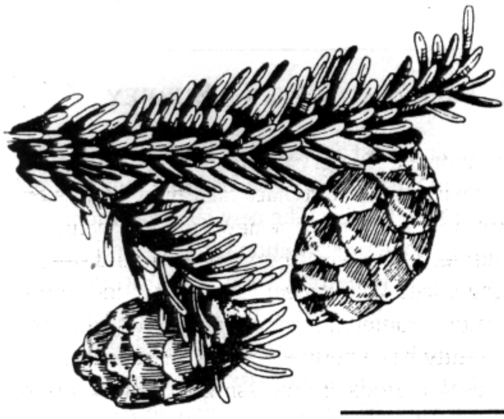
CANADIAN TREE IMPROVEMENT ASSOCIATION/
ASSOCIATION CANADIENNE POUR L'AMÉLIORATION DES ARBRES



Tree Seed Working Group

NEWSBULLETIN 20

No. 20 November 1993

A WORD FROM THE CHAIRPERSON

This year marks the 10th anniversary of the Tree Seed Working Group. From the original 93, membership has raised to 226. The TSWG has held regular Workshops at all but one CTIA meeting since its creation. Hugh Schooley presented a poster on the short history of TSWG at the recent 24th CTIA meeting in Fredericton.

This year's TSWG workshop themed "Seed Testing" tied in with the newly created Tree Seed Processing and Testing Working Party. Special thanks to Dave Kolotelo, Stephan Mercier, Peter de Groot, and Frank Schnekenburger for their interesting presentations.

The Tree Seed Working Group held its regular Biennial Business Meeting on August 16. Hugh Schooley will continue his great work as Editor of the NewsBulletin.

In 1993, Dave Bewick resigned as Coordinator of the TSPTWP owing to a new job reappointment. Dave Kolotelo acted as interim coordinator until his official appointment at the TSWG business meeting. The TSPTWP will try to serve the need of the many seed users of the TSWG. Objectives and activities planned for the TSPTWP can be read in this issue of the NewsBulletin.

Efforts will be made in the next two years to increase participation to the Cone and Seed Insect Working Party. Peter de Groot will encourage members of the IPMISO (Integrated Pest Management in Seed Orchards) Network to submit information reports of their activities and research findings to the NewsBulletin. IPMISO is comprised of entomologists, pathologists, and seed orchard pest managers with a focus of developing integrated pest management systems for seed orchards. Through this information exchange, both the CSIWP and IPMISO should benefit.

The TSWG intends to be actively involved in the 25th CTIA meeting to be held in Victoria, B.C. in 1995 by hosting another Workshop. In addition, a tour to the Surrey Seed Center has been requested by membership. Dave Kolotelo will act as liaison with the organizing committee of the 25th CTIA meeting. Please submit your suggestions for a theme and names of potential speakers.

— *Guy E. Caron, Group Chairperson*

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Queries, comments, and contributions of the "NEWSBULLETIN" are welcomed by the chairperson or the editor.

Tree Seed Processing and Testing Working Party (TSPTWP)

The TSPTWP had an informal meeting at the recent CTIA to discuss objectives and activities. It was generally agreed that this was a WP directed at operational facilities and should include the nurseries or seed users. Many members are unable to attend CTIA meetings and the WP should facilitate the exchange of information of concern to the membership. As a first step, the group agreed that each issue of this Newsbulletin could contain an article on one of the seed processing and testing facilities in Canada. The intent is to inform others on what is happening at these facilities (i.e.) what equipment is being used; what developments are occurring and what problem areas there are. This issue will feature the Tree Seed Centre of the BC Forest Service followed by the Kingclear, N.B facility for the Maritimes, in the March issue of the Newsbulletin.

All members favoured a relaxed, informal format for the committee, but no major concerns were raised for putting forward the WP's objectives. I feel the formalization of our objectives will be beneficial to attract new members and remind ourselves why we have this Working Party. Our objectives are:

1. To provide a forum for the discussion and exchange of information regarding tree seed processing, testing, storage and utilization.
2. To maintain an up-to-date directory of tree seed processing , testing and storage facilities.
3. To develop and promote standard procedures for processing, testing and utilizing tree seed.
4. To contribute to National statistics on amount of seed in storage and annual usage.

I look forward to receiving feedback on the TSPTWP objectives as described. Future considerations will be to update available information on processing, testing and storage facilities. In 1987 a Forest Tree Seed Storage Questionnaire was sent to facilities across Canada which supplied a page of information per facility; I feel it is worthwhile to update this list with additional information on processing equipment and testing facilities. There was debate on the usefulness of this information and whether the format should be reduced to give barebone facts of each facility. Your input will determine the direction of this objective.

A final note: if anyone has ideas on a theme for the 1995 CTIA Tree Seed Working Party workshop to be held in Victoria, B.C. please forward them to Guy, Hugh or myself.

— *David Kolotelo, Working Party Coordinator*

Editor's Notes

'Information is the only resource that grows richer when it is used'. I don't know who's words these are but they tell the truth. You are all invited to contribute some of your information to the next issue of our Newsbulletin. Do so and it is certain you will be helping someone.

— *Hugh Schooley*

B.C. Tree Seed Centre, Surrey

The British Columbia Forest Service Tree Seed Centre (TSC) was built in 1986 in Surrey to replace facilities which operated in Duncan from 1956 to 1986. The new facilities include areas for cone holding, cone preconditioning, cone and seed processing, seed storage, seed withdrawal and preparation, shipping, a seed laboratory, conference room and office space for staff. The TSC currently has a permanent staff of 12 with up to 20 auxiliary staff for peak periods of processing, inventory and seed preparation. Each year the TSC processes between 7000 to 10 000 hectoliters (hl) of cones averaged over about 200 to 300 new seedlots. The current inventory of seeds in storage is about 55 000 Kg representing over 4500 seedlots, 15 major species and several exotic wild stand and orchard sources. The seed preparation program annually handles about 2500 kg of seed for about 6000 individual seedling requests.

The cone holding area, protected from weather and predation, holds up to 6400 cone sacks stored on racks to receive ventilation from all sides. The cone preconditioning area is primarily used for *Abies* sp. which due to cone breakup are collected earlier and require more controlled conditions for after ripening. Generally all crops require dry, aerated storage from one to 12 weeks, during which time the moisture content of the cones and seeds gradually decreases mimicking the natural process of seed dispersal. Proper aeration and turning of cone sacks during storage is essential to disperse heat generated from cones drying and opening. Improper post collection handling can result in overheating, mold and/or casehardening, and result in a reduction in seed yield, and/or seed performance.

The processing plant which removes the seed from cones is comprised of a Bevco conveying system, a cross circulating batch kiln and a tumbler. Cones are manually input into the system and passed through an initial screening to remove debris and/or released seeds. The conveying system then takes the cones and spreads them onto trays which are automatically stacked onto dollies in preparation for kilning. The kiln has three chambers with a variety of kiln programs which range from 35 to 60°C for various durations. After kilning, dollies are unloaded onto the conveying system and cones are automatically loaded into the tumbler for seed extraction. The trays then continue along the conveying system for the loading of more cones to be kilned. The tumbler separates seeds from opened cones through rotary action within a cylindrical screen. Cones are vacuumed out of the building, disposed of on a contractual basis. Small lot tumblers are also available when seedlot size makes the standard tumbler inefficient in recovering seed.

The *Abies* species are not kilned as cone breakup is achieved through preconditioning and a separate processing line is dedicated to the *Abies* sp. This processing line is comprised of a four-screened vibratory machine (BM & M) and a two screened (Hance) scalper for peak production periods. This equipment separates seeds from axis', scales and other large particles.

The seed is cleaned in an integrated large scale production system (from BCC). The initial stage is scalping or screening of material to remove particles which could mechanically damage the seed during subsequent cleaning. The scalper consists of two initial electromagnetic screens followed by four eccentric drive grading screens. The separated seed is then placed in a rotary dewinger. All *Picea* sp. and *Pinus* sp., except white pine, are dewinged in warm water. The remaining species are dry dewinged. The wet dewinged seed is passed over an intermediate cleaning screen to remove further impurities followed by a liquid separation. Dry dewinged seed goes directly to secondary cleaning.

