CANADIAN TREE IMPROVEMENT ASSOCIATION/
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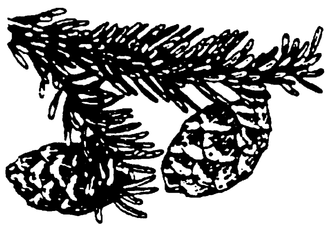

Tree Seed Working Group

NEWS BULLETIN

No. 38 December 2003

SEED ORCHARD PRACTICES

THIS ISSUE AT A GLANCE

CHAIR'S 'ARMCHAIR' REPORT

I wonder if everyone else is feeling the pressures of the season? It really is a time of year when we need to be thankful for what we have. Nothing brings that home more than a loss and the tree seed community has suffered a loss with the sudden death of Dr. David Gifford on August 15, 2003. Many of you will remember David from our last workshop at the CTIA in Edmonton and his ability to share his expertise on germination in an informative and practical fashion. It was my first meeting with David and I was looking forward to him contributing to our field of study for years to come. The Canadian Journal of Botany has graciously agreed to allow us to reprint a Memoriam by Dr.'s Bewley and Mullen of the University of Guelph. I extend my deepest sympathies to the family and friends of Dr. David Gifford.

I'd like to thank everyone who contributed articles to the **38th** edition of the News Bulletin. The theme of our next News Bulletin (**June 2004**) will be "**Environmental Impacts on Seed Biology**". I think this fits in nicely with the general CTIA meeting theme and hopefully initiates some good articles and discussion on this broad, but very important topic. I'm particularly interested in ideas and work occurring on 'after-effects" as well as what we know (or don't) about environmental variables and their role in meristem determination, pollination success, cone crop development, and dormancy induction. A wide gamut, so please give some thoughts to the next theme and contribute!

There has been a great deal of progress made in organizing next years CTIA meeting in **Kelowna, BC – July 26-29, 2004** with the theme of "**Climate Change and Forest Genetics**". The meeting will be joint between the CTIA, WFGA (Western Forest Genetics Association), NWSOMA (Northwest Seed Orchard Managers), BCSOA (British Columbia Seed Orchard Association), and the IUFRO Working Party on Resistance Breeding. It should be a great meeting and we consider it to be "the mother of all meetings" – at least until it is the next time for BC to host a CTIA meeting ☺. I encourage everyone to come to the sunny Okanagan and soak up some science, socialization, and sunshine – you won't be disappointed. For more details please refer to the following web-site http://www.for.gov.bc.ca/hti/ctia/index.htm .

The Tree Seed Working Group will be having a workshop at the CTIA meeting. A theme has not been decided on at this time, but if you have any suggestions, please bring them forward. I suggested two topics in the last armchair report a) Crown Architecture and its Control and b) Quality Assurance Monitoring (from seed production to sowing). I've had very little feedback and no other suggestions. I would like to decide on the workshop theme by mid February.

I send my best wishes to everyone for the holiday season. May you enjoy it safely with your loved ones.

David Kolotelo
Chairperson

EDITOR'S NOTES

There were a few hitches associated with the first electronic version of the last issue. I hope this one will have smooth sailing through cyber space, avoiding most of the storms.

The issue at hand contains many interesting contributions about seed orchard management practices as well as informative articles on other subjects.

Traffic on the TREESEED Discussion Group has been negligent other than the odd piece of spam. I encourage you to use it as a means of obtaining information to a question you may have or to announce an event or just to say something. If you are shy and do not want to reply to the discussion group you have the option of replying directly to the person who originated the discussion. Unfortunately, the rest of us lose by not being part of the discussion. Please subscribe if you have not already. IT'S FREE! If you have subscribed then consider trying to use it. HERE'S HOW:

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Comments, suggestions, and contributions for the News Bulletin are welcomed by the Chairperson or Editor.

MANAGING WESTERN REDCEDAR SEED ORCHARDS FOR REDUCED SELFING

Introduction

Western redcedar readily self-pollinates. This in itself is not unique. Many of our *Pinaceae* species also self but much of the resultant seed is selected against starting at prepollination through to seed germination and early nursery survival and growth. What makes western redcedar unique is that, on average, 30–50% of seed from either wildstand or seed orchard lots is from selfing, and the germination, growth, and survival are similar in the nursery to outcross seed. However, after outplanting, selfed seedlings grow approximately 10% slower than outcrossed, yet have similar survival (Russell *et al.* 2003). This could equate to over 4% reduction in merchantable volume at rotation (Wang and Russell 2002).

A number of trials, aimed at reducing selfing in both wildstand and seed orchards, have been conducted over the last several years. DNA analyses have shown that supplemental mass pollination and/or collecting from the upper crown can reduce selfing but not if a single tree has large amounts of both male and female flowers (Ritland 2003).

The annual western redcedar seed demand for the Maritime, under 600 m, seed planning unit (SPU) is approximately 7 million. Producing large quantities of western redcedar seed from small numbers of trees is relatively easy. However, producing quality seedlots that approach 100% outcrossing can create interesting challenges for the seed orchard manager.

Management Practices to Reduce Selfing

There are currently three major western redcedar seed orchards supplying A class seed for the Maritime SPU. Each orchard manager has developed their own unique management tools for efficiently increasing outcrossing.

TimberWest's Mt. Newton Seed Orchards The two western redcedar orchards at Mt. Newton were established in the mid-80's with untested grafted clones from phenotypic selections. The orchards, planted at 2 x 6 m, are comprised of 100 parents from Eastern Vancouver Island, Johnstone Strait, and South Coast Mainland areas.

The original management plan was to hedge the orchard trees at 2 m height for ease of management and to induce crops every other year by a foliar application of GA_3. This was very successful in producing large amounts of seed, with on average, 10 L of cones per ramet. However, with orchard seedlot analyses indicating 50–70% outcrossing, two new techniques were developed to reduce or eliminate selfing.

The first was to produce a small amount of controlled-cross seed from high breeding value parents and amplify the resultant seedlings through rooted cuttings. This technique works very well, as breeding to produce a large amount of high gain seed is relatively easy and cost-effective. Also, cuttings from the resultant juvenile donors root close to 100% and produce plants that are similar to seedlings in both form and growth. However, the additional cost of producing rooted cuttings has discouraged the use of this stocktype.

The second technique is to manage the orchard with two groups of unrelated clones; one group, whose crowns are encouraged to grow large, is to be used as the pollen parents, and the other group of smaller trees managed to produce female cones. The smaller female trees can either be potted stock that can be moved around or established in the ground among and around the larger trees. The original orchards at Mt Newton have been rogued heavily based on preliminary results of first generation polycross tests. The remaining high breeding value trees have been encouraged to produce a single leader and a raised crown to provide a pollen cloud. As additional results from the polycross field tests become available, smaller, unrelated trees with high breeding values are planted within the existing orchard and managed for cone production. This strategy should provide large amounts of outcross seed at relatively low cost.

Canfor's Sunshine Coast Seed Orchards The western redcedar orchard at Sechelt is a 16-year-old potted orchard. The compact growth form caused by growing in pots combined with planting at close spacing has made this orchard easy to manage.

Trials that varied the timing of induction to control relative amounts of male and female flowering were somewhat effective. However, although male flowers occurred in lesser amounts with some timings, they still occurred on ramets that produced collectable amounts of female cones. Therefore measures are still taken to prevent selfing. Hoods, made of remay cloth, are applied to female cones after pollen buds are removed from the hooded section and prior to pollen shed. Remay, also known as crop cover, is an inexpensive material that is somewhat porous but requires force for pollen to penetrate. The hoods minimize pollen that is produced behind and above the females from entering the conelet at the time of receptivity. Hoods, which have an open side facing down, are used rather than regular pollination bags because of the ease of pollination. In the future, high breeding value polymixes, from unrelated, selected clones, will be applied to the receptive females. Close to half of the cone crop is still outside the thousands of hoods applied to the trees. These cones are also hand-pollinated at receptivity with the same select polymix which may reduce selfing.

