Maple Syrup Digest

Vol. 26A, NO. 3 October 2014

Maple Syrup Digest
PO Box 6
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Greetings from your President

The nearly quarter century of Roy Hutchinson's editorship has ended and the Digest is now in the capable hands of Winton Pitcoff. Winton is the third Maple Digest Editor and at his age he could surpass the tenure of the previous two editors. The Digest is the lifeblood of NAMSC and it is vital in keeping our membership informed of pertinent council news.

Surely many of you are making travel plans to attend the annual conference in Nova Scotia. According to Google Maps it is 1,603 miles from my home near Mt. Summit, Indiana to the conference site, and probably much further for the Wisconsin and Minnesota members. The Nova Scotia Maple Producers Association has, I am sure, worked hard to host this upcoming meeting and I hope that many of you will be in attendance. It is a chance to see the latest maple technology and equipment, to attend valuable technical sessions and to renew old friendships and to make new ones.

The Executive Committee has prepared an agenda of important issues to be discussed and Treasurer Joe has worked hard to prepare a balance sheet for our perusal. As always, the annual meeting allows NAMSC and IMSI to work together for the betterment of the maple industry. It is my desire that you have made or will be making plans to attend this important conference later this month.

With Best Regards,
Dave Hamilton

In this issue...

Cover photo: This photo won first prize at the 2013 NAMSC/IMSI Conference. Minnesota photographers Stu and Corinne Peterson do usually pull their taps before it gets to this point, though.

MAPLE SYRUP DIGEST

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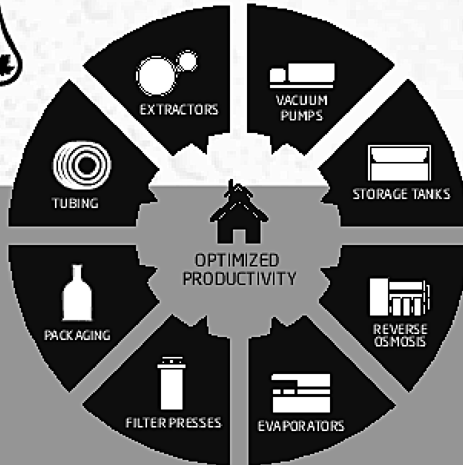

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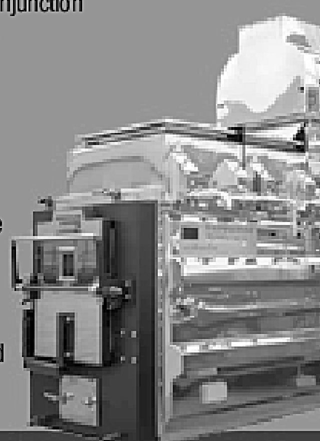

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Does sugar removal impact trees? A complex question to answer.

M.L. Isselhardt, T.D. Perkins, and A.K. van den Berg
University of Vermont, Proctor Maple Research Center

When a discussion about maple sugaring turns to modern, high vacuum sap collection or climate change one question arises frequently, does tapping injure maple trees? Unfortunately, that simple question can't be answered easily. Two main issues relate to the sustainability of maple sugaring; tree wounding and sugar removal. In other words, does a tapped maple tree grow more wood than is compartmentalized (functionally "removed" by the tree's normal wound response process) each year and/or does sap collection take more sugar from the tree than can be readily replaced through photosynthesis? These two issues, although separate in some respects, are inextricably intertwined. At the University of Vermont Proctor Maple Research Center, one component of a recently initiated, comprehensive re-examination of tapping guidelines is a long-term study focusing on the growth aspect of this question (funded by the Chittenden County Maple Sugarmakers Association and the Vermont Agricultural Experiment Station). The goal of this 5-10 year study is to determine whether gravity or high-vacuum sap collection impacts stem growth compared to untapped trees. This article will therefore leave the question of tree growth and wounding for another time and focus instead on issues related to sugar removal.

Sugar maples, like all trees, convert solar energy into chemical energy (sugar) through the process of photosynthesis. Trees allocate some of that energy to nonstructural carbohydrates (NSC), essentially soluble sugars and starch. Soluble sugars, such as sucrose, are the "active" form of NSC, which are used for various physiological functions such as growth, reproduction, cold tolerance, defense, and respiration.[1] Any excess NSC is stored as starch, which is the primary reserve compound for trees.

The balance of soluble sugars and starch is dynamic throughout the year and fluctuates depending on whether the tree is actively growing, dormant, or in the transition between these two states. Allocation to storage has historically been considered a passive process; trees put more into storage when production of NSC exceeds the immediate demand.[2] Wood NSC concentration has largely been assumed to be an indicator of tree health (i.e. trees with higher wood NSC concentrations must be comparatively healthier than individuals with lower concentrations).[3] Questions remain, however, whether or not this model is too simplistic and fails to fully capture how trees balance the current needs for NSC with potential future needs. Some evidence suggests that allocation of NSC to storage may

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even be in direct competition to allocation to growth.[4] If this is the case, then higher NSC concentrations might actually be an indicator of tree stress. Some recent work suggests that rather than a simple, single pool of storage NSC, there may be both fast and slow cycling NSC pools (Figure 1).[5] Fast cycling NSC pools may be used first (think of this as a checking account that is used to pay daily expenses). Under this model, reserves from slow cycling pools (more like a long-term savings account) are only used if needed, such as when photosynthesis or NSC in fast pools are insufficient to cover immediate needs.[6]

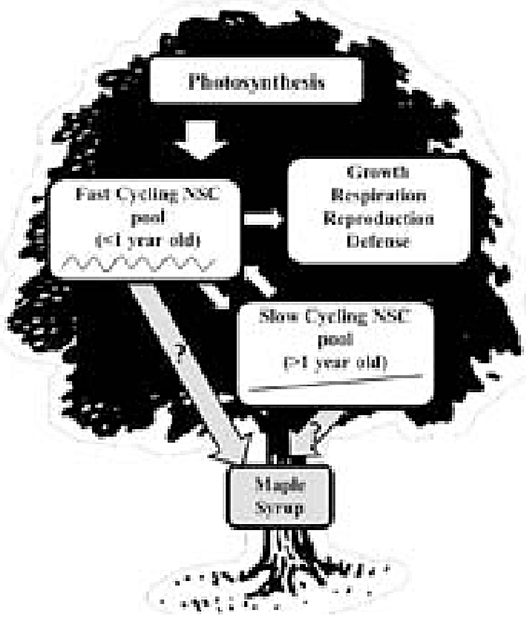

Figure 1: Movement of nonstructural carbohydrates (NSC) in sugar maples tapped for syrup production. Fast cycling NSC pool (<1year old) experiences wide annual fluctuations related to metabolic demand for critical processes. Slow cycling NSC pool (>1year old) represents stored NSC and accumulates proportionally with tree growth. Question marks illustrate gaps in knowledge as to which pool (or what mix of pools) contributes the NSC to maple syrup production. Adapted from Richardson et al. 2013.

