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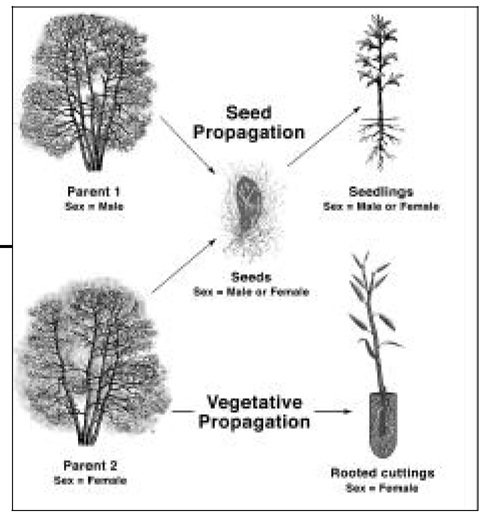
Forest Nursery Notes

Summer 2002



Cultural Perspectives
Sex And The Single Salix

Integrated Pest Management
What's With All The *Lygus*?

Cultural Perspectives
Strategies for Growing Large Seedlings

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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.

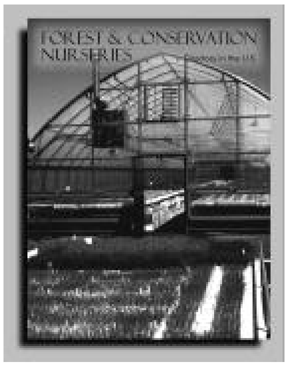
National Nursery Proceedings - Clicking on the arrow link will take you to a list of past proceedings from 1989 to 2001. We're still working on the presentations for 2000, but the other years contain PDF files of all the articles that were presented at the various meetings.

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

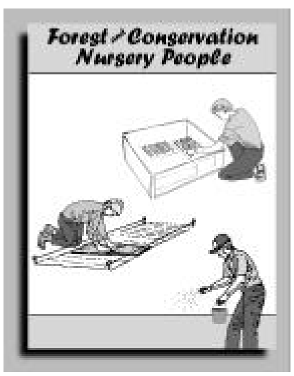
Native Plants Journal - This takes you to the new website where you can peruse issues and search for information on growing a wide variety of native plants in the Native Plants Network.

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

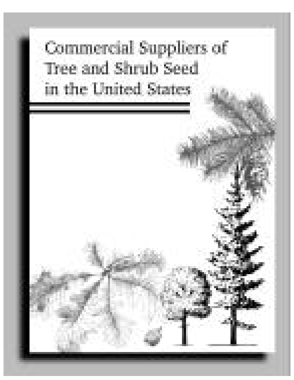
Directories—This section contains three directories that will help answer many questions:



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, 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 could 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 **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 Thursday afternoon, ***August 8, 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.

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>

The 21st Annual Nursery Pathology Workshop will be held in conjunction with the **Western International Forest Disease Work Conference (WIFDWC)** in Powell River, British Columbia. The Nursery Pathology Workshop will begin Monday September 9, 2002, 1 to 5 pm and continue as the group decides. If you would like to present a poster, please contact:

Alex Woods at: alex.woods@gems8.gov.bc.ca

Please access the WIFDWC website for more information at:

<http:/www.fs.fed.us/foresthealth/technology/wif

WIFDWC will be held Monday, September 9 to Friday, September 13, 2002 at the Coast Town Centre Hotel, 6660 Joyce Avenue, Powell River, BC. For reservations call the hotel directly at 604.485.3000. Registration form in available from the website.

2002 International Research Conference on Methyl Bromide Alternatives & Emissions Reduction will take place on November 6 to November 9 2002 at the Rosen Centre Hotel in Orlando, Florida. The agenda will be available October 1, 2002. All the information is available online at:

<www.mbao.org>

For reservations contact:
The Rosen Centre Hotel
9840 International Drive
Orlando, FL 32819
1.800.204.7234

For more information contact:
MBAO Office
144 W. Peace River Drive
Fresno, CA 93711-6953
559.447.2127
Rosemary Obenauf at robenauf@agresearch.nu
Gary Obenauf at gobenauf@agresearch.nu

International Plant Propagators' Society (IPPS) meetings always cover a wide range of basic plant propagation concepts, techniques, and technologies, and they 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

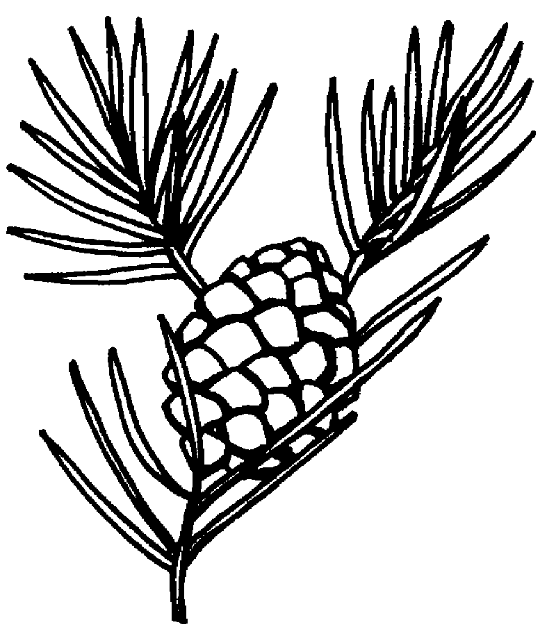
New Zealand Region Apr. 18-21 Timaru

IPPS Scandinavia Early Sept. To Be Determined

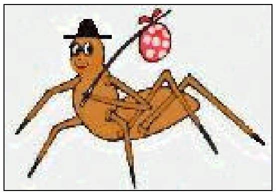
Southern Region, North America Sept. 29-Oct. 2 Baltimore, MD (with ER)

Western Region, North America Oct. 30-Nov 2 Mesa, Arizona

Southern Africa Potential Region March To Be Determined



Health and Safety



Spider bites are common in many parts of the United States, however serious bites are quite rare. Linda S. Rayor, PhD, arachnologist at Cornell University says, “People tend to accept the very real daily dangers of driving cars, crossing streets, working in public places, but exaggerate the minimal risks from spiders because they are poorly known and look frightening.” Edward P. Krenzelok, PharmD, director of the Pittsburgh Poison Center at Children’s Hospital of Pittsburgh, agrees. Out of 2.4 million cases reported to poison centers in 1998 only 9,253 were spider bites. Of those, 1,489 were treated in a hospital. There was one fatality.

Potentially hazardous spiders in the U.S. include the black widow, brown recluse, hobo and yellow sac spiders.

Black widow
Adult females are usually black with the classic reddish hourglass marking on the underside of the abdomen. They're found throughout the country, most often in outbuildings, firewood, and crawl spaces. Black widows are not aggressive, and would rather hide than bite. Bites are not fatal, but may cause severe pain, intense muscles spasms, leg and stomach rigidity, breathing problems, or nausea. Hospitalization may be required, but symptoms in untreated cases usually disappear within three days.