The liquid separation process is designed to remove resin, rocks and mechanically damaged seed. The moistened seed is then placed into a 3-staged seed dryer which uses progressively warmer and drier dehumidified air (30-35°C) to gently dry the seed to a target moisture content of 8%. The dry dewinged seed are generally at this low MC and require no further drying, although *Larix* and *Abies* sp. sometimes require additional drying due to their water retaining abilities or cone processing methods. The final stages in seed cleaning are the sizing of seed into four fractions on a scalper and the subsequent specific gravity separation of each fraction into three grades. This allows very efficient removal of debris. Fractions are presently recombined to form one homogeneous seedlot.

For specific seedlots or situations other machinery may be used in secondary cleaning (after dewinging) to increase efficiency. An M2B and fanning mill is used to separate out impurities. A newly acquired Micro III Crippen fanning mill is currently being installed and we do not have any experience with its use. A gravity table is also used for some species to provide a quick and efficient method of separating debris and/or unfilled seeds although it is infamous for requiring that the operator have a clear understanding of the principles of specific gravity separation.

After seeds are cleaned they are put into cool storage until moisture content and purity are determined. Ministry policy states that seeds must be between 4 and 9.9% moisture content and at least 97% purity for registration. The seed must be registered if it is to be used for crown land reforestation. The seedlot is further tested to determine seed size, germination percent and rate and an X-ray is taken of a representative sample as a permanent record of the seedlot. Sampling, preparation and testing procedures are based on ISTA and/or AOSA rules and procedures with some deviation based on additional information or logistical considerations.

Once registration requirements are met seeds are stored in one of three secure vaults operated at -18°C. Seeds are stored in plastic bags placed in waxed cardboard boxes. Withdrawal from storage occurs as requests for sowing or other purposes are received. Each year seedlots which have been actively used are withdrawn and inventoried; every second year a full inventory of all seedlots occurs. All species except Western red cedar (Cw) are stratified prior to sowing. Stratification is performed by the TSC 88% of the seedlots shipped; the remaining 12% are stratified by the nursery growing the seedlings. In addition to TSC stratification, clients may request enhanced separation such as Density Separation Processing; these services are in development and are applied to only a small volume. TSC preparation for sowing involves a 24-48 hour running water soak, drying and a warm and/or cold stratification period. The sequence of events and duration varies with species and in some cases, preferred test type. Western red cedar is coated with diatomaceous earth and binder i.e. pelletized, to facilitate handling during precision sowing. The pelletting service is provided on a contract basis.

Seed is shipped from the TSC in styrofoam boxes with icepacks to ensure conditions are cool and seed is not damaged in this fragile imbibed condition. The majority of shipping is overnight courier delivery service. We currently test about 10% of our sowing requests for moisture content and/or germination as part of our quality assurance program prior to shipping. We are investigating quick non-destructive methods of measuring MC (in the 20-40% range) prior to shipping and would be interested if other facilities have discovered equipment to this end.

Other recent developments include a PC-MS-Windows data base handling system (Cone and Seed Processing (CONSEP)) supporting all of our data tracking needs for cone processing and seed extraction, inventory, seed preparation, lab test results, schedules and other functions which are not well integrated in current PC systems.

One aspect of the seed extraction process that needs improvement is the control of relative humidity (RH) during kilning. We can control RH to some extent through overhead misting which circulates moisture through the chamber, but we generally do not get sufficient moisture with this process. A more efficient method that can be programmed into the kilning process along with temperature is required. The traditional procedure of drying seeds before stratification is being questioned and George Edwards and Carole Leadem are suggesting that the partial drying (required to enable efficient drying at the nursery) is preferably done after most or all of stratification is complete. This would increase the chances of adequate imbibition occurring. I am very interested in drying methods used across the country and if anyone has compared partially drying prior to and after stratification in terms of its effectiveness. Seed sizing and subsequent separate nursery culture has become an operational reality in the southern pines, but I am unaware of work published in this area for Canadian conifers. If anyone has further information on this topic we would be very interested in the results obtained.

Current research at the TSC involves the optimization of pretreatment methods for our conifers especially yellow cypress and western white pine which appear to have the most complex dormancy mechanisms of major B.C. conifers. The benefit of extended stratification on spruce seedlots and the variability in response between half sib-families is being addressed to aid in optimizing returns from these valuable seedlots. Seed storage is an area of continued work through analysis of available data and the initiation of long-term accelerated aging trials. The effects of temperature, moisture content and light and their relative importance need long-term examination to better understand the variability of dormancy, germination, and stratification mechanisms and their requirements.

We conduct tours at the TSC and look forward to seeing you here for the 1995 CTIA meeting if not sooner.

— *David Kolotelo*

IUFRO Cone and Seed Insects, Working Party S2.07-01

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This working party has about 280 names on their mailing/membership list (world wide) and produces an informative newsletter. They are in the process of updating their membership list and will use the information produced from a questionnaire to develop and distribute a membership directory similar to that of the CTIA-TSWG (our group). If you want to join this working party contact the Leader for a questionnaire immediately.

1992 Ontario Seed Orchard Survey

This survey, designed to develop an inventory of insect, disease and abiotic problems in seed orchards, was carried out for the third year in 1992. The program includes six white spruce, 14 black spruce, four jack pine, and one white pine seed orchards. Two visits are made each year, with 150 trees scrutinized in each seed orchard on each visit. The results of 1992's survey are as follows:

Insects - The eastern spruce budworm (*Choristoneura fumiferana*) was again the most prevalent insect. It was present in all white and in 13 black spruce seed orchards. The proportion of trees attacked ranged from 2.7 to 100%, with corresponding average defoliation ranging from 1 to 20%. The most severe damage was in a white spruce seed orchard where 100% of the trees were infested, with 20% average defoliation.

The yellowheaded spruce sawfly (*Pikonema alaskensis*) was found in two white spruce and six black spruce seed orchards. The numbers of trees infested varied from 1.6 to 8% and average defoliation of infested trees ranged from 1 to 10%.

The white pine weevil (*Pissodes strobi*) was found in eight black spruce, three white spruce, four jack pine and one white pine seed orchards. The proportion of leaders destroyed ranged from 1.3% in a jack pine seed, to 13.3% in a black spruce seed orchard.

The eastern pine shoot borer (*Eucosma gloriola*) was found in all four jack pine orchards and in the white pine seed orchard. Incidence and damage were low at three of the five locations, but serious in two jack pine orchards where 32.7 and 16.7% of the leaders, respectively, were destroyed.

The jack pine budworm (*Choristoneura p. pinus*) was found at the same two locations, infesting 67% and 4% trees. Defoliation, however, was very light (2 and 1%).

Other insects encountered but not causing any significant damage included the jack pine tip beetle (*Conophthorus banksianae*), the northern pitch twig moth (*Petrova albicapitana*), the spruce coneworm (*Dioryctria reniculelloides*) and the spruce shootworm (*Zeiraphera* spp.)

Diseases - The most commonly encountered diseases were two spruce needle rusts, *Chrysomyxa ledi* and *C. ledicola* which were found in five black and one white spruce seed orchards. Although the incidence was as high as 100% at two locations, actual foliar damage was 5% or less at all sites.

Armillaria root rot (*Armillaria ostoyae*) was found in four black and one white spruce seed orchards. The incidence was quite low, with the highest count 6.6% at one black spruce orchard, however, similarly low levels of damage recurring from year to year have a serious cumulative affect on plantations.

Diplodia tip blight (*Sphaeropsis sapinea*) infected 7.3 and 11.3% of the trees in two black spruce orchards.

Other diseases that were observed but which did not cause appreciable damage included spruce cone rust (*Chrysomyxa pirolata*), western gall rust (*Endrocronartium harknessii*), white pine blister rust (*Cronartium ribicola*), needle cast disease (*Isthmiella crepidiformis* and *Davisomycella ampla*) and pine needle rust (*Coleosporium asterum*).

Abiotic - Damage by late-spring frosts was prevalent in all six white and in five black spruce and in one jack pine orchards. The affected spruce plantations were all in northwestern Ontario. The heaviest damage was in a white spruce orchard, and a black spruce orchard; incidence rates were 95.3 and 74.7%, respectively, with accompanying new shoot damage of 13.0 and 19.0%. The affected jack pine orchard had 5% foliar damage on 1.3% of the trees. Chlorosis (yellowing of foliage), which is usually site-related, was recorded in five black spruce and two jack pine seed orchards. The number of trees affected was quite low in all cases, except for a jack pine orchard where 12.7% of the trees sustained average foliar damage of 30%.