Other questions about the production and use of NSC in trees also remain unanswered. For example, it is not known how much allocation of NSC to growth comes at the expense of other critical functions such as establishment of cold hardiness and resistance to decay. Additionally, it remains unknown how much of the reserve NSC stored within the tree are truly available for use. It is possible for a tree to die with a sizeable portion of its NSC untouched. Given these gaps in even our basic understanding of tree carbon relations, it should come as no surprise that the state of the science as it relates to how NSC removal in maples during the sugaring season impacts tree heath is nearly completely lacking.

It is important to understand that when NSC is removed during sugaring (in the form of sucrose-enriched xylem sap) is at the end of the dormant period. Trees have used stored NSC to maintain living tissue during the winter and need to mobilize additional NSC to fuel the growth of the stem, roots, and a new canopy of leaves. The size of the pool of stored NSC can therefore be considered a fixed quantity until after the time of bud break. After that time, even partially-expanded leaves can become net producers of NSC.[7] That is not to say that this early period of growth is not critical, just to say that there is a finite length of time where NSC pools are

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drawn from without replenishment. It is estimated that mature trees contain enough NSC to reflush the canopy of leaves several times.[8] This apparent abundance of NSC may in fact be part of trees long term survival strategy when faced with catastrophic but rare stresses (fire, ice storm, etc.).[9]

Equally important to understand is that as a tree grows its storage capacity also grows. This can best be illustrated in early work by University of Vermont maple researcher J. L. Hills, who estimated that sugaring (gravity sap extraction of around 2.75 lbs. syrup/tap) removed somewhere between 4-9% of a small trees total NSC.[10] Hills multiplied the concentration of starch and sugars in a portion of wood by the allometric volume of a small tree (around 8″ diameter) to estimate the tree's total available NSC. This percentage [of NSC removed] drops dramatically as trees get larger in size. Conversely, the percentage would be larger if modern equipment and practices are used, up to 20% of the small tree's total reserves. However, Hill's calculation assumed all NSC present throughout the entire tree was available to the sugarmaker or to the tree itself. Without knowing how much of the NSC is available to both sugarmaker and tree alike, the answer to the question of sustainability will include some uncertainty. Given the lack of clear and convincing evidence to the contrary it is reasonable to assume that even high vacuum sap extraction does not remove enough NSC to be considered an acute stress to the tree as long as tapping guidelines are adhered to and an otherwise healthy tree does not face additional stresses such including

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a fully suppressed canopy, prolonged drought or repeated defoliation. To what degree the annual removal of NSC by maple producers, perhaps in combination with other stresses (chronic or acute), could impact the overall health of trees will also remain unknown for the time being.

Notes

[1]Kozlowski, T.T. 1992. Carbohydrate Sources and Sinks in Woody Plants. *The Botanical Review* 58: 109-184.

[2]Chapin FS, Schulze ED, Mooney HA. 1990. The ecology and economics of storage in plants. *Annual Review of Ecology and Systematics* 21: 423–447.

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[4]Silpi, U., Lacointe, A., Kasempsap, P., Thanysawanyangura, S., Chantuma, P., Gohet, E., Musigamart, N., Clement, A., Ameglio, T. and Thaler, P. 2007. Carbohydrate reserves as a competing sink: evidence from tapping rubber trees. *Tree Physiology* 27: 881-889.

[5]Richardson AD, Carbone MS, Keenan TF, Czimczik CI, Hollinger DY, Murakami P, Schaberg PG, Xu XM. 2013. Seasonal dynamics and age of stemwood nonstructural carbohydrates in temperate forest trees. *New Phytologist* 197: 850–861.

[6]Carbone, Mariah S.; Czimczik, Claudia I.; Keenan, Trevor F.; et al. 2013 Age, allocation and availability of nonstructural carbon in mature red maple trees. *New Phytologist* 200:4. Pg. 1145-1155

[7]Keel, S.G. and Schädel 2010. Expanding leaves of mature deciduous forest trees rapidly become autotrophic. *Tree Physiology* 30: 1253-1259.

[8]Hoch G, Richter A, Korner C. 2003. Non-structural carbon compounds in temperate forest trees. *Plant, Cell & Environment* 26: 1067–1081.

[9]Sala A, Woodruff DR, Meinzer FC. 2012. Carbon dynamics in trees: feast or famine? *Tree Physiology* 32: 764–775.

[10]Hills, J. L. 1904 Vermont Agricultural Experiment Station Bulletin 104, The Maple Sap Flow. Pg. 219 Burlington: Vermont Agricultural Experiment Station.

Crop Reports

Two crop reports were submitted too late for the June *Digest* issue.

Ontario

The Ontario maple season started in early March throughout the Southwestern part of the Province. There were small runs of sap with very cold weather in between runs in the north. The deep snow required snow shoes to work in the woods and only during the calm before the next blizzard. By the end of March, the southwest of the Province had only 1/3 of a crop made. The first two weeks in April saw better sap runs with the southern parts of the Province done making syrup by mid-April and the north and eastern areas making syrup until May. The south and central areas had a normal to good crop of syrup. Algoma and eastern Ontario had 60-80% of a crop. This was not a good year for making syrup without vacuum tubing. Most bucket operations in our area had 70% of a normal crop.