Brown Recluse
This spider is most common in the South and Midwest. They are tan to dark brown, with a dark violin pattern on the front of their body. Brown recluse bites may not be noticed immediately. In severe cases, the venom can eventually cause skin breakdown; sores that scab, slough dead skin and then heals very slowly. In the extremely rare cases, non-healing skin ulcers, toxic shock syndrome or death occur.

Hobo
The hobo spider is large brown with gray markings, usually found in the northwestern U.S. The bites are similar to the brown recluse. Many bites attributed to the brown recluse were later found to be those of the hobo. The initial bite is painless. If the bite is severe, redness, blisters, sloughing of skin and scarring result. The wound will usually heal within 45 days, but can take up to 3 years. Long lasting headaches may be another symptom. Although usually rare, other symptoms include nausea, weakness, fatigue, temporary memory loss, or vision problems. Long-lasting problems that affect the body are generally rare but could lead to death.

Yellow Sac
These spiders are small, yellowish and are found throughout the United States. Bites generally produce instant, intense stinging pain, similar to a wasp sting. This may be followed by redness, swelling and itching, sometimes becoming a sloughing sore. Healing is usually complete within eight weeks. Although rare, dizziness, headache, fever, chills, nausea, anorexia, and sometimes shock may occur.

Prevention

Spiders are not out to attack people, but they bite only when cornered or disturbed. To avoid encounters with spiders:

- Never put your bare hands into areas you can’t see.
- Wear protective clothing (gloves, long sleeves, pants, hooded jackets) in crawl spaces and other potentially infested areas.
- Wear gloves to handle firewood, lumber and other stored items.
- Frequently vacuum corners, closets, behind furniture and under beds.
- Check firewood for spiders and egg sacs before bringing it into the house.
- Eliminate entry sites. Check door and window casings for a tight fit. Caulk openings at entry points of water pipes and electrical lines.
- Pesticides should be reserved for infestations after all other measures have failed.

Trying to completely rid your home of spider may not be the best strategy. As Dr. Rayor says, “The overwhelming majority of spiders are not poisonous to humans and should be appreciated instead for their ability to consume pest insects.”

Treatment

Cultural Perspectives

Sex and the Single *Salix*

The family Salicaceae contains hundreds of common woody shrubs and trees but consists of only 2 genera: the willows (*Salix* spp.) and the poplars, cottonwoods, and aspens (*Populus* spp.). This plant family is unusual for several different reasons:

1) They are dioecious (each plant is either male or female).

2) They more commonly reproduce by vegetative processes rather than seed.

3) Members of the Salicaceae dominate woody riparian vegetation in the northern hemisphere

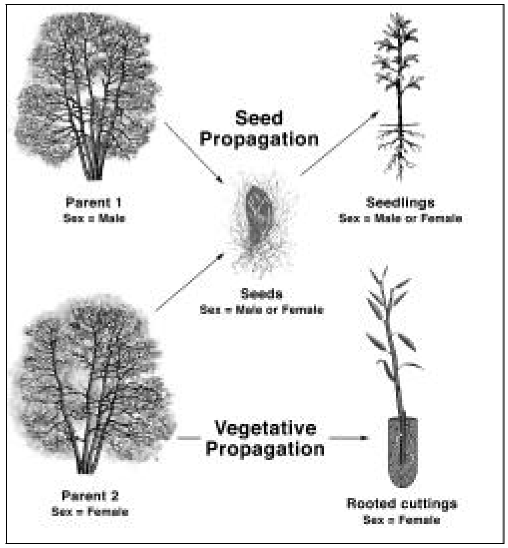


Figure 1 - Plants of the family Salicaceae are unisexual. This creates challenges for nursery managers and restorationists because vegetative propagation is the rule and produces individuals of the same sex.

Demand for willow and cottonwood species has become more common in the last decade because of an increased interest in riparian restoration. As we discussed in the July, 2000 issue of FNN, hardwood cuttings of these genera are widely being used both for bioengineering structures. Dormant unrooted hardwood cuttings of willow and cottonwood are collected on the project site or from stooling beds in the nursery, and then fabricated into vertical bundles, fascines, and brush mattresses. The hardwood cuttings in these structures are expected to sprout roots to increase soil stabilization and also grow into pioneer plants in the riparian ecosystem.

In addition, many riparian restoration projects stick unrooted cuttings directly in stream and river banks with the expectation that they will root and revegetate the site. Some nurseries also sell unrooted hardwood cuttings. Experience has shown that rooting success and plant establishment is much better if the cuttings are rooted in the nursery as bareroot stock or in containers. As a consequence, nurseries offer many species of willow, cottonwoods, and aspen for conservation projects.

The Problem

The concern is that all of these propagation techniques are vegetative, not sexual. Sexual propagation results in a mixture of genetic characteristics so that the offspring contain both male and female plants. On the other hand, asexual propagation methods produce exact clones of the mother plant. This is of particular concern with dioecious plants, such as *Salix* and *Populus* because all the progeny produced by vegetative propagation will have the same sex as their parent (Figure 1).

Restorationists and nursery workers have been collecting cuttings of willow and cottonwood without any consideration to the sex of the parent plant. In nature, these species often reproduce naturally from root sprouts or buried branches and, as a result, adjacent plants on the project site are often from the same clone. Branches often break off parent plants during floods, become buried further downstream, and root into new plants. If there are not many genetically different plants to start with, all the willows or cottonwood plants in a riparian community can be from only a few parents. A recent collecting trip to Little Butte Creek in Southern Oregon revealed that all the cottonwood plants in the watershed were female and probably from the same parent. Because of the lack of male plants, no seed or seedlings could be found and collectors had to go to an adjacent drainage to find any male plants.

The unisex problem becomes even worse when cuttings are brought back to the nursery and used to start stooling beds. Because cuttings will be collected from these beds for years, this greatly multiplies the number of plants of the same genetic origin. Walk through the stooling beds in your local nursery next spring when the willows or cottonwoods are flowering and you might be surprised.

A Solution

Because sexual and genetic diversity are critical in ecological restoration, the best solution is to propagate all plants by seed. However, due to the difficulty of collecting wild seed of *Salix* and *Populus*, it makes more sense to bring cuttings of known male and female plants back to the nursery and root them in containers or bareroot beds. The trick is to be able to distinguish male and female plants in the field. The easiest way to do this is to collect cuttings during the spring when they are flowering, and it is relatively easy to identify the anthers in male catkins (Figure 2A) and the pistils in female ones **(**Figure 2B). Unfortunately, the cuttings will not be dormant at this time and so rooting success will likely be poor. It is possible to identify the sex of dormant willows and cottonwoods by examining the size and location of the sexual buds. Male buds are typically larger than female buds and the floral structure can also be checked by slicing the buds with a razor blade. Either way, having a good mixture of sexually and genetically different plants in your stooling beds will insure that the cuttings that you harvest will promote biodiversity on your conservation and restoration projects.