An in-depth study to determine the relative effectiveness of supplemental mass pollination (SMP) with and without hoods as compared to no treatments in reducing selfing was conducted in 2003. The results from DNA analysis will help us to determine the most cost-effective method of managing this orchard for reduced selfing in the future.

Western Forest Products' Saanichton Forestry Centre Seed Orchards To test whether or not simple and inexpensive management techniques can reduce the proportion of seed produced by selfing in western redcedar orchards, various techniques are being tested:

1. A standard completely randomized orchard as a control.
2. A 'male' and 'female' orchard. Single rows of 'male' trees will be encouraged to grow large and produce pollen flowers through timing of gibberellic acid (GA_3) applications in crop years. Two 'female' rows between 'male' rows will be pruned back and cones will be induced through timing of GA_3 applications in crop years. Unique sets of clones were assigned to each of the 'male' and 'female' rows and clones were randomized within the rows.
3. A 'layered' orchard, where a second unrelated clone is grafted above the initial clone. At planting, this layout is similar to a standard randomized orchard.

The grafted stock was planted in the SFC orchard in 2000 at 4 x 6 m spacing. The clones deployed included top breeding values clones based on 7-year open-pollination progeny test results. The second clones in the layered orchard are grafted at about 1.75 m, thus not all upper grafts are established yet. The orchards are not producing enough pollen at present to adequately pollinate the available flowers or test the orchard designs. Results from this trial will not be known for a number of years, however, future information will help guide the management of new orchards which will be established in the interim with high breeding value clones selected from existing polycross tests.

SMP is employed in these orchards at present to produce high-quality seed. Supplemental pollination of western redcedar is a more costly approach to seed production, both in terms of labour and orchard stock. In western redcedar, the pollen harvest involves branch collections rather than pollen bud harvest, thereby removing infrastructure for future cone development. This is less than desirable in young orchards; it is not a significant issue when harvesting pollen from older orchards with many large trees.

Conclusions

Western redcedar orchards will be producing high quality seed for coastal British Columbia in the near future. With the arrival of new high breeding value clones selected from first generation polycross tests and aggressive management techniques to reduce selfing in combination with new DNA tools, future seedlots from the three industrial orchards will approach genetic worths of 10–15% volume gain at rotation.

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METHODS TO MAXIMIZE CONE HARVEST EFFICIENCY

The BC Ministry of Forests' Kalamalka Seed Orchards are located at the north end of the Okanagan Valley near Vernon, BC. The operation covers two separate sites totaling 72 ha. We currently manage eleven orchards: four interior spruce (white/Engelmann), three lodgepole pine, two western larch, a western white pine, and an interior Douglas-fir. Nine of these orchards are producing significant cone crops and we have collected over 630 hL of cones in a single year. Harvesting such large volumes of cones can present a challenge. Here are some thoughts and discussion of the techniques we have developed to increase harvest efficiency.

Quality of labour is one of the keys to a successful harvest. Motivated, happy and well-trained workers perform best. Seed orchard cone harvest does not suit piece-work, instead, a decent hourly rate, combined with monitoring of individual production rates, give the best results. People are naturally competitive and respond well to having their cone volumes measured. Making the right choices in hiring helps; tree planters have generally proved to be good cone collectors. Also important is having an experienced core group of returning seasonal workers who can assume lead responsibilities.

A well organized plan is vital. Here's some of what we do:

1. Survey the orchards to identify the crop trees – any tree worth picking. This can be done well before the start of cone harvest. Merge this information with your orchard database to produce master picking maps and lists.
2. Select a number of representative crop trees from each clone or family to use as "indicators" (we generally use four crop trees per clone). The indicators are the trees that will be assessed to determine if the clones they represent are ready to be harvested. It is good practice to distribute these trees throughout the orchard to allow for micro site differences. Create a map of these trees and mark them with a unique colour of flagging tape ahead of time so they can be readily identified in the orchard.
3. Check your indicators for ripeness. When a sufficient portion of the indicators are ready to pick (we use two out of four at Kalamalka) it is reasonable to assume that all the ramets of that clone are collectable.
4. Apply the information from the indicator survey to your crop tree database to generate picking maps for the field crews.

One might think that orchard trees will ripen in the same order every year. However, our experience has been that they do not.

The local climate at Kalamalka is generally hot and dry. Cones mature early and can progress from an unripe condition to open and shedding fairly quickly. This applies even to our lodgepole pine, a species which normally produces serotinous cones. Trees within each orchard exhibit a wide range of ripening behaviour. A limited supply of ladders and orchard lifts means that we must always concentrate our efforts on trees that are closest to seed shed. Since we have thousands of trees which must be prioritized for collection, an efficient method of assessing cone ripeness is essential to ensure good seed quality and minimize losses.

The definitive test for seed maturity – the seed cutting test where embryo length and megagametophyte condition are assessed – is too time consuming to be practical on an operational scale. Instead, we assume that cones about to shed contain mature seeds. So, what is required is a quick, reliable field method to predict cone opening. A simple examination of the cone's outward appearance does not work. Our method for determining the ripeness of western larch, interior spruce, and Douglas-fir cones involves examining the condition of the cone axis.

The axis is quickly exposed by cutting a cone in half lengthwise with pruners. If the axis appears brown and dried out then the cone is collectable. A desiccated axis indicates that the tree is no longer "feeding" the cone and therefore the cone is getting ready to shed seed. One the other hand, if the axis still contains moisture (easily detected by running the pruner blade along the axis and checking for droplets), then there is little danger of the cone opening in the near future, even if the seeds are mature. A moist axis indicates that the tree is still supporting the cone. The axis test method is easily taught to inexperienced field staff, requires no special equipment, and can be performed in the orchard.

The keys to a successful cone harvest are labour, planning, organization, and effective prioritization. Identify the crop trees and choose indicators, then combine the axis test with the indicator system to set harvest priorities. These techniques have been refined at Kalamalka through several intense cone collections. Hopefully they will prove to be useful at other facilities. Happy harvesting!

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J.D. IRVING, LIMITED PARKINDALE CLONAL SEED ORCHARD

Our tree improvement program began in 1979 with plus tree selection and the location of the Parkindale Seed Orchard site. The orchard site is situated in the southeastern corner of New Brunswick, about 30 minutes south of the city of Moncton. It is 125 ha in size, with 106 ha established at the present time. The following species are currently producing improved seed:

White spruce: 30 ha of first generation – 50% rogued. Producing lots of seed.
White spruce: 6 ha of second generation and still expanding – no seed expected until 2007.
Black spruce: 14 ha of first generation – 60% rogued. Producing lots of seed, but limited use of seed.
Black spruce: 8 ha of second generation – 25% rogued. Producing lots of seed.
Norway spruce: 7 ha of first generation – 10% rogued. Producing fair amounts of seed over the last 3 years.
Jack pine: 10 ha of first generation – 60% rogued. Producing lots of seed, but very limited use.
Jack pine: 9 ha of second generation – 10% rogued. Producing lots of seed.
Eastern larch: 11 ha of first generation – 50% rogued. Very little seed picked from these orchards. Seed not required.
Eastern white pine: 11 ha first generation – planted over the last 4 years. Already producing 8 hL of cones per year, in the last two years.

We use Gibberellins to stimulate flower production and operate an extensive drip irrigation system to achieve maximum growth at the early establishment stage. Our workforce consists of one-full time, hourly employee, who lives at the orchard. We also have 4 seasonal, full-time employees, who work from April to October or November each year. Additional hourly workers are hired during peak seasons, such as cone collecting.