Quebec

Quebec's maple syrup producers had a very good harvest for the 2014 season, but their patience was stretched thin due to the cold weather that persisted in early spring. The first tentative flows took place in mid-March in the regions of Saint-Jean-Valleyfield and Saint-Hyacinthe. However, it was only at the beginning of April that the

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maples really started to produce their precious maple water and producers from all regions were finally able to start production. Despite this late start, they were treated to favourable temperatures, light frosts at night and thaws during the day throughout April until the first week of May. Ultimately, these particular conditions did not affect the production of maple syrup in Quebec. The 42.7 million taps in production among the 7,300 maple companies in Quebec produced 113.7 million pounds of maple syrup, with an average yield of 2.67 pounds per tap.

The 2014 harvest did not surpass last year's record of 120.3 million pounds, but it goes down as the second best harvest, ahead of 2009 which produced 109.4 million pounds of maple syrup. In addition, nearly 75% of the maple syrup already inspected has been classified in the first three categories, Extra Light, Light and Medium. This very good harvest constitutes nearly 225,000 barrels of maple syrup that quality auditors need to classify and inspect.

This late season start meant that the strategic reserve played an essential role in ensuring continuous supply for various markets. In March and April, the Sales Agency sold 11.5 million pounds of maple syrup, bringing the level of the reserve to 52 million pounds at the end of April, which was the beginning of the production season. The reserve was created in 2000 to ensure stability to supply and prices, and thus allowing the entire local maple industry to grow.

NAMSC Executive Director Mike Girard recently found this antique Leader Evaporator Co. Salesman's set. The set has an arch with functional front and rear doors, grates, two styles of flue pans that were offered with heater pans, Monitor gathering tank, filter tank, round-bottom storage tank, a stack of sample squares of the metals used for the arch, pans, tanks, catalogues, letter and other literature.

All items fit in the original wood box stenciled inside and out "Leader Evaporator Co. Burlington VT." There are wood guides in the box to hold the arch and pans in place when packed. The letter is dated 1930, the catalogs are not dated but looking through and doing the math between the date founded and years of service it appears that the set was dated between 1930 and 1933.

Industry News: Grade Changes

US and Canada move forward with changes to grading regulations

North American Maple Syrup Council / International Maple Syrup Institute

Updates on progress at the federal level for the proposed changes to the maple syrup grading system:

U.S.: The notice for the proposed revision of the United States Standards for grades of maple syrup was published in the *Federal Register* on May 7, and allowed for a 60-day public comment period. The *Register* posting ended on July 7 and USDA officials are reviewing and addressing the comments received during the posting period. Approval of the new USDA regulations is expected in advance of the 2015 maple production season. Both IMSI and NAMSC sent comments to USDA in support of the Maple Grades Amendments published in the *Register*. In total, eleven comments from organizations and individuals were submitted through the online system, the majority of them in favor of the proposed regulations.

Canada: The Canadian Food Inspection Agency (CFIA) commenced work on the standard grades file following the unanimous passage of a motion in the Canadian Senate, recommending the adoption of the IMSI Standard Grades Proposal. Following a round of public consultation, the CFIA has prepared the draft regulations. They have been published for public comments in *Canada Gazette Part 1* on June 28. The 75 day public comment period ended on September 10. IMSI and NAMSC sent letters of support for all aspects which are aligned with the IMSI Maple Grades Proposal.

The grade changes have brought a significant amount of media attention to maple syrup, with outlets as diverse as *Forbes*, National Public Radio, and *USA Today* all covering the transition.

IMSI Market Study Group in Full Swing

Michael Farrell, Cornell Maple Program

As new producers enter the industry on a large scale and existing producers expand their operations, the production of maple syrup continues to grow at an extraordinary rate. Due in large part to the efforts of the Federation, bulk syrup prices remain relatively high and stable, fueling additional growth in output. There is widespread concern among many industry leaders that supply is growing faster than demand, creating a potentially large surplus that could be increasingly difficult for markets to absorb. Although the Federation's strategic reserve has been extremely beneficial to the industry, it will not be able to continue to grow in size year after year. It is clear that more efforts must be put in to marketing and promotion in order to bring supply and demand more closely in balance.

This past year I have had the fortunate opportunity to participate in a Market Study Group through the International Maple Syrup Institute (IMSI). The mission of the IMSI is to promote the use of pure maple syrup and protect the integrity of the product while encouraging cooperation among all persons or groups involved in any aspect of the maple industry. In this vein, a Market Study Group was assembled to study current trends in the maple markets and develop workable and realistic strategies for increasing the amount of pure maple products consumed worldwide. Members of the committee include Ray Bonenberg (Ontario), Dave Chapeskie (Ontario), Michael Farrell (New York), John Garwood (Quebec), Matthew Gordon (Vermont), Mark Harran (CT), David and Emma Marvin (Vermont) , and Richard Norman (CT), Yvon Poitras (New Brunswick), and Simon Trepanier (Quebec).

One of the first outcomes from the Market Study Group is the realization that the IMSI should be doing more to assist maple producers in marketing pure maple products. Although the IMSI has accomplished a lot towards this end, there is still much more that we can do. Pure maple occupies far less than 1% of the sweetener market in our society, and by working together we can help increase the share of the pie for pure maple. Moving forward, we will be including regular columns in various media outlets covering all aspects of marketing and promoting pure maple products. I will be coordinating the article submissions on behalf of the Market Study Group and submitting them to appropriate outlets. Our goal is to get out the most relevant and useful information so that maple producers throughout the US and Canada are well equipped to sell a variety of pure maple products to a growing marketplace. If you have any information or ideas to share in this regard, please send them to me at mlf36@cornell.edu. By working together and sharing information, we can sell more pure maple- the most delicious, nutritious, and sustainable sweetener in the world.

News from the states

Connecticut:
New Law Protects Landowners

Connecticut sugarmakers successfully campaigned for a new law that protects landowners from civil suits brought by people who injure themselves on private property while tapping trees or maintaining tubing. With similar provisions in place for people with pick-your-own fruit and vegetable operations, the Maple Syrup Producers Association of Connecticut said that the law would help sugarmakers expand production by alleviating concerns that private landowners have about allowing them to work in their woodlots. More details are available at: http://goo.gl/I0fWfk

Ohio:
OMPA Receives ODA Specialty Crop Block Grant

The Ohio Department of Agriculture recently approved a Specialty Crop Block Grant to the Ohio Maple Producers Association to better market Ohio maple syrup. The focus for the use of the grant funds will be, first, for Ohio maple syrup producers to sell more maple products directly to the consumer which will increases producer's income – make more money. Secondly, it will be to educate the consumer about Ohio's deep and rich maple history and heritage which will encourage them to purchase more maple products directly from the producers. Finally, being a part of the growing agri-tourism industry which shows people where their food comes from and encourages them to purchase directly from the grower. Agri-tourism also boosts local economies because when people travel they purchase fuel, food, lodging and shop.

