United States
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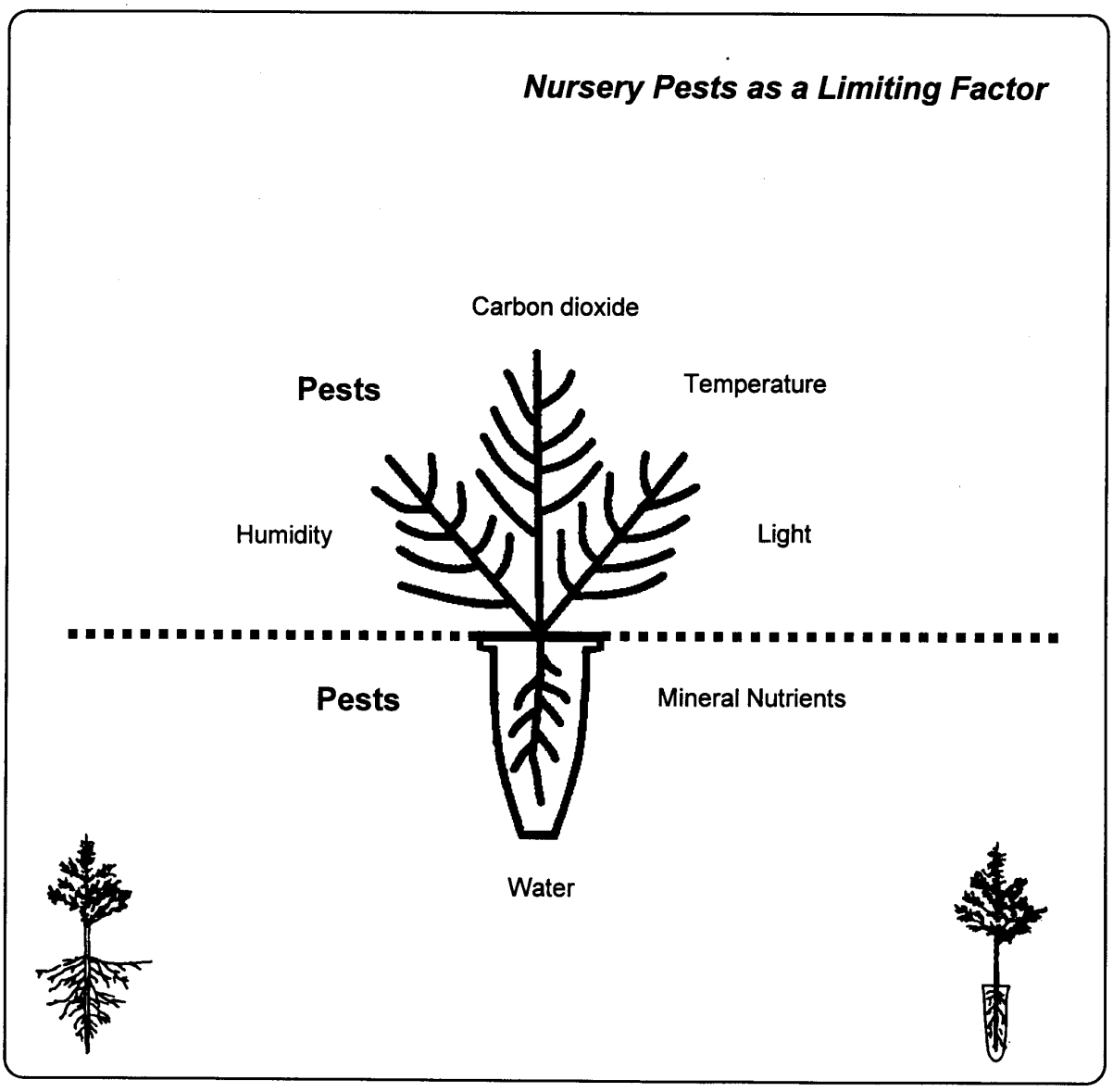
**Cooperative
Programs**

# Forest Nursery Notes

July 1994



This Technology Transfer Service is provided by:

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*FNN layout by Aleta Barthell*

# Forest Nursery Notes

July 1994


"Nature is not only more complex than we think . . .

it is more complex than we **can** think"

-Frank Egler

## *Reminder about change to semiannual issues.*

As announced last fall, FNN will only be published twice a year—in January and July. Some of you evidently didn't get the word, because I'm still getting inquiries about "missing" issues. You will continue to stay on the FNN mailing list as long as you return the Literature Order Form on the back page of each issue. Check the accuracy of the information on your mailing label, and then send the Literature Order Form back whether you want to order articles or not.

*TL*

# *Table of Contents*

# *Nursery Meetings*

## *"So Many Meetings, So Little Time"*

The Virginia Department of Forestry will be hosting the combined meeting of the ***Southern and Northeastern Forest Nursery Association Conference*** in Williamsburg, VA on **July 11-14, 1994.** The meeting agenda includes technical sessions on Reforestation Trends, Fumigation Alternatives, Hardwood Subjects, Pine Subjects, and Safety, Environment, and Insect Control. Nursery tours to New Kent Forestry Center and Union Camp's Forest Nursery will balance out the technical program. This meeting is located in the heart of Colonial Williamsburg and you can literally walk to many local historical landmarks. A Spouse's tour of James River Plantations is also scheduled. Time is running short, so call immediately if you want to attend:

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

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

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

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

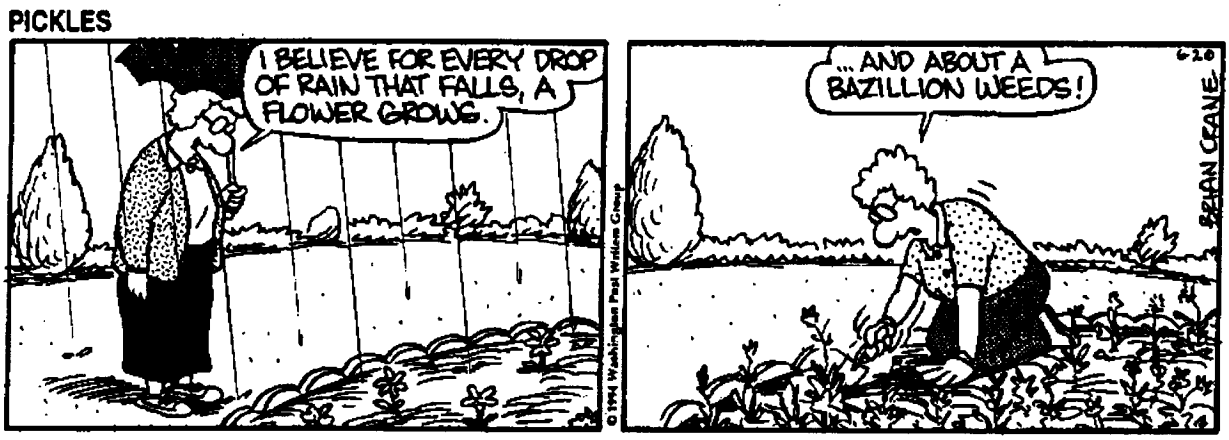
PHONE: 402-437-5178 ext. 13

A joint meeting of the ***Western Forest Nursery Association*** and the ***Forest Nursery Association of British Columbia*** will be held at the Best Western University Inn in Moscow, ID on ***August 15-19, 1994***. We have designed the agenda to be "user-friendly" - mornings are devoted to technical presentations which will be balanced by afternoon field trips to local nurseries. We will visiting four nurseries in all: the University of Idaho Forest Research Nursery (container and micropropagation), the USDA Forest Service Coeur d' Alene nursery (bareroot, container, seed processing, and tree improvement), and the container nurseries of the Potlatch Corporation and Western Forest Systems, Inc. A dinner cruise on Lake Coeur d' Alene and a beach picnic on the Snake River will highlight the natural beauty of Northern Idaho. An optional field tour of forest plantations is scheduled on Friday. If you are thinking of attending you can save $50 by registering before July 14, so call immediately:

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

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

This year, the ***Intermountain Container Seedling Growers'*** will sponsor a nursery disease diagnosis workshop on ***Aug. 15, 1994*** in Moscow, ID in conjunction with the Western Forest Nursery Council meeting. This informal meeting is a chance for local growers to get together and discuss common problems. If you are going to attend, start collecting those problem seedlings and storing them in the freezer so that you can participate in the "show-and-tell" session. You can register for the workshop by contacting Kas (see above listing) or give me a call.



***"Making the Grade"*** will be the theme of an international symposium on planting stock performance and quality assessment which will be held in Sault Ste. Marie, ON on ***Sept. 11-15, 1994***. The goal of this meeting is to bring together world leaders in plant quality assessment to synthesize the current state of knowledge and identify the direction for future work. The symposium is sponsored by the Ontario Forest Research Institute and the IUFRO Working Parties on Characterization of Plant Material, Physiology, and Nursery Operations, and will consist of invited presentations, volunteer papers, poster sessions, and field trips to the Research Institute and local nurseries. If you would like more information, contact:

Erika Menes, Conference Coordinator
Ontario Forest Research Institute
P.O. Box 969, 1235 Queen Street E.
Saint Ste. Marie, ON
CANADA P6A SNS

PHONE/FAX: 705-949-9188

The 35th annual meeting of the ***Western Region of the International Plant Propagators' Society*** will be held at the Red Lion Hotel in Costa Mesa, CA on ***Sept. 29-Oct. 1, 1994***. The agenda contains several topics which should be of interest to forest and conservation nurseries including germinant sowing, machine vision, irrigation efficiency, and a special section on Natives and Forestry. Local nursery tours and scenic stops will make this a particularly interesting meeting. IPPS 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:
Mike Evans
Tree of Life Nursery
P.O. Box 736
San Juan Capistrano, CA 92693
PHONE: 714-728-0685

A combined meeting of the ***North Central Forest Pest Workshop*** and the ***Mid-Continent Nursery Pathologists*** will be held in Sault Ste. Marie, ON on ***October 4-7, 1994***. The first half of the meeting will address the impact of pests on forest management, followed by several topics specific to nurseries: alternatives to fumigation, pest management strategies, and the fate of nursery diseases after outplanting. The deadline for presentations or posters was June 1, but you may still be able to squeeze in. For more information, contact:

Craig Howard
Ontario Forest Research Institute
P.O. Box 969, 1235 Queen Street E.
Saint Ste. Marie, ON
CANADA P6A SNS

PHONE: 705-949-2981

The first annual ***Integrated Forest Pest Management Course*** is scheduled for ***October 14-23, 1994*** in Sault Ste. Marie, ON. The goal of this course is to advance the skills and knowledge of forestry professionals in current techniques and principles for planning, implementing, and evaluating Integrated Forest Pest Management (IFPM) programs. In this context, IFPM applies to forest and conservation nurseries and "pest" refers to insects, diseases and competing vegetation. For more details, contact:

Eileen Harvey
Canadian Forest Service
1219 Queen Street East
Saint Ste. Marie, ON
CANADA P6A SM7

PHONE: 705-949-9461
FAX:705-759-5700

***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

# National Nursery Issues

## Plant Quarantines

For any of you who have ever tried to find out how to ship plant material across a state line, there is good news. The American Association of Nurserymen in cooperation with the National Plant Board of the USDA Animal and Plant Health Inspection Service has just released *Federal & State Quarantine Summaries.* This looseleaf book contains a listing of national and state-by-state information on plant quarantines regulations. Interstate transport has always been confusing, especially because simple things-like the definition of "nursery stock" -vary considerably. For example, seeds are included in Oregon, but not in Colorado. This handy reference also lists the principal contacts for quarantine information in each state and provides phone and FAX numbers. See the "Special Publications" section for ordering information.

## Worker Protection Standard Update

As reported in the January, 1993 issue of FNN, the U.S. Environmental Protection Agency (EPA) revised the Worker Protection Standard (WPS) for Agricultural Pesticides. The WPS governs pesticides used in the production of agricultural plants which includes forest and conservation seedlings. Most WPS provisions were due to take effect on April 15, 1994. However, before that date, legislation was enacted which delays implementation of some, but not all, of the new WPS standards until January 1, 1995. The new law was enacted to allow more time for the agricultural community to learn about the WPS and to properly prepare for implementation.

Specifics of the new revisions depend on how the WPS requirements appear on the pesticide label. Some requirements are fully spelled out on the label whereas others are referred to, but not thoroughly described. During 1994, you must comply with the WPS provisions that are spelled out, which include the requirements for personal protection equipment (PPE), the restricted entry interval (REI), and the requirement for "double notification" - if this requirement is on the label.

You do not need to comply with the "referenced" requirements until January 1, 1995. These requirements include pesticide safety training for agricultural workers and handlers, decontamination sites, notification of workers about pesticide applications, display of information about pesticide applications, emergency assistance, and display of safety posters. The new legislation also provides optional PPE requirements for some irrigation work and excludes crop advisors from WPS coverage for the remainder of this year.

Well, are you sufficiently confused? Maybe, ***Table 1*** on the following page will help. As you will see, the new WPS requirements are detailed and demanding, so check the WPS Handbook for the specifics. See the January, 1994 FNN for information on ordering the WPS Compliance Manual, Posters, and Worker Training Booklets. If you don't have a copy, let me know and I'll send you one.

**Source:**

Cress, D. Kansas Pesticide Newsletter 17(4); April 19, 1994

***Table 1. Worker Protection Standard for Agricultural Pesticides***

| *When Does It Apply?* | | | |
|---|---|---|---|
| WPS Requirement | 1994 | After 1/1/95 | Specific Details |
| Restricted Entry Interval | Yes | Yes | Already specified on the label. |
| Early Entry Activities involving contact with treated surfaces | Yes - no time limits | Yes - time limits | In 1994, no limit on worker time in treated area. After 1/1/95, usually only 1 hr/day. |
| Personal Protective Equipment (PPE) for Handlers | Yes | Yes | Already specified on the label. |
| PPE for Early Entry Workers contacting treated surfaces | Yes | Yes | Clean and fully-operational PPE must be provided by employer. |
| Choice of PPE for Early Entry Irrigation Workers | Yes | No | Until 1/1/95, choice of PPE or coveralls plus chemical-resistant gloves and footwear if there is pesticide contact only to lower body. After 1/1/95, must use PPE on label. |
| Notification of Workers about Applications | No | Yes | Required after 1/1/95. In most cases, employer can choose oral notification or posting, unless both are required by the label. Greenhouse uses require posting. |
| Double Notification - Oral and Posted Warnings | Yes | Yes | In 1994, employer must post and warn. After 1/1/95, must use the WPS field warning sign and follow new posting and notification requirements. |
| Protection for Crop Advisors | No | Yes | Applies after 1/1/95 |
| Pesticide Safety Training | No | Yes | WPS requires basic safety training for workers and more detailed training for handlers. |
| Additional Requirements:<br>- Poster Displays<br>- Decontamination Sites<br>- Emergency Assistance<br>- Monitoring Handlers | No | Yes | This delay gives employers time to learn and implement these new WPS requirements. |

# *Global Issues*

This section is an effort to make those of us with our heads in the seedlings stand up and take a look around at the larger natural resource issues that affect us all. I've tried to capture the salient points of a couple of recent articles, and encourage you to get copies of the entire articles. Directly, or indirectly, these issues are shaping the future of our profession.

## *Ecology, Public Opinion, and Natural Resource Management*

### Change is a Basic Fact of Ecology

In spite of what most people believe, there is no such thing as "natural balance," a "balance of nature," or a "natural steady-state system." Ecosystems, whether affected by people or not, constantly change, and have always done so. Many of those changes dramatically affect the ability of forests to produce goods and services that people depend on. Some ecosystem changes are caused by natural conditions that evolve at a very slow pace. Climate change, species evolution and migration, and soil formation are examples. Others occur in an instant. Disastrous wildfires, major storms, and volcanoes do their thing, and will continue to do so. Nature is neither easy, nor particularly kind.

Forests don't always respond to gradual changes in gradual ways. A forest may tolerate a gradual shift in climatic conditions, or a change in nutrient output, with no perceptive impact on trees or other major species for many years. Significant change may be hidden for many years within the "normal" variation in the system-trees live and die, animal populations cycle up and down, and the weather varies from year to year. But forests may also pass through a "threshold" where the trees suddenly die. We can see examples of these catastrophic events -the Yellowstone fires, death of large areas of forest in the Appalachian mountains and northern Europe. The causes for these declines are complicated and may be impossible to identify. The "chaos theory" states that many events in the environment occur in a random, unpredictable pattern, and that those random events sometimes are very important in influencing what happens to an ecosystem.

The fact remains, however, the concept of a stable climax plant community doesn't apply.

### Global Changes

The industrial revolution and the exponential increase in human population are causing changes on a global scale. Science has a hard time with these issues because what's happening is different than anything that has happened in the past, and there's no way to test global changes in a laboratory. Because scientists can't experimentally prove cause and effect, these global events must be tested with computer models which still are, in the words of their operators, "very crude approximations of reality."

In spite of this uncertainty, the likelihood of significant climate change is too high to ignore, and these changes are happening at an unnatural pace. Forests and other ecosystems face a hard time adjusting to the rate of climate change,

which may be 3 to 10 times faster than species can migrate. Ecosystem fragmentation also prohibits natural adjustments to environmental change.

## Public Opinion and Natural Resource Management

Policy governing the management of public lands in this country is made by political bodies that base their decisions on public opinion. It is in this area that I see the greatest threat to our forests. It comes from the rapidly growing distrust of natural resource management in any form. It stems from the underinformed or misinformed being led to believe that human management is the cause of our problems, so management should be abandoned in favor of "nature knows best".

But that suggests that we're responsible for figuring out what is acceptable to people on those forests, and what we can do that is most consistent with the ecological and economical realities that we face. To many in forest politics today, the answer is a different kind of management based more on the preservation of ecosystem structures and processes than on the resulting quantity of products. That makes a lot of sense, but there are still many political debates ahead as to how such management can be accomplished.

Another stumbling block is a growing fascination on the part of many people with the concept of "pre-settlement conditions," as though those had some magical quality. That idea must be approached with caution. First of all, we don't know what those conditions were and second, pre-settlement cannot be said to "pre-management." Native Americans manipulated forest and range lands considerably with the use of large scale wildfire. Even if we want to, we can't return to that. Nothing is the way it was in the 18th century and the forests can't be either. We have to accept that humans have a profound effect on ecosystems on a global scale, and the magnitude of that effect will continue to increase with the population.

So, what to do. Natural resource managers need to accept and plan for change. Specifically, we need to try and predict the onset of large-scale destructive events and avoid them if possible, as well as manipulate the vegetation so that it is more resilient under the pressures of stress. That means decentralized, science-based management and decision-making that is flexible and able to respond to fast-changing conditions. It needs to involve the public, but that public must be informed enough to see and understand what's actually happening in the forest. And it requires that the public be willing to trust professional managers to make reasonable decisions

**Source:**

Sampson, N. The Conservation Legacy 31. Pinchot Institute for Conservation.

Smith, D.I. 1993. Forest management and the theology of nature. American Forests 99(11/12): 13-16.