Cones are collected from early August (white spruce) to early October (Norway spruce and jack pine). The cones are dried and processed at the seed orchard during the fall and winter season. Our seed extraction plant was purchased in 1988 from B.C.C., a Swedish company. The largest quantity of cones processed at this facility was 500 hL, but we are capable of at least twice that quantity per year. We have also contracted some custom cleaning from other organizations over the past few years. We take pride in the quality of the seed produced at our facility.

Near-future activities include expansion of our second generation white spruce block and possible establishment of a red spruce orchard. The Irving Company will produce 25 million seedlings in 2004. An additional 2 million rooted cuttings will be produced from controlled crosses made in the top 20% of white and Norway spruce clones.

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HELICOPTER POLLINATIONS IN SEED ORCHARDS

Helicopter pollinations are nothing new for many people in the seed orchard business. The need and validity for pollen enhancement activities is dictated by growth and development of the ramets. Our experience, when walking through mature pine or spruce orchards, is that pollen availability and cloud density are normally not a problem. Where we begin to manage our pollen activities is when we know our pollen cloud is inadequate and receptive females are not being fertilized.

In 1999/2000 concern for seed set in mature lodgepole pine orchards came to the forefront with a number of projects initiated to understand what was happening in the North Okanagan. During this period, one project, under the direction of Drs. Owens and Wilson formerly of the University of Victoria, looked closely at pollen availability and its opportunity to fertilize the ovule.

We looked at pollen by counting pollen grains on a sticky microscope slide left in the orchard over night. We then picked flowers for dissection in the lab and a count of pollen grains on the micropyle. In most cases the count was 0 to 2 on each micropyle. We registered the numbers and then called a helicopter to fly approximately 8–12 m over the ramets to create a wind and to go slow enough so that pollen was visibly lifted up and circulated under the helicopter in the vortex of the blades. Even with large orchards of 6 000 ramets the flight lasted between 10 and 15 minutes. Sample slides were again collected that had only been out for half an hour and the pollen grain counts were 10 times that of the 24 hr count. Flower samples were taken throughout the orchard and pollen grains within the flower were on average 5 to 10 times that of the counts without the helicopter. Through our observations we are convinced that the use of a helicopter greatly increases pollination when the orchards are young and pollen clouds are not sufficient.

Next we looked at our mature spruce orchard and we thought this technique could improve seed set. Historical records have shown us that we can expect approximately 1.0 kg of seed per hL of cones harvested. This has been the average over the 5 previous harvests up to 2001.

In 2002, Vernon Seed Orchard Company harvested a large spruce crop of 729 hL from approximately 4 000 ramets. Even with a large pollen crop present on the ramets we decided to also mix the pollen on two occasions using a helicopter. We had very little wind during the receptive periods and to ensure pollen got into the flowers we felt mixing was needed along with the normal pollen flow within the orchard. We noted a number of things during mixing over the orchard. First, the pollen cloud resulting from the helicopter was clearly visible from over 10 km away. Second, when we had completed the mixing we walked through the orchard and found that we had not disturbed much of the pollen that was available to the cloud. We could not find ramets that looked as though we blew a lot of their pollen away. Third, the resulting seed set was 1.24 kg of seed per hL of cones.

Can we say for certain that the helicopter was the reason for the increase in seed/hL? No, but for the small cost of the helicopter and the value in the increase in production we can say that it is a good investment. The helicopter cost is less when compared to our affect on seed set from the ground using Supplemental Mass Pollination (SMP). SMP is on occasion the only choice when no pollen exists in the orchard and it happens to be a good female flowering year.

Others have expressed concern over selfing. The conifer species that we manage will naturally have some separation of males and females on the ramets. With this separation and the downward air flow of the helicopter vortex we are confident that we are not influencing selfing. Samples taken by Ministry of Forests scientist, Dr. Stoehr, have shown, through DNA markers, that the selfing rate is not any greater using helicopter versus what happens naturally within orchards.

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THE NEW BRUNSWICK BALSAM FIR CHRISTMAS TREE SEED ORCHARD

The Christmas tree industry in New Brunswick is a multi-million dollar industry that produces 500 000 trees each year. There are approximately 300 growers that use almost exclusively balsam fir as the species of choice. Many growers in New Brunswick purchase balsam fir seed, seedlings or bareroot stock from commercial or private nurseries for Christmas tree plantations.

A Christmas tree tree improvement program was initiated in 1986 with the objective of producing genetically improved seed for use by the growers. Improving the quality of trees planted could reduce the rotation age, minimize cultural requirements, and increase resistance to pests. The program has adopted a cooperative approach with involvement from the NB Department of Natural Resources and the NB Christmas Tree Co-op.

A clonal seed orchard strategy was adopted and a total of 233 plus trees was selected from 1986 to 1991. The trees were located throughout the province with 95% of the selections identified in cutovers or thinned areas. Most of the plus trees were between the ages of 8 to 20. The criteria for selection were based on branching characteristics (angle, internodal), growth rate, bud break, and foliage characteristics (color, needle ranking). Selected trees were free of any insect or disease problems.

The plus trees were grafted and planted in a breeding garden and clonal orchards. Two orchards totaling 3 ha were established at the Kingsclear Nursery and at Queensbury seed orchard. Based on phenological characteristics, the top 24 clones were selected for the seed orchards. The orchards were planted in 1990-92 at a spacing of 3 x 6 m. General maintenance such as fertilization and mowing has been routinely carried out in the orchards.

The first major cone crop was produced in 2002 with 2 500 L of cones collected and a total of 73 kg of seed extracted. The average seed germination was 50%. Topping was tried in a portion of one of the orchards and the results indicate a negative impact on cone production. The topped trees were multi-topped, but the cones still tended to be only found on one of the leaders. Trials with $GA_{4/7}$ injections have indicated a positive effect on cone production, with little or no effect on tree vigor.

The orchard trees are now 3+ m in height and are very healthy and growing vigorously.

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USE OF MOLECULAR MARKERS IN SEED ORCHARD MANAGEMENT

Introduction

Seedlots collected in wind-pollinated seed orchards have one major uncertainty associated with them and that is the male parentage of the seeds. There is no easy way to determine the male parents in wind-pollinated seedlots without the use of biochemical or molecular markers. Seed production in orchards from the onset of pollination to the harvest of cones is in a "black box". We assume that mating in orchards is fairly random, that contamination is low or absent, and that orchard management efforts, such as hormonal flower induction and SMP, are effective. However, to get a better handle on the above assumptions we have to apply markers. In the past, isozyme markers were used to shed some light into these assumptions, but isozymes are much less variable than DNA markers and many interpretations of isozyme based results relied on probabilities. With the development of very variable (polymorphic) DNA markers and the use of DNA amplification techniques, DNA analysis of operational seedlots becomes a lot more feasible. For example, using five to six markers, an orchard can be genotyped with about 90% of all clones being unique, i.e., easily identifiable.

The Technique

During the developmental work to produce molecular markers, we learn which parts of the DNA of a tree is likely to be different (polymorphic) among individual genotypes (clones) within a species. It is these stretches of DNA that we are exploiting during the genotyping of orchards. These potentially polymorphic stretches of DNA are amplified, i.e., biochemically copied millions of times so these particular segments of DNA then can be visualized on a gel using electrophoresis (without prior amplification there would not be enough DNA present to detect it) and the amplified DNA then can be compared among clones. This process of amplification of DNA is called PCR (polymerase chain reaction). Using several of these markers for genotyping clones in an orchard, there is a good chance that most clones will be found to be unique.

Each plant has three types of DNA: the nuclear (inherited from both parents), mitochondrial (mt), and chloroplast (cp) DNA. These latter two DNA types are also referred to as extra-nuclear DNA, with the mtDNA inherited only through the female parent and the cpDNA only inherited through the male parent in most commercial conifers. Therefore, for seed orchard questions related to the male gamete (pollen), genetic markers derived from cpDNA are ideal.

