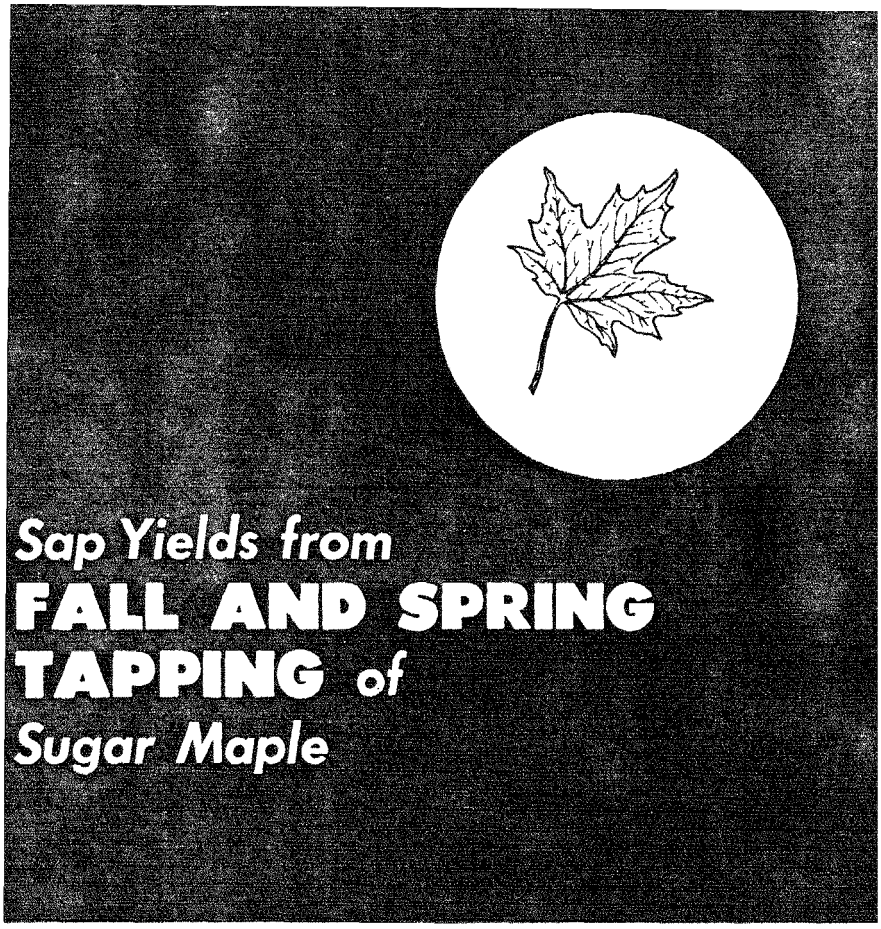

Sap Yields from FALL AND SPRING TAPPING *of Sugar Maple*

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WILL FALL TAPPING INCREASE SAP YIELD?

SOME maple sap producers have wondered whether they could increase the total sap yields by tapping their trees not only in the spring but also in the fall too. Our research indicates that tapping in the fall cannot be recommended.

Our study of fall tapping was begun in November 1964. Fall tapping was at least theoretically possible because temperature fluctuations like those of the normal spring tapping season occur to some extent in late fall and early winter. However, it was not known whether the volume and sugar concentration of fall-produced sap would be adequate to make such a practice feasible. Nor did we know whether fall tapping would affect the normal spring sap production from fall-tapped trees. The study reported here was set up to answer these questions.

STUDY METHODS

Ten large sugar maple trees located in each of two northern Vermont sugarbushes were tapped in late October 1964 and again in 1965; tapholes were located on the north, east, south, and west side of each tree (fig. 1). These tapholes, and all others used in this study, were 2½ inches deep (total depth) and 7/16 inch in diameter. All were located approximately 45 inches above the ground. After tapping, a paraformaldehyde pellet was placed

Figure 1.—Typical large, open-grown sugar maple trees like these were used for fall tapping experiments.

in the back of each hole and sap collection equipment (metal spout and plastic sap bag) was installed. The total volume and average sugar concentration of all sap produced during the fall were recorded for each taphole on each tree.