Collecting a good mixture of male and female cuttings also gives you the option of producing seed in the nursery. Direct stick the cuttings in containers and mix male and female plants in the beds. Many willows are sexually precocious and will produce flowers that same season and both willows and cottonwood should flower the following year. Because the plants are growing in close proximity, the percentage of seed set is high, and quality seed can be collected a few weeks after flowering. To insure good seed quality, collect the female capsules just before they open and place them in a brown paper bag to afterripen. When the cotton is just emerging from the capsules, the seed can be separated by using screens and compressed air. Cottonwood seed can be processed by hammer-milling the capsules and separating the seed with screens at low air flow. The exact procedure including screen sizes is given in Dreesen and others (2002).

Willow and cottonwood seed should be sown immediately with several seeds per cavity. They can be direct sown

Figure 2 - The sex of willows, cottonwoods, and aspens can easily be determined when the plants are in flower (A = male, B = Female).

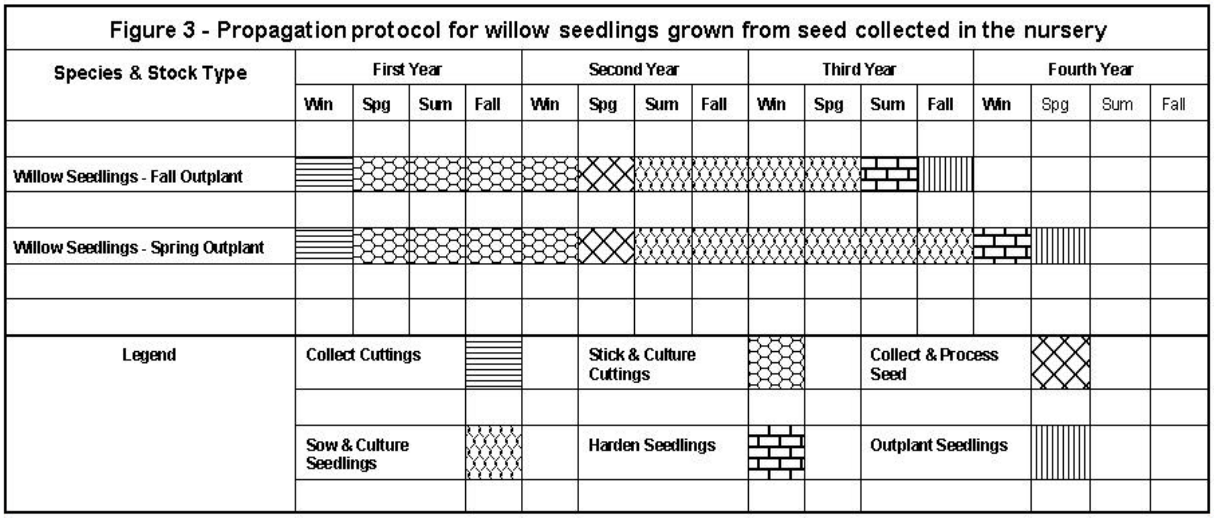


Figure 3 - Propagation protocol for willow seedlings grown from seed collected in the nursery

in medium-sized containers such as RL SuperCells (10 in^3 or 164 cm^3) or sown in miniplugs which are later transplanted into larger containers. Willow seed should be sown with no covering whereas cottonwood seed can be lightly covered. Seed must be kept *moist but not wet* by frequent light irrigations or ideally with a timed mist system. Germination is usually visible in a few days and germinants should be thinned by clipping to one plant per cavity within a few weeks.

A typical propagation protocol for willow seedlings grown from seed at the Los Lunas Plant Materials Center in New Mexico is shown in Figure 3. If the dormant hardwood cuttings are collected during the winter, they can be stuck in the nursery the following spring. The plants will flower the first or second season and seed can be collected and processed. By immediately sowing, shippable seedlings can be ready by the third or fourth year, depending on the container and desired target seedling size.

Summary

Plants of the Salicaceae are unique and so special measures must be taken to insure that genetic and sexual diversity is maintained during propagation. The critical thing is to identify the sex of willows, cottonwoods, and aspen when collecting cuttings in the field. Then, a sexually and genetically diverse mixture of cuttings can be obtained for bioengineering structures, direct sticking or for establishing stooling beds in the nursery. Seed propagation is encouraged whenever possible and it is relatively easy to force seed production from rooted cuttings in the nursery. Seedlings of the Salicaceae can be produced in as little as 3 years.

Sources:

Dreesen, D.; Harrington, J.; Subirge, T.; Stewart, P.; Fenchel, G. 2002. Riparian restoration in the Southwest: species selection, propagation, planting methods, and case studies. IN: Dumroese, K.; Riley, L.; Landis, T.D. tech. coords. National Nursery Proceedings.

Karrenberg, S.; Edwards, P.J.; Kollmann, J. 2002. The life history of Salicaceae living in the active zone of floodplains. Freshwater Biology 47: 733-748.

Testing Irrigation System Uniformity

Uneven water distribution is a factor universal to all sprinkler irrigation systems and can create potential problems for seedling culturing. For instance, most growers irrigate for the driest areas and in doing so, will over-irrigate all other areas. This not only wastes water and causes the over-irrigated areas to become saturated but it also over-applies any material being added though the irrigation system. In heavier media, the over-irrigated portion of the crop may be injured from having too little oxygen available to the roots. Over-irrigation can also leach out soluble fertilizers from the growing media.

If you are trying to apply materials such as fertilizers and pesticides through the irrigation system, variations in available moisture, oxygen, nutrients, pesticides due to poor uniformity of your irrigation system may explain a lot about the performance of your crop. Some of these effects are clearly visible in the nursery showing definite patterns tied to the locations of the irrigation nozzles (Figure 1) while others are less obvious .

The best way to check irrigation system uniformity is by placing containers in a grid pattern across a representative location in your nursery and measuring the amount of water in each container after a typical irrigation (Figure 2). We will describe this procedure and show how this information can be used to determine irrigation uniformity.
Procedures for testing your system (Adapted from Merriam, 1978)

1. Equipment needed:

Pressure gauge(s) – In addition to the gauge mounted on your irrigation system to monitor water pressure at the controls, you will want a hand held gauge that you can use to monitor pressure along irrigation lines. Depending upon the design of your sprinkler nozzles, you may need to add a small device called a “pitot tube” which can be inserted into the water stream in the nozzle to measure water pressure.

Hose and Container – A hose that will fit over the nozzle and gather all discharged water into a container. Measuring this discharged volume within a specified time will allow calculation of nozzle output rates. This is useful to check nozzle performance against manufacturer specifications to determine nozzle wear.