Use of DNA Markers

Clonal Verification Mistakes made during vegetative propagation and mislabeling can easily happen during the establishment of orchards. Usually these mistakes are noticed as one or several ramets of a single clone are noticeably different. These differences can be observed in phenology, foliage colour, and cone traits. Using DNA markers for verification is relatively straight forward as all markers must be the same among all ramets of a clone to be genetically identical. Markers based on nuclear DNA as well as mtDNA and cpDNA can be used for this purpose.

Mating Dynamics If a seed orchard manager or seed user is interested in the mating pattern in an orchard, genetic markers evaluating pollen dynamics must be used. To evaluate the female contribution is simply a matter of keeping track of the number or volume of cones harvested from each clone (better yet, the number of filled seed produced by all ramets of each clone) and clonal female gamete contributions can be calculated. To assess the male reproductive success of individual clones, markers of the cpDNA are the markers of choice to be evaluated in the embryo of a seed. As long as a large proportion of clones in an orchard can be uniquely identified (i.e., most clones are different from each other), assaying up to 500 bulked seeds per crop will be sufficient. By matching the cpDNA markers in the embryo to those of the paternal orchard clones, paternity and consequently, male reproductive success, can be inferred. Deviations from the expected are immediately observed, such as the disproportionate representation of some males. If non-bulked seed, i.e., seed with the maternal identity, nearest neighbour effects or preferential mating can also be determined.

In bulked lots, where the maternal identity is no longer available, female contribution to a bulked seedlot can also be determined by using mtDNA markers, as these are inherited through the female parent. Similar to determining paternity using cpDNA, female gamete contribution to a seedlot can be determined by matching the mtDNA markers of embryos with those of the potential mothers in the orchard.

A potential problem in seed orchards is selfing, either by self-pollinations or by pollinations from ramets of the same clone. To study selfing, cpDNA is most effective as the pollen parent in question may also be the female parent. By determining the genetic marker profile of a female, and if it is unique, selfing can easily be evaluated by calculating the proportion of fertilizations by a pollen donor that has the same, unique cpDNA marker profile. In this case, it is important that only unique clones are studied as a specific marker profile can only be contributed by a single clone. Therefore, it may not be possible to study selfing in all clones of the orchard, however, a sample of orchard clones will be representative of the selfing situation in a particular orchard. Clonal-row orchards should always be checked for selfing before the seed is used in reforestation.

Pollen contamination is also a common problem in many orchards. However, even the use of molecular markers is limited, even if every tree in the orchard could be uniquely genotyped. In such a situation, if markers in the embryos of a seedlot are found that could not be matched to one of the seed orchard parents, this would clearly indicate a contamination event. However, since the number of background pollen donors is close to infinite, we can never be sure that a marker profile in an embryo assigned to an orchard parent is not also present in the contaminating population. Thus, at best, we only can determine minimum levels of contamination.

Evaluation of SMP Efficacy SMP efficacy can be evaluated if the pollen donors are unique with respect to the rest of the orchard clones. If the pollen donors are present in the orchard, then a baseline estimate of their reproductive success must be determined first, to see how often they are reproductively successful in an open-pollinated situation only. The difference in reproductive success between the baseline values and SMP is the SMP efficacy. If, however, the SMP pollen donors are not present in an orchard, then the reproductive success of the SMP pollen donors is the SMP efficacy.

Control-pollination Verification Even when one is most careful, mistakes can happen during control-pollinations. This can be a mix-up of pollen lots or simply some level of pollen contamination in the applied pollen lots. As the male parent is known in control crosses, it is only a matter of matching the genetic cpDNA markers found in a sample of control-cross seed with those of the male parent. Any mistakes become apparent very quickly.

Cost of Molecular Analysis

There are several commercial labs that carry out this type of analysis. For example, at BC Research Inc. in Vancouver, it costs roughly $100 to genotype a clone and roughly $20 to analyze a seed (embryo). These costs are too high for routine analysis of seedlots on a yearly basis. However, it may be feasible to invest that type of money in special situations, such as for a one-time evaluation of SMP efficacy or if an orchard manager suspects that many ramets in an orchard are mislabeled.

Conclusion

Many questions regarding the mating dynamics in orchards and effectiveness of orchard management treatments can be answered using molecular techniques. In British Columbia, we have markers available to evaluate spruce, lodgepole pine, Douglas-fir, western redcedar, and western larch. Currently, the costs are prohibitive to carry out routine evaluations of all seedlots on a yearly basis, but costs have declined to make spot checks feasible. It would be prudent to check at least some seedlots from high gain orchards to see if the gamete contribution of individual clones is close to what we expect. We have the tools now, let's use them.

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SEED ORCHARD PEST MANAGEMENT AND INSECTICIDE DEREGISTRATION

Conifer seed production in British Columbia seed orchards is subject to the ravages of a multitude of insect pests. The provincial Seed Pest Management group strives to implement integrated pest management strategies to deal with these pests effectively. Without effective pest management programs, pests can reduce seed harvests by up to 90%. Although our goal is to use non-chemical management means wherever possible, we rely on insecticides for the control of many key pests. Pesticides are applied only when monitoring indicates they are needed and in the most environmentally sensitive method possible. Even so, without insecticides, we would be faced with large annual losses in seed production to insect depredation.

Many of the insecticides we currently use in seed production are at risk of being removed from the market. Insecticides are removed for one of several reasons. These include:

Re-evaluation. Many insecticides were originally registered for use many years ago. The registration requirements in the 1950's and 60's were quite lax by today's standards. Therefore these old poisons must be re-registered to ensure that they meet today's stringent safety and efficacy standards. Some of them will not make it and will lose their registration; many others will require label modifications to maintain their registration.

New safety data. If new data demonstrate safety issues, particularly for carcinogenic (cancer-causing) or teratogenic (mutation-causing) effects, registration may be suspended or removed.

Voluntary removal. Pesticide companies may decide to remove a registered compound from the market voluntarily. There is an annual fee required to maintain the registration, and some manufacturing, distribution, and sales costs are fixed. If the size of the market does not justify the risk and expense of marketing a product, the company will voluntarily remove it.

Pesticide Re-evaluation Programs

Canada has developed a four-part re-evaluation program to determine whether a pesticide's registration should be maintained. Human and environmental safety are the main concerns; most efficacy information is already available. Safety data for many of the older pesticides are lacking. These data concern safety to applicators, field workers, "bystanders", and consumers. Environmental concerns address risk to non-target organisms; fate in the soil, surface, and groundwater; aquatic habitats; persistence in the environment; and breakdown products.

Our approach is modelled on that of the US Environmental Protection Agency (EPA). They have developed a "risk cup" which determines the risk to humans of all sources of exposure of a chemical, as well of all sources of exposure by similar chemicals with a similar mechanism of toxicity. Previously, residue limits for a plant product (food, flowers, tree seedlings, etc.) were set as though that item was the only source of exposure for a consumer including all sources of exposure that result in lower residue tolerances, and label modifications to mitigate risk factors.

The Canadian programs are divided according to the re-registration data available from foreign sources, effectively meaning the USA. They are:

Program 1: Re-evaluation of pesticides for which a review of an equivalent product for re-registration by a foreign source (e.g., the US EPA) is underway. Canada can use the US data for our situation. After their review, the US writes a Reregistration Eligibility Decision (RED); Canada uses the US decisions as a basis for our decisions. For products used on food, the US grants IRED status (Interim Reregistration Eligibility Decision). The US Food Quality Protection Act process, which accounts for all other pesticides with a similar mechanism of toxicity, must be complete for a full RED (see Program 3).

***Insecticides used in seed orchards included in this program*:**

Insecticidal Soap. This product is considered non-toxic and its registration status has been almost completely preserved.

Program 2: Re-evaluation of pesticides for which no foreign review is available. A Canadian review is needed.

