CANADIAN TREE IMPROVEMENT ASSOCIATION/
ASSOCIATION CANADIENNE POUR L'AMÉLIORATION DES ARBRES

Tree Seed Working Group

NEWS BULLETIN

No. 27, November 1997

A WORD FROM THE CHAIRMAN

I wish to start my term as chairman of the Tree Seed Working Group by recognising the many contributions of our previous chairman, Guy Caron, to both the Tree Seed Working Group as well as to the Maritime tree breeding 'fraternity'. I will try my best to live up to the high standards that Guy set in his many research endeavours. There are three topics I wish to comment on in this issue: 1) the Canadian Tree Improvement Association/Association canadien pour l'amélioration des arbres (CTIA/ACAA) meeting and the Tree Seed Working Group workshop held in Quebec City August 18 to 21, 1997, 2) A tour of the National Forest Genetic Resources Centre, and 3) Topics that are currently of local interest.

1. CTIA and TSWG Workshop

A special thank you is extended to those who made presentations during our workshop. Tree breeders and seed orchard managers were provided with practical and timely information. The afternoon tour of pollen bank facilities, and the Duchesnay Station where a containerized seed orchard, pollen vacuum collector and electrostatic gun were viewed, generated much discussion. The CTIA meeting itself proved to once again be of the highest calibre. There was also an evening session addressing concerns with transgenic plants and the intellectual property of genetically improved material. The discussions during this evening session confirmed the fact that virtually everyone has a different outlook on these topics. On August 21st, a special one-day session addressing timber management for wood quality and end-product value succeeded in linking timber management issues and concerns with those of reforestation and tree breeding. This was somewhat comforting to those of us where reforestation and tree breeding is often under scrutiny. So, hats off to the organizers and hosts for the 26th CTIA Meeting/Congres ACAA for a job well done!

2. Tour of the National Forest Genetic Resources Centre - Fredericton

I find of late that the day to day business of chairing the Nova Scotia Tree Improvement Working Group as well as managing the Department of Natural Resources Tree Breeding Centre leaves little time for dealing with seed related research topics. However, a tour through the National Forest Genetic Resources Centre (NFRGC) in Fredericton, which was part of the Tenth Annual Maritime Seed Orchard Managers Workshop in October, rekindled an interest in pursuing better seed storage protocols at our own facility, especially for hardwood seeds. Dale Simpson and Bernie Daigle have been working very diligently and their hard work shows by the first-class facility that is now the NFGRC. In addition to receiving an update of the new facility from Dale and Bernie, Tannis Beardmore provided us a tour of the cryopreservation lab at the NFRGC as well as a brief overview of some of the current research projects on the 'very' long-term storage of tree seeds.

The NFRGC serves as a repository for forest tree seeds, and such, Dale and Bernie welcome contributions. Dale and Bernie are always hunting for collections to enhance their current seed in storage. Dale's number is (506)452-3530.

3. Topics of local interest

The white-marked tussock moth (*Orygia leucostigma* Fitch) is very active in Nova Scotia and is currently threatening one of two valuable white spruce selection plantations. A program to control this pest will have to be launched in the spring to save years of breeding work.

The majority of forest land in Nova Scotia is privately owned. Unfortunately, there are no regulations regarding mandatory restocking of harvested areas on these private holdings. Furthermore, private nurseries in Nova Scotia are not obligated in any way to use improved tree seed for the production of reforestation stock. It is 'buyer beware' when it comes to buying trees to plant on private woodlots. Even though the extra cost of using improved seed is often not passed on to the tree purchaser, it is simply a failure on the part of the tree purchaser to recognise the extra value associated with improved nursery stock. There is obviously work to be done here to convince both the small private woodlot owners of the merits of using of genetically improved, planting stock.

I cannot believe how easy it is to have INTERNET access at home and how hard it is to have the same service at the workplace. However I'm not going to give up yet. So there may still be hope for the Tree Breeding Centre to join the Tree Seed Working Groups' INTERNET discussion group TREESEED.

Lastly, please don't forget to forward News Bulletin articles to our Editor Ron Smith who has been doing a great job. Keep up the good work, Ron.

Howard Frame

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Comments, suggestions and contributions for the Newsletter are welcomed by the editor.

EDITORS NOTES

I wish to start my comments for this issue off by offering my sincere thanks to all those who sent in material for this issue. The electronic highway is slowly but surely improving! Virtually all of the electronic versions of contributions I received required little to no reformatting, which certainly makes my life easier, and it also cuts down on the numbers of mistakes that I have to take credit for.

The TREESEED Discussion Group is alive and well. As of November, we now have 81 subscribers. The use of this group has not been excessive, but steady.

Many agencies, including that of your editor, are in the process of converting or updating electronic mail services. If you are one of those, please remember to take a moment to send me your new email address (unsubscribing to TREESEED and the resubscribing with the new address seems to pose the fewest problems).

I also want to add a quick note regarding the Canadian Federal Government program called Common Office Environment (COE). The COE program involves standardizing the software packages used through the government, and as such, we are being converted to Microsoft Exchange. During the transition period, there have been a few glitches, not the least of which was the fact that a number of messages that I posted were not delivered (without my being notified that the messages were not delivered). This problem is largely solved now. If you have recently sent a message to me and have not heard back, it is not because I am ignoring you, but probably due to the growing pains. Please don't give up or get TOO frustrated. Most of the messages that are placed 'in limbo' are eventually recovered. Thanks for your patience!

Finally, I would like to add my comments to those of our Chairman, Howard Frame on the CTIA/ACAA meeting held in Quebec City this past August. Michel Villeneuve and colleagues did an outstanding job! The meetings went off like clockwork and the hospitality was exemplary. Stephan Mercier likewise, did a great job with the Tree Seed Workshop.

