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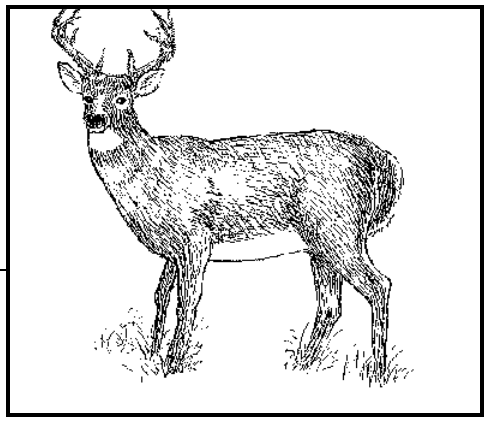
Forest Nursery Notes

Winter 2002



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The Expandable Stinger

Forest Nursery Notes Team

Tom D. Landis, Author and Editor
USDA Forest Service
Cooperative Programs
2606 Old Stage Road
Central Point, OR 97502
TEL: 541.858.6166
FAX: 541.858.6110
E-Mail: tdlandis@fs.fed.us

David Steinfeld, Author and Editor
USDA Forest Service
2606 Old Stage Road
Central Point, OR 97502
TEL: 541.858.6105
FAX: 541.858.6110
E-Mail: dsteinfeld@fs.fed.us

Rae Watson, Author and Layout
USDA Forest Service
2606 Old Stage Road
Central Point, OR 97502
TEL: 541.858.6131
FAX: 541.858.6110
E-Mail: rewatson@fs.fed.us

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Forest Nursery Notes
Winter 2002

Holiday Reflections: What a year it has been! The terrorist attacks of last September have shocked all Americans into a new reality and nothing will ever be the same. It is hard to imagine that such evil can exist in our world - especially from those who profess to believe in God. Reflecting on this senseless tragedy, I have come to conclude that the only way to counteract the evil in the world is to try harder to do good. We, in the nursery business, have a unique opportunity to contribute to the health and livability of our planet. The world is still a beautiful place and nurseries grow the plants to help keep it that way. So, take time to enjoy the true Spirit of this special season, and appreciate the blessing of family and friends.

Please Update Your Address: The FNN mailing list is always out-of-date so we would like to make sure that we have your latest address. Please take the time to check the mailing label and note any additions or corrections on the Literature Order Form at the back of this issue. In particular, check your telephone and FAX numbers because area codes keep changing. Supply the country code if you are a foreign subscriber. Also list your E-mail and website addresses if you have them.

Technical Requests. Every day we receive letters, telephone calls, Faxes, and E-mail messages from around the world requesting publications or asking for technical assistance. Our technology transfer team prides itself on responding to all inquiries as soon as possible but we do have to set some priorities. Forest and conservation nurseries in the United States receive first priority and then we handle requests from foreign countries. Our contact information is listed on the inside cover of this issue. If Tom is not around, then contact David or Rae and we'll get back to you as soon as possible. You can make things easier if you will remember a few things when contacting us:

- ♦ Telephone calls are hard to understand sometimes, especially when the caller has an accent. If you leave a voice mail message, please speak slowly and give your full mailing address, phone, FAX, and E-mail numbers.

- ♦ FAX messages are easy to process but be sure to give your complete name, address, and return FAX number *including country code.*

- ♦ E-mail is the best option because it is non-invasive and accessible around the clock. If you are requesting publications, be sure to give us your full mailing address.

Nursery Networks

New Website: My group, the Reforestation, Nurseries and Genetic Resources (RNGR) team, has a new website and the URL should be easy to remember:

<http://www.rngr.fs.fed.us>

Figure 1

On the homepage (**Figure 1**), the site contains three sections: Reforestation, Nurseries, and Genetic Resources. Click on the Nurseries link and you will go to another page, which contains several sections:

Publications - This section contains links to PDF files of our many technology transfer publications:

Forest Nursery Notes - We're still uploading back issues.

The Container Tree Nursery Manual - As you scroll down the 6 issues, note that the cover graphic changes. By clicking on the link, you can download PDF files of each volume by section. There is also a link to order hard copies from the US Government Bookstore.

Tree Planters' Notes - We're still working on the format but you can view a sample issue by clicking on the arrow link. We hope to have past issues scanned and uploaded soon.

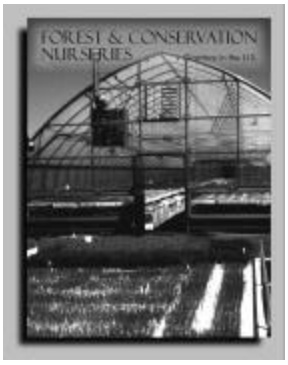
National Nursery Proceedings - Clicking on the arrow link will take you to a list of past proceedings from 1989 to 2001. We're still working on the presentations for 2000, but the other years contain PDF files of all the articles that were presented at the various meetings.

Tree Planting in the US - This section contains the latest version of this valuable report.

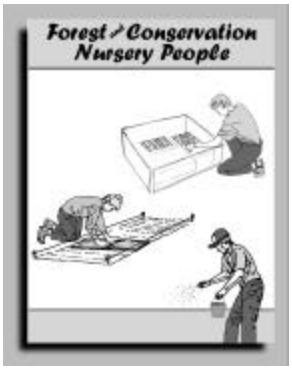
Native Plants Journal - This takes you to the new website where you can peruse issues and search for information on growing a wide variety of native plants in the Native Plants Network.

Forest Nursery Pests/Growing Healthy Seedlings - These valuable publications were out-of-print so we had them scanned and uploaded.

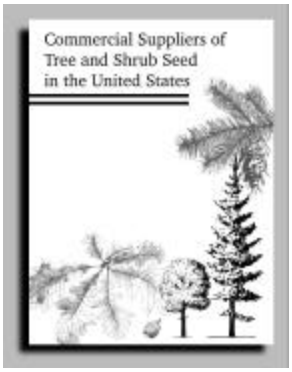
Directories—This section contains three directories that will help answer many questions:



Directory of Forest and Conservation Nurseries – This directory contains the latest addresses and production information for forest and conservation nurseries on a state-by-state basis. For those nurseries that have them, links to E-mail addresses and WWW home pages are also provided. Ownership category, type of nursery (container or bareroot), and current and potential seedling distribution are included. We are continuing to update this directory so contact us if your listing needs to be corrected. Over the last few months we sent out E-mails, Faxes and letters asking nurseries to update their listings. Many correspondents are interested in nursery production trends, so we would like to know your nursery production for the past 5 years if possible. If you have not received a letter and need to make changes to your listing, please Fax or E-mail the information to Rae Watson. See inside front cover for her phone, Fax and E-mail information.



Forest and Conservation Nursery People – This is a down-loadable MS Excel spreadsheet of people who work in the forest and conservation nursery field from around the world. It is composed of the mailing list for FNN so, if you'd like to be added to the directory or update your listing just fill out and return the Literature Order Form in the back of this issue.



Commercial Suppliers of Tree and Shrub Seed in the United States – This directory provides a list of vendors of tree and shrub seed for the US. The directory starts with some basic information on seed quality and then is followed by addresses and telephone and fax numbers. Services supplied by each vendor are also included along with an alphabetical list of all the tree and shrub seed sold in the US and common plant names. Again, much of this information is already out-of-date so please let us know if there are changes or additions.

Nursery Meetings

This section lists upcoming meetings and conferences that would be of interest to nursery, reforestation, and restoration personnel. Please send us any additions or corrections as soon as possible and we will get them into the next issue.

The International Union of Forest Research Organizations is planning to hold the **Fifth Meeting of the IUFRO Working Party S7.03.04 (Diseases and Insects in Forest Nurseries)** in the State of Kerala, India ***May 7 to May 9 2002*.** For questions and information please contact:

Stephen Fraedrich
USDA Forest Service
320 Green St.
Athens, GA 30602
TEL: 706.559.4273
FAX:706.559.4287
E-mail: sfraedrich@fs.fed.us

Dr. C. Mohanan
Division of Forest Pathology
Kerala Forest Research Institute
Peechi 680 653 Thrissur
E-mail: mohanan@kfri.org

A Joint Conference of the **Southern Forest Nursery Association & Northeastern Area Forest Nursery Association** will be held on ***July 15th to 18th, 2002*** at University of Florida Hotel and Conference Center in Gainesville, FL. The agenda is still being developed, but the focus topics will include: Controlling Nutsedge, Fumigation Alternatives, Pine and Hardwood Nursery Issues, and a "What's New" session. The meeting will also feature a tour of the Florida Division of Forestry Andrews Nursery in Chiefland. To receive registration information, contact Steve Gilly at:

Florida Division of Forestry
Andrews Nursery
P.O. Drawer 849
Chiefland, FL 32644-0849
TEL: 352.493.6096
FAX: 352.493.6084
E-mail: gillys@doacs.state.fl.us

The **Western Forest and Conservation Nursery Association (WFCNA)** will be meeting at the Westcoast Hotel in Olympia, WA on ***Aug. 5 to 8, 2002.*** On Monday, we are planning an optional field trip to Mount St. Helens restoration sites. The basic format for the next 3 days will be morning technical sessions followed by afternoon field trips. We will be visiting the Washington Dept. of Natural Resources Webster Nursery, the Weyerhaeuser Rochester Reforestation Center, and the Hood Canal Nursery. Contact Tom Landis for more details about the agenda or call the motel for reservations:

West Coast Hotel
2300 Evergreen Park Drive
Olympia, WA 98502
Res: 866.896.4000

Following the WFCNA meeting, the second annual meeting of the **Intertribal Nursery Council** will be held on Friday, ***August 9,2002*** at the West Coast Motel and Conference Center in Olympia, WA. This will be for "Tribal Members Only" but other interested people can sit in the back and observe. Contact Tom Landis for more information or call the motel for reservations:

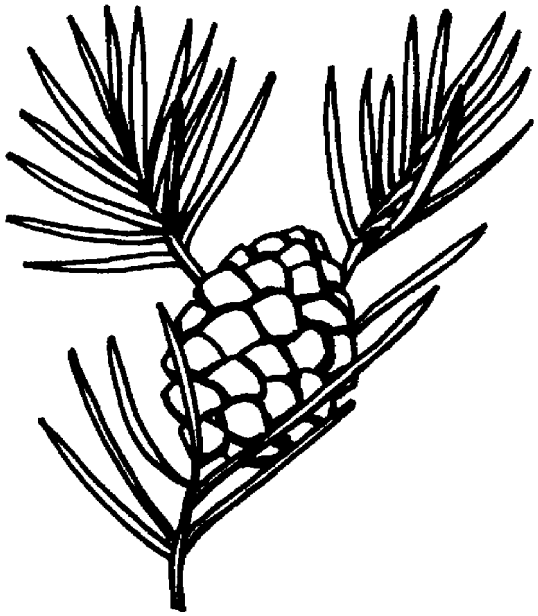
West Coast Hotel
2300 Evergreen Park Drive
Olympia, WA 98502
Res: 866.896.4000

The Twelfth Wildland Shrub Symposium: Seed and Soil Dynamics in Shrubland Ecosystems will be held at the University of Wyoming in Laramie, WY **August 12 to August 16, 2002.** Some of the session topics include seed production and industry issues, seed germination and plant propagation, soil surface and microsite ecology, and rare plant introductions. For those interested in presenting papers please email Ann Hild at annhild@uwyo.edu. Schedule and registration information is available online at:

<http://uwadmnsweb.uwyo.edu/renewableresources>

International Plant Propagators' Society (IPPS) meetings always cover a wide range of basic plant propagation concepts, techniques, and technologies, and are an excellent opportunity to expand your horticultural horizons. Currently, the Society has eight regions and one potential region. The IPPS home page (<http://www.ipps.org/>) contains a wealth of information on these meetings and how to join the organization. I heartily recommend it!

IPPS Region	**Date**	**Location**
Australian Region	May	Melbourne
Eastern Region, North America	Sept. 29-Oct. 2	Baltimore, MD (with SR)
Region of Great Britain & Ireland	Aug. 27 - 30	Southwest, Plymouth
New Zealand Region	Apr. 18-21	Timaru
IPPS Scandinavia	Early Sept.	To Be Determined
Southern Region, North America	Sept. 29-Oct. 2	Baltimore, MD (with ER)
Southern Africa Potential Region	March	To Be Determined



Cultural Perspectives

Micronutrients - Molybdenum

Molybdenum (Mo) is the sixth of the micronutrients that we have discussed in this series. It has the lowest average concentration in plant tissue - only 100 parts per billion (Table 1). Except for chlorine, molybdenum was the most recently recognized of the essential plant nutrients. The breakthrough came when molybdenum was found to be associated with "whiptail" disease of cauliflower and "yellow-spot" of citrus crops. However, the greatest response to molybdenum fertilization has been with pasture crops because of its stimulating effect on nitrogen fixing microorganisms.