(Information extracted from Can. Forest Service, Forest Insect and Disease Survey Bulletin for Ontario, Spring 1993. See Issue #18, page 8, for 1991 and Issue #16, page 6, for 1990 survey results).

Dimethoate controls cone maggots in tamarack seed orchards

Foliar applications of dimethoate ("Cygon 480-E", now available under a new label, "Dimethoate 480") significantly reduced the number of seeds damaged by cone maggots and increased the numbers of filled seeds per cone in tamarack. These results are based on field trials conducted by the New Brunswick Department of Natural Resources & Energy and the Prince Edward Island Department of Agriculture, Fisheries & Forestry, in collaboration with Forestry Canada - Maritimes Region. The insecticide was applied to the foliage to the point of runoff, at a rate of 0.25% active ingredient (5.2 ml of formulation per liter of water), using a hydraulic sprayer at a seed orchard near Queensbury, N.B., and a mist blower at an orchard near Charlottetown, P.E.I. The applications were made about three weeks after pollination, after most egg-laying by the larch cone maggot, *Strobilomyia laricis*, was complete. The mean numbers of filled seeds per cone for dimethoate-treated versus untreated trees were 3.0 vs. 0.9 at the N.B. orchard, and 4.9 vs. 2.7 at the P.E.I. orchard. The mean numbers of maggot-damaged seeds per cone for dimethoate-treated vs. untreated trees were 0.3 vs. 11.8 at N.B. and 2.1 vs. 11.0 at P.E.I. A second application, made 10 days after the first, at the P.E.I. orchard only, provided no better control than the single application. There was no evidence of phytotoxic effects to foliage, cones or seeds and no difference in percent germination of filled seed between seedlots from dimethoate-treated and untreated blocks. An application has been made for minor use registration of Dimethoate 480 for control of cone maggots in tamarack. For more details, please see Technical Note No. 284, available from Forestry Canada - Maritimes Region, P.O. Box 4000, Fredericton, N.B. E3B 5P7.

— J. Sweeney, Kathy Tosh, and Wade MacKinnon

Seed Research Program at the Ontario Forest Research Institute

Tom Noland in cooperation with Peter Scott from the University of Toronto, are examining white spruce seed from treeline conditions in northern Manitoba. They are being tested to see if pH affects their germination. Results so far indicate that a slight but significant stimulation (5%) of germination can be shown at pH 4.5 compared to seeds germinated with MilliQ purified water.

Kim Creasey from the Ontario Tree Seed Plant and Tom Noland are using the density separation process (DSP) to clean mechanically damaged seeds from jack pine seed lots containing significant percentages of damaged seed. Preliminary results indicate traditional DSP @ 30°C does not effectively remove damaged seed. However, the addition of adjuvant to the DSP water seems to help enrich the sunken fraction in damaged seed.

Fungal contamination of certain seedlots, especially white pine, is a concern of MNR's seed using clients. The MNR seed sterilization seed team (Sylvia Greifenhagen, Glenna Halicki, Kim Creasey, Tim Meyer, and Tom Noland) have found that fungicide, gamma radiation, and heat treatments decreased germination more than fungal contamination. Currently, they are trying surface sterilization with bleach and H_2O_2, and heat shock to remove or minimize fungal contamination of Pw seed without reducing its germination.

Finally, Bill Parker and Tom Noland are attempting to assess the contribution the natural seed bank makes to white pine natural regeneration. They will be collecting seed from Bill's plots and testing their germination; the number of natural seedlings will also be recorded.

The objectives of these studies seek to improve seed germination knowledge and therefore forest regeneration success. In addition, the seed sterilization study and the jack pine seed cleaning study seek to improve seed quality to provide better seeds for forest regeneration.

— Thomas L. Noland

BLACK/EUROPEAN ALDER - *ALNUS GLUTINOSA*

Other than the natural or inherent dormancy of various tree seed species, let your imagination go and consider the factors that actually cause dormancy. What we want to specifically target in this instance, is the effect of artificial drying, its relation to the seeds' internal moisture content and the overall impact on the germination process.

This is the question we asked ourselves; "WHY" does Black/European Alder have a stratifion requirement of "180" days? After reviewing the literature and evaluating the entire cleaning process, it was concluded that dormancy was actually induced. This occurred by artificially drying the seed to the required lower moisture content in preparation for a frozen storage environment.

Our solution; emulate a more natural course of seed extraction and once the seed had been extracted/cleaned, store above freezing at 2°C - 5°C. The cold storage environment, allows seed to be stored with an elevated internal moisture content. In this case the moisture content extended to a high of 10.54%.

Three seedlots were processed naturally and placed into cold storage in the late fall of 1991. Germination testing revealed that the stratification requirement was "14 days". Capacity and vigour or germinative energy was comparable if not better than seed that had been stratified for 180 days.

A retest completed 93/04/19, showed no loss of capacity or vigour over the storage period to date. The seedlots are on a two year test cycle and we will continue our scrutiny.

For those seed users growing Black/European Alder, listed below for your information are the three seedlots discussed.

S.S.N.	SYR	SLOT#	
1) 067-62-76-0-61	91	91/10/25 -	86% in 13 days
2) 067-72-80-0-00	91	91/12/01 -	85% in 10 days
3) 067-62-76-0-61	91	91/12/02 -	89% in 10 days

We find this type of a study intriguing and it is our intention to progress forward with further innovations within this challenging field of seed.

For an elaboration on the finer points of this project, please feel free to contact Kim Creasey at (705) 424-5311.

— Ed Moore and Kim Creasey

TWO MILLION SEEDS PER PLANT PER YEAR!!

Lythrum salicaria, purple loosestrife is a perennial, herbaceous weed that was introduced to eastern North America from Europe in the 1800s. It has spread to all provinces in Canada and many States, principally by moving along waterways. Once established in an area, the weed is not only a very aggressive plant capable of outcompeting most of our native wetland species and invading low-lying pasturelands, but also very prolific. A mature plant (4-5 years old) may have more than 30 stems and produce in excess of two million seeds per year. The seeds are disseminated by water, on wildlife, or through ingestion and subsequent transport to new areas.

SELECTED SEED RELATED STATISTICS: NEWFOUNDLAND

Source: Jill O'Neill, 1992, Selected Forest Statistics Newfoundland 1992, Canada/Newfoundland Cooperation Agreement for Forest Development Rept. 001.

Newfoundland seed collected and utilized 1980/81 - 1990/91

Year	Seed Collected (kg)	Area Seeded (ha)	Stock Bare-root	Produced Container	Area Industry (ha)	Planted Crown (ha)
1980/81	60	36	151 200	469 900	118	235
1981/82	10	54	1 165 100	944 300	427	347
1982/83	280	230	2 243 600	1 624 800	1194	410
1983/84	50	-	1 856 400	2 349 300	987	612
1984/85	50	-	3 242 400	2 597 971	1436	904
1985/86	-	-	3 102 795	3 508 222	1893	870
1986/87	522	-	595 340	1 654 814	409	393
1987/88	275	925	5 111 634	7 862 231	2624	2534
1988/89	4000	-	4 787 181	6 188 125	2475	1752
1989/90	207	1305	2 041 000	5 717 500	2468	1042
1990/91	-	-	3 188 750	4 721 250	1866	1622
Total	5454	2550	27 485 400	37 538 413	15 897	10 721

[a]Nursery production was limited in 1986/87 as a result of a provincial labour dispute. Seedlings not planted in 1986/87, as a result of the labour dispute, were carried over to 1987/88.

Saskatchewan Seed Trials Could Lead to Lower Costs

Preconditioned seed trials under way in Saskatchewan are helping to pin down the variables that best favour germination of jack pine and white spruce seeds. The results could mean lower regeneration costs.

Preconditioning essentially involves soaking the seed for a specified length of time and keeping it in cool aerated storage containers until the time of planting. Seed trials are then conducted using various site preparation techniques on different soil textures.

With help from Saskatchewan Natural Resources, Weyerhaeuser Canada and Mistik Management, Forestry Canada began the project two years ago. The project is partially funded by the Canada-Saskatchewan Partnership Agreement in Forestry.

