

COMPARISON OF THE "SMALL" SPOUT WITH THE TRADITIONAL 7/16" SPOUT

*T.R. Wilmot, T.D. Perkins, B. Stowe, and A.K. van den Berg
Proctor Maple Research Center
The University of Vermont
Underhill Center, Vermont*

The "small" spout, 19/64" or 5/16" in diameter, has been widely available to maple producers since the mid to late 1990's as a "healthy" alternative to the traditional 7/16" spout. While now in general use by producers in some regions, particularly those collecting sap by vacuum, the utility of these smaller spouts is still questioned by many sugarmakers, particularly those collecting sap by gravity. This article will review several studies conducted at the University of Vermont Proctor Maple Research Center comparing 7/16" spouts with small spouts (for the purposes of this article, 5/16", and 19/64" will be considered equally as "small" spouts). These studies were designed to examine sap yields, end-of-season drying, taphole closure and wounding (wood staining). While it is understood that even smaller diameter spouts are in use by some producers, as well as spout adaptors, and spouts made from non-plastic materials such as stainless steel, this research focused on common plastic spouts of the types offered by maple equipment dealers across the region.

When the small spouts were introduced, the principal benefit of switching from a 7/16" to a 5/16" or smaller hole was thought to be a reduction in damage to the tree. The difference in cross sectional area of the two holes is considerable: a 7/16" hole is 0.152 sq. inches in area, while a 5/16" hole is 0.077 sq in. or approximately 50% less. Taphole closure, understandably, is more rapid with a smaller hole, and the use of a smaller drill bit allowed many producers to switch to battery operated drills for tapping with small spouts (these of course can also be used for larger tapholes, albeit less efficiently). Because there was less visible damage, some producers assumed that tapping guidelines should be adjusted to allow for tapping smaller trees. An assessment of internal damage, which requires destruction of the test trees, was necessary to answer questions about just how much less impact the small spouts have on the maples. This subject will be covered below.

For most producers, the determining factor in whether or not to switch to smaller spouts is sap yield. Because the hole is smaller, it seems intuitive that less sap will flow from the hole. We tested this hypothesis in a number of studies over a period of several years, using both gravity (bucket) collection and vacuum collection methods.

SAP COLLECTION UNDER GRAVITY

Gravity collections were made using large and small spouts each spring between 1998 and 2002. In all trials we used plastic spouts connected to a short length of tubing, which entered a covered 5 gallon bucket hung on the tree.

Spouts were generally new, however if they had been previously used they were well washed in the lab. When used spouts were tested, both large and small spout were of equal age. Spouts from various manufacturers were tested; we found no significant differences in the performance of different brands of large or small plastic spouts under gravity collection.

Results for gravity collection are shown in Table 1. Values are gallons of sap/tap per season, or the ratio of sap production of small spouts to large spouts.

Table 1. Comparison of gravity sap yield for large and small spouts from 1998-2002.

Year	1998	1999	2000	2001	2002
Tree Size	Small	Small	Large	Large	Large
5/16" Spouts	8.2	9.1	21.4	10.4	13.6
7/16" Spouts	10.5	9.1	17.5	12.5	17.1
Ratio Sm/Lg	0.79	1.01	1.23	0.83	0.80

For the five year period, the yields averaged 12.54 gallons/taphole for small spouts and 13.29 gallons/taphole for large spouts, or 94% as much sap using small spouts compared to large spouts. In 1998 and 1999 we collected sap primarily from small trees (<8" dbh) while later collections were from larger trees (> 10" dbh). This explains why yields from 2000 from either size spout were

greater than those of the previous years; other differences among years were primarily due to weather conditions. Small trees were used in the study because these trees were slated to be cut down to study internal wounds.

In 1998 we also studied yields from holes of different depths with each size spout. Holes that were 1 1/2" deep yielded 98% as much sap as holes 2 1/2" deep for either sized spout, while holes 3/4" deep yielded approximately 86% as much sap as holes 1 1/2" deep.

In addition to recording seasonal sap yield from large and small spouts, we collected weekly data during the years 2000-2002 from both sized spouts, using buckets, in order to explore possible differences in end-of-season taphole drying. In two of these three years, both sized tapholes dried at about the same time; while in the third year (2000), the tapholes fitted with small spouts ran about two weeks longer than the 7/16" tapholes.

Using specially constructed chambers (Fig.1) that isolated the sap from each taphole, sap yields under vacuum from large and small spouts were compared in 1999 and 2000. Vacuum in these tests was approximately 15" mercury at the



SAP COLLECTION UNDER VACUUM

Figure 1.
*A chamber used
to collect and
measure sap
volume under
vacuum.*

taphole. In 1999 the sap yield using small spouts was 95% of the yield from large spouts, while in 2000 sap yield using small spouts was 107% of the yield from large spouts (Fig. 2). These minor differences can be easily explained by tree to tree variation; thus we concluded that at this vacuum level there were no real differences in sap yield using either sized spouts.