Table 1 - The seven essential micronutrients and their typical concentrations in seedling tissue

Element	Symbol	Average Concentration in Plant Tissue (%)	Adequate Range in Seedling Tissue (ppm)		Where and When Published
			Bareroot	Container	
Iron	Fe	0.01	50 to 100	40 to 200	Forest Nursery Notes: July, 1997
Manganese	Mn	0.005	100 to 5,000	100 to 250	Forest Nursery Notes: January, 1998
Zinc	Zn	0.002	10 to 125	30 to 150	Forest Nursery Notes: July, 1998
Copper	Cu	0.0006	4 to 12	4 to 20	Tree Planters' Notes: 49 (3)
Molybdenum	**Mo**	**0.0001**	**0.05 to 0.25**	**0.25 to 5.00**	**This Issue**
Boron	B	0.002	10 to 100	20 to 100	Forest Nursery Notes: Summer 2001
Chloride	Cl	0.01	10 to 3,000	NA	To Do: Summer, 2002

Role in Plant Nutrition

Molybdenum functions as a metal component of several enzyme systems, and its value is attributable to its ability to undergo valence ("electrical charge") changes. The two enzymes utilizing molybdenum in higher plants are nitrate reductase and nitrogenase, and both facilitate nitrogen uptake.

Fertilizers supply nitrogen as either nitrate (NO_3^-) or ammonium (NH_4^+) ions or a mixture of both. Plants are able to take up both forms but incorporation into organic molecules within plants requires that the nitrogen be part of an ammonium (NH_4^+) ion. The conversion process from nitrate to ammonium is accomplished by the enzyme nitrate reductase. Molybdenum is necessary for the chemical reaction reducing nitrate ions to ammonium ions prior to their incorporation into functional and structural components such as amino acids, amides, chlorophyll, and others. The actual molybdenum requirement depends in part on the nitrogen supply. Nursery plants, which receive high levels of nitrogen fertilizer, will therefore have a higher demand for molybdenum. In general, for plant metabolism to proceed, only one molybdenum atom is required for every million nitrogen atoms. For this reason, this essential micronutrient is sometimes overlooked since trace amounts contained in soil, growing media, and applied fertilizers can often take care of minimum plant requirements.

The other enzyme, nitrogenase, allows legumes and other plants to fix atmospheric nitrogen (N_2). Hence, the root nodules of legumes, and those of non-leguminous nitrogen fixers such as alder, have a relatively high requirement for molybdenum. This requirement is reduced if adequate nitrogen is present in the soil or supplied from fertilization. Conversely, on molybdenum deficient soils, nitrogen fertilization of legumes and other nodule forming plants can be reduced or replaced by the application of molybdenum fertilizer combined with inoculations of the appropriate microorganisms.

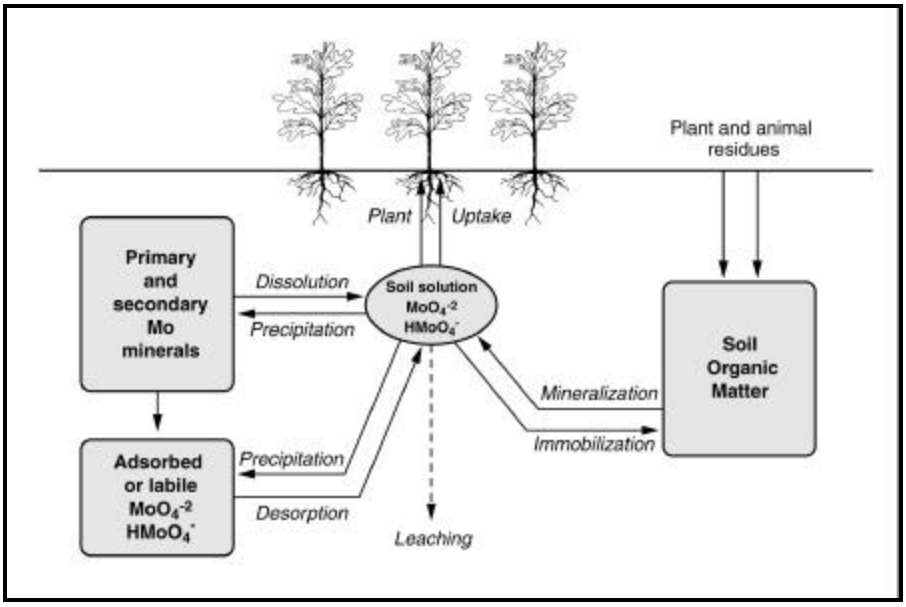


Figure 1

Although not as well documented as its role in nitrate reduction, molybdenum has other functions in higher plants. Molybdenum deficient plants typically have lower levels of sugars and ascorbic acid, and concentrations of some amino acids can be extremely low.

Availability and Uptake

The main sources of molybdenum to the soil solution include primary and secondary minerals, iron and aluminum oxides, and that held in soil organic matter (**Figure 1**). Because molybdenum ions are negatively charged, they are not tightly held in the cation exchange complex of soil particles. Therefore, molybdenum can be readily leached under high rainfall or irrigation conditions, similar to other anions such as phosphate and nitrate. Soils with low organic matter content are even more vulnerable to leaching because they possess fewer cation exchange sites.

Molybdenum is a non-ferrous metallic element, and is absorbed by plants as an anion (MoO_4^{2-}). In whole plant tissue, it is normally found in the range of 0.1 to 5.0 ppm on a dry weight basis (Table 1). Molybdenum is unique among the metallic trace elements in that its availability increases with increasing pH, unlike other nutrient elements such as iron and manganese. This would cause an impending molybdenum deficiency to materialize more quickly under acidic soil conditions, which is the case in most forest nursery soils and artificial growing media. Molybdenum is taken up by the roots in accordance with metabolic need. Since it moves readily in both the xylem and phloem, molybdenum is translocated within the plant.

There is an ongoing debate as to how much lower the requirement for molybdenum is when plants are supplied with nitrogen in the already reduced form of ammonium or urea. The fact remains that there will always be some requirement for molybdenum since nitrification ($NH_4^+ >>> NO_3^-$) occurs naturally in growing substrates, thus some nitrate will always be present.

Diagnosis of Deficiencies and Toxicities

Deficiency symptoms - Visible deficiency symptoms vary by plant species and the form of nitrogen fertilizer. Symptoms can develop in the foliage of nitrate fed plants below 1 ppm on a dry weight basis, but normally occurs within the range of 0.1 to 1.0 ppm. Because of molybdenum's importance to the uptake of nitrate fertilizers, the presence of elevated tissue nitrate levels can be used along with visual symptoms to help diagnose molybdenum deficiency. When deprived of molybdenum, legumes and other nitrogen fixing plants may display typical symptoms of nitrogen deficiency, including stunting and lack of vigor.

Plants supplied with both forms of nitrogen but operating under molybdenum deficient conditions display local necrosis and chlorosis of leaf tissue. Many agricultural crops exhibit drastic irregularities in leaf formation - a symptom called "whiptail" (**Figure 2**). Local chlorosis along leaf veins ("yellow spot" in citrus)

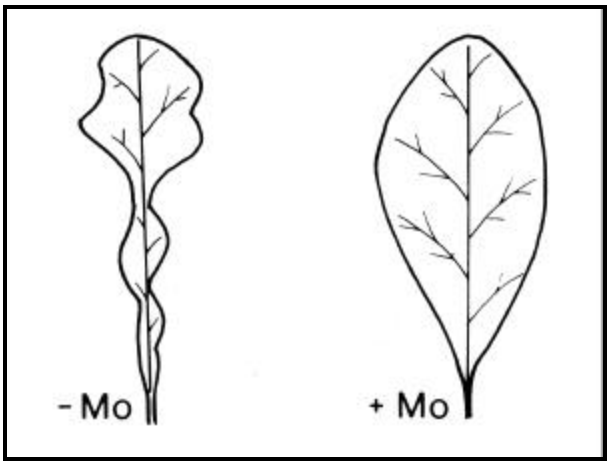


Figure 2

is another classic molybdenum deficiency symptom. This condition is not well known in forest and conservation crops. In some broadleaf tree seedlings, molybdenum deficiency causes scorching and burning of the leaf margins whereas in other species, the primary symptoms are interveinal chlorosis and necrosis. Nutrition trials with two conifer species showed no visual deficiency symptoms and only a slight stunting effect.

Toxicity symptoms - In agricultural species, toxicity symptoms take the form of leaf malformation and a golden yellow discoloration of shoot tissue. Instances of molybdenum toxicity have not been observed on forest and conservation plant species. Since there is a relatively large range between deficiency and toxicity levels, most plants are able to withstand tissue levels up to 1000 ppm of molybdenum.

Molydenum Management

Molybdenum deficiencies have never been reported in forests, and should not be a problem in forest and conservation nurseries. However, as always, prevention is the best management strategy.

Monitoring - Tissue testing is the best diagnostic tool since molybdenum deficiency can often go undetected or, in nitrogen fixing plants, be indistinguishable from nitrogen deficiency. The recommended foliar concentrations for molybdenum in forest and conservation species can vary from as little as 0.05 to 5 ppm (Table 1). Elevated tissue nitrate levels with visual symptoms can also help pinpoint molybdenum deficiency.

Soil Management - On acid soils, where a molybdenum deficiency could be expected, soil applications or seed

Table 2 - Some common fertilizers containing molydbenum (Mo)

Fertilizer	Chemical Notation	Mo (%)	Use in Nurseries
Single Nutrient Fertilizers			
Ammonium molybdate	$(NH_4)_6Mo_7O_{24}$ $2H_2O$	54	Foliar application
Sodium molybdate	NH_4MoO_4 $2H_2O$	39	Seed treatment
Molybdenum trioxide	MoO_3	66	Foliar application
Multinutrient Fertilizers			
Soluble Trace Element Mix— STEM®	Mo as Sodium molybdate	0.4	Foliar or soil applications
Micromax®	Mo as Sodium molybdate	0.1	Incorporation in growing media
Frits	Mo as Sodium molybdate	0.005 to 0.07	Only for soil applications
Plant-Prod® Chelated Micronutrient Mix	Mo as Sodium molybdate	0.06	Foliar or soil applications
Compound 111®	Mo as Sodium molybdate	0.025	Incorporation in growing media
Osmocote Plus®	Mo as Sodium molybdate	0.02	Incorporation in growing media

treatments may be warranted. The recommended soil application rates are very low, ranging from 0.5 to 5 oz of fertilizer per acre (35 to 350 g/ha). On acid soils, liming can increase the availability of molybdenum.

Fertilization - To our knowledge, molybdenum fertilization has never been required in bareroot nurseries. However, nurseries growing alder, locust, acacia or other nitrogen fixing plants should be aware of their greater molybdenum requirement. Where molybdenum deficiency has been confirmed, the most effective treatment is the application of a foliar spray using ammonium or sodium molybdate (Table 2).

Artificial growing media do not contain any molybdenum and so it must be included in the fertilization program. Based on blended fertilizers available on the market, container forest seedlings are receiving application rates ranging from 0.003 to 0.05 ppm on a constant basis (based on a 100 ppm nitrogen regime). It should be noted that some micronutrient fertilizer mixes do not contain any molybdenum so always check the technical grade analysis on the bag or call the supplier if there is any question. Pelletizing lupine tree seed with molybdenum oxide has been an effective treatment for curing deficiencies in New Zealand.

Conclusions and Recommendations

Molybdenum deficiencies should not be a problem in forest and conservation nurseries, especially as long as good soil management is practiced. Maintenance of soil pH is particularly critical. Because of its importance of molybdenum to nitrogen fixation, nurseries growing leguminous plants should be especially watchful. A regular program of tissue analysis should detect any problems and deficiencies can be easily cured with fertilizers.

Acknowledgment - Eric van Steenis of the British Columbia Ministry of Forests assisted with the writing of this article and his help is gratefully acknowledged.

Sources:

Johnson, C.M. 1965. Chapter 20 - Molybdenum. IN: Chapman, H.D. Diagnostic criteria for plants and soils. Riverside, CA: Homer D. Chapman: 286-297.