Following mechanical site preparation in the spring of 1991, preconditioned seed was planted in 1992 using different methods. The first employed a broadcase spreader, the Cyclone Seeder; the second used the Accu-Seeder with and without Cerkon Shelters. Seed germination levels resulting from these methods will ultimately be compared to those for dry seeding done on similar sites three years ago.

Why use preconditioned seed? Because higher germination levels and predicted low costs could translate into a cost-effective, reliable means of reforestation.

(Reprinted from 'Partners in Forestry' Vol. 2, No. 1. For more information contact Judy Samoil, Northern Forestry Centre, 5320-122 Street, Edmonton, Alberta, T6H 3S5).

From Selection to Seed Production: A Case Study by J.D. Irving Ltd. Using Second Generation Black Spruce and Jack Pine

(From information prepared for Orchard Managers Meeting, Orono, Maine, 1993)

Introduction

Considerable discussion has taken place in the Maritimes regarding new seed orchard designs i.e., the meadow orchard concept (Sweet, 1992) and clonal production systems using rooted cuttings (Mullin, 1992; Park et al., 1993). To improve both cost and genetic efficiencies research has yielded valuable information for several important Maritimes species on how to stimulate early flowering (Greenwood et al., 1993). These techniques are important for the efficient implementation of both meadow orchards and clonal production strategies. This paper provides a case study for black spruce and jack pine beginning with selection of second generation individuals and proceeding through to seed production. The main emphasis is on 16 clones of each species that were grafted in 1989. An additional 24 clones of each species were grafted in 1990 and these will also be referred to. This paper deals mainly with grafts raised in the greenhouse although some comparison with field grown grafts will also be made.

Accelerated Growth

Accelerated growth (AG) procedures were used to rear the grafts in the greenhouse (Greenwood et al., 1991). The selections were grafted in 1989 largely by top-cleft grafting, in January or February. The grafts flushed and by April, five of the better ramets from each clone were selected to receive AG treatments. They were blacked out for two weeks in April; near the end of May placed in a cooler for six weeks; and then returned to the greenhouse with extended photoperiod. The trees elongated and had become dormant by early November; temperatures were lowered to just above freezing until early January when the cycle was repeated. At the end of the second cycle in the second year, the trees were moved into the breeding hall where they remained, switching to only one growth cycle per year.

This regime is quite effective for the spruces. Black spruce grafts will typically be 1.0-1.5 m in height with a well developed crown two years after grafting. With jack pine, AG is successful if high-pressure sodium vapour lamps are available in the greenhouse because jack pine appears to have a higher light requirement, however, even with higher light intensity, the grafts tend to be spindly. Our current thinking for jack pine is that it might be better to accelerate growth for only two cycles and move into a normal growth pattern in the second year.

Flowering Results

The main objective of the breeding hall program in black spruce is to complete polycrosses not finished in the field, but more importantly to provide full-sib seedlots of the highest genetic quality for vegetative amplification. Flower induction in black spruce with $GA_{4/7}$ begins when the trees are over 1 meter in height and are subjectively judged to have sufficient crown volume to support twenty or so cones. The grafts are generally large enough for treatment after two years of growth acceleration. In the breeding hall, flower induction was done in 1991 on black spruce clones grafted in 1989 using foliar application of $GA_{4/7}$ (400 mg/l) with four applications (bi-weekly, beginning at flushing). Average numbers of female and male flowers per tree were 45.6 and 22.4 respectively. The percentages of 16 clones with female and male flowers were 94% and 81%. Six clones which were grafted in 1990 had developed sufficiently such that during the fourth accelerated cycle $GA_{4/7}$ was applied. This resulted in a significant number of female flowers in 1992, only 28 months after grafting. Two thousand seedlings are currently being hedged for rooted cutting production from crosses made in 1992. More than double that number are anticipated from crosses made in 1993.

For jack pine, the objective of the trees in the breeding hall is to complete polycrosses not successfully completed in the field and to facilitate completion of pair-matings for third generation selection after accelerated progeny test information is available and assortative mating can be conducted. For this reason, large early flower crops are not as critical as in black spruce. For this reason, $GA_{4/7}$ was not applied to the grafts. In the absence of flower induction treatments, the female and male flower counts were 5.8 and 13.8 per tree respectively and the percentages of clones bearing flowers were 94% and 75%. Had $GA_{4/7}$ been applied, the numbers of female flowers per tree would undoubtedly have increased.

Breeding Hall - Seed Orchard Comparison

The clones in the breeding hall were also established in the second generation clonal seed orchard. The grafts were planted in the seed orchard in 1989 and received intensive management including irrigation and regular fertilization. In 1992, the crowns of the black spruce grafts were still not developed enough to consider $GA_{4/7}$ application and no flowering occurred in 1992 and 1993. In 1993, 175 of the first transplants received foliar applications of $GA_{4/7}$ and some flowering is anticipated in 1992. This clearly demonstrates the benefits of accelerated growth procedures for this species. For jack pine, specific data was not collected, however, polycross matings were conducted in 1992 on 29 second generation clones in the seed orchard. No male flowers were observed in 1992 and very few in 1993. The grafts had been established in the seed orchard in 1989 and 1990. The flowers were bagged almost exclusively on the leaders and there were more ramets available for each clone than could be accommodated in the breeding hall. For jack pine, the benefit of growth acceleration and breeding hall culture for female flower production is not as great compared to black spruce if a number of ramets are available in a seed orchard or clone bank. If male flowers are required for pair matings, breeding hall culture will save at least two years.

Summary

In summary, these results provide clear examples of the turnaround time from selection to seed production for black spruce and jack pine. Whether grafts are managed intensively outdoors or cultured with accelerated growth in a breeding hall is a function of availability of facilities, species biology, the specific objectives of the breeding program and consideration of alternative stock production options.

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— *Greg Adams and Hartmut Kunze*

Seeds of Wood Plants of the United States

This classic publication, which was last published by the USDA Forest Service as Agriculture Handbook 450 in 1974, is going to be updated. The basic format will remain the same. Part I will again cover the basic concepts of seed development, collection, processing, testing, and seedling establishment. Part II will include specific information for seeds of different genera of woody plants. The new manual will cover all of North America, Hawaii and the US Territories. A two volume format is being considered to reduce the size of the book - one for temperate zone plants and one for subtropical plants. It is hoped to have the new edition published in about 3 years.

The general sections in Part I will be completely rewritten and author assignments have tentatively been made. The chapters for each genus in Part II will only have to be updated because most of this information is still accurate. Chapters will be computer-scanned and converted to a standard word processing format to facilitate the inclusion of new information, which will be gathered by a computer search of the published literature. The computer literature search will only reveal formal published research, and we know that many of you have developed your own operational procedures. Help us make the "New Handbook as useful as possible by sending us any published "in-house" reports that you may have or just jot down anecdotal information.

Contact Frank Bonner, Southern Forest Exper. Stat., P.O. Box 906, Stackville, Mississippi, 39759, USA.

Tropical Seed Manual

The Forest Tree and Shrub Seed Committee of the ISTA (International Seed Testing Association) is compiling information on the seeds of tropical trees for inclusion in a seed manual. Data is needed on flowering and fruiting, seed development, collection, cleaning, testing, and storing. All contributions will be properly cited and acknowledged. Please share any published or unpublished information with the project coordinator: Karen Poulsen, DANIDA Forest Seed Centre, Krogerupvej 3A, DK-3050 Humlebaek, Denmark.

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Reports of Meetings Attended

Touring New Brunswick

This year's CTIA meeting in Fredericton, New Brunswick offered participants four field tours. I took them all. The following article outlines the tours and indicates various TSWG members who may be contacted for more information.

The first tour was on Sunday, August 15, a day long pre-conference trip through northwestern New Brunswick. Our route took us back and forth across the St. John River valley, travelling upstream from Fredericton to near Edmonston. The scenery was fantastic.

First stop was at the N.B. Min. Nat. Resources and Energy's first generation white spruce and tamarack clonal seed orchard at Queenbury. A balsam fir orchard is also being established and second generation orchards are planned. The 35-hectare site is well prepared and supports a grass cover crop. Tree spacing is 6 by 3 metres. Last year the spruce trees planted in 1985, '86, and '87 produced 37, 18, and 39 (with s.m.p.) seeds per cone, respectively, and yielded a total of 3621 litres of cones and 57.3 kg of seed. The tamarack planted in 1984 and '85 yielded 354 litres of cones and 0.79 kg of seed. There were no cones in the orchards this year. For additional information, contact Kathy Tosh.