# *Special Publications*

## Ordering Information

The following publications are featured here because they are of special interest to nursery folks. If you would like a copy, there are two different ordering procedures. **Numbered** or **Lettered** publications can be requested by circling the appropriate listing on the Literature Order Form and returning it to me. Special Order (SO) publications are either too long or too expensive for us to provide free copies, but prices and ordering instructions are provided here and following the individual listings in the New Nursery Literature section.

**SO**. ***Proceedings: Northeastern and Intermountain Forest and Conservation Nursery Associations.*** Landis, Thomas D., tech. coord.; 1993 August 2-5; St. Louis, MO. Gen. Tech. Rep. RM-243. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 1994. 158 p.

This publication is a compilation of 25 articles on various aspects of nursery management in northeastern and western North America. In addition to general nursery technical reports, this publication contains papers relating to three special focus topics: Soil Management, Organic Matter Management, and Integrated Pest Management and Biocontrol.

Cost: Free **Order From:** USDA Forest Service
Rocky Mountain Research Station
Publications Distribution
240 W. Prospect
Ft. Collins, CO 80526-2098

**PHONE:** 303-498-1719
**FAX:** 303-498-1660

**SO.** ***Proceedings: Nursery Management Workshop.*** van Buijtenen, J.P.; Simms, T. tech. coords.; 1991 Sept. 10-12; Alexandria, LA. Pub. 148. College Station, TX: Reforestation Dept. 1993. 145 p.

Although it took a few years to get published, this softbound publication contains review articles on the entire sequence of bareroot nursery culture of southern pines. All the articles are well written but of particular note are: a holistic approach to nursery soil management (#221), the latest in herbicide testing (#276), and a practical approach to defining and producing the target seedling (#186). Order individual articles by number on the Literature Order Form, or copies of the entire Proceedings from the following address:

Cost: Free **Order From:** Texas Forest Service
Reforestation Dept.
Horticulture/Forest Science Bldg.
College Station, TX 77843-2135

**PHONE:** 409-845-2641
**FAX:** 409-845-5764

**SO.** ***Common-sense pest control.*** Olkowski, W.; Daar, S.; Olkowski, H. Newton, CT: The Taunton Press. 715 p. 1991.

This handsome hardbook book was published a couple of years ago, but somehow I missed it. It contains 9 sections on almost every aspect of the Integrated Pest Management (IPM) approach to all types of pests, from those affecting plants to those of structures, and even humans. The authors are associated with the Bio-Integral Resouce Center in Berkeley, CA and present a well-balanced, rational approach to pest management. While it doesn't specifically address forest and conservation nursery pest problems, this excellent reference book contains discussions on basic concepts of IPM using an ecosystem approach. It is well illustrated throughout with numerous examples, including many from an historical perspective, and will be a good addition to your reference library.

**Cost:** $40.00
+ $2.50 S&H

**Order From:** American Association of Nurserymen
1250 I Street NW, Suite 500
Washington, DC 20005
**PHONE:** 202-789-2900
**FAX:** 202-789-1893

**SO.** ***Federal & State Quarantine Summaries.*** American Association of Nurserymen and USDA -Animal & Plant Health Inspection Service. AAN Publication A-2-40330. Washington, DC: American Association of Nurserymen.

This looseleaf book is a compilation of US and state regulation of nursery stock. See National Nursery Issues Section for more information on content.

**Cost:** $27.50

**Order From:** American Association of Nurserymen
1205 I Street NW, Suite 500
Washington, DC 20005
**PHONE:** 202-789-2900
**FAX** : 202-789-1893

**SO.** ***Provincial seedling stock type selection and ordering guidelines.*** Scagel, R.; Bowden, R.; Madill, M.; Kooistra, C. British Columbia Ministry of Forests. 75 p. 1993.

The spiral-bound publication explains the process of how to match seedlings to the outplanting site. Although written specifically for British Columbia forests, the concepts and principles have a much wider application. Good color photographs and illustrations make this an excellent example of technology transfer.

**Cost:** Free

**Order From:** British Columbia Ministry of Forests
Silviculture Branch
31 Bastion Square
Victoria, BC
CANADA V8W 3E7

**PHONE**: 604-387-8903
**FAX**: 604-356-6052

**SO.** ***Improving planting stock quality-the Humboldt experience.*** Jenkinson, J.L.; Nelson, J.A.; Huddleston, M.E. Gen. Tech. Rep. PSW-GTR-143. USDA Forest Service, Pacific Southwest Research Station. 1993. 219 p.

This comprehensive softbound publication describes the implementation and results of a seedling testing program that was developed to improve the survival and growth potential of planting stock at the USDA Forest Service Humboldt Nursery on the north coast of California. It is well organized and illustrated and provides a good example of how seedling quality can be monitored in the nursery and after outplanting, and how these results can be used to improve nursery culture.

**Cost:** Free

**Order From:** Pacific Southwest Research Station
Publications Dept.
P.O. Box 245
Berkeley, CA 94701-0245

**PHONE:** 510-559-6300
**FAX:** 510-559-6440

**SO.** ***Tree and Shrub Planting Handbook -A Guide for Conservation Plantings in Utah and Nevada.*** Townsend, L.R.; Schen, D.C.; Murphy, P.; Hanson, M.L. Salt Lake City, UT: Utah Div. of State Lands and Forestry. 1993.

This loose-leaf workbook contains 6 chapters that explain how to plan and design windbreaks and other conservation plantings. Of particular interest are a species selection guide with color photographs, and a checklist of seedling stock specifications. Although oriented towards the Intermountain West, this publication will be a good reference to anyone involved in conservation plantings.

**Cost:** $35.00
+ S&H

**Order From:** State of Utah
Sovereing Lands and Forestry
Suite 425
Salt Lake City, UT 84180-1204

**PHONE:** 801-538-5504
**FAX:** 801-355-0922

# Health and Safety

## Start a Nursery Safety Program

I'm sure that all of you have some sort of safety program, but you may want to consider some of the following ideas. First, lead by example. Safety awareness starts at the top of your organization and is followed through by your supervisors and foremen. Without this approach, whatever programs you write on paper will be frustratingly difficult to enforce.

The Hazardous Communications Laws or Right-to-Know laws were written to reduce the possibility of chemically-caused illnesses and injuries and to give physicians the information they need to diagnose and treat pesticide poisonings. By committing to follow the guidelines of these laws, your nursery is making a commitment to your employee health and welfare through duration and continued safety awareness.

All nurseries must comply with the Federal Hazardous Communication Act under OSHA (Occupational Safety and Health Administration), and you may be subject to additional regulations in your state. For example, in Texas, nursery managers must follow the Texas Department of Agricultural Hazards Communication Act. Under the OSHA regulations, all nurseries are required to have a written Hazcom program. Your program should include a brief outline of your nursery's policy regarding the following:

***1. Container labeling policy.*** It is the responsibility of the nursery to verify that chemical containers are properly labeled at the time of receiving them from the manufacturer or distributor and to see that all other containers used in the nursery for chemicals must also be labeled and have a hazard warning.

***2. Inventory of hazardous materials.*** An up-to--date inventory of all chemicals used by your nursery and the location where exposure to the chemical is most common.

***3. Material Safety Data Sheet (MSDS).*** Your nursery must keep a file of an MSDS for each type of chemical used or stored. It is your responsibility to get these if the manufacturer does not send one for each product.

***4. Employee training.*** All employees must be familiar with the MSDS information, how to read warnings on labels, and what hazardous signs mean on your nursery. Employees who use chemicals should be trained and that training recorded.

***5. Non-employees.*** Contractors and companies delivering hazardous chemicals should be made aware of hazardous areas and your policies and should also have access to MSDS sheets.

***6. Respirator and other protective gear.*** OSHA has specific guidelines regarding the care and use of respirators. Other protective gear should be worn as recommended on the MSDS. It is also an OSHA regulation that persons who wear a respirator first have a pulmonary function test and be tested annually.

Once it is written and you have management sign off on it, begin to get your supervisors and foreman-level employees involved in helping pull together and review the information. From there, you will be able to see what specific areas must be targeted. No matter how comprehensive your nursery program, each department will have situations unique to it. Each department then should have written policies regarding those situations. It is well documented that most accidents come from new employees or employees borrowed out of other departments. Having department guidelines helps your supervisors and foremen remember to go over hazards and make new or borrowed employees accountable to that training. Document all training. This is your only protection in law suits, and once again, it is a form of enforcement to make sure training is carried out.

Maintaining safety awareness is not an easy task nor is covering these regulations. Management will find themselves taking a hard look at the types of chemicals and the volume of chemicals used at their nursery. IPM programs become more critical and meaningful. Here are some ideas you may consider when setting up your program:

** If you can afford it, consider hiring a safety consultant to help you get started. They're not as expensive as you might think.*

** Start a safety committee made up of all departments from supervisory I level on down. Have the committee inspect the nursery periodically. Look for unusual hazards such as acid injectors, cleaning tanks, and steam pipes.*

** Target new employees. If you have a large nursery, make them wear a different colored hat or something until they are past orientation period. We have them wear an orange safety vest.*

** Coordinate pesticide application. Discuss how your applicators should handle drift, and inform other workers. Consider what area you should quarantine after applying a pesticide. Coordinate irrigation with pesticide application.*

** Put everything in writing. Obviously, document all accidents. Designate one person to order or sign off on purchase orders on all chemical orders. It is this person's responsibility to update the MSDS.*

** And finally, make it fun. Safety programs can be good ways to bring people together. Your commitment to your employee's welfare can be a great morale booster. Competitions, prizes, rallies are all ways to keep up interest throughout the year. Safety programs are winners for all parties concerned. Employees benefit from increased concern for their health and welfare, the employer benefits from better chemical management and lower accident costs. And the environment benefits from less pesticide use.*

***Source:***

Hubbard, A. 1994. Safety Programs to Satisfy the Right-to-Know Laws. Combined 1992 Proceedings, International Plant Propagators Society 42: 388-390.

## *Computer Access to Pesticide Information*

Your computer can be one of the foundations of your nursery safety program. A couple of new computer reference products will make it easy to quickly access the latest information about pesticides. Chemical and Pharmaceutical Press, Inc. (C & P Press), publishers of the traditional Chemical Reference Guide books, is offering an **Electronic Pesticide Reference** program that makes material safety data sheets (MSDS) instantly available on your computer screen. This program contains the complete texts of the Crop Protection Chemicals Reference (10th edition), the MSDS reference for Crop Protection Chemicals (6th edition) and the Turf and Ornamental Chemical Reference. With this program on your computer, you will be able to search for products, compare specific information on different pesticides, and print the MSDS and product summaries. In particular, you will be able to quickly access important emergency treatment instructions in the case of an accident. I'm sure that you have the MSDS's for all the chemicals that you use filed somewhere around the nursery, but could you really find them in an emergency? The Electronic Pesticide Reference is available in 2 formats: a diskette version for $495 and a CD-Rom version for $395. For specific information, contact:

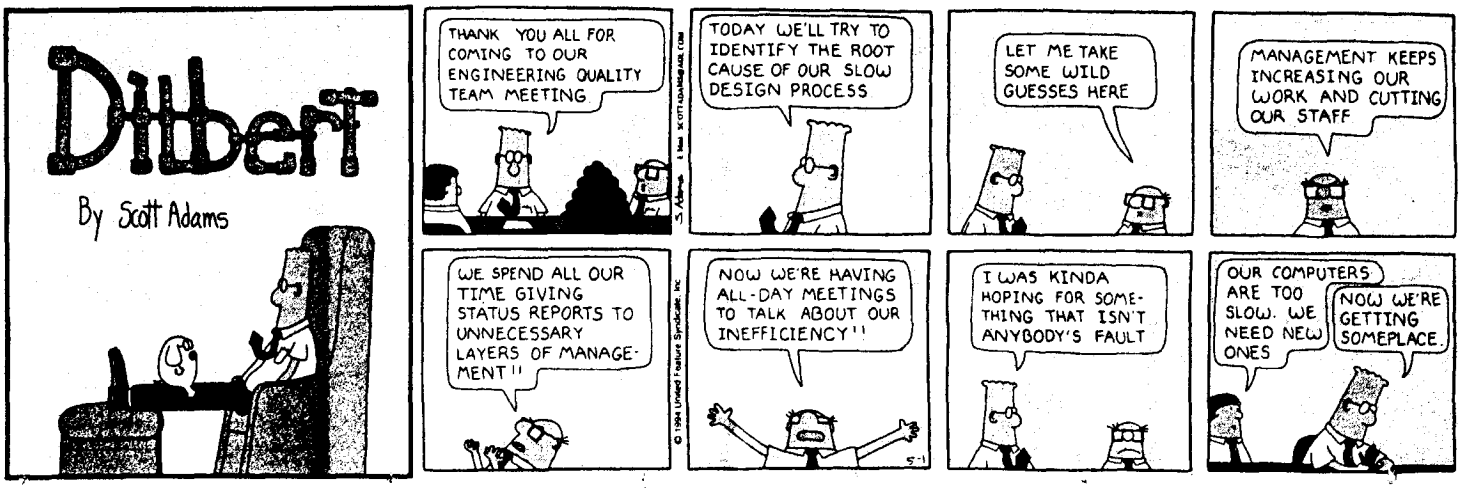
Terrie Daskalakis C & P Press 888 Seventh Ave., Suite 2800 New York, NY 10106

PHONE: 800-544-7377
FAX:212-399-1122

**Source:**

Glover, S. 1994. CD-ROM pesticide database speeds label, MSDS reference. Custom Applicator, Feb. 1994.

Whitten, M. 1994. Greenhouse Manager 13(1): 50-51.

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# Cultural Perspectives

## To Cover Crop or Not to Cover Crop - That is the question

Bareroot nursery managers have been on the horns of a dilemma for some time. They know that they need to rotate their crops and have observed increased soil tilth after crop rotation, but cover crops and green manure crops have a couple of drawbacks:

1. They may actually cause a decrease in soil organic matter levels due to the "primer" effect in which decomposing organisms build up populations on the cover crop and then go on to breakdown resident organic matter.

2. Some crops, notably legumes, stimulate populations of fungal soil pathogens. This was not a problem when we had methyl bromide fumigants will be a serious one if/when they are gone.

Well, the plot thickens. A couple of recent studies have shown that cover crops can decrease the leaching of nitrate-nitrogen, and so may help reduce groundwater pollution. Both studies found that leaving land fallow, even just over the winter, contributes to the leaching of nitrates. Tests in lettuce fields in the Saunas valley of California show that soil nitrate levels often double during the winter fallow season when nitrogen mineralization reaches its annual maximum. The average nitrate content in the root zone under six different cover crops was found to be lower than the bare soil control during January (grey bar) and much lower after the cover crops were incorporated (black bar) ***(Figure 1)***. This decrease was due to two factors. Obviously, the cover crops reduced teachable nitrates by organically fixing it into their biomass, but the researchers also found that soil moisture was significantly lower in the cover crop plots. As for the possibility of soil pathogen activity, no damping-off due to Pythium spp. or Rhizoctonia spp. was observed in the study plots.

Should you use cover or green manure crops? It's a complicated questions and you'll just have to look at the big picture and consider all possible effects. Hey, nobody said it was going to be easy!!!

**Sources:**

Gouin, F. 1992. Fallow land contributes to nitrate pollution. Free State Nursery News 5(3)

Jackson, L.E.; Wyland, L.J.; Klein, J.A.; Smith, R.F.; Chaney, W.E.; Koike, S.T. 1993. Winter cover crops can decrease soil nitrate, leaching potential. California Agriculture 47(5): 12-15.

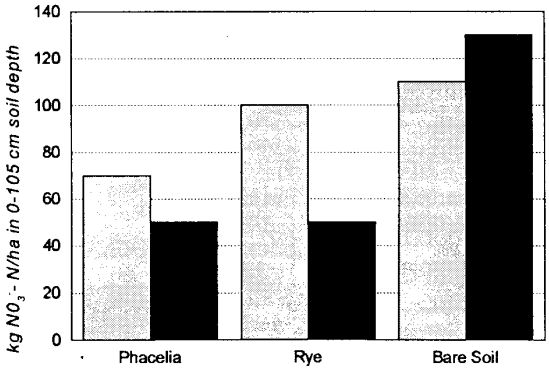


*Figure 1.*

*Nitrate ($NO_3$ - N) leaching was less under two cover crops than in bare fallow.*

## *Limiting Factors: Pests*

As we have been discussing in the last several issues of FNN, plants need six different "limiting" factors for good growth. Four are found in the ambient environment (light, temperature, humidity, and carbon dioxide) and two (mineral nutrients and water) are supplied from the soil or growing medium. This model assumes that we are growing in a completely sterile environment which, as we all know, we don't. The nursery environment contain a myriad of microorganisms which can affect our crops either positively or negatively *(Figure 2)*. We discussed one type of beneficial soil microorganism, mycorrhizal fungi, in previous issues but potentially damaging critters are more likely to limit seedling growth. Although we try to exclude all types of pests from the nursery environment, nature abhors a vacuum, and so pests can still become a problem.

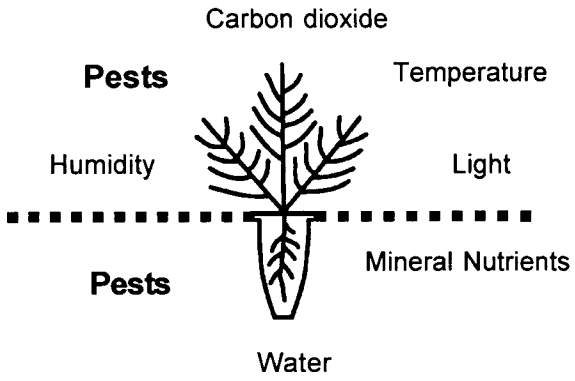


*Figure 2.*

*Pests can become limiting factors in the atmospheric and edaphic environment.*

**Definitions**

In forest and conservation nurseries, a **pest** can be defined as any biotic stress factor that can cause disease. Many different organisms can become pests including fungi, bacteria, viruses, animals, and even weeds, which can cause growth loss through competition for water, light, or mineral nutrients. The definition of a pest is subjective, however; an organism becomes a pest when it has a negative effect on humans or their material goods. Many nursery pests do not cause problems in the natural environment, but under the ideal nursery conditions, these normally innocuous organisms can cause disease.

A **symptom** is a general term used to describe the physiological or morphological response of the host seedling to a stress factor. Disease symptoms can be obvious, such as foliar chlorosis, or more subtle, such as reduced growth. Both pests and abiotic stresses can cause symptoms to develop. **Signs** are actual evidence of a pest-for example, the fungal mycelia that are sometimes evident on the diseased part of the seedling. Although both symptoms and signs are used in disease diagnosis, signs are more helpful because they implicate a specific organism or group of organisms, whereas symptoms may be caused by a variety of biotic or abiotic factors.

The mere presence of a pest in the nursery does not constitute a problem; pests only become problems when they cause significant economic loss. A pest that is causing minor losses is not generally considered to be a problem because the cost of treatment would exceed the economic benefit of control. The definition of a **pest problem,** therefore, is subjective in that it involves an assessment of actual economic impact, or the potential for economic impact, by the nursery manager. The prudent manager will attempt to promptly identify all potential pests and monitor their impact so that they can be controlled before they reach damaging levels.