Handreck, K.A. Black, N.D. 1994. Growing Media for Ornamental Plants and Turf. Randwick, NSW. Australia: University of New South Wales Press.

Havlin, J.L.; Beaton, J.D.; Tisdale, S.L.; Werner, L.N. 1999. Soil fertility and fertilizers. New Jersey: Prentice-Hall, Inc. 499 p.

Marschner, H. 1986. Mineral nutrition of higher plants. San Diego, CA: Academic Press, Inc.

The International Molybdenum Association (IMOA). Website: <www.imoa.org.uk>

Stone, E.L. Microelement nutrition of forest trees: a review. 1968. IN: Forest Fertilization: Theory and Practice. Muscle Shoals, AL: Tennessee Valley Authority, National Fertilizer Development Center: 132-175.

Van den Driessche, R. 1989. Nutrient deficiency symptoms in container-grown Douglas-fir and white spruce seedlings. FRDA Report 100. Victoria, BC: B. C. Ministry of Forests. 29 p.

Western Fertilizer Handbook, Seventh Edition, 1985. California Fertilizer Association, 701-12th Street, Sacramento, California 95814.

Will, G. M. 1990. Influence of trace-element deficiencies on plantation forestry in New Zealand. Forest Ecology and Management 37 (1-3): 1-6.

Types of Overwinter Injury

Winter has arrived, and so it is time to start thinking about protecting your precious seedlings from overwinter injury. As you know, the weather has really been erratic over the past decade and that big "blue norther" could be just around the corner.

Before you can properly protect seedlings, however, you should have a good understanding of the different types of overwinter injury. Some authors distinguish many different types of cold injury, including some that are not prevalent in forest nurseries, such as frost smothering and frost cankers. I consider only three types of cold weather injury to be significant: cold injury, winter drying, and frost heaving. Although the types are listed separately, seedlings are often damaged by a combination of cold temperature stresses.

Table 1 - Comparison of three types of overwinter injury in nurseries

	Caused By	Symptoms	Related to Seedling Hardiness or Dormancy	Stock Types Affected BR= Bareroot C= Container
Cold Injury	Unseasonably cold air temperatures	Meristems most affected: shoot tips, cambium, roots	Yes	BR & C
Winter Burn	Frozen soils and drying winds	Exposed foliage affected	No	BR & C, especially small plants
Frost Heaving	Repeated soil freezing and thawing	Root system exposed and seedling toppling	No	BR, especially small seedlings and transplants

1. Cold injury. This category concerns injuries caused by direct freezing of seedling tissue. When seedlings are actively growing, cold damage rarely occurs until the temperature of plant tissues reaches approximately 30 ^{o}F (- 1 ^{o}C). At lower temperatures, however, the degree of cold injury depends on the hardiness of the different seedling tissues. *Cold injury is directly related to seedling dormancy and cold hardiness* (Table 1).

Hosts - All species are susceptible to cold injury when succulent, but species and seed sources from low elevations, coastal areas, and southern latitudes are particularly vulnerable.

Symptoms/Damage - Foliar cold injury is initially expressed as pale, water-soaked tissue that eventually turns from straw-colored to brown or bright red, depending on the seedling species and degree of injury. Symptoms develop relatively quickly after exposure to freezing temperatures, usually within a couple of weeks, and meristematic tissues such as shoot tips show damage first (Table 1). This characteristic helps distinguish cold injury from winter desiccation, which usually affects all exposed foliage and develops over a longer time period. Buds can sometimes be killed by frosts that do not injure hardier foliage. The most insidious form of cold injury is cambial damage, which can easily be overlooked because the bark must be removed to expose the symptoms. Cold-damaged cambial tissue turns varying shades of brown within a few days, and this damage may occur in intermittent patches along the stem. Roots are particularly susceptible to cold injury because they do not harden as much as the shoots - this is crucially important for container seedlings that are stored outside.

Pattern of injury - Cold injury can develop from a single frost event or during an extended period of cold weather. Damage is most common in the fall or early spring, when seedlings are entering or coming out of dormancy. Some species show wide individual variation in cold tolerance, and so damage can be scattered. Symptom expression may be delayed during an extended period of cold weather but can be accelerated by bringing the seedlings into a warm environment. Cambial or root injury may be expressed as delayed bud break or foliar

wilting after the seedlings are returned to a growth-promoting environment. wilting after the seedlings are returned to a growth-promoting environment.

Management - Losses to cold injury can be significantly reduced by carefully planned and executed cultural practices:

- Only raise species and seed sources that are adapted to the local environment, especially in bareroot nurseries. Exotics will require special handling and protection.
- Develop growing schedules that include an adequate hardening period. Late summer applications of nitrogen fertilizer and heavy irrigation prolong seedling succulence, whereas moderate nutrient and drought stressing promote hardening.
- Avoid moving container seedlings out of enclosed growing structures until they are adequately cold hardy or all danger of frost has passed.
- Utilize thermal mass to protect seedling roots by grouping container stock on the ground with some sort of insulating material around the perimeter.
- Protect non-hardy seedlings with irrigation (**Figure 1**), supplemental heat, or protective coverings.
- Monitor seedling hardiness with cold hardiness tests to determine when frost protection should begin.

Figure 1—Frost protection with irrigation can be effective, but the weight of ice and oversaturated soils can cause problems.

2. Winter drying. This type of damage is actually desiccation injury, which occurs whenever seedlings are exposed to drying conditions, generally wind or direct sunlight. Damage is most severe when the soil or growing medium remains frozen for extended periods while the foliage is still losing water through transpiration. Seedlings can even become desiccated when they are stored under refrigeration without proper packaging. *Winter drying is not directly related to seedling dormancy or cold hardiness* (Table 1).

Hosts - Conifer seedlings are most susceptible, although hardwoods can become damaged in extreme circumstances. Container seedlings are more susceptible than bareroot stock, because of the limited amount of moisture reserves in small containers (Table 1).

Symptoms/Damage - Winter drying is sometimes referred to as "winter burn" because affected foliage often turns bright red and appears scorched. All exposed foliage is susceptible, but generally the needle tips are most commonly injured; buds within symptomatic foliage may not be damaged and generally produce normal shoots after outplanting. Tip dieback or even seedling mortality can occur in extreme cases. Winter drying can be distinguished from cold injury by foliage color and timing of symptom expression.

Pattern of injury - Winter drying is slower to develop than cold injury, usually requiring weeks rather than days. Desiccation is most severe wherever seedling foliage is exposed to direct sunlight or drying winds, and so bareroot seedlings on the south side of the seedbed are most at risk. Container seedlings that are exposed around the perimeter of the storage area are often severely damaged, especially when the root systems are not properly insulated. In areas with snow cover, shoots that protrude above the snow often show winter burn.

Management - Preventative cultural practices and protective structures can reduce winter drying losses:

- Protect seedlings from direct exposure to sun and wind with sheltering structures. Container seedlings should be stored in a shadehouse, and bareroot stock can be protected with windbreaks or shade frames.
- Orient windbreaks perpendicular to prevailing winter wind, and shade seedlings if possible. Of course, the most effective protection is refrigerated storage as long as the storage containers contain a moisture barrier.
- Cover seedling foliage with mulches or sheeting material, but these must be removed in the early spring to prevent heat buildup or mold damage to covered seedlings. Complete snow cover provides an ideal type of protection; some nurseries have had success with snow- making equipment.
- If possible, irrigate seedlings during periods of mild mid-winter weather.
- Anti-desiccant foliar sprays may provide some degree of protection, but more tests are needed.

3. Frost heaving. This third type of cold damage is

unique to bareroot seedlings and transplants, in particular (Table 1). Frost heaving is a purely mechanical phenomenon that results from repeated freezing and thawing of the soil surface.

Hosts - Small first-year seedlings and newly established transplants are most susceptible, especially plug+one stock. Slow growing species, such as spruces and true firs, and seedlings with a shallow root system are particularly vulnerable (Table 1).

Symptoms/Damage - Frost-heaved seedlings appear to have been pulled from the soil, and often have fallen over on the soil surface with the upper part of the root system exposed. Seedling foliage usually appears desiccated.

Pattern of injury - Damage can occur at any time during the winter, but is particularly severe when the ground surface is exposed during periods of alternately warm and cold weather. Due to the repetitive nature of the frost heaving action, the degree of injury is a function of the exposure period, but eventually seedlings are lifted out of the ground and topple over. Damage often occurs in patches and is most common in wet, fine-textured soils.

Management - Prevention is the only management option as seedlings that have been even partially heaved will not develop normally.

- Seedling growing schedules should encourage root growth on small first-year seedlings.
- Select coarse-textured, well-drained soils and level before forming seedbeds; raised beds are recommended.
- Schedule root wrenching or undercutting to allow adequate time for new root establishment before winter.
- Use thick mulches, shade frames, or fabric coverings to insulate seedbeds and to reduce frost action.

Equipment, Products, and Services

The Long Tube Stocktype and Expandable Stinger

Nurseries are growing larger and larger stock for restoration projects. The size and shape of containers have evolved from the short, round 1-gallon containers to containers that are much deeper and narrower. While longer containers offer greater survival and growth potential, the biggest drawback is the difficulty and high costs of outplanting. These limitations can be overcome with the use of the long tube stocktype and the expandable stinger.

The Long Tube Stocktype

Long tubes consist of a 3 inch (7.6 cm) PVC pipe that is lined with Vexar® tubing (Figure 1). The pipe can be cut to any length, depending on the species growth habits, soils and climate of the outplanting site and project objectives. Typically, long tube containers are cut at 6 inch (15cm) increments, 12, 18, and 24 (30, 46, 61 cm). A 24 inch (61 cm) long tube is comparable in volume to a one-gallon container. Vexar tubing is cut to lengths longer than the PVC pipe to allow at least 3 inches (7.6cm) or more netting to extend above the pipe. The extended netting can either be folded down over the pipe or kept upright for protections from browsing. Vexar tubing is specially ordered from the manufacturer to be made of biodegradable plastic so that it will breakdown in the soil after outplanting.

Figure 1

Advantages of the Long Tube

1. Greater root depth - From late spring to early fall, rainfall is low for much of the Western United States and most soils dry out by mid summer. After outplanting, long tube seedlings have the advantage of beginning root growth at much deeper soil depths during the first growing season. This allows roots greater access to either the water table or soil levels with higher moisture contents.

2. High root surface area - Long tubes have a high root surface area, which can be an advantage to early seedling establishment. Comparing the 24-inch (61 cm) long tube to other one-gallon (3,785 cm^3) containers, the long tube has twice the root surface area as the round one-gallon (3,785 cm^3) container and a third more than the "Tall One" Treepot™ container. This greater surface area creates more root-soil contact, resulting in potentially greater root egress into the native soil during initial establishment.

3. Easy to extract - The original reason for placing Vexar netting within the PVC pipe was to protect roots and stem from animal damage. A more important reason for using this material is because it holds the growing media together to allow easy and complete extraction without damage to the seedling. Seedlings would be hard to extract from the long tubes because of their weight and the high surface area. Without the Vexar, seedlings would have to be pulled from their container by the stem, which can result in physical injury. With long tube containers, this stress is eliminated because seedlings are extracted by pulling the Vexar netting.

This makes it possible to extract long tube seedlings at any time. Most container seedlings can only be extracted late in the growing season after a firm root plug has developed. Unfortunately, this firm root plug often becomes root-bound and prevents good root egress after outplanting. The netting in the long tube gives the client a greater outplanting window and more flexibility in planning.

4. Eliminates root spiraling - The Vexar lining in the long tube also has another benefit. In round containers with smooth walls, roots grow in a spiral pattern. However, in long tubes, new roots follow the diamond-shaped pattern of the Vexar to the bottom of the container where they are air-pruned. This effectively prevents root spiraling and results in a better root system after outplanting.

