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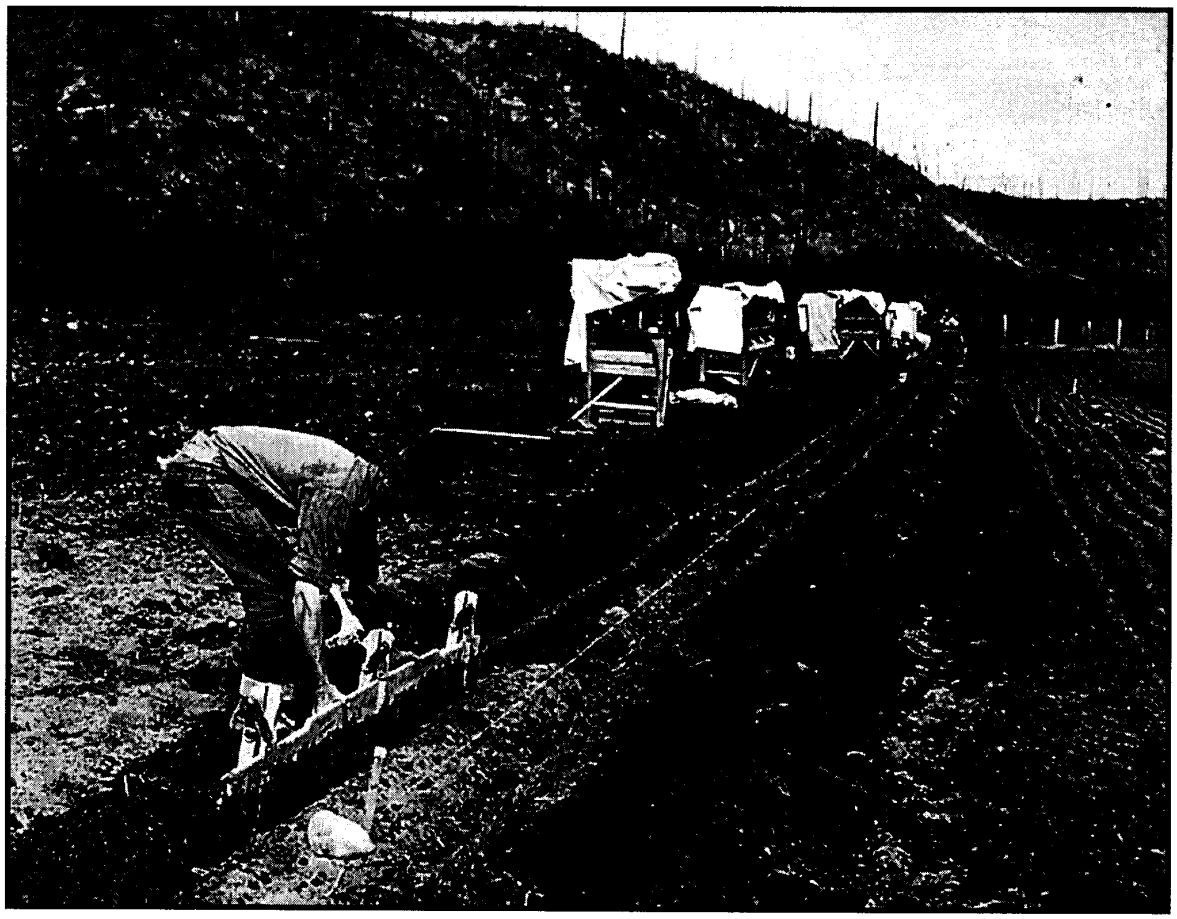
Forest Nursery Notes

January 1995



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Cover photo: *Hand transplanting at the USDA Forest Service Savenac Nursery in Montana circa 1929 (see article on page 38).*

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Forest Nursery Notes

January 1995

Finally - You don't know how happy that we are to have this issue of FNN done! It's been a busy, frustrating couple of months. I won't go into the sordid details, but let's just say that it's unnerving to smell burning electrical wiring coming from your computer. Anyway, here it is and we'll try to be more punctual next issue.

Belated Holiday Wishes - Well, we made it through another hectic holiday season. I don't know about you but it seems to start earlier and get more commercial every year. Rather than be cynical about the crass exploitation, I hope that you were able to find the time to reflect on the true meaning of this Special Season, and so feel renewed and ready for the promises of the New Year.

Making FNN Multilingual? - In an effort to make FNN a truly international publication, we are analyzing the possibility of publishing it in Spanish and maybe French. Obviously, the translation and extra printing will be an additional expense and so we need to survey readers to find out if it would be worthwhile. So, if you would like to see a Spanish or French version of FNN, write us a letter and give us your opinion. We will study the costs involved, see if we can find the funding, and then report back to you in the July, 1995 issue.

TL

Contents

Nursery Meetings and Workshops

"So Many Meetings, So Little Time "

The 6th biennial meeting of the ***Northern Container Nursery Association*** will be held on ***February 7-8, 1995*** at the Claridge Motor Inn in Rhinelander, WI. This two-day meeting will be co-hosted by the Oconto River Seed Orchard and Tourney Nursery of the USDA Forest Service. The agenda features technical sessions the first day followed by an Open Forum dedicated to informal discussions. The second day will consist of field trips to the Consolidated Paper Greenhouses, and the Forth Floral Greenhouse and Garden Center. Contact Bill or Barb for more specific information:

Bill Sery
Oconto River Seed Orchard
18100 Saul's Spring Road
White Lake, WI 54491
PHONE: 715-276-7400

Barb Jones
J.W. Tourney Nursery
PO Box 445
Watersmeet, MI 49969
PHONE: 906-358-4523

The annual ***Western Nursery Pathology Workshop*** will be held on ***Mar. 20-23, 1995*** at the Cypress Inn in Poulsbo, WA. This informal meeting consists of an mixture of technical presentations and discussions, and anyone interested in seedling pathology is invited to attend. This year's agenda will include a discussion on Alternatives to Methyl Bromide Fumigation. For more information, contact:

Diane Hildebrand

USDA Forest Service, FID
P.O. Box 3623
Portland, OR 97208-3623
PHONE: 503-326-6697
FAX:503-326-5569

The Asean Forest Tree Seed Centre Project is sponsoring an international symposium on ***"Recent Advances in Tropical Tree Seed Technology and Planting Stock Production"*** for ***June 12-14, 1995*** in Haad Yai, THAILAND. The program will cover several aspects of seed quality, seedling production, and mycorrhizae and other beneficial organisms. Invited speakers will be followed by voluntary papers and, if you can send them a title and abstract as soon as possible, they are will accepting papers and posters. A post symposium tour to a nursery, wildlife sanctuary, and tropical forest types. For more information, contact:

Symposium Secretariat
ASEAN Forest Tree Seed Centre
Mauk-Lek, Saraburi 18180
THAILAND
PHONE: 66-36-341-305
FAX: 66-36-341-859

The ***Integrated Pest Management Course for Forest Nurseries*** is scheduled for ***June] 7-25, 1995*** in Kemptville, Ontario, CANADA. This 10-day course will examine IPM for nurseries and seed orchards within the broad context of diseases, insects, competing vegetation, as well as abiotic problems. The diverse format will include lectures, discussion periods, field exercises and site visits, and will feature world class instructors from across North America. For more details, contact:

Eileen Harvey
Canadian Forest Service
Forest Pest Management Institute
1219 Queen Street East
Sault Ste. Marie, ON
CANADA P6A SM7
PHONE: 705-949-9461
FAX: 705-759-5700

E-MAIL: eharvey@pmoeafpm.fpmi.forestry.ca

The second annual ***Southwestern Container Growers' Meeting*** will be held in Las Vegas, NM (yes, that's New Mexico!!) on ***June 20-21, 1994,*** and John Harrington and his staff at the New Mexico State University Mora Research Center will be our hosts. This year's focus topic will be Growing Media and, as always, the format for the meeting will be informal discussions with everyone invited to contribute. In addition to a tour of the Mora Research Center, we will be visiting riparian and mine reclamation outplanting sites. Anyone interested in growing forest and conservation seedlings in containers is invited to attend, but we want to keep this meeting small and informal and so attendance may be limited. For more information, contact me or John Harrington:

John Harrington
New Mexico State University
Mora Research Center
P.O. Box 359
Mora, NM 87732
PHONE: 505-3 87-2319
FAX:505-387-9012

Afforestation of First Rotation Sites - Production of Appropriate Seedlings, Seedling Establishment, and Stand Treatment is the title of a pre-IUFRO World Congress meeting being planned for ***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. Volunteer papers and posters are now being accepted on the theme topics. Attendance will be limited to 50 persons, so contact Anders Mattsson soon for more specifics:

Anders Mattsson
Swedish University of Agricultural Sciences
Faculty of Forestry
Dept. of Forest Yield Research
5-776 98 Garpenberg
SWEDEN
PHONE: 46-225-26000
FAX:46-225-26100

Figure A. Historical bulletin from Bessey Nursery, NE

Nursery workers wanted - "$1.76 per day plus room and board". No, this isn't a typo. This bulletin was issued by the USDA Forest Service Bessey Nursery in 1918 (Figure A). My, how times have changed! The new, improved ***Western Forest and Conservation Nursery Association*** will be holding their annual meeting at the Ramada Inn in Kearney, NE on ***August 7-11, 1995***. Our host will be Clark Fleege of the USDA Forest Service Bessey Nursery, which has the distinction of being the oldest continuously operated forest nursery in the US. Following on the success of last year's meeting, the agenda for 3-day meeting will consist of morning technical sessions followed by afternoon field trips. Focus topics include nursery safety, fertilization scheduling, marketing and partnerships, and propagation of junipers, and we are soliciting speakers on these or other nursery-related topics. The afternoon field trips will include: Bessey Nursery and Nebraska National Forest, a variety of Great Plains outplantings, and a tour of local historical and recreational attractions. The first meeting announcement will be sent out soon, but if you would like to make sure that you are on the mailing list, contact:

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

The ***Northeastern Area State, Federal and Provincial Nurseryman's Association*** will be holding their annual meeting at the Spring Mill State Park Inn in Mitchell, IN on ***August 14-17,* 1995.** Jim Wichman of the Vallonia State Nursery will be our host. The agenda is still being developed and features panel discussions on cultural and management topics as well as a tour of the nursery. 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
PHONE: 812-3 S 8-3621
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 Sept. *14-16,* 1995.** The agenda is still being developed but will include many topics of interest to people working in forest and conservation nurseries. The Portland area has many ornamental nurseries as well as those growing forest and conservation species. 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

Wilbur Bluhm

IPPS, Western Region

743 Linda Avenue NE

Salem, OR 97303

PHONE: 503-393-2934

Program Chairman

Allan Elliott

Carlton Plants

P.O. Box 398

Dayton, OR 97114

PHONE: 503-868-7971

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 is still under development but currently contains technical sessions 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
CANADA V3Y 1Z1
PHONE: 604-465-6276
FAX:604-465-9829

The University of Montana and Bitterroot Native Growers, Inc. will present a symposium on ***The Restoration of Disturbed Lands: an Ecological Approach*** at the Holiday Inn in Missoula, Montana on ***October 31- November 3, 1995***. The goal of this conference is to explore the theoretical and technical aspects of restoring disturbed wildlands through a dialogue between restoration scientists and practitioners. Proposed technical sessions include the soil environment, genetics, ecophysiology, community ecology, horticulture as well as specific case studies. Field trips to the Bitterroot Native Growers container nursery, and highway, mineland, and riparian restoration projects in the area. For more information, contact:

Clare Kelly
University of Montana
Continuing Education
Missoula, MT 59812
PHONE: 406-243-4623

FAX: 406-243-2047

National Nursery Issues

Methyl Bromide Fumigation - Update

As we have been discussing in FNN for the past several years, the future of methyl bromide fumigation is in jeopardy. Because it is thought to contribute to the depletion of the protective ozone layer in the earth's atmosphere, the US Environmental Protection Agency (EPA) has ruled that methyl bromide production be frozen at current levels until it is completely banned by the year 2001. See Watson and others *(General and Miscellaneous* in New Nursery Literature Section) for a very complete history of the basis for the ban. There are some rumors that to encourage early removal of the product from the market a $1 to $3.50 per pound tax will be added to the cost of methyl bromide fumigants. The typical cost of fumigating an acre is about $1300 and, if this tax does go into effect, the cost would increase to $1650 to $2500 per acre.