Water collection containers - Up to 50 or more containers (can) will be needed depending upon size and density of your grid (Figure 2). Each container must have identical sized openings and vertical sides. Paper or plastic cups

Figure 1

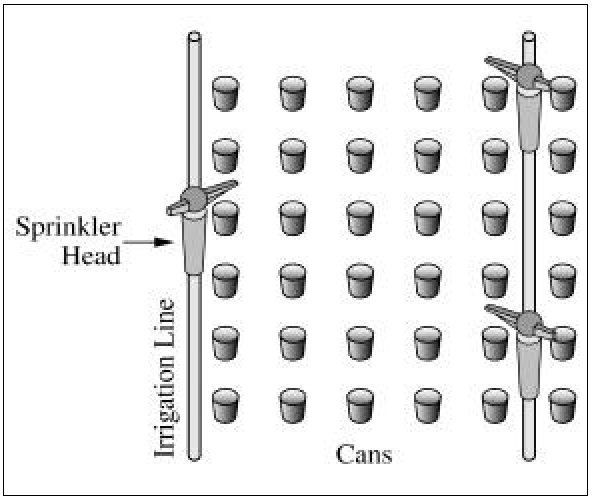


Figure 2

work well. For traveling booms, consider using a row of pill cups or test tubes that fit inside a row of empty cells placed parallel to the boom.

Tape Measure - Used to set out collection containers on the established grid. Also needed to measure the top opening of the collection containers.

Paper - A preprinted form containing notes, section with grid marks to draw the grid, etc. Also needed to record trial results. (Figure 3)

Watch - To time the duration of each irrigation.

Graduated cylinder - To measure collected water. Should be accurate to 2 ml.

Calculator or Computer - Using raw collection data, a calculator or computer can be used to determine the average volume, percent of variation from the average, and the coefficient of uniformity. A computer spreadsheet allows easy storage of records and the ability to graph the results.

Compass and anemometer – If wind is a factor during measurements, wind direction and speed must be taken. This information can be taken with a compass and anemometer.

2. Lay out a grid of collection containers. - Design a grid pattern between two or more sprinkler heads. The actual spacing of the grid needs to fit the seedling bed or container table and can be varied depending upon the degree of detail needed. For instance, in a typical container bench situation, a 60 cm or even a 90 cm grid can be used to get a quick picture. Then a 15 to 25 cm grid may be chosen to fine-tune the system. Once the grid spacing is determined, it is critical to place the collection containers at exact intervals with their tops level.

3. Record notes and sketch the grid onto a form. - Develop a form onto which all data about the system and the test can be recorded for later reference (Figure 3). Include the "Test Identification Number".
A number containing the year, month, day, and sequential test on that day (e.g. 2001-01-15-01) is recommended. This type of system will provide for easy reference and, if used as a computer file name, will store your tests in the correct order in the file. Include a sketch of the grid being used. Sketch a north-facing arrow to show the orientation of the seedling bed and the collection containers. Draw in the location of the sprinklers.

4. Test the system. - Irrigate for a typical length of time and record this duration. Measure and record the amount of water collected in each container. Use a graduated cylinder to obtain an accurate measurement of volume in each collection container. Record the collected quantities directly to the paper grid (Figure 3). This will prevent confusion over where the collections were made and can provide a quick visual analysis of the irrigation distribution pattern. For open-type facilities like shelterhouse and shadehouse structures, you will need to consider wind conditions under which the system is operated. Be sure to record the wind direction, speed and time of day during each test.

<u>Data analysis</u>

Distribution variability: To determine the variability in irrigation application, calculate the coefficient of uniformity using collection container test data in the following formula:

CU = 100 [1.0 - (B / A)]

Where: CU = coefficient of uniformity (%)
B = sum of deviations of individual values from the mean value
A = sum of the individual values

Irrigation System Test Record

Test Number________________

Nursery ________________________ House or Bed ___________________________________
Name of Nursery — Name or Code of Shelter house, seedbed, polybag bed, etc.

Irrigation System __________Nozzles____________ Spacing ___ __ _/__ __ ___Type ________
Type of system i.e. (Solid Set or Traveling boom) — Make and model — Distance between lines/nozzles — Rectangular or triangular

Location of Grid____
Specific location of grid layout (EXAMPLE: Waterline #4, between sprinklers #8 and #9.

Collection Container ______________________________ Inside Diameter of Top ___________
Type of Container (i.e. 4 Oz. Plastic Dixie Cup) — mm

Duration of Test _________________ min. Wind ______________ System Pressure__________
Length of time water collected — Speed and direction of wind — During test

Technician __________________________________Date_____________ Time_____________
Name of person(s) performing test — Date — Time of day

Figure 3

A completely uniform irrigation pattern will produce a CU of 100%, and the lower the CU, the more variable the irrigation. The standard target for most agricultural irrigation systems is a CU of 85%, which also works well for forest and conservation crops.

Distribution patterns: Determine the average cup volume and subtract it from the volume of each individual cup. Place these values on your paper grid. Negative numbers indicate points where rates are less than the average and positive numbers are greater than average. You might see a pattern of wetter and drier spots associated with the location of the sprinkler heads.

Irrigation rates: To find the average delivery rate (inches or centimeters of water per hour) of your system, sum all cup volumes and divide by the total collection area (area of cup opening multiplied by the number of collection cups), then divide by the hours the system was tested. This value can be used to determine timing and application rates.

Fine Tuning Your System

- Check Location of Nozzles. They should be located at equal distances along the supply line.

- Check the Alignment of Nozzles. For most nozzles to operate properly, they must be installed exactly above (or below) the supply line. Any that are tilted may be causing distribution problems. Reinstall nozzles that are tilted.

- Adjust the System. Water distribution of both solid set and traveling boom type irrigation systems can be adjusted by raising or lowering the height of the nozzles above the crop surface and/or adjusting the water pressure. Water distribution will change dramatically as the crop grows higher and intercepts the water at different levels. Rather than waiting until you notice dry spots or actual growth differences in your crop, try some “pre-crop” checks with the cups raised to different levels. This will provide you with data to know when to raise the booms or sprinklers as the crop grows in height. Remember to periodically clean all filters of the irrigation system to assure that uniform water pressure is being emitted from each nozzle.

- Other Corrective Measures. If the coverage is still not acceptable, try installing different nozzles. Last and most drastic would be to change the spacing of the nozzles or the type of system being used. Changes being considered for a solid set system can be tested using a small “model” system of two supply lines with four nozzles. Test the water distribution of the trial system the same way you tested the production system.