Figure 2

The Expandable Stinger

Although long tube seedlings less than 24 inches (61 cm) can be planted by shovel or power auger on soils that are low in rock fragments, these soil types are rarely found in the mountainous terrain of the Western States. Recently, a planting device called the expandable stinger (US Patent 6,158,362 with additional patents pending) was invented to plant long tube seedlings or non-rooted cuttings of *Salix* and *Populus* in soils with high rock content. Attached to the arm of an excavator (**Figure 2**), the expandable stinger is hydraulically operated and can plant seedlings or cuttings on any soil type or slope gradient. The expandable stinger is composed of two parallel steel shafts, which are narrowed to a point at the end to form a "beak". The shafts are hinged in the middle so that they open and close in a scissor-like manner. Each half of the beak is formed to create a long hollow chamber in the middle when they are closed. On the outplanting site, a long tube seedling or non-rooted cutting is inserted into the beak. The expandable stinger is then maneuvered to the planting spot, where the beak is inserted into the soil (**Figure 3A**). The beak is opened allowing the seedling to drop to the bottom of the created hole (**Figure 3B**). While the beak is open, the stinger is lifted from the soil leaving the seedling in place (**Figure 3C**). On sandy or coarse textured soils, the sides of the hole will collapse on the plug, forming a good soil contact. Other soil types and soil conditions might require manually tamping the soil around the plug. Ideally, long tube containers are planted several inches below ground line (**Figure 3C**).

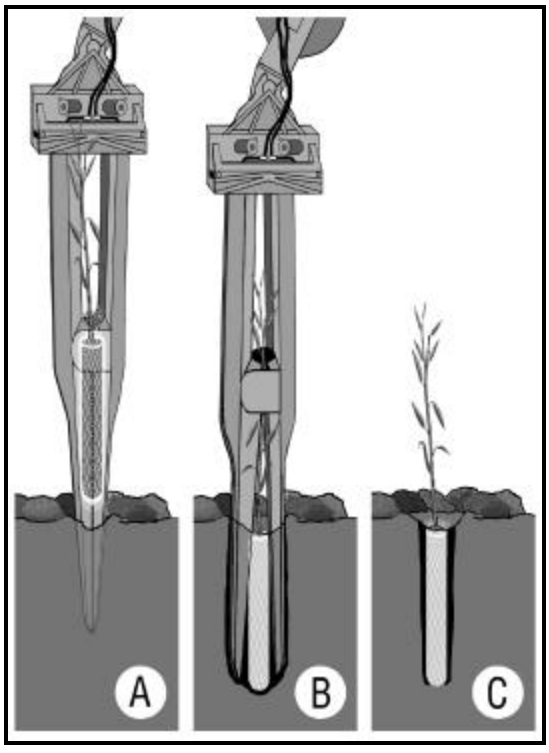


Figure 3

The expandable stinger can plant seedlings and non-rooted cuttings at a rate of one to five per minute depending on planting density, soil type, site accessibility and degree of planning. Generally, planting rates decrease on rocky soils and steeper slopes and increase where planting densities are high and travel time from one planting area to another is minimal. Having a supply of seedlings or cuttings at the site and ready for planting increases efficiency. However, this can be a challenge due to the large size and weight of these containers. Due to the inaccessibility of many sites to trucks, other methods of seedling transportation have been developed such as using a trailer attached to an all terrain vehicle.

Applications and Limitations

The long tube stocktype and the expandable stinger increase the possibilities for restoring severely disturbed sites such as gravel bars along streams, steep road cut and fill slopes, decommissioned roads, and mining spoils. The expandable stinger is restricted to those sites accessible to an excavator. The main limitation is the steepness of slope, which for safe operation, is less than 40 percent slope gradient. The size of the excavator also determines the planting radius. Smaller excavators can reach 25 feet (7.6m) while the larger machines extend planting to a 50-foot (15.2m) radius. A potential limitation to the long tube is the decomposition rate of the Vexar tubing. Although the tubing is composed of biodegradable plastic, it is unclear how fast this material breaks down in different soil types and moisture regimes.

For more information about the expandable stinger, please contact Dan Culley at 509-382-4824 or contact him at daytrac@hscis.net.

Effectiveness of Commercially Available Deer Repellents

Animal browsing is a serious problem in many forest and conservation nurseries and seems to be getting worse each year. Deer are a particularly serious pest. We presented some information on chemical repellents in the July 2000 issue of FNN, but actual data on feeding damage was unavailable.

A recent publication by the Missoula Technology and Development Center evaluates 20 commercially available deer repellents. (See #113 in New Nursery Literature Section). Western red cedar (*Thuja plicata*) seedlings, a preferred browse species, were planted in fenced pastures at the Olympia, WA Field Station of the USDA Animal and Plant Health Inspection Service, Wildlife Service National Wildlife Research Center. Seedlings were planted in the winter of 1999 and immediately treated with deer repellents. Five or six captive black-tailed deer were then brought in for taste testing! For 18 weeks thereafter, seedlings were assessed weekly for the number of deer bites taken out of each seedling. The maximum number of bites a seedling could sustain before it was considered defoliated was twenty-five.

Table 1 – Effectiveness of chemical repellents for reducing black-tailed deer damage to western red cedar seedlings during the winter

Product	Manufacturer	Active Ingredient
Most Effective		
Bye Deer	Security Products Co., Phoenix, AZ	Sodium salts of mixed fatty acids
Deerbuster's Deer Repellent Sachets	Trident Enterprises, Frederick, MD	Meat meal & red pepper
Get Away Deer and Rabbit Repellent	DRR, IntAgra, Inc., Minneapolis, MN	Capsaicin & isothiocynate
Deer Away Big Game Repellent Powder	IntAgra, Inc., Minneapolis, MN	Putrescent whole egg solids
Moderately Effective		
Deer Away Big Game Repellent Spray	IntAgra, Inc., Minneapolis, MN	Putrescent whole egg solids
Plantskydd	Tree World, Lackawanna, NY	Edible animal protein
Deer Stopper	Landscape Plus, Chester, NJ	Thiram, capsaicin, egg solids
Tree Guard	Nortech Forest Technologies, Inc., St. Paul, MN	Denatonium benzoate
Not Tonight Deer	Not Tonight Deer, Mendocino, CA	Dehydrated whole egg solids, Montock pepper
Deerburster's Coyote Urine Sachet	Trident Enterprises, Frederick, MD	Coyote urine
N.I.M.B.Y	DMX Industries, St. Louis, MO	Capsaicin and capsaicinoid product, castor oil
Dr. T's Deer Blocker	Dr. T's Nature Products, Inc., Pelham, GA	Putrescent whole eggs, capsaicin, garlic
Least Effective		
Hot Sauce	Miller Chemical and Fertilizer Corp. Hanover, PA	Capsaicin and related compounds
Plant Pro-Tec	Plant Pro-tec, LLC, Palo Cedro, CA	Oil of garlic, capsaicin
Detour	Sudbury Consumer Products Co., Phoenix, AZ	Thiram
Hinder	Pace International LP. Kirkland	Ammonium soaps of higher fatty acids
Wolfin	Pro Cell Bioteknik, Horefors, Sweden	Di (N-alkyl)sulfides
Deerburster's Deer and Insect Repellent	Trident Enterprises, Frederick, MD	Garlic juice
Ropel	Burlington Scientific Corp., Farminton, NY	Denatonium bensozate, thymol
Orange TKO	TKO Industries, Calgary, Alberta, Canada	D-limonene

The results indicate that the most effective repellents are those that emit sulfurous odors such as egg or slaughterhouse waste (Table 1). Repellents that use bittering agents to repel have proven ineffective while those containing active ingredients causing pain or irritation are probably not at concentrations high enough to be effective.

The most effective products generally eliminate browsing for a month and can provide good protection for 2 to 3 months, but their effectiveness can be expected to decline significantly after 3 to 4 months (**Figure 1**).

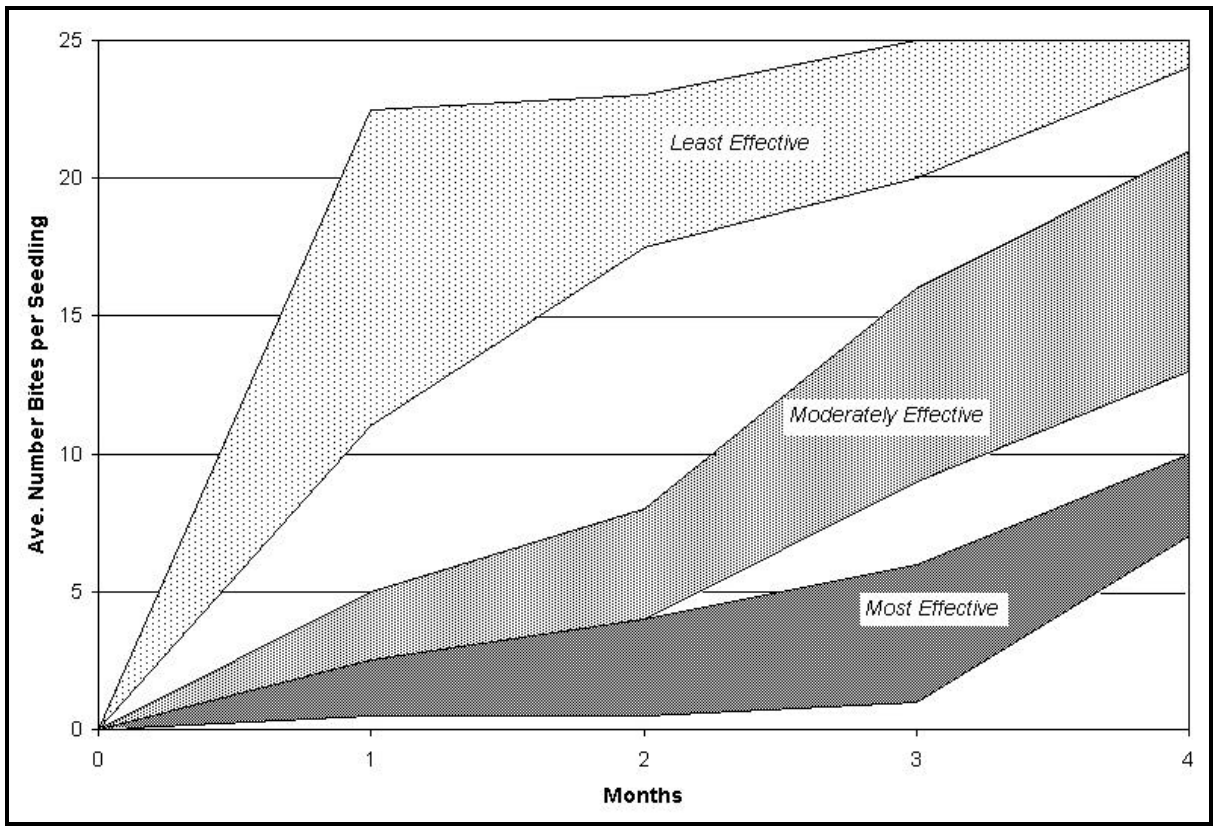


Figure 1 – Duration of protection for three categories of deer repellent chemicals during the winter (See Table 1 for repellents in each category.) Graph adapted from Trent, Nolte and Wagner, 2001

This study was conducted again in the spring 1999, but *none of the repellents provided complete protection after the first month*. This second test emphasizes that the efficacy of chemical repellents can change with the season, so growers should also consider other controls such as fencing or netting.

Summary

If you decide to use a game repellent, their effectiveness depends on other factors and especially the season. Several repellents were effective for up to 3 months during the winter but none provided extended protection during the spring. The most effective game repellent in both winter and spring testing was the Deer Away Big Game Repellent Powder. Other factors including deer population density, palatability of species, weather conditions, and availability of alternative food sources must also be considered. Under extreme deer predation, other IPM strategies including exclusion fencing and netting might be a more effective option.

Sources

Trent, A., Nolte, D., and Wagner, K. Comparison of Commercial Deer Repellents. 2001. Tech Tip 0124-2331-MTDC. USDA Forest Service, Technology & Development Program, Missoula Technology and Development Center. 6p.

Horticultural Humor

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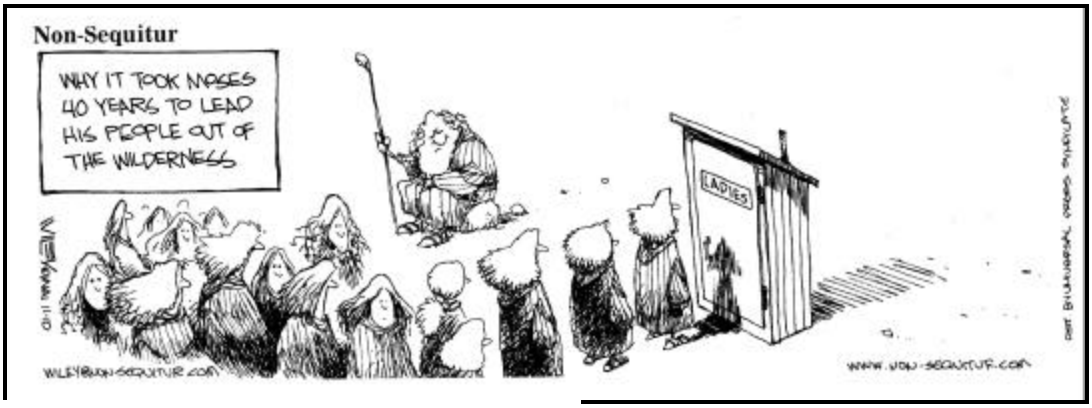

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Bareroot Production

1. Bareroot stock production. Mohammed, G. H.; McLeod, G. R.; Menes, P. A.; Timmer, V. R. IN: Regenerating the Canadian forest: principles and practice for Ontario, p. 265-279. R.G. Wagner and S.J. Colombo, eds. Ontario Ministry of Natural Resources and Fitzhenry & Whiteside Ltd. 2001.