This will be accomplished through the Maple Madness Driving Trail in March, creating a MAPLE OHIO MAGAZINE, which will include March maple events across Ohio and other maple related information, and improving the website to have more tour and maple information which producers and consumers will benefit from.

Because of this opportunity, all Ohio producers should be marking their calendar now to participate in the 2015 Maple Madness Trail, the biggest and best maple tour in the United States, March 14 & 15, 21 & 22. You do not have to be making syrup, just be willing to open your sugarhouse and welcome visitors and sell them your maple syrup. You don't even need a sugarhouse, maybe a garage set up with products to sell and maple displays and information will do the trick.

In other exciting Ohio maple news, March is about to be officially declared MAPLE MONTH in Ohio. First, the Ohio House of Representatives passed a House Bill stating it, and then the Ohio Senate followed and passed their Ohio Senate bill. The legislation is now awaiting Governor Kasick's signature to make March Maple Month in Ohio.

Vermont:
VMSMA Mourns Loss of Mr. Maple

The Vermont Maple Sugar Makers' Association is saddened to announce the passing of Everett Willard on July

7 at the age of 94. Willard was a long-time employee of the Vermont Agency of Agriculture. He helped organize the Vermont Maple Promotion Board and was a member of the Vermont Industry Council and the VMSMA. He was often referred to as "Mr. Maple" for his dedication to the Vermont maple industry.

Recognitions received by Willard include: "Friend of Agriculture" from the New England Association of Agricultural Extension Agents (1985); the George D. Aiken Agriculturalist of the Year (1986); the Vermont Farm Bureau Wallace Award, jointly with Dorothy (1993); induction into the American Maple Museum Hall of Fame in Crogan, New York (1996); and being honored as one of the eight inaugural members of the Vermont Agricultural Hall of Fame (2003).

New York:

New State Fair exhibit for NYSMP

The New York State Maple Producers Association built a new educational exhibit in the Horticulture Building at the 2014 Great New York State Fair, to educate the public on where maple syrup comes from and how it is produced. The exhibit featured a working tubing system with water flowing through clear sap lines into a releaser, which periodically filled and dumped, creating noise and a splash. Educational displays also included a cutaway of a tree to show how sap flows up and down in a maple tree as the temperature changes. The exhibit's construction featured taphole maple. The Association also sold everything from maple syrup to maple creams to maple popcorn to maple ice cream.

National:

Mistake in temporary grading kits

The 2014 temporary grading kits produced for the Vermont Maple Sugar Makers Association and distributed through nationally by many equipment dealers were found to have an error. This year's kits were made for the new grading system, and the lightest grade sample – Grade A: Golden Color with Delicate Taste – was made too light. Each grade sample is meant to show the darkest color a batch of syrup can be in order to be labeled as that grade. As a result, all syrups graded as Grade A: Golden Color with Delicate Taste were properly graded, but some batches that should have been allowable in the lightest grade had the kit been correct were instead classified as Amber Color with Rich Taste.

U.S. Crop Production Report

Released June 11, 2014, by the National Agricultural Statistics Service (NASS), Agricultural Statistics Board, United States Department of Agriculture (USDA).

Maple Syrup Taps, Yield, and Production – States and United States: 2012-2014

State	Number of taps			Yield per tap			Production		
	2012	2013	2014	2012	2013	2014	2012	2013	2014
	(1,000 taps)	(1,000 taps)	(1,000 taps)	(gallons)	(gallons)	(gallons)	(1,000 gallons)	(1,000 gallons)	(1,000 gallons)
Connecticut	70	78	83	0.157	0.256	0.193	11	20	16
Maine	1,500	1,880	1,850	0.240	0.298	0.295	360	560	545
Massachusetts	250	280	290	0.160	0.225	0.210	40	63	61
Michigan	430	490	430	0.151	0.302	0.212	65	148	91
New Hampshire	440	470	490	0.173	0.264	0.229	76	124	112
New York	2,070	2,200	2,200	0.174	0.261	0.248	360	574	546
Ohio	410	440	450	0.244	0.352	0.289	100	155	130
Pennsylvania	501	583	588	0.192	0.230	0.248	96	134	146
Vermont	3,500	4,200	4,270	0.214	0.352	0.309	750	1,480	1,320
Wisconsin	600	740	700	0.083	0.358	0.286	50	265	200
United States	9,771	11,361	11,351	0.195	0.310	0.279	1,908	3,523	3,167

Maple Syrup Price and Value – States and United States: 2012-2014

[Blank data cells indicate estimation period has not yet begun]

State	Average price per gallon			Value of production		
	2012	2013	2014 [1]	2012	2013	2014 [1]
	(dollars)	(dollars)	(dollars)	(1,000 dollars)	(1,000 dollars)	(1,000 dollars)
Connecticut	63.40	71.00		697	1,420	
Maine	33.00	32.00		11,880	17,920	
Massachusetts	51.50	59.10		2,060	3,723	
Michigan	51.60	48.80		3,354	7,222	
New Hampshire	52.50	53.40		3,990	6,622	
New York	43.50	43.60		15,660	25,026	
Ohio	42.50	36.90		4,250	5,720	
Pennsylvania	39.40	35.60		3,782	4,770	
Vermont	35.50	33.40		26,625	49,432	
Wisconsin	45.60	37.40		2,280	9,911	
United States	39.10	37.40		74,578	131,766	

[1] Price and value for 2014 will be published in *Crop Production* released June 2015.


