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SEED TRANSFER

THIS ISSUE AT A GLANCE

CHAIR'S 'ARMCHAIR' REPORT

Happy Holidays to all. As 2007 draws to a close we can look forward to a wide variety of meetings and extension events in 2008. The CTIA will be having its meeting in Quebec City August 25th to 28th with a special tour of the Berthier nursery and tree seed centre on Sunday August 24th just before the CTIA. Please see Fabienne Colas's note on the topic and look for updates on the conference web site: http://www.iufro-ctia2008.ca/index.php

In January, our Northern Silviculture Committee in BC is addressing "Changing Northern BC Forests – Silvicultural Challenges and Implications" and this meeting will explore many of the options and information available regarding strategies to deal with the post-Mountain pine beetle and climate change scenarios that this portion of BC needs to deal with now. Nationally, a meeting was held in November in Sault Ste. Marie "Adapting to Change: Managing Tree Seed Under an Uncertain Climate" and Kathleen Brosemer has provided an overview of the meeting and indicated that proceedings should be available in the spring of 2008.

We at the BC Ministry of Forests and Range Tree Seed Centre are celebrating 50 years in operation this year and are planning several activities for clients, neighbours, and staff. I am also hoping to incorporate a technical session in the mix and this will likely take place prior to the next News Bulletin. We will be advertising heavily in BC, but if others would like to be made aware of upcoming activities, please send me an e-mail and I'll include you in our announcement distribution list.

Last, but certainly not least is the upcoming Tree Seeds 2008 meeting with the theme of 'Trees, Seeds and a Changing Climate" that is being co-

Kathy Tosh
NB Dept. Natural Resources
Tree Improvement Unit
3732 Route 102
Island View, NB E3E 1G3
E-mail: kathy.tosh@gnb.ca

WATER ACTIVITY: A NEW PARADIGM FOR SEED AND POLLEN MANAGEMENT

A Concept Developed in the Food Industry

Water activity (Aw) measurement is a concept developed, and mainly used, by food-processing and pharmaceutical industries for "Intermediate moisture products". Contrary to water measurements such as moisture content (MC) that quantify the total amount of water in a product (quantitative analysis), the measurement of Aw pictures the intensity of the connections of water with other molecules such as carbohydrates, lipids and proteins; it is a qualitative analysis.

Water activity illustrates the energy status of water and consequently its degree of availability and mobility in a product. Aw is a ratio of vapour pressures between the measured sample and pure water. It ranges from 0 to 1, and corresponds to an equilibrium relative humidity from 0 to 100 %. As Aw increases, the energy that binds water with other molecules decreases so the water becomes more and more available for unwanted chemical and biotic reactions in the product such as oxidation of the molecules and development of bacteria or fungi (Fig. 1). These reactions cause the degradation or aging of the product. Thus, Aw is a more reliable predictor of the organic product's stability than the total water amount.

The determination of Aw consists of measuring the equilibrium relative humidity generated by a sample placed in a tight vial or container at a given temperature; Aw meters are consequently some kind of hygrometers fitted with specific probes.

A Fast, Simple and Non-destructive Measure

Water activity measurement has two major operational advantages:

- The data are obtained very quickly. Depending on the samples analysed and the accuracy required, the result is obtained in less than 30 seconds to approximately 20 minutes.
- The sample is not destroyed and can be used again. This is of great interest for very small or precious samples such as pollen or seeds related to specific crossings or samples devoted to *ex situ* conservation programs.

Water activity measurement also has additional advantages. It works by itself and no additional equipment such as an oven or weighing scale is needed. Routine or analytic use requires a short training period and the portable apparatus can be used anywhere. Thanks to recent technologies, the Aw equipment is affordable and obtains reliable, high precision measurements.

Aw is Suitable for Forest Reproductive Material Moisture Management

Thanks to major R&D work done since 2000, the Forest Ecosystems research team of Cemagref located at Nogent-sur-Vernisson, France determined that moisture management of pollen and seeds can be monitored via Aw measures (Philippe et al. 2006). However, the measure only applies to orthodox seeds because the high MC of recalcitrant seeds during storage exceeds the range of the Aw scale.

The work was carried out using seeds of the two main coniferous species used in France, *Pseudotsuga menziesii* (Mirb.) Franco. and *Pinus pinaster* Ait.; broadleaved species were primarily represented by *Fagus sylvatica* L. and *Fraxinus exelsior* L. with a few experiments done on *Ulmus minor* Mill. samaras. Some R&D work was done on pollen of the three main coniferous species involved in controlled pollination in France: *Pseudotsuga menziesii*, *Larix kaempferi* Carr., and *Pinus pinaster*. This work, based on construction and interpretation of sorption isotherms, allowed for the identification of the ideal water activity for a given species. Adopting the optimal Aw value minimizes the deterioration processes and contributes to maintaining the viability of seeds or pollen. Fortunately, optimal Aw values determined from the sorption isotherms agreed with storage MC recommendations found in the literature. Optimal recommended storage MCs are more often expressed as a range of values rather than a single one; this demonstrates that MC is not a single factor but a consequence of the combination of the Aw value, composition, and structure of seeds or pollen. By managing seedlots in these optimal conditions defined with Aw from their harvest to their final use, it is now possible to better preserve them over time.