**Pest Diagnosis**

Diagnosis consists of a systematic search for the causes of a pest problem using symptoms, signs,

and pattern of occurrence. Pest diagnosis consists of three sequential steps:

1. Identifying the problem
2. Diagnosing its true cause-is a pest involved?
3. Determining the impact on nursery production.

Identification requires a certain degree of experience and training. Nursery workers need a rudimentary knowledge of seedling physiology and morphology before they can detect minor deviations from the normal seedling condition. This knowledge can come from either direct experience or formal training, but ideally a grower will have a combination of both. A formal education in horticulture and seedling physiology provides a sound conceptual background, but there is no substitute for actual nursery experience. Direct "hands-on" experience with seedlings at all stages of nursery culture is necessary to quickly recognize an abnormal condition.

Early detection is extremely important for controlling nursery pests, especially for integrated pest management (IPM) programs. Nursery workers must adopt an attitude of vigilance , and make periodic inspections of the crop so that problems can be identified early. Many pests are difficult to eradicate once they become established. Most nursery pests cause readily identifiable symptoms such as discolored foliage, but many problems do not become evident until irreversible injury has already occurred. This is particularly true for root problems because foliar symptoms only develop after the roots are already severely damaged. Minor stunting or undetectable growth loss is especially difficult to diagnose unless the grower has some type of growth standards for comparison. Seedling measurements, such as shoot height, stem caliper, and total dry weight, should be taken regularly and growth curves constructed for each seedling species so that "normal" growth patterns can be established. Growth of subsequent crops can then be compared to these growth standards and potential problems identified.

## Steps in pest diagnosis

A systematic approach to diagnosis of disease or pest problems is most effective ***(Figure 3)***. The following procedure requires only a 5 or 10 power hand lens, a sharp knife, and an inquiring, open attitude. Regardless of the available equipment, the most important attribute in pest diagnosis is "the ability to observe accurately." If possible, make the diagnosis with other members of the nursery staff, especially those in charge of day-to-day cultural operations, because they may be able to relate the symptoms to some recent cultural or climatic incident.

1. Check all parts of the seedling for symptoms and determine what parts are actually affected. Frequently, foliar symptoms are an indication of root disease, so remove the seedling from the soil or container and carefully check the root system. Note the symptom pattern on the seedling itself-is one part of the shoot or root system affected more than another?

2. Determine whether all species or seedlots within a species are equally affected. Abiotic problems usually affect several different species of seedlings, whereas pest damage is often restricted to one species. Environmental stresses are nondiscriminatory, but pests are often host-specific. Exceptions to this general rule do exist, however. Frosts can injure one species or ecotype, and there apparently is a genetic predisposition to other types of abiotic injury, such as pesticide phytotoxicity. When only a single, occasional seedling is affected, the problem is usually genetic.

3. Note the symptom pattern within the propagation area and whether it is random or regular ***(See Table 2)***. Are these areas related to any

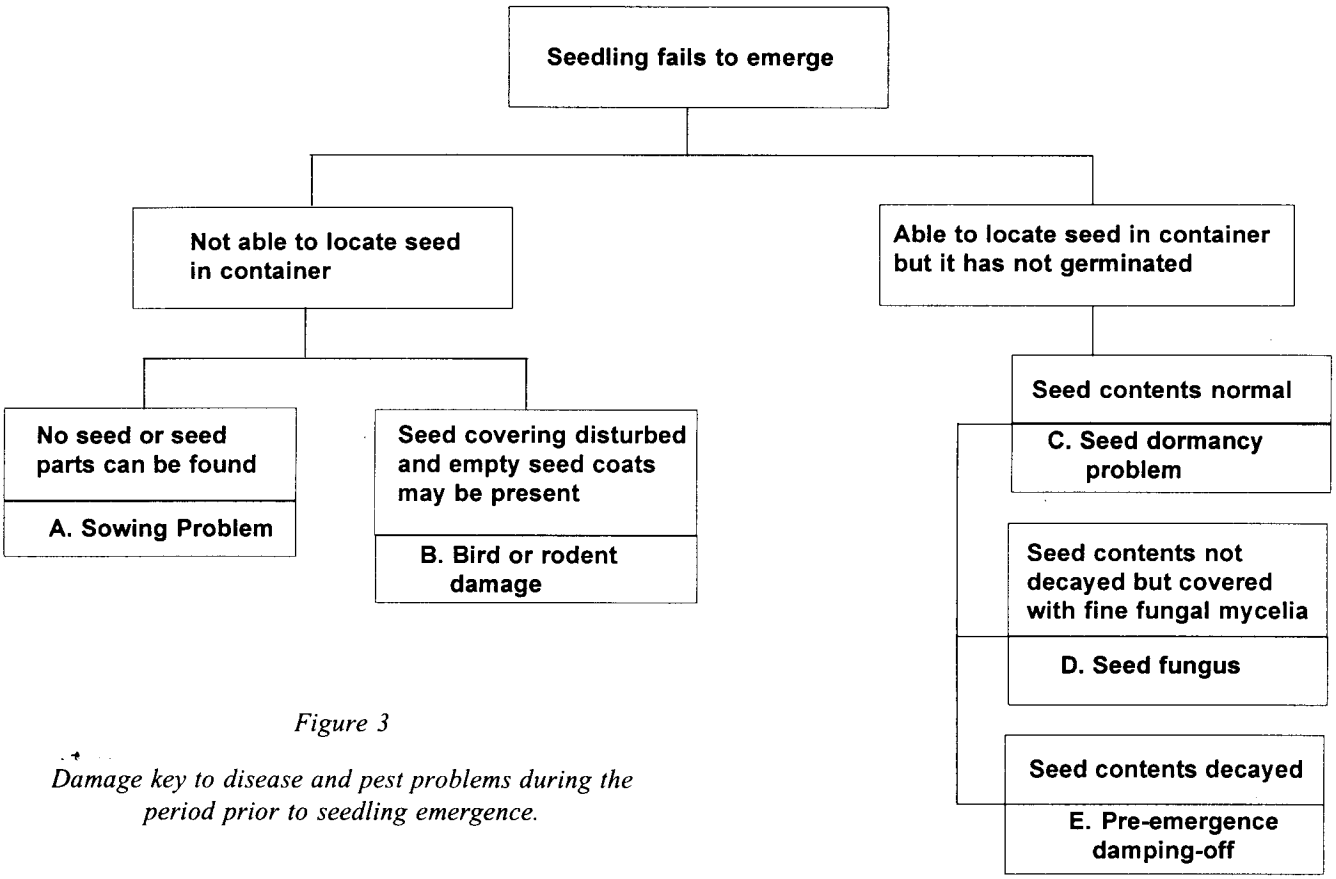


*Figure 3*

*Damage key to disease and pest problems during the period prior to seedling emergence.*

cultural operation such as the irrigation application pattern or to structural features in the propagation area? Abiotic problems are usually expressed in a regular pattern that can be correlated to some cultural factor such as container type or position in the seedbed. Pest damage is often initially random in distribution because of fungal inocula randomly introduced from the air or on seeds, and some species of insect only damage one seedling. Disease "pockets" are diagnostic because they typically result from the secondary spread of a fungal pathogen.

4. Check several symptomatic seedlings thoroughly with a hand lens for signs of a pest. Fungal mycelia or fruiting bodies are sometimes visible on the affected tissue. Check at different times of day because most insects are quite small and some species are only active at night. Collect specimens of any potential pests for subsequent identification.

5. Always consider the possibility of abiotic damage. Check cultural and weather records and ask nursery workers about any unusual incidents. Examine the soil or growing medium for evidence of adverse conditions such as waterlogging (sour smell or excessive growth of algae) or salinity build-up (white crusts on the soil surface or around the bottom drainage hole of the container).

6. Establish the disease history. When did the symptoms first appear? Is this problem new or has it been observed before? Try to correlate these facts with cultural or weather records. Abiotic problems are usually related to a particular damaging incident and their symptoms usually develop rapidly, whereas pest problems develop more slowly and may spread over time if environmental conditions are favorable ***(Table 2)***.

| Disease characteristics | Type of Problem | |
|---|---|---|
| | Abiotic | Biotic |
| Hosts | Often affects several species or ages of seedlings | Usually restricted to one species and age class |
| Symptoms | | |
| Pattern within growing area | Regular: spatially related to some environmental factor | Random locations initially |
| Rate of development | Rapid and uniform | Relatively slow and uneven |
| Signs | No evidence of a pest | Evidence of a pest may be present |
| Spread | Related to one incident with no secondary spread | May spread over time if conditions warrant |

*Table 2. Characteristics used to diagnose biotic problems (pests) from abiotic ones.*

7. Document your analysis of the problem with written notes and color photographs if possible. Many times symptoms or signs will change over time, or other saprophytic organisms may colonize the affected tissue and obscure the true cause of the problem. Collect diseased seedlings to send to a pest specialist for confirmation.

Insect pest problems are particularly difficult to diagnose because the insect is often gone by the time the symptoms become obvious. Diagnosis of insect-caused root injury is especially difficult because many root feeding insects, such as root weevils, have larvae that live in the soil or growing medium and adults that are active only at night. Insect problems can often be diagnosed by monitoring their populations within the growing area. Because they are so mobile and often nocturnal, the presence and abundance of many insect pests can be monitored with pheromone traps or yellow stick cards.

After completing your diagnosis, it is a good idea to contact other local nurseries to see if they have had similar problems. It may be that the pest problem has already been identified, and effective control measures already tested and established.

## Assistance with pest problems.

Experienced nursery managers can diagnose common pest problems in their nurseries and initiate proven treatments. It is a good idea, however, to have this tentative diagnosis confirmed by a pest specialist because many nursery diseases are relatively complicated, and may involve more than one pest or a predisposing environmental stress factor. Accurate pest diagnosis is essential before proper control measures can be designed, and an improper diagnosis could lead to additional seedling losses if the wrong control treatment was applied.

Many fungal diseases cannot be accurately diagnosed until the causal organism is isolated from the diseased tissue and grown on an artificial medium, because the symptoms of many diseases are similar. For example, a particular shoot blight of conifer seedlings can be caused by either of two genera of fungi: *Sirococcus* spp. or *Sphaeropsis* spp. These fungi can only be differentiated microscopically by examination of the fruiting bodies in slides of fresh diseased tissue or of cultures: the spores of *Sphaeropsis* are larger and darker

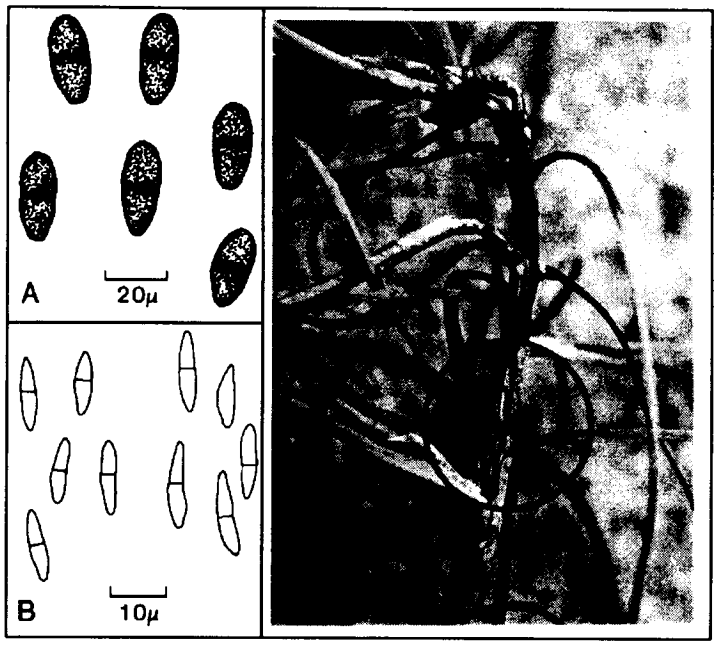


*Figure 4.*
*Diseases cannot always be definitely diagnosed by symptoms alone; this shoot blight (**symptom**) could have been caused by either of two different funal pathogens. Positive diagnosis requires culturing the fungus from the black pycnidia (**sign**, circle) and identifying it, based on spore characteristics, as eiter Sphaeropsis sapinea (**A**) or Sirococcus strobilinus (**B**).*

than the spores of Sirococcus ***(Figure 4)***. This isolation procedure and taxonomic identification require the special laboratory equipment and techniques of a trained pest specialist.

Assistance with disease and pest problems is available from a variety of sources, including private pest consultants, State and Provincial forestry organizations, the extension service of State agricultural universities, and Federal forestry organizations. Pest specialists in the United States Government are located in the regional offices of the State and Private Forestry Division of the USDA Forest Service. Canadian nurseries should contact the pest specialists at their local office of the Canadian Forestry Service or Provincial extension personnel.

## Collection, storage, and shipping of disease samples.

Most disease and pest diagnoses require careful examination of the affected seedlings by a trained pest specialist, and so disease samples must be collected and shipped to a diagnostic laboratory. Sample collection and handling should consist of the following steps:

1. Collect samples as soon as the symptoms become evident and especially when signs develop. If sample collection is delayed, secondary organisms may become established and mask the symptoms of the original disease or insect problem. Sample the entire seedling so that the pest specialist can examine all facets of the disease. If possible, collect a series of seedlings showing a gradation of disease from healthy to severely damaged seedlings; this allows the pest specialist to make relative comparisons and estimate the disease impact. Leave container seedlings in their containers if possible so that pests in the medium or evidence on the containers can be examined.

2. Protect samples from deterioration due to heat or drying by placing the seedlings in plastic bags and storing them under refrigeration. Insects should be placed in a bottle with air holes and some plant material for food in the bottom. Make sure that all samples are properly identified with species, seed lot, age, date, description of the symptoms and signs, and any other useful information such as location in the nursery and previous cultural practices and weather conditions. Use pencil on all labels because ink often smears in humid sample bags.

3. Submit a written description of the disease problem with your tentative diagnosis and color photographs of the symptoms if possible.

4. Ship samples to the diagnostic laboratory as quickly as possible. The best procedure is to contact the pest specialist for specific handling and shipping recommendations.

**Assessing disease and pest impact**

The fact that a disease or pest exists in a container nursery does not necessarily mean it will affect nursery production, so an assessment of its impact is required. A disease or pest problem may not be economically serious if it remains at an endemic level or can be controlled early enough that the number of seedlings lost remains within the normal oversow factors.

The impact of a disease or pest reflects economic loss and can be measured in terms of expected growth loss or direct seedling mortality. It is simple enough to inventory dead seedlings, but growth losses are more difficult to quantify. If the growth loss is severe enough, the seedlings will not reach the desired size within the normal crop rotation, and may have to be culled. If some of the diseased seedlings are merely stunted, but have the potential for recovery; they can be held-over for additional growth, and the major impact of the disease will be the cost of the additional growing time. When the disease is infectious, the seedlings will often have to be culled even if the actual infection is relatively minor. Some fungal pests such as *Botrytis cinerea* can develop into aggressive storage molds.

The normal procedure for determining the impact of a disease or pest is to conduct an inventory of the affected seed lots and directly count or statistically estimate the percent seedling loss. A pest specialist snould be consulted to train the grading crew to recognize diseased seedlings and establish grading standards for categories such as "cull," "hold-over," and "shippable." A complicating factor with many fungal diseases is that seedlings may be infected but do not yet exhibit symptoms; these latent infections are extremely difficult to diagnose, even by a trained pathologist. Sometimes a second disease survey must be run later to identify latent infections.

Disease and pest impact information can be used to make management decisions concerning therapeutic control measures for the current crop as well as help to plan preventative control measures for future crops.

**Sources:**

Bohmont, B.L. 1983. The new pesticide user's guide. Reston, VA: Reston Publishing Co. 452 p.

Landis, T.D.; Tinus, R.W.; McDonald, S.E.; Barnett, J.P. 1989. The container tree nursery manual, Vol. 5: Nursery pests and mycorrhizae. Washington, DC: USDA Forest Service: 4-20.

Olkowski, W.; Daar, S.; Olkowski, H. 1991. Common-sense pest control. Newton,CT: The Taunton Press. 715 p.

Streets, R.B. 1972. The diagnosis of plant diseases: a field and laboratory manual empasizing the most practical methods for rapid identification. Tucson, AZ: University of Arizona Press. 130 p.

# Integrated Pest Management

I've decided to add this new section to emphasize the need to establish an Integrated Pest Management (IPM) program at your nursery, and to highlight some of the innovative new approaches that are being developed.

**Also See:** "Limiting Factors: pests" in Cultural Perspectives Section, and "Common-sense pest control" in Special Publications Section.

## Stop Using Traditional Pesticides and See What Happens

During the discussion at a recent meeting, someone suggested this interesting concept which is the inverse of the recommended practice of always leaving "control" plots whenever you apply a pesticide. Instead of applying those routine pesticide applications to the entire crop, leave a small control section untreated and see if a pest problem develops. Nurseries that have tried this approach have found that they can actually have am increase in seedling yield while saving money by using less pesticide: ***(Figure 5)***.

**Source:**

Dumroese, R.K.; Wenny, D.L.; Quick, K.E. 1990. Reducing pesticide use without reducing yield. Tree Planters' Notes 41(4): 28-32.

## Using Chlorine to Prevent Nursery Diseases

One of the basic tenets of Integrated Pest Management (IPM) is to minimize the use of pesticides. We all realize that some pesticides are necessary to raise a crop of quality tree seedlings, but agree that we should also use the least toxic pesticides. When chlorine is used as a pesticide, it can help prevent pests from entering the nursery environment-another keystone of IPM. By eliminating the source of nursery pests, the need for more toxic pesticides is significantly reduced.

In the form of laundry bleach, chlorine is one of the most available and affordable chemicals in the world. When most people they think of bleach, they don't think of it as a pesticide. For years, however, nursery workers have used bleach solutions to sterilize greenhouse benches, floors, and other surfaces in the propagation area. Chlorine is also commonly used to treat irrigation water that is infected with fungi or other pests. When used properly, chlorine is a safe, easy-to-use chemical that should be a basic tool in nursery culture.

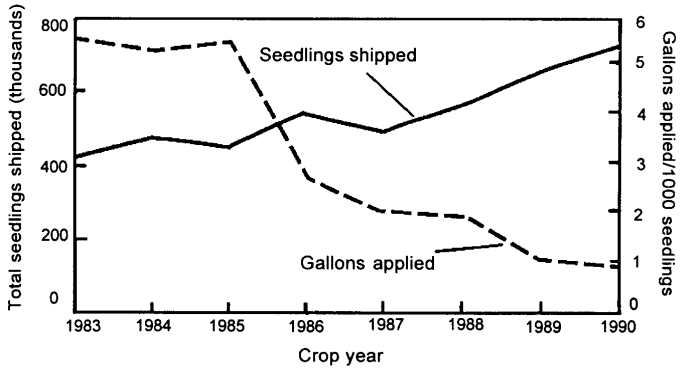


*Figure 5. Nurseries have found that often they can maintain or even increase seedling yield while reducing use of traditional pesticides.*

## Basic Chemistry and Mode of Action.

Chlorine is a very irritating, heavy, greenish-yellow gas with a very pungent odor; therefore, for operational purposes, chlorine is always applied in a solution. Chlorine solutions are strong oxidizing agents that kill organisms by chemically "burning" their tissue. Chlorine has two modes of action: as a sterilant, which destroys all organisms, and as a disinfectant, which selectively destroy pests.