The second stop was at Fraser Inc.'s Three Brooks, 12.4 hectare, black spruce seedling, seed orchard. Trees were planted between 1979 and '84 on a rich site formerly used for growing potatoes. The layout of the trees is particularity interesting. The oldest trees are in the centre of the orchard; subsequent planting each year was done in a band surrounding the trees planted in previous year. In 1990 these orchards produced 10 695 litres of cones and 48 280 000 seeds, but no seed has been collected since, even though 1992 was a good crop year. Ron Smith has made extensive use of this orchard to study how fertilizer effects seed production so contact him for further information.

Third stop was at J.D. Irving Limited's Black Brook forest limits. These occupy 188 000 hectares of which 70 000 have been planted following harvest. About 6 million trees or 3000 hectares are planted each year, all with improved stock. We visited a plantation, planted with white and red spruce in 1963, where several types of commercial thinning are being tested. It won't be many more years before plantations like this one will be providing a major component of the annual harvest. In another nearby plantation we were shown how failure to control competing vegetation while planted trees are becoming established can greatly reduce survival and growth. All tree improvement planting tests for the Black Brook limits are centralized in one area. We visited this area and were overwhelmed by all the tests being conducted. Greg Adams is primarily responsible for the tree improvement work and can be contacted for information.

The next tour, on Monday, involved a full afternoon's visit to Forestry Canada's Acadia Forest Experimental Station. Management of this 9000-hectare forested area has been the responsibility of the Canadian Forest Service since 1933. It was initially a silviculture research area; the first genetics experiments were planted in 1960. We examined jack pine provenance trials established in 1982, and similar trials of different spruce and larch species, and hybrids of each, that were established in the 1960s. We walked through a trial plantation containing 210 clones of tamarack established as rooted cuttings in 1981. In the nursery we examined tests of white and black spruce steckings and white spruce emblings. Similar plantings were seen in a field planting demonstration. Doug Fowler was responsible for a lot of the earlier work at the Station but most of work is currently being done by Yill Sung Park who can be contacted for additional information.

On Wednesday, in mid-afternoon, everyone boarded buses for the short drive to the Provincial Tree Nursery and Seed Extraction Plant at Kingsclear. Here the province's tree improvement work is concentrating on white spruce, black spruce, jack pine, and tamarack. We examined retrospective family tests and concurrent progeny tests, as well as first and second generation seed orchards of these species. There is also a seed orchard of balsam fir which is being grown to support the province's Christmas tree producers. Contact Kathy Tosh for information about this work. We were guided through the seed extraction and processing plant by Craig Carr and Donna Messer. Both of these people would welcome the opportunity to provide information about this facility. This tour lasted only two hours, but no one left afterwards because one of the buildings had been cleared to make space for the Association's 'banquet', a lobster/steak supper that was followed by 'fluidized conversation' accompanied by live country music. A good time was had by all.

Thursday, August 19, offered a day-long post-conference tour of J.D. Irving Limited's Sussex Tree Nursery, Parkindale Seed Orchard and some recently established demonstration plantations. On this tour we traveled east along the St. John River and experienced more beautiful scenery.

The nursery was established in 1973 but since the early 1980s it has been used primarily for tree improvement work on black, white, red, and Norway spruces and on jack pine. The facility includes four heated greenhouses, six cold frames, and a large breeding hall. Research here has included accelerated growth procedures, flower induction, and early testing of progeny. Most results have been implemented into operational breeding programs. Recent work has involved production of black spruce rooted cuttings of full-sib crosses of second generation selections.

The next stop was at Parkindale, where the Company's clonal seed orchards and seed extraction plant are located. The 110 ha area was harvested in 1981 and underwent extensive site preparation before trees were planted (stumped, burned, subsoiled, ploughed, rockpicked, and a cover crop established). Currently, 61.5 ha have first generation seed orchards (Sb, Sw, Sn, Pj, and Lt) and 18.8 ha have second generation orchards (Sb and Pj). Over 37 000 trees have been planted (6 x6 m spacing for most). They are intensively managed (fertilized, irrigated, and treated with GA) to encourage operational seed production. Currently, all seedling production except for Norway and red spruce, utilizes orchard seed. Seed was collected in second generation jack pine orchards in 1992 and will be collected in second generation black spruce next year if this year's flower induction treatments are successful.

The seed extractory plant (BCC) was established on the site in 1988. It is a very compact setup with several machines serving dual purposes, ie., kiln also used to dry/condition seed and cone tumbler also serves as a de-winger. Prior to extraction cones are stored in a large pole-framed, screened building. This building served as an excellent lunch area. In an after lunch talk we were told of the Irving Company's significant participation in Canada's Model Forest Program and the Fundy Forest.

The final stop on this tour was at Dubee Settlement to look at Norway and black spruce provenance tests established in 1981. In the Norway spruce test, 10-year average heights ranged from 2.21 to 3.56 m, weevil damage was not a serious problem, and 11 selections have been made among the top six provenances for breeding purposes. In the black spruce, overall average 9-year height was 3.16 m, a seeding seed orchard was rogued (50%) based on family ranks, and second generation selections were made. Greg Adams is primarily responsible for the tree improvement work and can be contacted for information.

SYMPOSIUM "GENETIC CONSERVATION AND PRODUCTION OF TROPICAL FOREST TREE SEED"

The symposium was held June 10-25, 1993 in Chiang Mai, Thailand's principal northern city, which is the capital of the largely mountainous province of Chiang Mai, about 20 000 square km in area. Chiang Mai city (founded in 1296) is 700 km north of Bangkok and is located in a fertile valley 300 m about sea level. Mountains surrounding Chiang Mai city form the lower extremities of the Himalayan foothills and host several hill tribes of Tibeto-Burman origin.

The symposium was very well attended, with about 250-300 participants from China, SE Asia, India, Africa, Australia, Europe, and North and South America. Morning plenary sessions featured presentations by major speakers, and afternoons were split into two concurrent sessions focusing on either genetics or seed production topics. Since the proceedings will be published in the near future, I will comment on some recurring themes that ran throughout the various sessions instead of specific papers.

Economic constraints

A major problem throughout tropical regions is the lack of commitment (both in $ and trained personnel) by local governments. Notable exceptions are Malaysia, Thailand and the Philippines. Delegates from both developed and developing countries were urged to continue to lobby their governments for more support for forestry research and technical aid in the tropics. The establishment and protection of forest seed production areas and other genetic resource areas was also given high priority.

Although seed orchards have been established in a number of tropical countries, the importance of long-term maintenance or cost of collecting seed orchard material is not always understood. For example, in Africa, 60% of the trees died of drought because the seed orchard was not watered, and another seed orchard was destroyed because there was no protection from fire. Another difficulty is the pervasive attitude that seed orcahrds are considered somewhat sacred, resulting in extreme reluctance to rogue undesirable trees.

Lack of understanding of the biology of tropical species

Because of the incredible species diversity in the tropics, little is known even about basic flowering biology of most forest trees. From recent research, it appears that one of the major constraints to seed production is lack of pollination. In angiosperms, this stems from lack of insects or other animal vectors, but may also result from the lack of synchrony of male and female flowering. In conifers, poor pollination is primarily due to the long pollen dispersal period. In B.C., for example, pollen dispersal occurs over 2 weeks, but in Thailand, pollen is dispersed over 2 months. In regard to seeds, major problems are high moisture content (in pines), and difficulty in storing tropical seeds for long periods.

Initiatives such as the organization of tropical forestry symposia and technical training as well as the funding of tropical tree seed centres, have done much to redress these inadequacies. A number of major initiatives have been organized and funded by the United Nations, and individual governments (e.g., Australia, Canada, United States, Germany, Denmark, France). Considerable interest in tropical regions has also been shown by international NGOs (non-governmental organizations), and international research organizations (e.g., IUFRO).

Species diversity

Most speakers and attendees appreciated the value of species diversity in tropical forests, but the fact remains that tremendous losses in species richness and diversity have already occurred. Insects, birds, and mammals (e.g., bats) are important vectors for pollination and seed dispersal in tropical forests. The loss of habitat and the indiscriminate use of pesticides have had a major effect on animal populations. My personal impressions as a birdwatcher (and in the introductory comments to the "Guide to the birds of Thailand") was the scarcity of birds, both in numbers and in species. Depletion of forest lands by logging and clearing for agriculture has been largely responsible for the loss of habitat.

