**Research Highlights 2003-2004**

**FOOD SAFETY / SAP & SYRUP CHEMISTRY**

**Sources of Contamination in Maple Syrup:** Lead can be a contaminant of maple syrup. Our goal is to reduce lead levels in syrup by identifying the sources of lead in maple equipment and altering production practices to reduce contamination of sap and syrup where it occurs. We are also interested in identifying natural levels of paraformaldehyde in maple sap (if any) and the influence of PF use on the level of formaldehyde in the finished product. *Perkins, Wilmot, van den Berg* USDA.

**Characterizing “Metabolism” Off-Flavors in Maple Syrup:** There is currently no identifiable cause for “metabolism”, an off-flavor which occasionally develops in maple syrup, reducing its marketability. Our research aims to identify the compounds in maple syrup which are responsible for metabolism off-flavors. Once identified, it may be possible to develop better strategies to cope with and reduce the occurrence of this problem. *Perkins, van den Berg, Isselhardt* USDA.

**Adulteration of Maple Syrup:** Several agents are used to modify the characteristics of maple syrup. Sometimes these treatments are part of normal sugaring operations that are used incorrectly, and thus become contaminants, and sometimes illegal substances are used to purposefully make syrup lighter in color. This line of research seeks to develop rapid screening tests to detect contamination or adulterants in maple syrup. *Perkins, van den Berg, Isselhardt* USDA

**PRODUCTION OF SAP AND SYRUP / MAPLE EQUIPMENT**

**Effects of Forest Fertilization in Sugarbushes:** A new PMRC brochure “Fertilization of Sugarbushes” was published in October 2004. This brochure describes fertilization research conducted by PMRC staff between 1988 and 2003, as well offering instructions and recommendations for sugarmakers who wish to fertilize their land. The brochure also contains information about the potential geographical range of nutrient-deficient soils, tips on evaluating stand nutrition by recognizing key indicator plants, and considerations for sugarmakers who wish to certify their syrup as organic. *Perkins, Wilmot, Zando* FREEMAN FOUNDATION, NAMSC

**Evaluation of Small Spouts:** This study compares sap production and wounding using normal and small spouts. Under most conditions, sap yield was roughly the same for either size spout using vacuum, but was occasionally a little less for small spouts with gravity flow. In large trees under gravity or vacuum, wood discoloration from small taphole wounds was significantly less than internal damage caused by large tapholes. Starting in 2000, groups of trees at the Proctor Center were tapped with small and large spouts at three different dates in the spring in order to determine which timing maximizes sugar yield. Results varied from year-to-year, depending on the weather and snowpack. Data from the first two seasons suggest that under gravity, the longevity of tapholes drilled very early and fitted with small spouts is greater than that of larger (7/16”) tapholes. Also, there were similar sap volume yields from trees tapped Feb 1 and Mar 1 in most years. *Perkins, Wilmot, van den Berg, Isselhardt* CCMSMA, NAMSC, UVM AES

**Vented versus Closed 5/16” Tubing:** It is widely recommended that tubing systems be closed rather than open or vented. It is common to see 5/16” lines full of sap that appears to be stagnant. It is true that when the end spout is pulled on a so-called stagnant line the sap will drain out rapidly leading producers to believe that lines need to be vented to allow them to drain properly. After close observation, vented lines move a little sap and a great deal of air very rapidly while closed lines move at a reduced rate yet produce much more sap due to the fact that they are moving sap and not air. The stagnation effect is an illusion. While sap runs faster through vented compared to non-vented tubing systems, venting of tubing resulted in a 32% loss of sap production, probably due to faster drying of tapholes and loss of natural vacuum on slopes. *Stowe Isselhardt* NAMSC

**Optimum Number of Spouts per 5/16” Line under Vacuum:** We compared sap production from tubing setups with 1, 5, 10, and 15 spouts per 5/16” line. Single tap setups produced the most sap, with lesser amounts from the 10 tap (20% reduction) and 15 tap (28% reduction) lines. It is felt that the distance of the 5/16” line plays a large roll in the efficiency of a tubing installation. The theory being that shorter lines transmit vacuum more effectively and in general produce more sap. *Stowe, Isselhardt, van den Berg* NAMSC

**New Versus Used Tubing Under Vacuum:** Occasionally sugarmakers will recycle used tubing or delay replacement of tubing in their sugarbush. We compared sap production from new and used washed 5/16” tubing. New tubing produced, over two seasons, an average of 10-30% more sap than used washed tubing. *Stowe, Isselhardt, van den Berg* NAMSC

**A Three Year Comparison of Tubing and Installation Methods in a Field Environment:** This study compares the materials and methods of vacuum tubing installations of three equipment manufacturers. The participants were assigned approximately 200 taps within the sugarbush at The Proctor Center and asked to install a tubing system. Sap production, quality, longevity, maintainability, and costs are being recorded with the goal of deciding which is the most efficient and cost effective. The study is currently in its first year. *Perkins, Stowe, Isselhardt* NAMSC, CCMSMA

