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WALNUT SAP FLOW AND SYRUP MAKING FIELD TRIAL

JAN-MARCH 2019

Conducted in partnership with the West Virginia Department of Agriculture

by Mike Rechlin

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This report integrates the experiences of a major field trial at the Dalen site conducted by Future Generations under a WVDA research contract. It also integrates work done by two producers in WV and the Virginia Tech Catawba Farm in VA.

TRIAL SITES

A 107 tap study area was established at John Dalen's farm in Franklin WV. At this site we carried out a series of trials to learn about walnut sap flow, and to address sap and syrup production issues as they arose. We also collaborated with walnut sap producers in Palestine and Leon WV, and with Virginia Tech's Catawba Sustainability Center in Blacksburg VA.
The analysis section of this report is based on the work done at the Dalen farm study area.

John Dalen – Franklin WV
Chip Matheney – Palestine WV
Mark Lambert – Leon WV
Adam Taylor – VT Catawba Farm, Blacksburg VA

SAP AND SYRUP PRODUCTION DATA

Owner	Location	Collection Type	Tap Date	Number of taps
John Dalen	Upper bench	Tubing + Bags (equally divided)	1/29	82
John Dalen	Riverside	Bags	2/15	10
John Dalen	Back area	Bags	2/17	10
John Dalen	Roadside	Bags	3/16	5
Chip Matheny	Farm	Buckets	1/19 + 2/19	40
Mark Lambert	Farm	Buckets	1/2	29
VT, Catawba farm	Sust. Ctr.	Tubing	End of March	44

Owner	Sap volume	Syrup Produced
John Dalen	161 gallons	1.5 (plus discarded sour sap)
Chip Matheney	150	2.5 gal
Mark Lambert	150	1.9 gal
Adam Taylor, manager	65 gallons	Did not evaporate

THE DALEN FARM STUDY SITE

This section looks at the issues we faced in this, our first try at tapping walnut. It tries to analyze these issues and look ahead to what could be done to increase walnut sap yield and syrup production

LEAKY TAPS

We tapped out the end of January using CDL clear polycarbonate spouts, and as soon as the sap started running, we discovered that over half of our taps were leaking. We tried to tap the spouts in further, but that did not stop the leaks. Finally, on March 13th we replaced those spouts with more highly tapered (old style) 7/16-inch plastic spouts, which stopped the leaking.

Analysis: Walnut is a softer wood than Sugar maple. Sugar maple, also called hard maple, has a Janka hardness rating of 1450. Walnut has a rating of only 1010. In the Janka rating system, the higher the number, the harder the wood. The CDL clear spouts have a barrel taper of 0.02-inches, the older blue 7/16-inch plastic spouts have a barrel taper of 0.13 inches. The greater taper on the 7/16-inch spouts allowed them to seal better in the softer walnut wood.

Recommendation: Through this work we came to the conclusion that walnut specific tapping strategies need to be developed. In this case, a more highly tapered 5/16-inch tubbing spout should be developed to give a tight seal in the softer wood.

NOT MUCH SAP

In the 2019 season, we obtained just 1.6 gallons of sap per tree. It is well known that walnut does not yield as much sap as maple. Tapping maple without vacuum you could expect to get up to from 10 gallons of sap per tree. The lower volume of walnut sap makes sense in that walnut has a relatively thin layer of white sapwood, and the black heartwood is dead and does not produce sap. However, we noticed a tremendous variation between trees with, on any given sap run, a few trees producing a lot of sap and many giving little or nothing.

Analysis: There is always genetic and tap placement issues that result in sap flow variation. However, it makes no physiological sense that if pressure builds in some trees, causing sap flow when tapped, that other trees would not have any pressure buildup.

Recommendation: The reason for this variation needs further investigation.

THE SAP FLOW SEASON

We tapped the end of January which is the typical time for tapping maple in our area. By early February we were getting sap runs. Of the two lines we established, only one was running, and only a few bags were giving an appreciable amount of sap. When we addressed the leaking issue we also reamed out the holes for the larger 7/16-inch spouts and deepened the holes to 2-inches, thinking that the thick bark on the walnut had not allowed us to get a full 1.5 inches of sapwood exposed. In mid-February we added more bags (river area and back side) hoping to increase production. Although we had a few good producing trees from both areas, in general the yield was still highly variable between trees and most trees produced little sap. By the end of February our upper area bags had stopped filling at all, and the trees on tubing were producing minimal amounts of sap. Mid-March we tapped 5 more trees, moving bags from upper area “non-producers.” All five late tapped trees produced good quantities of sap through the rest of the season.

Analysis: Based on this year’s observations we have to conclude that end of season tapping produces the most sap. Even though Walnut is known to leaf out later than maple, the sap flow season for both species ends when you no longer have freeze/thaw cycles to initiate sap flow. If we had tapped all our trees in March instead of January and February, we would have had only three weeks of sap flow weather but could possibly have collected more sap with less work.