After fine-tuning collect water volume data again and compare coefficient of uniformity values and distribution variability. If the adjustment worked, there should be a higher coefficient value. Periodic checks of your irrigation system are required at a minimum at the beginning of each crop. The orifice of all nozzles wear over time, especially nozzles of a soft material such as plastic or brass. Wettable powders such as fungicides are known to increase nozzle wear.
Consider having your data analyzed by others. There are university programs and irrigation system vendors who utilize sophisticated computer analysis programs to calculate factors such as uniformity coefficient, distribution uniformity and scheduling coefficient. They may also provide “3D” graphics or “density” diagrams allowing visual analysis of irrigation distribution. However, these programs are likely to have certain data collection protocols for the programs to work properly, so be aware that data you collect on your own may not fit into their program. If there is a chance that you will be working with a university specialist or a vendor, it is highly advisable that you contact these sources before you begin testing.

Some newer programs only require a single sprinkler and one or two lines of collection containers. The computer program will do the rest, filling in overlapping sprinklers, etc. These programs are intended to save you time and effort. However, these programs rely mostly upon theory. Uneven pressure at individual nozzles and even the collision of water droplets can cause actual distribution to vary from the theoretical. You may want to make your collections exactly as required by the program but also run a couple of “check” tests of the system using a full grid

Large Containers - Strategies For Growing Large Seedlings For Native Plant Restoration

Introduction

Back in the early 1970's, when forest and conservation plants were first grown in greenhouses, all the containers were in the 2.5 to 10 in^3 (0.04 to 0.64 l) range. The largest volume container listed in Volume Two: Containers and Growing Media of the Container Tree Nursery Manual was 30 in^3 or 0.49 l. Since then, the trend has been to grow plants in larger containers. This is particularly true for restoration projects where large plant materials are needed to survive and grow on harsh sites or those with competing vegetation (Figure 1). Large container stock is currently being used in forest road stabilization, restoration of recreation sites, and riparian restoration projects.

The interest in large containers is based on the generally accepted premise that larger stock survives and grows better after outplanting. Of course, the drawbacks to larger stock types are cost and handling. The challenge to the grower, therefore, is to produce large container plants at an affordable price. This paper will address some of the basic growing strategies growers need to consider in the production of plants in large containers.

Propagation Environments, Equipment, and Materials

Structures. The type of propagation structure needed to produce high quality seedlings in large containers is different than traditional forest nurseries. Most small container nurseries grow plants from seeds and greenhouses are used to culture the small plants and protect them from drying and other stresses. Irrigation and fertigation is particularly crucial as small volume containers dry out very rapidly - sometimes, in a hour or less.

Because large containers do not require greenhouses, nurseries can be established with less capital outlay. In many cases, the only investment in materials is the purchase of large containers, storage racks, irrigation system and the development of a simple outdoor growing space. For this reason, producing seedlings in large containers can be a viable opportunity for small nursery growers, volunteer organizations, and school groups. Small plugs can be purchased from another nursery and then transplanted into the large containers. Once established, the stock requires only water, fertilizer, and protection from extreme weather.

Figure 1 - Woody shrubs and trees are being grown in large containers for restoration projects (L to R: D-40 Deepot, Tall One Treepot, 2 gallon Treepot, 4 gallon Treepot).

Choosing the container. Selecting the best type of container for your particular crop can be a daunting task considering the myriad of sizes, shapes and styles on the market today (Table 1). Your choice should be based on the biological needs of plant and the target seedling specifications of the customer. Some considerations might include:

1. Objectives of the outplanting project
2. Type of plant material (seedling or rooted cutting)
3. Plant characteristics
4. Limiting factors on the outplanting site
5. The outplanting window
6. The type of outplanting tool

Container Size. The size of the container is determined by the size and species of the target seedling required by the outplanting project. Deciduous tree species, which include willows, cottonwood, maples, alders and ash tend to be very fast growing species and can fill out a range of container sizes in just one growing season. Evergreen tree species - firs, pines, cedars and hemlock B will fill smaller containers the first year and then can

Table 1 - Common large containers used in restoration projects.

be

Container						
Brand	**Volume**		**Shape**	**Material**	**Color**	**Anti-spiraling**
	In^3	**liters**				
Hiko™	32 79	.52 1.29	round	rigid plastic	black	vertical ribs
Deepots ™	40	.65	round	rigid plastic	black	vertical ribs
Zipset™ Plant Bands	32 50 90 126	.52 .82 1.47 2.06	square	paper	tan	square sides
Long Tube	85 127 170 212	1.39 2.08 2.78 3.47	round	rigid plastic	white	Vexar™ netting
Styroblock™	32 43 61 195	.52 .70 1.0 3.19	round	styrofoam	white	vertical ribs
Copperblock™	32 43 61 195	.52 .70 1.0 3.19	round	styrofoam	white	copper, vertical ribs
Treepots™	101 173 380 467 588	1.65 2.83 6.23 7.65 9.63	square	rigid plastic	black	vertical ribs
Treepots™	650 1848	10.65 30.28	round	rigid plastic	black	vertical ribs
Poly-cel™	69 139 254 462 693 1062 1986	1.13 2.28 4.16 7.57 11.35 17.40 32.54	round	thin plastic	black	none

repotted into larger containers for another one or two growing seasons. Fast growing shrub species **B** ceanothus, bitterbrush, mountain mahogany **B** are often grown in small containers in the spring and transplanted into larger containers several months later. Slower growing shrub species must remain in smaller cells for a full growing season before transplanting to larger ones.

Container Dimensions. The shape and taper of a container will influence how easy the root plug is extracted from a container, and will also determine whether a support structure is required. A rule of thumb is a single container will need support if the length is over 1.5 times the diameter of the opening.

Bottom openings of large containers are either round or square and there are advantages and disadvantages to both. Square containers are less likely to have spiraling roots than round containers, however many round containers have been designed in recent years to prevent root spiraling (see discussion below). When consolidated, square containers have a higher seedling density and have little to no air space between each container. In colder climates this translates to less heat loss from the sides of each container and better protection from cold temperatures. Round containers have more air space surrounding them which reduces the humidity that can lead to foliar diseases.

The depth of a container can be very important to seedling survival and growth, especially on drier sites, where surface soils dry out by early summer but soil moisture is still available at deeper soil depths. On these sites, the deeper soil moisture is accessed by the longer root system, and this could be the difference between establishment and failure. Outplanting equipment has been developed for long containers including power augers and the expandable stinger. (See FNN, Winter 2002)

Composition Material. Large containers are generally constructed from Styrofoam, flexible or rigid plastic or treated paper. Styrofoam containers are constructed as blocks that contain a set of cavities. Styroblocks do not require support, and can be reused for many years. Styrofoam is a good insulator so protects the roots against cold or hot temperatures. A drawback to styroblocks is that seedlings cannot be separated or consolidated.

Plastic containers come in a variety of thickness, from very thin sleeves, like the Poly-cel™, to very dense, rigid containers, like the Hiko™ and Deepot™ containers. Generally the denser the plastic the longer the lifespan. Very dense plastic containers can have life spans of greater than a decade, especially if they are treated well. Thinner plastics might last half that length of time, while plastic sleeves, like the Poly-cel™ are designed for one or two years and are not reusable.
Paper containers, like the Zipset™ containers, are biodegradable and have a life span of 9 to 18 months, depending on their thickness. Even though these containers are biodegradable, the container must still be removed before outplanting.