2. © Survival and growth of *Fagus sylvatica* seedlings root-pruned prior to transplanting under competitive conditions. Andersen, L. Scandinavian Journal of Forest Research 16(4):318-323. 2001.

Business Management

3. Electronic nursery solutions: high-tech companies are designing more tools for growers. Rodda, K. Nursery Management and Production 17(6):41-42, 44-46. 2001.

4. © Nursery builds a composting division. Farrell, M. BioCycle 42(7):34-36. 2001. At Weston Nurseries in Massachusetts, composting has evolved from a side venture to a serious part of the business.

5. © Nursery shifts from growing plants to composting. BioCycle 40(9):33-34. 2001. New York State firm mixes food residuals with other organic material to make compost.

Container Production

Diverse Species

6. Container stock production. Odlum, K.; Scarratt, J.; Timmer, V.; Duckett, S.; Ross-Slomke, P. IN: Regenerating the Canadian forest: principles and practice for Ontario, p. 281-306. R.G. Wagner and S.J. Colombo, eds. Ontario Ministry of Natural Resources and Fitzhenry & Whiteside Ltd. 2001.

7. Fiber pots with Spin Out for nursery crop production. Ruter, J. M. International Plant Propagators' Society, combined proceedings 2000, 50:509-512. 2001.

8. Geotropic lateral roots of container-grown longleaf pine seedlings. South, D. B.; Shelton, J.; Enebak, S. A. Native Plants Journal 2(2):126-130. 2001.

9. Pots past and future. Appleton, B. Nursery Management and Production 17(10):71-76. 2001. Containers now provide more functions than holding media and roots.

10. Raising forest seedlings in Vietnam: current status. Tsurumi, K.; Daido, T.; Shibata, M. International Plant Propagators' Society, combined proceedings 2000, 50:671-674. 2001.

11. Routines for quality production of forest plants in container trays. Andersen, M. N. International Plant Propagators' Society, combined proceedings 2000, 50:246-248. 2001.

12. Start seedlings right. Whitcomb, C. Nursery Management and Production 17(8):70-71. 2001. Root pruning will increase horizontal roots and vastly improve crops.

13. Tackling container handling. Landicho, S. American Nurseryman 193(9):32-36. 2001. New technology for transporting pots offers growers ways to automate this labor intensive task.

14. Update on fiber pot research at Penn State: the Plantable Pot. Beattie, D. J.; Berghage, R.; Day, D. International Plant Propagators' Society, combined proceedings 2000, 50:445-447. 2001.

15. © Acceleration of frost hardening in *Vaccinium vitis-idaea* by nitrogen fertilization. Taulavuori, K.; Taulavuori, E.; Niinimaa, A.; Laine, K. Oecologia 127 (3):321-323. 2001.

16. Can seed treatments improve germination of rare salt marsh species? Kreiberg, P. International Plant Propagators' Society, combined proceedings 2000, 50:583-584. 2001.

17. Cold stratification delays germination of black huckleberry seeds. Barney, D. L.; Shafii, B.; Price, W. J. HortScience 36(4):813. 2001.

18. Container stock versus direct seeding for woody species in restoration sites. Young, T. P.; Evans, R. Y. International Plant Propagators' Society, combined proceedings 2000, 50:577-582. 2001.

19. Drying and cold storage affect germination of black huckleberry seeds. Shafii, B.; Barney, D. L. HortScience 36(1):145-147. 2001.

20. © The effect of seed scarification and soil-media on germination, growth, storage, and survival of seedlings of five species of *Prosopis* L. (Mimosaceae). Vilela, A. E.; Ravetta, D. A. Journal of Arid Environments 48(2):171-184. 2001.

21. Equipment modifications for harvesting fluffy seeds. Kujawski, J.; Englert, J.; Dusty, D.; Ugiansky, R. J. Native Plants Journal 2(2):114-115. 2001.

22. Germination improvement of *Atriplex nummularia* (Chenopodiaceae) by pericarp elimination. Peluc, S. I.; Parera, C. A. Seed Science and Technology 28(3):559-566. 2000.

23. © Germination of dimorphic seeds of *Suaeda moquinii* under high salinity stress. Khan, M. A.; Gul, B.; Weber, D. J. Australian Journal of Botany 49(2):185-192. 2001.

24. Germination requirements of seeds of *Helianthus paradoxus* (Asteraceae). Van Auken, O. W. Texas Journal of Science 53(2):157-170. 2001.

25. Glacier Point restoration project. Chandler, A. F. International Plant Propagators' Society, combined proceedings 2000, 50:585-588. 2001.

26. Influence of misting interval and hormone concentration for propagation of native azaleas. File, S. L.; Knight, P. R.; Brzuszek, R. F. International Plant Propagators' Society, combined proceedings 2000, 50:546-550. 2001.

27. © Methods to overcome seed dormancy in *Echinacea angustifolia* DC. Macchia, M.; Angelini, L. G.; Ceccarini, L. Scientia Horticulturae 89(4):317-324. 2001.

28. Niche marketing of native plants. Niemeyer, D. P. International Plant Propagators' Society, combined proceedings 2000, 50:281-284. 2001.

29. Preliminary study shows that cold, moist stratification increases germination of 2 native *Illicium* species. Olsen, R. T.; Ruter, J. M. Native Plants Journal 2(2):79-83. 2001.

30. Propagation of pawpaw (*Asimina triloba*). Finneseth, C.; Kester, S.; Geneve, R.; Pomper, K.; Layne, D. International Plant Propagators' Society, combined proceedings 2000, 50:413-416. 2001.

31. Propagation protocol for *Astragalus bibullatus*. McCue, K.; Belt, E.; Yurlina, M. Native Plants Journal 2 (2):131-132. 2001.

32. Propagation protocol for Devil's Club (*Oplopanax horridus*). Luna, T. Native Plants Journal 2(2):106-108. 2001.

33. Propagation protocol for poison oak (*Toxicodendron diversilobum*). Evans, M. Native Plants Journal 2(2):108-109. 2001.

34. Propagation protocol for poison sumac (*Toxicodendron vernix*). Kujawski, J. Native Plants Journal 2(2):112-113. 2001.

35. Propagation protocol for stinging nettle (*Urtica dioica*). Luna, T. Native Plants Journal 2(2):110-111. 2001.

36. © Respiration in dormant and non-dormant bitterbrush seeds. Booth, D. T.; Sowa, S. Journal of Arid Environments 48(1):35-39. 2001.

37. © Restoration of wet fen meadows by topsoil removal: vegetation development and germination biology of fen species. Patzelt, A.; Wild, U.; Pfadenhauer, J. Restoration Ecology 9(2):127-136. 2001.

38. Rooting pinkroot... then keeping them alive. Bir, R. E. International Plant Propagators' Society, combined proceedings 2000, 50:372-373. 2001.

39. © Seed dormancy in bay laurel (*Laurus nobilis* L.). Takos, I. A. New Forests 21(2):105-114. 2001.

40. Vegetative propagation and production of *Ceratiola ericoides* Michx. for use in restoration. Thetford, M.; Miller, D.; Penniman, P. Native Plants Journal 2(2):116-125. 2001.

SO. Native woody plant seed collection guide. Banerjee, S. M.; Creasey, K.; Gertzen, D. D. British Columbia Ministry of Forests. 146 p. 2001. After some basic information on monitoring and forecasting seed crops, collection, and field storage and transportation, the guide lists species alphabetically. For each, 4 color photos show the flowering, forecasting, collecting, and seed stages, along with matching descriptions. ORDER FROM: Crown Publications, Inc. 521 Fort Street, Victoria, BC Canada V8W 1E7. Phone (250) 386-4636. http://www.crownpub.bc.ca/ Price: $29.95 Cdn. + S&H.

41. Availability of phosphorus to nursery plants. Thomas, M. B.; Spurway, M. I.; Adams, J. A. International Plant Propagators' Society, combined proceedings 2000, 50:49-54. 2001.

42. Chemical injectors made easy. Pennisi, B. V.; van Iersel, M. Greenhouse Management and Production 21 (9):45-50. 2001. Injectors are used to apply water-soluble fertilizers, pesticides, plant growth regulators, wetting agents and mineral acids.

43. CRFs: releasing quality crops. Pilon, P. Greenhouse Grower 19(12):36, 38, 40, 43. 2001. Understanding the formulations and methods of release will simplify your use of controlled release fertilizers in container production.

44. © Fertiliser use efficiency by containerised nursery plants. 1. Plant growth and nutrient uptake. Huett, D. O. Australian Journal of Agricultural Research 48:251-258. 1997.

45. © Fertiliser use efficiency by containerised nursery plants. 2. Nutrient leaching. Huett, D. O. Australian Journal of Agricultural Research 48:259-265. 1997.

46. © Fertilization practice in Finnish forest nurseries from the standpoint of environmental impact. Juntunen, M. L.; Rikala, R. New Forests 21 (2):141-158. 2001.

47. Good nutrition. Hambling, B.; Fung, M.; Kernaghan, G.; Khasa, D. American Nurseryman 193 (6):52-53. 2001. Growers can rely on semihydroponics to monitor plants' nutrient needs and assess other factors, such as optimal pH and salinity.

48. © Growth and nitrogen retranslocation of nutrient loaded *Picea mariana* seedlings planted on boreal mixedwood sites. Imo, M.; Timmer, V. R. Canadian Journal of Forest Research 31(8):1357-1366. 2001.

49. © Growth dynamics and mycorrhizas of Norway spruce (*Picea abies*) seedling in relation to boron supply. Mottonen, M.; Lehto, T.; Aphalo, P. J. Trees 15 (6):319-326. 2001.

50. © Hardwood seedling root and nutrient parameters for a model of nutrient uptake. Kelly, J. M.; Scarbrough, J. D.; Mays, P. A. Journal of Environmental Quality 30(2):427-439. 2001.

51. © The importance of early season phosphorus nutrition. Grant, C. A.; Flaten, D. N.; Tomasiewicz, D. J.; Sheppard, S. C. Canadian Journal of Plant Science 81 (2):211-224. 2001.

52. © Longevities and nitrogen, phosphorus, and potassium release patterns of polymer-coated controlled-release fertilizers at 30 degrees C and 40 degrees C. Huett, D. O.; Gogel, B. J. Communications in Soil Science and Plant Analysis 31(7-8):959-973. 2000.

53. No excess copper here. Ledford, D. Nursery Management and Production 17(9):61-62, 66. 2001. How one North Carolina grower eased his fears with soil tests.

54. © Nutrient retranslocation response of *Picea mariana* seedlings to nitrogen supply. Salifu, K. F.; Timmer, V. R. Soil Science Society of American Journal 65(3):905-913. 2001.

55. © Response of *Quercus petraea* seedlings to nitrogen fertilization. Berger, T. W.; Glatzel, G. Forest Ecology and Management 149(1-3):1-14. 2001.

56. © Responses of *Populus tremuloides* seedlings to solution pH and calcium. Lu, E. Y.; Sucoff, E. I. Journal of Plant Nutrition 24(1):15-28. 2001.

57. © Responses of quaking aspen (*Populus tremuloides*) seedlings to solution calcium. Lu, E. Y.; Sucoff, E. I. Canadian Journal of Forest Research 31 (1):123-131. 2001.

General and Miscellaneous

58. © Conservation of natural ecosystems of poplar and willow. de Vries, S. M. G. Forestry Chronicle 77 (2):255-257. 2001. Specifically concerned with riparian ecosystems.

59. Get the facts: how to conduct accurate in-house trials and research. Mathers, H. Nursery Management and Production 17(7):69-72, 74-75. 2001.