Membership Update

We are in the process of updating our membership list. Attached to the May 1997 Issue of the NewsBulletin, was a form to be returned to the Editor. This is a reminder to those who have not yet done so, to please the form and return it to me by March 31, 1998. I will be purging the membership list at that time. For those who have sent in changes of addresses, etc. I haven't ignored you! These changes should be incorporated into the updated membership list for the Tree Seed Working Group which I will include with the May 1998 Issue.

Ron Smith

Erratum

A New Seed Viability Test

I goofed BIG TIME in the last NewsBulletin. I had several correspondences with Tom Noland regarding the excellent contribution he and Gina Mohammad provided for the last issue. However, in the interest of making things fit (can I blame cutbacks?), I managed to inadvertently leave off their names (there were also a couple of other errors that I will not mention at this time). Therefore, you will find included with this NewsBulletin, two replacement pages (3/4 and 5/6) Please replace the corresponding pages in the May 1997 issue of the NewsBulletin.

Again my apologies to Tom and Gina.

Ron Smith

Seed Trivia - Did you know?

In many conifers, cones hang pendant when mature, but in whitebark pine, the cones are upright and exposed along the branches, making it easier for birds to access them. The Clark's nutcracker also aids in dispersal, because whitebark pine seeds have no wings.

Interactive Effects of Substrate and Canopy Cover on Conifer Germination and First-Year Survivorship

The following is an abstract of a poster presented at the 1997 Annual Meeting of the Ecological Society of America, August 10-14, 1997, Albuquerque, New Mexico, U.S.A

Three years of field germination trials were conducted in the Coastal Western Hemlock (CWH), the Interior Douglas-fir (IDF), and the Sub-Boreal Spruce (SBS) biogeoclimatic zones of British Columbia, representing a climatic gradient of increasing continentality. Four seedbeds (mineral soil, forest floor, rotting wood, and moss mats) were tested under a range of light conditions induced by partial cutting in 120 year old even-aged stands. Counted seeds of five local conifer species were introduced to each seedbed under rodent-excluding cages at each site, with Douglas-fir and western red cedar tested at all three locations. Seed losses to rodents were nevertheless important for some (larger-seeded) tree species at some sites in some years, being greater in partially shaded plots.

Across all species, locations and years, substrate explained 22.0% of the variance in germination, compared to only 5.0% of the variance in first-year seedling survival. In contrast, canopy effects accounted for 3.2% of the variance in germination and 5.7% of the variance in survival. Germination of most species was usually highest under uncut or partially cut canopies, but survival was better under higher (but not fully open) light treatments. Moss was a universally poor substrate and rotting wood was generally superior or equivalent to mineral soil (as was burned forest floor, where tested). Undisturbed forest floor was a more effective seedbed than moss, but less effective than soil or wood. Substrate effects were often more pronounced in full-light environments, where desiccation of organic seedbeds limited both germination and survivorship. Germination was usually negatively correlated with global irradiance measurements made at each plot, the only exceptions being subalpine fir and lodgepole pine in the SBS. Field germination of other species and at other sites can be said to benefit from canopy protection. First-year survival of most tree species was positively correlated with global irradiance, though survival of a number of shade-tolerant species exhibited a negative correlation (namely, Sitka spruce, western redcedar and western hemlock in the CWH, and subalpine fir and redcedar in the SBS). Successful natural regeneration of these species is typically associated with some degree of canopy protection.

In general, rotting wood is a perfectly adequate, and often superior (e.g., in the SBS) seedbed; its presence should be maintained and encouraged in forest management, and an abundance of well decomposed wood at ground level can be considered indicative of good potential for natural regeneration. Opportunities for "spot seeding" of conifers into rotting wood may be worth pursuing. Conversely, moss mats cannot support high levels of tree seed germination or early seedling survival; this suggests that stands with a mossy understorey will not support natural regeneration without some kind of treatment (scarification) or until the moss dries up and dies back after canopy opening. Organic seedbeds are not necessarily more suitable in the shade; they apparently still dry out through a combination of evaporation and transpiration, or simply provide a physical barrier for early root penetration and nutrition of young conifer seedlings. Some level of partial canopy retention seems to promote both superior germination and early seedling survival of most species in all climates tested. Wider application of "shelterwood" methods (whether in uniform or patch configurations) of regeneration cutting should be encouraged across British Columbia.

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Stratification of White Pine & Tamarack Seed

The Atlantic Forest Seed Centre (AFSC) is always looking for ways to increase seed germination. This past spring several stratification tests were initiated at the Seed Centre. Two species, white pine and tamarack were tested. The results of these tests are presented below.

White Pine

The germination of white pine can be somewhat sporadic and low, so to address these concerns the Seed Centre has looked at length of stratification. The usual procedure for white pine at the AFSC has been a 24 hour soak, followed by a two week chilling. To test if this stratification period was optimum, we stratified 400-seed lots for two, three, or four weeks. Germination test results are presented (Table 1). Unstratified with unstratified 'fresh' seed were used as controls.

Table 1. Summary of the results from the white pine stratification test.

Stratification	Germination (%) (15 days)	Germination (%) (21 days)
Fresh	29%	33%
2 Weeks	64%	77%
3 Weeks	73%	81%
4 Weeks	69%	80%

As you can see by the results, the three week stratification at both 15 days and 21 days gives the best germination percentage. Although the 3 week stratification is not that much higher than the 2 week, the fact that it comes up quicker and has a higher overall germination should be of benefit to nurseries.

Tamarack

Although tamarack seed usually germinate quite readily without stratification, literature from the west coast suggests that stratifying seed of western larch improves its germination. To test whether or not germination could similarly be improved for tamarack, we stratified 400-seed lots for a two, three, or five week period. Germination test results are presented in the Table 2. Fresh seed was also tested as a comparison.

Table 2. Summary of the results from the tamarack stratification test.