With the exception of the white styroblocks, most large containers are black and when they are exposed to sunlight, can reach lethal temperatures. White containers are more reflective and less likely to have heat buildup.

Root Controls. The problem of root spiraling in round containers is well documented. Spiraling is a serious problem in some large containers when the bottom is partially enclosed (Treepot and Poly-cel). Others are open-bottomed (like the Zipset and long tube) or have a large drainage hole at the end of the container (Deepot, Stroblock, Hiko) which prevents spiraling at the bottom. Open-bottomed containers must be supported above an air layer to promote air pruning. If this is not possible, they can be placed on copper-treated landscape fabric such as Tex-R™ brand, which inhibits root growth. Copper coating the container walls have proven to be an effective

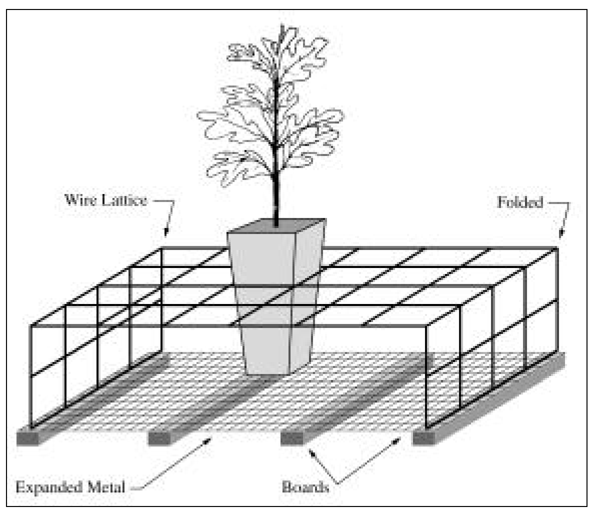


Figure 2 - Most large containers are individual free-standing cavities, and require some sort of rack system for support and handling.

way to "chemically prune" roots and prevent spiraling. Copperblocks™ are a type of styroblock with the cavities pre-treated with a copper coating. Other containers can be painted with a copper product such as Spinout™. In the long tube system, the PVC pipes are lined with Vexar netting to prevent spiraling.

Support and Handling. Large containers can be expensive and labor intensive to support and move. A good container handling system should support individual tall containers against toppling and also allow easy movement of many containers at once. Styroblocks and DeePots are the only large containers that do not need some type of rack or other support system. Most tall individual containers like the Treepots, or Long Tubes will need to have a support structure built to keep the containers from toppling during transportation or slight winds. Wooded pallets, pear bins, or storage racks can be modified to store large containers but they must be made strong enough so that they can be moved by a forklift or pallet jack (Figure 2).

Growing Schedules

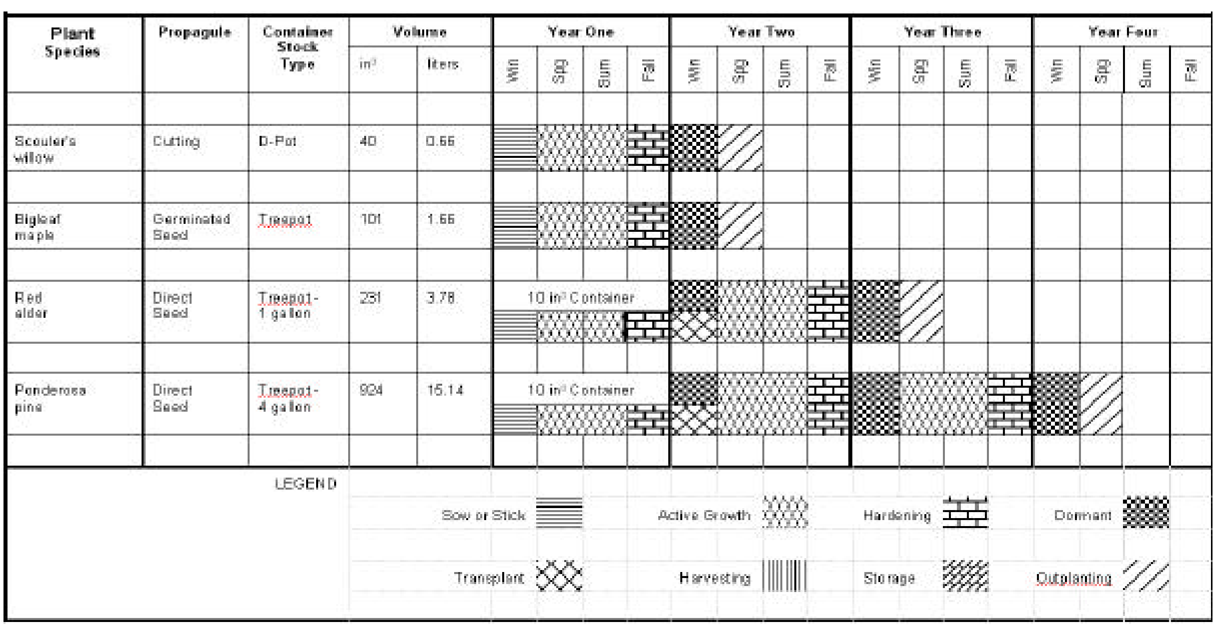
Some species of plants can be direct sown in large containers whereas other are first grown in small containers and then transplanted into larger containers. The decision to direct sow or transplant is a function of species characteristics and the type of propagule. Cuttings from willows and cottonwood can be direct stuck in large containers. Transplanting is a better option for slower growing plants and for the larger stock types. Transplanting ensures that every large container has a live plant but reduces the need for costly propagation structures for the larger stock.

Growing schedules are the best way to illustrate the time that it will take to produce the desired target seedling and also show the various phases of nursery production. Figure 3 shows growing schedules for four species of native woody plants grown in different large containers. Note that the red alder and ponderosa pine are grown in 10 in^3 (164 cm^3) containers for the first year before they are transplanted. In general, the larger the final container, the longer it takes to produce a shippable plant (Figure 3). Fast growing species like willows can generally be grown in one season whereas slower growing species may take up to four years to produce.

Cultural Procedures and Production Costs

Types of growing medium and cultural procedures including filling the containers, irrigation, fertilization, and pest management are different for large containers. There is considerable variation in the costs of producing the

Figure 3 - Growing Schedules for several plants in large containers at J.H. Stone Nursery



Integrated Pest Management

What's With All The *Lygus*?

Introduction

Tarnished plant bugs, commonly called by their generic name *Lygus*, are widespread pests to many agricultural crops. It has only been in the past 20 years that this insect has been confirmed as a damaging agent in conifer seedling nurseries. Since then, *Lygus* has been found in nurseries around the world. A disturbing trend is that the number of injured seedlings is increasing every year, and more species of *Lygus* are involved.