60. © Poplars: trees of the people, trees of the future. Gordon, J. C. Forestry Chronicle 77(2):217-219. 2001.

61. The provenance and production of Scottish broadleaved trees. Thompson, S. International Plant Propagators' Society, combined proceedings 2000, 50:155-161. 2001.

62. © The role of forest plantations in the world's future timber supply. Sedjo, R. A. Forestry Chronicle 77(2):221-225. 2001.

63. A stake in the environment. Gainer, B. L. American Nurseryman 194(1):48-53. 2001. Several environmental regulations have a large impact on the way growers do business, especially those affecting water quality and use, pesticide use, spray drift and noise.

64. © Sticks, carrots, and reforestation investment. Zhang, D.; Flick, W. A. Land Economics 77(3):443-456. 2001.

65. Systematic experimental designs for mixed-species plantings. Goelz, J. Native Plants Journal 2 (2):90-96. 2001.

66. This business of the environment. Meeks, P. FarWest Magazine 45(8):86-89. 2001. Nurseries do more than their part to be good stewards of the land, from recycling poly film to composting to conserving water.

67. © Willows: an underestimated resource for environment and society. Verwijst, T. Forestry Chronicle 77(2):281-285. 2001.

Genetics and Tree Improvement

Genome
Aa
Bb
cc
Dd

68. © The development of improved willow clones for eastern North America. Kopp, R. F.; Smart, L. B.; Maynard, C. A.; Isebrands, J. G.; Tuskan, G. A.; Abrahamson, L. P. Forestry Chronicle 77(2):287-292. 2001.

69. © Diversity in physiological and morphological characteristics of four cottonwood (*Populus deltoides* var. *wislizenii*) populations in New Mexico: evidence for a genetic component of variation. Rowland, D. L. Canadian Journal of Forest Research 31:845-853. 2001.

70. © Quantitative genetics of spring and fall cold hardiness in seedlings from two Oregon populations of coastal Douglas-fir. O'Neill, G. A.; Adams, W. T.; Aitken, S. N. Forest Ecology and Management 149(1-3):305-318. 2001.

71. © Role of selection versus historical isolation in racial differentiation of ponderosa pine in southern Oregon: an investigation of alternative hypotheses. Sorensen, F. C.; Mandel, N. L.; Aagaard, J. E. Canadian Journal of Forest Research 31(7):1127-1139. 2001.

72. © Sitka alder (*Alnus sinuata* Rydb.) genetic diversity in germination, frost hardiness and growth attributes. Benowicz, A.; El-Kassaby, Y. A.; Guy, R. D.; Ying, C. C. Silvae Genetica 49(4-5):206-212. 2000.

73. © Stability and seed movement for loblolly pine in the western Gulf Region. Yeiser, J. L.; Lowe, W.; van Buijtenen, J. P. Silvae Genetica 50(2):81-88. 2001.

74. © Utilization and management of red alder genetic resources in British Columbia. Hamann, A. Forestry Chronicle 77(4):705-712. 2001.

Mycorrhizae & Beneficial Microorganisms

75. © Advances in inoculant technology: a brief review. Date, R. A. Australian Journal of Experimental Agriculture 41(3):321-325. 2001.

76. Benefits and opportunities with mycorrhizal fungi in nursery propagation and production systems. Davies, F. T., Jr. International Plant Propagators' Society, combined proceedings 2000, 50:482-489. 2001.

77. © Mycorrhizal dependency and growth responses of *Acacia nilotica* and *Albizzia lebbeck* to inoculation by indigenous AM fungi as influenced by available soil P levels in a semi-arid Alfisol wasteland. Sharma, M. P.; Bhatia, N. P.; Adholeya, A. New Forests 21 (1):89-104. 2001.

78. Mycorrhizal fungal inoculation of woody seed propagation substrate. Acree, G. E.; Appleton, B. L. International Plant Propagators' Society, combined proceedings 2000, 50:551-555. 2001.

79. © Responses of agronomically important crops to inoculation with *Azospirillum*. Dobbelaere, S.; Croonenborghs, A.; Thys, A.; Ptacek, D. et al Australian Journal of Plant Physiology 28(9):871-879. 2991.

80. The roots of mycorrhizae. Acree, G. Nursery Management and Production 17(9):71-74. 2001. What to know before using these beneficial fungi.

81. Using mycorrhizal fungi during the propagation of woody horticultural crops. Scagel, C. F. International Plant Propagators' Society, combined proceedings 2000, 50:589-594. 2001.

Nursery Structures & Equipment

82. Build a better coldframe: a guide for overwintering materials. Rodda, K. Nursery Management and Production 17(9):56-60. 2001.

83. Energy costs prompt look at alternative heat sources. Bartok, J. W., Jr. Greenhouse Management and Production 21(10):70-71. 2001.

84. Growers join forced to lower energy costs. Rodda, K. Greenhouse Management and Production 21 (8):63-65. 2001. Some look to energy cooperatives for buying power.

85. Heating the natural way. Lund, J. W. Greenhouse Management and Production 21(8):66-69. 2001. Liskey Farms uses geothermal water to heat its greenhouse facility, and for other purposes.

86. House hunting. Howell, D. OAN Digger 45(9):28-30, 32-34. 2001. The types of greenhouses are as varied as the costs, and it takes a lot of research and strategizing to find which, if any, is right for your operation.

87. Improve fan cooling. Bartok, J. W., Jr. Greenhouse Management and Production 21(7):88-89. 2001.

88. Mist nozzle evaluation. Jones, A. M. International Plant Propagators' Society, combined proceedings 2000, 50:299-302. 2001.

89. Structures and coverings: built for heat. Hopkins, M. Greenhouse Grower 19(7):76-78, 80, 82-83. 2001. Eight ways to make your greenhouses more energy efficient this heating season.

90. Ten ways to reduce your energy bill. Both, A. J. Greenhouse Grower 19(8):56, 58, 62. 2001.

91. Waterjet stinger: a tool for planting dormant nonrooted cuttings. Hoag, J. C.; Simmonson, B.; Cornforth, B.; St. John, L. Native Plants Journal 2(2):84-89. 2001. Using high-pressure water to bore holes for planting dormant, nonrooted cuttings.

Outplanting Performance

92. © Achieving restoration success: myths in bottomland hardwood forests. Stanturf, J. A.; Schoenholtz, S. H.; Schweitzer, C. J.; Shepard, J. P. Restoration Ecology 9(2):189-200. 2001.

93. A comparison of bareroot and container stock: discussion. Mohammed, G. H.; McLeod, G. R.; Menes, P. A.; Timmer, V. R. IN: Regenerating the Canadian forest: principles and practice for Ontario, p. 343-348. R. G. Wagner and S.J. Colombo, eds. Ontario Ministry of Natural Resources and Fitzhenry & Whiteside Ltd. 2001.

94. © Early seedling growth of *Pinus sylvestris* after sowing with a mixture of stand and orchard seed in dense spacings. Wennstrom, U.; Bergsten, U.; Nilsson, J. E. Canadian Journal of Forest Research 31(7):1184-1194. 2001.

95. © The effect of salinity on the emergence and seedling growth of *Picea mariana*, *Picea glauca*, and *Pinus banksiana*. Croser, C.; Renault, S.; Franklin, J.; Zwiazek, J. Environmental Pollution 115(1):9-16. 2001.

96. © Effect of water stress conditioning on morphology, physiology and field performance of *Pinus halepensis* Mill. seedlings. Royo, A.; Gil, L.; Pardos, J. A. New Forests 21(2):127-140. 2001.

97. Effects of stock type on seedling performance in the northern interior of British Columbia: twenty-year results. Hunt, J. A. British Columbia Ministry of Forests, Silviculture Note 29. 6 p. 2002.

98. © Effects of thinning in a *Pinus sylvestris* L. stand on foliar water relations of *Fagus sylvatica* L. seedlings planted within the pinewood. Aranda, I.; Gil, L.; Pardos, J. A. Trees 15(6):358-364. 2001.

99. © Frost heaving in a boreal soil in relation to soil scarification and snow cover. Bergsten, U.; Goulet, F.; Lundmark, T.; Lofvenius, M. O. Canadian Journal of Forest Research 31(6):1084-1092. 2001.

100. Guidelines for shelterbelt planting in the Falkland Islands. Low, A.; McAdam, J. United Kingdom Falkland Islands Trust and Department of Agriculture, Stanley. 32 p. 1999.

101. © Influence of a willow canopy on tree seedling establishment for wetland restoration. McLeod, K. W.; Reed, M. R.; Nelson, E. A. Wetlands 21(3):395-402. 2001.

102. © Managing succession in conifer plantations: converting young red pine (*Pinus resinosa* Ait.) plantations to native forest types by thinning and underplanting. Parker, W. C.; Elliott, K. A.; Dey, D. C.; Boysen, E.; Newmaster, S. G. Forestry Chronicle 77 (4):721-734. 2001.

103. Mediterranean climate effects. I. Conifer water use across a Sierra Nevada ecotone. Royce, E. B.; Barbour, M. G. American Journal of Botany 88(5):911-918. 2001.

104. © Planting in open tapering conical cavities made in peat plough ribbons improves stability and growth. Seaby, D. A.; Schaible, R. C. Forestry 74 (2):119-127. 2001.

105. Survival and growth of individual trees in mixed-species plantations of bottomland hardwoods on 2 Mississippi delta soil types. Goelz, J. C. G. Native Plants Journal 2(2):98-104. 2001.

106. © Temperature thresholds of shoot elongation in provenances of *Pinus contorta*. Chuine, I.; Aitken, S. N.; Ying, C. C. Canadian Journal of Forest Research 31 (8):1444-1455. 2001.

107. © Trade-offs in seedling survival, growth, and physiology among hardwood species of contrasting successional status along a light-availability gradient. Kaelke, C. M.; Kruger, E. L.; Reich, P. B. Canadian Journal of Forest Research 31(9):1602-1616. 2001.

108. © Tree shelters improve the survival and growth of planted Engelmann spruce seedlings in southwestern Colorado. Jacobs, D. F.; Steinbeck, K. Western Journal of Applied Forestry 16(3):114-120. 2001.

SO. Regenerating the Canadian forest: principles and practice for Ontario. Wagner, R. G.; Colombo, S. J. ,. eds Ontario Ministry of Natural Resources and Fitzhenry & Whiteside Ltd, Markham, Ontario. 650 p. 2001. ORDER FROM: any book seller. ISBN 1-55041-378-3.

Pest Management

109. Abiotic diseases of woody ornamentals. Schubert, T. S.; Walker, J. T. IN: Diseases of woody ornamentals and trees in nurseries, p. 7-22. R.K. Jones and D.M. Benson, eds. American Phytopathological Society. 2001.

110. Be aware of eriophyid mites. Cloyd, R. Greenhouse Management and Production 21(7):83, 85. 2001.

111. Biological control of woody ornamental diseases. Mahafee, W. F. IN: Diseases of woody ornamentals and trees in nurseries, p. 435-441. R.K. Jones and D.M. Benson, eds. American Phytopathological Society. 2001.

112. Bt in your corner. Henderson, J. Nursery Management and Production 17(11):57-59. 2001. Helpful tips for ensuring success with Bacillus thuringiensis pest control products.

113. Comparison of commercial deer repellents. Trent, A.; Nolte, D.; Wagner, K. USDA Forest Service, Technology and Development Program, Tech Tips 0124-2331-MTDC. 6 p. 2001. Available online at http://fsweb.mtdc.wo.fs.fed.us.

114. Correct solutions begin with correct diagnoses. Powell, C. C. Nursery Management and Production 17 (7):76-78. 2001.

115. Degrees of separation. Herms, D. A. American Nurseryman 194(4):34-40. 2001. By using degree days and observing bloom times, growers can predict when insect pests emerge and are most vulnerable to pesticides.

116. Diseases and mycorrhizae. Whitney, R. D.; Greifenhagen, S.; McLaughlin, J.; Meyer, T.; Gross, H. L. IN: Regenerating the Canadian forest: principles and practice for Ontario, p. 459-482. R.G. Wagner and S.J. Colombo, eds. Ontario Ministry of Natural Resources and Fitzhenry & Whiteside Ltd. 2001.

117. Effects of radio frequency waves on fungal colonization of styroblock containers. James, R. L.; Trent, A. USDA Forest Service, Northern Region, Forest Health Protection Report 01-10. 10 p. 2001.

118. Evaluation of novel fungicides and irrigation methods for grey mould control on *Calluna vulgaris*. McQuilken, M. P. International Plant Propagators' Society, combined proceedings 2000, 50:137-141. 2001.