Stratification	Germination (%) (14 days)	Germination (%) (21 days)
Fresh	32%	70%
2 Weeks	53%	67%
3 Weeks	79%	80%
5 Weeks	70%	71%

As can be seen from the results, stratifying the seed for 3 weeks gave the best results. Not only was the overall germination better, but most of the seed germinated by 14 days. Although, the unstratified seed which is the norm for tamarack gave similar results to the 2 and 5 week stratification, the germination after 14 days was considerable lower than the stratified seed.

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Report of the Annual General Meeting of the Western Forest and Conservation Nursery Association, Boise, Idaho, August 19-21, 1997

This excellent meeting was organized by Dr. Tom Landis, USDA-FS, Corvallis, OR; and Kay Bealle, Nursery Manager, Lucky Peak Nursery, Boise, ID. The theme of the meeting was "Propagating native plants for fire rehabilitation, forest health, and streambank revegetation". All papers from the meeting will be published as a General Technical Report of the USDA-FS Pacific NW Experiment Station some time in 1998.

There were a number of recurring themes relating to forest nurseries, technology transfer, and government and community involvement in forestry, which are summarized below. For me, the "take-home message" was the number of parallels (and differences) between what is happening in the American and the Canadian forest community today, plus the glimpses of what we might expect in the near future and beyond. Some of the trends or salient 'take-home messages' that I left with included the following:

Forest Nurseries: Corresponding with decreasing support for nurseries by the US federal government is an increased involvement by the private sector; Propagation of native species for conservation and restoration is increasing; An increasing number of tree, shrub, forb, and grass are being grown for non-traditional forestry uses including fire rehabilitation, streambank stabilization, wildlife forage, and improving water quality; Seeds of native species are often in short supply; and there is a general lack of knowledge on how to propagate native species.

Technology Co-operatives: Interest in technology cooperatives is increasing on both sides of the border, e.g., the Nursery Technology Coop at Oregon State University and the LUSTR Cooperative, in Thunder Bay, Ontario.

Community involvement in restoration activities: Public involvement in restoration activities as evidenced by the formation of coalitions of federal, state, and citizen groups and their involvement in rehabilitation projects as well as volunteers growing and planting trees for city streets and parks

Environmental Protection: Increasing concern over the environment has and will continue to impact forest nurseries e.g., tighter water quality standards for nursery effluents, the phasing out the use of methyl bromide (damage to human health and ozone layer) and other potentially hazardous substances.

I compliment both Tom Landis and Kay Bealle (and all the behind-the-scenes helpers) on a very successful meeting. Everything ran seamlessly, primarily due to the attention paid to the small details. Tom attends a LOT of meetings as an extension officer for the USDA-FS, so he has some definite ideas about how meetings should be run (he's a pretty big guy, too, so usually no argues with him). Tom's meeting tips were field-tested at Boise, and I can verify that they are 100% effective!

Meeting tip #1: Use the "Yaker-Saker" to ensure your speakers finish on time. No meeting should be without one! The Yaker Saker is constructed from a lawn watering timer and has three lights. The green light is lit for about 20 minutes, and the yellow light is on for about 10 minutes. When the red light comes up, you're done! The enforcer is the session moderator, who sits in the front row equipped with a water canon.

Meeting tip #2. Have trouble getting the audience back from the breaks? Offer them door prizes such baseball caps, gift certificates, etc. When attendees register for the meeting, print their registration numbers on the back of their name tag. At the meeting, 4 to 5 winning numbers are drawn promptly at the end of each break. You must be present in the meeting room to win.

Meeting tip #3. Have plenty of variety. Present technical sessions in the morning, and plan stimulating field trips for the afternoon. This helps keep audience attention and interest up for the technical sessions. Good food and BBQs don't hurt either.

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Request for Information

The following request was posted on the internet in the TREESEED Discussion Group. Although Mike did not specifically ask that it be published in the Newsbulletin, I never-the-less took the liberty to do so.

I need to track down potential sources of Eucalyptus viminalis seed. At this stage I am interested in both small single tree, source identified seedlots for possible use in a breeding program as well as larger bulk supplies suitable for broad hectare plantings.

If anyone has seed available or knows of people/organisations I can contact, particularly in South America, I would very much appreciate it.
Regards

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Upcoming Meeting

The following announcement was kindly forwarded to us by Bruce Downey on behalf of Rogelio Rodriguez-Sotres.

Sixth International Workshop on Seeds
Merida, Yucatan Mexico
January 24-28, 1999 (Tentative)

The 6th International Workshop on Seeds will be held in the City of Merida, in the Mayaland of Yucatan, Mexico. This region is famous for its numerous archaeological sites, beautiful cities, folklore, hospitality, and last but not least, its vicinity to worldwide famous Caribbean beaches.

The meeting will provide a forum for discussion of the current status of seed research and technology and will include invited plenary lectures, volunteer papers and daily poster sessions. The Workshop's format will be similar to that in previous meetings, encouraging full participation of the attendees in all sessions. Contributions to the Seed Biology Workshop are welcomed in, but not restricted to, any of the following seed-related subjects:

1. SEED DEVELOPMENT
   - Embryogenesis
   - Assimilate partitioning and reserve deposition
   - Phytohormonal control
   - Late maturation events
2. GERMINATION
   - Imbibition and early events
   - Biochemistry and Molecular Biology
   - Phytohormone action
3. SEED DORMANCY AND SEED ECOLOGY
   - Induction and breaking of dormancy
   - Biochemical and molecular basis of dormancy
   - Formation and manipulation of soil seed banks
   - Ecology of germination
4. VIGOR, STORAGE AND CONSERVATION
   - Mechanisms of seed deterioration and longevity
   - Germplasm preservation
5. APPLICATIONS OF SEED BIOLOGY
   - Modification of seed composition
   - Vegetation management via seeds
   - Seed priming, hydration and dehydration
   - Modeling dormancy and germination
   - Technology of artificial seeds

For further information, please contact:

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Can Seed Orchards Meet Demands for High-Gain Seed Production: Are Orchards Obsolete?