Recommendation: Conduct a more scientific study measuring total sap flow from trees tapped at different times.

3/16 INCH NATURAL VACUUM

We tapped trees on two 3/16-inch lines on an upper shelf, running those lines down to the floodplain where we set up our evaporator. Each line had at least 20 feet of elevation change which should have developed a natural vacuum at least in the mid-teens, when measured in inches of mercury. However, we were unable to achieve this vacuum. To minimize the loss in value of high-quality saw logs on the landowner’s walnut trees, we tapped below the lateral line of tubing.

Tapping below the lateral line with vacuum is being encouraged in order to increase the tapping zone of the tree. Our decision was made in consultation with 3/16-inch tubing specialist Tom Wilmot, who said in an email “In one study of mine there was no difference in seasonal sap yield between 5/16 and 3/16, above and below the tap hole.” The theory is that the natural vacuum on the 3/16 line or the artificial vacuum on the 5/16 -inch line was sufficient to draw sap up to the lateral line, keeping a positive draw on the sap even during nighttime periods of negative vacuum. Tapping below the lateral line should not have affected natural vacuum levels, but it did.

Analysis (1): The problem with natural vacuum (3/16-inch tubing) in walnut: Throughout our study, we were never able to obtain the levels of vacuum on our lines that we thought we should. The best end of line vacuum we could get was around 9 inches of mercury. Initially we thought it was because of the leaky taps. That problem was remedied, with no change in the vacuum levels. One sap line was not running at all, and we thought we may not have enough trees on that line to fill the line with enough sap to develop a vacuum. We added more trees, with no appreciable change in vacuum, although it did go from no flow to marginal flow. Finally, we realized that we were not getting our tubes full of enough sap because the walnut trees were producing excessive amounts of gas.

A natural vacuum 3/16-inch system requires the line being full sap to pull a vacuum when given an elevation change. With a full tube, for every foot of vertical drop you create 0.88 inches of vacuum with a full tube. In a study comparing sap flow in 3/16-inch systems, we found that on the average 9.2 percent of the tube is sap filled in the walnut, whereas 85 percent of the tube is filled with sap in the maple. We believe that explains why we were not able to develop the vacuum we expected with our given elevation drop.

Figuring out why maple and walnut are so different is another question to answer. Our hypothesis is that it has to do with the cellular structure of the two species. Maple is a diffuse porous species; walnut is a semi-ring porous species. Walnut shares characteristics with diffuse porous species—such as maple—which have a sap flow, but also with ring porous species—like oak—that do not. Ring porous species have large early springwood pores. Walnut has large pores throughout the annual ring—not just in early spring. Those large, non-sap producing pores could be the source of the extra gas in the sap.

Once we came to this realization, which was late in the season, we hooked up a vacuum pump to one line—immediately increasing vacuum to 18 inches at the line and increasing sap flow from an average of 4.7ml/minute to 19 ml/minute.

Analysis (2): Because we were not lifting the sap up to the lateral line and maintaining a positive movement away from the tree, tapping below the lateral line, in this case, shortened the tapping season. During freeze periods, when the trees created a negative vacuum, the microbially contaminated sap in the lines was drawn back into the tap hole. This initiates compartmentalization by the tree and vascular plugging by the growing microbes. These trees yielded less sap and closed off their sap flow earlier in the season. Based on what we saw this season, trees with sap bags outproduced tress on vacuum.

Recommendation: Our trees on tubing produced very little sap this year. Most of our production came from trees on buckets and bags. This needs to be repeated using vacuum created by a vacuum pump capable of removing the excess tree gasses and delivering appreciable vacuum to the entire line.

SAP FLOW VARIATION BETWEEN TREES

As noted earlier some trees produced lots of sap and other trees hardly produced any sap. This variation has been noted by others, as well as the observation that a tree that produces well one year may then produce poorly the next year. The question is, "why?" One could hypothesize that bigger trees would produce more sap than smaller trees. Another hypothesis could be that trees where the tap hole extended in to the non-producing heartwood produced more poorly than trees where the tap hole was completely in the light-color sapwood. To investigate, we designed an experiment to test these hypotheses. We took our highest producing trees and measured their stump diameters and tap hole depths. We then took our poorest producing trees and did the same.

Analysis: The results, given below, show no appreciable differences.

	Tap Hole Depth	**Stump Diameter**
Good Producers	2.0 inches	23 inches
Poor Producers	2.0 inches	22 inches

Recommendation: More research in this area is needed.

With support from:
The West Virginia Department of Agriculture through a Specialty Crop Block Grant
Future Generations University

"This publication was supported by the U.S. Department of Agriculture's (USDA) Agricultural Marketing Service through grant 16-SCBGP-WV-002. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the USDA."