nurseries

Water Quality Index	*Do Not Exceed Limit**	
Salinity (Electrical Conductivity)	1500 uS/cm (umhos/cm)	
Toxic Ions		
Sodium (Na^+)	50 ppm	2.2 meq
Chloride (Cl^-)	70 ppm	2.0 meq
Boron (B)	0.75 ppm	N/A
Accessory Ions		
Calcium (Ca^{2+})	100 ppm	5.0 meq
Magnesium (Mg^{2+})	50 ppm	4.3 meq
Sulfate (SO_4^{2-})	250 ppm	5.2 meq
Foliar Staining Ions		
Bicarbonate (HCO_3^-)	60 ppm	1.0 meq
Total Hardness (Ca+Mg)	206 ppm	----------

* = These values assume a porous and free draining growing medium. Water with much lower salt concentrations can cause serious problems if poor drainage or irrigation practices allow salts to accumulate. 1 part per million (ppm) = 1 milligram per liter (mg/l): the conversion between milliequivalents (meq) and ppm varies with the atomic weight and electrical charge of the ion. Boron has several different ionic forms in irrigation water and therefore a specific conversion cannot be made.

groundwater that is contaminated by saltwater intrusion. Some salt ions, such as the calcium and magnesium that are found in "hard" water, can be either troublesome or beneficial depending on their concentrations. Moderate levels of calcium and magnesium can be beneficial because they are plant nutrients and are often difficult to formulate into liquid fertilizer solutions. Higher concentrations cause deposits ("scale") on irrigation nozzles and other surfaces. Other ions, especially boron, can be toxic to tree crops at concentrations of less than 1 part per million *(Table 1).*

Types of Irrigation Systems

Although several types of irrigation are used for other nursery crops, sprinkler irrigation is still the norm for the propagation of both bareroot and container stock in forest and conservation nurseries. A typical sprinkler irrigation system consists of a pump, pressure tank, pipes, and sprinkler heads. Fixed rotary sprinklers are standard in bareroot nurseries and are laid out on a grid with the irrigation lines running along the paths between the seedbeds. In container nurseries, either fixed sprinklers or mobile booms are commonly used.

Uniform water application in a fixed sprinkler irrigation system is determined by five factors:

1. nozzle design and function
2. size of the orifice
3. water pressure at the nozzle
4. spacing and pattern of the heads
5. wind direction and speed.

Because of the centrifugal force caused by the rotary motion, all fixed sprinkler irrigation systems create water distribution patterns resembling a "doughnut" *(Figure D).* Engineers design irrigation systems to compensate for this inherent defect by insuring that nozzles have enough overlap. Irrigation uniformity is measured as the

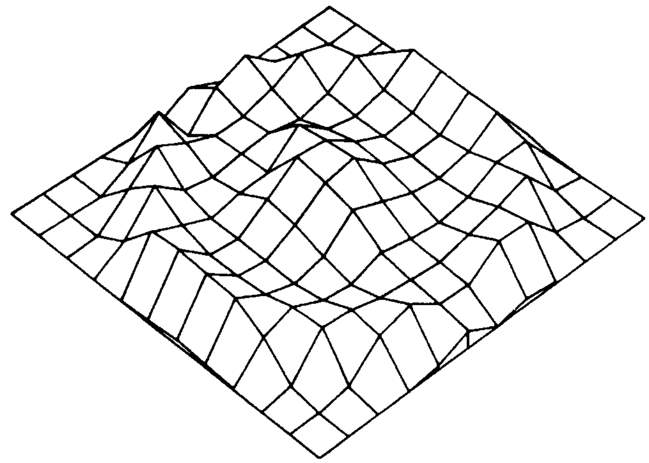

Figure D. Sprinkler distribution patterns can be modeled on computers, using cup test data. This three-dimensional graph illustrates a common problem encountered with fixed overhead sprinkler systems: a "doughnut" patter, resulting from low water pressure at a single nozzle.

coefficient of uniformity and the standard target is around 85%. Actual irrigation efficiencies are probably less in actual practice. Most growers tend to overirrigate because water is inexpensive and excess water quickly soaks out of sight in bareroot nurseries. Samples from a container nursery with a fixed overhead irrigation system, however, show that irrigation waste can be as high as 80%.

Although they are more expensive, mobile irrigation booms are becoming more common in container nurseries because they apply water evenly and only to the propagation areas - not to the aisles and border areas. Reducing runoff and possible discharge of fertilizer or pesticide pollutants is becoming a major consideration in irrigation system design. Sampling with boom systems have shown them to be significantly better in water distribution and runoff compared to fixed irrigation.