Soil fumigation is the most common use of methyl bromide and we in North America are among the principal users (Table 1):

Table 1 - Methyl bromide sales in tons by use category and region (Watson and others 1992)

Regions	Soil	Quarantine/ Commodity	Structural	Chemical Intermediates	Total	(%)
Africa	1,381	325	132	---	1,838	(2.8)
Asia	8,400	5,265	906	34	14,605	(21.9)
Australia	693	185	50	---	928	(1.4)
Europe	16,582	991	644	902	19,119	(28.7)
North Africa	367	65	---	---	432	(0.6)
North America	22,743	1,219	1,382	2,757	28,101	(42.2)
South America	1,140	361	120	---	1,621	(2.4)
Total	51,306	8,411	3,234	3,693	66,644	(100.0)
(%)	(77.0)	(12.6)	(4.9)	(5.5)	(100.0)	

Nurseries that have used methyl bromide fumigants have divided into 2 philosophies. The first group is convinced that the loss in inevitable, and so are already switching to other chemical or cultural alternatives. Others believe that new research and political pressure will result in a lifting or a modification of the EPA ban that would allow methyl bromide fumigation to continue. Let's take a look at both positions:

Methyl bromide alternatives - Methyl bromide is still the most effective and popular soil fumigant and comparisons with other chemicals have shown that nothing has such broad spectrum effectiveness. Some other alternative fumigants are already in operational use in forest and conservation nurseries, however. Dazomet (Basamid^{R}) is the most common and does an acceptable job, although it causes phytotoxicity with adjacent crops such as western white pine. Tests with pure chloropicrin show fair control of soil pathogens, but it does not kill weed seeds. Tests with Triform^{R} (a mixture of dichloropropene and chloropicrin) are underway in the South. Howard Ohr at the University of California-Riverside (909-7874140) is testing methyl iodide, a close chemical relative of methyl bromide, which may hold promise for soil fumigation. Although methyl iodide is currently expensive, the production costs would necessarily go down if the demand increases. The best part if that its ozone depleting potential less than 0.2, compared to 0.6 for methyl bromide.

Biological control alternatives, such as mycorrhizal fungi and antagonistic rhizobacteria, are also being tested and some show encouraging results. Other biological alternatives, such as brassica cover crops and organic matter amendments, have not lived up to expectations. Solar and heat sterilization are also being tested operationally and heat treatments seem particularly promising if the application technology can be worked out (See Integrated Pest Management section for more discussion).

Other studies on methyl bromide alternatives are currently underway. A comprehensive project to evaluate several alternative control technologies for soilborne pathogens is being conducted by the Forest and Insect Disease branch of the USDA Forest Service at nurseries across the US. The Southern Forest Nursery Management Cooperative at Auburn University is studying alternative fumigants and they have concluded that methyl bromide is hard to beat because it controls all soil pests for up to 2-3 years. They also analyzed 33 published articles on fumigation in forest nurseries and found that most fumigants gave better seedbed densities and an increase in seedling size compared to the controls. Methyl bromide fumigants consistently gave the best results and metham-sodium was second in efficacy. The USDA Agricultural Research Service (ARS) is also funding research into methyl bromide alternatives for soil fumigation. Several other recent publications are also listed in the New Nursery Literature Section.

Methyl bromide promoters - Other people are convinced that the EPA is overreacting and have organized to defend methyl bromide fumigation. The Methyl Bromide Working Group, a consortium of companies that produce and distribute fumigants, is mounting a vigorous campaign to educate policy makers and support more scientific research. They have filed a lawsuit in the US Court of Appeals that challenges the EPA decision to ban methyl bromide, and plan to file other legal petitions directly with that agency. According to their director, Peter Sparber, they believe that they have an excellent chance of exempting methyl bromide from the Clean Air Act well before the final ban takes effect. The Methyl Bromide Global Coalition is an international group of methyl bromide manufacturers who are supporting research to investigate the possible contribution of methyl bromide generated by human activities to stratospheric ozone depletion. All of this

research will be completed within the next 3 years so that it can have the greatest impact on policy makers. The Coalition is also publishing an informational newsletter that discusses what is currently known about methyl bromide in the atmosphere (Figure B), its use around the world, and regulatory considerations in the development of alternatives. For a copy of the newsletter or just for more information, contact:

Peter Sparber, Director
Sparber and Associates, Inc.
1319 F Street, NW; Suite 301
Washington, DC 20004
PHONE: 202-737-6327
FAX: 202-393-4385

I'll continue to remain neutral as to the pros and cons of methyl bromide use, but I am pleased to see that we will finally get the basic research to answer the question of whether forest and conservation nurseries can use methyl bromide fumigants with a clear conscience.

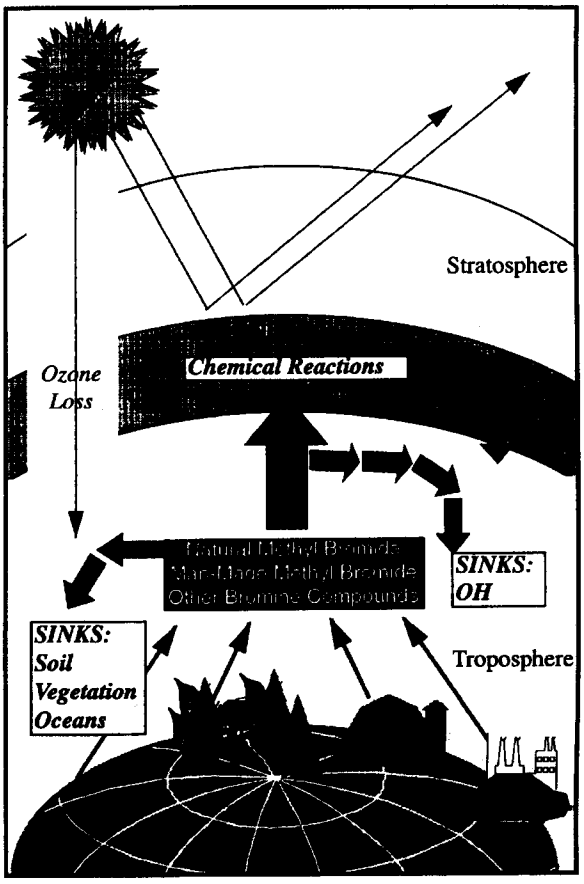

Figure B. Sources and sinks of methyl bromide in the environment. (Used with permission from the Methyl Bromide Global Coalition; prepared by Julie Bedford, Science and Policy Associates, Inc.)

Sources:

Carey, B. 1994. Fumigation trials/Historical efficacies of fumigants in forest tree nurseries. Southern Forest Nursery Management Cooperative Newsletter, Fall, 1994. Auburn, AL: Auburn University. 10 p.

James, R.L.; Hildebrand, D.M.; Frankel, S.J.; Cram, M.M.; O'Brien, J.G. 1994. Alternative technologies for management of soil-borne diseases in bareroot forest nurseries in the United States. 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: 91-96.

Methyl Bromide Global Coalition. 1994. Methyl bromide global monitor 1(1), Spring/Summer. Washington; DC: Methyl Bromide Global Coalition. 4 p.

Watson, R.T.; Albritton, D.L.; Andersen, S.O.; Lee-Bapty, S. 1992. United Nations Environmental Programme. Montreal Protocol Assessment Supplement No. 41. Nairobi, Kenya: United Nations Environment Programme, Ozone Secretariat. 41 p.

Ecological Alternatives

Recycling Nursery Plastics

Forest and conservation nurseries have a professional obligation to practice recycling, and set a good example for other industries. I'm sure that you are all recycling waste paper, aluminum, metal, and motor oil but what do you do with all your used plastic? Even for the dedicated recycler, finding somebody who will accept plastics has been a challenge. There are two basic problems. The first is that there are so many different types of plastics, and the second is that markets for used plastics vary across the nation. Most people are familiar with the recyclability of pop bottles and milk jugs, because they have very strong markets nationally. Until lately, there has been little demand for used nursery plastics and so they have been discarded into landfills. Recently, however, several firms have been working to develop markets for used nursery plastics. Before we get to that however, let's discuss the various types of plastics.

Plastics are made from polymer resins and the seven most common types can be identified by a number surrounded by the triangular "chasing arrows" symbol on the bottoms of plastic containers (Figure C). Plastics must be sorted into these categories before recycling because

Figure C. Recycling symbols indicate types of plastics

each resin has its own properties such as specific melting temperatures and processing qualities. The four most common nursery plastics are marked with an asterisk (Table 2):

Table 2. Types of plastics and some examples of domestic and nursery use

Code	Resin Type	Common Examples
1	Polyethylene Terephthalate (PET)	Pop and mineral water bottles, clear or colored
* 2	High Density Polyethylene (HDPE)	Milk/water jugs, grocery bags,
	"Blown" type	detergent, and auto oil bottles.
	"Injected" type	Margarine tubs. ***Nursery trays, cells, and block containers.***
3	Polyvinyl Chloride (V)	Food wrap and vegetable oil bottles.
* 4	Low Density Polyethylene (LDPE)	Grocery produce bags. ***Greenhouse poly coverings, mulch plastic sheeting, growing media and fertilizer bags, and some containers.***
* 5	Polypropylene (PP)	Food tubes and jar lids. ***Some nursery pots.***
* 6	Polystyrene (PS)	Styrofoam cups, yoghurt containers, plates, meat trays, clear plastic cups. ***Block containers***.
7	Others	Other resins or multiple resin.

Note that in the #2 HDPE plastic category there are two forms: blown (bottle style) and injection molded (tub style). Often, these must be separated before recycling because the resins are of different thicknesses and therefore can not be melted down together. This may also be true for other items - like different types of plastic bags (the smooth bags are #4 and the stiffer crinkly bags are #2). The rule of thumb is to always ask your recycler exactly what is accepted and how it should be sorted and prepared.

The Oregon Association of Nurserymen (OAN) has been working with local nurseries to establish a recycling program for used nursery plastics such as polyethylene film and containers. The program is still in its infancy but markets for used poly tarps have developed in Asia. Other firms are also developing markets for used nursery plastics. National Waste Technologies, Inc. is making plastic wood out of 50% used poly film, and for this use, it does not have to be completely clean.

The secret to recycling film plastic (#4) is to separate it by colors, clean it, and keep it clean. Mulch plastic is already in strips and poly coverings can be cut lengthwise along the furring strips to produce plastic sheets approximately 22 x 100 ft. (6.7 x 30.5 m). There are several hand- or tractor-powered rollers that can be used to process the film as it is removed from the ground or from structures (Figures D and E). Most use a PVC pipe as a core and are powered by the tractor PTO. Using a plastic sheet as a ground cover keeps the film strips from getting dirty, and the slick sheets also make the rolling easier by reducing ground friction. Stationary balers and conventional hay balers have also worked, and by using plastic baling twine, the whole bale can be shredded at the recyclers.

In addition to film plastic, the OAN program will also accept used containers of types #2, #5, and #6. In order to finalize the recycling markets, we need to know how much used nursery plastic could be available. So, if you would like

Figure D. Strips of used plastics film are cleaned and ready for baling. (Courtesy of Ron Lapotin)

Figure E. Plastic nursery film can be baled with conventional farm equipment. (Courtesy of Ron Lapotin)

to participate in this program, please contact Ron Lapotin with a list of what types of used plastics that you have, an estimate of how much (weight or volume), and when they would be available:

Ron Lapotin
Oregon Garden Products
3150 SE Winter Bridge Road
Hillsboro, OR 97123
PHONE: 503-640-4633 ext.205
FAX:503-357-4871

I would also be most interested in the details of other recycling programs for used nursery plastics, so please let me know and I'll pass on the information in the July 1995 issue.

Sources:
Bartok, J.W., Jr. 1992. Recycling film plastic. In: Proceedings, 1992 International Summer Meeting of the American Society of Agricultural Engineers; 1992 June 21-24; Charlotte, NC. Pap. 92-4031. St. Joseph, MI: American Society of Agricultural Engineers. 6 p.

Grey, D. 1994. Recycle by numbers. The Digger, Feb. 1994. Milwaukie, OR: Oregon Association of Nurserymen: 35.

Hemphill, D.D., Jr. 1993. Agricultural plastics as solid waste: what are the options for disposal? HortTechnology 3(1): 70-73.

York, J. 1994. Waste Reduction and Recycling News 5(10). Sandpoint, ID: USDA Forest Service, Sandpoint Ranger District.

Contemplating Composts?

Recycling of organic wastes is becoming big business. Instead of ecological altruism, however, this trend is due to legal and economic considerations. For example, recent legislation in Michigan has completely banned disposal of yard waste in landfills and solid waste incinerators. And in California, communities are currently required by law to utilize 25% of their municipal waste for composting and by the year 2,000, this will increase to 50%. Financial incentives may become available to develop new markets for compost products. For example, the California Integrated Waste Management Board has allocated over $350,000 to encourage the use of municipal composts in agriculture.