As breeding programs begin deploying elite breeding parents into traditional seed orchards, their random design and size may limit the cost effective production of high-gain seed. Flowering periodicity and poor control over paternal contribution (including contamination) require specific orchard management procedures (flower induction, bloom delay, SMP, crop protection) to improve the genetic worth of production crops. Certainly, traditional orchard design will provide seed with a gain approximating the average breeding value of orchard parents. However, if optimizing gain from a specified number of elite parents is important, then our concepts about large, randomly designed orchard designs must change.

Two options being seriously considered for delivery of high gain material include smaller breeding style orchards with associated vegetative bulking techniques (cuttings or embryogenesis). However, the genetic worth of any particular individual from full-sibling production is not known although sub-lines of somatic embryos are being tested. In addition to some elite clones not lending themselves to cloning (poor callusing or rooting), their costs range from about one third to four times that of a seedling established from seed. While the more cost effective delivery tool for high-gain propagules is seed production, are we prepared to change our concepts of orchard production to facilitate full-sibling seed production?

We have begun testing alternate orchard designs (see Sweet 1995) adapting some of the ideas New Zealand has developed for Radiata pine (i.e., hedge and meadow orchards). In 1991, we established a clonal-row, crowned-pruned Douglas-fir research orchard. Six ramets, spaced 2.5 within and 4 meters between rows, from each of 20 clones were established in each of four blocks. Two of the four blocks were pruned conventionally (toping with some inter-nodal branches removed) and height was maintained at 3 meters. The other two blocks received more severe pruning with most of the center bole being removed creating a bowl-like shape and height growth maintained to less than 2 meters.

British Columbia has just recently established the goal of supplying 75% of all reforestation propagules (about 200-250 million annually) from orchard seed and doubling province-wide genetic gain by the year 2007. Orchard establishment to meet these production goals are in place or are in the establishment phase. However, doubling gain in the next 10 years is another matter. One step towards meeting these goals is demonstrating that crowned-pruned clonal row orchards can produce operational quantities of full-sibling seed. However, before making specific recommendations, several questions had to be answered. Will a 2 meter tree produce or be induced to produce seed and pollen cones? Will a clonal row orchard suffer from excessive selfing? Will easier access to the flowering crop facilitate SMP efficacy and crop protection? What is the effect of competing pollen cloud density (including within and contaminating pollen) on SMP efficacy?

The answer to all these questions has been encouraging. Both pollen and seed cone production in even the severely crowned pruned material does occur. Our management strategy for flowering includes annual induction of half the orchard (one block of each of the two pruning regimes). Aside from trying to establish some limited amount of summer drought, induction involves girdling and gibberellin $A_{4/7}$ treatments. Because of the high vigour of the ramets, we use a full circle girdle, cutting to the cambium with a sharp grafting knife. Girdling is completed one-three weeks before vegetative bud flush. GA is applied as a single dose stem injection done when 10-20% of the vegetative bud flush has occurred. As part of our annual monitoring, we record the number of spring flowers, the flushing date and the number and volume of cones harvested and average filled seeds per cone per ramet. We also record the annual pollen cloud density (24 hour pollen catch) over the receptivity period of the orchard.

We have now collected three years of induction and cone maturation. Table 1 shows the annual production and seed yields for the three induction periods by clone. Table 1 does not show pollen production which has been good for all clones on both pruning regimes.

Table 1: Flowering and seed yield data for three consecutive years within a Douglas-fir clonal-row seed orchard showing the number of flowering ramets, the average number of cones and filled seed per ramet, and the average filled seed per cone per ramet for each of 20 clones within each of two pruning regimes; two meter (2M) and three meters (3M).

	1995		1996		1997	
	2M	3M	2M	3M	2M	3M
% Ramets Flowering	54.2	62.5	71.2	54.2	70.8	75.8
Number of Cones/Ramet	22.8	25.6	37.4	14.6	33.4	23
Number of Seed/Ramet	825	897	1352	478	N/A	N/A
Filled Seed/Cone	36.2	34.9	36.2	32.7	N/A	N/A

N/A - Data not available at printing

Data in Table 1 show some interesting trends. Flower response to induction treatments has been consistent for both the average percentage of ramets flowering and the average number of cones per ramet in spite of the poor natural induction conditions for these three years. Of particular interest is the response in the more severe pruning regime. Even with less than half of the crown volume, the 2 meter trees produced as many or more flowers than their 3 meter counterparts. Also the filled seed yields per cone were high, about 50% of the seed potential for Douglas-fir (30-35 filled seed per cone) which is our upper goal for operational production.

We are not certain if the average number of cones per ramet will stay constant or rise. We feel the carrying capacity of the trees is more like 60-100 cones per ramet. If this is the case then we could expect an average of 2-3 million filled seed per hectare of managed orchard (based on 1000 producing ramets per hectare at 10 m2/ramet). While we may be optimistic about attaining such numbers, we believe that operational quantities of seed can be produced in such an orchard. But can we demonstrate that full-sibling production is feasible (i.e., low selfing rates and high SMP efficacy)?

In a recent pollination trial using six of the 20 Douglas-fir clones, Stoehr et al. (1997) found selfing rates to average 6% (range 0-19%) and SMP efficacy averaged 55% (range 33-73%). The selfing rates are comparable to a conventional, randomly designed orchard and the SMP efficacy rates were greater than twice the currently accepted average value of 20% (El-Kassaby et al. 1993 and Webber 1995). We attribute this improved SMP efficacy rate to two important factors. First, access to the crop was more convenient (2-3 meter trees) compared to the taller trees (5-7 meters) in the earlier studies. Second, pollen production (we harvest as much pollen as we can) and hence, competing pollen cloud density, was less in our pruned orchard. We are currently evaluating other factors limiting production (i.e., competing pollen cloud density, pollination technique, abortion/insect losses). This includes annual monitoring of flowering, pollen cloud density, daily meteorological values (especially temperature) and routine screening of clonal seed lots using specific DNA markers (see Stoehr et al. 1997). It is our long term goal to demonstrate that crown pruned, clonal row orchards can produce operational quantities of full-sibling seed.