Risks to forestry workers

Although not specially mentioned during the symposium, the prevalence of diseases and parasites in tropical areas poses risks to people working in rural and forested areas. Mentioned several times, however, was the very real risk of being shot by poachers. Many countries, in response to local and international pressure, have officially banned or severely limited logging in tropical forests. Logging in Thailand was banned in 1989 after heavy rains in deforested areas resulted in massive landslides and loss of life. However, almost no money is allocated to enforcement, so such pronouncements may have little effect, and the value of tropical hardwoods represents a high financial incentive for illegal logging. The unfortunate forester or researcher who inadvertently stumbles upon such activity in a remote area has little defnese against armed poachers.

Social forestry

Forestry is very important in tropical areas where indigenous native people are still very much involved and dependent upon the forests for food, medicine, shelter, and fuel. Much forestry is conducted by farmers, and indigenous people and farmers are often the best source of information on forest management, seed collection and seedling production. Other products obtained from the forests are gum, rattan, bamboo, dyes, tanning bark, and medicinal products.

Technological problems

Foreign aid project administrators in various tropical areas in Asia and Latin America pointed out that technological difficulties have a major impact on project management. Many developing countries have modern technology, but it may or may not work, i.e., communications, in some countries, telephone service is good, but the mail is unreliable, whereas in other localities, the reverse may be true. Unreliable power supplies may damage or destroy computers and sensitive equipment. The shortage of technical personnel, replacement parts, and funds are all contributing factors, as well as low expectations or mistrust of technology.

Cultural value orientations

Foreign aid workers and technical advisors generally appreciated that cultural adjustments would be necessary, but, prior to actually working in the countries, did not appreciate the extent to which differences in cultural values would affect their ability to achieve project objectives. Technical advisors will probably have to provide more direction than usually given in North America. Because of inherent differences in cultural values, participants may have difficulty in defining goals, since goal-setting is an unaccustomed practice for most people. Respect for hierarchical authority is very strong, and participants may feel uncomfortable directly expressing their opinions.

Carole L. Leadem

BIOLOGY AND CONTROL OF REPRODUCTIVE PROCESSES IN FOREST TREES: NOTES ON THE IUFRO SYMPOSIUM, AUGUST 22-26, 1993, VICTORIA, B.C.

This symposium was highlighted by eight invited keynote reports, 34 volunteered platform presentations, and 17 poster presentations.

Keynote speakers outlined advances that had been made in various aspects of sexual reproductive biology in relation to tree improvement and seed crop management. They identified problems and possible solutions and opportunities arising out of new discoveries.

Most of the volunteered reports were concerned with conifers; only two dealt with hardwood species. A few reports were concerned with ecological, physiological, and molecular genetic aspects of sexual development and reproductive biology but most were geared to manipulating rather than understanding the systems. The researchers appeared to be motivated by a need to find practical solutions to problems as opposed to searching for new knowledge.

Summary of keynote reports

Since the last meeting of this IUFRO Section in 1985, many advances have been made in methodologies for promoting seed production in conifers, but the long term effects of the treatments on tree health and seed quality are not well understood. There is very little empirical information on methodologies for controlling sexual development of hardwoods. We do not have a good understanding of site requirements for sexual reproductive development in conifers or hardwoods.

We now have a much better understanding of the metabolism, transport, and role of gibberellins in conifers. In spruces, dehydroxylated gibberellins, GA_1 and GA_2, promote growth during the early stages of shoot elongation, and the monohydroxylated forms, GA_4 and GA_7, promote sexual development during late stages of shoot elongation. The nonhydroxylated GA_9 is a storage form and precursor of the morphogenetically active forms. The ratios of morphogenetically active forms to the storage form or to each other may provide indices for reproductive or growth potential. We have much less knowledge about the role of other phytohormones in sexual development of trees.

Genetic development in trees continues to be blocked because young trees are not sexually competent and old trees do not root easily. Our understanding of the physiology and molecular genetics of phase change and ageing is poor. New approaches to understanding the control of gene expression need to be applied in answering basic questions. Are phase changes due to genetic or epigenetic events that interact with genes controlling traits like sexual competence or rooting ability, or are traits controlled independently?

Maturing seed orchards can easily meet operational seed production targets but the genetic gain is compromised by phenology gaps between pollen release and seed cone receptivity, by fecundity differentials among clones, by environmental control of sexual asymmetry, and by selfing, inbreeding, and pollen contamination from external seed sources. These problems can be overcome by use of supplemental pollination. However, we need methods to force pollen production to allow large scale collection, so that true quality can be estimated and large scale pollination facilitated.

Biological constraints to production and use of genetically improved seed include periodic or inadequate initiation of sexual development, abortion of developing strobili, ovules, and embryos, losses of cones, seeds, and trees to foraging animals and insects and diseases, differential responses of clones to gibberellin and fertilizer treatments, nutritional disorders, and seed quality problems such as maturation, dormancy, storability, and germination requirements.

Genetic gain can be facilitated by large scale controlled pollination in seed orchards containing as few as 10 clones. This compares with much larger numbers of clones required in open-pollinated seed orchards. The rate of increase in genetic gain increases with seed orchard turnover time. Control-pollinated meadow orchards have short turnaround times of 4 to 5 years, compared with 10 to 20 years for open pollinated seed orchards and hedge orchards. Genetic change as a result of tree improvement activities raises questions about possible risks associated with the deployment of genetically altered trees.

(Bonnet-Masimbert, Cecich, Chalupka, El-Kassaby, Greenwood, Oden, Owens, Sweet, and Webber)

Summary of volunteered reports

Seed orchard type, location, site, and climate

In radiata pine, meadow orchards produce more filled seed per cone than hedge orchards, (Setiwati and Sweet); the number of seed strobili is influenced first by temperature and second by rainfall. This needs to be considered in site selection (Dickson and Sweet). Fast- and slow-growing rootstocks of loblolly pine did not influence scion growth or strobilus production in reciprocal grafts (Mikeand and Jett). Species with low site requirements and high stress resistance are likely to flower earlier than species with high site requirements (Chalupka and Cecich). Offlocation Scots pine orchards display large gaps between pollen release and seed-cone receptivity. For local seed sources there is complete overlap and, even without nearby stands, contamination rates up to 90% are observed. Pollen clouds can move over 200 km (Pulkinen and Rantio-Lehtimaki). Orchard progeny of northern sources grown in the south of Finland are not hardy in the north because of contamination from local pollen. All new orchards of northern sources will be established in the north (Harji). In Scots pine orchards, sexual asymmetry depends on climatic conditions. Seed strobilus production begins earlier but pollen strobilus production does not change when seed sources are transferred to the south. For sources transferred from south to north, pollen strobilus production begins earlier but seed strobilus production does not change. Rootstocks influence flowering date (Danusevicius et al.). In a Norway spruce orchard of northern sources established in central Finland, the pollen shed and seed-cone receptivity is very close with seed cones receptive one to two days before pollen shed. There was no difference among clones. Pollen shed and receptivity were earlier on south-facing slopes (Nikannen). The length of microsporogenesis is best predicted by heat sums rather than calendar date (Luomajoki). Locating orchards near sources of pollution (SO2, Ni and Cu) results in production of aberrant seed and pollen. Meiotic lesions and ovule mortality increase and embryo length and seed germination are reduced (Fedorkov). At the edge of its range, in permafrost and low rainfall areas, Scots pine has high mutation rates that are associated with mitotic and meiotic anomalies (Muratova). For Siberian pine, anomalies of sexual development include division of haploid cells to compensate for sterility (Tretyakova). In British Columbia most of 83 orchards are located in drier parts of the province because the climate is more conducive to frequent cone production. Orchard seed provides 11% of seed for artificial regeneration at this time; 50% by the year 2000 (Barber).