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Research: Invasive Species

Imidacloprid contamination of maple sap following Asian longhorned beetle quarantine treatment

Richard S. Cowles,[1] Anthony Lagalante,[2] and Kyle Lombard[3]

The Asian longhorned beetle (ALB), threatens hardwood forest tree species in North America, especially maples. First detected in the U.S. in 2006, it has now been discovered in and quarantines have occurred in IL, MA, NJ, NY, and OH. In order to eradicate this foreign pest, USDA APHIS (Animal Plant Health Inspection Service) has a prescriptive treatment protocol: all infested trees are cut down, the stumps are ground, and portions of the trees are chipped to a maximum dimension of one inch, which is sufficiently small that no ALB larvae or pupae can survive. Nearby uninfested potential host trees are either: (1) removed and chipped, as though they were infested, or (2) treated in three successive years with imidacloprid, a systemic insecticide. Systemic insecticides are those products that, when applied to one part of the plant, are transported within xylem and/or phloem sap to other plant parts. Approved methods for applying imidacloprid to protect maple trees include trunk injection, as has been implemented in the Worcester, MA, quarantine area, or soil injection, which has been used along with limited trunk injection in all other quarantine areas (USDA 2011).

USDA considers basal soil injection of imidacloprid to be the most effective and cost-effective option (USDA 2005). In the eradication program, imidacloprid is applied to protect all host trees within a 0.5 mile radius of any infested tree. For soil injection, the maximum labeled dosage, or 1.42 g active ingredient of imidacloprid is applied per dbh (diameter at breast height) inch of trunk. For trunk injection, trees between 2 and 24 inches dbh are treated with one Mauget capsule per 2 inches dbh; for trees greater than 24 inches dbh, the dosage is increased to 2 capsules per 2 inches dbh (USDA 2011).

Both the Asian longhorned beetle and the use of imidacloprid to protect sugar maples from this pest pose a threat to maple syrup producers. Maple syrup is marketed as a pure, natural sweetener. Protection of maples from infestation by ALB or other pests could require trees to be treated with imidacloprid, and, if residues are found in the syrup from these trees, that syrup must not be marketed. We asked: (1) Do treatments following the quarantine protocol of sugar maples result in detectable imidacloprid in sap or syrup? (2) Do soil applications cause higher residues than trunk injection? (3) What concentrations may we expect in sap and processed syrup from trees treated

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[1]Connecticut Agricultural Experiment Station, Valley Laboratory, Windsor, CT, 06095. Richard.Cowles@ct.gov

[2]Department of Chemistry, Villanova University, Villanova, PA 19085-1699

[3]Forest Health Specialist, NH Division of Forests & Lands, Concord, NH 03302

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to protect them from ALB? (4) For trunk injections, does tapping above or below the insecticide injection site influence detected contamination of the sap? and (5) Does boiling of sap to process it into syrup destroy imidacloprid residues?

Field Experiment

Maple trees were selected for this study at The Caroline A. Fox Research and Demonstration Forest, Hillsboro, New Hampshire, operated by NH Division of Forests and Soils. They had have never previously been exposed to imidacloprid. Trees were chosen based upon ease of access, diameter of 10 – 22 inches (large enough for tapping; 14.6 ± 0.4 dbh inches, mean ± se), and good overall health of the trunk. A randomized complete block design was established to allow the treatments (untreated trees, soil injected, trunk injected but tapped below the injection point, and trunk injected but tapped above the injection point) to have trees matched with respect to tree diameter. A minimum of 12 trees were used for each treatment group. A constraint on randomization was the requirement that untreated control trees physically matching the treated trees were located far enough from those being treated to prevent contamination via root uptake from soil.

Maple trees were treated on July 18, 2013. We used the imidacloprid soil injection dosages and trunk injection protocols for ALB quarantine specified by USDA APHIS (2011). For soil treatment, the root flare was exposed, and an imi-

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dacloprid suspension (a 1:10 dilution of Xytect 2F [Rainbow Tree Care]) sufficient to provide 1.42 g active ingredient per inch dbh was poured directly onto the exposed bark, and the soil was then returned to cover the root flare. For trunk injection, capsules (Mauget, Arcadia, CA) specifically designed for ALB quarantine treatment contained 4 ml per capsule of a 10% imidacloprid formulation. These were applied at 3 feet height on the bole of the tree at a dosage of one capsule for every 2 inches dbh. These injections are higher on the trunk than would be normal procedure, to allow tapping of trees in 2014 at positions above and below the injection sites. An 11/64" high helix drill bit was used to drill approximately 0.5 inches into the xylem, at a slight downward angle, and a feeder tube inserted into this hole. The injection capsule was then pressurized and tapped with a mallet onto the feeder tube to break the capsule's internal seal. After the capsule had emptied, the capsule was removed. The imidacloprid solution did not empty from a few capsules into trees: these were removed, and replacement capsules were inserted in freshly drilled holes on July 19 to ensure correct dosing of every tree.

Trees were tapped during the normal sap flow period in 2014, and four weekly samples (March 21, March 28, April 4, and April 11) of 15 ml from each tapped tree were frozen and shipped overnight to Villanova for analysis. Taps were inserted at least six inches below or 12 inches above trunk injection sites for the trunk injection treatment groups, and about 3 feet above the ground for the soil application treatment group. No special consideration was given to place the tap a specified lateral distance from holes left from trunk injection. However, as injection sites were no more than ~6 inches apart, around the circumference of the trunk, taps could be no more than 3 inches lateral distance from injection sites.

The concentrations of imidacloprid and its important insecticidal metabolites were performed at Villanova University. Imidacloprid and two of its insecticidal metabolites were quantified, because their combined concentrations are treated as "imidacloprid" by regulators (U.S. National Archives and Records Administration 2010). The quantification method used high performance liquid chromatography coupled with tandem mass spectroscopy (HPLC/MS/MS) (Fig. 1). This method first separates chemicals carried in liquid solution by their affinity for a stationary adsorbent coating particles packed into a column. Compounds are identified first by their retention time in this packed column. As each compound leaves the column, it is charged with a high voltage from a spray tip. Each compound has a mass-to-charge ratio that is dependent on the molecular weight of the compound. Next, this ionized compound is fragmented and these fragments have unique mass-to-charge ratios due to the chemical structure of the original compound. Thus, the combination of retention time, and parent and fragment mass-to-charge values allow for unambiguous identification of target molecules. There were a total of 160 samples analyzed for 3 compounds, for

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a total of 480 chemical determinations from this experiment. An additional 19 trees had been measured in preparation for this experiment. These were tapped along with the experimental trees and the sap samples analyzed for imidacloprid and imidacloprid metabolite residues, for an additional 76 samples and 228 determinations.