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1997 News from Northeastern Ontario

This short article is to let people know some of what has been going on. I have owed Ron a contribution to the News Bulletin for quite some time; I hope this is of interest to the readers.

I'll start with an item which has influenced the Tree Improvement Program in the entire province. The Ontario Ministry of Natural Resources (OMNR) and the other members of the Ontario Tree Improvement Board (OTIB) approved a new Partnership Agreement. The Agreement has dramatically changed the responsibility and funding for the tree improvement program. In a nutshell, the OMNR provides scientific and technical support for OTIB by paying for the Provincial Geneticist, Provincial Data Analyst, Provincial Tree Improvement and Genetics Coordinator, and three Regional Tree Improvement Specialists. The forest companies and other members of OTIB are responsible for all of the operational aspects and costs associated with the program.

Roguing

Now to the good stuff in the northeast! The Northeast Seed Management Association (NESMA) did the first roguing of three black spruce orchards in 1997. Two orchards at the Island Lake Tree Improvement Area had over 48,000 trees removed and chipped to reduce the original number of trees in these orchards by approximately 40%. The job was done under contract by the same company which had completed the final roguing of the two jack pine orchards at the same location in 1996.

A jack pine seed orchard managed by Domtar in White River was rogued for the first time this fall. Approximately 40% of the 21,600 trees were cut and left in the orchard. Future plans for this orchard planted in 1990 include height and condition assessment of all of the remaining trees before the crown management work in the spring of 1998.

Half of the E. B. Eddy jack pine orchard in Durban Township was rogued for the final time this past spring. The remainder will be rogued next year.

Studies

The jack pine orchard at Aidie Creek was used to get a better understanding of cone and seed ripening by picking cones every two weeks from

August 1 to October 10/97. The cone processing will be done this winter and results mentioned in another News Bulletin. In addition, a small cone collection time study was done in the same orchard to compare production rates picking from ladders and from the ground during cool and cold weather conditions. A small study of squirrel cone collection habits was also done in this orchard; the results will help planning future cone collections in jack pine orchards.

The Cone Crop Monitoring System which was developed by Frank Schenkenburger and Peter deGroot was used in two jack pine orchards to estimate cone crop size, seed production and to determine the cone and seed pests in the orchard. This software which is part of a larger decision support system is used on a regular basis to "keep tabs on" the productivity of orchards.

The black spruce orchard at Aidie Creek received nitrogen fertilization to induce flowering in 1996. The assessment of the results will be available in the winter. However, preliminary results show that the treatment was probably not effective; this may have been due to the generally poor year for black spruce cone production, so we may have provided more evidence that treatments will not overcome Mother Nature's own agenda. Cone induction fertilization was carried out in the Ramore jack pine orchard this spring; more on this later.

The two jack pine and two black spruce Farm Field Tests at the Swastika Tree Nursery were assessed in September. The total height and condition were recorded; these tests have been assessed annually for five to seven years depending on year of planting. The next step is to do some additional analysis with the data to determine things such as age/age correlations.

Advanced Generation Work

In the fall of 1996, the selections for the Breeding Zone # 1 advanced generation seed orchard were made. The Infusion or Main population selections numbered 300 and 49 Elite selections were made as per the strategy presented by Dennis Joyce at the 1993 Canadian Tree Improvement Association meeting in Frederiction, N. B.

The crop was sown at the Swastika Tree Nursery in April 1997 and placed in the holding area in August after choosing the best seedlings from each selection to be used at the planting sites. The height of the trees in the Elite population were measured in September; Infusion and Elite trees were packed for frozen storage in the first week of November. The two Elite sites and one Infusion site will be planted as early as possible in 1998 in the Chapleau area..

The plan is to begin the process with a black spruce population beginning in the fall of 1998 and have it completed in the summer of 2000.

Software

The final version of Seedwhere will soon be released; this is a system built on the Ontario Climate Model to match up seed sources with acceptable planting areas. The initial work for this and revising the Seed Zones began about six years ago.

Earlier this year we were looking for a method of calculating the cost/benefit of crown management from the point of view of cone collection costs. Richard Fleming and Tim Burns at the CFS in Sault Ste. Marie have provided us with a simple model which we have just begun testing.

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Norway Spruce Breeding

In the last News Bulletin, Howard Frame reported some results on the breeding success of the agencies involved in Norway spruce breeding in the Maritimes. We would like to present some results from controlled crosses conducted as part of genetic studies of at the Canadian Forest Service, Laurentian Forestry Centre. All the results presented hereafter are for controlled crosses made to evaluate, among other parameters, specific combining ability (one source of pollen per cross). Both fresh and stored pollen was used. In 1994, 2 out of 12 sources (genotypes) of pollen used were stored in a freezer. Although not verified statistically, it did not appear that seed set differed between fresh and stored pollen. Pollen was applied with a syringe, and on average, about 1 ml of pollen was used per pollination, per bag. A cross was considered successful when at least one sound seed per cone was produced.

Table 1 presents the breeding success obtained from 1994 to 1996. In 1995, all the crosses were made on one genotype because no natural flowering occurred and only one reacted to flower induction treatment. Climatic conditions prevailing the year before were not favourable to flower bud differentiation.

