

WHY DO SOME MAPLE TREES PRODUCE MORE SAP? *Reprinted from Farming, the Journal of Northeast Agriculture. April, 2011*

When all maple sap was collected using buckets, sugarmakers were well aware of the individual “personalities” of many of their trees. Aspects of a tree’s personality included whether or not it gave sweeter sap, ran early or late, or produced a little or a lot more sap than other trees. Today, the vast majority of maple sap is collected using tubing; sap from many trees is pooled in large tanks, and yields from specific trees are largely unnoticed. Tubing, especially in conjunction with vacuum, provides great benefits, and in a forest where every tree is tapped, it may be of little interest to most sugarmakers exactly where all the sap is coming from. Nevertheless, understanding, and perhaps predicting the different performances of the trees in a sugarbush is an aspect of maple physiology that remains fascinating.

Many researchers, in addition to many sugarmakers, have observed that there is a great range in the amount of sap produced from individual trees in a forest. Some researchers have reported in articles that the highest yielding tree produced as much as 30 times more sap than the lowest yielding tree. What producer wouldn’t want to find the tree that yielded 30 times as much sap as another? These studies don’t always report the size, health or other physical characteristics of the trees being compared, so it is not always clear if trees with such dramatically different performances were at all similar. One of the largest studies on this subject was performed during the 50’s and 60’s at the University of Vermont Proctor Maple Research Center by Dr. James Marvin and colleagues¹. These authors reported that when the sap yields from each of 27 trees was totaled over a many years, the highest yielding trees out-produced the lowest yielding trees by two to three times. They also noted that the variation in sap sweetness over the same time period was considerably less than the variation in sap volume. In other words, if one were to search out the best trees for syrup production, according to this study it would be more important to find the trees that produced the highest volume of sap rather than the sweetest sap.

The data from the studies described above came from gravity collection using buckets (and probably PFA tablets); we might wonder—are vacuum yields different? Recent studies from the Proctor Center, as well as others from Canada, have used vacuum chambers, described in an earlier column, to capture sap from an individual tree while maintaining a constant vacuum at the taphole. Over a period of several years I have noted that the best producing trees usually out-produce the poorest trees under vacuum by about 2 or 3 to 1, similar to the earlier Vermont study on gravity. Considerably more variation between the best and the poorest trees has been described in the Canadian studies.

Another characteristic of the variability between trees, noted by many authors, is that trees that produce the greatest amount of sap one year tend to do so nearly every year, and vice versa. This same phenomenon has often been recorded for sap sugar concentration—the sweetest trees one year tended to be the sweetest every year. Thus it might be very useful to learn how to identify these trees.

What made Marvin and colleagues’ 18 year study unique was that over time the two characteristics of sap production, sap volume and sap sweetness were found to be generally correlated: the sweeter trees tended to produce more sap. This is not to say that such a relationship was always present—there were exceptions among trees, and there were years when there was no good correlation. Marvin cautions that it took many years of data (and many trees) to arrive at this correlation. Other authors of shorter-term studies have not reported a correlation between sap sweetness and sap volume. Many researchers and sugarmakers, including myself, can point to trees that are either superior in sap yield or sap sugar

concentration, but not both. Because most forest managers do not have time for a decades long study before making decisions about which will be best crop trees for sugaring, some fool-proof method for identifying superior sap trees has long been sought. Researchers have examined a host of physical characteristics, including diameter, height, various measures of crown size, and growth rate, in an attempt to correlate them with sap volume yield. Out of these many attributes, diameter seems to be the most reliable in predicting sap volume—larger trees tend to give more sap. This should come as no real surprise; however, there are many exceptions to this rule—the relationship between tree size and sap volume is rather weak. My own experience with measuring sap volume under both gravity and vacuum has pointed to individual trees that are clearly superior to others; some of these trees are large, and some are among the smallest trees in a group.

All of this recounting of research findings may leave the reader confused—for the truth is, we don't have a good explanation for much of the variation in sap yield among trees in a forest. Do some trees have much better developed root systems than others? Do some root systems tap wetter soils? Are some trees genetically predisposed to yield more sap from a wound? While it may be possible that some trees have superior storage capacity for starch, which could lead to more sugar appearing in the spring sap, it is harder to find anatomical clues that would lead to more spring sap volume. During one season I collected sap from trees with similar diameters but a range of crown dieback conditions, and found that, unlike differences in sap sweetness, sap volume was strongly affected by the health of the tree—the more dieback, generally the less sap produced. Recent additions to our understanding of the maple sap flow mechanism may offer an explanation for a correlation between sap sweetness and volume, but I will leave that for another column. Among healthy trees, reasons for their different behaviors remain one of the enduring enigmas of maple science.

¹Marvin, J.W., Morselli, M., and F.M Laing. 1967. A correlation between sugar concentration and volume yields in sugar maple—an 18-year study. *Forest Sci.* Vol. 13, No. 4.