In February, each year, all spouts and collection equipment were removed from the trees. The existing tapholes were then reamed with a ½-inch drill bit; new paraformaldehyde pellets were inserted in each hole; and the collection equipment was re-installed. At the same time, 10 adjacent trees on each sugarbush that had not been tapped in the fall were tapped with four tapholes located and equipped as mentioned above. Sap volume and sugar concentration were recorded until the last week of April for each tree.

The effects of fall tapping on normal spring yields were studied further in the fall and spring of 1965-66 when we used a different method of re-tapping in the spring. In this phase of the work, 48 trees were paired on the basis of similar yield during the 1964-65 sugaring season. During the first week in November 1965, one member of each pair was randomly selected for tapping. Tapping consisted of drilling two tapholes—one on the north side and one on the south side of each tree. Sap collections and sugar determinations were recorded from each tap through February 15, 1966. At that time all spouts and collection equipment were removed from each taphole, and the tapholes were plugged with a cork. A new taphole was then drilled approximately 5 inches to one side of each of the plugged tapholes. Concurrently, the other member of each pair of trees was tapped with two tapholes (north and south) each. Volume collections and sap sugar concentrations were recorded for all trees until April 28, 1966.

RESULTS AND DISCUSSION

Volume of Fall-Produced Sap

The study clearly showed that sap can be obtained from tapped maple trees during the fall. However, both the amount and the sugar concentration of this sap were lower than that obtained during the normal spring tapping season.

An average of 2.45 gallons of sap was obtained from each taphole in the fall of 1964 (table 1). The yield from these same trees in the spring (after reaming of the taphole) amounted to 5.54 gallons. The other set of similar trees in the same sugarbush that were tapped only in the spring yielded 8.07 gallons of sap.

When these same trees were tapped in a similar manner during the fall and spring of 1965-66, slightly larger volumes of sap were obtained (table 1), but the relationships between fall and spring yields were nearly identical with the 1964-65 results. For all trees in both years, fall sap yields were approximately one-third the spring yields from trees not fall-tapped.

The reduced fall yields may be related to the frequency and range of air temperature fluctuations throughout the tapping period. Favorable sap production days—i.e., cool nights (below 32° F.) followed by above-freezing days—do not occur as often in the fall as in the spring. Likewise, the length of the below-freezing period is usually greater in the spring than in the fall.

Table 1.—*Average volume and sugar concentration of sap produced per taphole from trees tapped both in the fall and in the spring, and in the spring only*

Tapping period	Volume in gallons	Sugar concentration in percent
TAPHOLES REAMED IN SPRING		
Fall and spring:		
Nov. 1, 1964—Feb. 11, 1965	2.45	1.9
Feb. 12, 1965—May 5, 1965	5.54	3.1
Spring only:		
Feb. 12, 1965—May 5, 1965	8.07	3.0
Fall and spring:		
Nov. 1, 1965—Feb. 15, 1966	4.18	1.8
Feb. 15, 1966—April 28, 1966	6.27	2.5
Spring only:		
Feb. 16, 1966—April 28, 1966	11.96	2.7
NEW TAPHOLES IN THE SPRING[1]		
Fall and spring:		
Nov. 1, 1965—Feb. 15, 1966	6.26	2.4
Feb. 15, 1966—April 28, 1966	17.04	3.3
Spring only:		
Feb. 15, 1966—April 28, 1966	25.15	3.0

[1] Yields from trees paired on the basis of previous yields.

The range in air temperature during the fall also may affect the recharge process within the tree. Marvin (*1958*) has noted that the flow of sap is more or less proportional to the conditioning period that precedes sap flow. In general, the longer the sub-freezing period before a period of above-freezing temperatures, the greater the flow and amount of sap produced. The reduced length and severity of this sub-freezing period in the fall may reduce water recharge within the tree, and thereby reduce the potential for large yields.

Soil moisture levels also may affect fall sap yields. The normal spring season often is characterized by melting snow and frequent rainy periods that result in excessive soil moisture. This readily available source of moisture in the surface soil horizons may contribute to more rapid recharge in the tree and larger volume production. In the fall, these higher moisture levels are usually not present.