From these laboratory analyses, it is clear that soil application and trunk injection are equivalent with respect to introducing imidacloprid into maples. In each treatment group, there were one or two trees (9 – 18% of each group) for which there were no detections of imidacloprid over the course of the sap harvest season; there were no differences among treatments with respect to the proportion of non-detectably contaminated trees. There were no detections of imidacloprid from the trees designated as untreated controls, making this group significantly different from the other three groups (Fisher's Exact test on numbers of trees with and without detections, P = 2.2 × 10-6) (Microsoft Research 2014). The concentrations of imidacloprid and metabolites detected among the three treatment groups varied widely and required logarithmic transformation prior to statistical analysis; the concentrations of imidacloprid and its metabolites were equivalent among these groups (Table 1). Maximum detection of imidacloprid in the trunk injection treatments were 2,580 ppb when the tap was placed above the injection site and 982 ppb when the tap was placed below the injection site. The maximum detection for imidacloprid for the soil treatment was 246 ppb in sap.

Finding statistically equivalent concentrations for imidacloprid contamination when the taps were placed above and below trunk injections sites was unexpected. We planned this comparison because imidacloprid (and other neonicotinoid insecticides) are stated to be acropetalar, that is, they are xylem mobile and move upwards and outwards in plants (Sur and Stork 2003). If they exclusively moved upwards, then sap drawn from taps placed in maple trees below trunk injections sites for insecticide treatments should never experience contamination with the insecticide. Our experiment clearly disproves exclusive upward movement, and the placement of taps in any trees treated with imidacloprid, either through soil or trunk injection methods, clearly can be expected to yield contaminated sap. Unfortunately, as other research has demonstrated, xylem conducts materials in trees both upwards and downwards (Tattar and Tattar 1999), and even limited downward movement can cause contamination of sap in trunk-injected trees when taps are placed below injection sites.

Downward movement of imidacloprid following trunk injection may be more dramatic, however. An example of possible extreme downward translocation and transport through a root graft was detected in Tree #5, an untreated tree (but not chosen to be used among the 12 replicates of the main experiment), which was 50 feet away from Tree #3, which was trunk injected. Tree #5 had imidacloprid present at 0.441, 2.62, 76, and 42.6 ppb in the four sap sampling dates, and olefin at

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1.4 ppb detected on April 11. This was a unique instance of imidacloprid and metabolite detection in an untreated tree, but the degree of contamination is remarkable, if indeed it resulted from downward translocation and movement across a root graft.

Laboratory experiment

We wished to compare the concentrations of imidacloprid and its metabolites in fresh sap, versus sap that was boiled to produce syrup. This is an important question, because if cooking sap to make syrup destroyed the residues, this would mitigate imidacloprid contamination. To study the effects of sap processing on these chemicals, a commercial, uncontaminated syrup (Trader Joe's, Monrovia, CA) was diluted 50-fold to simulate sap. Analytical standards of imidacloprid, imidacloprid olefin, dihydroxy imidacloprid and 5-hydroxy imidacloprid were added to triplicate samples of 50 ml each of diluted syrup to yield 150 ppb concentrations. A small quantity was analyzed by HPLC/MS/MS, and then the samples were heated until evaporated to the consistency of syrup. The cooked samples were re-diluted to the starting volume, and the residues re-tested. The final concentrations were compared with the initial concentrations to calculate changes resulting from cooking.

[T]he placement of taps in any trees treated with imidacloprid, either through soil or trunk injection methods, clearly can be expected to yield contaminated sap.

From this experiment, we found that imidacloprid decreased in concentration by 3.6%, which was within the margin of measurement error. The dihydroxy imidacloprid was not recovered, indicating that it was completely converted; the imidacloprid olefin residues increased in these samples, demonstrating that the dihydroxy metabolite is converted to the olefin compound. The 5-hydroxy imidacloprid concentrations decreased by about 35%, and for these samples the olefin metabolite concentration also increased. Therefore, since imidacloprid and its olefin metabolite are stable during cooking to produce maple syrup from sap, and the less stable metabolites are converted in part or totally to the olefin metabolite, we can expect that processing sap to make syrup will only serve to concentrate imidacloprid and its metabolites to approximately the same degree as the reduction in liquid volume.

Conclusions

Imidacloprid and its metabolites, which are grouped together and are considered to be equivalent for regulatory purposes, are readily detected in maple sap from trees treated either through soil application or from trunk injection. Small differences that we measured related to the time of sampling, over the four week sap collection

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Table 1. Contamination (parts per billion [ppb], mean ± se) of maple sap in 2014 with imidacloprid and its chief insecticidal metabolites following soil or trunk injections in 2013 of imidacloprid, following USDA Asian longhorned beetle treatment protocols.

				Concentrations found in sap*		
Treatment	tap placement	n	dbh (in.)	imidacloprid	5-hyroxy	olefin
Untreated	-	16	14.1 ± 0.8	0 ± 0	0 ± 0	0 ± 0
Soil drench	-	15	14.5 ± 0.3	18 ± 5	2.0 ± 0.4	2.7 ± 0.7
Trunk inject	above injection	13	14.7 ± 0.6	102 ± 51	1.9 ± 0.9	2.2 ± 1.2
Trunk inject	below injection	12	14.8 ± 0.5	56 ± 24	1.1 ± 0.4	1.1 ± 0.4

*The only significant differences among treatment groups were between the untreated control and the remaining three treatment groups. Repeated measures analysis of variance performed on the treated groups, on log-transformed concentrations ($F \leq 1.5$; df = 2, 22; $P > 0.2$).

period, and related to differences in tree diameter, have no practical significance to maple syrup producers, because no detection of imidacloprid can be tolerated in maple products. Furthermore, cooking sap to produce syrup or candy will concentrate illegal residues of imidacloprid and its metabolites. Because imidacloprid can persist for multiple years in tree tissues (Cowles et al. 2006), the only practical option for maple syrup producers will be to permanently exclude trees from harvesting sap, if they ever are treated with imidacloprid.