119. © A long-term study of *Phytophthora* species in Germany. 1. Phytophthora species which could be definitely identified. Werres, S.; Marwitz, R.; Poerschke, U.; Themann, K. Zeitschrift fur Pflanzenkrankheiten und Pflanzenschutz 108(2):113-120. 2001.

120. Management strategies for fighting *Phytophthora*. Hausbeck, M. Greenhouse Management and Production 21(8):75-76. 2002.

121. © Molecular evidence suggests that *Ceratobasidium bicorne* has an anamorphy known as a conifer pathogen. Hietala, A. M.; Vahala, J.; Hantula, J. Mycological Research 105(5):555-562. 2001.

122. On trial. Chase, A. R. American Nurseryman 194 (7):64-66. 2001. Research explores the effectiveness of fungicides in controlling various plant diseases.

123. Pinpointing plant problems. Powell, C. C. Nursery Management and Production 17(9):75-77. 2001.

124. Plant pathogens, beware: adding compost to your arsenal and using it properly can send harmful microorganisms packing. Scheuerell, S. Farwest Magazine 45(8):67-68, 70-71. 2001.

125. © Pre- and post-inoculation water stress affects *Sphaeropsis sapinea* canker length in *Pinus halepensis* seedlings. Paoletti, E.; Danti, R.; Strati, S. Forest Pathology 31(4):209-218. 2001.

126. © Resistance reaction of conifer species (European larch, Norway spruce, Scots pine) to infection by selected necrotrophic damping-off pathogens. Kacprzak, M.; Asiegbu, F. O.; Daniel, G.; Stenlid, J.; Manka, M.; Johansson, M. European Journal of Plant Pathology 107(2):191-207. 2001.

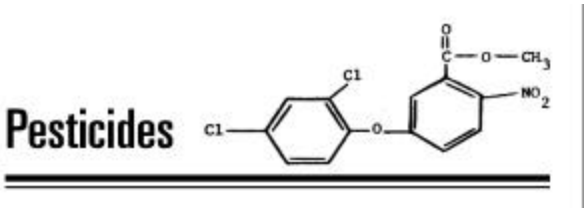
127. Successful insect management on perennials. Pilon, P. Greenhouse Management and Production 21 (8):40, 42. 2001. Sound fundamentals help to create Sawyer Nursery's pest management plan.

128. Uncovering the mysteries of gray mold. Stelljes, K. B. Agricultural Research 49(9):18-19. 2001.

SO. Avian repellents: options, modes of action, and economic considerations. Mason, J. R.; Clark, L. IN: Repellents in wildlife management: proceedings of a symposium, p. 371-391. National Wildlife Research Center, Fort Collins, CO. 1997. Considers visual, auditory, tactile, chemosensory, and physiologic repellents currently available for use in the U.S. DOWNLOAD from http://www.aphis.usda.gov/ws/nwrc/repelsym/mason.pdf.

SO. Damaging agents in European forest nurseries: practical handbook. Nef, L.; Perrin, R. European Commission. 352 p. 1999. The largest portion of the book consists of the description of major damaging agents, divided by abiotic diesease, fungal diseases, and mites and insects. For each, symptoms, signs and damage, casual agent, hosts, influencing factors, and control are discussed and accompanied by numerous color photos. ORDER FROM: European Union. http://eur-op.eu.int/general/en/s-ad.htm, then choose Online Ordering Service and search title. Price 30 Euros.

SO. Diseases of woody ornamentals and trees in nurseries. Jones, R. K.; Benson, D. M. APS Press. 482 p. 2001. ORDER FROM: American Phytopathological Society, 3340 Pilot Knob Road, St. Paul, MN 55121-2097. Sections: Abiotic causes of disease; Biotic causes of disease; General diseases; Diseases of specific crops; Disease management. Price $89.



129. Bactericides and disinfectants. Simone, G. W. IN: Diseases of woody ornamentals and trees in nurseries, p. 417-422. R.K. Jones and D.M. Benson, eds. American Phytopathological Society. 2001.

130. Choosing an herbicide: considerations when using pre-emergents on ornamentals. Stamps, R. H. Nursery Management and Production 17(6):65-67. 2001. Herbicide selection is usually based on target weeds, crops grown, growing media and site of application. There other factors should also be considered: Labeling for chemigation; restricted entry intervals, relative leaching potential indexes, relative runoff potential indexes, and herbicide group.

131. The dilemma of tank mixing. Cloyd, R. Greenhouse Management and Production 21(11):66-67. 2001.

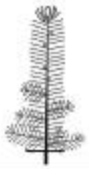
132. Fungicides for ornamental crops in the nursery. Jeffers, S. N.; Miller, R. W.; Powell, C. C., Jr. IN: Diseases of woody ornamentals and trees in nurseries, p. 409-416. R.K. Jones and D.M. Benson, eds. American Phytopathological Society. 2001.

Seedling Harvesting and Storage

133. Handling and planting of seedlings. Paterson, J.; DeYoe, D.; Millson, S.; Galloway, R. IN: Regenerating the Canadian forest: principles and practice for Ontario, p. 325-341. R.G. Wagner and S.J. Colombo, eds. Ontario Ministry of Natural Resources and Fitzhenry & Whiteside Ltd. 2001.

134. © Storage duration and temperature effect on the functional integrity of container and bare-root *Pinus radiata* D. Don stock-types. Mena-Petite, A.; Ortega-Lasuen, U.; Gonzalez-Moro, M. B.; Lacuesta, M.; Munoz-Rueda, A. Trees 15(5):289-296. 2001.

Seedling Physiology and Morphology



135. Assessment of nursery stock quality in Ontario. Colombo, S. J.; Sampson, P. H.; Templeton, C. W. G.; McDonough, T. C.; Menes, P. A.; DeYoe, D.; Grossnickle, S. C. IN: Regenerating the Canadian forest: principles and practice for Ontario, p. 307-323. R.G. Wagner and S.J. Colombo, eds. Ontario Ministry of Natural Resources and Fitzhenry & Whiteside Ltd. 2001.

136. Cold acclimation and deacclimation of shoots and roots of conifer seedlings. Bigras, F. J.; Ryyppo, A.; Lindstrom, A.; Stattin, E. IN: Conifer cold hardiness, p. 57-88. F.J. Bigras and S.J. Colombo, eds. Kluwer Academic Publishers. 2001.

137. Cold hardiness of radiata pine (*Pinus radiata* D. Don). Greer, D. H.; Menzies, M. I.; Warrington, I. J. IN: Conifer cold hardiness, p. 555-573. F.J. Bigras and S.J. Colombo, eds. Kluwer Academic Publishers. 2001.

138. Cold hardiness of Scots pine (*Pinus sylvestris* L.). Repo, T.; Nilsson, J. E.; Rikala, R.; Ryyppo, A.; Sutinen, M. L. IN: Conifer cold hardiness, p. 463-493. F.J. Bigras and S.J. Colombo, eds. Kluwer Academic Publishers. 2001.

139. Cold hardiness of yellow-cedar (*Chamaecyparis nootkatensis* (D. Don) Spach). Hawkins, B. J.; Bussell, J. H.; Arnott, J. T. IN: Conifer cold hardiness, p. 531-554. F.J. Bigras and S.J. Colombo, eds. Kluwer Academic Publishers. 2001.

140. Ecophysiological principles. Grossnickle, S. C.; Parker, W. C.; Blake, T. J.; Sutton, R. E. IN: Regenerating the Canadian forest: principles and practice for Ontario, p. 91-118. R.G. Wagner and S.J. Colombo, eds. Ontario Ministry of Natural Resources and Fitzhenry & Whiteside Ltd. 2001.

141. © Effect of lateral far-red light supplementation on the growth and morphology of birch seedlings and its interaction with mineral nutrition. Aphalo, P. J.; Lehto, T. Trees 15(5):297-303. 2001.

142. Effects of applied ABA on growth cessation, bud dormancy, cold acclimation, leaf senescence and N mobilization in apple nursery plants. Guak, S.; Fichigami, L. H. Journal of Horticultural Science and Biotechnology 76(4):459-464. 2001.

143. © Effects of climatic warming on cold hardiness of some northern woody plants assessed from simulation experiments. Ogren, E. Physiologia Plantarum 112(1):71-77. 2001.

144. © Fast, nondestructive measurement of frost hardiness in conifer seedlings by VIS+NIR spectroscopy. Sundblad, L. G.; Andersson, M.; Gelaadi, P.; Salomonson, A.; Sjostrom, M. Tree Physiology 21(11):751-757. 2001.

145. Genecology and gene resource management strategies for conifer cold hardiness. Aitken, S. N.; Hannerz, M. IN: Conifer cold hardiness, p. 23-53. F.J. Bigras and S.J. Colombo, eds. Kluwer Academic Publishers. 2001.

146. © Germination of CO_2-enriched *Pinus taeda* L. seeds and subsequent seedling growth responses of CO_2 enrichment. Hussain, M.; Kubiske, M. E.; Connor, K. F. Functional Ecology 15(3):344-350. 2001.

147. © Growth and resource use of birch seedlings under elevated carbon dioxide and temperature. Kellomaki, S.; Wang, K. Y. Annals of Botany 87 (5):669-682. 2001.

148. © Growth dynamics of oak seedlings (*Quercus macrocarpa* Michx. and *Quercus muhlenbergii* Engelm.) from gallery forests: implications for forest expansion into grasslands. Danner, B. T.; Knapp, A. K. Trees 15(5):271-277. 2001.

149. © Growth, morphology, and gas exchange in white spruce (*Picea glauca*) seedlings acclimated to different humidity conditions. Roberts, J. J.; Zwiazek, J. J. Canadian Journal of Forest Research 31(6):1038-1045. 2001.

150. © Growth responses of rooted cuttings from five clones of *Picea abies* (L.) Karst. after a short drought period. Nordborg, F.; Welander, N. T. Scandinavian Journal of Forest Research 16(4):324-330. 2001.

151. Hardy vs. dormant. Anisko, T. American Nurseryman 194(10):40-42. 2001.

152. © Hydraulic conductance in aspen (*Populus tremuloides*) seedlings exposed to low root temperatures. Wan, X.; Zwiazek, J. J.; Lieffers, V. J.; Landhausser, S. M. Tree Physiology 21(10):691-696. 2001.

153. Influence of nursery cultural practices on cold hardiness of coniferous forest tree seedlings. Colombo, S. J.; Menzies, M. I.; O'Reilly, C. IN: Conifer cold hardiness, p. 223-252. F.J. Bigras and S.J. Colombo, eds. Kluwer Academic Publishers. 2001.

154. © Intra-specific variation in xylem cavitation in interior live oak (*Quercus wislizenii* A. DC.). Matzner, S. L.; Rice, K. J.; Richards, J. H. Journal of Experimental Botany 52(357):783-789. 2001.

155. Mechanisms of frost survival and freeze-damage in nature. Sutinen, M. L.; Arora, R.; Wisniewski, M.; Ashworth, E.; Strimbeck, R.; Palta, J. IN: Conifer cold hardiness, p. 89-120. F.J. Bigras and S.J. Colombo, eds. Kluwer Academic Publishers. 2001.

156. Metabolic changes during cold acclimation and subsequent freezing and thawing. Oquist, G.; Gardestrom, P.; Huner, N. P. A. IN: Conifer cold hardiness, p. 137-163. F.J. Bigras and S.J. Colombo, eds. Kluwer Academic Publishers. 2001.

157. Methods for measuring cold hardiness of conifers. Burr, K. E.; Hawkins, C. D. B.; L'Hirondell, S. J.; Binder, W. D.; George, M. F.; Repo, T. IN: Conifer cold hardiness, p. 369-401. F.J. Bigras and S.J. Colombo, eds. Kluwer Academic Publishers. 2001.

158. Modelling cold hardiness development and loss in conifers. Greer, D. H.; Leinonen, I.; Repo, T. IN: Conifer cold hardiness, p. 437-460. F.J. Bigras and S.J. Colombo, eds. Kluwer Academic Publishers. 2001.

159. © Photosynthetic light response of flooded cherrybark oak (*Quercus pagoda*) seedlings grown in two light regimes. Gardiner, E. S.; Krauss, K. W. Tree Physiology 21(15):1103-1111. 2001.