Figure 2* - Lygus *injured pine seedling (left).

Damage

Lygus attacks most conifer species with the exception of hemlock and true fir, and shows a preference for 1+0 stock types. Deformation of terminal shoots, loss of terminal leaders, flagging of the needles, and stem lesions are among the most common symptoms of *Lygus* feeding. *Lygus* adults (Figure 1) and nymphs prefer to feed on actively growing terminal meristems. Their feeding causes a small lesion near or on the terminal apex of conifer seedlings. The injection of enzymes that hydrolyse plant cell walls results in the destruction of the apical meristem. In pine, this is expressed in a distinctive terminal distortion with the needles being thicker, shorter than normal, and twisted (Figure 2). In most cases, the entire tip of the seedling is twisted over, and if a bud has formed, it usually develops on an angle. Attacks often cause the initiation of adult needles, and often, an elongated scar is found down one side of the stem. Later in the season, this injury results in the loss of apical dominance and the development of multiple tops. In spruce, *Lygus* damage initially causes a checking or 'shepherds crook' at the tip of the stem. This frequently develops into a seedling with two leaders. A scar is usually obvious down one side of the stem. In western red cedar, damage is expressed as distorted growing tips on a variety of branches that gives a 'clubbed' appearance to the affected seedlings.

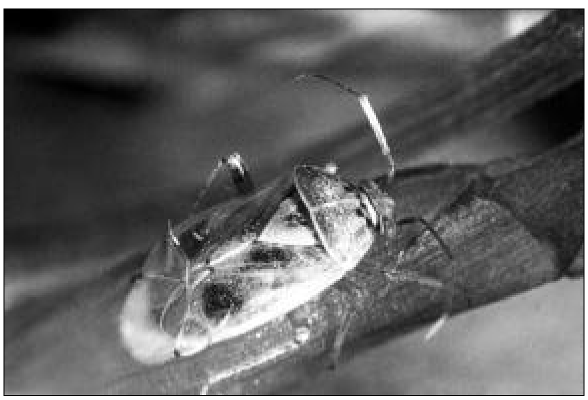


***Figure 1 - Adult* Lygus**

In both bareroot and container nurseries, *Lygus* damage is more prevalent around the perimeter of the growing area. In greenhouses, seedlings closest to entrances usually sustain the most damage. Even when the roofs and sides are removed from the houses, most damage occurs around the outside edges and along inside aisles. In pine, larch and Douglas-fir, damage usually occurs in small patches of 2 to 5 seedlings. In contrast, *Lygus* related damage in spruce is observed as single attacks and not in patches of seedlings. Seedlings are susceptible to attack as soon as the first true needles are developed and damage continues through the growing season, from mid-May to late September. Often their migration is determined by factors in surrounding areas. For instance, nurseries surrounded by alfalfa fields can find a large increase in Lygus populations when the alfafa is harvested. Once frosts begin in the fall, the adults seek overwintering sites and damage ceases.

*Lygu*s Species

Studies done in nurseries located in the southwest corner and interior of BC have shown that the composition of *Lygus* species vary by nursery location and climate. In 1996 and 1997, a taxonomic identification of adults caught on sticky traps were determined for a series of nurseries. In total, five *Lygus* species (Table 1) were positively identified from lodgepole pine or western red cedar seedlings - *L. shulli Knight*, *L. hesperus Knight*, *L. elisus* Van Duzee, *L. lineolaris* P. de Beauvois and *L. robustus* Uhler. In 1998, a caging study was done to compare the life

Table 1 - Trapping results for *Lygus* bugs in British Columbia forest tree nurseries

Lygus species	Frazer Valley	Okanagan Valley	Interior
L. shulli Knight	Yes	Yes	No
L. hesperus Knight	Yes	Yes	No
L. elisus Van Dusee	Yes	No	Yes
L. lineolaris P. de Beauvois	No	No	Yes
L. robustus Uhler	No	No	Yes

cycle and feeding habits of the two predominant species, *L. shulli* and *L. elisus.* At 25^{o}C, both species developed from egg to adult in 23-24 days. But at cooler temperatures, *L. elisus* completed its cycle in 63 days at 15^{o}C compared to *L. shulli* in 93 days at 12.5^{o}C. This suggests that the mix of *Lygus* species at a given nursery may change considerably depending on exterior environmental conditions and location.

Monitoring *Lygus*

Past *Lygus* monitoring has been done with sweep nets but recently the use of yellow sticky traps (Figure 3) has become an alternative. In 1995, a small monitoring program was initiated at a reforestation nursery in BC to determine the effectiveness of the traps. Results from this preliminary study showed that yellow sticky traps could be used effectively to monitor *Lygus* bugs in conifer nurseries. In 1996, populations of *Lygus* bugs were monitored at two reforestation nurseries throughout the summer to determine the temporal distribution of *Lygus* species within the crop and surrounding vegetation. Three sizes of plastic traps were used (small, 12.7 by 19.1 cm; medium, 17.8 by 19.1 cm; large, 19.1 by 30.5 cm) and each trap size was positioned at 2 heights (5 cm and 30 cm) above the seedling canopy. In general, small traps caught more *Lygus* per trap and per cm2 than the medium or large traps. Within the crop, more *Lygus* per trap and per cm2 were caught on traps positioned 5 cm above the canopy than at 30 cm. The advantage of the smaller trap cards within the crop are cost, evaluation time and their utility in monitoring other pests (i.e. fungus gnats and thrips).

Figure 3 - Yellow sticky traps

***Lygus* Control**

Bareroot Stock. Control of *Lygus* includes eliminating host weeds, vacuum systems, avoiding the sowing of susceptible species adjacent to the fields and the use of pesticides. At J. Herbert Stone Nursery, bug vacuuming with the Bug Vac and pesticides are used in combination for their 1+0 bare root crop. At the first indication of seedling damage or presence of *Lygus* in sticky traps, a pass is made in the field with a Bug Vac. This equipment covers three beds and pulls insects from the trees through a vacuum system as it passes over the beds. The insects are torn apart as they are sucked through the fan system. If this treatment has not been effective or there has been a steep increase in the population of insects, the insecticide, esfenvalerate, is then applied. Monitoring and treatment applications are continued until the presence of *Lygus* and seedling damage has tapered off.