***Insecticides used in seed orchards included in this program*:** None.

Program 3: Re-evaluation of pesticides which were granted an IRED by the US EPA and are scheduled for re-assessment under US Food Quality Protection Act (FQPA). The FQPA lumps chemicals with similar mechanisms of toxicity and looks at aggregate exposure from all sources. Canada will adopt EPA conclusions. Once the FQPA assessment is complete and risk mitigation factors (i.e. use limits) are developed, the IRED gets upgraded to a full RED and re-registration is granted.

***Insecticides used in seed orchards included in this program*:**

Acephate (Orthene): Some restrictions apply as a result of the degradation product methamidophos (Monitor). Soluble powder formulations must be in water-soluble bags only (this is good!). Remove hand-applied treatments to trees, shrubs, and outdoor ornamentals. (IRED only; RED pending US FQPA assessment).

Carbaryl (Sevin): Restrictions to home and garden use; some restrictions to ornamental uses. (IRED only; RED pending US FQPA assessment).

Diazinon: All indoor and outdoor residential applications cancelled. Many agricultural applications cancelled; rate reduction for ornamentals; number of applications per year reduced to one. (IRED only; RED pending US FQPA assessment).

Dicofol (Kelthane): All residential uses eliminated. Additional protective equipment required; enclosed cabs on tractors required. Handheld sprayer application eliminated for liquid formulations. Maximum of one application per year. Maximum 0.55 lb/acre for non-residential ornamentals. (US FQPA completed; RED active).

Dimethoate (Cygon, Lagon): US re-registration review currently underway. All residential uses to be eliminated. Worker hazards and risks to bird toxicity will likely result in label modifications. (US IRED not yet granted).

Endosulfan (Thiodan): All residential applications cancelled. All WP formulations must be in water-soluble bags. Enclosed cabs required for airblast applications; REI for WP on ornamental trees is 4 days. (US FQPA completed; RED active).

Fenbutatin-oxide (Vendex): Minor changes in application requirements. (US FQPA completed; RED active).

Malathion: US re-registration review currently underway. Documents suggest little change in labelling requirements, except perhaps to some REI's. Most residential uses preserved. (US IRED not yet granted).

Oxydemeton Methyl (Metasystox-R): Total usage is very low. Worker hazard and environmental risk to birds is high. These three factors led registrant to remove their registration in Canada.

Program 4: These are special reviews, partial reviews, or reviews targeting specific uses and user groups, not a complete re-evaluation.
***Insecticides used in seed orchards included in this program*:** None.

Conclusions

Commercial registration in Canada of most of the insecticides used in seed orchards will be maintained, with some modifications. Domestic (residential indoor and outdoor uses) of most have been, or shortly will be, cancelled. We frequently hear of the impending loss of registered insecticides: these are losses of domestic registrations, not commercial registrations. The pesticides used on commercial seed orchards are not, for the most part, being threatened with loss of registration.

The one insecticide which has already been lost, oxydemeton-methyl (Metasystox-R), was removed from the market voluntarily. This will present a problem for management of two key pests, the Douglas-fir Cone Gall Midge (*Contarinia oregonensis*), and the Red Cedar Midge (*Mayetiola thujae*). Management of these insects relies upon timely applications of a systemic insecticide, applied according to pest monitoring results. In 2003, populations of these pests were low so the loss of Metasystox-R was not important. In future years, efficacy data should be gathered for the other systemic insecticide available to us, dimethoate. A minor-use label expansion of dimethoate could be a viable replacement for Metasystox-R.

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STRATIFICATION MOISTURE CONTENT

The moisture content of seed in stratification is an attribute, in addition to germination, that we monitor as part of our Quality Assurance (QA) program. Over the past few years we have noticed in interior spruce, (*Picea glauca*, *P. engelmannii* and hybrids), that the stratification moisture content of orchard seed was lower than that of wild seed. A more detailed look at other species illustrated that this phenomenon was not restricted to interior spruce (Table 1).

Assuming a 5% significance level ($\propto = 0.05$) we see no statistically significant difference in *Pseudotsuga menziesii* var. *menziesii* and *Pinus monticola.* All other species showed a significant difference between wild and orchard seed for stratification moisture content! Among these species *Larix occidentalis* was atypical as the orchard-produced seed had a higher stratification moisture content. The remaining species all appeared to have reduced stratification moisture contents from orchard-produced seed.

Does this have any practical importance or is this just an attribute of seed produced in the orchard environment? An initial look at germination does not indicate any significant falldowns attributable to these 'different' moisture levels during stratification. We will be expanding our monitoring this year in this area and try to increase sample sizes for some species (i.e., wild-produced *Pseudotsuga menziesii* var *menziesii*).

Table 1. A comparison of stratification moisture content (MC.) levels between wild-stand and orchard-produced seed (sample sizes [#] and p-values for t-test included[1]).

	Wild seed		Orchard seed			t-test
Species	#	MC	#	MC	Diff.	*P* value
Pseudotsuga menziesii var. *menziesii*	6	32	53	31.6	-0.4	0.724
Pinus monticola	17	35.2	105	35.6	+ 0.4	0.568
Pinus contorta var. *contorta*	109	30.2	21	28.4	-1.8	**0.028**
Tsuga heterophylla	26	26.1	30	24.1	-2	**< 0.001**
Larix occidentalis	66	30.9	32	32.7	+1.8	**< 0.001**
Picea sitchensis	20	27.7	11	22.4	-5.3	**< 0.001**
Picea glauca, *P. engelmannii* and hybrids	42	31.1	95	26.1	-5	**< 0.001**

The main concern is with *Picea sitchensis* as the moisture content of orchard seed is quite low and close to the estimated lower limit of dormancy breakage in *Picea glauca* (20%) (Downie *et al.* 1998). No specific data exist for *P. sitchensis*, but it seems reasonable to assume that the lower limit will be similar between the two species. Does this impact germination? Do we need to extend the soaking period in some seed orchard-produced seedlots? It is too early to say, but this should be taken as a warning of potential problems before more data are available.

It is generally accepted that seed orchard seed is larger than wild-produced seed, at least in the *Pinaceae* (Kolotelo 2000). The unadressed question to date is how this increase in size is allocated to the embryo, megagametophyte, and seed coat. Are all three structures larger in orchard seed in the same proportions? Does the 'thicker' seed coat (or other structures surrounding the megagametophyte) decrease the rate of moisture uptake? Does the greater amount of seed reserves result in increased seed 'vigour'?

There are more questions than answers. This is an introduction and a call for all to be aware of this potential issue. As many reforestation programs are moving to the use of more orchard-produced seed this is the time to carefully examine the differences in seed characteristics. Once a program is fully relying on orchard-produced seed it becomes difficult to quantify the changes in seed attributes relative to natural populations (especially with operational characteristics like stratification moisture content). I hope that this encourages other facilities to look at quantifying differences in seed characteristics between wild-produced and orchard-produced seedlots.

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[1] t-tests were performed in MS-EXCEL with the TTEST function assuming unequal variances between samples.

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A BRIEF REVIEW OF GERMINATION TESTING REQUIREMENTS FOR EASTERN WHITE PINE (*Pinus strobus* L.) SEEDS

According to the Rules of the International Seed Testing Association (ISTA 2003), germination of eastern white pine seed requires paired tests of no pre-chilling and 28 day pre-chilling at 3-5^{0}C with germination on top of germination paper at 20°C or 20–30°C with 8 hour photoperiod for 28 days. These germination requirements are different from the rules of the Association of the Official Seed Analysts (AOSA 2002) which require paired tests with no pre-chilling and pre-chilling of 28–42 days and germination at 20–30°C with more than 8 hours of light for 21 days. The differences in pre-treatment and testing conditions between the two rules were recognized earlier and former members of the AOSA Tree and Shrub Seed Sub-Committee agreed to carry out co-operative testing of the requirements for pre-chilling, germination temperature, and photoperiod. In this paper we report the co-operative test results and briefly discuss them with published and unpublished information.

