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Research: Tapping

Is Tapping Below the Lateral Line a Good Idea?

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One of the primary factors limiting sustainable tapping practices in maple production is the size of the tapping band (Buzzell 1986, van den Berg and Perkins 2014). Tapping of trees with short droplines, excessively deep tapholes, larger 7/16" spouts, and multiple tapholes per tree over a period of time can lead to the development of inadequate sound wood to tap into. Maple producers can attempt to overcome this problem in several ways: by maximizing growth potential through thinning, by only tapping trees of an appropriate size, through the use of appropriate tapping guidelines (number of taps per tree and depth of tapholes), and by using a dropline of sufficient length (Buzzell 1986, Heiligmann *et al.* 2006, van den Berg 2012). Despite taking reasonable precautions, growth of trees is sometimes not fast enough to prevent the build-up of excessive zones of compartmentalization. The result of this is that producers begin to experience an increased incidence of tapping into stained (compartmentalized) wood, which is clearly a non-sustainable management practice (van den Berg et al. 2013).

Excessive compartmentalization leads to the problem of finding enough new fresh wood to tap, and may lead to a reduced sap-conducting capacity of the tree to supply the leaves with water for photosynthesis, culminating in reduced growth which only serves to further compound the problem. A relatively easy way for producers to know whether they are tapping into old wood is to periodically examine their drill shavings during tapping. Productive wood will be white or cream-colored and just slightly damp. Drill shavings that include a significant amount of tan or brown-colored wood is an indication that non-conductive wood was tapped into. Such tapholes are thought to produce lower sap flows.

With the use of vacuum, tapping below the lateral line might be a potential strategy for increasing the size of the tapping band, as it would increase the size of the tapping band and would decrease the probability of tapping into brown wood, therefore increasing tapping sustainability and reducing any losses in sap yield associated with tapping into stained wood. Consideration of tapping below the lateral line is a relatively recent development, thus there has been an inadequate amount of research to examine the possible benefits and drawbacks of employing this technique. One possible negative trade off in using this approach is that the vacuum level at the taphole is likely to be slightly lower. Furthermore, while sap should be able to be pulled upward through an inverted dropline with vacuum, the recently increased understanding of the importance of good sanitation in achieving high yields (Perkins *et al.* 2010, Perkins and van den Berg 2012, Childs 2010) suggests that increased microbial contamination of residual sap and increased backflow in inverted droplines might induce reduc-

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tions in sap yields. Thus it is important to understand the possible positive aspects as well as the negative consequences when considering tapping below the lateral line so that producers are able to fully assess the feasibility of this approach.

This research was conducted to determine whether tapping below the lateral line in vacuum tubing operations results in the same quantity of sap from a taphole as normal (above the lateral line) tapping, and thus whether tapping below the lateral is a reasonable management alternative which might be employed to increase the size of the tapping band in maple sap production. It will also inform us as to any tradeoffs (reductions) in yield that might result from this approach. A small reduction in yield might be a reasonable penalty to pay for a large increase in the size of the tapping band.

Materials and Methods

This study was conducted at the University of Vermont Proctor Maple Research Center in Underhill Center, Vermont, during the spring sap flow seasons of 2015 and 2016. Thirty-three large sugar maple trees averaging 17.8″ diameter that had been tapped for at least 50 years were used.

The trees were divided into three treatment groups:

- A control treatment with all taps placed above the lateral line with standard 5/16″ polycarbonate spouts.
- An experimental treatment with all taps placed below the lateral line with standard 5/16″ polycarbonate spouts.

- An experimental treatment with all taps placed below the lateral line using 5/16″ polycarbonate Check-valve spouts.

All droplines were 24″ long and had been previously used and cleaned with water. Spouts were new each year. One and a half inch deep tapholes were drilled for all treatments on the same day each of the two seasons. Trees with tapholes drilled above the lateral line were especially well inspected in an attempt to locate areas where it was deemed unlikely to encounter staining from previous tapholes. Drill shavings for each taphole were visually inspected during tapping for the presence of brown wood, indicating the taphole had penetrated into a compartmentalized area. Tapholes were drilled in the same compass quadrant each year to reduce directional variability in sap flow. Droplines were placed as nearly straight-up or straight-down (depending upon the treatment) as possible (Figure 1). The spouts in all below the lateral treatments were placed in an inverted position, with the tubing connection pointing upward, whereas the spout in the above the lateral treatment were placed in the regular position with the spout tubing fitting pointing downward. Each dropline was connected to its own lateral line which ran to individual 40 gal vacuum chambers.

Approximately 24-25″ Hg vacuum was pulled on each chamber. The vacuum pump remained on for the entire season. At the end of the sap flow season, chambers were opened and sap depth was measured with a meter stick and converted to volume. Sap sugar content was measured at the same time

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with a calibrated Misco refractometer. During the 2016 season, high sap production required about half the chambers to be opened mid-season and volume and sap sugar concentrations measured at that time and again at the end of the season. Total sap sugar concentration was volume-averaged in those cases.

Mean sap volume and mean sap sugar concentration were determined for each treatment for each season. The proportion of tapholes hitting stained wood was also determined, as was the mean sap volume and sap sugar concentration for tapholes hitting stained wood.

Results

The volume of sap produced in 2016 was considerably higher than in 2015, although less sweet, but the same patterns were observed in both seasons. Therefore, the results are presented as averages across both seasons.