Container Stock. Nurseries in BC use a preventive spray program of 2 to 4 application of cypermethrin each growing season to prevent *Lygus* bug damage. In recent years, some Canadian growers have commented on the variability of protection offered by cypermethrin in controlling *Lygus* feeding on conifer seedlings. A caging study was initiated in 1996 to determine the effectiveness of cypermethrin (Cymbush 250 EC) and dimethoate (Cygon 2E) residues in preventing feeding damage by *Lygus*. The seedlings were compared at four post-spray intervals (3, 7, 11, and 15 days after spray application) and at four seedling ages (8,13,16 and 22 weeks after sowing). Dimethoate (Cygon 2E) was chosen as a comparison as it is registered for *Lygus* control in alfalfa and provides good control of *Lygus* species in strawberries. It is also used in conifer nurseries in California, where it provides excellent control of *L. hesperus*. In general, cypermethrin was significantly more effective than dimethoate in preventing *Lygus* bug damage in lodgepole pine seedlings at 8, 13, and 22 weeks after sowing. The proportion of seedling damage due to *Lygus* bug feeding was less than 10 percent for both insecticides at 13, 16 and 22 weeks after emergence but as high as 70 % in the first 8 week after seedling emergence. These results suggest that a more intensive protection program is required during early seedling growth stage. During the first 8 weeks after seedling emergence, the greatest protection by both insecticides occurred within the first 7 days after application, then after the insecticides were ineffective.

Recommendations

1. Monitoring *Lygus* bugs within the crop should start soon after seedling emergence and continue on a weekly basis throughout the susceptible growth period (0 - 11 weeks after emergence).

2. Based on nursery trials, *Lygus* monitoring is most efficient when small 5.1 x 7.5 in. (13 x 19 cm) yellow sticky traps are placed every 3,230 to 5,380 ft^2 (300 to 500 m2) of seedling area. Sticky traps should be positioned 1 ft (30 cm) above the ground, one per 5,380 ft^2 (500 m^2) of surrounding vegetation.

3. Monitoring *Lygus* from surrounding vegetation can provide an estimation of the size of the *Lygus* bug population. This information can help predict the arrival of *Lygus* bugs within the crop and timing of insecticide applications. Perimeter monitoring should start when mean daily temperatures are above 41 ^{o}F (5 ^{o}C) and continue until peak of flight of the first generation.

4. A significant negative relationship was found between the age of container seedlings and the mean proportion of seedling damaged by L*ygus* bug suggesting that protection of seedlings, especially for lodgepole pine, should be most intensive in the first 13 weeks from sowing.

Special thanks to David Trotter of the British Columbia Ministry of Forestry for this section.

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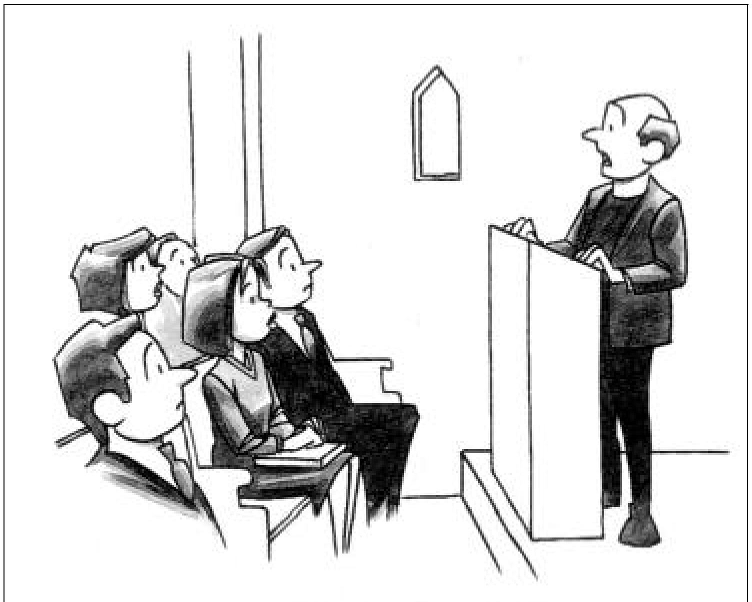
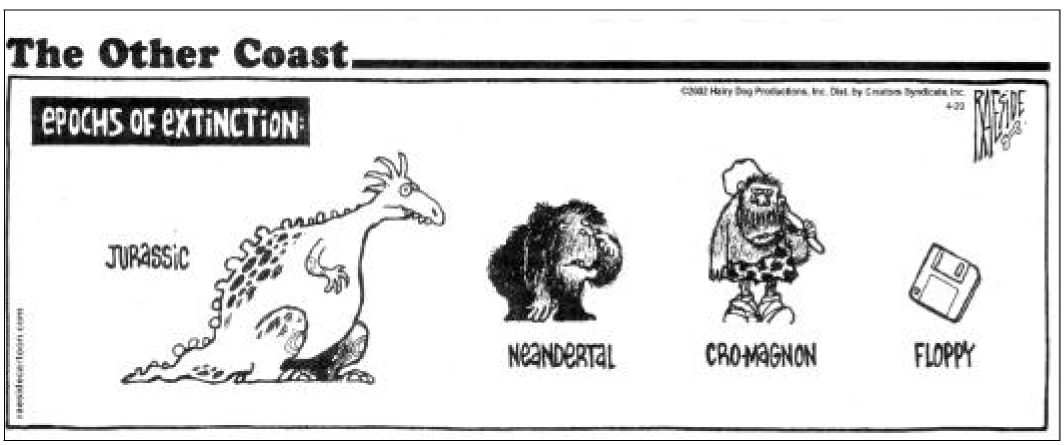
Horticultural Humor



"And now I'll take a 5-minute break
while all of you check your cell phones for messages."



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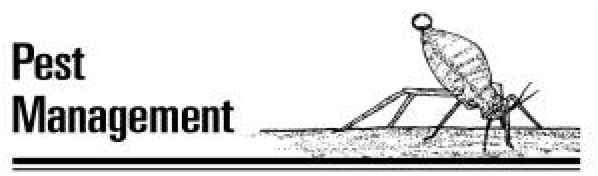

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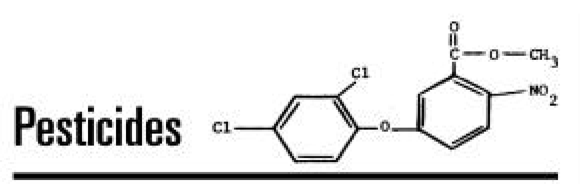

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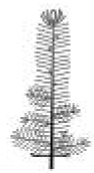

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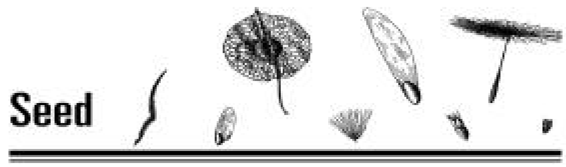

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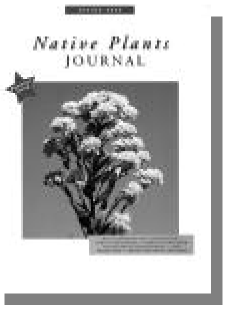

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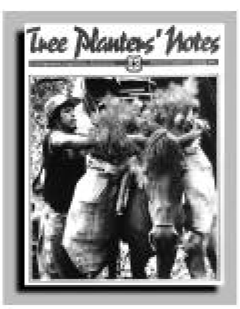

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