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Resources

Maple production videos

A series of videos featuring Dr. Michael Farrell, director of Cornell University's Uihlein Forest covers subjects such as identifying maple trees, filtering and finishing, grading, setting up a tubing system, and more, is available online at: https://www.extension.org/pages/71043/youtube-channel-maple-syrup-series

The Sugar Season: A Year in the Life of Maple Syrup

Douglas Whynott is fascinated with traditional New England industries. The author of five books and Emerson College writing professor has published works on commercial beekeeping, Cape Cod's bluefin tuna, Maine boatyards, and veterinary clinics. In his latest book, the recently released "The Sugar Season: A Year in the Life of Maple Syrup — and One Family's Quest for the Sweetest Harvest," Whynott chronicles a sugaring season at Bascom's Maple Farm in New Hampshire during one of the warmest years in history. The book follows the Bascom family through the 2012 season, weaving in looks at the trade, history, and culture of the maple syrup industry and an outlook on its future amid the threat of climate change. The book is available online at: http://amzn.com/0306822040

The Sugarmaker's Companion

The Sugarmaker's Companion, by Dr. Michael Farrell, director of Cornell University's Uihlein Forest, addresses the small- and large-scale syrup producer seeking to make a profitable business from maple, birch, and walnut sap. This comprehensive work incorporates valuable information on ecological forest management, value-added products, and the most up-to-date techniques on sap collection and processing. It is, most importantly, a guide to an integrated sugaring operation, interconnected to the whole-farm system, woodland, and community. The book is available online at: http://amzn.com/1603583971

Some in maple season and out of season tests on 3/16” maple tubing

Stephen Childs, NYS Maple Specialist

During the 2014 maple season the Cornell Maple Program maintained three demonstration sites using 3/16″ maple tubing. Each site was set up in February and tapped the last week of February. The first sap run occurred on March 10. The demonstrations were meant to compare sap yield from a new 5/16″ lateral line with eight taps using 5/16″ standard black check valve spouts on a new 5/16″ drop lines, with sap yield from a new 3/16″ lateral line with eight taps using 5/16″ standard black check valve spouts on a new 5/16″ drop lines for 8 inches then fitted to 3/16″ drop line.

Eight trees were tapped in each demonstration with the two treatments tapped in the same tree, about seven inches apart, in the same basic orientation. The first demonstration had 14 feet of drop from the highest tap on the highest tree to the top of the collection tank. Sap yield was collected following each run starting on March 11. The graph below shows the sap yield difference between the 5/16″ lateral line and 3/16″ lateral line each with eight taps in gallons of sap per tap. The 3/16″ lateral line yielded 10.3 gallons of sap per tap over the season and the 5/16″ lateral line yielded 5.8 gallons of sap per tap or an increase of 4.5 gallons of sap per tap.

The second demonstration was set up exactly like the first except with 17 feet of drop from the spouts on the highest tree to the top of the collection tank. The graph below illustrates the results of this demonstration and showing a very similar increase of 4.5 gallons of sap per tap.

The third demonstration was again the same set up as the first and second except with 32 feet of drop.

In this case the vacuum created by the 3/16″ lateral line appears to stolen sap from the spouts hooked to the 5/16″ line with the 3/16″ line, yielding 16.6 gallons of sap per tap, while the 5/16″ lateral line yielded just 3.3 gallons of sap per tap for a difference of 13.3 gallons of sap per tap more in the 3/16″.

Results from this kind of demonstration create many new questions such as how many taps are needed on a 3/16″ line to result in good vacuum and how many taps can a 3/16″ line support. This demonstration demonstrates that eight taps seems sufficient to generate significant vacuum, though vacuum tests were not included in this demonstration – it was simply a yield comparison. Testing the number of taps necess
generate excellent vacuum will n
be conducted during the maple s
as testing that with a simulated se
to answer the question of how ma

Flow rates of 3/16 tubing at various number of fittings				
	gallons per hour	taps supported	leaks	vacuum at top
1 fitting	11.2	55.9	0	24"
4 fittings	10.2	51.1	0	24"
8 fittings	9.8	49	0	24"
16 fittings	9.6	48.1	0	24"
24 fittings	9.4	46.9	0	24"
Flow rates of 3/16 tubing at various leak rates				
no fittings	13.8	68.8	0	24.2"
no fittings	12.6	63.1	1	16"
no fittings	10.9	54.5	2	11"
no fittings	10.3	51.6	3	5"

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ground to obtain the drop of 35″ on about a 13% slope. The line siphoned water from the jugs to establish the volume of water that could be conducted through the 3/16″ lines over time. A vacuum gauge was plumbed in at the top of the line to measure vacuum pull on the line. Fittings were added to the line in increments to assess how adding T's would influence the flow level. The flow rate of .2 gallons of sap per hours per tap is used to estimate how many taps the 3/16″ tubing could support.

The chart below indicates just how many fittings were in the line, followed by how much water was siphoned through the line per hour, followed by the number of taps the 3/16″ line could support if taps were contributing .2 gallons of sap per hour. The next column lists the number of leaks in the line and the vacuum measured at the top. The number of taps that the calculations say can be supported is much larger than I would have anticipated, ranging between 47 where 24 fittings were in the line, to 56 where only a fit-

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ting for the vacuum gauge was in the line. I'm not suggesting producers consider going to such high numbers but it is interesting that it appears the line can support them. More testing needs to be done to determine what the vacuum levels are at other points in the line. It is likely that the high vacuum levels only occur at the top and decline as you move down the line but that needs to be tested.

The remaining factor that was tested this summer is the influence of leaks in a 3/16" tubing system. To look at this, leaks were created in the line as it was siphoning water from the jug at the top by drilling a 1/16" hole in the line. The first hole was drilled twenty feet of elevation below the tank, the second hole ten feet below, and the third hole five feet below the elevation of the water tank. The leaks both reduced flow rate and significantly reduced vacuum at the top. As suspected, leaks will significantly reduce the vacuum advantage provided by the 3/16" tubing. A 1/16" hole is very small compared to the average squirel damage typically seen in maple tubing systems.