160. Red spruce (*Picea rubens* Sarg.) cold hardiness and freezing injury susceptibility. DeHayes, D. H.; Schaberg, P. G.; Strimbeck, G. R. IN: Conifer cold hardiness, p. 495-529. F.J. Bigras and S.J. Colombo, eds. Kluwer Academic Publishers. 2001.

161. Resistance to water stress in seedlings of eight European provenances of *Pinus halepensis* Mill. Calamassi, R.; Rocca, G. D.; Falusi, M.; Paoletti, E.; Strati, S. Annals of Forest Science 58(6):663-672. 2001.

162. © Role of boron in drought resistance in Norway spruce (*Picea abies*) seedlings. Mottonen, M.; Aphalo, P. J.; Lehto, T. Tree Physiology 21(10):673-681. 2001.

163. © Seasonal patterns of photosynthesis in Douglas fir seedlings during the third and fourth year of exposure to elevated CO_2 and temperature. Lewis, J. D.; Lucash, M.; Olszyk, D.; Tingey, D. T. Plant, Cell and Environment 24(5):539-548. 2001.

164. © Seasonal root growth of Scots pine seedlings in relation to shoot phenology, carbohydrate status, and nutrient supply. Iivonen, S.; Rikala, R.; Vapaavuori, E. Canadian Journal of Forest Research 31 (9):1569-1578. 2001.

165. A short order. Warner, R. M.; Erwin, J. E. American Nurseryman 193(6):43-46, 48-50. 2001. Nursery professionals can use chemical growth retardants to control perennial height.

166. Turning a new leaf. Miller, T. I. FarWest Magazine 45(8):112-114. 2001. Copper chelate-urea combination serves as a less expensive option for defoliation and induced terminal budding.

167. © Variation in water relations characteristics of terminal shoots of Port-Orford-cedar (*Chamaecyparis lawsoniana*) seedlings. Zobel, D. B.; Riley, L.; Kitzmiller, J. H.; Sniezko, R. A. Tree Physiology 21(11):743-749. 2001.

SO: Conifer cold hardiness. Bigras, F. J.; Colombo, S. J. Kluwer Academic Publishers. 596 p. 2001. ORDER FROM: any book seller. Price $235.

168. Dormancy of yellow cedar seeds is terminated by gibberellic acid in combination with fluridone or with osmotic priming and moist chilling. Schmitz, N.; Xia, J. H.; Kermode, A. R. Seed Science and Technology 29(2):331-346. 2001.

169. © Effects of moist chilling and solid matrix priming on germination of loblolly pine (*Pinus taeda* L.) seeds. Wu, L.; Hallgren, S. W.; Ferris, D. M.; Conway, K. E. New Forests 21(1):1-16. 2001.

170. Evaluating the germination capacity of commercial seedlots of *Quercus petraea*. Le Pichon, C.; Guibert, M. Seed Science and Technology 29 (2):377-385. 2001.

171. © Heat shock, mass-dependent germination, and seed yield as related components of fitness in *Cistus ladanifer*. Delgado, J. A.; Serrano, J. M.; Lopez, F.; Acosta, F. J. Environmental and Experimental Botany 46(1):11-20. 2001.

172. An improved fluorescein diacetate seed viability test for jack pine, black spruce and white spruce. Noland, T. L.; Mohammed, G. H.; Seymour, N. H. Seed Science and Technology 29(2):509-516. 2001.

173. © The interaction of heat and smoke in the release of seed dormancy in seven species from southwestern Western Australia. Tieu, A.; Dixon, K. W.; Meney, K. A.; Sivasithamparam, K. Annals of Botany 88(2):259-265. 2001.

174. © A machine vision system for seeds germination quality evaluatio using fuzzy logic. Urena, R.; Rodriguez, F.; Berenguel, M. Computers and Electronics in Agriculture 32(1):1-20. 2001.

175. Natural seed dispersal and its effects on germination. Munson, R. H. International Plant Propagators' Society, combined proceedings 2000, 50:426-428. 2001.

176. Rocky Mountain juniper seed. Scianna, J. D. Native Plants Journal 2(2):73-78. 2001.

177. Seed management. Noland, T. L.; Creasey, K. R.; Wang, B. S. P. IN: Regenerating the Canadian forest: principles and practice for Ontario, p. 243-263. R.G. Wagner and S.J. Colombo, eds. Ontario Ministry of Natural Resources and Fitzhenry & Whiteside Ltd. 2001.

Soil Management & Growing Media

Peat Moss
Selected Canadian Sphagnum

178. Can I use municipal waste compost in my propagation media? Chong, C. International Plant Propagators' Society, combined proceedings 2000, 50:290-295. 2001.

179. © Comparison of laboratory- and field-derived soil water retention curves for a fine sand soil using tensiometric, resistance and capacitance methods. Morgan, K. T.; Parsons, L. R.; Wheaton, T. A. Plant and Soil 234(2):153-157. 2001.

180. Compost utilization in ornamental and nursery crop production systems. Fitzpatrick, G. E. IN: Compost utilization in horticultural cropping, p. 135-150. CRC Press. 2001.

181. Environmental and quality issues affecting the selection of growing media. Dawson, C. S. International Plant Propagators' Society, combined proceedings 2000, 50:142-147. 2001.

182. Expanded polystyrene as a substitute for perlite in rooting media. Dunn, D. E.; Cole, J. C. International Plant Propagators' Society, combined proceedings 2000, 50:532-537. 2001.

183. © Fulfilling special needs of nurseries. Miller, M. BioCycle 42(4):55-56, 58. 2001. Dollar value of a nursery crop is much higher per acre than most agricultural crops, so composts have to meet more narrow parameters.

184. A guide to propagation composts. Dobson, A. International Plant Propagators' Society, combined proceedings 2000, 50:148-152. 2001.

185. Issues relating to the properties of potting media. Tolley, I. S.; Hall, R. G. International Plant Propagators' Society, combined proceedings 2000, 50:105-108. 2001.

186. Match growing mix pH to the plant. Swanekamp, B. Greenhouse Management and Production 21(9):51-52, 54-58. 2001.

187. © Moving composted manure to nurseries and landscapers. Teffeau, K. M. BioCycle 41(10):58-61. 2001. Compost producers and nurseries explore ways to utilize composted poultry litter.

188. Putting on airs. Meeks, P. FarWest Magazine 45 (8):102-106. 2001. Choose containers and soil mixes wisely to improve media aeration, a key to healthy growth.

189. Quality of peat-based growing media -- what is the current status? Nielsen, K. L.; Sorensen, I. U.; Christensen, L. P. International Plant Propagators' Society, combined proceedings 2000, 50:252-256. 2001.

190. © Targeting composted manure for nursery mixes. Swanson, L.; Charlton, W. BioCycle 42(2):51-52. 2001.

191. Understanding media - pH management. Part 9. Using ammonium fertilizer and low alkalinity to lower pH of soilless media. Fisher, P. R.; Argo, W. R.; Bilodeau, L. J.; Smith, B. R. Greenhouse Grower 19 (10):116, 118, 120, 122, 124, 126. 2001.

192. © Use of urea to correct immature urban composts for agricultural purposes. Madrid, F.; Murillo, J. M.; Lopez, R.; Cabrera, F. Communications in Soil Science and Plant Analysis 31(15-16):2635-2649. 2000.

193. Volatilization of 1,3-dichloropropene in Florida plasticulture and effects on fall squash production. Nelson, S. D.; Riegel, C.; Allen, L. H., Jr.; Dickson, D. W.; Gan, J.; Locascio, S. J.; Mitchell, D. J. Journal of the American Society for Horticultural Science 126 (4):496-502. 2001.

Tropical Forestry & Agroforestry

194. The effects of electric impulse on growth of *Rhizophora mucronata* seedlings (Rhizophorales: Rhizophoraceae). Kathiresan, K.; Rajendran, N. Revista de Biologia Tropical 48(4):919-925. 2000.

195. © Growth and biomass production in *Azadirachta indica* seedlings in response to nutrients (N and P) and moisture stress. Puri, S.; Swamy, S. L. Agroforestry Systems 51(1):57-68. 2001.

196. Leachate from earthworm castings breaks seed dormancy and preferentially promostes radicle growth in jute. Ayanlaja, S. A.; Owa, S. O.; Adigun, M. O.; Senjobi, B. A.; Olaleye, A. O. HortScience 36 (1):143-144. 2001.

197. © Monitoring of black mangrove restoration with nursery-reared seedlings on an arid coastal lagoon. Toledo, G.; Rojas, A.; Bashan, Y. Hydrobiologia 444(1):101-109. 2001.

198. Seed ecology at the northern limit of the tropical rain forest in America. Vazquez-Yanes, C.; Orozco-Segovia, A.; Sanchez-Coronado, M. E.; Rojas-Arechiga, M.; Batis, A. I. IN: Seed biology: advances and applications, p. 375-388. M. Black, K.J. Bradford, and J. Vazquez-Ramos, eds. CAB International. 2000.

199. Techniques for land regeneration. Wiles, E. International Plant Propagators' Society, combined proceedings 2000, 50:87-89. 2001.

Vegetative Propagation and Tissue Culture

200. Improved adventitious rooting in *Quercus* through the use of a modified stoolbed technique. Hawver, G.; Bassuk, N. International Plant Propagators' Society, combined proceedings 2000, 50:307-313. 2001.

201. A novel system for propagating *Acer rubrum* 'Franksred' cuttings without mist. Owen, J. S., Jr.; Maynard, B. K. International Plant Propagators' Society, combined proceedings 2000, 50:346-350. 2001.

202. Recent advances in forest tree cuttings. Asada, T.; Shibata, M. International Plant Propagators' Society, combined proceedings 2000, 50:638-642. 2001.

203. Root formation in relationship to auxin uptake in cuttings treated by the dilute soak, quick dip, and talc methods. Geneve, R. L. International Plant Propagators' Society, combined proceedings 2000, 50:409-412. 2001.

204. Timing of low solar irradiance affects *Quercus* and *Acer* propagation. Zaczek, J. J.; Heuser, C. W., Jr.; Steiner, K. C. International Plant Propagators' Society, combined proceedings 2000, 50:434-441. 2001.

205. Using electrical conductivity: a possible indicator for the rooting of cuttings. Barnes, H. W. International Plant Propagators' Society, combined proceedings 2000, 50:276-280. 2001.

Water Management

206. 21st century irrigation. Sawada, S. T. American Nurseryman 194(9):34-37. 2001. Overlook Nurseries fully automated their irrigation system.

207. Compare subirrigation systems. Uva, W. L. Greenhouse Management and Production 21(11):42-44, 53-58. 2001. Ebb and flow rolling benches, movable trays, flood floors and trough benches are described and cost benefits of subirrigation are shown.

208. Irrigation scheduling for a sandy soil using mobile frequency domain reflectometry with a checkbook method. Laboski, C. A. M.; Lamb, J. A.; Dowdy, R. H.; Baker, J. M.; Wright, J. Journal of Soil and Water Conservation 56(2):97-100. 2001.

209. Stability of provenance differences during development of hard maple seedlings irrigated at two frequencies. St. Hilaire, R.; Graves, W. R. HortScience 36(4):654-657. 2001.

210. Utilization of functional water for plant propagation. Tagata, H.; Fujimori, T. International Plant Propagators' Society, combined proceedings 2000, 50:643-644. 2001. "Functional water" is defined as physcially and chemically processed water that has additional functions, such as higher reactivitty, probably due to structural changes of the water caused by pH change, reducing oxidation-reduction potential, increasing surface activity, etc.

211. Watering: senses vs. sensors. DiLeone, J. OAN Digger 45(7):33-38. 2001.

Weed Control

212. Mapping weed populations: the cost of counting and identifying seedlings and seeds. Wiles, L. J.; Schweizer, E. E. IN: International conference on precision agriculture, proceedings of the 4th, p. 499-510. P.C. Robert, R.H. Rust, and W.E. Larson, eds. ASA-CSSA-SSSA. 1999.

213. Taking control. Mathers, H. American Nurseryman 194(7):46-48, 50, 52-53. 2001. Controlling weeds can be challenging, but if growers know what they are up against and understand how some herbicides on the market can help, they will have more control over this problem.

214. Working around weeds. Shenberger, L. American Nurseryman 193(4):64-66. 2001. Several weed control methods seem promising and nonphytotoxic for containerized liners.

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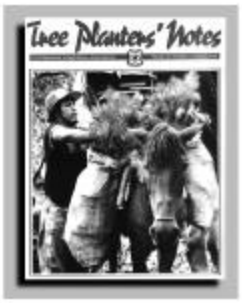

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