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Walnut – Observations on The Timing of Tapping

2020 Sap Flow Season

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NORTHEAST SARE
Sustainable Agriculture Research & Education

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INTRODUCTION

Tapping walnut trees for sap collection and syrup production provides a syrup producer the opportunity to tap into the new, growing, and potentially lucrative specialty tree syrup market. The bulk price for walnut syrup in West Virginia this past season ranged from $150-$250/gallon, with retail sale prices topping $500/gallon (Tonoloway Farm, 2020). To get there, potential walnut syrup producers need to know how and when to tap their trees to maximize sap production. During the 2020 sap flow season, Future Generations University, with a grant from the NE SARE program, conducted studies looking at the application of vacuum, spout design, tapping procedures, and the timing of sap flow in walnut trees. This paper presents part of the findings of that work.

Black walnut (*Juglans nigra*) trees are anatomically and physiologically different from maple trees. Although we know a lot about maples and their sap flow, we know relatively little about sugar sap flow in walnut trees. Wood anatomists classify walnut as a semi-ring porous wood. Like maple and other diffuse porous species, it has small pores, called vessels, evenly distributed throughout its xylem. However, like oak and other ring porous species, walnut also has large pores in the summerwood of its xylem. Diffuse porous species, when tapped, exude a sweet sap during their dormant season. Ring porous species do not. Walnut trees, with a wood structure right in the middle, produce some, but not a lot, of sweet sap. A tapped maple tree can be expected to produce up to 10 gallons of sap through gravity flow. Our studies found that a walnut tap will produce around 2 gallons of sap during the season. To be commercially viable with that low volume of flow, it is imperative that a producer collect as much as he or she can by tapping at the right time and with the right methods.

When tapped during the dormant season, a tree exudes sap because of the buildup of internal pressure, more precisely because of the difference in pressure between the inside of the tree and the ambient environment. Different species use different physiological mechanism to build up that pressure. Maple trees build up stem pressure through physical and biological processes (Cirelli, et.al, 2008) that rely on freeze/thaw cycles. On the other hand, birch trees, another diffuse porous species, build up internal pressure through osmotic processes in their roots, known as root pressure. Instead of freeze/thaw cycles for initiation, root pressure relies on a warming of the soil. Because of this requirement, the sap flow season in birch tends to be after the sap flow season in maple.

Walnut trees have been shown to rely on stem pressure as well as root pressure to pressurize their xylem. As one would expect, stem pressure dominates during the winter and early spring months with root pressure dominating in the warmer fall and late spring. In walnut trees, stem pressure has been shown to develop only 7% of the theoretical maximum, whereas root pressure developed up to 55% of the theoretical maximum (Ameglio, Et.al, 2001, and Ewers, Et. al., 2001).

Which leads to the dilemma of when is the best time to tap: late winter or spring?

STUDY DESIGN

In this study, we were trying to determine the optimal time to tap for the collection of walnut sap. The study was conducted at Elton Bower's farm in Pendleton County, West Virginia. We choose 10 similarly sized open grown walnut trees growing along a stream. Each tree was tapped three times at two-week intervals. The first tap hole "A" was drilled on February 8nd, the second "B" on February 23rd, and the third "C" on March 8th. Because of an assumed later sap flow season for walnut trees, the first tapping was two weeks after maple tapping on the same farm. The walnut trees were tapped with 7/16-inch stainless steel spouts and 5/16-inch drop lines flowing into 5-gallon buckets with lids. The sap was collected periodically, with the recorded volumes representing the total sap accumulation since the previous collection. The final sap collection was on March 31st.

PROBLEMS ENCOUNTERED

Wind was a problem, and there were times when some buckets tipped. Because of this, the volumes collected on any particular collection date do not correctly represent total sap flow for that period. The volumes on Table 1 let us know that there was one or more sap flow event during that period and, because only a few buckets tipped on a few dates, an approximation of the sap flow intensity.

Also, because walnut sap flow had ceased on other studies being conducted at this site, we ended our study on March 31st, even though the third tapping on each tree was still producing sap from the fresh tap holes. As will be seen in the serendipity and discovery section of this paper, that was a mistake.

RESULTS AND OBSERVATIONS

Table 1 shows the cumulative amount of sap collected from the 10 study trees at each collection date. Tap A, in the first column, was active for 33 days and collected the most sap; 2.4 gallons/tree. This was during the traditional maple sap flow season, and it is assumed that the sap collected was due to stem pressure initiated by freeze/thaw cycles. The Ameglio and Ewers study showed that during this time walnut trees develop a relatively low 7% of the theoretical stem pressure, resulting in slow sap flow and an average seasonal per tree accumulation of only 2.4 gallons. This low stem pressure helps explain the observation in Figure 1, a photo taken while sap was flowing without pressure registering on the pressure gauge. During the entire season, this gauge did not register any pressure, although the tree regularly exuded sap.