Both bareroot and container nurseries are potential markets for composts produced from organic and municipal waste. Composts are an excellent nursery soil amendment because they encourage the formation of aggregates, improve soil tilth, and stimulate the microbial component of the soil. Bareroot nurseries can also use composts as organic mulches. For container nurseries, composts are being tested in a wide variety of artificial growing media, and this trend will only increase in the fixture. In fact, because forest and conservation nurseries produced non-consumptive plants, there is even more opportunity to use municipal composts that may pose health hazards when used on food crops.

Before using any type of compost, however, nursery managers should consider the following questions:

1. What is compost? There is no such thing as a standard or typical compost. Rather, it is a complex mixture of humus-like constituents such as partially decomposed organic wastes, the decomposing organisms, and the microbial by-products.

2. What is this particular compost made from? Municipal and industrial composts are the most variable type because their quality depends on the source material. In particular, be aware of toxic contaminants that could poison your seedlings or harm your workers. Some composts contain a high proportion of inert materials such as stones, glass, or plastic that may lower their value as a soil amendment.

3. What is the pH and mineral nutrient level? Composts contain organic nutrients and so not only affect fertility directly, but also indirectly through their effect on pH. Many composts have a neutral pH but others can be as high as 8.5, which could cause serious nutrient availability problems. The overall nutrient composition of municipal composts is typically low compared to traditional fertilizers. Milorganite^{R}, which has been used in forest nurseries for several decades, has a fertilizer

analysis of only 6-2-0 (Figures F). These nutrients are slow-release, however, and so compost application rates should be based both on nutrient content and release rate.

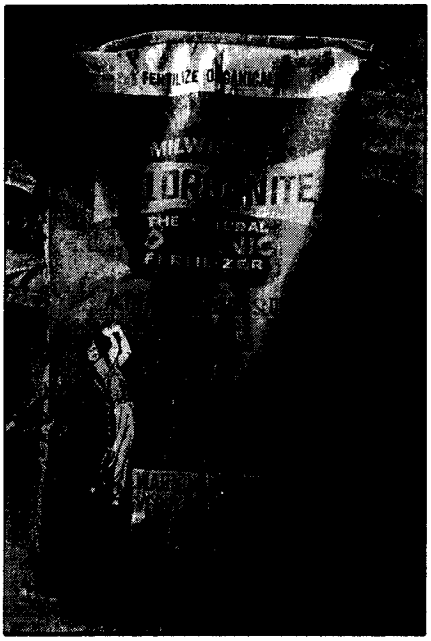

Figure F. Milorganite[R] fertilizer is made from municipal waste from Milwaukie, WI.

There is also the potential for mineral nutrient imbalances. In particular, many composts that are made from wood wastes have a very low carbon-to-nitrogen (C:N) ratio. If these materials are used before they have fully matured, the decomposing microorganisms will outcompete your seedlings for nitrogen and induce a serious deficiency which is expressed as chlorosis and stunting. Bareroot nurseries that have added too much uncomposted sawdust to their seedbeds have learned this lesson all too well. Incorporating immature composts during the fallow year and supplementing with nitrogen fertilizer gives them time to "compost in place", and will prevent nitrogen availability problems.

4. How sensitive is my crop? In general, most forest and conservation plants can tolerate composts in almost any form if they are applied at the proper rate, in the proper manner, and at the proper time. Newly-sown seedlings will be much more sensitive than transplants, however.

If the compost is immature or became anaerobic during storage, toxic acetic acids can form and may prove phytotoxic to sensitive plants after application. High soluble salts, and sodium in particular, are another common problem, especially with composts containing a high proportion of manure or municipal sludge.

Most serious problems with compost quality can be identified by asking a few simple questions. If you want to sure, request a chemical analysis and specify the following: pH, electrical conductivity (soluble salts), major nutrients, and potentially toxic chemicals. Another good idea is to obtain a sample of the compost, mix it with the appropriate amount of soil or growing media components, and perform a seedling germination bioassay. Researchers are attempting to develop simple tests of compost biomaturity that are cheap and easy to use. A light absorption test, similar to the glucometers already used by diabetes, shows particular promise and may soon be on the market.

Composts are an inexpensive source of organic matter and forest and conservation nurseries should help to develop new markets, from an ecological as well as economic standpoint.

Sources:

American Nurseryman. 1994. Composting for profit. American Nurseryman 180(10):14

Kuipers, W. 1994. Compost happens: a Michigan landscape company turns organic-waste disposal legislation into an opportunity for a new venture. American Nurseryman 180(11): 51-5 5.

Richard, T. 1994. Planning to use composts? Ask these questions. Something to Grow On: Alabama's Ornamental Newsletter, March 1994. Auburn, AL: Auburn University, Alabama Cooperative Extension Service.

Williams,G.; Williams, P. 1994. Toward a simple test for compost biomaturity. HortIdeas 11(4): 1.

Integrated Pest Management

Rediscovering Heat Treatments

One of the basic tenets of Integrated Pest Management (IPM) is to minimize the use of pesticides. In the July, 1994 issue of FNN we discussed the use of chlorine as a least-toxic chemical treatment, but it would be even better to use no chemicals at all. Heat treatments had been used to control agricultural pests for decades, but easy accessible and inexpensive chemical pesticides have made them less attractive in recent years. Now, with the potential loss of some pesticides, such as methyl bromide fumigants, growers are rediscovering heat treatments.

Heat can be used for "sterilization" or "pasteurization" depending on the objectives of the treatment. Sterilization kills all the organisms, and requires higher temperatures than pasteurization, which is intended to selectively kill pathogens. The types of pests controlled depends on the temperature (Figure G). Although some nursery pests such as weeds are not killed until very high temperatures, premoistening to promote germination can make them much more susceptible. Operationally, the controlling factors are treatment temperature and length of contact time. The target temperature and the treatment time will depend on the type of application.

Heat has several potential uses for controlling pests:

1. Sterilizing equipment and growth containers.

2. Pasteurizing soil or growing media.,

3. Sanitizing seeds or cuttings,

Sterilizing growth containers - For the last 20 years, container growers have used a variety of chemicals to sanitize their used containers but many of these materials, such as bleach, are irritating to nursery workers or may contribute to water pollution. It was also difficult to completely eradicate residual pests from containers with rough cell walls, such as styrofoam blocks. In the overall effort to reduce chemical use, several growers in the Pacific Northwest began operational trials to use heat to sterilize their containers. Heat can be applied in a couple of different ways: steam sprays, or hot water dips. The latter technique was found to be most effective because the temperature and treatment time were easier to monitor and control. Many nurseries have designed custom

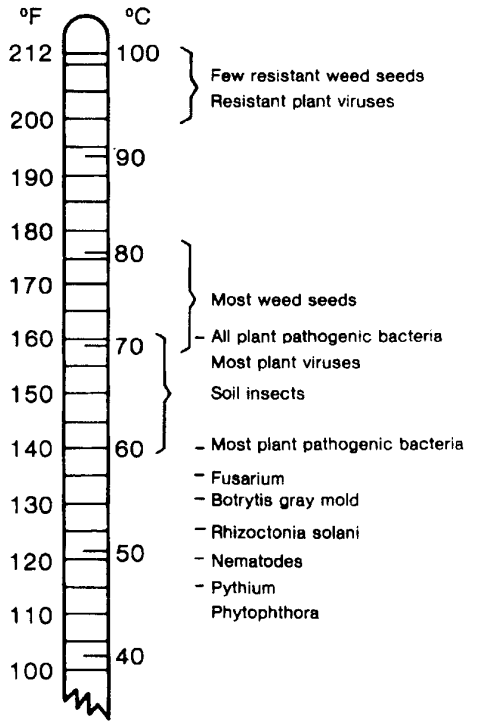

Figure G. Any source of heat can be used but the types of pests controlled depends on temperature (modified from Baker and Roistacher, 1957)

dip tanks to treat their containers, but commercial hot water tanks are also available from:

Northern Factory Sales, Inc.
1950 SW Trott Ave,
P.O. Box 660
Willmar, MN 56201
PHONE: 612-235-2288
FAX:612-235-2297

The following time/temperature combinations have proven effective at the USDA Forest Service, Coeur d' Alene Nursery (Table 3):

Table 3 - Treatment temperatures and times for sterilizing used containers

Dipping Temperature		Dipping Time	
°C	°F	Ray Leach Cells	Styrofoam Blocks
< 68	< 155	Ineffective	Ineffective
68 to 70	155 to 159	30 seconds	2 minutes
71 to 73	160 to 164	15 seconds	2 minutes
74 to 88	165 to 190	15 seconds	1 minute
> 88	> 190	Damages Containers	Damages Containers

Steam pasteurization of soils - With the proposed phase-out of methyl bromide fumigation, there is renewed interest in heat as a way to pasteurize bareroot nursery soils. The amount of heat required to raise the temperature of a given volume of soil depends on its physical characteristics, moisture content, and the desired increase in temperature. Most plant pathogenic bacteria and fungi can be eliminated by raising the temperature to around 160 °F (72 °C), and so most sources recommend maintaining a temperature of 140 to 177 °F (60 to 80 °C) for at least 30 minutes. The rate at which heat must be supplied depends on how quickly the soil must be brought up to the treatment temperature. For most applications, 30 minutes of heating time is recommended giving a total treatment time of 1 hour.

Steam is much more efficient way of heating soil than hot water because when steam is injected, 970 Btu's of heat are released in the phase change back to water. Although 2 methods of steam treatment (free-flowing and aerated) are common, aerated steam systems are advantageous because they use less steam, provide more rapid and even heating, and after treatment, they allow the soil to cool more quickly.

The challenge is to design a practical and economical field application system. In the 1950's, steam rakes and blades (Figure H) were commonly used to treat soils but this technology was all but abandoned when the development of methyl bromide fumigation. Several growers are beginning to experiment with steam soil pasteurization. Operational trials in Florida have shown that the steam treatment eliminated Fusarium, Pythium, root knot and other diseases from Chrysanthemum cutting beds, and is cost-competitive with methyl bromide. In 1995, the USDA Forest Service, Missoula Technology

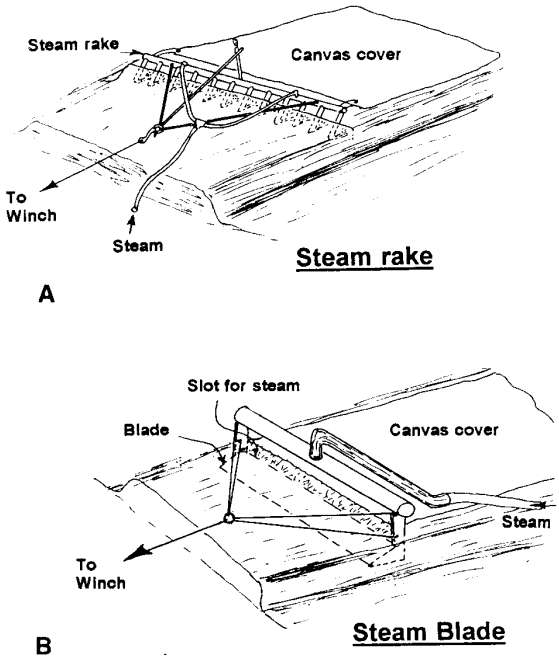

Figure H. In the years before methyl bromide, steam rakes (A) and blades (B) were used to heat treat nursery seedbeds. (from Bartok, 1994)

and Development Center (MTDC) will build a prototype machine to steam treat nursery beds and obtain data on its effectiveness and operation costs. One key design feature will be to design a tarp or some other way to maintaining the target temperature for the required treatment time. I'll report the results of the operational trials in future issues of FNN.

Sanitizing seeds and cuttings - Hot water soaks have been traditionally used to soften the seed coat of legumes and other hard seeded species. Although this is undoubtedly effective, the heat treatment also sterilizes the seed coat, removing pathogens that could reduce germination. Seeds of ornamental species are often soaked in hot water prior to sowing. The seeds are placed in mesh bags and immersed in water at approximately 50 °C (122 °F) for 30 minutes, and then cooled in running tap water.

Hot water is also being used to disinfect cuttings prior to sticking. For example, immersing tropical ornamental cuttings in hot water [49 °C (121 °F) for 10 min], followed by a hormone treatment significantly increased rooting compared to either treatment used alone. Brief exposure to very hot water has also shown promise for eliminating whiteflies, scale insects, and mites on stock plants, and application equipment is currently under development.

Hot water as a herbicide? - One of the newest uses of heat in agriculture is for controlling weeds. The Aqua Heat® company is marketing a line of equipment that will kill weeds on contact by spraying them with water just below the boiling point. The heat melts the epicuticular wax on the leaves of the weeds and then they die from desiccation within a couple of days. Sprayers are available for non-crop land, under orchards, and even within-row applications. For more information, contact:

Aqua Heat
5155 East River Road, Suite #405
Minneapolis, MN 55421
PHONE: 612-572-9884
FAX:612-572-9893

So, it seems that heat treatments are coming back into vogue as a component of nursery IPM programs. I'd be interested in hearing of any more applications that you might be willing to share.