Sugar Concentration of Fall-Produced Sap

A second distinguishing feature of fall-produced sap is its low sugar concentration. The average values of 1.9 and 1.8 percent contrast sharply with the values of 3.0 and 2.7 for trees similarly tapped in the spring (table 1). This difference is important in sugaring operations. Approximately 44 gallons of 1.9-percent sap are required to produce 1 gallon of standard density syrup, but only 29 gallons of 3.0-percent sap are required. Production costs would be increased considerably in processing the lower sugar-content sap.

These low sugar concentrations in fall-produced sap are thought to be related to carbohydrate transformations within the tree. Starch accumulates in most woody plants throughout the summer and reaches a maximum in early autumn (*Kramer and Kozlowski 1960*). With the beginning of winter this starch content begins to decrease with a concurrent increase in sugar, most often in the form of sucrose. In general, this starch transformation process is associated with and accelerated by decreases in temperature. Kramer and Kozlowski indicate this is rather unusual because "one would expect chemical reactions to be slowed down by tempera-

tures near freezing." They conclude that perhaps some inhibitor of enzyme action is present at high temperatures which disappears during a period of low temperature. Thus, sugar in the tree should build up in the spring after the cold winter temperatures; and this spring buildup could account for the higher spring sap-sugar concentrations.

Effect of Fall Tapping of Spring Sap Yields

Spring yields for trees tapped in the fall and those not tapped in the fall differed considerably. The two spring volume yields, 5.54 and 8.07 gallons (table 1), were significantly different at the 5-percent level. But the sugar concentration in the sap during spring flows was approximately the same for those trees tapped both in the fall and spring and those tapped only in the spring.

We do not know what factors are responsible for these spring volume differences. One possibility is that the potentials for sap production were not equal for both groups of trees because the fall-tapped trees had reamed tapholes in the spring but the spring-tapped trees had newly constructed tapholes. Some dead or desiccated tissue may have remained in the fall tapholes even after reaming, and this might have reduced yields from these tapholes. A recent Canadian investigation (*Morgan Arboretum 1965*) indicated that reaming was not a satisfactory substitute for new tapholes if maximum sap yields were to be obtained.

However, the method of re-tapping was eliminated as a possible cause of spring yield differences when we used a different method of re-tapping in 1965-66. Instead of reaming existing holes, we drilled new holes in these trees. With this method of re-tapping, trees that had been tapped in the fall still produced significantly less (1-percent level) sap than trees not tapped in the fall (table 1). Non-significant differences were found in average sap-sugar concentrations for these trees.

These results suggest that fall tapping has a detrimental effect on spring yields. Comparisons of the fall plus spring yields of trees tapped in the fall with the yields of trees tapped only in the spring also reveal that *total* yields are essentially equal (table 1).

For example, in 1964-65 the combined fall and spring yield of 7.99 gallons is very close to the 8.07 gallons yield of trees tapped only in the spring. Similar figures for 1965-66 are 10.45 and 11.96 for the group with reamed tapholes and 23.30 and 25.15 for the group with new tapholes.

Most of the reduction in spring yield from fall-tapped trees occurs in late spring:

	Sap yield	
	Early spring '66 (gallons)	*Late spring '66 (gallons)*
Fall-tapped trees	10.34	6.70
Trees not fall-tapped	11.78	13.37

Thus, apparently fall-tapped trees simply run out of material sooner than trees that have not been fall-tapped. And the fact that the amount of the late spring reduction is essentially equal to the yield obtained in the fall suggests that each tree has a fixed potential that is not much affected by the timing of the sap removal.

Possibly the amount of carbohydrate (sugar) available for sap is fixed within a tree; reduction of this substrate below a certain level may trigger physical or chemical changes within the tree that stop sap flow even though moisture is available and weather conditions are favorable. Additional research on the mechanisms of sap production, storage, and flow will be required to explain adequately the reduction in spring sap yield of trees also tapped the previous fall.

However, regardless of the physiological reasons for these results, we do not feel we can recommend fall tapping. It provides no increase in total sap production and reduces the amount of sugar obtained from each tree.

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