When any form of chlorine is added to water, hypochlorite (HOCl) and chlorite ($OCl^-$) are formed. The HOCl form is the most effective disinfectant. The standard measure of chlorination effectiveness is defined as the sum of HOCL and OCL- molecules, which is known as free residual chlorine. Other synonymous terms are available chlorine, total chlorine, and free chlorine. Any of these chlorine terms should not be confused with the chloride ion ($Cl^-$) which is important for water quality but has no disinfectant properties.

Many other chemicals react with the chlorine in solution and reduce its effectiveness. The chemistry of chlorination is pretty scary but suffice it to say that enough chlorine must be added to result in an effective level of available chlorine *(**See Figure 6**)*.

## Sources of chlorine.

Chlorine is commercially available in three forms:

### Chlorine gas ($Cl_2$)

Chlorine gas is furnished commercially as a liquid in pressurized metal cylinders; when the gas is bubbled through water, it forms HOCl and $OCl^-$. Although this is the simplest source from a chemical standpoint, $Cl_2$ is very toxic and its corrosive nature makes it difficult to handle operationally.

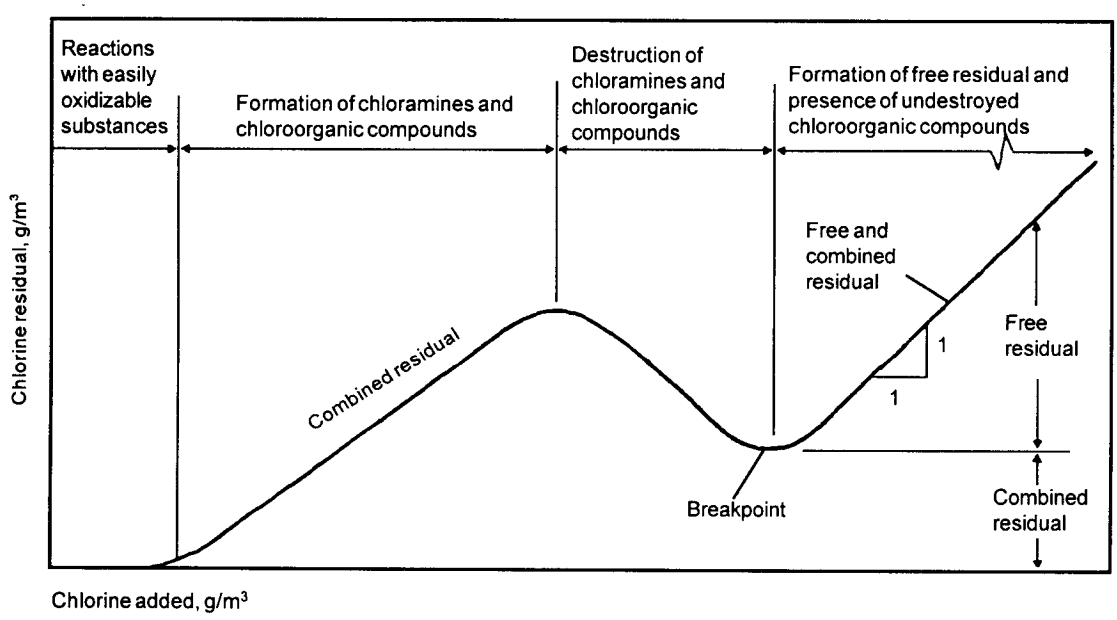


*Figure 6.*

*Many things combine with chlorine to reduce its activity in solution, and so enough must be added to produce an effective concentration of "free residual" chlorine.*

**Calcium Hypochlorite [$Ca(OCl)_2$]**

Calcium hypochlorite is a common form of chlorine used for domestic water treatment, and is available commercially either as a granulated powder, large tablets, or liquid solutions. Most commercial formulations are 65% calcium hypochlorite, with the balance being stabilizers and inert materials. Calcium hypochlorite is relatively stable as long as it is kept free from water and may be stored for extended periods in solid form. However, the same property that makes calcium hypochlorite stable also makes it difficult to dissolve completely in water. This is particularly true in cold water and so calcium hypochlorite always should be dissolved in a small quantity of warm water before use. Large tablets can be added directly to the solution where it will slowly dissolve to yield a continuous supply of chlorine to the water. However, care should be exercised in the placement of the tablets to ensure proper mixing of the chemical and the water.

**Sodium Hypochlorite (NaOCl)**

Liquid household bleach is the most common form of chlorine used in horticultural applications. Although it is also available in solid form, sodium hypochlorite does not store well, readily absorbing moisture from the atmosphere and releasing chlorine gas. Household bleach usually is marketed as an aqueous solution containing 5.25% sodium hypochlorite. Commercial bleach solutions containing from 9.5 to 15% sodium hypochlorite are also available in large containers from chemical suppliers, but are not as stable as household bleach. Sodium hypochlorite solutions are generally more expensive than granular calcium hypochlorite due to the additional shipping and handling costs associated with the water.

Where a continuous supply of chlorinated water is required, concentrated solutions of sodium or calcium hypochlorite can be injected. Chlorine injector systems are commercially available that consist of a feed tank and an electrically operated pump with a variable output. Chlorine injectors must always be installed with an approved check valve arrangement to prevent back flow into the fresh water system.

## Formulations, Units, and Monitoring

With chlorine gas, chlorination is accomplished by bubbling a metered amount of gas into water. Because of the danger involved and the expense of the metering equipment, the use of chlorine gas for chlorination usually is limited to large-scale treatments of irrigation water supplies. Injection of chlorine gas is specified and monitored in parts per million (ppm) of available chlorine.

Liquid bleach or solid calcium hypochlorite are mixed with water to form solutions. Unfortunately, chlorine solutions are formulated with different units than those with which they are monitored which can be confusing. For ease of formulation, chlorine solutions are mixed using volumes of liquids or weights of solid products whereas their effectiveness is monitored in ppm. Bleach solutions are generally calculated as either % bleach or % sodium hypochlorite; these are not the same, however, and growers must be aware of the difference. For example, a "10% bleach solution" is a standard concentration which contains 1 part bleach: 9 parts water. This is NOT the same as a "10% sodium hypochlorite" solution because liquid bleach contains only 5.25% sodium hypochlorite. Actually a "10% bleach solution" is equivalent to a "0.5% sodium hypochlorite" formulation.

For monitoring, however, we need to use ppm units. The calculations to determine the ppm of available chlorine in a solution are relatively simple. For example, to calculate the available chlorine in a 10% bleach solution:

*First, calculate % available chlorine (HOCl + OCl):*

Laundry Bleach = 5.25% NaOCl

Atomic Weights
Na = 23
O = 16
Cl = 36
Total = 75

$\frac{52}{75} = 0.69$

0.69 X 5.25 = 3.6% (HOCl + OCl)

*Next, convert to ppm:* $\frac{3.6}{100} = \frac{X}{1{,}000{,}000}$ X = 36,000 ppm

Therefore, a fresh 10% bleach solution contains 36,000 ppm of available chlorine. Remember, however, that this value will decrease as chlorine volatilizes and is chemically tied-up on other dissolved and suspended materials in the water ***(See Figure 7)***.

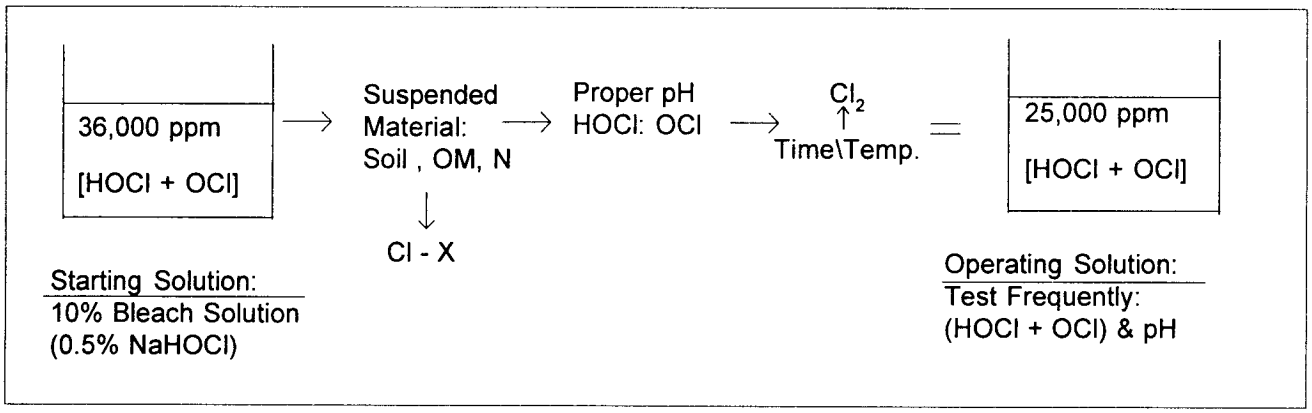


*Figure 7.*

*Although bleach solutions are formulated as % product by weight or volume, chlorine effectiveness is monitored in parts per million (ppm) of available chlorine [HOCl + OCl]*

Complete monitoring of chlorine in the work environment requires 2 different test kits: one for the chlorine gas in the air for worker safety, and one for available chlorine in solution to monitor chlorination effectiveness. Portable gas analysis kits are available for approximately $400-500, including models that can check 8-hour worker exposure limits. Water test kits using the DPD colorometric test for chlorine can be purchased for $300-400, but can only read the "available chlorine" in the 0200 ppm range. The less expensive ($40) swimming pool kits only have a range up to 10 ppm. Because of these limited ranges, these test kits will not be useful for all nursery applications.

## Types of Applications

Let's look at some recommended applications for chlorine solutions that appear in the literature. When other formulations are given, I've converted to % laundry bleach solution to make comparisons easier:

**Surface disinfection of propagation material:** Chlorine solutions can be used to remove pathogenic fungi from the surfaces of seeds prior to sowing, or sanitize cuttings prior to sticking:

***Seeds*** - *"Place seeds loosely in mesh bags and soak for 10 minutes in a 40% bleach solution ".* This procedure eliminates *Fusarium* spp. and other potentially pathogenic fungi from conifer seeds and is a recommendation for relatively hard seeded species such as *Pinus* spp. Either the solution concentration or the soaking time may have to be decreased for softer-coated seeds such as *Fraxinus* spp. After treatment, rinse the seeds thoroughly in running water for at least 48 hours.

***Cuttings*** - *"Dip stems in a 0.5% sodium hypochlorite solution for 20 minutes "* (=10% bleach solution). This treatment is recommended to remove crown gall bacteria which are carried on the surface of rose cuttings. The concentration and treatment times may be much less for more sensitive plant material, and so growers must experiment with their species and operating conditions.

**Sterilization of Used Containers and Surfaces in Propagation Area:**

***Benches and other surfaces*** - *"Clean thoroughly and then wipe with a bleach solution* of *1 part bleach: 9 parts water"* = (10% bleach solution).

***Containers*** - *"Clean out all growing media, rinse, and store overnight. Dip into a soak tank* of *0. 5% bleach solution and let stand for at least 10 seconds ".* This published recommendation sounds like a very dilute concentration. Maybe they mean a 0.5 % NaOCI solution which would be the standard 10% bleach solution.

**Disinfecting Irrigation water** - *"Chlorine dosage should be great enough to provide a residual of 0.4 ppm with a contact time of 30 minutes ".* Chlorine injectors are usually followed by some sort of temporary storage so that the chlorine can have time to work. The presence of waterborne pathogens such as *Pythium* spp. and *Phytophthora* spp. can be detected with apple or pear baits.

## Factors that affect chlorine activity

Chlorination is a dynamic chemical process, and effective chlorination is influenced by a number of factors. Proper chlorination requires frequent monitoring of the solution and a thorough understanding of the factors involved:

**1. Concentration.**
The quantity of chlorine compound that must be added to a quantity of water in order to maintain a given concentration depends on the available chlorine content of the compound, the concentration of the compound, the volume of water to be treated, and the amount lost due to the reaction with other chemicals in the water. Experiment with solution concentrations and treatment times, especially when sanitizing plant material. The chlorine concentration will vary considerably between different applications. For example, water treatment requires only about 1 ppm available chlorine compared to the 36,000 ppm in a 10% bleach solution.

**2. Time.** The effectiveness of the chlorine treatment depends greatly on the relationship between exposure time and concentration. Most of the sanitizing action of the chlorine will often occur within the first few minutes of exposure. The type of application will also affect the exposure time. To sanitize living tissue, a longer soak

with a weaker solution may be more appropriate, whereas a shorter dip in a higher concentration is needed to sterilize containers. Because of the many variables that are involved, experience is the best guide to the correct combination of concentration of chlorine and treatment time.

**3. pH.**

Solution pH has a significant effect on the activity of chlorine in water. When chlorine gas or one of the hypochlorite salts is added to water, each will generate C12, HOCI, and OCl- in various proportions, depending on the pH of the solution ***(See Figure 8)***. *To* maximize the proportion of HOCl and, hence, the effectiveness of the solution, the pH should be kept around 6.5. The pH of irrigation water supplies may vary from moderately acid to moderately alkaline, and stabilizers included in many commercial chlorine products can raise pH significantly. Chemical buffers can be used to maintain the pH in the desired range, and the pH of the chlorine solution should be monitored regularly.

**4. Organic matter.**

Chlorine has a particular affinity for organic matter. Dirty water "uses up" the available chlorine much faster than clean water ***(See Figure 7)***. The amount of free available chlorine in the solution constantly decreases as chlorination takes place. Therefore, the chlorine level should be checked and renewed regularly when dirty water is used - for example, when used containers are being sterilized. For the same reason, containers should be cleaned thoroughly before putting them in the chlorination tank.

**5. Temperature.**

The activity of chlorine increases as the temperature of the solution increases. In situations where the water temperature is low, there is a significant reduction in chlorine activity. On the other hand, solutions that are too warm will cause excessive $Cl_2$ volatilization ***(See Figure 7)***.

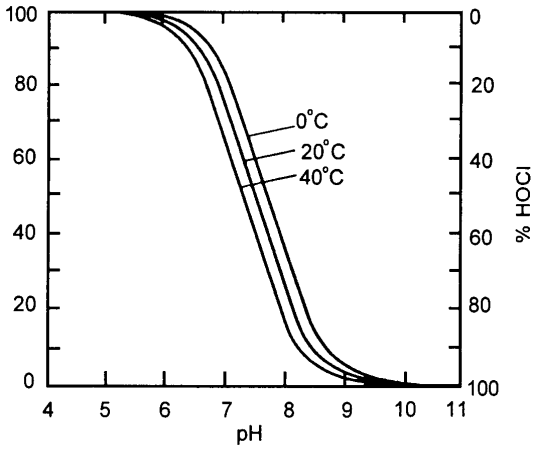


*Figure 8.*

*Distribution of [HOCl] and [OCl-] as a function of pH and temperature.*

**6. Growth stage of the pathogen** . Pathogens can be present as either mycelia or spores. Chlorine will readily kill mycelia, but some fungal spores are 10 to 1000 times more difficult to kill. Chlorine kills only on contact, not systemically, and is only effective on exposed pathogens such as those suspended in water or those on the surface. But chlorine cannot kill pathogens it cannot reach, such as those imbedded in root fragments imbedded in the walls of a Styrofoam container. Soaking materials before treating stimulates spore germination and activates mycelia, making pathogens easier to kill.

## Worker Safety

Dilute chlorine solutions can irritate skin and bleach clothing, so workers should always wear protective gloves and aprons. The airborne exposure concentration for chlorine determines the limit for worker exposure. Chlorine vaporizes readily, and the odor of chlorine is detectable between 0.2 and 0.4 ppm. Above 0.5 ppm,

chlorine vapors irritate the eyes, nose, and throat of exposed workers although this varies considerably between individuals. The current legal exposure limits are 1 ppm for an 8-hour workday and 0.5 ppm for short-term (15 min.) exposures. Be sure and check your Material Safety Data Sheet for more specific exposure, storage, and handling information.

## Wastewater considerations

Large volumes of spent chlorinated water may be considered an industrial waste water if it is discharged to a municipal wastewater treatment plant or to surface waters. Operators of large scale chlorination operations may be required to obtain a discharge permit. On a more practical basis, just letting a tank of bleach solution set for a few days until the smell of chlorine is gone should take care of the problem. If you want to be absolutely sure, however, check with your local water quality officials.

## Practical rules for successful chlorination: A summary

**1. Clean materials before treating and change the water frequently.** Chlorination efficiency is very poor with dirty water and therefore seeds, cuttings, containers, and propagation surfaces must be cleaned before treatment. Chlorine solutions should be changed regularly.

**2. Monitor the chlorine solution.** Chlorine concentration and pH should be monitored frequently with test kits, both to maintain effectiveness and prevent health problems.

**3. Ventilate the work area.** Levels of chlorine great enough to cause worker discomfort are excessive and well above that required for proper sanitation. In the absence of air-monitoring equipment, chlorine concentrations are usually adequate if they can be smelled by a person not desensitized by long exposure to the odor. The concentration is too high if workers are irritated continually by the odor.

**Sources:**


American Conference of Governmental Industrial Hygienists. 1991. Documentation of the threshold limit values and biological exposure indicies. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc.: 252255.

Boyette, M.D.; Ritchie, D.F.; Carballo, S.J.; Blankenship, S.M. Sanders, D.C. 1993. Chlorination and postharvest disease control. HortTechnology 3(4): 395-400.

Campbell, S.J.; Landis, T.D. 1990. Managing seedborne diseases in western forest nurseries. Tree Planters' Notes 41(4): 37.

de Fossard, R.A. 1994. Treatment of plants with hypochlorite solutions. Combined 1992 Proceedings, International Plant Propagators' Society 42: 65-67.

Landis, T.D.; Tinus, R.W.; McDonald, S.E.; Barnett, J.P. 1989. The container tree nursery manual, Vol. 4: Seedling nutrition and irrigation. Washington, DC: USDA Forest Service: 91-92.

Landis, T.D.; Tinus, R.W.; McDonald, S.E.; Barnett, J.P. 1989. The container tree nursery manual, Vol. 5: Nursery pests and mycorrhizae. Washington, DC: USDA Forest Service: 82-84.

Olkowski, W.; Daar, S.; Olkowski, H. 1991. Common-sense pest control. Newton, CT: The Taunton Press. 715 p.

U.S. Environmental Protection Agency. 1982. Manual of individual water supply systems. Pub. EPA-570/9-82-004. Washington, DC: US-EPA, Office of Drinking Water. 155 p.