Methods

The seedlots were from Chalk River in eastern Ontario, Canada; Minnesota, Southern Ohio, North Carolina, USA; and Germany (origin unknown). Participating laboratories from Canada, Germany, Norway, and USA carried out the testing. Methods used consisted of five seed sources, four pre-chilling treatment periods (0, 28, 42 and 56 days), two germination temperatures (22° and 20–30°C), two photoperiods (8- and 16-hours) and 35 days of test period. Four replications of 50 to 100 seeds each were used for each treatment. However, some laboratories did not test all the treatments and/or conditions.

Results

Of the variables tested, no pre-chilling provided the greatest variability in germination among seedlots (Table 1). The degree of dormancy, comparing the difference in germination between the non-chilled and 28 day pre-chilled seeds, varied among the five seed sources (3–48%) (Table 1). Seeds from southern Ohio were the most dormant with a difference of 48%, followed by North Carolina with 42%, and 33%, 20%, and 3% for Eastern Ontario, Minnesota, and Germany, respectively. This seems to confirm an earlier report by Fowler and Dwight (1964) that eastern white pine seeds from the southern part of the species range exhibit deeper dormancy than those from the northern range. Pre-chilling greatly enhanced germination. There was little difference in germination between the two temperature regimes and the extended photoperiod tended to increase germination.

To compare the effect of temperature on germination, the alternating regime of 20–30°C was 11% better than the constant 22°C for non-chilled but only 1% better for the pre-chilled seeds of all sources (Table 2). Although the 16-hour photoperiod promoted greater germination on average (18.5%) on non-chilled seeds than the 8-hour photoperiod, its effect on prechilled seeds was only a 0.5% increase. These findings clearly confirm the beneficial effect of pre-chilling in reducing the seed's sensitivity towards germination temperature and photoperiod (Mittal *et al.* 1987; Wang 1987; Wang and Berjak 2000).

Based on these results, laboratory germination testing for eastern white pine seeds should be conducted using 28 days pre-chilling and a germination condition of 20–30°C with an 8- hour photoperiod for 28 days.

Table 1. Effects of dormancy, pre-chilling, temperature, and photoperiod on the germination (%) of eastern white pine seeds from five sources

Seed source	Dormancy[1]	Pre-chilling		Temperature		Photoperiod	
		Non-chilled	Chilled[2]	20–30°C	22°C	8-hour	16-hour
Southern Ohio	48	36	85	75	71	69	76
North Carolina	42	38	81	72	69	66	74
Eastern Ontario	33	51	86	78	76	74	79
Minnesota	20	67	86	82	80	77	84
Germany	3	82	85	83	85	84	83
Average	29	55	85	78	76	74	79

[1] Difference in germination between the non-chilled and 28-day pre-chilled seeds.
[2] Average germination of seeds pre-chilled for 28, 42, and 56 days.

Discussion

In discussing the optimum period for pre-chilling eastern white pine seeds, we must remember that dormancy in tree seeds varies among individual trees within a stand, between stands within a crop year, between locations, and among crop years (Wang 1976). This could be the reason for the controversy in prechilling requirements for this species. For example, test results of eastern white pine seeds from the Atlantic Forest Tree Seed Centre of the New Brunswick Department of Natural Resources showed that the best germination results were from 3 weeks of cold stratification as compared to 2 or 4 weeks (Tosh and Messer 1997). Krugman and Jenkinson (1974) recommended 60-day cold stratification as the pre-treatment for eastern white pine seeds.

At the Petawawa Research Forest, many research trials of eastern white pine seedlots of the Ottawa Valley were carried out over the years. The results consistently showed that 28 day pre-chilling gave the best results as compared to 21 or 35 days. In another experiment to compare the effect of cold-water soaking and 21 day pre-chilling on 12 seedlots of eastern white pine from the Upper Ottawa Valley, dormancy varied from very shallow (3%) to very deep (76%). The average germination of the 12 lots was 62% for the non-chilled control, 76% for the 3-day cold-water soaked, and 92% for the 21 day pre-chilled (Wang, unpublished data). Fowler (1959) reported that removal of the seedcoat was the most effective treatment for rapid germination (91%) of eastern white pine from an Ontario source and 20-day cold stratification of intact seeds was the next best treatment (84%). In contrast, 20-day cold stratification of intact seeds was the best for seeds from a Québec source (45%). Soaking intact seeds in aerated water for 3 days enhanced the germination of the Ontario seedlot to 80% but of the Québec seedlot to only 10%. It is interesting to note the different response of eastern white pine seed sources to the same pre-treatment.

The cooperative testing results seem to suggest that although the degree of dormancy varied greatly among the 5 seed sources, their dormancy was uniformly broken and maximum germination was achieved by the 28-day prechilling treatment.

In view of the above, it can be recommended that eastern white pine seeds require 28 days pre-chilling and a germination condition with an alternating temperature of 20–30°C and an 8-hour photoperiod for laboratory testing. One of the exceptions to this is when eastern white pine seeds are stored at sub-freezing temperatures for some time. An extended pre-chilling period is required due to induced deeper dormancy (Wang 1982).

Acknowledgements

We wish to acknowledge the contributions of eastern white pine seedlots and participation in this cooperative testing from Bob Kaarfalt of the National Tree Seed Laboratory, US Forest Service; Frank Bonner (retired) of the Southern Research Station, US Forest Service; Gisela Eicke of Germany; and participation in the testing from G. Saether of Norway and George Edwards (retired) of the Canadian Forest Service.

Table 2. Average germination (%) of five eastern white pine seedlots after 28 days following four pre-chilling periods, two germination temperatures and two photoperiods

		Germination after 28 days					
Pre-chilling		20–30°C			22°C		
period (days)	Seed source	8-hour	16-hour	Mean	8-hour	16-hour	Mean
0	Southern Ohio	31	55	43	16	42	29
	North Carolina	36	54	45	17	43	30
	Eastern Ontario	51	63	57	29	59	44
	Minnesota	65	80	73	41	78	60
	Germany	82	78	80	84	84	84
Average of non-chilled		53	66	60	37	61	49
28	Southern Ohio	84	83	84	83	85	84
	North Carolina	81	81	81	76	83	80
	Eastern Ontario	86	87	87	84	84	84
	Minnesota	83	88	86	86	86	86
	Germany	85	83	84	86	85	86
Average of 28 day pre-chilled		84	84	84	83	85	84
42	Southern Ohio	87	85	86	84	85	85
	North Carolina	80	79	80	79	83	81
	Eastern Ontario	85	85	85	87	86	87
	Minnesota	84	86	85	90	88	89
	Germany	87	82	85	82	84	83
Average of 42 day pre-chilled		85	83	84	84	85	85
56	Southern Ohio	83	86	85	84	88	86
	North Carolina	79	81	80	80	85	83
	Eastern Ontario	83	84	84	88	87	88
	Minnesota	87	83	85	83	85	84
	Germany	83	85	84	85	85	85
Average of 56 day pre-chilled		83	84	84	84	86	85
Average of all pre-chilled		84	84	84	84	85	85

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IN MEMORIAM

Prof. David J. Gifford. 1944–2003

David passed away suddenly on 15 August 2003 a few days short of his 59th birthday. He was born in Liverpool, England, emigrated to Canada in 1967, and spent some time in research technical positions. Realizing that he was not achieving his potential, he enrolled in a B.Sc. program at the University of Alberta and, being excited by the lectures given by the faculty of the Botany Department, went on to obtain a First Class Honors in Botany. This established his career interest in plants, and he next completed his Ph.D. on formate metabolism in barley leaves with Edwin Cossins in the same department. After being awarded a Natural Sciences and Engineering Research Council of Canada (NSERC) postdoctoral fellowship, he then joined the laboratory of Derek Bewley at the University of Calgary, studying the mobilization and control of storage proteins in the castor bean seed. After a brief time with Gil Schultz in the Department of Medical Biochemistry at Calgary, he was appointed as Assistant Professor of Botany at the University of Alberta in 1986. In 1997, he was promoted to Full Professor in the Department of Biological Sciences at the University of Alberta.