Sources:

Baker, K.F.; Roistacher, C.N. 1957. In: Baker, K.F. The U.C. System for producing healthy container-grown plants. Calif Agric. Exper. Sta. Ext. Serv. Manual 23. Parramatta, Australia: Australian Nurserymen's Association Ltd.: 34-51.

Bartok, J.W. Jr. 1994. Steam sterilization of growing media. In: Landis, T.D.; Dumroese, 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: 162-164.

Hata, T.Y.; Hara, A.H.; Nagao, M.A.; Hu, B.K.S. 1994. Hot-water treatment and indole-3-butyric acid stimulates rooting and shoot development of tropical ornamental cuttings. HortTechnology 4(2): 159-162.

Karrsky, R. 1994. MTDC Project Status Report: Methyl Bromide Alternatives. Missoula, MT: USDA Forest Service, Missoula Technology and Development Center.

Nichols, J. 1994. Hot water controls whitefly infestations. Greenhouse Manager 13(8):16.

Collembolas For Biocontrol?

The potential loss of methyl bromide fumigants is forcing us to take a harder look at biocontrol of soil pathogens. As discussed in the Section on Soil Management Plans, nursery soils are a complex of physical, chemical, and biological factors. The possibility of biological control has not been thoroughly investigated in forest and conservation nurseries, but the future direction of disease management is likely to involve increasing the biological density and diversity of beneficial organisms in nursery soils. Fumigated soils are "brittle" because the balance between pathogens and beneficials has been seriously disturbed.

The change from a simplified soil ecosystem managed by periodic fumigation to a healthy soil ecosystem where pathogens are limited by natural dynamics requires greater understanding of the soil microorganisms and a more holistic approach to management. Most biological control research regarding pathogenic soil fungi has focused on bacteria or beneficial fungi while soil animals have been largely ignored.

Many small animals, especially the collembolans, are mycophagous and feed on fungi associated with plant roots. Collembolans are small [0.5 to 8 mm (0.02 to 0.31)] wingless insects that are found in virtually all soils, and over 5,000 species have been described. Along with mites, they are the most abundant arthropods in soil. They are known as springtails due to the presence of the furculum on their abdomen, which serves as a spring and allows them to jump away from predators (Figure I).

Collembolans are especially common in the rhizosphere, where fungal food sources are readily available. Several species are active feeders on pathogenic soil fungi such as *Fusarium* spp. and thus, there is a potential for biocontrol. Tests in Japan have demonstrated effective management of *Fusarium* on cucumbers by the collembolan *Sinella curviseta.* Examination of gut contents of collembolans from pot cultures have revealed that they also eat mycorrhizal fungal hyphae and spores. In natural soil systems, however, collembolans are very selective and feeding preference studies found that they preferred conidial forming fungi, such as *Fusarium,* and did not damage

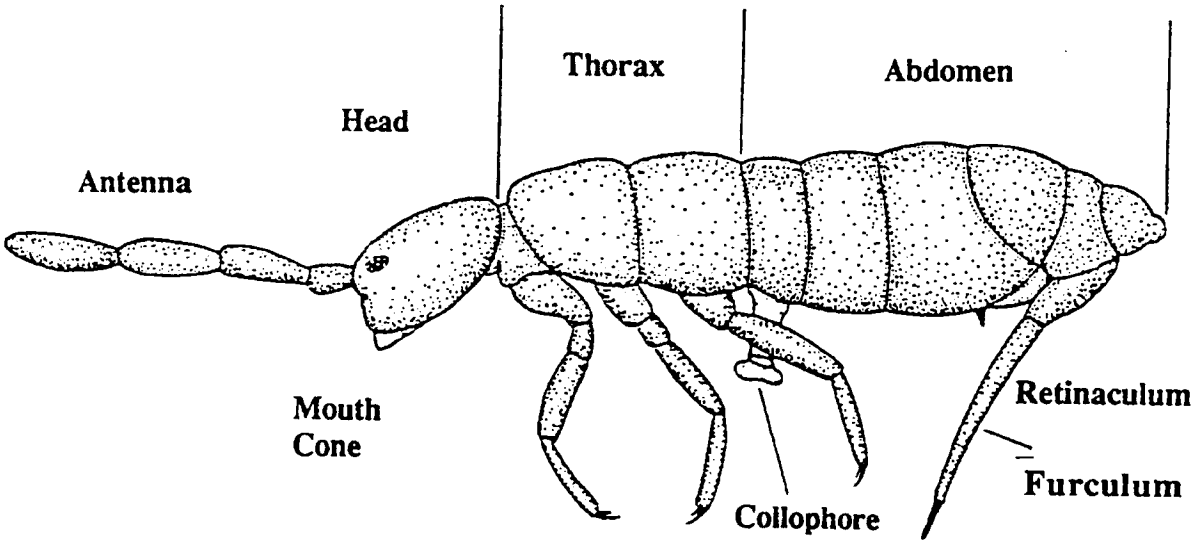

Figure I. A typical Collembola, or springtail (modified from Eisenbeis and Wichard, 1987)

mycorrhizae. The best possibilities for biocontrol may involve a combination of collembolans and beneficial soil fungi. *Rhizoctonia solani* on cotton was suppressed by a combination of three biocontrol fungi, *Trichoderma harzianum, Gliocladium virens, Laetisaria arvalis* and the collembolan *Proisotoma minuta.*

Further research is needed to identify the appropriate collembolan species that feed on a particular fungal pathogen, and to manage the soil environment to facilitate suppression. Collembolans have been shown to be sensitive to changes in soil structure, temperature, water content, and pH and so the challenge will be to maintain an attractive soil environment: high organic matter, good soil structure, and moist water content. A better understanding of natural control mechanisms, such as collembolans and beneficial soil fungi, will allow nursery managers to maintain a healthy soil microenvironment and less the need for chemical control.

Source:

This article is modified from: Klironomos, J.; Bainbridge, D. 1994. Collembolas: possible control for *Fusarium* and *Rhizoctonia.* Unpublished Report. San Diego, CA: San Diego State University, Biology Department. 6 p. They cited the following:

Eisenbeis, G.; Wichard, W. 1987. Atlas on the biology of soil arthropods. Berlin: Springer-Verlag.

Lartey, R.T.; Curl, E.A.; Peterson, C.M. 1994. Interactions of mycophagous collembola and biological control fungi in the suppression of *Rhizoctonia solani. Soil* Biology and Biochemistry 26: 81-88.

Nakamura, Y.; Matsuzaki, L; and Itakura, J. 1992. Effect of grazing by *Sinella curviseta* (Collembola) on *Fusarium oxysporum* f. sp. *cucumerinum* causing cucumber disease. Pedobiologia 36: 168-171.

Cultural Perspectives

Treating Irrigation Water

As you all know, water is the life-blood of your nursery. I'm sure that your source of irrigation water was tested when the nursery was developed but water quality does change. Surface water sources can easily become contaminated from runoff and even very deep aquifers that were once considered to be pristine have been found to be contaminated by nitrates or pesticide residues. Therefore, more and more nurseries are installing some sort of water treatment system to protect their crops.

Before you consider buying the same system that your neighbor has, remember that you have to know exactly what contaminants you want to get rid o£ Keep these two points in mind:

* No single water treatment will correct all water quality problems, and so it may be necessary to install several systems in a series. Be wary of vendor claims and talk to water quality specialists and other nurseries before investing in a system.

* All systems have limitations and life expectancies, and require routine maintenance, monitoring, or both.

The performance of the major types of water treatment systems should be compared side by side in terms of how they work, what they remove, and what are their limitations (Table 4).

Distillation

How it works: Impurities are isolated when the water evaporates, and the steam is cooled and condenses into distilled water.

What it removes: Salt, nitrates, heavy metals.

Limitations: Distillation is slow and consumes considerable energy, and is therefore relatively expensive. Distilled water can corrode some metals such as iron and copper.

Activated carbon filters

How it works: Water is filtered through carbon granules that chemically adsorb impurities.

What it removes: Volatile organic chemicals, some pesticides, and odor, color, and taste problems.

Limitations: Filters must be replaced regularly or contaminants will be released back into water. Poorly maintained filters can be breeding grounds for bacteria.

Reverse osmosis (RO)

How it works: A semipermeable membrane filters out dissolved impurities (Figure J).

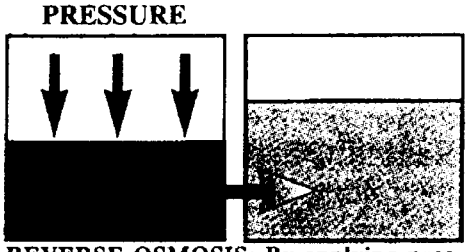

Figure J. Reverse osmosis works by applying pressure and forcing water through a semipermeable membrane (modified from Bienbaum 1994)

Table 4. Comparison of different water treatment options (from Hirschi and others)

Contaminants	Activated carbon filters	Chlorination	Distillation	Cation or anion exchange/ water softener	Mechanical filtrations	Reverse osmosis	Ultraviolet radiation	Ozonation
Chlorine	X							
Coliform bacteria, other microorganisms		X					X	X
Color	X	X		X				X
Hydrogen sulfide		X						X
Inorganics, minerals, and heavy metals (lead, mercury, arsenic , cadmium, barium)	X		X	X		X		
Iron/manganese–dissolved		X		X				X
Iron/manganese–insoluble					X			
Nitrate			X	X		X		
Odor and off-taste	X	X	X	X		X		X
Some pesticides	X					X		
Radium			X	X		X		
Radon gas	X							
Salt			X			X		
Sand, silt, clay (turbidity)					X			
Volatile organic chemicals	X		X			X		
Water hardness				X				

What it removes: Inorganic minerals, especially salts such as sodium, calcium, magnesium, boron etc. Also effective on volatile organics and some pesticides.

Limitations: The main problems are that the process takes time, and so treated water must be accumulated in storage. RO membranes are expensive, and must be regularly maintained. As much as 20-50°io of intake water is discarded and this very saline water needs to be disposed of properly.

Ion exchange systems (e.g. water softeners)

How it works: Canon and anion exchange systems are different and so remove different

minerals. For a typical domestic water softener, water passes through resin beads that are periodically recharged with sodium ions, where they are exchanged for calcium and magnesium ions which are then flushed from the system.

What it removes: Calcium and magnesium (hard water), and iron and manganese in low concentrations. Anion exchange units remove nitrate, but canon exchange units will not.

Limitations: Sodium is added to the water during treatment and so typical water softeners should NEVER be used in a nursery application.

Mechanical filtration

How it works: Many different types are available using sand, filter paper, and other straining materials.

What it removes: Dirt, sediment, weed seeds, and insoluble iron and manganese

Limitations: Mechanical filtration does not remove dissolved salts and, depending on the filter size, smaller pathogens (Figure K).

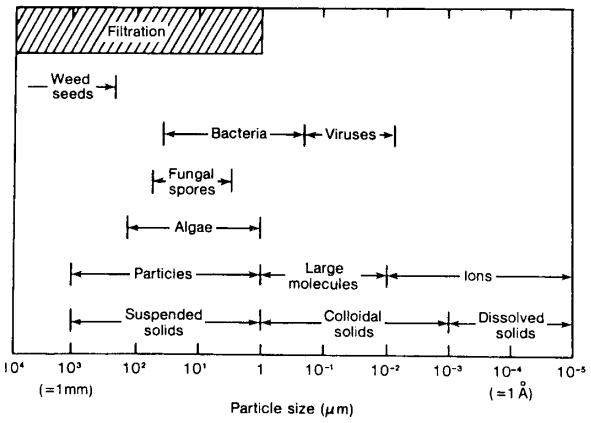

Figure K. Inorganic particles and some pests can be filtered from nursery irrigation water (modified from Tchobanoglous and Schroeder, 1985)

Chlorination (also see section in July, 1994 issue of FNN)

How it works: Liquid injectors meter chlorine into the water in direct proportion to water flow. Granular products can be added to ponds or tanks where they dissolve into reactive chlorine, which remains effective for a period of time.

What it removes: Bacteria, fungi, and other microbial pests

Limitations: The system must be designed to provide adequate contact time. Chlorine is corrosive, and injection systems must be properly maintained.

Ultraviolet (Ul) radiation

How it works: A special light bulb generates UV radiation which kills biological organisms in the water line.

What it removes: Bacteria, fungi, and other microbial pests

Limitations: May not be effective when water flow is too fast or water is clouded with suspended particles. UV does not have a residual effect like chlorine.

Ozonation

How it works: A corona discharge generator converts air to ozone, which is injected into a water line where it kills microbes after a contact time of around 4 minutes.