# *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. ***Effect of root culturing practices on the survival and growth of 1 +0 silver oak (Grevillea robusta Parker) seedlings.*** Misra, K. K.; Jaiswal, H. R. Indian Journal of Forestry 16(3): 287-289. 1993.

(SO). ***Improving planting stock quality—the Humboldt experience.*** Jenkinson, J. L.; Nelson, J. A.; Huddleston, M. E. USDA Forest Service, Pacific Southwest Research Station, General Technical Report PSW-143. 1993. Chapters: Reforestation and the nursery; Assessing planting stock quality; Seed source assessments; Assessing nursery culture alternatives; Moving into the `90's. ORDER FROM: USDA Forest Service, Pacific Southwest Research Station, P.O. Box 245, Berkeley, CA 94701-0245. Free.

## *Business Management*

2. ***Getting employees to solve problems on their own.*** Kehoe, K. R. American Nurseryman 179(10):79-83. 1994. A step-by-step, common sense system for solving problems and making decisions.

3. ***Hiring and keeping good employees.*** Berry, J. B. International Plant Propagators' Society, combined proceedings 42:348-351. 1992. 1994.

4. ***How to come to terms with ADA regulations.*** Batts, J. Nursery Manager 9(12):64, 6668. 1993.

5. ***Leasing: a viable alternative?*** Bean, W. Greenhouse Grower 12(3):22, 24. 1994. Leasing can be a more cost-effective option than paying cash or bank financing.

6. ***On legal grounds... when hiring.*** Perry, P. M. American Nurseryman 179(9):58-65. 1994.

7. ***Taming workers' comp.*** Nawrocki, J. J. American Nurseryman 179(9):79-85. 1994.

8. ***Training persons with mental disabilities as greenhouse integrated pest management scouts.*** Eddy, R. T.; Sadof, C. S. HortTechnology 3(4):459-461. 1993.

9. ***Tree seedling distribution program - G. White State Forest Nursery.*** Biram, D. IN: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM- 243, p. 143-148. Landis, T.D.,

ed. Proceedings: Northeastern and Intermountain Forest and Conservation Nursery Associations. 1994.

10. ***Understanding OSHA: what to do before the inspector arrives.*** Steingold, F. S. American Nurseryman 179(9):74-77. 1994.

## Container Production

11. ***Benefits of progressively increasing container size during nursery production depend on fertilizer regime and species.*** Beeson, R. C., Jr.' Journal of the American Society for Horticultural Science 118(6):752756. 1993.

12. ***Comparison of chopped newspaper with microfoam for winter protection of container-grown nursery stock.*** Pellett, N.; Heleba, D. HortTechnology 4(1):55-57. 1994.

13. ***The copper connection: the benefits of growing woody ornamentals in copper-treated containers.*** Struve, D. K.; Arnold, M. A.; Beeson, R., Jr.; Ruter, J. M.; Svenson, S.; Witte, W. T. American Nurseryman 179(4):5254, 56-61. 1994.

14. ***Effect of copper-treated containers on transplant survival and regrowth of four tree species.*** Struve, D. K. Journal of Environmental Horticulture 11(4):196-199. 1994.

15. ***Overview of the Speedling, Incorporated, transplant industry operation.*** Thomas, B. M. HortTechnology 3(4):406-408. 1993.

16. ***Plug + one production of Colorado blue spruce at the Colorado State Forest Service nursery.*** Moench, R. D. IN: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-243, p. 111-112. Landis, T.D., ed. Proceedings: Northeastern and Intermountain Forest and Conservation Nursery Associations. 1994.

17. ***Sowing at 1.4-cm (0.6-inch) depth produces heaviest Douglas-fir roots in small containers.*** Minore, D.; Weatherly, H. G.; Cunningham, P. G. Tree Planters' Notes 44(3):122-124. 1993.

## Diverse Species

18. ***Factors influencing the germination of seeds of Fallugia paradoxa (Rosaceae).*** Veit, V.; Van Auken, O. W. Texas Journal of Science 45(4):325-333. 1993.

19. ***Growing Indian paintbrush.*** Borland, J. American Nurseryman 179(6):48-50, 52-53. 1994.

20. ***Influence of dry storage on seed viability and germination of eight intermountain rushes.*** Hurd, E. G.; Shaw, N. L. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-226:220. Tellman, B.; Cortner, H.J.; Wallace, M.G.; DeBano, L.F., Hamre, R.H., eds. Riparian management: common threads and shared interests. 1993.

21. ***Nursery grown plants for wetland mitigation projects.*** Beagle, G. A. IN: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-243, p. 105-110. Landis, T.D., ed. Proceedings: Northeastern and Intermountain Forest and Conservation Nursery Associations. 1994.

22. ***Propagating some native California perennials.*** Smith, M. N. International Plant Propagators' Society, combined proceedings 42:210213. 1992. 1994.

23. ***Woody plant selection for riparian agroforestry projects.*** Schoeneberger, M. M. IN: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM- 243, p. 123-129. Landis, T.D., ed. Proceedings: Northeastern and Intermountain Forest and Conservation Nursery Associations. 1994.

## *Fertilization and Nutrition*

24. ***Effects of light, nitrogen, and phosphorus on red pine seedling growth and nutrient use efficiency.*** Elliott, K. J.; White, A. S. Forest Science 40(1):47-58. 1994.

*25* ***Effects of soil water content and initial root volume on the nutrient status of 2+0 Douglas-fir seedlings.*** Haase, D. L.; Rose, R. New Forests 8(3):265-277. 1994.

26. ***Foliar application of liquid urea-triazone-based nitrogen fertilizers and crop safety.*** Clapp, J. G., Jr. HortTechnology 3(4):442-444. 1993.

*27* ***Growth and nutrition of small Betula pendula plants at different relative addition rates of manganese.*** Goransson, A. Tree Physiology 14(4):375-388. 1994.

*28* ***Growth and nutrition of small Betula pendula plants at different relative addition rates of iron.*** Goransson, A. Trees: Structure and Function 8(1):31-38. 1993.

29. ***Irrigating and fertilizing to grow better nursery seedlings.*** Kormanik, P. P.; Sung, S. S.; Kormanik, T. L. IN: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-243, p. 115-121. Landis, T.D., ed. Proceedings: Northeastern and Intermountain Forest and Conservation Nursery Associations. 1994.

30. ***A look at: micron nutrient fertilizers.*** Greenhouse Manager 12(12):101-102, 104-105. 1994.

31. ***MacroMixer: a spreadsheet program to aid mixing macron nutrients for solution culture.*** Kawabata, O.; Criley, R. A. HortScience 28(11):1131-1132. 1993.

32. ***Nitrate nitrogen movement through the soil profile beneath a containerized greenhouse crop irrigated with two leaching fractions and two wetting agent levels.*** McAvoy, R. J. Journal of the American Society for Horticultural Science 119(3):446-451. 1994.

33. ***Nitrogen and phosphorus interactions in an intensively managed nursery soil plant system.*** Teng, Y.; Timmer, V. R. Soil Science Society of America Journal 58(1):232-238. 1994.

34. ***Nitrogen nutrition of containerized citrus nursery plants.*** Maust, B. E.; Williamson, J. G. Journal of the American Society for Horticultural Science 119(2):195-201. 1994.

*35* ***Potassium deficiency causes injuries to Picea pungens glauca in nurseries.*** Alt, D.; Jacob, S.; Rau, N.; Wirth, R. Plant and Soil 155/156:427-429. 1993.

*36* ***Symptoms of mineral nutrient deficiencies and the nutrient concentration ranges in seedlings of Eucalyptus maculata Hook.*** Dell, B.; Robinson, J. M. Plant and Soil 155/156:255261. 1993.

*37* ***Unbalanced nutrient status and epicuticular wax of Scots pine needles.*** Ylimartimo, A.; Paakkonen, E.; Holopainen, T.; Rita, H. Canadian Journal of Forest Research 24(3):522532. 1994.

## *General and Miscellaneous*

38. ***Bootheel ag water quality and precise application project.*** Holmes, B. IN: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-243, p. 39-41. Landis, T.D., ed. Proceedings: Northeastern and Intermountain

Forest and Conservation Nursery Associations. 1994. Describes prescription farming, where the application rates of inputs vary from point to point within a field.

39. ***Evolution of electronic communications to transfer agricultural weather information.*** Perry, K. B.; Getz, R. R.; Kimsey, H. R., Jr. HortTechnology 3(3):348-350. 1993.

40. ***Foresters and the EMAIL revolution: a glorious opportunity.*** Rose, S. Forestry Chronicle 70(1):55-57. 1994.

41. ***Increasing sustainability by intercropping.*** Coolman, R. M.; Hoyt, G. D. HortTechnology 3(3):309-312. 1993.

42. ***Limiting factors, high yields, and law of the maximum.*** Wallace, A.; Wallace, G. A. Horticultural Reviews 15:409-448. 1993. Crop yields have increased about 2.5% per year for the past 50 years. This paper outlines the important role of management in the continuation of progress, especially when coupled with plant breeding and possible advances from biotechnology.

43. ***A simple technique to randomize and label large experimental plantings.*** Okie, W. R.; Joyner, W. R.; Beckman, T. G. HortScience 29(2):123-125. 1994.

44. ***Using geographic information systems in a nursery.*** Westin, S. C. IN: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-243, p. 113. Landis, T.D., ed. Proceedings: Northeastern and Intermountain Forest and Conservation Nursery Associations. 1994.

*(SO).* ***Pacific Northwest nursery directory and report, 1994.*** USDA Forest Service, Pacific Northwest Region, State and Private Forestry. 54 p. 1994. Contains a directory of nurseries in Oregon, Washington, California, Idaho, Montana, and Nevada, and production statistics for bareroot and container stock from those nurseries. ORDER FROM: USDA Forest Service, Pacific Northwest Region, State and Private Forestry, P.O. Box 3623, Portland, OR 97208. Free.

## *Genetics and Tree Improvement*

*45* ***Genetic improvement of tree species for remediation of hazardous wastes.*** **S**tomp, A. M.; Han, K. H.; Wilbert, S.; Gordon, M. P. In Vitro Cellular and Developmental Biology 29P(4): 227-232. 1993.

46. ***Genetic variation in the Ponderosae of the southwest.*** Rehfeldt, G. E. American Journal of Botany 80(3):330-343. 1993.

47. ***Genetically improved ponderosa pine seedlings outgrow nursery-run seedlings with and without competition—early findings.*** McDonald, P. M.; Fiddler, G. O.; Kitzmiller, J. H. Western Journal of Applied Forestry 9(2):57-61. 1994.

48. ***Monitoring the output of a hybrid larch seed orchard using isozyme markers.*** Ennos, R. A.; Qian, T. Forestry 67(1):63-74. 1994.

49. ***Nursery management and tree improvement.*** Long, E. M.; Peoples, B. A. Texas A&M University, Texas Forest Service, Publication 148:119-126. Nursery Management Workshop, proceedings. 1991.

50. ***Reforestation of South Korea: the history and analysis of a unique case in forest tree improvement and forestry.*** Kim, K. H.; Zsuffa, L. Forestry Chronicle 70(1):58-64. 1994.

51. ***Some genetic aspects of human intervention in forest regeneration: considerations based on examples from an experiment in northern Sweden.*** Ackzell, L.; Lindgren, D. Forestry 67(2): 133-148. 1994.

(SO). ***Genetic variation and seed zones of Douglas-fir in the Siskiyou National Forest.*** Campbell, R. K.; Sugano, A. I. USDA Forest Service, Pacific Northwest Research Station, Research Paper PNW-461. 23 p. 1993. ORDER FROM: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208. Free.

## *Mycorrhizae and Beneficial Microorganisms*

52. ***Current status of outplanting studies using ectomycorrhiza- inoculated forest trees.*** Castellano, M. A. IN: Mycorrhizae and plant health, p. 261-281. F.L. Pfleger and R.D. Linderman, eds. American Phytopathological Society. 1994.

*53* ***An economic approach to evaluate the role of mycorrhizas in managed ecosystems.*** Miller, M.; McGonigle, T.; Addy, H. Plant and Soil 159(1):27-35. 1994.

*54* ***Effect of mineral nutrition on the germination of basidiospores of Rhizopogon luteolus in the rhizosphere of Pinus radiata.*** Theodorou, C. Soil Biology and Biochemistry 25(6):647- 649. 1993.

*55* ***The effectiveness of ectomycorrhizal fungi in increasing the growth of Eucalyptus globulus Labill. in relation to root colonization and hyphal development in soil.*** Thomson, B. D.; Grove, T. S.; Malajczuk, N.; Hardy, G. E. S~ J. New Phytologist 126(3):517-524. 1994.

56. ***The effects of cultural practices and pesticides on VAM fungi.*** Kurle, J. E.; Pfleger, F. L. IN: Mycorrhizae and plant health, p. 10 1-131. F.L. Pfleger and R.D. Linderman, eds. American Phytopathological Society. 1994.

57. ***Effects of ectomycorrhizae on biogeochemistry and soil structure.*** MacFall, J. S. IN: Mycorrhizae and plant health, p. 213-237. F.L. Pfleger and R.D. Linderman, eds. American Phytopathological Society. 1994.

*58* ***Effects of mycorrhizal inoculation and fertilizer regime on emergence of Sitka spruce seedlings in bare-root nursery seedbeds.*** Ingleby, K.; Wilson, J.; Mason, P. A.; Munro, R. C.; Walker, C.; Mason, W. L. Canadian Journal of Forest Research 24(3):618-623. 1994.

59. ***Effects of nursery cultural practices on management of specific ectomycorrhizae on bareroot tree seedlings.*** Cordell, C. E. IN: Mycorrhizae and plant health, p. 133-151. F.L. Pfleger and R.D. Linderman, eds. American Phytopathological Society. 1994.

*60* ***The fungus-specificity of mycorrhization helper bacteria (HMBs) used as an alternative to soil fumigation for ectomycorrhizal inoculation of bare-root Douglas-fir planting stocks with Laccaria laccata.*** Duponnois, R.; Garbaye, J.; Bouchard, D.; Churin, J. L. Plant and Soil 157(2):257-262. 1993.

61. ***Growth of outplanted lodgepole pine seedlings one year after inoculation with plant growth promoting rhizobacteria.*** Chanway, C. P.; Holl, F. B. Forest Science 40(2):238-246. 1994.

62. ***The importance of mycorrhiza to forest trees.*** Malajczuk, N.; Jones, N.; Neely, C. The World Bank, Asia Technical Department, Agriculture Division. Land Resources Series no. 2. 1993. 27 p.

*63* ***Interactions between mycorrhizal fungi and other soil organisms.*** Fitter, A. H.; Garbaye, J. Plant and Soil 159(1): 123-132. 1994.

64. ***Involvement of cropping systems, plant produced compounds and inoculum production in the functioning of VAM fungi.*** Safer, G. R. IN: Mycorrhizae and plant health, p. 239259. F.L. Pfleger and R.D. Linderman, eds. American Phytopathological Society. 1994.

*65* ***Nitrate uptake in maritime pine (Pinus pinaster and the ectomycorrhizal fungus Hebeloma cylindrosporum: effect of ectomycorrhizal symbiosis.*** Plassard, C.; Barry, D.; Eltrop, L.; Mousain, D. Canadian Journal of Botany 72(2):189-197. 1994.

*66* ***Possible role of soil microorganisms in aggregation in soils.*** Tisdall, J. M. Plant and Soil 159(1):115-121. 1994.

*67* ***Propagation and storage of vesicular-arbuscular mycorrhizal fungi isolated from Saskatchewan agricultural soils.*** Talukdar, N. C.; Germida, J. J. Canadian Journal of Botany 71(10):1328- 1335. 1993.

68. ***Role of ectomycorrhizal fungi in biocontrol.*** Duchesne, L. C. IN: Mycorrhizae and plant health, p. 27-45. F.L. Pfleger and R.D. Linderman, eds. American Phytopathological Society. 1994.

69. ***Role of ectomycorrhizal fungi in minesite reclamation.*** Malajczuk, N.; Redden, P.; Brundrett, M. IN: Mycorrhizae and plant health, p. 83-100. F.L. Pfleger and R.D. Linderman, eds. American Phytopathological Society. 1994.

70. ***Role of VAM fungi in biocontrol.*** Linderman, R. G. IN: Mycorrhizae and plant health, p.1-25. F.L. Pfleger and R.G. Linderman, eds. American Phytopathological Society. 1994.

71. ***Role of VAM fungi in mine land revegetation.*** Pfleger, F. L.; Stewart, E. L.; Noyd, R. K. IN: Mycorrhizae and plant health, p. 47-81. F.L. Pfleger and R.D. Linderman, eds. American Phytopathological Society. 1994.

*72* ***The screening and selection of inoculant arbuscular- mycorrhizal and ectomycorrhizal fungi.*** Dodd, J. C.; Thomson, B. D. Plant and Soil 159(1):149-158. 1994.

(SO). ***Mycorrhizae and plant health.*** Pfleger, F. L.; Linderman, R. G. American Phytopathological Society. 344 p. 1994. ORDER FROM: American Phytopathological Society, 3340 Pilot Knob Road, St. Paul, MN 55121-2097. Phone: 1-800-328-7560. Price: $39 in U.S.; $48 elsewhere.

## *Nursery Structures and Equipment*

73. **1993** ***Missoula Technology and Development Center nursery and reforestation projects.*** Karsky, R. J. IN: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-243, p. 33-38. Landis, T.D., ed. Proceedings: Northeastern and Intermountain Forest and Conservation Nursery Associations. 1994. Discusses various projects, including machine vision, seedling counter, root pruner, seed separator, smart toolbar, hardwood cuttings planter, scarification for natural regeneration of hardwoods, steep slope site preparation, seedling protection, mulch, pollen equipment and a portable power platform.

74. **Accuracy** ***of quantum sensors measuring yield photo flux and photosynthetic photo flux.*** Barnes, C.; Tibbitts, T.; Sager, J.; Deitzer, G.; Bubenheim, D.; Koerner, G.; Bugbee, B. HortScience 28(12):1197-1200. 1993.

75. ***Considering installing screening? This is what you need to know.*** Bethke, J. A. Greenhouse Manager 13(1):36-38. 1994.

76. ***Don't overlook benefits of HAF.*** Bartok, J. W., Jr. Greenhouse Manager 12(11):90-92. 1994. Horizontal air flow fans.

77. ***Gearing up for smooth running.*** Burchfield, G. American Nurseryman 179(5):46-51. 1994. Take time for engine maintenance to assure more efficient operations.

78. ***A look at: infrared poly film.*** Greenhouse Manager *13(2)*: 80-81. 1994.

79. ***A look at: shading compounds.*** Greenhouse Manager 13(3): 75. 1994.

80. ***A look at: soil sterilizers.*** Greenhouse Manager 12(10): 144-146. 1994.

81. ***Measuring root surface area and mean root diameter of peach seedlings by digital image analysis.*** Tagliavini, M.; Veto, L. J.; Looney, N. E. HortScience 28(11):1129-1130. 1993.