Juvenility and the reproductive cycle

Abbreviation of the reproductive cycle from 3 years to 2 years in yellow cedar is a response to favourable environmental conditions (El-Kassaby). Over 80% of jack pine seedlings can be coaxed to produce pollen strobili, with over 25 strobilus clusters per tree in 3 years from seed following continuous growth for 12 months and creating a nitrogen deficiency during the sexual inductive phase of development (Fogal et al.). Cambiums from juvenile and mature scions of radiata pine grafted onto 2-yr-old rootstocks differed in many cytological characteristics, attributed to differences in apical meristems usually conserved during vegetative propagation (Riding et al.). In loblolly pine, pollen production can be induced by topworking juvenile scions into crowns of mature seed orchard trees (Bramlett et al.).

Tree growth patterns and sexual development

Vegetative, seed, pollen and latent buds are characteristically associated with different parts of each new shoot in *Picea*. This should be considered when applying gibberellins to individual buds (Powell). Vegetative and sexual development patterns vary in repeatable patterns along the tree axis within successive growth years (Mialet et al.). In Siberian pine, seed producing shoots are most vigorous, pollen producing shoots are least vigorous, and vegetative shoots are intermediate (Goroshkevich and Vorobzev). Proliferated pollen and seed cones that are intermediate between vegetative and sexual forms (1 to 3% of black spruce trees) are produced. They represent up to 1% of the total number of sexual buds (Caron and Fournier).

Responses to gibberellins and other phytohormone treatments

Young white spruce seedlings in containers do not respond to $GA_{4/7}$, root pruning, or heat stress. On older trees in orchards treatments promote seed strobili more than pollen strobili. Top-pruned trees produce seed but not pollen strobili (D'Aoust et al.). Stimulation of sexual development by root pruning and $GA_{4/7}$ application to black spruce is inhibited by application of cytokinins. Thus, root-produced cytokinins inhibit sexual development (Smith and Greenwood). For controlled crosses of large Douglas-fir trees, branch injections can reduce amounts of GA required and the possible detrimental effects to the rest of the tree (Bastien et al.). In *Larix laricina* strobili develop early on short shoots and later on long shoots. However, early $GA_{4/7}$ treatment promotes sexual buds on both types of shoots (Eysteinsson). In 38-year-old *Larix occidentalis* seed trees, $GA_{4/7}$ injections promoted three- to ten-fold increases in seed cone production (Shearer). $GA_{4/7}$ applications to hemlock trees pruned to produce seed strobili on a few large branches increased seed and pollen strobilus production and ABA level in buds, but decreased IAA levels; on trees pruned to produce pollen strobili on large numbers of low vigour shoots, $GA_{4/7}$ again promoted both types of sexual strobili but had no effects on ABA or IAA (Sheng et al.). Economically viable increases in strobilus production were observed after treatment of 6- and 12-month-old grafts of radiata pine with $GA_{4/7}$ (Darling et al.). GA_3 promoted pollen and seed strobilus production on 1- to 2-yr-old seedlings of *Cupressus macrocarpa* (Milne).

Responses to fertilizer applications and other treatments

Ovuliferous flowering of *Alnus rubra* responds to spacing and irrigation but not to P fertilization (Harrington and Debell). In *Pinus pinaster*, highly fecund trees respond better than low fecund trees to soil fertilizer applications (Alazard). Highly fecund scots pine trees responded better than low fecund trees to soil fertilizer treatments; trees produced more cones, larger cones, and more seed, (Kurn). Application of NPK to soil increased seed strobilus production of *Pinus pinaster* (Ngo Quang De). The optimum rate of NH_4NO_3 application to soil to promote sexual development and seed production of loblolly pine is 224 kg N/ha. Foliar N increased continuously with increase in application rate but strobilus production did not. N application did not alter the level of other elements in foliage (Schmidtling). Application of NH_4NO_3 to soil increased strobilus production of loblolly pine whereas foliar-applied urea depressed it. Foliar N was increased by both treatments; foliar-applied urea cannot be used to reduce rates of fertilizer applied to orchards (Jett et al.). Application of $CaNO_3$ and $GA_{4/7}$ promoted sexual development of Douglas-fir; arginine, proline, and polyamines (spermidine and spermine) were seen at high levels in sexual buds but low in vegetative buds (Daoudi and Bonnet-Masimbert).

Monitoring for sexual development

In radiata pine, timing of $GA_{4/7}$ application coincides with initiation of long shoot buds. However, the phenology of bud development varies with clone, location of orchard, size of shoot, and age of ramet. Buds need to be examined internally as well as externally to determine stage of development (Dickson et al.). X-radiography can be used to non-destructively monitor Douglas-fir buds to characterize stages of bud development and differentiate sexual versus vegetative buds (Bonhomme et al.). In Douglas-fir, GA_4 is high in seed bud primordia and GA_7 is high in pollen bud primordia. GA_9 accumulates in vegetative buds (Doumas et al.). Polyamine content of buds may be useful as potential indicators of sexual development (Daoudi and Bonnet-Masimbert). Energetics of water movement at night and relationships to organic P, nucleic acids, and gibberellins are being studied in relation to sexual development in trees (Stoyanova). Phenolic compounds are higher in flowering compared to non-flowering aspen trees (Lapa).

Pollen, pollination, and supplemental mass pollination (SMP)

Sampling systems can be developed to estimate pollen production per tree and number of shoots needed to produce a specified volume of pollen in white pine (Meagher). Douglas fir pollen elongates but does not germinate in vitro. Attempts to induce germination have not produced reliable techniques to date (Bonnet-Masimbert et al.). Exudation of the pollination drop in white spruce occurs after cone closure. Thus, supplemental pollination shouldn't interfere with the functioning of the pollination droplet (Runions et al.). In Scots pine, SMP increases genetic gain by overcoming phenology gaps, low pollen production by some clones, and contamination (Ericksson et al.). Large scale electrostatic pollination of large larch trees takes 2 minutes, requires less pollen, and significantly increases percent filled seed (Philippe and Baldet). In radiata pine, liquid pollination produces larger seeds with higher germination energy. Isolation bags reduce seed yields per cone but not seed quality (Setiawati and Sweet). Chloroplast DNA (cpDNA) from Douglas-fir can be used to distinguish clones. Since cpDNA is paternally inherited, it may provide a means for monitoring pollen contribution to progeny of seed orchards (Newton et al.).

Seed development and quality evaluation

In radiata pine $GA_{4/7}$ does not influence seed yield per cone nor seed germination (Setiawati and Sweet). The genetic and physiological quality of black spruce is not affected by $GA_{4/7}$ or root pruning, (Deslauriers et al.). In Norway spruce progeny from crosses bred in a greenhouse were less frost hardy than progeny from the same crosses bred in an outdoor orchard (Johnsen et al.). Studies on ABA during in vivo embryogenesis of loblolly pine may help develop in vitro embryogenesis methods (Kapik et al). Aqueous extracts of pine and birch leaves may accelerate or inhibit germination of scots pine seeds (Popova and Popov).

Constraints to sexual development

In radiata pine, control pollination in isolation bags reduces seed set compared to open pollination; failure occurs prior to embryo formation but after growth of pollen tubes; ovules collapse 14 months after pollination (Yetty et al.). In Pacific yew, the number of seed and pollen strobili is related to the amount of light received by the canopy; frost damage and mites are responsible for bud failures and up to 100% of seed loss (Vance and DeFazio). A fungus, *Sphaeropsis sapinea*, causes abortion of first-year cones, seed abortion, and seedling mortality in radiata pine. Benlate reduces impact on cones and seedlings (Grbavac and Darling). In *Quercus robur* orchards, some clones are largely pollen generators others are seed generators; most pollen stays within 20 m of source but will spread up to 250 m; only 2 to 19% of acorns survive because of high rates of insect infestation (Efimov).

Genetics of reproduction

Early flowering is genetically controlled by one or a few genes (Chalupka and Cecich). Response to $GA_{4/7}$ is heritable in Scots pine (Chalupka). In *Pinus pinaster*, fecundity is heritable (Alazard). In radiata pine, protein markers may be associated with specific stages of microsporogenesis (Wang and Fountain). MADS-box genes with high homologies to those in *Antirrhinium* and *Arabidopsis* were identified in a birch *Betula pendula* (Tikka et al.).

— *Willard Fogal, Petawawa National Forestry Institute*

Upcoming Meetings

Agricultural seed treatment - progress and prospects

January 5-7, 1994
University of Kent, Canterbury, UK

The Symposium will draw together the many disciplines involved in the science and technology of seed treatments, their application and use.