What it removes: Bacteria, waterborne fungi, nematodes.

Limitations: Ozone does not have a residual effect like chlorine, but is safer to use and can be cheaper.

Sources:
Biernbaum, J. 1994. Treat your water right. Greenhouse Grower 12(2): 31, 33-35.

Hirschi, M.C.; Simmons, F.W.; Peterson, D.; Giles, E. 1994. 50 Ways Farmers Can Protect Their Groundwater. North Regional Extension Pub. 522. Urbana, IL: University of Illinois, Cooperative Extension. 189 p.

Landis, T.D.; Timis, R.W.; McDonald, S.E.; Barnett, J.P. 1989. The Container Tree Nursery Manual, Volume Four: Seedling Nutrition and Irrigation. Agric. Handbk. 674. Washington, DC: U.S. Department of Agriculture, Forest Service: 90-93.

Roberts, D.R. 1993. How to use ozone to eradicate pathogens. Nursery Manager 9(6): 74.

Tchobanoglous,G.; Schroeder, E.D. 1985. Water quality characteristics, modeling, modification. Menlo Park, CA: AddisonWesley Publishing Co. 768 p.

What is a Soil Management Plan, and why would you want one?

Next to water, soil is the most important resource of a bareroot nursery, and must be properly managed if the nursery is to be successful. Soil quality is not fixed, but instead, soil is living and constantly changing. Even the most productive nursery soil can be ruined by improper cultural practices. Seedling harvesting is particularly harmful. Bareroot seedlings differ from most other crops in that the entire plant, including the roots, is removed and so little organic matter is returned to the soil. Due to the necessity of having to lift bareroot seedlings during the dormant winter period when the weather is often wet, soil structure can be seriously damaged within a relatively few years (Figure L).

Figure L. Seedling harvesting during wet winter weather can seriously damage soil productivity

Many soil problems can be avoided by careful nursery site selection, but economic and political considerations often outweigh biological factors when a new nursery is established. Few nursery managers have had the luxury of participating in the selection of their nursery site, and so must manage their soil in the best way that they can. Frequently, new nursery managers find that they have inherited a worn-out soil that must be coaxed back into full productivity.

Bareroot seedling production is a complex interplay between the physical, chemical, and biological properties of the soil, and the cultural operations used at the nursery. Cultural practices, such as fertilization and irrigation, must be properly scheduled and executed to complement the unique characteristics of individual nursery soils. For example, even moderately saline or alkaline water can severely reduce soil productivity if irrigation is improperly applied

and corrective soil amendments are not used. Soil microorganisms, both beneficial mycorrhizal fungi and root rot pathogens, are also affected by soil characteristics and nursery cultural practices.

Steps in Developing a Soil Management Plan

Soil management must be approached in a **planned, systematic** manner. Because of the complex nature of a productive nursery soil, a series of spontaneous, unrelated cultural treatments will not produce the desired result. Soils are unique - there are no two nurseries that will have exactly the same soil conditions. For this reason, each nursery should attempt to develop a written soil management plan that considers the special nature of their nursery soils. Because of differences in economics and management objectives, the exact size and complexity of the plan will vary with the size and resources of the nursery.

A typical nursery soil management plan consists of four sequential processes:

1. *Mapping nursery soils - an* accurate soil survey is the foundation of a functional soil management plan but I have found that many nurseries do not have an up-to-date soil map.

2. *Analyzing soil survey results* - the results from the soil survey must be interpreted and correlated to seedling growth.

3. *Assessing soil production potential* - soil survey results must be integrated with operational realities.

4. *Implementing and updating the plan* - soil management is a continuing process, and so the plan will need to be periodically adjusted to reflect changing soil conditions or production goals.

Let's look at the first step: Mapping nursery soils

Obtain general soil survey information about your nursery - One of the best sources of soils information is the USDA-Soil Conservation Service (SCS), which conducts largescale soil surveys across the nation. Packets containing maps and descriptions of the major soil types occurring around the nursery are available by county from the local SCS office. Although the information from these surveys is too general to use for the Soil Management Plan, they will give a good idea of the soil types and conditions that may be encountered during the intensive nursery soil survey.

Make an accurate, up-to-date nursery map -One of the easiest ways to produce a map is to obtain a recent aerial photograph of your nursery from the local USDA - Agricultural Stabilization and Conservation Service (ASCS), SCS, or County Extension office. Enlargements of the aerial photos can be obtained from the master files in the Salt Lake City Office of the ASCS. A working map can be produced by outlining the boundaries of the nursery, and then enlarging or reducing it on a copying machine (Figure M). The scale of the map can be determined by measuring the distance between two easily recognizable landmarks on the ground, and comparing that distance to the map distance.

Establish nursery management units - A management unit, often called a **"block",** is the smallest area that can be managed for a particular crop. Blocks are usually controlled by roads, irrigation lines, windbreaks, or other features of natural topography. For example, the nursery blocks at the Colorado State Forest Nursery in Ft. Collins are determined by the location of the surrounding windbreaks (Figure M). The nursery blocks will delineate the sampling populations for the soil survey, and should be identified with a number or letter to aid the sampling process. The intensive field analysis and soil samples for testing will be collected within the boundaries of these blocks.

Determine soil survey sampling criteria -Before the survey can begin, it is necessary to identify the physical, chemical, and biological conditions **("limiting factors")** that affect seedling growth at your nursery. Some of these are standard for most forest and conservation nurseries, but others will be unique to specific sites. Note that these sampling criteria are different from those used in standard SCS surveys. Some typical examples include:

Physical Factors

* Depth of arable soil (Figure N)
* Soil texture
* Soil structure
* Compaction layers

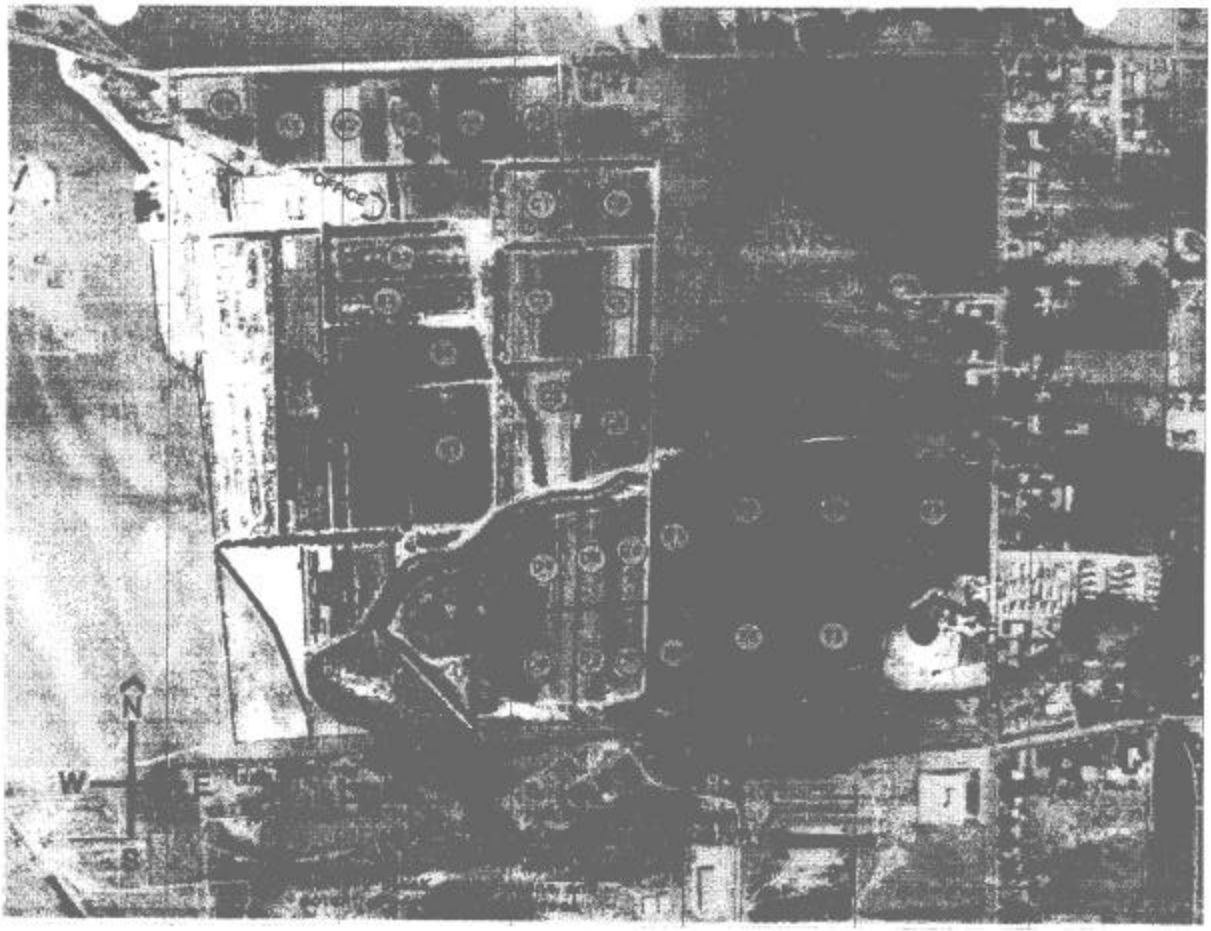

Figure M. Maps for soil surveys can be made from aerial photos and the nursery blocks can be superimposed.

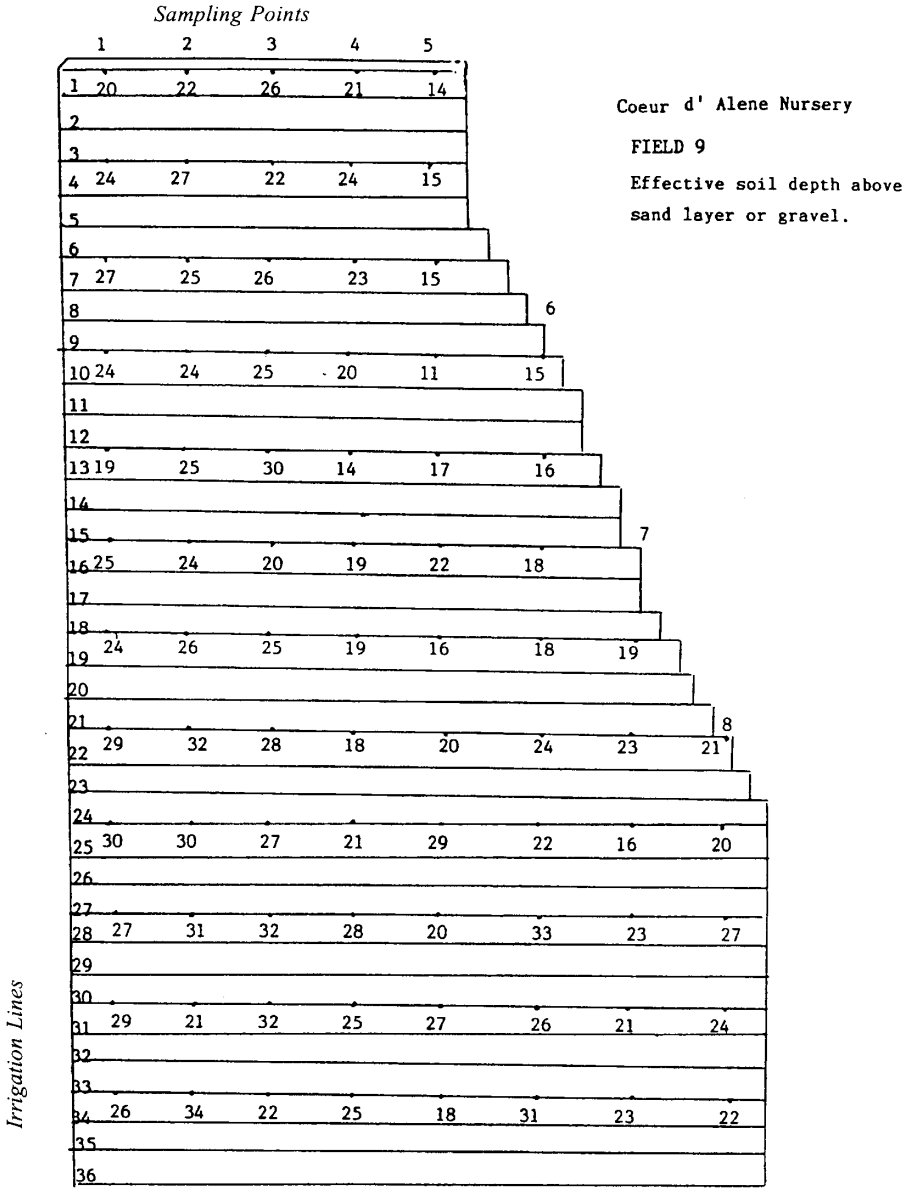

Figure N. The soil sampling grid at Coeur d' Alene nursery was oriented around the irrigation system.