82. ***Reduce your labor and energy costs by upgrading greenhouse controls.*** Whitten, M. Greenhouse Manager 12(11):62-64, 66-67, 6871. 1994. Contains several short articles: It doesn't cost a fortune. Improved controls provide quick paybacks. First step: electronic thermostats. Automation benefits all, big or small. A look at: environmental computers.

83. ***Relative costs of a weed-activated versus conventional sprayer in northern Great Plains fallow.*** Ahrens, W. H. Weed Technology 8(1):50-57. 1994.

84. ***Screen test: guidelines for selecting screens, cleaning screens, dealing with reduced airflow.*** Baker, J. R.; Shearin, E. A. Greenhouse Manager 13(1):42,45. 1994.

85. ***A simple low volume laboratory research spray system.*** Campbell, R. A.; Wood, J. E.; Mitchell, E. G.; Studens, J.; Wagner, R. G. Weed Technology 8(1):87-92. 1994.

86. ***Step-by-step guide to retrofitting with screens.*** Baker, J. R.; Shearin, E. A. Greenhouse Manager 13(3):78-79. 1994.

87. ***Think positive: examine the pros and cons of positive pressure cooling.*** Thomas, S. H. Greenhouse Manager 13(1):56, 58-60. 1994.

88. ***Top 4 reasons why your cooling system may be less than efficient - and how you can*** fix *it.* Thomas, S. H. Greenhouse Manager 13(1):62. 1994.

89. ***Try these beneficial light sources.*** Bartok, J. W., Jr. Greenhouse Manager 13(3):97, 99. 1994.

90. ***Venting the heat from greenhouses.*** Bartok, J. W., Jr. Greenhouse Manager 13(1):83-84. 1994.

## *Outplanting Performance*

*91 * ***Comparing natural and planted black spruce seedlings. 1. Water relations and growth.*** Bernier, P. Y. Canadian Journal of Forest Research 23(11):2427-2434. 1993.

*92* ***Comparing natural and planted black spruce seedlings. IL Nutrient uptake and efficiency of use.*** Munson, A. D.; Bernier, P. Y. Canadian Journal of Forest Research 23 (11):243 5-2442. 1993 .

*93* ***A comparison of planting, sowing and natural regeneration for Pinus sylvestris (L.) in boreal Sweden.*** Ackzell, L. Forest Ecology and Management 61(3-4):229-245. 1993.

94. ***Effect of seedling age and taproot length on performance of oak.*** Chaney, W. R.; Byrnes, W. R. Northern Journal of Applied Forestry 10(4):175-178. 1993.

95. ***Effects of Viterra root dips and benomyl on root growth potential and survival of longleaf pine seedlings.*** South, D. B.; Loewenstein, N. J. Southern Journal of Applied Forestry 18(1):19-23. 1994.

*96* ***Fall lifting and long-term freezer storage of ponderosa pine seedlings: effects on starch, root growth, and field performance.*** Omi, S. K.; Rose, R.; Sabin, T. E. Canadian Journal of Forest Research 24(3):624-637. 1994.

97. ***Field performance of container systems in British Columbia.*** Johnson, C. M. Forestry Chronicle 70(2):137-139. 1994.

*98* ***Field performance potential of interior spruce seedlings: effects of stress treatments and prediction by root growth potential and needle conductance.*** Simpson, D. G.; Thompson, C. F.; Sutherland, C. D. Canadian Journal of Forest Research 24(3):576-586. 1994.

*99* ***Five year field comparison on naturally regenerated Pinus taeda L. to genetically improved container stock, with and without release.*** Cain, M. D.; Barnett, J. P. New Forests 8(2):123-141. 1994.

100. ***Frost heaving of softwood seedlings, planted on a sandy clay loam site.*** Nova Scotia Department of Natural Resources, Forest Research Report 40. 11 p. 1992.

* 101 * ***Integration of nursery practices and vegetation management: economic and biological potential for improving regeneration.*** South, D. B.; Mitchell, R. J.; Zutter, B. R.; Balneaves, J. M.; Barber, B. L.; Nelson, D. G.; Zwolinski, J. B. Canadian Journal of Forest Research 23(10):2083-2092. 1993.

* 102* ***Interactions among seedling diameter grade, weed control, and soil cultivation for Pinus radiata in South Africa.*** South, D. B.; Zwolinski, J. B.; Donald, D. G. M. Canadian Journal of Forest Research 23(10):2078-2082. 1993.

103. ***Reforestation costs on private lands in interior Alaska.*** Maisch, J. C.; Hanson, D.; Sprankle, J. Northern Journal of Applied Forestry 11(1):32-33. 1994.

104. ***Stock quality assessment: forecasting survival or performance on a reforestation site.*** Grossnickle, S. C. ; Folk, R. S. Tree Planters' Notes 44(3):113-121. 1993.

105. ***Treeshelter use in producing container-grown and landscape-grown trees.*** Burger, D. W.; Srihra, P.; Harris, R. W. International Plant Propagators' Society, combined proceedings 42:221-224. 1992. 1994.

(SO). ***Effects of removal of the paperpot container on growth and development of black spruce seedlings on a drained peatland clearcut in northeastern Ontario.*** Sundstrom, E. Forestry Canada, Great Lakes Forestry Centre, Information Report O-X-418. 22 p. 1992. ORDER FROM: Communications Services, Forestry Canada, Ontario Region, Great Lakes Forestry Centre, P.O. Box 490, Sault Ste. Marie, Ontario P6A SM7 Canada. Free.

(SO). ***Provincial seedling stock type selection and order guidelines.*** Scagel, R.; Bowden, R.; Madill, M.; Kooistra, C. British Columbia Ministry of Forests. 75 p. 1993. Provides a framework for the selection of stock types suitable for the different planting seasons and sites in British Columbia. Documents the logic and reference tables necessary for making an informed stock type selection and provides tips for maintaining stock quality and vigor during the planting process. ORDER FROM: British Columbia Ministry of Forests, Silviculture Branch, 31 Bastion Square, Victoria, BC V8W 3E7 Canada. Phone: (604) 387-8903. Free.

(SO). ***Tree and shrub planting handbook: a guide for conservation plantings in Utah and Nevada.*** Townsend, L. R.; Schen, D. C.; Murphy, P.; Hanson, M. L. Utah Division of State Lands and Forestry. 1993. Chapters: Landowner objectives and benefits; Planning and design considerations; Species selection matrices; Planting guidelines; Establishment and maintenance. ORDER FROM: Utah Division of State Lands and Forestry, Salt Lake City, Utah. $35.00 + S&H

## *Pest Management*

106. ***Alternative technologies for management of soil-borne diseases in bareroot forest nurseries in the United States.*** James, R. L.; Hildebrand, D. M.; Frankel, S. J.; Cram, M. M.; O'Brien, J. G. IN: USDA Forest Service, Rocky

Mountain Forest and Range Experiment Station, General Technical Report RM-243, p. 91- 96. Landis, T.D., ed. Proceedings: Northeastern and Intermountain Forest and Conservation Nursery Associations. 1994.

107. ***Back to the future—pest management without methyl bromide.*** Smith, R. S. , Jr. ; Fraedrich, S. W. Tree Planters' Notes 44(3):8790. 1993.

108. ***Chemical control of Rhizoctonia seedling blight of longleaf pine.*** Runion, G. B.; Kelley, W. D.; Land, D. H.; Gilly, S. P.; Sharp, D. J. Southern Journal of Applied Forestry 18(1):5-9. 1994.

109. ***Chlorination and postharvest disease control.*** Boyette, M. D.; Ritchie, D. F.; Carballo, S. J.; Blankenship, S. M.; Sanders, D. C. HortTechnology 3(4):395-400. 1993.

110. ***Commercial application and mass rearing of beneficial insects for integrated pest management.*** Papacek, D. International Plant Propagators' Society, combined proceedings 42:95-98. 1992. 1994.

* 111 * ***Conidial germination and formation of necrosis in pine seedlings by Gremmeniella abietina at low temperatures.*** Petaisto, R. L. European Journal of Forest Pathology 23:290294. 1993.

* 112* ***Development of suppressiveness to diseases caused by Rhizoctonia solani in soils amended with composted and noncomposted manure.*** Voland, R. P.; Epstein, A. H. Plant Disease 78(6):461-466. 1994.

113. ***Disease and insect control in forest tree nurseries.*** Cordell, C. E.; Affeltranger, C. E. Texas A&M University, Texas Forest Service, Publication 148:78-87. Nursery Management Workshop, proceedings. 1991.

* 114* ***Does nursery production reduce antiherbivore defenses of white spruce? Evidence from feeding experiments with snowshoe hares.*** Rodgers, A. R.; Williams, D.; Sinclair, A. R. E.; Sullivan, T. P.; Andersen, R. J. Canadian Journal of Forest Research 23(11):23582361. 1993.

* 115 * ***Eradication of primary inoculum of Botrytis cinerea by soil solarization.*** Lopez-Herrera, C. J.; Verdu-Valiente, B.; Melero-Vara, J. M. Plant Disease 78(6):594-597. 1994.

* 116* ***First report of Fusarium subglutinans f. sp. pini on pine seedlings in South Africa.*** Vijoen, A.; Wingfield, M. J. Plant Disease 78(3):309-312. 1994.

* 117* ***Frequency of benzimidazole- and dicarboximide-resistant strains of Botrytis cinerea in western Oregon small fruit and snap bean plantings.*** Johnson, K. B.; Sawyer, T. L.; Powelson, M. L. Plant Disease 78(6):572-577. 1994.

118. ***Getting to the root of the problem.*** Pscheidt, J. W. American Nurseryman 179(5):64-68, 70-73. 1994. How to accurately diagnose Phytophthora diseases and save your nursery money in the long run.

119. ***Green manure effects on soilborne pathogens.*** Stone, J. K.; Hansen, E. M. IN: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-243, p. 57-64. Landis, T.D., ed. Proceedings: Northeastern and Intermountain Forest and Conservation Nursery Associations. 1994.

* 120* ***High temperature, darkness, and drought predispose black spruce seedlings to gray mold.*** Zhang, P. G.; Sutton, J. C. Canadian Journal of Botany 72(2):135-142. 1994.

121. ***Integrated pest management in Canadian forest nurseries - current perspectives and future opportunities.*** Meyer, T. R.; Irvine, M.; Harvey, E. M.; McDonough, T. IN: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-243, p. 69-78. Landis, T.D., ed. Proceedings: Northeastern and Intermountain Forest and Conservation Nursery Associations. 1994.

122. ***Interactions between seedbed mulches and seedling disease development.*** Barnard, E. L.; Fraedrich, S. W.; Gilly, S. P. IN: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-243, p. 97-104. Landis, T.D., ed. Proceedings: Northeastern and Intermountain Forest and Conservation Nursery Associations. 1994.

123. ***IPM program for ornamental nurseries in Wisconsin.*** Delahaut, K. IN: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-243, p. 79-83. Landis, T.D., ed. Proceedings: Northeastern and Intermountain Forest am Conservation Nursery Associations. 1994.

124. ***A look at: insect traps.*** Greenhouse Manager 13(1):52-54. 1994.

125. ***Making greater use of introduced micro-organisms for biological control of plant pathogens.*** Cook, R. J. Annual Review of Phytopathology 31:53-80. 1993.

126. ***Making the change to integrated pest management.*** Zagory, E. M.; Rosetta, R. International Plant Propagators' Society, combined proceedings 42:246-250. 1992. 1994.

127. ***Managing fungi resistance.*** Peerbolt, A. The Digger 38(5): 22, 24-25. 1994. Various products and strategies are available to help growers keep pathogens off balance.

128. ***Nursery integrated pest management in Wisconsin.*** Delahaut, K. A.; Koval, C. F. HortTechnology 4(1):72-75. 1994.

129. ***A overview of integrated pest management for plant propagation.*** Parrella, M. P. International Plant Propagators' Society, combined proceedings 42:242-245. 1992. 1994.

130. ***Plant protection - management of pest control techniques.*** Harden, J. International Plant Propagators' Society, combined proceedings 42:99-102. 1992. 1994.

* 131 * ***Potential and limitations of natural repellents against early destructive browsing by livestock and game.*** Von Carlowitz, P. G.; Wolf, G. V. Agroforestry Systems 16:33-40. 1991. Materials tested are fluffed-up sheep wool, sisal fibers, fibers from pods of the kapok tree, extracts from the fruits of Solanum campylacanthum and the latex of Euphorbia tirucalli.

* 132* ***Potential role*** of ***fungi and bacteria in Chinese fir replant soil.*** Zhang, Q.; Zak, J. C. Canadian Journal of Botany 72(1): 73-78. 1994.

133. ***Predicting pest problems.*** Shetlar, D. American Nurseryman 179(8):46-59. 1994. How the weather affects pest populations, and what you can do to help prevent problems this coming year.

134. ***Resources for establishing an IPM program for ornamental plants.*** Flint, M. L. International Plant Propagators' Society, combined proceedings 42:251-255. 1992. 1994.

135. ***Shopping for a plant disease clinic.*** Simone, G. W. Greenhouse Manager 12(12):120-122. 1994.

136. ***Silicon reduces Pythium losses.*** Lawson, R. H. Greenhouse Manager 13(1):81-82. 1994.

137. ***Soil moisture and Fusarium root rot of white pine seedlings.*** Juzwik, J.; Menes, P. J.; Rugg, D. J. IN: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-243, p. 85-90. Landis, T.D., ed. Proceedings: Northeastern and Intermountain Forest and Conservation Nursery Associations. 1994.

138. ***Take control with bio-controls (Part 2).*** Gill, S.; Maclachlan, W. Greenhouse Grower 12(3):44-46. 1994. Results of a field trial evaluating effectiveness of biological agents suitable for fungus gnat control.

139. ***Treatment of plants with hypochlorite solutions.*** de Fossard, R. A. International Plant Propagators' Society, combined proceedings 42:65-67. 1992. 1994.

140. ***Use of insecticidal oils and soaps for pest control.*** Mizell, R. F. III. International Plant Propagators' Society, combined proceedings 42:385-387. 1992. 1994.

(SO) ***Common sense pest control.*** Olkowski, W.; Daar, S.; Olkowski, H. Newton, CT: The Taunton Press. 715 p. 1991. ORDER FROM: Garden Centers of America, 1250 I Street NW, Suite 500, Washington, DC 20005. Phone: 202789-2900. Price: $40.00 + $2.50 S&H.

## *Pesticides*

141. ***For safe keeping: a guide to pesticide storage.*** Pagliasotti, S. The Digger 38(5):27-29. 1994. Proper chemical storage not only is the law, it can save you from accidents, unnecessary exposure and save time and money.

142. ***Low -volume sprayers cut waste.*** Bartok, J. W., Jr. Greenhouse Manager 12(12):123-125.. 1994.

143. ***New herbicides for ornamentals.*** Gilliam, C. H. International Plant Propagators' Society, combined proceedings 42:381-383. 1992. 1994.

144. ***Safety programs to satisfy the Right-To-Know laws.*** Hubbard, A. International Plant Propagators' Society, combined proceedings 42:338-390. 1992. 1994.

* 145 * ***Use of the GLEAMS model to estimate pesticide overland and subsurface transport in USDA Forest Service nursery applications.*** Craig, J. P.; Weiss, R. C. Water Science and Technology 28(3-5):425-429. 1993.

146. ***The who, what, when and why of listing pesticide applications.*** Pagliasotti, S. The Digger 38(4):17-19. 1994. Hints on complying with pesticide record-keeping laws.

147. ***The Worker Protection Standard.*** Geistlinger, L. American Nurseryman 179(1):46-57. 1994. What it involves, when it takes effect and what you must do to remain in compliance.

148. ***The Worker Protection Standard from A to Z.*** Pagliasotti, S. The Digger 38(4):30-35. 1994.

(SO). ***Pesticide sprayers for small farms.*** Ross, D. S. University of Maryland, Cooperative Extension Service, Bulletin 317. 24 p. 1990. ORDER FROM: Northeast Regional Agricultural Engineering Service, Cooperative Extension, 152 Riley-Robb Hall, Ithaca, NY 14853. Phone: (607) 255-7654. Price: $3.75.

(SO). ***Pesticides and groundwater: a guide for the pesticide user.*** Sailus, M. Northeast Regional Agricultural Engineering Service, NRAES-34. 1992 revised. ORDER FROM: Northeast Regional Agricultural Engineering Service, Cooperative Extension, 152 Riley Robb Hall, Ithaca, NY 14853. Phone: (607) 255-7654. Price: $4.00.

## Seedling Harvesting and Storage

* 149* ***The gravitational forces generated by dropping plants and the response of Sitka spruce seedlings to dropping.*** McKay, H. M.; Gardiner, B. A.; Mason, W. L.; Nelson, D. G.; Hollingsworth, M. K. Canadian Journal of Forest Research 23(11):2443-2451. 1993.

* 150* ***Lifting and storing bareroot blue oak (Quercus douglasii seedlings.*** McCreary, D. D.; Tecklin, J. New Forests 8(2):89- 103. 1994.

151. ***Lifting, grading, and packing forest tree nursery seedlings.*** Stauder, A. F. III. Texas A&M University, Texas Forest Service, Publication 148:127-133. Nursery Management Workshop, proceedings. 1991.

152. ***A low-cost microcomputer system for controlling relative humidity in horticultural storages.*** Adam, L. R.; Pritchard, M. K. HortTechnology 4(1): 51-54. 1994.

153. ***Storing and shipping reforestation seedlings.*** Brissette, J. C. Texas ,A&M University, Texas Forest Service, Publication 148:134-143. Nursery Management Workshop, proceedings. 1991.

## Seedling Physiology and Morphology

* 154* ***After effects of maternal environment on autumn frost hardiness in Pinus sylvestris seedlings in relation to cultivation techniques.*** Andersson, B. Tree Physiology 14(3): 313-322. 1994.

155. ***Autumn frost hardening of one-year-old Pinus sylvestris (L.) seedlings: effect of origin and parent trees.*** Aho, M. L. Scandinavian Journal of Forest Research 9(1):17-24. 1994.

* 156* ***Bud and cambial zone phenology of lateral branches from Douglas-fir (Pseudotsuga menziesii seedlings.*** Rensing, K. H.; Owens, J. N. Canadian Journal of Forest Research 24(2):286-296. 1994.

* 157* ***Bud development in coastal Douglas-fir in response to different dormancy-induction treatments.*** MacDonald, J. E.; Owens, J. N. Canadian Journal of Botany 71(10):1280-1290. 1993.

* 158* ***Carbohydrate reserve accumulation and depletion in Engelmann spruce (Picea engelmannii Parry): effects of cold storage and pre-storage $CO_2$ enrichment.*** Chomba, B. M.; Guy, R. D.; Weger, H. G. Tree Physiology 13(4):351-364. 1993.

* 159* ***Changes in protein synthesis during drought conditioning in roots of jack pine seedlings (Pinus banksiana Lamb.).*** Mayne, M. B.; Subramanian, M.; Blake, T. J.; Coleman, J. R.; Blumwald, E. Tree Physiology 14(5):509 519. 1994.