Tap hole B was drilled 13 days later than tap hole A. It was hypothesized that delaying tapping would keep tap holes producing later in the season with the potential to capture later season sap runs and increase total seasonal yield. This did not turn out to be the case. Although the

fresher tap holes did allow for significantly more sap to be collected on March 4th, both sets of tap holes had dried up and stopped exuding sap by March 31st. This second set of tap holes had only a 20-day season with a production of 1.5 gallons of sap/tap hole. Having fresher holes later in the season did not make up for the lost sap flow earlier in the season and drilling later did not extend the length of the season.

Tap hole C was drilled on March 15th. Between March 15th and March 31st, the temperatures registered at the nearby Upper Tract weather station only dropped below freezing on the nights of March 18th and March 24th. During this period, spouts "A" and "B" failed to produce any sap flow, while the newer tap holes on spouts "C" produced 19.5 quarts of sap. Pressure was obviously building in those trees, but "A" and "B" tap holes had sufficiently dried up, or maybe more appropriately plugged up, to shut off sap flow. Had we kept the study going, I would expect the fresher tap hole "C" would have continued to exude sap for some period of time.

Table 1. *Sap collected from 10 walnut trees with three staggered tapings.*

Date	Tap A (qt)	Tap B (qt)	Tap C (qt)
2/12	14.4		
2/16	9.1		
2/18	19.5		
2/23	10.3		
2/25	19.0	18.8	
3/4	17.5	30.5	
3/8	2.5	5.8	
3/15	3.6	5.3	21
3/31	0	0	19.5
Total	95.9	60.4	40.3
Total Days	33	20	
Gal/tap	2.4	1.5	

Figure 1. *Sap flow with no registered internal pressure buildup*

SERENDIPITY AND DISCOVERY

On April 16th, two and a half weeks after the maple sap flow season at this farm was over and we had terminated our walnut sap flow studies, area producer Christoph Herby drilled a hole in a walnut tree. The hole was drilled to create an injury so we could look at compartmentalization associated with a tap hole. Much to his surprise a steady stream of sap flowed out of the tree. After getting a call that evening, I drilled a hole in a walnut tree on the morning of April 17th and had a full 2-gallon bucket of sap by noon. The flow rate was measured at 120 drops/minute. The sap ran heavily for the next 2 days and then stopped.

April was an unusually cool month in our area, with freezing nights on April 16,17,18 and 19. A week earlier, Christoph was digging a ditch when his backhoe severed some roots on a walnut tree, which immediately started to exude sap. This late season sap flow corresponds closely to the time in our area when tapped birch trees exude sap due to root pressure. The Ameglio and Ewers study showed higher potential tree stem pressures, up to 55% of the theoretical maximum, due to root pressure. The late season freeze/thaw cycles could have combined with an April buildup of root pressure resulting in a few days of exceptional sap flow. Our ten study trees averaged 2.4 gallons of sap over a 33-day sap flow season. My one tree produced 2 gallons of sap in a half day.

As with any good research project, we are left with more questions than answers. The sugar content of the April sap I collected was in the 1% range, comparable to that collected during the earlier collections. In a partial boil, the April sap did not give off a buddy smell in the steam. However, both of these are one-tree, one-time measurements and observations. The sap flow on my tree stopped abruptly after three days. If you wanted to catch that run, how would you know which 3 days?

One of the unknowns is the role pectin could be playing. Unlike maple, walnut trees have a lot of pectin in their sap. Pectin is a big, heavy (60,000+ grams/mole) polysaccharide molecule, comprised of long chains of sugars. It is found in the cell walls of plants, and when heated forms a gel, which is why we add it to fruit juice to make jelly. Pectin in walnut sap is known to plug the pores of a reverse osmosis membrane and it causes walnut syrup to be hard to filter. It has been noticed by walnut syrup producers that late season syrup is harder to filter than earlier in the season syrup, presumed to be caused by an increase in pectin content.

Could it be that the tree is releasing pectin into the sap as a response mechanism to seal off the tap hole wound and limit the entry of decay causing microorganisms, thereby closing off sap flow and shortening the sap flow season? The mid-April sap flow event went from intense to nothing in only three days. If you waited to tap until April, you might have a very short season. However, you might get as much or more sap as you would have by collecting all February and March. A good tapping strategy could be to put in one spout to collect during February and March, and a second (using the Cornell 2 tap concept) to collect from that final April push? That

is, assuming the trees growth rate and the xylem killed in the tapping would sustainably allow for that strategy.

CITATIONS

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