Chemical Factors

* Soil reaction (pH)
* Electrical conductivity
* Aluminum saturation

% Calcium carbonate

Biological Factors

* High populations of soil pathogens
* Proper mycorrhizal fungi
* Stubborn weeds

Some of these factors (depth, texture) can be obtained by an on-site soil survey, and others (chemical content, pathogen populations) must be determined through soil testing.

Lay out a sampling grid for the survey -Although the sampling locations should not be biased, it is best to use a regularly-spaced pattern that will insure that they cover the entire nursery block. This insures that variations in soil conditions are adequately represented in the sample. Each sampling point can be identified by block and sampling point number from the grid. Referencing the grid to the irrigation lines is a good idea, so that the sampling points can be relocated easily. The number of samples that are needed within each block is primarily a function of soil variation, time, and economics. For example, a sampling grid at 100 ft. X 100 ft. intervals has been used at Forest Service nurseries, which amounts to about 9 sample points per acre (Figure N). Nurseries that are lucky enough to have large areas of uniform soil can get by with fewer samples; in that case, the sampling grid could be expanded to 200 ft. X 200 ft., or about 4 sample points per acre.

The Soil Management Plan will be only as good as the data gathered during the survey, but the time to do the sampling and the cost of laboratory soil analysis are always limiting. It may be most economical to survey only a few blocks of the nursery at a time; this can often be accomplished during the rest year of the rotation. In this way, the entire nursery can be surveyed in a few years and the cost of the laboratory analysis can be spread out.

After you have constructed your soil map and have decided on a sampling design, you are ready to begin the soil survey itself. The next article in this series, Conducting the Soil Survey, will be presented in the July, 1995 Issue of FNN.

Sources:

Landis, T.D.; Boyer, D.S. What is a soil management plan and why would you 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.

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. **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. **Numbered** or **Lettered** publications can be requested by circling the appropriate listing on the Literature Order Form and returning it to me.

SO. Greenhouse Engineering. Aldrich, R.A.; Bartok, J.W. Jr. 1994. Publication No. NRAES-33. Ithaca, NY: Northeast Regional Agricultural Engineering Service. 212 p.

This was one of my primary references for Volume One of the Container Tree Nursery Manual, and contains useful, easy-to-read information on greenhouse construction and operation. This 3rd revision of this softbound book features many helpful tables, illustrations, and appendices. It is a "must have" for all container nurseries, and for the price is a real bargain.

COST: $25.00

ORDER FROM:

Northeast Regional Agric. Engineering Service

Cooperative Extension

152 Riley-Robb Hall

Ithaca, NY 14853-5701

PHONE: 607-255-7654

FAX: 607-255-4080

SO. Hortus Northwest. A Pacific Northwest native plant directory and journal. Canby, OR: Hortus Northwest. Semiannual.

This journal contains technical articles on all aspects of revegetation and restoration, from seed collection and propagation to establishment techniques. It also contains a comprehensive directory of commercial seed and plant sources and advertisements for nurseries and restoration contractors. The new standard 8x11 inch color format is both attractive and readable. A one-year subscription for two issues is extremely reasonable:

COST: $9.00
($12.00 foreign)

ORDER FROM: Hortus Northwest
P.O. Box 955
Canby, OR 97013

PHONE: 503-266-7968
FAX: 503-399-6173

SO. 50 Ways Farmers Can Protect Their Groundwater. Hirschi, M.C.; Simmons, F. W.; Peterson, D.; Giles, E. 1994. North Regional Extension Pub. 522. Urbana, IL: University of Illinois, Cooperative Extension. 189 p. ISBN 1-883097-00-2

This colorfully illustrated softbound book features research and management tips on ways to cut back on pesticides and fertilizers without cutting yields, ways to apply chemicals more efficiently, and ways to determine which might leach to groundwater. This information is presented in an easy-to-read manner and should be an addition to any nursery's library - especially, considering the price!!

COST: $5.00

ORDER FROM: University of Illinois
Ag. Publication Office
69-IR Mumford Hall
Urbana, IL 61801

PHONE: 217-333-2007
FAX: 217-244-7503

SO. Machinery For Horticulture. Bell, B; Cousins, S. 1991. Ipswich, United Kingdom: Farming Press Books. 295 p. ISBN 0-85236-231-5.

This handy hardbound book contains chapters on tractors and self-propelled machinery and a wide range of sowing, cultivating, and harvesting equipment including operation and maintenance. For the container nursery, it has a couple of chapters on greenhouse equipment. I found "The Workshop" and "Power for Horticulture" chapters particularly useful because they explain tools and maintenance right down to the types of metals and nuts and bolts used for fabrication. Numerous black and white photos and illustrations make this publication even more practical.

COST: $39.45
50.50 (CAN)

ORDER FROM: Diamond Farm Enterprises
PO Box 537
Alexandria Bay, NY 13607

PHONE: 613-475-1771
FAX:613-475-3748

SO. Managing Diseases In Greenhouse Crops. Jarvis, W.R. 1992. St. Paul, MN: American Phytopathology Society. 288 p. ISBN 0-89054-122-1.

This hardbound book discusses holistic disease control through management of your propagation structure, environmental control equipment, and cultural procedures. In particular, I like the author's ecophysiological approach to managing plant stress and key environmental factors, such as temperature and humidity, as the key to disease control.

COST: $79.00
99.00 (foreign)
+ 3.50 (S&H)

ORDER FROM: APS Press
3340 Pilot Knob Road
St. Paul, MN 55121-2097

PHONE: 800-328-7560
FAX: 612-454-0766

SO. Pests Of Landscape Trees And Shrubs. Dreistadt, S.H.; Clark, J.K.; Flint, M.L. 1994. Pub. No. 3359. Berkeley, CA: University of California, Div. of Agriculture and Natural Resources. 327 p.

This softbound, color-illustrated book is, as the names states, oriented to the ornamental and landscape industry but the basic principles also apply to forest and conservation species. It is particularly useful to help answer all those questions that nurseries get from homeowners who expect them to know everything about all kinds of plants.

COST: $32.00

ORDER FROM:

ANR Publications
University of California
6701 San Pablo Avenue
Oakland, CA 94608-1239

PHONE: 510-642-2431
FAX: 510-643-5470

SO. Forest Nursery Practice. Aldhous, J.R.; Mason, W.L. 1994. Bulletin No. 111 London, Forestry Commission 268 p. ISBN 0-11-710323-3

This softbound book is a revision of the 1972 manual "Nursery Practice", and covers the propagation of both bareroot and container forest nursery stock. The chapters range from Nursery Policy and Planning, to Lifting, Storage, Handling, and Despatch and are illustrated in B/W with some color photographs. Although the use of metric units and the fact that the pesticides mentioned only apply to Great Britain make some adjustments necessary, nursery managers will find much useful information in this handy reference.

COST: $39.30
25.00 pounds

ORDER FROM:

HMSO Publications Centre
PO Box 276
London
GREAT BRITAIN SW8 SDT

SO. Reforestation Equipment. Hallman, R. 1993. Publ. No. TE02EI 1. Missoula, MT: USDA Forest Service, Technology and Development Center. 268 p.

This softbound book presents information about the types of equipment that are currently being used in Site Preparation, Direct Seeding, Planting, and Protection and Growth Enhancement Products. Each category of equipment has sections that discuss its Function, Description, Advantages, Disadvantages, Specifications, and Sources. Numerous black and white drawings and photographs illustrate each piece of equipment and help to show how they are used.

COST: FREE **ORDER FROM:** USDA Forest Service
Technology and Development Center
Ft. Missoula, MT 59801

PHONE: 406-329-3900
FAX: 406-329-3719

SO. Proceedings of the 1993 Forest Nursery Association of British Columbia Meeting. Huber R. tech. coord. 1993. Sept. 13-15, 1993; Courtenay, BC. Victoria, BC: Forest Nursery Association of British Columbia. 92 p.

This softbound publication contains 18 papers on the theme of "Changing Forestry Practices -Meeting the Challenges", which address current reforestation policy in Canada and the US. Ralph only has a limited number of copies, so contact him soon if you want one.

COST: FREE **ORDER FROM:** Ralph Huber
B.C. Ministry of Forests
3-31 Bastion Square
Victoria, BC
CANADA V8W 3E7

PHONE: 604-3 87-8942
FAX: 604-387-1467

#A. National Proceedings, Forest and Conservation Nursery Associations. Landis, T.D.; Dumroese, R.K., tech. coords. 1994. Gen. Tech. Rep. RM-257. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. 318 p.

This proceedings is a compilation of 43 papers which were presented at the Southern and Northeastern Forest Nursery Association, Western Forest Nursery Association, and Forest Nursery Association of British Columbia conferences during 1994. The technical content of these papers covers a wide range of topics on bareroot and container seedling culture, ranging from seed collection and processing to reforestation trends. The Proceedings is currently in press and should be available in a couple of months.

#B. Nursery Planning, Development, and Management, Vol. 1. The Container Tree Nursery Manual. Landis, T.D.; Tinus, R.W.; McDonald, S.E.; Barnett, J.P. 1994. Agric. Handbk. 674. Washington, DC: U.S. Department of Agriculture, Forest Service. 188 p.

This latest volume in the series took over 2 years to complete and will hopefully be worth the wait. Featuring many color photographs and other useful illustrations, this softbound book covers the basics of starting a container nursery in 5 chapters: Initial Planning and Feasibility Assessment; Site Selection; Nursery Design and Site Layout; Environmental Controls and Seedling Production Equipment; and Nursery Management. It is currently at the printers and should be ready for distribution in another month or so.

#C. Directory of Forest and Conservation Tree Nurseries in the Unites States. Okholm, D.J.; Abriel, R.D. 1994. Pub. No. R6-CP-TP-02-94. Portland, OR: USDA Forest Service, State and Private Forestry. 99 p.

This handsome softbound book replaces the previous directory that was published back in 1987. It consists of two sections. The first lists nurseries by state with complete addresses, information on ownership type, stock type, seedling distribution, and potential production. The second listing offers information on the various classes of seedlings produced as well as special nursery products and services. Tables and graphs of changes in nursery ownership since the previous directory and seedling distribution by ownership category help show the development of the nursery industry and current trends. This handy reference will be a useful addition to everyone's library.

#D. Hardwood Nursery Guide. Williams, R.D.; Hanks, S.H. 1994. Agric. Handbk. 473. Washington, DC: USDA Forest Service. 78 p.

Although this popular softbound book had been out of print for many years, it remains a valuable reference for the bareroot propagation of hardwood tree seedlings. The new emphasis on biodiversity and ecosystem management has created an increasing demand for broadleaved trees, and so the Forest Service decided to reprint this book now instead of waiting for a complete rewriting. Major sections include soil management; seed; seedbed preparation, sowing, and care; vegetative propagation; nursery protection: inventory; and seedling handling. Of course, pesticides and their use have changed considerably m the past 30 years and so an extensive section of updated information is included as a preface and in the appendices.

COME AND GET THEM! We have been going through our stock of nursery publications and would like to get rid of surplus copies. You can order a free copy of any of the following by circling the appropriate letter on the Literature Order Form on the back page and returning it to me. Note that supplies vary, and so orders will be filled on a first-come, first-served basis.

#E. Tree Planting in the United States, 1992. Moulton, R.J.; Mangold, R.D.; Snellgrove, J.D. 1994. Washington, DC: USDA Forest Service, State and Private Forestry. 15 p.

This pamphlet summarizes tree planting, timber stand improvement, and nursery production activities on all ownerships of forest land in the US. A national summary discussing historical trends and national statistics is followed by tables of specifics by state and ownership category.

#F. Tree Planters' Notes, Volume 44, Number 1 (Winter 1993)

#G. Tree Planters' Notes, Volume 44, Number 2 (Spring 1993)

#H. Tree Planters' Notes, Volume 44, Number 3 (Summer 1993)

#I. Tree Planters' Notes, Volume 44, Number 4 (Fall 1993)

#J. Tree Planters' Notes, Volume 45, Number 1 (Winter 1994)

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Source:
Derr, J.F. 1994. Something to Grow On: Alabama's Ornamental Newsletter.
Fall, 1994. Auburn, AL: Alabama Cooperative Extension Service.