**MAPLE PHYSIOLOGY & GENETICS**

**Relationship Between Tapholes on Opposite Sides of a Tree:** Taphole guidelines were established in part because it is believed that tapping a tree below a certain diameter with more than one hole will result in decreased sap yield from each hole. To further our understanding of the way that an open taphole changes sap flow in the rest of the tree, electronic sensors that measure sap pressure at the taphole are being used to compare pressure on one side of a tree while a taphole is either open or closed on the opposite side. Trees of different diameters have been compared. *Wilmot* UVM AES
Mechanisms of Sap Flow: What Area of a Tree Contributes Sap to a Taphole? Using electronic sensors which can measure pressure in different parts of the trunk, we experimented with trees of various sizes to determine the timing and extent of sap movement toward an open taphole. Results have shown that the general behavior of sap movement is similar under both gravity and vacuum, but vacuum draws sap from a larger area of the wood, and affects areas of the trunk more rapidly than gravity. Results also suggest that there is considerable sap movement in a horizontal direction, and therefore tapholes on opposite sides of the tree may be drawing from the same area of wood, depending on the duration the sap flow event. Wilmot, Perkins HATCH

Molecular Genetics of Sap Sweetness: Mature, field grown trees and younger, plantation grown half sib families from both higher and lower yielding mother trees have been monitored extensively for their sap characteristics. The polymerase chain reaction techniques are being used to create a database of DNA fingerprints. Differences in fragment patterns are the focus of current experiments. Such DNA markers will later become the basis for identifying higher yielding trees at the seedling or sapling stage, thus saving time and energy in the production of improved stocks of sugar maple. Baribault, Currier USDA

Portable Chlorophyll Meters as an Indicator of Maple Health and Nutrient Status: Portable chlorophyll meters accurately estimate chlorophyll and nitrogen content in agricultural and some forest species and thus can provide an assessment of relative health status. This research evaluates the ability of chlorophyll meters to estimate these parameters in sugar maple. The relationship between chlorophyll fluorescence and the physiological health of sugar maple will also be investigated. van den Berg, Perkins, Cate EPA

Fall Coloration in Sugar Maple: While important economically and scientifically, the process of fall coloration in sugar maple has not been widely studied. Our current research aims to improve the basic understanding of the process and identify factors that may be valuable in predicting the timing and quality of fall coloration. Specifically, anthocyanin pigments and their function and relation to physiological processes during fall senescence will be examined. van den Berg EPA

FOREST ECOLOGY & HEALTH

Effects of Ice Storm Damage on Carbohydrate Reserves, Growth, and Survival in Sugar Maple: The Ice Storm of 1998 caused extensive damage to sugarbushes in New England, New York, and Canada. The loss of crowns resulted in depleted carbohydrate reserves in heavily damaged trees for two-three years after damage. The amount of carbohydrates stored in wood and root tissue was related to the amount of crown loss. This research is aimed at improving knowledge of how crown loss affects tree carbon reserves, sap production, growth, and survival in ice-storm-affected areas. Perkins, Wilmot, van den Berg VTFRP

Effects of Global Change on the Maple Sugaring Industry: This research is examining the potential effects of global warming on sap production in the northeast. A survey of sugarmakers will be conducted to find long-term records of production that might show evidence of global change. In addition, computer modeling will be employed to predict the effect of warmer spring seasons on maple flow. Perkins, Wilmot, Hoffmann USDA HATCH, NAMSC, DOE EPSCoR

Fern Effects on Sugar Maple Regeneration: Sugarmakers have long recognized that areas dense with hay-scented fern are often associated with poor regeneration of sugar maple. We compared sugar maple seedling survival of unmanipulated plots with plots that had ferns removed. Seedling survival is strongly correlated to fern density. Plots with high fern density had very low sugar maple seedling survival (and very low light levels), whereas plots with ferns removed had higher seedling survival (and higher light levels). removal may improve seedling densities in areas where regeneration is poor. Hane NAMSC

Acid Rain Effects on Forested Ecosystems: Forest decline was a major concern throughout the 1980’s and in the early 1990’s. While the Clean Air Act of 1990 addressed some aspects of pollution, acid rain does continue to fall. Long-term vegetation plots on Camels Hump Mtn. are measured periodically to assess the current state of forest health and growth. Perkins, van den Berg EPA

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NAMSC = North American Maple Syrup Council  EPA = US Environmental Protection Agency
USDA = US Department of Agriculture  CCMSMA = Chittenden Co. Maple Sugar Makers Association  HATCH = USDA Hatch
UVM AES = University of Vermont Agricultural Experiment Station, VTFPR = Vermont Department of Forests, Parks & Recreation