Northern NY Agricultural Development Program
2016-2017 Project Report

Clonal Micropropagation of High Sugar Producing Trees of Sugar Maple

Project Leader(s):

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Collaborator(s):

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Cooperating Producers:

- John Reardon, Franklin County: identified for work in 2018

Background:

One of the more costly aspects of maple sugar production is the energy and time required for evaporation. These costs are a function of the sap sugar concentration, as sap with higher sugar levels requires fewer inputs. If producers were able to plant and harvest from trees with naturally higher sugar sap concentrations (i.e., 'sweet trees'), producer productivity would increase and costs would decrease. If sweet trees could be clonally propagated (e.g., from cuttings), there would be an opportunity for the establishment of a nursery crop industry based on these trees.

The concentration of sugar in sap will range from 2% (or lower) up to ~8%, and will vary with the year, environment, planting site, and the genetics of individual trees. Because the sugar sap concentration is determined genetically, trees producing sap with higher sugar concentrations can be selected. High sugar producing maple trees have been identified in long-term research projects in New York and Pennsylvania by the U.S. Forest Service and Cornell University, and in Ontario, Canada, by the University of Guelph.

For any trait of sugar maple (*Acer saccharum* Marsh.), such as resistance to insects or high sugar production, trees can be identified, but trees propagated from seed will not necessarily have the desired trait. The only means to assure getting trees with a desired property is to clonally propagate them from the 'mother' tree as done through the grafting of fruit trees and vines; thus far, this has not proved practical with maple. Successfully establishing tissue culture plant specimens from sugar maple is the first step of a longer-term project to clonally propagate trees with any desired trait.

In 2014-2016, a research group at the University of Guelph was able to solve the problem of clonally propagating sugar maple by getting buds from trees to grow in vitro on sterile media in the laboratory. The leader of this Northern New York Agricultural Development Program-funded project, Keith Perry visited the Guelph laboratory in 2016 to learn their methods, and personnel from the University of Guelph visited at the Uihlein Forest and demonstrated their methods at the Uihlein Potato Farm & Laboratory in Lake Placid.

The goal of this project has been to:

1) establish buds from high sugar selections of maple in tissue culture media,
2) clonally propagate these trees, and
3) ultimately make them available to maple sugar producers in Northern NY for planting.

The work has been conducted at the Uihlein Foundation Seed Potato Farm of Cornell University in Lake Placid, NY, in cooperation with a support lab at Cornell University in Ithaca, NY.

Methods:

In April 2017, late season sugar concentrations were measured in sap from tapped trees in the Uihlein Maple Field Station in Lake Placid (Appendix 1). Cuttings from relatively high sap sugar producing trees were taken, buds removed, surface sterilized and put onto sterile tissue culture media in small plastic boxes (Appendix 2). After two weeks and later, plants that were 'clean,' without contamination from bacteria and fungi, were transferred onto new media every two weeks.

Results:

Objective 1: Introduce surface-sterilized buds from high sugar producing maple trees into sterile tissue culture

Over a period of three weeks, cuttings were taken and a total of 433 maple buds were excised and placed into sterile tissue culture. After two months, 18 plants had survived, but not all were actively growing.

Objective 2: Maintain tissue culture lines from high sugar producing maple trees and clonally increase the number of plants for each line

As of 31 December 2017, after approximately 7 months of growth, three of the original buds (~1 %) were alive and growing well. These represent three separate clonal lines, from which a total of 7 plants have been produced. Plant 1 was subdivided into 4

separate plantlets. Plant 11 was divided into two plants. Plant 6 is sizeable, but has not yet been divided (Appendix 3).

Several factors were identified as important for obtaining excised buds that survived and continued to grow. These include:

- the use of a surface disinfectant more mild than chlorox (NaDCC; Caisson #D011-500GM),
- selection of buds in a swollen, enlarged state,
- frequently transfer of buds to new media (every 7 days),
- inclusion of zeatin (5 μM) in the medium,
- the use of the antimicrobial product PPM to inhibit contaminant growth, and
- low light intensity.

Some of these factors were not identified at the outset of the project and proved limiting. Thus, our efficiency of recovery was very low. We anticipate a far greater recovery in work planned for 2018.

Conclusions/Outcomes/Impacts:

High sugar producing maple plants have been established in tissue culture and are being clonally propagated within the Uihlein Foundation Seed Potato Farm program where facilities for this work are available. Three different plant lines have been established, and it has been demonstrated that these plants can be divided and increased in number. This propagation work will continue in 2018 with the longer-term goal of producing rooted plants that can be provided to producers for planting.

Conditions to allow additional 'sweet trees' to be established in tissue culture have been improved and the derived technique will be applied in 2018 to establish additional plant lines from different high sugar trees.

The goals of this project and the potential for improved productivity through high sugar producing trees were communicated to producers in NY at regional meetings.

Outreach:

This work was cited in presentations on regenerating sugar maple and research updates from the Uihlein Forest at the following events:

- 2018 New York State Maple Conference. Verona, NY, 1/6/2018
- Lewis County NY Maple School, Croghan, NY, 1/20/2018
- St Lawrence County Maple Expo, Gouverneur, NY, 1/27/2018

Next Steps:

This is a long-term project. For benefits to producers to be realized, a continued investment of time, effort and funding will be required. As an outcome of the investment of the Northern New York Agricultural Development Program resources in this project, support to continue this work is being made available through the College of Agriculture and Life Science (CALS) at Cornell University. There will be three goals in 2018:
1) to continue the maintenance and expansion of sugar maple tissue culture plant lines established in 2017,

2) to increase the number of these 'sweet tree' lines introduced into tissue culture, and
3) to produce additional data that can be used to attract longer-term funding for the project.

To accommodate the work to be done in 2018, maple tissue culture work is also being done on the Cornell campus in Ithaca, NY. The goal is to free up time and resources at the Uihlein Foundation Seed Potato Farm in Lake Placid in spring 2018 to make new 'sweet tree' introductions into tissue culture.

Work to keep NY producers informed about this project and solicit input on additional 'sweet trees' will be continued through presentations at regional conferences.

Acknowledgments:
This project was supported in part through funds provided by the College of Agriculture and Life Sciences at Cornell University to project leader Keith Perry.

Reports and/or articles in which results of this project have been published.
None have yet been produced.

For More Information:
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2016-2017 PROJECT APPENDIX 1: Clonal Micropropagation of High Sugar Producing Trees of Sugar Maple: Late Season Sap Sugar Concentrations, (% Soluble Sugar Concentration), Uihlein Maple Field Station, Lake Placid, 4 April 2017

Note: measurement was late-season April under suboptimal conditions and % Soluble Sugar Concentration (SSC) figures are much lower than would be expected. These figures provide a reference for the relative sugar levels of trees to be expected.

Tree #	% SSC
21	2.8
41	2.3
44	2.0
51	3.0
642	2.5
649	3.2
745	2.8
746	2.6
747	2.9
750	2.7
778	3.2
780	1.9
790	4.0
795	3.0
883	2.1
912	3.5
913	2.0
935	3.0
1539	4.1
2696	2.5
2972	3.1
2978	2.9
2981	3.8
2982	2.9
2984	3.8
2997	2.8
2997	3.0
3000	3.1