Root Pruning Chemical

By now, I'm sure you have seen or heard about the use of copper compounds to chemically root prune container seedlings (Figure P). A new product, called Spin Out[R], is being marketed by the Griffin Corporation. Although many homemade copper compounds have been used, Spin Our is the only commercially available copper product that is registered for controlling root development in container tree seedlings. It is currently registered in the US, Australia, New Zealand, and Japan and registration is pending in Canada. Spin Out[R] can be applied to the inside wall of the cavities in either styrofoam blocks or plastic containers, where it prunes the lateral roots and creates a more fibrous root system. Chemical root pruning offers several other biological and operational advantages:

* Improved water and nutrient uptake

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* More stable trees after outplanting

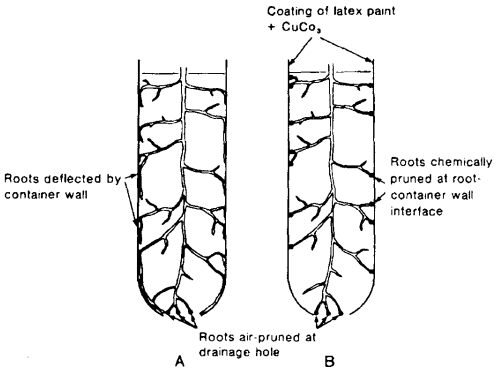

Figure P. Roots can be chemically pruned by coating the inside of the container cavity with copper compounds

For more information:

Griffin Corporation
PO Box 1847
Valdosta, GA 31603
PHONE: 800-242-8635
FAX: 713-952-3328

Source:
Herzinger, K. 1994. Grow quality forest seedlings with Spin Outs.
Houston, TX: Griffin Corp.

Growing Media with Coconut Fiber

Nurseries in tropical countries have been using the coir pith from the husks of coconuts as a component of their growing media for many years. Now, the Scotts Company has introduced a new line of media based on this totally renewable resource. Sphagnum peat moss has traditionally been the standard basis for all artificial soils but trials at Michigan State and North Carolina State University have shown equal or superior performance. Coir pith wets faster and more thoroughly because its fibers do not initially repel water like peat fibers, and these new media also shrink less that peat-based products. Greater total porosity means better root growth and plug formation, and the cation exchange capacity of coir mixes is equal to or greater than typical peat-vermiculite media. Because coir is inherently free from debris sometimes found in peat moss, containers fill more easily. Growers also report fewer problems with algae and fungus gnats when using coir-based media.

Of course, the true test of any product is how well it works under your own operational conditions. For more information of Redi-Earth® and Metro Mix® 366 Coir Mixes, contact your local Scotts distributor:

	Phone	FAX
Atlanta, GA	800-233-1298	404-255-8735
Allentown, PA	800-548-3071	610-395-0322
Richardson, TX	800-243-6560	214-669-3754
Milpitas, CA	800-233-1297	408-263-8944

Computer-assisted Transplanting

Transplanting seedlings is one of the oldest cultural practices in forest and conservation nurseries. In nurseries during the first half of this century, all seedlings were transplanted at least once (sometimes twice) and it was always done by hand (Figure Q). In modern nurseries, almost all transplanting is now done mechanically. The Silver Mountain Equipment company has developed a way to convert standard transplanters to computer drive systems that increase the speed and efficiency of transplanting, which means higher quality transplant stock. Traditionally, mechanical transplanting equipment has lacked a ground drive system

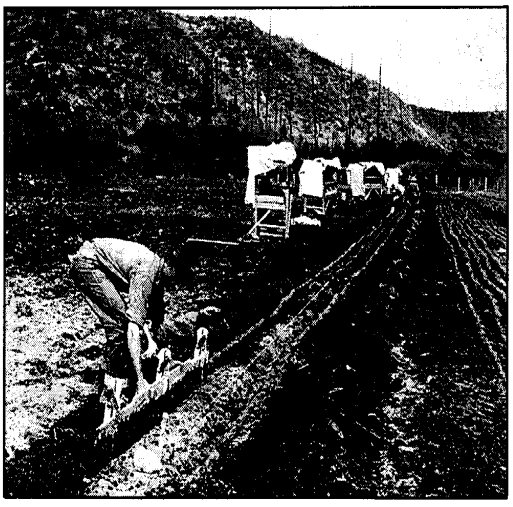

Figure Q. In early forest nurseries, all seedlings were transplanted by hand and often more than once.

that will not slip with changes in surface soil conditions or during wet weather. The new computer drive system provides steady measured ground speed which permits accurate spacing of the transplants and virtually eliminates J-roots with properly adjusted equipment. At the present time, Silver Mountain is offering custom conversion of existing transplanters, but they have also been approached by commercial manufacturers to supply the Computer Drive Systems under a licensing agreement. For more information, contact:

Jim Heater
Silver Mountain Equipment, Inc.
4672 Drift Creek Road, SE
Sublimity, OR 97385
PHONE: 503-769-7127
FAX: 503-769-3549

Health and Safety

Back Belts May Not Protect While Lifting

Nursery work often requires long hours of bending and lifting, especially during the seedling harvesting, grading, and shipping period. In the past few years, you can see many nursery workers wearing back braces, and they swear that they offer back support. But the following article casts serious doubt on that assertion:

New Report Says Back Belts May Cause Harm, by Melissa Steineger

Everywhere you look these days it seems people are wearing back supports, those black nylon belts often with suspenders, that everyone from grocery store cashiers to truck drivers have donned. No wonder, since nationally the number of complaints about low back pain are second only to the common cold.

But a new federal report says back belts "do not mitigate the hazards to workers posed by repeated lifting, pushing, pulling, twisting, or bending" and "may produce temporary strain on the cardiovascular system". That jibes with what chiropractor Dr. David A. Torkko, D.C. has found. "Back braces don't protect the back," he says unequivocally. "We don't recommend that our patients wear them."

Back belts, weight belts, or back braces all work by increasing pressure on the abdominal cavity, thus assisting the muscles holding up the spine. Their therapeutic use may have begun with corsets used to help patients with back pain in earlier days. But what Torkko has found is that some patients rely on belts so heavily that their muscles actually atrophy because the belt takes over the work of the muscles. A similar brace, the cervical collar, has been used so extensively by patients, he says, that when the collar is removed they can no longer hold up their heads.

Cynthia Alvarado, M.S., O.T.R./L., an occupational therapist at Portland Rehabilitation Center, has seen similar problems. Belts, Alvarado allows, can be useful as a reminder to lift properly for worker whose jobs requires frequent lifting. But, she adds, good lifting practices are better for the back. Used properly, she says, belts should be left dangling from the shoulder straps and loosely wrapped around the waist, then cinched very tight for actually lifting. Instead, many workers with relatively sedentary jobs are leaving the belts on all day to relieve low back pain.

To physical therapist Joe Keeney, belts offer virtually nothing. "Our theory here," says Keeney, who also works at Portland Rehabilitation, "is that you have to create a lumbar support with your muscles. Strengthening abdominal muscles would be a better solution than back belts."

"These devices are being marketed as a solution to back injury, and the existing scientific evidence does not support this claim." says Dr. Linda Rosenstock, Director of the National Institute of Occupational Safety and Health (NIOSH). .NIOSH recently reviewed existing studies of back belt use to evaluate claims that back belts can reduce work-related back injuries. In fact, the NIOSH study indicates the belts can do more harm than good because workers think they are protected and may attempt to lift more than they can. NIOSH researchers also uncovered indications that a tightly fitted weight belt can put a strain on the cardiovascular system by increasing heart rates

and blood pressure levels during exertion. The study, which did not consider previously injured workers whose doctors have prescribed back belt use, "does not recommend the use of back belts to prevent injuries among uninjured workers and does not consider back belts to be personal protective equipment." "People wear them because they think they are protective," says Marie Haring Sweeney, chairwoman of the group that conducted the NIOSH study. "The data really doesn't support that."

For a free copy of the NIOSH Working Group report "Workplace use of back belts", contact:

NIOSH Publications
Mail Stop C-13
4676 Columbia Parkway
Cincinnati, OH 45226-1998
PHONE: 800-356-4674
FAX: 513-533-8573

Source:

Steineger, M. 1994. New report says back belts may cause harm.
Portland, OR: In Balance Magazine (Winter 1994-1995) 2(3): 1,12. Reprinted with permission. No portion of this article may be photocopied, reprinted, reproduced for electronic media or otherwise reproduced without express written permission of the author.

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 asterisks 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. ***Development of a portable solar warmer-cum-nursery plant protector for high altitude areas.*** Sohni, S. K. Indian Journal of Forestry 17(1):91-96. 1994.

2. ***Early lifting and* transplanting of *flowering dogwood seedlings increases survival in the southern United States.*** Ruter, J. M.; Garber, M. P.; Moorhead, D. J. Journal of Environmental Horticulture 12(3):164-166. 1994.

3. ***Hardwood production techniques at midwestern nurseries.*** Stauder, A. F. IN: National proceedings, Forest and Conservation Nursery Associations, p. 2630. T.D. Landis and R.K. Dumroese, ed. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-257. 1994.

4. ***Nursery sterilization and inoculation regimes for alder production.*** Moffat, A. J. Forestry 67(4):313-327 1994.

5. ***Portable root wash station.*** Fawcett, R.; Paterson, J. Ontario Ministry of Natural

6. ***Undercutting in loblolly and white pine seedbeds.*** Dierauf, T. A. IN: National proceedings, Forest and Conservation Nursery Associations, p. 56-72. T.D. Landis and R.K. Dumroese, ed. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-257. 1994.

7. ***Undercutting in loblolly pine.*** Rakestraw, J.; Lowerts, G. IN: National proceedings, Forest and Conservation Nursery Associations, p. 50-55. T.D. Landis and R.K. Dumroese, ed. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-257. 1994.

8. ***Use of frost fabric as a seedbed mulch and frost protection method.*** Moench, R. D. IN: National proceedings, Forest and Conservation Nursery Associations, p. 165-167. T.D. Landis and R.K. Dumroese, ed. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-257. 1994.

9. ***The use of rootdips on North American conifer seedlings: a review of the literature.*** Sloan, J. P. Tree Planters' Notes 45(1):2631. 1994.

(SO) ***Winter sowings produce 1-0 sugar pine planting stock in the Sierra Nevada.*** Jenkinson, J. L.; McCain, A. H. USDA Forest Service, Pacific Southwest Research Station, Research Paper PSW- 291. 10 p. 1993. ORDER FROM: USDA Forest Service, Pacific Southwest Research Station, P.O. Box 245, Berkeley, CA 95701- 0245. Free.

Business Management

10. ***Changes in the British Columbia seedling program.*** Haddow, C. Forest Nursery Association of British Columbia, proceedings of 1993 meeting, p. 11-15. 1994.

11. ***Changing seedling requests: effects on nursery operation.*** Pelton, S. Forest Nursery Association of British Columbia, proceedings of 1993 meeting, p. 55-58. 1994.

12. ***Do something for safety's sake.*** Bartok, J. W., Jr. Greenhouse Manager 13(7):105-106. 1994.

13. ***The future - computer applications.*** Collins, B. International Plant Propagators' Society, combined proceedings, 1993, 43:67-70. 1994.

14. ***Looking to automate? Here's a step-by-step approach.*** Whitten, M. Greenhouse Manager 13(7):65-67. 1994. Guidelines to help you size up your needs before investing in new equipment or systems.

15. ***Microcomputer orderprocessing and inventory control.*** Wenny, D. L.; Geer, L. IN: National proceedings, Forest and Conservation Nursery Associations, p.157161. T.D. Landis and R.K. Dumroese, ed. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-257. 1994.

16. ***Nursery diversification for the future.*** Scholtes, J. Forest Nursery Association of British Columbia, proceedings of 1993 meeting, p. 51-54. 1994.

17. ***Silvicultural systems - changes and trends.*** Murphy, B. Forest Nursery Association of British Columbia, proceedings of 1993 meeting, p. 5-10. 1994. Due to changes in forest management practices, demand for seedlings will decline, customer needs will be more diverse and quality seedlings will be in high demand.

18. ***Take CARE.*** McCann, K. R. Greenhouse Grower 11(13):20,22- 23. 1993. The greenhouse CARE system offers computerized graphical tracking of your crops' growth.

19. ***Think green!*** Onofrey, D. Greenhouse Grower 11(13):75-76, 78. 1993. With or without state bans, composting is catching on as an alternative to dumping plant material in landfills.

20. ***What can we do to protect our workers from heat stress now that summer is here?*** The Digger 38(6):36-37. 1994.

21. ***What to expect from your suppliers.*** Bartok, J. W., Jr. Greenhouse Manager 13(9):92-93. 1994.

(SO) ***Hazard communications manual: a suggested model program.*** American Association of Nurserymen. 1993? A 70-page looseleaf binds to help you comply with OSHA Hazard Communication Standard. Contents: Introduction to the Federal OSHA hazard communication standard; Summary of OSHA hazard communication standard and compliance checklist; Suggested written hazard communication program; Hints on developing an employee training program; How to read and understand material safety data sheets. ORDER FROM: American Association of Nurseryman, 1250 I Street NW, Suite 500, Washington, DC 20005. Phone (202) 789-2900.. Fax (202) 7891893. Price: $40 to members, $80 to nonmembers + $2.50 S&H.