160. ***Cold hardiness estimates of woody taxa from cultivated and wild collections.*** Dirr, M. A.; Lindstrom, O. M.; Lewandowski, R.; Vehr, M. J. Journal of Environmental Horticulture 11(4):200-203. 1994.

* 161 * ***Cold-induced purpling of Pinus contorta seedlings depends on previous daylength treatment.*** Camm, E. L.; McCallum, J.; Leaf, E.; Koupai-Abyazani, M. R. Plant, Cell and Environment 16: 761-764. 1993.

162. ***Effect of nursery culture and bud status on freeze injury to Pinus taeda and P. elliotii seedlings.*** South, D. B.; Donald, D. G. M.; Rakestraw, J. L. South African Forestry Journal 166:37-45. 1993.

* 163*** *Effect of nursery culture on morphological development of western hemlock seedlings during field establishment. I. Flushing, shoot elongation, and bud development.*** O'Reilly, C.; Owens, J. N.; Arnott, J. T.; Dunsworth, B. G. Canadian Journal of Forest Research 24(1):53-60. 1994.

* 164* ***Effect of nursery culture on morphological development of western hemlock seedlings during field establishment. II. Survival, shoot length components, and needle length.*** O'Reilly, C.; Owens, J. N.; Arnott, J. T.; Dunsworth, B. G. Canadian Journal of Forest Research 24(1):61-70. 1994.

* 165* ***The effect of seaweed concentrate on the growth of Pinus pinea seedlings.*** Atzmon, N.; Van Staden, J. New Forests 8(3): 279-288. 1994.

* 166* ***Effects of frozen storage duration and soil temperature on the stomatal conductance and net photosynthesis of Picea glauca seed lings.*** Harper, G. J.; Camm, E. L. Canadian Journal of Forest Research 23(12):2459-2466. 1993.

* 167* ***Element concentrations in the xylem sap of Picea abies (L.) Karst. seedlings extracted by various methods under different environmental conditions.*** Berger, A.; Oren, R.; Schulze, E. Tree Physiology 14(2):111-128. 1994.

* 168* ***Growth cessation and bud dormancy in relation to ABA level in seedlings and coppice shoots of Betula pubescens as affected by a short photoperiod, water stress and chilling.*** Rinne, P.; Saarelainen, A.; Junttila, O. Physiologia Plantarum 90(3):451-458. 1994.

169. ***Heat tolerance, cold hardiness, and bud dormancy relationships in seedlings of selected conifers.*** Burr, K. E.; Wanner, S. J.; Tinus, R. W. Journal of the American Society for Horticultural Science 118(6):840-844. 1993.

* 170* ***Increased drought resistance of black locust seedlings via pretreatment of seeds with paclobutrazol.*** Hui-Juan, S.; Bin, Z. Canadian Journal of Forest Research 23(12):2548-2551. 1993.

* 171* ***Influence of dormancy induction treatments on the photosynthetic response of field planted western hemlock seedlings.*** Major, J. E.; Grossnickle, S. C.; Arnott, J. T. Forest Ecology and Management 63(2-3):235-246. 1994.

* 172* ***The influence of elevated ozone on freezing tolerance of red spruce seedlings.*** Waite, C. E.; DeHayes, D. H.; Rebbeck, J.; Schier, G. A.; Johnson, A. H. New Phytologist 126(2):327-335. 1994.

* 173 * ***Influence of nursery culture on growth, cold hardiness, and drought resistance of yellow cypress.*** Arnott, J. T.; Grossnickle, S. C.; Puttonen, P.; Mitchell, A. K.; Folk, R. S. Canadian Journal of Forest Research 23(12):2537-2547. 1993.

* 174* ***Influence of nursery culture on western red cedar. I. Measurement of seedling attributes before fall and spring planting.*** Major, J. E.; Grossnickle, S. C.; Folk, R. S.; Arnott, J. T. New Forests 8(3):211-229. 1994.

* 175 * ***Influence of nursery culture on western red cedar. II. Freezing tolerance of fall planted seedlings and morphological develop ment of fall- and spring planted seedlings.*** Folk, R. S.; Grossnickle, S. C.; Major, J. E.; Arnott, J. T. New Forests 8(3):231-247. 1994.

*176* ***The influence of ultraviolet-B light and carbon dioxide enrichment on the growth and physiology of seedlings of three conifer species.*** Yakimchuk, R.; Hoddinott, J. Canadian Journal of Forest Research 24(1):1-8. 1994.

177. ***Inundation tolerance of riparian plant species.*** DeShield, M. A., Jr.; Reddy, M. R.; Leonard, S.; Assar, N. H.; Brown, W. T. Wetland Journal 6(1):20-21. 1994.

178. ***Photoperiod extension with two types of light sources: effects on growth and development of conifer species.*** Omi, S. K.; Eggleston, K. L. Tree Planters' Notes 44(3):105-112. 1993.

*179* ***Photoperiod influences dehardening of Chamaecyparis nootkatensis seedlings.*** Hawkins, B. J.; McDonald, S. E. Canadian Journal of Forest Research 23(11):2452-2454. 1993.

*180* ***Photosynthetic acclimation to low temperature by western red cedar seedlings.*** Weger, H. G.; Simim, S. N.; Guy, R. D. Plant, Cell and Environment 16:71 I-717. 1993.

181. ***Physiological testing*** of ***plants as a management tool.*** Tinus, R. W. International Plant Propagators' Society, combined proceedings 42:225-230. 1992. 1994.

182. ***Response of plants with severed taproots to different hydrologic regimes.*** McIninch, S.; Garbisch, E. Wetland Journal 6(1):22-23. 1994.

*183* ***Rest break in Norway spruce seedlings: test of a dynamic temperature response hypothesis.*** Hanninen, H.; Backman, R. Canadian Journal of Forest Research 24(3):558-563. 1994.

* 184* ***Seasonal patterns and environmental regulation of frost hardiness in shoots of seedlings of Thuja plicata Chamaecyparis nootkatensis, and Picea glauca.*** Silim, S. N.; Lavender, D. P. Canadian Journal of Botany 72(3):309-316. 1994.

*185* ***Spring growth of Douglas-fir seedlings from two bud development regimes.*** Graham, J. S.; Hobbs, S. D. New Forests 8(1):15-24. 1994.

186. ***The target seedling and how to produce it.*** Omi, S. K. Texas A&M University, Texas Forest Service, Publication 148:88-118. Nursery Management Workshop, proceedings. 1991.

187. ***Timing of cold temperature exposure affects root and shoot frost hardiness of Picea mariana container seedlings.*** Colombo, S. J. Scandinavian Journal of Forest Research 9(1):52-59. 1994.

# *Seeds*

188. ***Aspen seed collection and extraction.*** Fung, M. Y. P.; Hamel, B. A. Tree Planters' Notes 44(3):98-100. 1993.

* 189* ***Effects of seed size on seedling attributes in Sitka spruce.*** Chaisurisri, K.; Edwards, D. G. W.; El-Kassaby, Y.A. New Forests 8(1):81-87. 1994.

190. ***Germination of western larch seed surface sterilized with bleach.*** Nayital, R. K.; Wenny, D. L.; Verma, K. S. Indian Journal of Forestry 16(4):319-322. 1993.

191. ***Growth performance in seedlings derived from premature cone collections from natural populations of black spruce and white spruce.*** Mosseler, A.; Johnsen, K. H.; Tricco, P. Seed Science and Technology 21(3):537-544. 1993.

192. ***Induction of dormancy in nondormant seeds.*** Khan, A. A. Journal of the American Society for Horticultural Science 119(3): 408413. 1994.

*193* ***A laboratory study of the effect of temperature on red pine seed germination.*** Flannigan, M. D.; Woodward, F. I. Forest Ecology and Management 62(1-4):145-156. 1993.

194. ***Loblolly pine seed dormancy. I. The relationship between protein synthesis and the loss of dormancy.*** Schneider, W. L.; Gifford, D. J. Physiologic Plantarum 90(2):246-252. 1994.

195. ***Loblolly tree seed collection system.*** Hallman, D. Tree Planters' Notes 44(3):101104. 1993.

* 196* ***Photostimulation of seed germination during soil tillage.*** Scopel, A. L.; Ballare, C. L.; Radosevich, S. R. New Phytologist 126(1):145152. 1994.

197. ***Predicting anatomical maturity of Pinus sylvestris L. seeds in northern Fennoscandia.*** Sahlen, K.; Bergsten, U. Scandinavian Journal of Forest Research 9(2):154-157. 1994.

198. ***Propagation of the temperate woody flora of Mexico.*** Nicholson, R.; Fairey, J.; Schoenfeld, C.; Shemluck, M.; Estrada, E. International Plant Propagators' Society, combined proceedings 42:442-446. 1992. 1994.

199. ***A review of Lasiodiplodia theobromae with particular reference to its occurrence on coniferous seeds.*** Cilliers, A. J.; Swart, W. J.; Wingfield, M. J. South African Forestry Journal 166:47-52. 1993.

*200* ***Seed mass effects on germination and growth of diverse European Scots pine populations.*** Reich, P. B.; Oleksyn, J.; Tjoelker, M. G. Canadian Journal of Forest Research 24(2):306320. 1994.

201. ***Seed, seed handling, and sowing.*** Barnett, J. P. Texas A&M University, Texas Forest Service, Publication 148:24-38. Nursery Management Workshop, proceedings. 1991.

202. ***Supply of improved radiata pine seed.*** Vincent, T. G. New Zealand Forestry 38(3):4548. 1993.

(SO). ***Ex situ storage of seeds, pollen and in vitro cultures of perennial woody plant species.*** Wang, B. S. P.; Charest, P. J.; Downie, B. Food and Agricultural Organization, FAO Forestry Paper 113. 1993. ORDER FROM: Unipub, 4611-F Assembly Drive, Lanham, MD 20706 4391. Phone (800) 274-4447 or (301) 459 7666. Order number F3854. Price: $8.00.

(SO). ***Seed germination theory and practice.*** Deno, N. C. 242 p. 2nd ed. 1993. Contents: Introduction; Principles; Germination, definition and description; Design of the experiments; Rates of germination; Inhibitor destruction by dry storage; Inhibitor destruction by moist conditions; Two or more inhibiting systems; Seeds embedded in fruits; Physical mechanisms for inhibiting germination; Outdoor exposure and oscillating temperatures; Photoeffects; Exogenous chemical effects and the stimulation of germination by gibberellins; Dry storage and longevity of seeds; Growing plants from seeds; Collection of seeds; Plant nomenclature; Endangered species and their conservation; Lists of genera studied arranged by their plant families; Rate theory in more detail; Data on germination arranged by genera. ORDER FROM: Norman C. Deno, 139 Lenor Drive, State College, PA 16801. Price: $20.00.

## *Soil Management and Growing Media*

203. ***Assessment of wetting agents for use in nurseries.*** Handreck, K. A. International Plant Propagators' Society, combined proceedings 42:73-80. 1992. 1994.

204. ***Calculating compost capacity.*** Tyler, R. American Nurseryman 179(7):47-51. 1994.

205. ***Changes in physical and chemical properties of a loamy sand soil when amended with composted poultry litter.*** Warren, S. L.; Fonteno, W. C. Journal of Environmental Horticulture 11(4):186-190. 1993.

206. ***Coal ash as a propagation medium.*** Gleeson, M. B. International Plant Propagators' Society, combined proceedings 42:91-94. 1992. 1994.

207. ***Composting leaves for potting mix.*** McCloud, T. L. International Plant Propagators' Society, combined proceedings 42:447-448. 1992. 1994.

208. ***Field practices affect neutron moisture meter accuracy.*** Hanson, B. R.; Dickey, G. L. California Agriculture 47(6):29-31. 1993.

209. ***Growth of Rudbeckia and leaching of nitrates in potting media amended with composted coffee processing residue, municipal solid waste and sewage sludge.*** Bugbee, G. J. Compost Science and Utilization 2(1):72-79. 1994.

210. ***The importance of aeration in container media.*** Wong, S. The Digger 38(3):30-31. 1994.

*211 * ***The influence of different forest organic matter on the growth of one year old planted Norway spruce seedlings in a greenhouse experiment.*** Hallsby, G. New Forests 8(1):43 60. 1994.

*212* ***The influence of shade and clouds on soil water potential: the buffered behavior of hydraulic lift.*** Williams, K.; Caldwell, M. M.; Richards, J. H. Plant and Soil 157(1):83-95. 1993.

213. ***A new rockwool based growing medium for container plant production.*** Barletta, M. International Plant Propagators' Society, combined proceedings 42:149-151. 1992. 1994.

214. ***Overview of green manures /cover crops.*** Power, J. F. IN: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-243, p. 47-50. Landis, T.D., ed. Proceedings: Northeastern and Intermountain Forest and Conservation Nursery Associations. 1994.

215. ***An overview of the role of organic amendments in forest nurseries.*** Rose, R. IN: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-243, p. 43-50. Landis, T.D., ed. Proceedings: Northeastern and Intermountain Forest and Conservation Nursery Associations. 1994.

216. ***Recycling green nursery waste.*** Skimina, C. A. International Plant Propagators' Society, combined proceedings 42:256-259. 1992. 1994.

217. ***A review of materials for propagation media.*** Gordon, I. International Plant Propagators' Society, combined proceedings 42:85-90. 1992. 1994.

218. ***Soil compaction: causes, effects, management in bareroot nurseries.*** Allmaras, R. R.; Juzwik, J.; Overton, R. P.; Copeland, S. M. IN: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-243, p. 19-32. Landis, T.D., ed. Proceedings: Northeastern and Intermountain Forest and Conservation Nursery Associations. 1994.

219. ***Soil management plan for the G.O. White State Forest Nursery.*** Meinert, D.; Viele, D.; Knoernschild, T.; Moore, M. IN: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-243, p. 9-18. Landis, T.D., ed. Proceedings: Northeastern and Intermountain Forest and Conservation Nursery Associations. 1994.

220. ***Soil organic matter and available water capacity.*** Hudson, B. D. Journal of Soil and Water Conservation 49(2):189-194. 1994.

221. ***Soils aspects of nursery management.*** Davey, C. B. Texas A&M University, Texas Forest Service, Publication 148:1-23. Nursery Management Workshop, proceedings. 1991.

222. ***The use of composted rice hulls in rooting and potting media.*** Lovelace, W.; Kuczmarski, D. International Plant Propagators' Society, combined proceedings 42:449-450. 1992. 1994.

223. ***Use of composts in nursery potting substrates.*** Bilderback, T. E. International Plant Propagators' Society, combined proceedings 42:376-380. 1992. 1994.

224. ***The use of green overwinter mulch in the Illinois State Nursery program.*** Stauder, A. F. III. IN: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-243, p. 51-53. Landis, T.D., ed. Proceedings: Northeastern and Intermountain Forest and Conservation Nursery Associations. 1994.

225. ***Use of wheat as a living mulch to replace hydromulch for fall sown seedbeds.*** Wichman, J. IN: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-243, p. 55-56. Landis, T.D., ed. Proceedings: Northeastern and Intermountain Forest and Conservation Nursery Associations. 1994.

226. ***Using municipal organic wastes at Lincoln-Oakes Nurseries.*** Morgenson, G. IN: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-243, p. 65-67. Landis, T.D., ed. Proceedings: Northeastern and Intermountain Forest and Conservation Nursery Associations. 1994.

(SO). ***Composting to reduce the waste stream: a guide to small scale food and yard waste composting.*** Dickson, N.; Richard, T.; Kozlowski, R. Northeast Regional Agricultural Engineering Service, NRAES-43. 44 p. 1991. ORDER FROM: Northeast Regional Agricultural Engineering Service, Cooperative Extension, 152 Riley-Robb Hall, Ithaca, NY 14853. Phone: (607) 255-7654. Price: $7.00.

(SO). ***On farm composting handbook.*** Rynk, R.; van de Kamp, M.; Willson, G. B.; Singley, M. E.; Richard, T. L.; Kolega, J. J. Northeast Regional Agricultural Engineering Service, NRAES-54. 186 p. 1992. Chapters: Benefits and drawbacks; The composting process; Raw materials; Composting methods; Composting operations; Management; Site and environmental considerations; Using compost; Marketing agricultural compost; Farm composting economics - focus on production costs; Other options for waste management and composting. ORDER FROM: Northeast Regional Agricultural Engineering Service, 152 Riley-Robb Hall, Cooperative Extension, Ithaca, NY 14853-5701. Phone (607) 255- 7654. Price $15.00.

(SO). ***Rodale book of composting.*** Martin, D. L.; Gershuny, G. Rodale Press. 278 p. 1992. Chapters: Composting throughout history; The benefits of compost; Life inside a compost heap; The frontiers of composting; Materials for composting; Using manure; Methods; Composting with earthworms; Compost structures; Shredders and other equipment; Using compost; Large scale composting. ORDER FROM: Rodale Press, 33 E. Minor Dr., Emmanus, PA 18098. Phone (800)527-8200. Price: $24.98 inc. S&H.

## *Tropical Forestry and Agroforestry*

227. ***Effect of leaf leachate of Robinia pseudoacacia on seed germination and growth of some agricultural crops.*** Bhardwaj, S. D. Indian Journal of Forestry 16(3):285-286. 1993.

228. ***Effects of a growth retardant and shoot pruning on the growth of Acacia mangium seedlings.*** Abod, S. A.; Leong, C. K. Journal of Tropical Forest Science 6(3):239-248. 1994.

*229* ***Germination studies on seed of fruit trees indigenous to Malawi.*** Prins, H.; Maghembe, J. A. Forest Ecology and Manage ment 64(2-3):111-125. 1994.

*230* ***Influence of irradiance on photosynthesis, morphology and growth of mangosteen (Garcinia mangostana L.) seedlings.*** Wiebel, J.; Chacko, E. K.; Downton, W. J. S.; Ludders, P. Tree Physiology 14(3):263-274. 1994.

*231 * ***Presowing seed treatments on four African Acacia species: appropriate technology for use in forestry for rural development.*** Masamba, C. Forest Ecology and Management 64(2-3): 1 OS-109. 1994.

232. ***Seeds of Puerto Rican trees and shrubs: second installment.*** Francis, J. K.; Rodriguez, A. USDA Forest Service, Southern Forest Experiment Station, Research Note SO-374. 5 p. 1993.

233. ***Standardization of containers for growth and vigour of tree seedlings in the nursery.*** Gopakumar, S.; Gopikumar, K. Journal of Tropical Forest Science 6(1):26-36. 1993.

(SO). ***Nursery technology for agroforestry: application in arid and semiarid regions.*** Puri, S.; Khosla, P. K. International Science Publisher. 390 p. 1993. Sections: Background; Plant production systems; Container-grown seedlings; Propagation method; Seedling improvement strategies; Plant stock evaluation; Protection. ORDER FROM: International Science Publisher, 2840 Broadway, New York, NY 10025. Price: $62.00.

## *Vegetative Propagation and Tissue Culture*

234. ***Advances using indole-3-butyric acid (IBA) dissolved in water for rooting cuttings, transplanting, and grafting.*** Kroin, J. International Plant Propagators' Society, combined proceedings 42:489-492. 1992. 1994.