Most nurseries control irrigation duration with a time clock which regulates a series of solenoid valves that turn the water on and off in each irrigation line or zone. These controllers can be programmed to time the duration of irrigation in each zone, which allows the irrigator to adjust the amount of water applied to the demands of each crop. Controllers make irrigation at night and on weekends possible, but have the disadvantage that the same amount of water is applied each time regardless of climate or crop condition. Fully-controlled container nurseries use environmental computers with "on-demand" control systems to regulate irrigation by monitoring accumulated light, vapor pressure deficit, or evaporative demand. While these new computer systems offer new possibilities, personal monitoring of irrigation is still recommended. Irrigation is such a critical part of nursery culture and seedling water use can change so rapidly that reliance on a fully-automated control system is not advised without regular supervision.

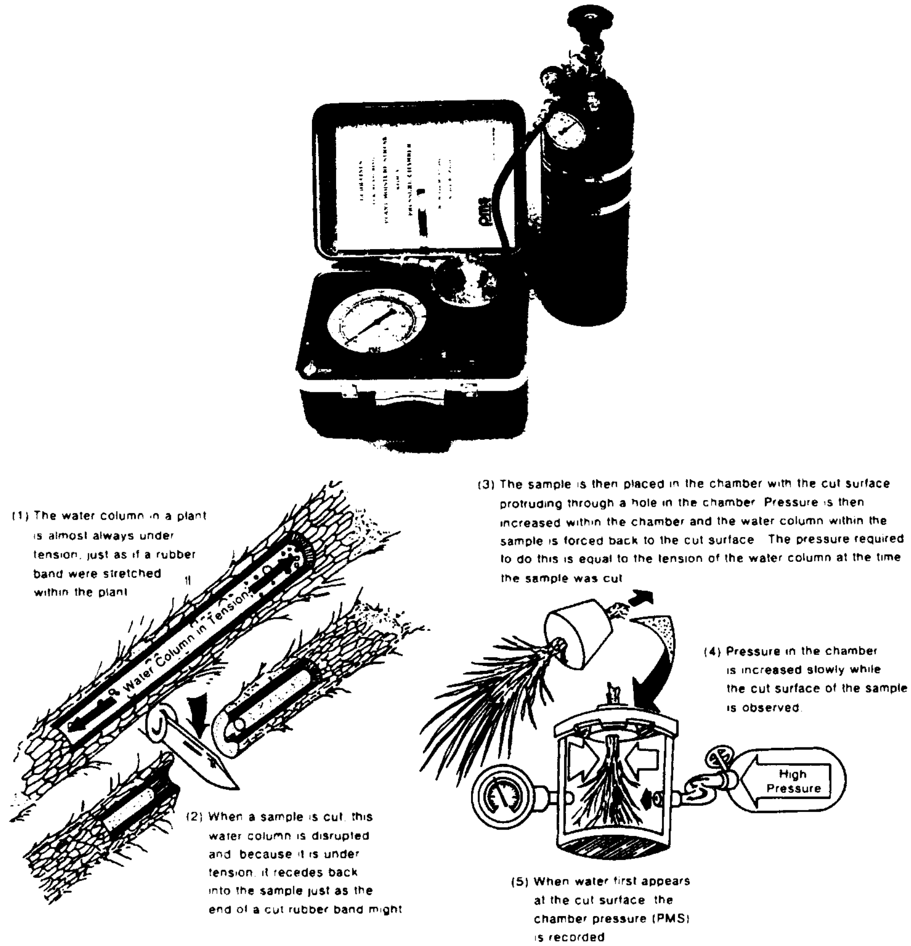

Figure E. The pressure chamber offers a direct measure of plant water potential or plant water stress (courtesy of PMS Instrument Company, Corvallis, OR).

Monitoring Seedling Water Use

Growers can monitor water in the soil or growing medium, and in the seedlings themselves. Irrigators in bareroot nurseries generally rely on the feel or appearance of the soil, the weather, and seedling vigor to determine water requirements. Tensiometers or gypsum blocks are sometimes installed at permanent locations within the seedbed to give the grower an indication of soil moisture conditions. There is just no surefire way to accurately monitor soil moisture levels in bareroot nurseries, however, but experienced irrigators are able to keep soils in the ideal moisture range without too much trouble.

Container growers have a few more options, although the typical small capacity containers provide seedlings with minimal water reserves. Measuring container weight is the most popular and practical way to monitor seedling water use. The basic principle is simple - because water is a significant component of container weight, monitoring the weight change of sample containers provides a nondestructive way to measure water loss. The only piece of equipment needed is an accurate scale that can be moved through the productions areas to weigh the sample containers. Although weights vary with many factors and have to be adjusted for seedling size, growers construct easy-to-use tables of irrigation weights as a percentage of their wet weight.