Table 1. Norway spruce breeding summary of the number of crosses (CR) and (% success), number of pollinations (NP), number of cones (NC), total numbers of full seeds (FS), sound seeds per cone (SSPC), the coefficient of variation (CV) and range for SSPC.

YEAR	CR	NP	NC	FS	SSPC	CV (%)	RANGE
1994	77 (70)	2	407	10762	32	122	2-196
1995	9 (100)	2	49	4244	90	50	2-177
1996	106 (99)	1	559	29431	54	94	1-230

In 1996, we obtained 70% more seeds per cone (32 vs. 54) than in 1994 even if one pollination was used instead of two. The main explanation of this success is simply because pollination was better synchronized with female flower receptivity. Ovuliferous scales of Norway spruce female flowers must be completely depressed (or reversed) to be fully receptive; unlike our native spruces, which are fully receptive when the margins of the scales are reflexed. To choose the best time to pollinate, variation between genotypes must also be considered. Norway spruce female flowers, according to genotype and origin, show a great variation in the degree of ovuliferous scale depression. This factor and the quality of some pollen lots could explain why the coefficient of variation remained high in 1996.

Compared with the SSPC obtained from open pollination in the same breeding orchard, we obtained about the same relative success for 1994 and 1996 (Table 2) but we can see that our pollination technique was less efficient (relative success) than natural pollination. Although seed yields are not high, we easily obtain 150 to 200 sound seeds per cross, with a germination percentage generally over 80%.

Assuming good quality pollen is applied at the optimum time, we believe that the next step to increase SSPC is to improve the pollination technique e.g., should we consider the brush pollination technique? Some plant breeders prefer it, but in forestry this technique is not so easy to use considering the risk of contamination and the length of the process.

Table 2. Sound seeds per cone from open-pollination (SSPC-OP) and controlled crosses (SSPC-CP) in the Valcartier Norway spruce breeding orchard and relative success (RS) of controlled pollination (SSPC-OP/SSPC-CP) for 1994 and 1996.

YEAR	SSPC-OP	SSPC-CP	RS (%)
1994	66	32	48
1996	142	54	38

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Cone Crop Monitoring Goes Hi-Tech.

ConeSys is a computer software package designed to assist seed orchard managers to collect, process and store information about the quality and quantity of seed orchard crops. ConeSys also contains a data base on cone and seed insects and registered pest control products and their efficacy and a decision support program that determines the costs and benefits of various pest management options.

ConeSys was developed in Ontario from 1990 to 1996, as result of a series of consultations, workshops and field trials with seed orchard managers. The data collection program, which became known as the Cone Crop Monitoring System (CCMS) was based on the cone and seed inventory management system developed in the southern US states and from our experience gained by constructing life tables for jack pine and black spruce A pilot program in 1991 allowed seed orchard managers to become familiar with the concepts and practice of CCMS and determine its utility. After collecting data for one year, it became obvious that collecting and handling data was cumbersome and tedious and that automation was necessary. Seed orchard managers also recognized the need to sort and manage accumulating information on insects and control from various sources into an information management system (IMS) and the need to process this information along with CCMS data into a decision support system (DSS).

ConeSys incorporates four menu-driven modules or programs. The first program (CCMSDAT) collects data on the size and condition of a cone crop at various times. Editing and processing of the data is done by CCMSPC, which also makes predictions about future cone, seed and seedling yields. The third program called CCMSIMS provides information on cone and seed insects and registered pest control products and their efficacy. CCMSDSS is a decision support program that determines the costs and benefits of various pest management options or scenarios. Typically, users would proceed sequentially through the four programs, that is, they would collect data with CCMSDAT, process it with CCMSPC followed by an examination of CCMSIMS to obtain data about the pest and control products and then proceed to CCMSDSS to make a decision. Each program can also be used independently; for example, to identify an insect the seed orchard manager would use the identification key provided in CCMSIMS.

ConeSys is a DOS-based program designed to run on an IBM-compatible 80386 PC or higher and requires DOS 3.1 or higher, a minimum of 4 MB of RAM and approximately 4 MB of available hard disk space. The data collection program CCMSDAT was intended for use on a hand held DAP technologies PC1000 or PC9000® data logger with accompanying communications hardware and software: it will also run on most PCs.

ConeSys has been and can be used in a number of ways. Thus far seed orchard managers in Ontario have primarily used CCMSDAT and CCMSPC to determine the size and health of their seed orchard crop. The predictive capabilities of CCMSPC have enabled them to estimate work load requirements for harvesting cones. This has been especially useful for contracting out. Preliminary field trials have indicated that the amount of cones harvested have been within 1-3 hectolitres of the estimate provided by CCMSPC. ConeSys has also been used to identify good and poor crop tree, clones or families. Some seed orchard managers have chosen not to identify the cause of seed losses in order to expedite the data collection process. ConeSys is versatile and thus can be tailored to meet the needs of most seed orchard managers. Other seed orchard managers are using ConeSys to evaluate the effects of fertilization and other cultural treatments on cone and seed production: ConeSys has a built in feature to enable users to identify various treatments.

A detailed user's guide describing step-by-step procedures in ConeSys and the software are available from

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N.B.T.I.C. : 20 Years Together and 10 years of Breeding

The New Brunswick Tree Improvement Council recently celebrated its twenty-year anniversary. Industry and government, as well as the universities, have co-operated to achieve genetic improvement of four native species: black spruce (*Picea mariana* (Mill. B.S.P.)) , white spruce (*Picea glauca* (Moench) Voss), jack pine (*Pinus banksiana* Lamb.) and tamarack (*Larix laricina* (Du Roi) K. Koch). The landmark for the N.B. Dept. of Natural Resources and Energy (D.N.R.E.) is ten years of tree breeding.

Techniques have been refined and skills improved over the years as staff has become familiar with the biology of the four species in the program. In the last ten years, D.N.R.E. has bagged almost 200,000 females using close to 8700 bags equaling almost 2500 crosses (Table 1).