Container Production

22. ***Container size alters root growth of western black cherry as measured via image analysis.*** Oddiraju, V. G.; Beyl, C. A.; Barker, P. A.; Stutte, G. W. HortScience 29(8):910-913. 1994.

23. ***Developing container conifer seedling specifications... a balanced approach?*** van Steenis, E. IN: National proceedings, Forest and Conservation Nursery Associations, p. 84-91. T.D. Landis and R.K. Dumroese, ed. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-257. 1994. Discusses carbon fixation as it relates to plants and photosynthesis.

24. ***Growth and ectomycorrhizal development of northern red oak seedlings treated with IBA.*** Crunkilton, D. D.; Garrett, H. E.; Pallardy, S. G. HortScience 29(7):771-773. 1994.

25. ***Growth responses of four vigorous-rooted tree species in cupric hydroxide-treated containers.*** Ruter, J. M. HortScience 29(9):1089. 1994.

26. ***Improving conifer seedling quality with CONFER.*** Smith, D. B.; Lloyd, E.; O'Neill, G. IN: National proceedings, Forest and Conservation Nursery Associations, p. 280-283. T.D. Landis and R.K. Dumroese, ed. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-257. 1994.

27. ***Mother Nature knows best.*** Davis, T. Nursery Manager 10(9):42-45. 1994. Examples of successful overwintering by making snow, using leaves for insulation, or storing in wooded areas.

28. ***Pepper transplants are excessively damaged by brushing.*** Latimer, J. G. HortScience 29(9):1002-1003. 1994. Mechanical damage caused by brushing was excessive for the small amount of growth regulation provided.

29. ***The potential for chemical root pruning an container nurseries.*** Regan, R. P.; Landis, T. D.; Green, J. L. International Plant Propagators' Society, combined proceedings, 1993, 43:208-212. 1994.

30. ***Pulsing temps at sunrise.*** Faust, J. E.; Verlinden, S.; Heins, R. D. Greenhouse Grower 12(1):82, 84-85. 1994. Two ways to reduce the rate of stem elongation on plants: pulsing temperatures at sunrise and syringing plant foliage.

31. ***Security blankets.*** lies, J. K.; Agnew, N. H.; Taber, H. G.; Christians, N. E. American Nurseryman 180(7):54-62. 1994. An evaluation of 5 structureless overwintering systems for container-grown herbaceous perennials.

32. ***Seedling development of sugar maple and black maple irrigated at various frequencies.*** Graves, W. R. HortSeience 29(. I 1 x:1292-1294. 1994.

33. ***Shading of plants.*** Andersson, N. E. International Plant Propagators' Society, combined proceedings, 1993, 43:194-195. 1994.

34. ***Sodium metabisulfite reduces fungal inoculum in containers used for conifer nursery crops.*** Dumroese, R. K.; James, R. L.; Wenny, D. L. Tree Planters' Notes 44(4):161-165. 1993.

35. ***The use of a pin type seedling extractor.*** Willingdon, T. Forest Nursery Association of British Columbia, proceedings of 1993 meeting, p. 61-62. 1994.

36. ***Using copper compounds to modify roots on container-grown trees.*** Appleton, B. L. International Plant Propagators' Society, combined proceedings, 1993, 43:376-379. 1994.

37. ***Using "limiting factors" to design and manage propagation environments.*** Landis, T. D. International Plant Propagators' Society, combined proceedings, 1993, 43:213-218. 1994.

(SO) ***Nursery planning, development, and management. The container tree nursery manual, volume* 1.** Landis, T. D.; Tinus, R. W.; McDonald, S. E.; Barnett, J.. P. USDA Agriculture Handbook 674, volume 1. 188 p. 1994. Chapters: Initial planning and feasibility assessment; Site selection; Nursery design and site layout; Environmental controls and seedling production equipment; Nursery management. ORDER FROM: Tom Landis, USDA Forest Service, State and Private Forestry, P.O. Box 3623, Portland, OR 97208. Free.

Diverse Species

38. ***The benefits of wet-acclimating woody wetland plant species.*** McIninch, S.; Garbisch, E.; Biggs, D. Wetlands Journal 6(2):19-23. 1994.

39. ***Conserving threatened rare plants: some nursery strategies.*** Edson, J. L.; Wenny, D. L.; Leege-Brusven, A.; Everett, R. L.; Henderson, D. M. IN: National proceedings, Forest and Conservation Nursery Associations, p. 149-156. T.D. Landis and R.K. Dumroese, ed. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-257. 1994.

40. ***The effects of osmotic pre-sowing treatment on laboratory germination in a range of wildflower species.*** Tallowin, J. R. B.; Rook, A. J.; Brookman, S. K. E. Annals of Applied Biology 124(2):363370. 1994.

41. ***Fern propagation from spores.*** O' Dell, K. International Plant Propagators' Society, combined proceedings, 1993, 43:462- 463. 1994.

42. ***Flowering and seed yield in three species of prairie plants.*** Bohnen, J. L.; Hanchek, A. M. HortTechnology 4(3):255259. 1994.

43. ***A germination study of purple sage.*** Love, B.; Johnson, W. S.; Fernandez, G. C. J. HortTechnology 4(3):244-247. 1994.

44. ***Investigating native plant marketability.*** Shank, D. Hortus Northwest 5(1):19, 41. 1994.

45. ***Matric priming increases germination rate of Great Basin native perennial grasses.*** Hardegree, S. P. Agronomy Journal 86: 289-293. 1994.

46 ***Native seed collection, processing, and storage for revegetation projects in the western United States.*** Lippitt, L.; Fidelibus, M. W.; Bainbridge, D. A. Restoration Ecology 2(2): 120-131. 1994.

47. ***Native woody shrub propagation -three key steps.*** Finnerty, T. L. International Plant Propagators' Society, combined proceedings, 1993, 43:311-312. 1994. 1) Know your plants; 2) Planning and scheduling; 3) Recordkeeping.

48. ***Native woody shrub propagation -three key steps. Part 1. Know your plants.*** Finnerty, To L. North American Regions Plant Propagator 6(1 j:16-18. 1994.

49. ***Native woody shrub propagation -three key steps. Part 11. Planning, scheduling, and good recordkeeping.*** Finnerty, T. L. North American Regions Plant Propagator 6(2):16-18. 1994.

50. ***The propagation of Australian native plants from cuttings at the Australian National Botanic Gardens (ANGBG).*** Carmen, P. International Plant Propagators' Society, combined proceedings, 1993, 43:60-63. 1994.

51. ***Propagation of Juniperus for conservation planting.*** Cregg, B.; Lee, S.; Hovland, T.; Fleege, C.; Gleason, J. IN: National proceedings, Forest and Conservation Nursery Associations, p. 273277. T.D. Landis and R.K. Dumroese, ed. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-257. 1994.

52. ***Propagation of Pacific Northwest native plants from seed.*** Date, L. International Plant Propagators' Society, combined proceedings, 1993, 43:299-300. 1994.

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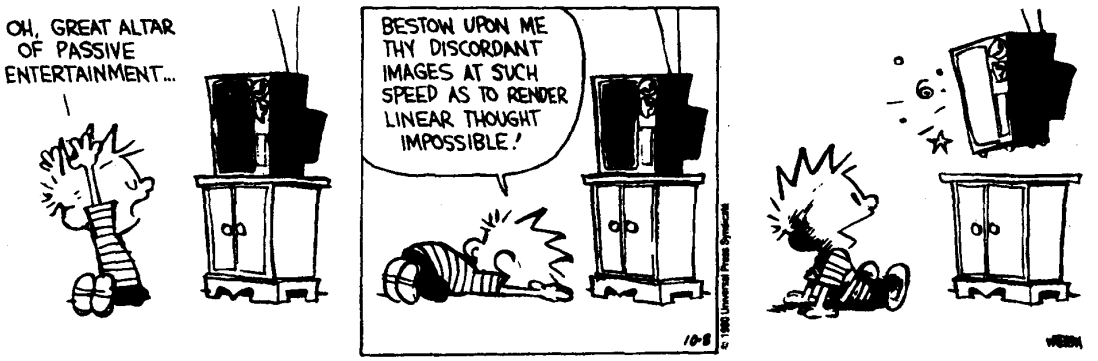

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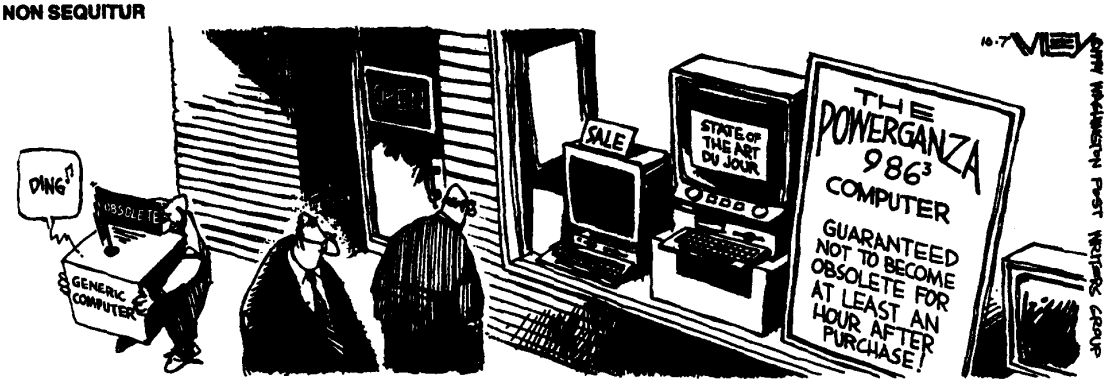

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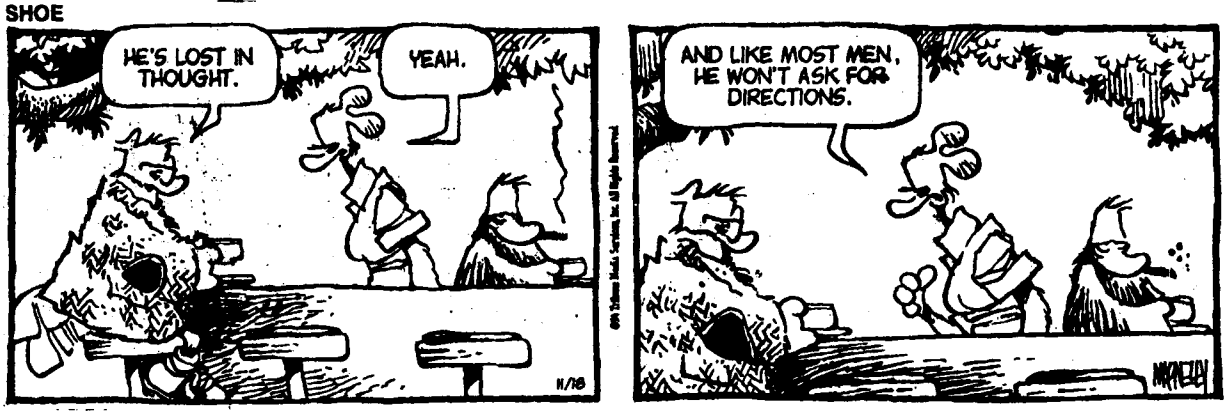

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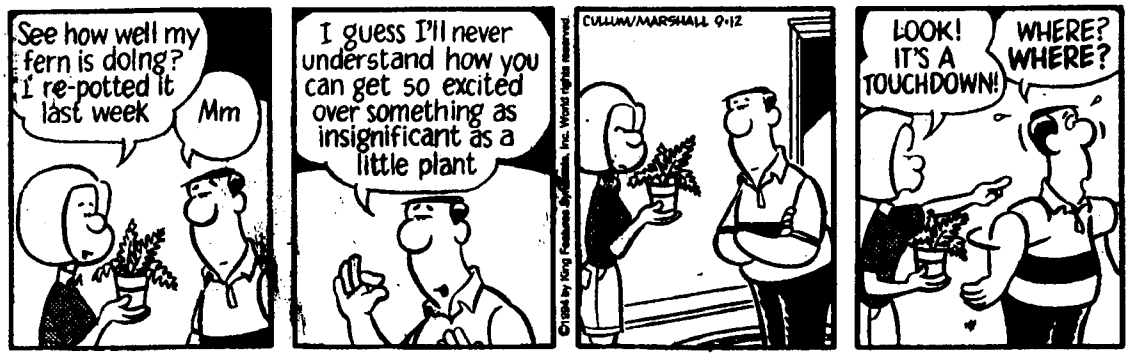

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