Envisaged Sessions:

Cereal Seed Treatment Strategies/
Cereal Seed Treatments/
Seed Treatment for Non Graminaceous Crops/
Potatoes, Bulbs and Corns/
Biological Seed Treatments/
Application of Seed Treatments, Coatings and Pelleting/
Regulatory Requirements/
Poster Session/
Demonstrations and Exhibits

For further information, please contact: Conference Associates & Services, Ltd STS, 55 New Cavendish Street, London W1M 7R3, GB-Great Britain (☎ 071 486 0531 / Fax: 071 935 7559).

Mechanisms of woody plant defenses against herbivores

February 2-5, 1994
Joint meeting of IUFRO working parties on "Mechanisms of plant resistance (S2.05-06)", Integrated control of scolytid bark beetles (S2.07-05)" and "Population dynamics of forest insects (S2.07-06)" in Kihei, Wailea, Hawaii. Contact: **Dr. W.J. Mattson**, Pesticide research Center, Michigan State University, East Lansing, MI48824, USA (Fax: +1-517-353-5598).

Behaviour, Population Dynamics, and control of Forest Insects

February 6-11, 1994
Joint meeting of IUFRO working parties "Integrated control of scolytid bark beetles (S2.07-05)" and "Population dynamics of forest insects (S2-07-06)" in Maui, Hawaii. Contact: **Dr. T.L. Payne**, c/o Ohio Agricultural Research and Development Center, 116 Agricultural Administration Building, 2120 Fyffe Road, Columbus OH 43210, USA (Fax: +1-614-292-3263).

16th Annual Agricultural Seed Technology Conference

February 15-16, 1994
Iowa State University, Seed Science Center. Registration and program details will be mailed out in autumn. If further information is needed, please contact: **Helene Lawrence**, 164 Seed Science Center, Iowa State University, Ames, IA 96011, U.S.A. (☎ 535-294-8745).

International Short Course in Forest Genetics and Tree Improvement

March 14-25, 1994
Course to focus on world forestry trends, genetic basis for tree improvement, seed distribution and collection, seed orchards, progeny testing, quantitative genetics, and breeding strategies. Will cover tropical hardwoods, MPTs (including eucalypts). Mexican and Central American pines, and indigenous and exotic species. Instruction in English. Contact: **Ann Coughlin**, North Carolina State University, College of Forest Resources, Box 8001, Raleigh, North Carolina 27695-8001, USA (☎ 919/515-3184 / Fax: 919/515-7231).

Sixth Workshop of the IUFRO Working Party S2.04-06 Molecular Genetics of Forest Trees

May 21-24, 1994
Scarborough, Maine, USA. For information contact: **Prof. Michael S. Greenwood**, Dept. of Forest Biology, The University of Maine, Orono (☎ +1-207-581-2838 / Fax: +1-207-581-2858).

5th International Symposium Genetics and Molecular Biology of Plant Nutrition

July 17-24, 1994
The symposium will offer summary papers, reports, and posters dealing with genetic and molecular biological aspects of the following and related topics: nutrient acquisition, plant nutrient requirements and responses, functional aspects and efficiency of nutrient use, mineral composition, and tolerance of toxic ions and salts. Papers dealing with all species of crops will be welcome, as well as papers on wild species. Please refer inquiries to: **D.W. Rains**, Department of Agronomy & Range Science, University of California, Davis, CA 95616 (☎ 916-752-1711 / Fax: 916-752-4361).

1st International Symposium on Plant Dormancy

August 4-6, 1994
This interdisciplinary symposium is patterned after the NATO Advanced Research Workshop series. It will include keynote and invited speakers, contributed paper and poster sessions, extensive discussion periods, and topical workshops. It is strategically scheduled to bridge the gap between the ASPP meeting in Portland and that of the American Society for Horticultural Science in Corvallis. Session topics include: Approaches to Dormancy Research; Physiology, Biochemistry and Gene Expression Related to (1) Temperature, (2) Hydrational Status, and (3) Photoperiodism; and Agricultural and Biotechnological Manipulation. Workshop topics include: Seed Dormancy; Bud Dormancy; Physiological, Biochemical, and Molecular Aspects of Plant Dormancy; and Control in Agricultural Cropping Systems (including breeding). Attendance will be limited by application to a maximum of about 75 participants, with a proportion of applications available to advanced graduate students and postdoctoral researchers. For additional information and/or future announcements, contact: **Dr. Gregory A. Lang**, 137 Julian C. Miller Hall, Louisiana State University, Baton Rouge, LA 70803-2120 (☎ 504-388-1043 / Fax: 504-388-1068).

International Symposium on Scots Pine Provenances and Breeding and Selection (Working Party S2.02-18)

September 13-17, 1994
For information contact: **Dr. J. Danusevicious**, Lithuanian Forest Research Institute, Department of Forest Genetics and Reforestation, 4312 Kaunas-Girionys, Lithuania (☎ +7-127-547241; 744460 / Fax: +7-127-54447446).

IUFRO World Congress

August 6-12, 1995
Finland will host the 20th IUFRO World Congress. This important event will focus on forestry science with all its linkages to the environment, development and the economy. The Congress will take place in modern facilities within the city of Tampere, beautifully located in the Finnish landscape. Post-congress excursions will be arranged in Finland as well as in other Nordic Countries and the Soviet Union.

Recent Publications

Bergsten, U.; Nygren, M.; Skre, O. 1992. Scots pine seed development and ripening - effects of cone and seed treatment on the seed quality. Final Report on SNS-Project No. 37. Swedish Univ. Agric. Sci. 39 pp.

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Buse, L.J. 1993. Regeneration of jack pine and black spruce using Dupont tree eggs [direct seeding] Min. Nat. Resour., Northw. Reg. Sci. and Tech., Thunder Bay, Ont. Tech. Note No. 19. 8 p.

Caron, G.E.; Wang, B.S.P.; Schooley, H.O. 1993. Variation in *Picea glauca* seed germination associated with the year of cone collection. Can. J. For. Res. 23: 1306-1313.

Caron, G.E.; Powell, G.R. 1993. Patterns of on-shoot positioning of seed cones in relation to shoot length and position in the crowns of young *Picea mariana*. Trees 7: 182-188.

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Clarke, S.R.; Negron, J.F.; DeBarr, G.L. 1992. Effects of four Pyrethroids on scale insect (Homoptera) populations and their natural enemies in Loblolly and shortleaf pine seed orchards. J. Econ. Entomol. 85: 1246-52.

DaRos, N.; Ostermeyer, A.; Roques, A.; Raimbault, A. 1993. Insect damage to cones of exotic conifer species introduced in arboreta. I. Interspecific variations within the genus *Picea*. J. Appl. Entomol. 115: 113-133.

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Grant, G.G.; Katovich, S.A.; Hall, D.J.; Lombardo, D.; Slessor, K.N. 1993. Sex pheromone identification and trapping of *Dioryctria resinosella* (Lepidoptera: Pyralidae). Environ. Entomol. 22: 154-61.

Jenkins, J.J.; Roques, A. 1993. Attractiveness of colour traps to *Strobilomyia* spp. (DIPTERA: Anthomyiidae). Environ. Entomol. 22: 297-304.

Martinsson, O.; Hannerz, M. 1992. Det nya Ryssland oppnar dorren for froexport, (The new Russia open the door for exportation of seeds). Skogen 4: 35-36. (in Swedish).

Mosseler, A. 1992. Seed yield and quality from early cone collections of black spruce and white spruce. Seed Sci. & Technol. 20: 473-482.

Niwa, C.G.; Overhulser, D.L. 1992. Oviposition and development of *Megastigmus spermotrophus* (Hymenoptera: Torymidae) in unfertilized seeds. J. Econ. Entomol. 85: 2323-28.

Nord, J.C.; DeBarr, G.L. 1992. Persistence of insecticides in a loblolly pine seed orchard for control of the leaffooted pine seed bus, *Leptoglossus corculus* (Say) (Hemiptera: Coreidae). Can. Ent. 124: 617-29.

Normark, E.; Bergsten, U. 1992. Skogssadd i nytt ljus, (Direct seeding in a new light) Skog + Forskning Nr 3: 6-9. (in Swedish).

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Sidders, R.G. 1993. Bracke seeding rate trials: Fifth year results. Ontario Min. Nat. Resources, Northwest Region, Tech. Rep. No. 72. 19 pp.

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