Table 1. Summary, by species, of tree breeding efforts in New Brunswick for the period 1986-1996.

	Tamarack	White spruce	Black spruce	Jack pine
No. Bags	1928	3378	451	2941
No. ♀ Bagged	43854	110146	22956	18753
No. Crosses	444	941	321	734
Avg No. ♀ /bag	21.0	29.2	34.0	5.3
Avg No. full seeds per cone	5.0	10.9	8.9	17.2

Amalgamating ten years worth of tree breeding data has resulted in some interesting (but obvious in the field) trends. When looking at Table 1, you see that because jack pine females are located all over the tree, you tend to get fewer numbers of flowers per bag than, for example, with the spruces.

The number of full seeds per cone varies quite a bit, but in jack pine, seemed to increase in 1993 when we started doing our controlled pollinations exclusively in the breeding garden (Figure 1). Doing the pollinations in the breeding garden allowed us to keep a closer eye on female receptivity than when the work was done in family tests in the filed. Those who work with jack pine know that, with respect to time of receptivity, this species shows a great variation among clones and even on females located on the same trees.

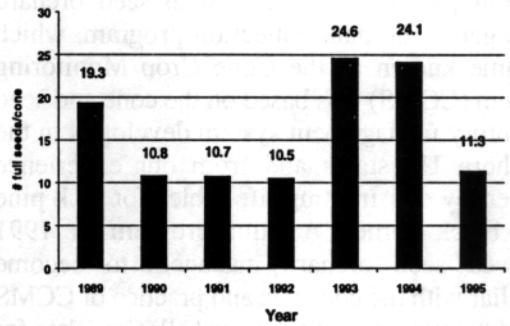

Figure 1. Summary of the mean numbers of full seeds per cone from controlled pollinations, by year, in jack pine.

Our breeding efforts have resulted in rogueing of 1st generation white spruce and tamarack clonal seed orchards, testing of 2nd generation black spruce and jack pine selections , and producing material for 2nd generation white spruce selections as well as 3rd generation black spruce and jack pine selections.

Since 1990, D.N.R.E. has grown only improved stock for its reforestation efforts and is currently harvesting second generation seed from its black spruce and jack pine orchards. The demand for seedlings reached an all time low in 1993, so meeting reforestation quotas hasn't been difficult (Figure 2).

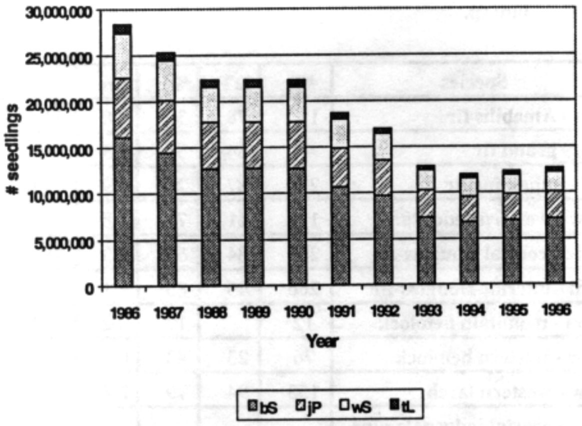

Figure 2. Seedling production, by species, at New Brunswick Provincial nurseries 1986-1996; black spruce (bS), jack pine (jP), white spruce(wS), and tamarack (tL).

We have also improved our pollen handling techniques over the years, and currently have close to three kilograms of viable pollen in storage (Figure 3).

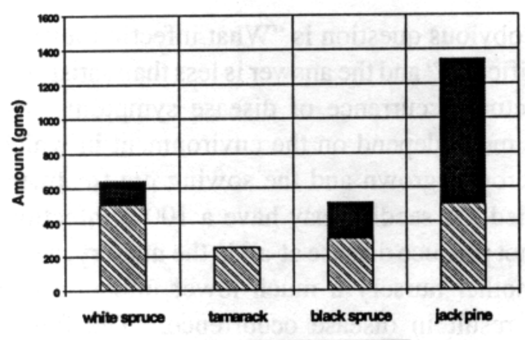

Figure 3. Summary of pollen in storage as of 1996.

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Fungal Assay Results

The BC Ministry of Forests Tree Seed Centre has been testing seedlots for seed-borne pathogens since 1991. To date, there have been 3667 tests performed on the three most significant pathogens: *Caloscypha fulgens* [seed or cold fungus]; *Fusarium sp* [that may cause damping-off or root rot] and *Sirococcus conigenus* [Sirococcus blight]. This note is intended to provide a summary of this fungal assay testing.

Fungal assays are important for seed owners to understand the disease potential of seedlots they own and possible correct problems related to collection and post-collection handling methods. For nurseries the fungal assays indicate seedlots which may cause diseases and may benefit from seed treatments. The status of fungal assay testing is presented in Table 1. Column headings are explained here for simplicity:

- **[#T]** is the total number of tests performed by host pathogen combination
- **[%T]** is the percentage of seedlots tested
- **[%I]** is the percentage of seedlots tested showing an infection > 0.0 %
- **[Ave]** is the mean infection percentage of infected seedlots; and
- **[MaxI]** is the maximum infection percentage of tested seedlots.

The fungal assay results are intended to identify seedlots infected with seed-borne pathogens that may result in disease occurrence at the nursery. The percentage of seedlots showing an infection [%I] indicates the probability or risk of encountering a seedlot infected with a pathogen (e.g. Fdc-coastal Douglas-fir has a 67% probability of being infected with *Fusarium* sp.). The average infection percentage indicates the severity of infection as the proportion of seeds harboring the pathogen. This value allows one to assess the level of infection of an individual seedlots as compared to the species average. The maximum infection percentage indicates the worst-case scenario for each species/pathogen combination.