To sum this project up, 3/16" tubing can provide some yield benefit by creating natural vacuum. That benefit will be directly related to the elevation drop of the lateral line. Additional fittings in the line will only gradually reduce the flow rate but leaks will significantly reduce yield results. Much more testing needs to be done before the dynamics of slope, vacuum and tapping rates on a 3/16" lateral line are fully understood. This study is intended to add a little more to that understanding. A special thanks to Bob Beil, Gordon Putman and the Upper Hudson Maple Producers for their support for this study.

Maple educational events

Maple syrup and nutrition, Rhode Island November 7

Dr. Navindra P. Seeram will give a talk on the nutritional values of maple syrup on November 7 at 7:00 p.m. at the University of Rhode Island. RSVP required by November 1 to Thomas Buck, President, Rhode Island Maple Association, 401-377-2418. Dr. Seeram has conducted extensive research into the nutritive and health properties of maple sap and syrup.

Lake Erie Maple Expo November 7-8

The third annual Lake Erie Maple Expo will be held November 7-8. This year there will be four In-depth Maple Syrup Production Workshops held on Friday, November 7 from 10 am - 2 pm. Three very popular workshops will return in 2014 at the same locations as last year: Managing Vacuum Tubing Systems, Tubing System Installation and a special Beginners Workshop. New this year will be a Maple Confections Workshop. The registration for the workshops is separate from the LEME registration, and lunch is included. Sign up early as space is limited

The Expo will open Friday evening with a tradeshow from 5-8 pm. There will also be several informal discussion groups with some of the maple experts. On Saturday, the tradeshow will open at 8:00 a.m., the seminars will run from 9:00 a.m. to 4:00 p.m. with a break for lunch, which is included in the registration fee. During the day participants will be able to attend four breakout sessions, selecting from more than 25 different topics. Presenting the topics this year will be maple specialists, industry and commercial experts, and producers from Pennsylvania, New York and Ohio These will include Dr. Tim Perkins and Mark Isselhardt from the UVM Proctor Maple Research Center, Steve Childs from Cornell University and Glen and Ruth Goodrich from Goodrich Maple Products. Also presenting will be many experts from the maple industry, including speakers from Leader Evaporator, Dominion & Grimm, Lapierre USA and CDL as well as programs presented by local maple producer from the tri-state area.

Information is available on the Northwest Pa. Maple Syrup Producers Association website www.pamaple.org, the Ohio Maple Producers Association websites www.ohiomaple.org and the Ohio Maple Blog at www.ohiomaple.wordpress.com.

Verona, NY Maple Conference January 9-10

The 2015 Verona Maple Conference is scheduled for January 9-10. The Conference will be hosted for the 16th consecutive year by the Vernon-Verona-Sherrill (V.V.S.) FFA and features the largest trade show of its kind in the United States with nearly 50 maple vendors, equipment manufacturers, supply dealers, and maple product distributors. Last year's trade show highlighted the latest in R.O.'s, evaporators, vacuum pumps, tubing, and every supply available to maple producers.

More than 35 workshops will be scheduled during four time slots of Saturday's conference. Leading maple researchers, presenters, maple confectioners and experienced industry producers share their knowledge and expertise in an open, interactive presentation format. Through demonstrations and discussions, participants have a great opportunity to learn from the best in our maple industry.

A registration form available in the next issue of *Maple News*, and forms will also be available online through the Cornell Maple website. Deadline for pre-registration is December 10. All pre-registered attendees will be "first-served" at Saturday's luncheon. Pre-registration receives a $30 discount from at-the-door registrations.

New York Maple Events

October 18: **Chenango County Maple Workshop and Tour**, Contact: Kenneth A. Smith, Cornell Cooperative Extension of Chenango Co., 99 North Main Street, Norwich, NY 13815, (607) 334-5841 ext. 19, kas294@cornell.edu

October 18: **Forest regeneration, fencing and tree planting workshop**, Uihlein Forest Lake Placid, Contact: Michael Farrell, Ph.D., The Henry II and Mildred A. Uihlein Director of The Uihlein Forest, 157 Bear Cub Lane, Lake Placid, NY 12946, mlf36@cornell.edu, Office (518) 523 9337 Cell: (518) 637 7000

October 21: **Maple Production for the Beginner**, Ulster County, Contact: Liz Higgins, Ag Program Leader Cornell Cooperative Extension of Ulster County, 232 Plaza Road, Kingston NY 12401, (845) 340-3990, emh56@cornell.edu

October 25: **Central Area Grading Workshop**, contact Countryside Hardware, 1712 Albany Street, DeRuyter, NY 13052, (315) 852-3326; (315) 852-3327, store@countrysidehardware.com

November 1: **Columbia-Greene County Maple Value Added Training**, Contact: Marilyn Wyman, CCE of Greene County, Agroforestry Resource Center, 6055 Route 23, Acra, NY 12405, (518) 622-9820 ext. 36, mfw10@cornell.edu

November 15: **Maple Confection I Workshop**, Wyoming County, Contact: Deb Welch, Cornell Cooperative Extension of Wyoming County, 401 North Main Street, Warsaw NY 14569; (585) 786-2251; djw275@cornell.edu

November 22: **Sullivan County Maple Value Added Training**, Contact: Michelle Lipari, Cooperative Extension Sullivan County, 64 Ferndale-Loomis Rd., Liberty, NY 12754, (845) 292-6180, ext. 129, mml249@cornell.edu

December 6: **Southern Tier Maple Program**, Contact: Brett Chedzoy, Cornell Cooperative Extension - Schuyler County, Agriculture and Natural Resources, office: (607) 535-7161; cell: (607) 742-3657; bjc226@cornell.edu

December 13: **Onondaga County Maple School**, Contact: Kristina Ferrare, Cornell Cooperative Extension of Onondaga County, The Atrium, 2 Clinton Square, Syracuse, NY 13202, (315) 424-9485 ext 231, www.ExtendOnondaga.org

December 20: **Maple Confection Workshop I**, Steuben County, Contact: Stephanie Mehlenbacher, Cornell Cooperative Extension of Steuben County, 3 Pulteney Square East, Bath, NY 14810, (607) 583-3240 sms64@cornell.edu

North American Maple Syrup Council Research Fund

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