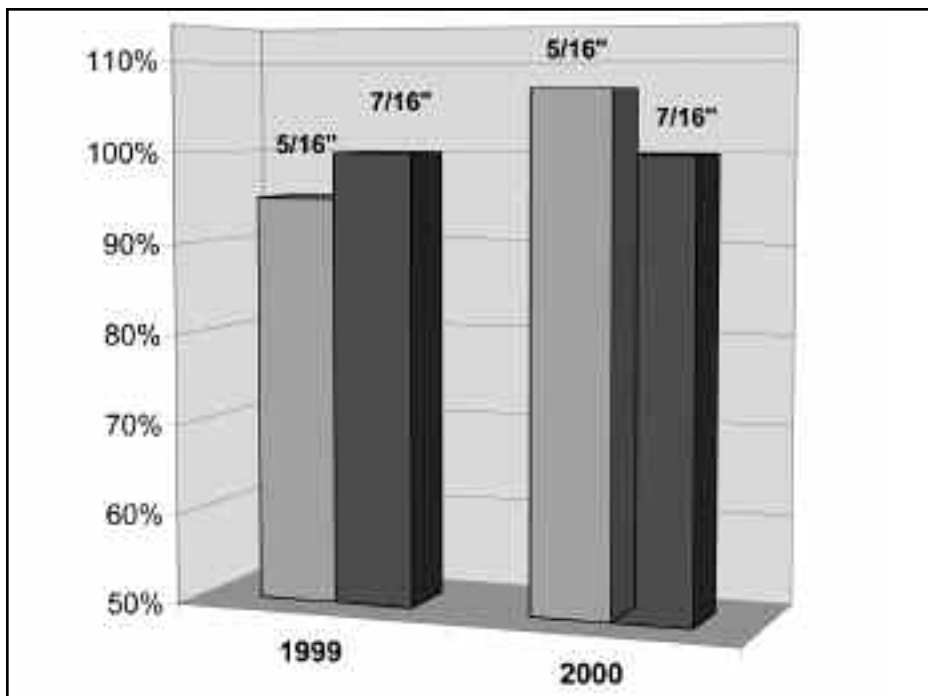


Figure 2. Sap Yield under vacuum for 5/16" and 7/16" spouts. Yield for 7/16" spouts was adjusted to 100%. There was no significant difference between yields for either size spouts in both years.

INTERNAL DAMAGE

Staining of the wood surrounding a wound, such as a taphole, has long been recognized as an indication of the portion of the tree that has become non-functional for sap transfer. While it is now recognized that the non-functional area surrounding a wound is somewhat larger than the area that is stained, comparing the area that is stained between trees with similar wounds is a good way to assess the relative damage inflicted by those wounds. These stains, believed to be caused primarily by fungi, can be measured only after the tree is cut down and dissected. Several groups of trees were sacrificed as part of our comparative studies of large and small spouts.

Although sap yields using small spouts with gravity averaged 94% of yields from large spouts, staining from gravity collection with small spouts was much less: only about 59% the volume of stains from large spouts. A few of the trees

had extensive stained areas when a taphole depth of 2 ½" was used. In these small trees, the staining had merged with a non-functional area in the tree's center (the heartwood), creating a larger than expected wound response. This is a good argument for not tapping small trees, as the non-functional area that may be created can represent a significant fraction of the total sap transport system.

In order to compare wounding under vacuum in an unbiased way, we chose to cut down several large (> 14" dbh) trees. These trees were connected to a vacuum system, and tapped with one large and one small spout on each tree. The spouts were staggered vertically to avoid any interaction of one wound with another. In these trees, the stained area resulting from small spouts ranged from 62% of the area of the large spout stain in the same tree, to 100% of the large spout stain. On average, the volume of stained wood resulting from the 5/16" holes was 80% of the stained wood resulting from 7/16" holes.

CONCLUSION AND SUMMARY

Small (5/16" or 19/64") spouts have a number of advantages over 7/16" spouts. Among these are:

1. The 5/16" holes are 50% smaller in cross sectional area than the 7/16" holes and usually close sooner than larger diameter holes.
2. The internal staining resulting from the wound, which is a measure of tree damage, is less with smaller diameter tapholes.
3. Because the bit is smaller, more holes can be drilled on a single charge using a battery operated drill.

Sap yield using small diameter spouts averaged slightly less than the yield from large spouts when collecting sap by gravity. With buckets, there was considerable variability from one year to the next in terms of which size spout had better yields. Sap yields using vacuum were the same for both 5/16" and 7/16" spouts. We did not test yields or other parameters resulting from the use of still smaller spouts, or adaptors, or spouts made from materials other than plastic.

Finally, there remains the question of whether or not the use of small spouts should allow for the use of more spouts per tree, or the tapping of smaller trees. Tapping guidelines, which recommend limiting the number of spouts based on tree diameter, serve two purposes: 1) protecting the health of the tree, particularly of the tapping band, and 2) promoting efficient use of sap collecting resources. In consideration of the latter, we have found that adding a second tap on a large (24"+ dbh) tree will yield on average only about 50% more sap than a single tap when collecting with vacuum, while adding additional expense and additional materials to maintain year round. If a second tap was added to a smaller tree, 15" diameter for example, the added yield would undoubtedly be a lot less than 50%. In terms of tree health, while the internal damage resulting from a 5/16" hole was less than from a 7/16" hole, the differences that we found were not so dramatic as to suggest that the tree could sustain additional yearly wounds. Because sap yields with 5/16" spouts were similar to yields from 7/16" spouts using vacuum, and almost as large as 7/16" yields using gravity, we see

no reason to change the current number of spouts per tree. As to the question of tapping small trees, (<10" dbh), producers can make their own decisions about the cost vs. benefits of putting buckets or tubing on small trees, but should consider our findings regarding wounds in small trees described above, and also understand that the yield from small trees is usually small.

ACKNOWLEDGMENTS

This research was funded in part by grants from the North American Maple Syrup Council and the Chittenden County Maple Sugar Makers Association.