Table 2 - Guidelines for monitoring plant moisture stress

Plant Water Potential (Predawn)		*Relative Stress Rating*	*Seedling Response/ Cultural Implications*
MPa	*Bars*		
0.0 to - 0.5	0 to 5	Slight	Rapid Growth
- 0.5 to - 1.0	5 to 10	Moderate	Reduced Growth Best for Hardening
- 1.0 to - 1.5	10 to 15	High	Restricted Growth Variable Hardening
-1.5 to - 2.5	15 to 25	Severe	Increasing Injury
< - 2.5	> 25	Extreme	Injury or Death

Plant water potential readings are the most accurate way to monitor seedling water status and predawn readings with a pressure chamber give the most useful information *(Figure E).* Pressure chambers can be used during the growing season to schedule irrigation, as well as during the hardening phase to monitor induced moisture stress *(Table* 2). In bareroot nurseries, pressure chambers are also sometimes used during dry periods in the lifting season to determine when supplemental irrigation is required.

Water has such an overriding importance to seedling culture that growers must know the quality of their irrigation sources and carefully manage the amount of irrigation that they supply to their crops. The proper amount of irrigation is becoming a political as well as a biological concern as the question of what happens to nursery runoff comes under increasing scrutiny.

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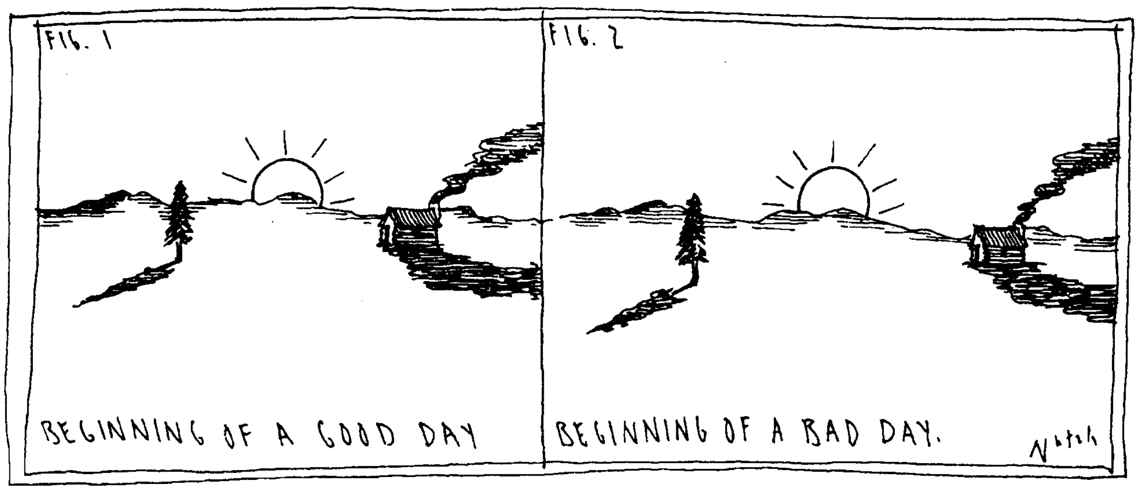
Editorial

Copping An Attitude

I have been intending to write an editorial for some time on the importance of having a good attitude. Now, I don't have to, because the following cartoon just about says it all:



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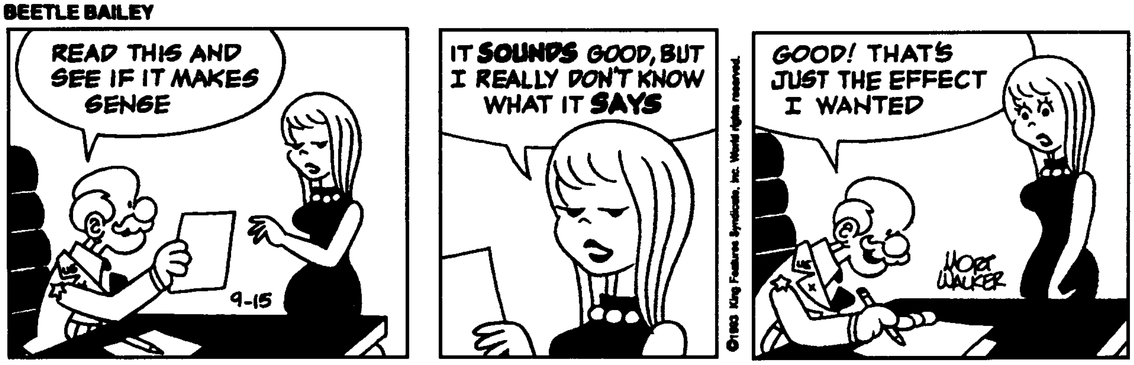
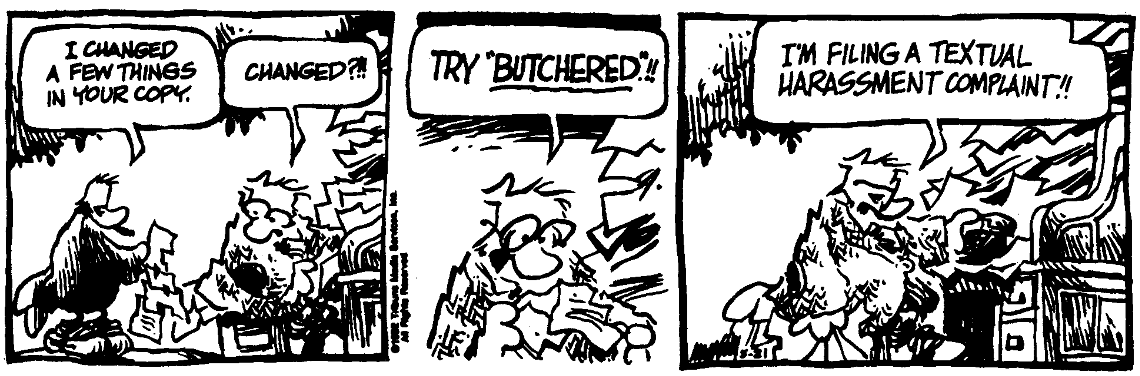