Table 1. Summary of the current status of fungal assay testing, by pathogen and tree species.

A. Caloscypha fulgens

Species	#T	%T	%I	Ave	MaxI
Ba - Amabilis fir	64	28	13	0.9	2.0
Bg - grand fir					
Bl - subalpine fir	73	45	42	2.6	9.6
Cw - western redcedar					
Fdc - coastal Douglas-fir	70	21	1	0.4	0.4
Fdi - interior Douglas-fir	98	17	7	1.0	4.4
Hm - mountain hemlock					
Hw - western hemlock	49	15	6	0.4	0.4
Lw - western larch					
Plc - coastal lodgepole pine	4	8	0	0.0	0.0
Pli - interior lodgepole pine	32	2	0	0.0	0.0
Pw - western white pine					
Py - Ponderosa pine	3	2	0	0.0	0.0
SS - Sitka spruce	13	7	31	14.4	37.6
Sx - interior spruce	180	15	24	2.2	16.0
SxS - Sitka X interior hybrid spruce	2	4	100	1.1	1.8
Ye - yellow cedar					
	588		17	2.5	37.6

B. Sirococcus conigenus

Species	#T	%T	%I	Ave	MaxI
Ba - Amabilis fir					
Bg - grand fir					
Bl - subalpine fir					
Cw - western redcedar					
Fdc - coastal Douglas-fir	4	1	0	0.0	0.0
Fdi - interior Douglas-fir	6	1	0	0.0	0.0
Hm - mountain hemlock					
Hw - western hemlock	92	27	12	0.5	1.6
Lw - western larch	2	1	100	0.9	1.4
Plc - coastal lodgepole pine	6	12	0	0.0	0.0
Pli - interior lodgepole pine	10	1	0	0.0	0.0
Pw - western white pine					
Py - Ponderosa pine					
SS - Sitka spruce	28	14	21	0.3	1.1
Sx - interior spruce	474	39	25	0.7	3.6
SxS - Sitka X interior hybrid spruce	14	29	29	0.6	1.0
Ye - yellow cedar					
	634		23	0.7	3.6

C. Fusarium sp.

Species	#T	%T	%I	Ave	MaxI
Ba - Amabilis fir	180	78	33	0.8	11.6
Bg - grand fir	49	84	37	1.3	7.0
Bl - subalpine fir	239	87	24	0.9	14.0
Cw - western redcedar	112	41	71	1.8	20.4
Fdc - coastal Douglas-fir	284	84	67	2.3	75.4
Fdi - interior Douglas-fir	266	45	85	2.1	19.4
Hm - mountain hemlock	12		17	0.2	0.2
Hw - western hemlock	76	23	43	0.8	4.8
Lw - western larch	153	94	79	2.8	43.2
Plc - coastal lodgepole pine					
Pli - interior lodgepole pine	488	33	6	0.3	1.2
Pw - western white pine	42	37	79	1.7	5.8
Py - Ponderosa pine	90	58	71	1.9	9.8
SS - Sitka spruce	8	4	38	1.7	4.0
Sx - interior spruce	442	41	35	1.8	39.8
SxS - Sitka X interior hybrid spruce	1	2	100	3.8	3.8
Ye - yellow cedar	3	5	33	0.2	0.2
	2445		44	1.9	75.4

The obvious question is "What infection level is significant?" and the answer is less than satisfying as actual occurrence of disease symptoms will very much depend on the environment in which the crop is grown and the sowing pre-treatment applied. A seedlot may have a 100% infection, but not produce disease at-all in the nursery, while at another nursery a much lower infection rate may result in disease occurrence. The fungal assays are based on dry seed as the results are more reproducible than with stratified seed and stratification regimes may vary by nurseries performing their own seed pretreatment. The situation is even more complex for *Fusarium* assays as results are only to the genus level, although individual *Fusarium* species may or may not be pathogenic to conifer tree seeds. For those interested in more details on fungal assay protocols or contractors providing this service please contact me directly.

A set of tree species/pathogen priories has been established based on nursery experience and discussions among the following people: Paige Axelrood, BC Research; John Dennis, Canadian

Forest Service; Melody Neumann, ECOS Biological Consultants (currently working on her Ph.D. in Australia); Mike Peterson, Applied Forest Sciences; Dave Trotter, Nursery Extension Services and myself.

Table 2. Summary of fungal assay testing priorities, by species, for Fusarium spp. (Fus), Caloscypha (Cal) and Sirococcus (Sir).

Species	Fus	Cal	Sir
Ba - Amabilis fir	Medium	Medium	Low
Bg - grand fir	Low	Low	Low
Bl - subalpine fir	High	High	Low
Cw - western redcedar	Low	Low	Low
Fdc - coastal Douglas-fir	Low	High	Low
Fdi - interior Douglas-fir	Low	Low	Low
Hw - western hemlock	Low	Medium	Low
Lw - western larch	Low	High	Low
Plc - coastal lodgepole pine	Low	Low	Low
Pli - interior lodgepole pine	Low	Low	Low
Pw - western white pine	Low	High	Low
Py - Ponderosa pine	Low	High	Low
SS - Sitka spruce	High	High	High
Sx - interior spruce	High	High	High
SxS - Sitka X interior hybrid spruce	High	High	High
Ye - yellow cedar	Low	Low	Low

These fungal assay priorities are being used to schedule testing of new seedlots and those in long-term storage which have not been tested.

Please note: The information contained in this article will also be included in an upcoming issue of Seed and Seedling Extension Topics, the newsletter published by the BC Ministry of Forests, Nursery and Seed Operations Branch

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(See page 2 for Daves' address)

Recent Publications

Burczyk, J., T. Nikkanen, and A. Lewandowski, 1997. Evidence of an Unbalanced Mating Pattern in a Seed Orchard Composed of Two Larch Species. Silvae Gen. 46:176-181.

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