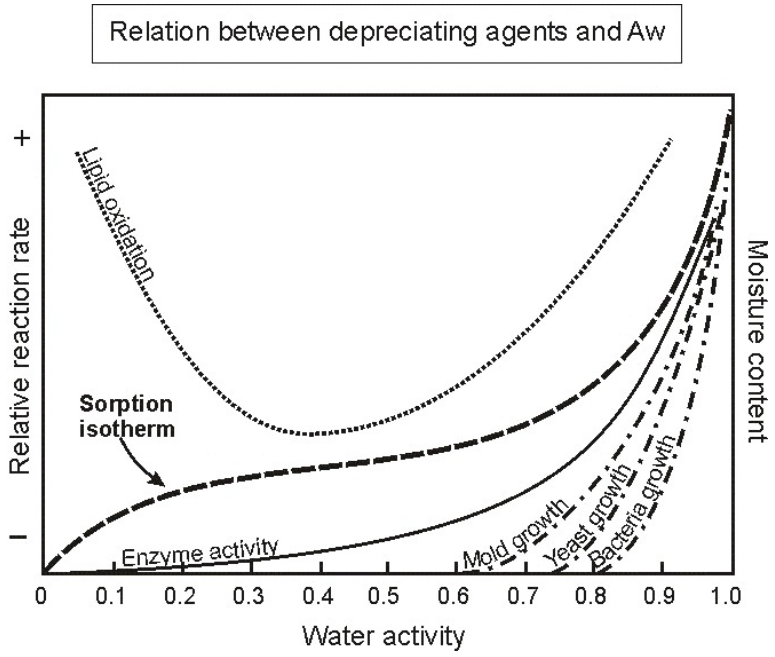

Figure 1. Relative activity of deterioration agents to different water activity. Adapted from Labuza T.P., L. Mc Nally, D. Gallagher, J. Hawkes et F. Hurtado, 1972. Stability of intermediate moisture foods. 1: lipid oxidation. J. Food Sci. 37: 154–159 and other sources.

Aw is not Affected by the Diversity of Seed and Pollen Sources

The characteristics of forest reproductive material for a given species are essentially variable due to the parental genetic diversity and uncontrolled environmental conditions during seed and pollen formation. Aw measurement is not dependent on the phenotypic variability of forest reproductive materials including difference in size, ripeness or percentage of empty or dead seeds. As a result, Cemagref demonstrated that the same moisture content of pollen or seed samples within a species may correspond to significantly different Aw values (Baldet and Verger 2004). This makes water content a weak predictor of pollen and seed stability during all of the moisture management phases for short- or long-term storage. Aw provides better information than MC for predicting seed or pollen conservation because Aw describes the global biological and chemical potential of water of an organic compound as a whole.

A Technique Currently Routinely Used in France

In 2003, the two main French tree seed centres (Office national des Forêts [La Joux] and the Vilmorin Company [Angers]) cooperated with Cemagref and INRA in a joint development project. They quickly decided to adopt, on an operational basis, this fast and non-destructive technique for the moisture management of forest tree seedlots. French State forest seed orchards also routinely use the Aw measure for managing larch pollen used for artificial pollination.

A Research and Technology Transfer Project Between France and Quebec

Since spring 2007, with the collaboration of Cemagref, the Direction de la Recherche Forestière and the Centre de semences forestières de Berthier, both from the Quebec Ministry of Natural Resources, a project was initiated using Aw as a new criterion for seed and pollen management in the province. The project was funded by a Quebec-France program (61^{e} Commission de la coopération franco-québécoise). The work was divided into two parts:

- R&D is performed at the Direction de la Recherche and primarily consists of determinating the best Aw values for the conservation of seed and pollen of major reforestation species in Quebec.
- Operational integration of the Aw criteria as a quality test during the extraction process and the conservation of seedlots at the

Berthier seed centre.

Work started with black spruce (*Picea mariana*), which is the major reforestation species (Baldet et al. 2007, in French). After seven months, the main techniques have been transferred to Quebec and the best stability determined for black spruce seeds. These results are consistent with models adopted in France and confirm the interest of Aw measurement on forest seeds when applied to this boreal species. At the same time, the CSFB collected information on Aw from each seed quality test. These data will be of great interest to better characterize the tree seed bank with the Aw criterion in terms of mean values and variability for a given species. Over the next months, we will continue to describe the water dynamics of other species used in Quebec as well as complete the operational implementation of Aw at the seed centre in Berthier. A more complete picture of our results will be presented at the CTIA meeting in Quebec in August 2008.

Aw, a Valuable Tool for Pollen and Seed Managers

Cemagref and DRF think that Aw is of great interest for seed and pollen management. Monitoring the moisture status and deterioration of seed and pollen lots with such a biological indicator rather than a physical one is a good direction to take. We are convinced that many other tree seed centres that store orthodox seeds can implement this measure successfully without a significant cost. We are ready for new collaborations; mutual benefits can be expected by improving general knowledge of forest reproductive material water dynamics prior to and during storage.

Different applications such as planned monitoring of Aw during seed conservation may also be of great interest to prevent sudden detrimental seed deterioration. Monitoring the stability of seeds during storage with Aw could lead to a reduction in frequency of germination tests and, therefore, generate recurrent savings without loss of information.

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For more information on the collaboration project between France and Quebec : http://www.cemagref.fr/Informations/Presse/InfMediaEV/infomedia82EV/im82PollensEV.htm

Patrick Baldet
Cemagref
Unité de recherche Écosystèmes forestiers
Domaine des Barres
45290 Nogent-sur-Vernisson
France
E-mail: patrick.baldet@cemagref.fr

Fabienne Colas
Ministère des Ressources naturelles et de la Faune
Direction de la Recherche forestière
2700, rue Einstein
Quebec, QC G1P 3W8

Michèle Bettez
Ministère des Ressources naturelles et de la Faune
Direction générale des pépinières et des stations piscicoles
Centre de semences forestières de Berthier
1690, chemin Grande Côte
Berthier, QC J0K 1A0