SHOE



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Bareroot Production

1. ***Covariances between morphological characteristics in bareroot Pinus sylvesfris nursery stock.*** Jalkanen, A. Scandinavian Journal of Forest Research 8(4):540-549. 1993.

2. ***Variability of morphological characteristics in bareroot Pinus sylvesfris nursery stock.*** Jalkanen, A.; Rikala, R.; Smolander, H. Scandinavian Journal of Forest Research 7(1): 83-97. 1992.

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5. ***Control by code.*** Moller- Seiler, L.; Higginbotham, J. S. American Nurseryman 178(1):89-94, 96-98. 1993. How a West Coast grower uses bar code scanners to improve and simplify inventory control.

6. ***Family and medical leave.*** Gorman, R. American Nurseryman 178(8):90-92, 94-99. 1993.

7. ***Maximize your meetings.*** Kehoe, K. R. American Nurseryman 178(10):64-66, 6869. 1993.

8. ***The price is right? Consider your competition, expenses when valuating your merchandise.*** Brumfield, R. G. Greenhouse Manager 12(5):94-97. 1993.

9. ***Pricing for profit.*** Barton, S. S. American Nurseryman 178(1):124-129. 1993.

10. ***Think about it: how would you like to live next to your greenhouses?*** Bartok, J. W. , Jr. Greenhouse Manager 12(9):83. 1993. Consideration of visual appearance, traffic, noise, lighting, odor, runoff, and safety will make for more pleasant neighborhood relationships.

11. ***Working with a safety net.*** Becker, T. B. American Nurseryman 178(8):56-63. 1993.

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12. ***Calculating filled and empty cells based on number of seeds sown per cell: a microcomputer application.*** Wenny, D. L. Tree Planters' Notes 44(2):49-52. 1993.

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17. ***Nursery production alternatives for reduction or elimination of circling tree roots.*** Appleton, B. L. Journal of Arboriculture 19(6):383-388. 1993. Discusses in-ground fabric, rigid plastic and "pot-in-pot" containers, low-profile, soil sock and copper-treated containers.

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19. ***Field stratification of antelope bitterbrush seeds.*** Young, J. A.; Wight, J. R.; Mowbray, J. E. Journal of Range Management 46:325-330. 1993.

20. ***Seed dormancy in the Colorado Plateau shrub Mahonia fremontii (Berberidaceae) and its ecological and evolutionary implications.*** Baskin, C. C.; Baskin, J. M.; Meyer, S. E. Southwestern Naturalist 38(2):91-99. 1993.

21. ***Seeding month and seed soaking affect buffalograss establishment.*** Fry, J.; Upham, W.; Leuthold, L. HortScience 28(9):902-903. 1993.

22. ***Stratification improves seed germination of five native wildflower species.*** Bratcher, C. B.; Dole, J. M.; Cole, J. C. HortScience 28(9):899-901. 1993.

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24. ***Composted turkey, litter: 11. Effect on plant growth.*** Tyler, H. H.; Warren, S. L.; Bilderback, T. E.; Perry, K. B. Journal of Environmental Horticulture 11(3):137-141. 1993.

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27 ***Growth and nutrition of birch seedlings in relation to potassium supply rate.*** Ericsson, T.; Kahr, M. Trees: Structure and Function 7:78-85. 1993.

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29. ***Nitrate loading to the soil profile underlying two containerized nursery crops supplied controlled release fertilizer.*** Brand, M. H.; McAvoy, R. J.; Corbett, E. G. Journal of Environmental Horticulture 11(2):82-85. 1993.

30. ***Prevent greenhouse crop problems before they happen with tissue tests.*** Erwin, J. Greenhouse *Manager 12(7):113-114. 1993.*

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