His high quality teaching and research and his extensive contributions to the university and Canadian scientific community have been recognized in many ways, from his appointment to Professor, to his receipt of the Tree Physiology Award for Outstanding Research Contributions from the Canadian Society of Plant Physiologists. In this Society, he took on many roles, including Western Director, Senior Director, and he was due to assume the Presidency in 2005.

Dave was a valued member of the Editorial Board of the Canadian Journal of Botany. He served as Associate Editor for nearly 10 years, and in addition reviewed many papers dealing with seed biology for the Journal.

Dave's research focused primarily on the seeds of gymnosperms, particularly on the regulation of the mobilization of their stored lipid and protein reserves during postgerminative growth. Other notable research interests included collaborative studies of pine somatic and zygotic embryos with the forest biotechnology company CellFor Inc. (Vancouver, B.C.), a world leader in the conifer plantation reforestation industry. The seeds of gymnosperms provide unique and difficult challenges as research tools, and it required persistence and courage on Dave's part to continue to face these and to produce novel and interesting results.

Joining Dave in his efforts to better understand the mechanisms involved in gymnosperm germination have been a number of excellent graduate students. Many of these students are now establishing themselves in independent careers at various institutions across North America.

In addition to being a researcher of note, Dave was also a strong family man, and his wife, Judy, and two daughters, Robyn and Jessica, were a very important part of his life. He enjoyed the great outdoors, particularly cycling and hiking in the summer and cross-country skiing in the winter. With his passing, the Canadian plant community has lost a fine scientist, friend, and a great human being.

Dr. Derek Bewley, FRSC, and Dr. Robert Mullen
University of Guelph

Editor's Note: The Tree Seed Working Group of the Canadian Tree Improvement Association gratefully acknowledges the National Research Council of Canada for allowing the reproduction of this obituary which appeared in the August 2003 issue of Canadian Journal of Botany 81(8):v-vi.

KEW SEED INFORMATION DATABASE

Release 5 of Kew's Seed Information Database (SID) is now live (went out in July, actually!) on our internet site at: http://www.rbgkew.org.uk/data/sid/. A number of changes and improvements have been made in this release, most notably: A new module containing seed protein contents for ca 2 400 species has been added.

{HYPERLINK \l "plant life-form"} Raunkiaer life-form has been added for ca 7 060 species.

Species taxonomy has been greatly improved by the removal of ca 1 650 synonyms. A number of important groups of vascular plants have been covered including conifers, the order Fagales, and the families Euphorbiaceae and Fabaceae.

SID can now also be accessed via Kew's electronic Plant Information Centre (ePIC). If you would like to search ePIC for other types of plant information, {HYPERLINK http://www.kew.org/epic/index.htm . In addition, the seed weight dataset has been expanded to include an extra 590 entries.

The seed storage behaviour dataset has been expanded to include data for an additional 260 species and a number of existing entries have been updated to take into account new research observations.

The dispersal dataset has been expanded to include data for an additional 730 species.

The germination dataset has been expanded to include data for an additional 285 species.

The seed oil content dataset has been expanded to include an extra 50 entries. So please have a look and let us know what you think, by emailing: sid@rbgkew.org.uk .

As always, constructive criticism gratefully received, as will be offers of data and tip-offs to where it might be found.

We're hoping to do a further release in January 2004.

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SEED ORCHARD MANAGEMENT MANUAL

A manual for managing conifer seed orchards in eastern Canada is now in press: Smith, R.F.; Adam, C.I.G. 2003. A Manual for Managing Conifer Seed Orchards in Eastern Canada. Produced jointly through the cooperation between the Forest Ecosystem Science Co-operative Inc, Forest Genetics Ontario, Living Legacy Trust, the Ontario Ministry of Natural Resources, and Natural Resources Canada, the manual attempts to provide a detailed 'how-to-do everything' for seed orchard managers and contains a compilation of significant 'new' and up-to-date information starting with site selection and ending with designing and managing seed orchards to increase genetic gain.

The publication is comprised of nine chapters plus appendices. The main topics covered in the 9 chapters are as follows: Planning, Site Preparation, Design and Establishment, Vegetation Management, Fertility Management, Management of Pests and Other Factors, Crown Management, Seed and Pollen Cone Management, and Managing Seed Orchards to Increase Genetic Gain and Genetic Diversity.

Copies of this publication should be available early in 2004. To request a copy, please contact:

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777 Red River Road
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For more information on the manual, please contact Ron Smith.

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NEW BOOK

CABI Publishing has just published the following book:

The Biology of Seeds: Recent Research Advances

Edited by: G. Nicholás, K.J. Bradford, D. Côme and H.W. Pritchard

October 2003 496 Pages Hardback

ISBN: 0 85199 653 1 £95.00 (US$175.00)

This title is essential reading for those studying and researching in the areas of seed science, plant physiology, biochemistry, and ecology. This book presents edited and revised papers from the seventh International Workshop on Seeds, held in Salamanca, Spain, in May 2002. The key topics addressed include seed development, germination and dormancy, as well as desiccation, seed ecology and seed biotechnology. For further information and to order this book, please visit: www.cabi-publishing.org/Bookshop/book_detail.asp?isbn=0851996531

SEED PROPAGATION OF MEDITERRANEAN TREES AND SHRUBS

Conserving plant diversity is extremely difficult if you don't know how to propagate the species you need to defend. In many Mediterranean areas restoration of degraded land is generally done with a limited number of woody plants simply because most nurseries don't know how to grow Mediterranean trees and shrubs from seed.

Mediterranean flora is well described from a botanical point of view. Information is available for what concerns botanical and ecological characteristics, distribution and occurrence, value and use of many species but little is known about their natural and artificial regeneration. The absence of this information is particularly serious because it represents a lack of knowledge to address a multipurpose approach to planting, restoration and reclamation and may explain the reason why plantings are often carried out with a narrow number of species which are easy to grow in the nursery. This practice greatly reduces levels of biodiversity and it is even more worrisome with regard to shrubs and minor hardwood which are the greater part (60 to 70%) of the Mediterranean woody flora.

APAT, the Italian Agency for Environment Protection has published a handbook regarding Seed propagation of Mediterranean trees and shrubs. Even if the work is not complete (many items need further research), the main target of this handbook is to offer information about propagation by seed of 120 Mediterranean trees and shrubs. More than 30 authors have given valuable contributions to the volume, most of them are Italian but also Spanish, English, Polish, and Australian researchers have participated.