Tapping below the lateral line produced approximately the same volume of sap (33.8 gal sap/tap) as tapping above the lateral (34.3 gal sap/tap), as long as the taphole above the lateral did not hit stained wood (Figure 2). Despite careful inspection during tapping, an average of about 8% of tapholes drilled above the lateral line hit some stained wood (the average of the previous two seasons was 13% for this area of the UVM PMRC sugarbush). None of the tapholes drilled below the lateral line hit stained wood. Tapholes with visible staining produced an average of 14.0 gal of sap, or only 40.8% of the amount of sap as a taphole not hitting stained wood. Stained wood does not allow sap to pass through, thus there was less fresh conductive wood area for sap to be generated from in tapholes with staining. Sap volume produced from such tapholes is likely to be proportional to the amount of staining hit by the taphole – the more stain encountered, the less sap produced. When these tapholes with stain are factored in, tapping above the lateral line produced, on average, about 10% less sap than tapping below the lateral line, representing a significant loss in yield and income for maple producers. Tapping below the lateral line using Check-valve spouts produced about 12% more sap (38.0 gal/tap) than tapping above the lateral, although the added volume did not achieve statistical significance.

Neither tapping treatment, the use of Check-valve spouts, nor the pres-

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Figure 1. Tapped trees showing dropline BELOW the lateral (left) and dropline ABOVE the lateral (right) treatments.

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ence of stained wood affected the sugar content of the sap collected (Figure 3). Although both tapping below the lateral and tapping below the lateral with Check-valve spouts produced slightly less sweet sap, these averages were not statistically significantly lower than the sap sugar content in the above the lateral tapping treatment. It is likely that the natural trend towards slightly higher sugar content as one moves higher up on the stem is responsible for this observation. It is also worth noting that tapholes where old stain was encountered did not produce less sweet sap (although there was less volume), indicating that the conductive wood that was encountered in these tapholes produced sap of the same quality as that of a taphole where stained wood was not encountered.

Conclusions

Based upon these findings, tapping below the lateral line with good vacuum and good sanitation practices doesn't negatively affect sap yield or sugar content. Tapping into stained wood does result in large reductions in sap yield (and thus reduces producer profit), but doesn't impact sap sugar content.

Sanitation effects were small and non-significant in this study (note that the pump remained on the entire season and that no mechanical releasers were plumbed into the system, so backflow was very minimal), however we recommend that new spouts with periodic replacement of droplines should be used to maintain good taphole productivity, especially when tapping below the lateral line. The use of Check-valve spouts would be a further precaution that might give some additional benefit, especially in systems using mechanical releasers. Further, we recommend that the tubing connection of spouts tapped below the lateral line be oriented facing downward. This would help to provide a small air gap in the spout and tubing and reduce sap backflow and reintroduction of microbes into the taphole at times.

Tapping below the lateral line will place the spout and dropline closer to the ground and in so doing increase the chance of animal damage. It is also

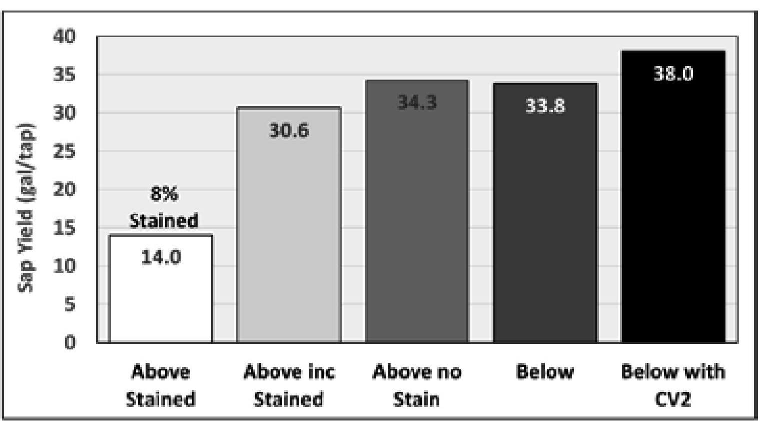

Figure 2. Average sap yield (gal/tap) for the 2015 and 2016 seasons by experimental treatment. Numbers within bars indicate sap yield (gal/tap) for each treatment. The number above the first bar indicates the average percentage of tapholes drilled above the lateral which contained at least some staining.

unknown from these results how the spout and dropline would react to a large snowfall during the season. Additionally, having sap remain in the line may increase the possibility of spout frost heaving. Producers should weigh the potential benefits while also considering that some practical issues may lead to unintended consequences.

Clearly tapping below the lateral expands the size of the tapping band, and is especially useful in those cases where historical use of large spouts, overtapping, and slow tree growth has led to difficulty finding adequate fresh wood to tap into. In such areas, tapping below the lateral might be a useful tool to reduce the probability of tapping into old stain, and thus increase tapping sustainability, sap yields, and producer profits.

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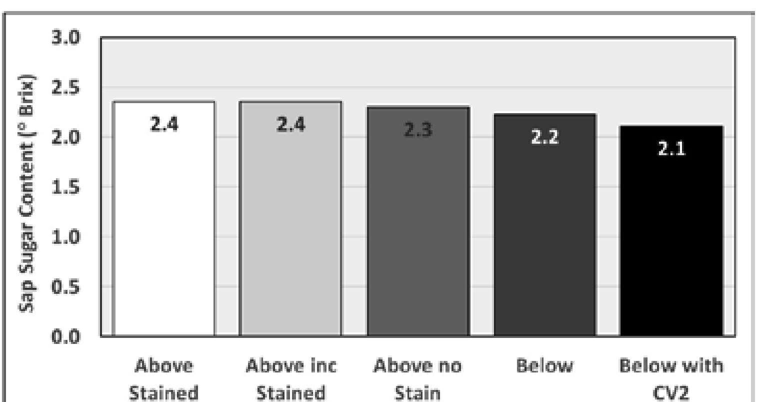

Figure 3. Average sap sugar content (°Brix) for the 2015 and 2016 seasons by experimental treatment. Numbers within the bars indicate the average sugar content for each treatment. Differences were not statistically significant.

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