235. ***Artificial seeds in micropropagation.*** Norgaard, J. V. International Plant Propagators' Society, combined proceedings 42:182-184. 1992. 1994.

236. ***Clonal propagation for reforestation.*** Caldwell, T. American Pulpwood Association, Technical Release 91-R-94. 2 p. 1991. Describes procedure used by International Forest Seed Company to produce rooted cuttings of rust resistant seedlings.

237. ***Clonal propagation of biofuel trees with emphasis on silver maple.*** Preece, J. E.; Huetteman, C. A.; Ashby, W. C.; Roth, P. L. International Plant Propagators' Society, combined proceedings 42:483-487. 1992. 1994.

238. ***The effects of shoot age on root formation of cuttings of Eucalyptus grandis W. Hill ex Maiden.*** Carter, A. S.; Slee, M. U. International Plant Propagators' Society, combined proceedings 42:43-47. 1992. 1994.

*239* ***Growth analyses on in vitro, ex vitro and auxin-rooted hypocotyl cuttings of Pinus contorta Dougl. ex Loud.*** Gronroos, R.; Flygh, G.; Kahr, M.; von Arnold, S. New Phytologist 125(4): 829-836. 1993.

*240* ***Growth and branching habit of rooted cuttings collected from epicormic shoots of Betula pendula Roth.*** Cameron, A. D.; Sani, H. Tree Physiology 14(4):427-436. 1994.

241. ***In vitro root suckering of aspen (Populus tremuloides).*** *Louis,* K.; Hanson, C. V.; Hackett, W. P.; Mohn, C. A. International Plant Propagators' Society, combined proceedings 42:472-475. 1992. 1994.

242. ***The influence of juvenility on plant propagation.*** Sommer, L. International Plant Propagators' Society, combined proceedings 42:175-176. 1992. 1994.

*243* ***Micropropagation and rejuvenation of Sequoia sempervirens (Lamb) Endl: a review.*** Arnaud, Y.; Franclet, A.; Tranvan, H.; Jacques, -M. Annales des Sciences Forestieres 50:273-295. 1993.

*244* ***Micropropagation of western hemlock (Tsuga heterophylla [Raf.] Sarg.) from embryonic explants.*** Harry, I. S.; Lu, C. Y.; Sharma, K. K.; Thorpe, T. A. New Forests 8(1):1-13. 1994.

245. ***Progress report on propagation of Juniperus for conservation planting.*** Wagner, A. M.; Mexal, J. G.; Harrington, J. T.; Fisher, J. T. IN: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-243, p. 131-135. Landis, T.D., ed. Proceedings: Northeastern and Intermountain Forest and Conservation Nursery Associations. 1994.

246. ***Promotion of rooting of shoot cuttings of Datura stramonium L. by IBA.*** Pal, M.; Mishra, M.; Bhandari, H. C. S. Indian Journal o Forestry 16(4):336-338. 1993.

247. ***Propagation of Atlantic white cedar by stem cuttings.*** Hinesley, L. E.; Blazich, F. A.; Snelling, L. K. HortScience 29(3):217-219. 1994.

248. ***Rooting baldcypress stem cuttings.*** Copes D. L.; Randall, W. K. Tree Planters' Notes 44(3):125-127. 1993.

249. ***Timing of collection and seed source affects rooting of white fir stem cuttings.*** Wagner, A. M.; Harrington, J. T.; Fisher, J. T. IN: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-243, p. 137-141. Landis, T.D., ed. Proceedings: Northeastern and Intermountain Forest and Conservation Nursery Associations. 1994.

250. ***Update on root promoting chemicals and formulations.*** Dirr, M. A. International Plant Propagators' Society, combined proceedings 42:361-365. 1992. 1994.

## *Water Management and Irrigation*

251. ***Capillary mat irrigation system for container nursery plants.*** Bartok, J.W., Jr. American Society of Agricultural Engineers, Paper 93 1017. 1993. 8 p.

252. ***Container nursery nitrate nitrogen runoff a six-state summary.*** Yeager, T.; Wright, R.; Fare, D.; Gilliam, C.; Johnson, J.; Bilderback, T.; Zondag, R. International Plant Propagators' Society, combined proceedings 42:345-347. 1992. 1994.

253. ***Nitrate non point pollution potential in midwestern bareroot nurseries.*** Schultz, R. C.; Thompson, J. R.; Ovrom, P.; Rodrigues, C. A. IN: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-243, p. 1-8. Landis, T.D., ed. Proceedings: Northeastern and Intermountain Forest and Conservation Nursery Associations. 1994.

*254* ***Occurrence of Phytophthora species in recirculated nursery irrigation effluents.*** MacDonald, J. D.; Ali-Shtayeh, M. S.; Kabashima, J.; Stites, J. Plant Disease 78(6):607-611. 1994.

*255* ***Pollution control and prevention at containerized nursery operations.*** Alexander, S. V. Water Science and Technology 28(3-5):509-517. 1993.

256. ***Potential evapotranspiration as a means of predicting irrigation timing in greenhouse tomatoes grown in peat bags.*** Norrie, J.; Graham, M. E. D.; Gosselin, A. Journal of the American Society for Horticultural Science 119(2):163-168. 1994.

257. ***Reduction of nitrates in nursery surface and ground water.*** Amos, R. R. International Plant Propagators' Society, combined proceedings 42:507-512. 1992. 1994.

258. ***Six state survey of container nursery nitrate nitrogen runoff.*** Yeager, T.; Wright, R.; Fare, D.; Gilliam, C.; Johnson, J.; Bilderback, T.; Zondag, R. Journal of Environmental Horticulture 11(4):206-208. 1994.

259. ***A thirst for conservation.*** Wilkerson, D. C.; Arnold, M. American Nurseryman 179(2):56-61. 1994. Here's a look at what you can do to help conserve and safeguard our increasingly scarce water resources.

260. ***Using a constructed wetland to treat waste water and propagate wetland species.*** Beagle, G Justin, J. Tree Planters' Notes 44(3):93-97. 1993.

261. ***Water conserving irrigation systems.*** Burger, D. W. International Plant Propagators' Society, combined proceedings 42:260-266. 1992. 1994.

262. ***Water quality in propagation.*** Bunker, E. International Plant Propagators' Society, combined proceedings 42:81-84. 1992. 1994.

(SO). ***Irrigation design: Book 1, design flow and operating pressure.*** Hawes, L.; Kier, D. HydroTech Publications. 1993. Contains tables and charts concerning friction losses, maximum flow amounts, and other valuable facts concerning irrigation design. ORDER FROM: American Nurseryman Publishing Co., Suite 2100, 77 W. Washington, Chicago, IL 60602-2904. Phone: 800-621-5727. Item A-7022. Price: $9.95.

## *Weed Control*

263. ***Chemical weed control progress at Saskatchewan Government forest nurseries.*** Matthews, J. Forestry Canada, Maritimes Region, Information Report M-X-184E, p. 3739. Lanteigne, L.J.; Burns, T.W.; Clark, P., eds. Canadian Forest Nursery Weed Management Association, proceedings of annual meeting, 1991. 1993.

264. ***Copper-treated Styrofoam blocks for liverwort control.*** Trotter, D.; Shrimpton, G. Forestry Canada, Maritimes Region, Information Report M-X-184E, p. 28-29. Lanteigne, L.J.; Burns, T.W.; Clark, P., eds. Canadian Forest Nursery Weed Management Association, proceedings of annual meeting, 1991. 1993.

265. ***Effects of tank-mix combinations of non-selective foliar and selective soil-applied herbicides on three weed species.*** Hydrick, D. E.; Shaw, D. R. Weed Technology 8(1):129133. 1994.

266. ***Field bindweed (Convolvulus arvensis control with fluroxypyr.*** Macdonald, R. T.; Hall, J. C.; O'Toole, J. J.; Swanton, C. J. Weed Technology 7(4):966-971. 1993.

267. ***Herbicide levels in nursery containment pond water and sediments.*** Camper, N. D.; Whitwell, T.; Keese, R. J.; Riley, M. B. Journal of Environmental Horticulture 12(1):8-12. 1994.

268. ***Herbicide use during propagation affects root initiation and development.*** Gilliam, C. H.; Eakes, D. J.; Olive, J. W. Journal of Environmental Horticulture 11(4):157-159. 1993.

269. ***Metolachlor and simazine leaching through horticultural substrates.*** Mahnken, G. E.; Skroch, W. A.; Sheets, T. J.; Leidy, R. B. Journal of Environmental Horticulture 12(1):5558. 1994.

270. ***Napropamide dissipation in Ontario forest nursery soils.*** Irvine, M. T.; Clegg, S. B. Forestry Canada, Maritimes Region, Information Report M-X-184E, p. 18-21. Lanteigne, L.J.; Burns, T.W.; Clark, P., eds. Canadian Forest Nursery Weed Management Association, proceedings of annual meeting, 1991. 1993.

271. ***Selection of herbicide alternatives based on probable leaching to groundwater.*** Franklin, R. E.; Quisenberry, V. L.; Gossett, B. J.; Murdock, E. C. Weed Technology 8(1):6-16. 1994.

272. ***Slow-release delivery system for herbicides in container grown stock*** Gorski, S. F. Weed Technology 7(4):894-899. 1993.

273. ***Testing mechanical weeders at the G. Howard Ferguson Forest Station.*** Lucas, S. Forestry Canada, Maritimes Region, Information Report M-X-184E, p. 30-31. Lanteigne, L.J.; Burns, T.W.; Clark, P., eds. Canadian Forest Nursery Weed Management Association, proceedings of annual meeting, 1991. 1993.

274. ***Toxicity of imazethapyr to purple (Cyperus rotundus and yellow netsedges (C. esculentus).*** Richburg, J. S. Ill.; Wilcut, J. W.; Wehtje, G. R. Weed Technology 7(4):900-905. 1993.

275. ***Weed control in container grown herbaceous perennials.*** Derr, J. F. HortScience 29(2):95-97. 1994.

276. ***Weed management in forest nurseries.*** Abrahamson, L. Texas A&M University, Texas Forest Service, Publication 148:39-77. Nursery Management Workshop, proceedings. 1991.

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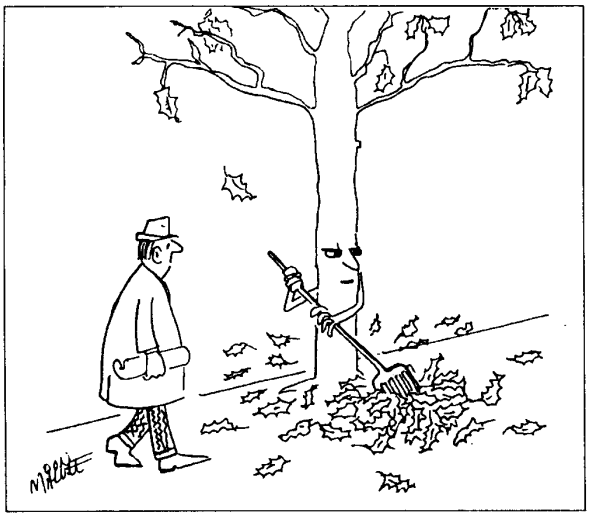
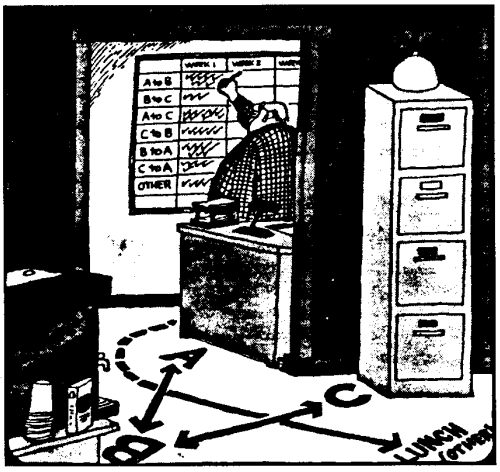




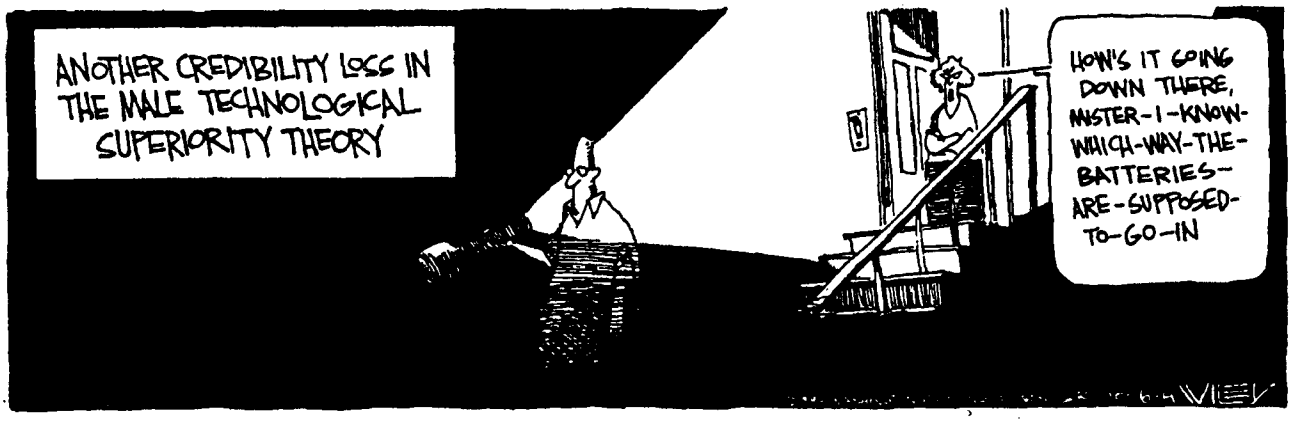

**Another business executive totally overwhelmed by his left brain.**

***For you propagators of riparian and wetland species***

**THE FAR SIDE**

**"Well, actually, Doreen, I rather resent being called a 'swamp thing.' ... I prefer the term 'wetlands-challenged mutant.'"**

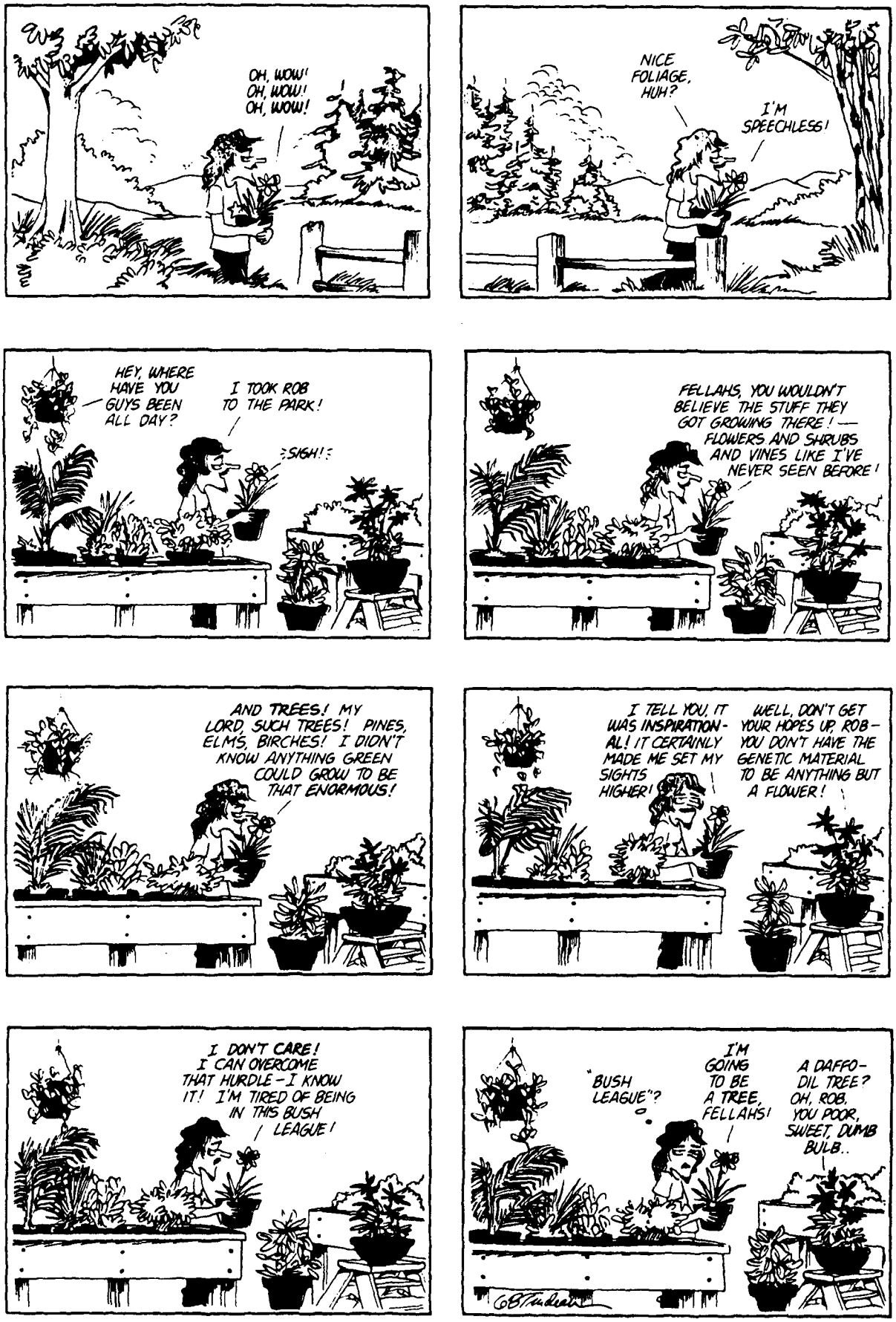
**NON SEQUITUR**




***Does this sound familiar?***

**DILBERT**


**FRANK & ERNEST**


OH, WOW! OH, WOW! OH, WOW!
NICE FOLIAGE, HUH?
I'M SPEECHLESS!
HEY, WHERE HAVE YOU GUYS BEEN ALL DAY?
I TOOK ROB TO THE PARK!
:SIGH!:
FELLAHS, YOU WOULDN'T BELIEVE THE STUFF THEY GOT GROWING THERE! — FLOWERS AND SHRUBS AND VINES LIKE I'VE NEVER SEEN BEFORE!
AND TREES! MY LORD, SUCH TREES! PINES, ELMS, BIRCHES! I DIDN'T KNOW ANYTHING GREEN COULD GROW TO BE THAT ENORMOUS!
I TELL YOU, IT WAS INSPIRATIONAL! IT CERTAINLY MADE ME SET MY SIGHTS HIGHER!
WELL, DON'T GET YOUR HOPES UP, ROB — YOU DON'T HAVE THE GENETIC MATERIAL TO BE ANYTHING BUT A FLOWER!
I DON'T CARE! I CAN OVERCOME THAT HURDLE — I KNOW IT! I'M TIRED OF BEING IN THIS BUSH LEAGUE!
"BUSH LEAGUE"?
I'M GOING TO BE A TREE, FELLAHS!
A DAFFODIL TREE? OH, ROB, YOU POOR, SWEET, DUMB BULB..
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