Seed propagation of Mediterranean trees and shrubs is available on the web: http://www.sinanet.anpa.it/documentazione/PubblicazioniAPAT/pdf/seedprop.pdf

A pdf version (1.4 Mb) can be sent by e-mail (requests to Beti Piotto: piotto@apat.it)

A limited number of (paper) copies are available and can be requested (official paper please) to:

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HOT FOAM WEED CONTROL SYSTEM

The New Zealand based Waipuna Hot Foam Weed Control System uses heat to kill weeds, along with an organic, biodegradable foam, derived from a 100% natural, non-toxic extract of corn and coconut sugar. The foam functions as a surfactant, disseminating and maintaining the required heat, and it dissipates harmlessly in a few minutes. The hot water/foam combination can be applied at 3-5 mi/hr. The handheld wand can be fitted with a variety of emitters. One of the 3 types available is double-headed, which enables simultaneous treatment of both sides of a fenceline. The system is successfully operating in Europe, USA, Australia, and New Zealand. Demonstrations with a van mounted unit were held in Victoria, BC in August. Waipuna leases the equipment and requires that all applicators are certified (training included). The cost is US$500/mo (maintenance included) for a minimum 3-4 year lease. The sales manager approved the scenario in which a group (e.g., several seed orchards) could lease the unit collectively. For further information or to inquire regarding the possibility of a demonstration please contact Mary Sanh, Commercial Representative (Vancouver Island based) (marysanh@shaw.ca), or Ian Webster, Sales Manager (iwebster@waipuna.com)

NEW FIELD GUIDE FOR SECOND GENERATION PROGENY TESTS

Forest Genetics Ontario and the Forest Ecosystem Science Co-operative Inc., with the assistance of the Ontario Ministry of Natural Resources and the Ontario Living Legacy Trust, published a new tree improvement field guide in October. The document was prepared by KBM Forestry Consultants Inc. and is titled “Field Guide to Second-Generation Progeny Test Establishment, Management, and Assessment.” The Preface to the Guide is reprinted below together with a list of Chapter headings.

Large cooperative tree improvement programs began in Ontario during the 1980s. This partnership between forest companies and the Ontario Ministry of Natural Resources has resulted in the establishment of breeding programs for several boreal conifer species and has produced dozens of first generation seed orchards, clonal orchards, breeding archives and family tests. Many of these programs are moving into their second generation, capitalizing on the gains produced from the first generation activities. Along with those gains many lessons were learned that can be applied to make establishment and management of second generation programs more effective and cost efficient.

A major second generation activity is the planting and management of second generation progeny tests. These tests are the backbone of any tree improvement program and their design, establishment, management and measurement have a profound effect on the level of genetic gain realized from the program and ultimately on the return on the significant investment that has gone into it.

This field guide was prepared to provide a source of information covering all aspects of importance to the field level tree improvement practitioner charged with the responsibility of establishing and managing second generation progeny tests. However, it may also be of interest to others involved in the program who make decisions about the allocation of money and resources. As well, students pursuing a career in the field of tree improvement will find it informative.

The guide is organized into seven chapters that follow the progression of activities that are undertaken in managing a second generation progeny test from start to finish. The authors have avoided being prescriptive, recognizing that the objectives of individual tree improvement programs and on-the-ground local conditions that will be encountered by the test manager will determine what is the best approach. Recommendations have been included where it was felt that specific guidance should be given. Suggested readings are presented at the end of each chapter along with a listing of reference sources. The reader is encouraged to consult the originals of these references for complete details and other insights that could not be included here.

Chapter 1.	Site Selection and Planning
Chapter 2.	Site Preparation
Chapter 3.	Establishment
Chapter 4.	Vegetation Control
Chapter 5.	Pest and Damage Management
Chapter 6.	Test Assessment and Measurement Guidelines
Chapter 7.	Record Keeping

Further information about the Guide is available by contacting:

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IUFRO TREE SEED SYMPOSIUM

The IUFRO Unit 2.09.00 Seed Physiology and Technology conference was held at the University of Georgia, in Athens, Georgia, August 10-15. Gary Johnson of the National Tree Seed Laboratory, USDA Forest Service in Georgia hosted the symposium. Thirty individuals attended from eight countries. The meeting topics were diverse covering such areas as seed germination pretreatments, seed vigor testing methods, germination periodicity of conifers, seed ageing, and seed production and storage. In addition to the conference presentations we were fortunate to have field trips to the Whitehall Teaching Forest at the University of Georgia and the State Botanical Garden of Georgia.

The Power Point presentations and the Abstracts of the poster and oral presentations are available on-line through the National Tree Seed Laboratory web site (http://ntsl.fs.fed.us/ntsl_iufro.html). In addition, the journal, Seed Technology (published jointly by the Association of Official Seed Analysts and Society of Commercial Seed Technologists) dedicated one issue of the journal to the conference and printed a selection of the conference papers. These proceedings are available through the Seed Technology web site http://www.seedtechnology.net/publstij.htm.

The next meeting will be held September 20-22, 2004, at the Nanjing Forestry University, in Nanjing, Jiangsu, P.R. China. A workshop will be held prior to the meeting, September 17-19, on seed storage and seed dormancy. For more information about the meeting and workshop please contact Dr. Fangyuan Yu, Email: fyyu@njfu.edu.cn or visit the meeting web site http://www.njfu.edu.cn/seed2/index.htm.

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ISTA SEED TESTING WORKSHOP

The ISTA Forest Tree and Shrub Seed Committee and the Forestry and Game Management Research Institute of the Czech Republic hosted a workshop which was held in Prague, Czech Republic October 20–25, 2003. This was the first ISTA workshop in several years which dealt specifically with tree and shrub seed. The purpose of the workshop was to look at practical problems related to seed testing of conifer and broadleaf species.

The workshop was attended by 42 participants and included researchers, lab technicians and managers representing government and private sector interests from 20 countries. Canada was well represented by Dr. George W. Edwards (FTB, Forest Tree Beginnings), Dr. Jack Sutherland (consultant), and Bernard Daigle (National Tree Seed Centre).

Presentations covered topics which included germination testing, excised embryo tests, seed dormancy, evaluation of normal and abnormal germinants, and seed purity to mention but a few. Lively discussion resulted from a practical exercise on determining seed viability through the use tetrazolium stain.

In addition to the formal presentations, participants were taken on two half-day trips. The first was to the ISTA Seed Testing laboratory for agriculture crops in Prague. The participants were taken through the various steps and procedures that are followed by the laboratory. The second excursion took us to the Dendrological Gardens of the Research Institute of Ornamental Gardening, located just outside of the city. Established in 1976, the garden is spread over 80 ha and includes about 5 000 species of native and non-native plants.

Finally, two post-meeting trips were available to participants. The first was a one-day excursion to the State Tree Seed Centre in Tyniste nad Orlici. The second consisted of a three-day trip to visit the Seed Testing Laboratory for Forest Tree Seeds in Uherske Hradiste in the southeastern part of the Czech Republic and then continue on to the Republic of Slovakia to the Forest Seed Testing Laboratory in Liptovsky Hradok.

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UPCOMING MEETINGS

Seed Ecology 2004 Rhodes Island Greece
April 29th-May 4, 2004
Contact: Costas Thanos cthanos@biol.uoa.gr
or
http://www.biology.uoa.gr/SeedEcology2004.htm/

ISTA Seed Symposium 2004 27th Congress
"Towards the Future in Seed Production, Evaluation and Improvement"
May 13-24, 2004 Budapest, Hungary
www.seedtest.org for more information

Ninth International Symposium on Plant Seeds: Seeds in the -omics Era
May 15-19, 2004 Gatersleben, Germany
http://meetings.ipk-gatersleben.de/seeds2004/ for more information

Molecular Aspects of Germination and Dormancy
May 24-25, 2004 Wageningen, The Netherlands
and

Third International Symposium on Plant Dormancy
May 25-28, 2004 Wageningen, The Netherlands
www.css.cornell.edu/ISSS/isss.htm for more information

Annual AOSA/SCST Meeting
June 11-14, 2004 Tunica, Mississippi
Contact: Lee Daughtry 662-325-3992

Canadian Tree Improvement Association
plus Tree Seed Working Group Workshop
July 26-29, 2004 Kelowna, BC
Contact: Dave Kolotelo
Dave.Kolotelo@gems7.gov.bc.
or http://www.for.gov.bc.ca/hti/ctia/index.htm

IUFRO Seed Physiology & Technology Research Group
Tree Seed Symposium
September 20-22, 2004 Nanjing, China
Contact: Fangyuan Yu fyyu@njfu.edu.cn or
http://www.njfu.edu.cn/seed2/index.htm

SELECTED REFERENCES – SEED ORCHARD PRACTICES

A sampling of articles related to the theme of this News Bulletin from Dave's files.

General

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