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SUGAR-WATER DENSITIES IN SUGAR-MAPLE TREES (*ACER SACCHARUM*) AT THE RAYSTOWN FIELD STATION

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ABSTRACT

The purpose of this study was to examine whether the sugar concentration of sugar-maple trees (*Acer saccharum*) at the Raystown Field Station (Entriken, PA) is related to tree diameter, crown height, crown width, or number of maple-syrup taps per tree. Of these factors, we found that only tree diameter was significantly positively correlated with sugar concentration (P =0.009 on the first day of testing; P = 0.002 on the second day; P = 0.002 for both days). These findings may help syrup makers choose better quality trees from which to collect sugar water.

INTRODUCTION

Each spring, Juniata students and faculty visit Raystown Field Station (designated as Station #1 in our report) to gather and harvest sugar water, which is processed into maple syrup. Tapped maple trees (*Acer saccharum*) are assumed to contain an average sugar-water density of ~2.0 percent, but there are some significant variations from this average. Higher sugar-water concentrations yield high quality syrup with less boiling. Currently, maple trees are randomly chosen for tapping, because the factors affecting concentrations of sugar water are unknown. Therefore, the purpose of this study was to determine whether easily observed external properties of a tree are indicative of sugar-water concentrations. We hypothesized that tree size and degree of tapping would have significant impacts upon sugar-water concentration. This hypothesis was worth testing because, if proven, then larger trees could be chosen for tapping. This method of selection could save syrup makers time and energy, and may result in a higher quality product.

FIELD SITE

Station #1 at the Raystown Field Station is surrounded by woods containing sugar-maple trees tapped to make syrup. This wooded area lies between the Field Station building and Raystown Lake (labeled 111c in Molesevitch, 1977). The soil of the study area is characterized as fine-loamy, mixed, and mesic in composition (Molesevitch, 1977; Table 1). A small stream runs the length of our testing area, its

mouth emptying into the lake. On the first day of data collection, the weather was cold, cloudy, and there was a slight drizzle. On the second day, the weather was partly cloudy, and cool. We believe that weather has an effect upon sugar concentration, possibly explaining why, on the second day of testing, we were unable to take samples from 10 trees.

METHODS AND MATERIALS

We randomly chose 27 trees for testing, and marked each with surveyor's tape. We used a pipette to take samples of sugar water from taps already in place. We did not take samples from collecting buckets because these may be inaccurate, due to evaporation and dilution with rainwater. A few drops of sugar water were placed onto a refractometer calibrated with deionized water. Sugar-water density was expressed as percent sugar. After each reading, the refractometer was rinsed with deionized water and wiped clean with tissue paper. Since sugar water varies in concentration per sample, an average sugar-water concentration was calculated for each tree based on three samples taken from as many different taps as possible.

Tree diameter estimated using a measuring tape. Three categories of crown height were recognized. A tree had a "low" crown if it was between 0 and 10 feet from the ground, while a "medium" crown was from 11 to 20 feet, and a "high" crown was greater than 20 feet. Crown width was also characterized as "narrow", "medium", or "wide", based upon how far the lowest branches reached out from the tree trunk. Lastly, the number of taps per tree were recorded.

The mean sugar-water concentration for each tree on a single sampling date was found by adding the three sample concentrations together and then dividing by three. Averages for both sampling dates were calculated as averages of these averages for each tree. Effects of tree size and number of taps per tree on sugar-water density were assessed with regression analysis and one-way analysis of variance, using Minitab software (following Heath, 1995). A P-value of less than .05 was considered significant.

RESULTS

Only tree diameter was significantly correlated with sugar-water density (Table 1; Figs. 1-3). This was true on day 1 ($F = 8.02$, $P = 0.009$, $r^2 = 0.243$), day 2 ($F = 14.27$, $P = 0.002$, $r^2 = 0.488$), and both days combined ($F = 13.85$, $P = 0.002$, $r^2 = 0.480$). Note that fewer trees were sampled on day 2 because sugar water was unavailable in 10 trees. However, sugar water-density was unrelated to crown height (ANOVA: F = 3.33, P = 0.075) or number of taps per tree ($F = 1.16$, $P = 0.299$, $r^2 = 0.072$). Data were not sufficient to determine whether there was a relationship between sugar-water density and crown width.

Table 1. Relationships of sugar-water concentration (averaged for two sampling days) to maple-tree size and number of taps.

Sugar Concentration Vs. ...	F-value	P-value	R-squared
Height of Crown	3.33	0.075	N/A
Diameter (Both Concentration Days)	13.85	**0.002**	0.480
Width of Crown	N/A	N/A	N/A
Number of Taps	1.16	0.299	0.072

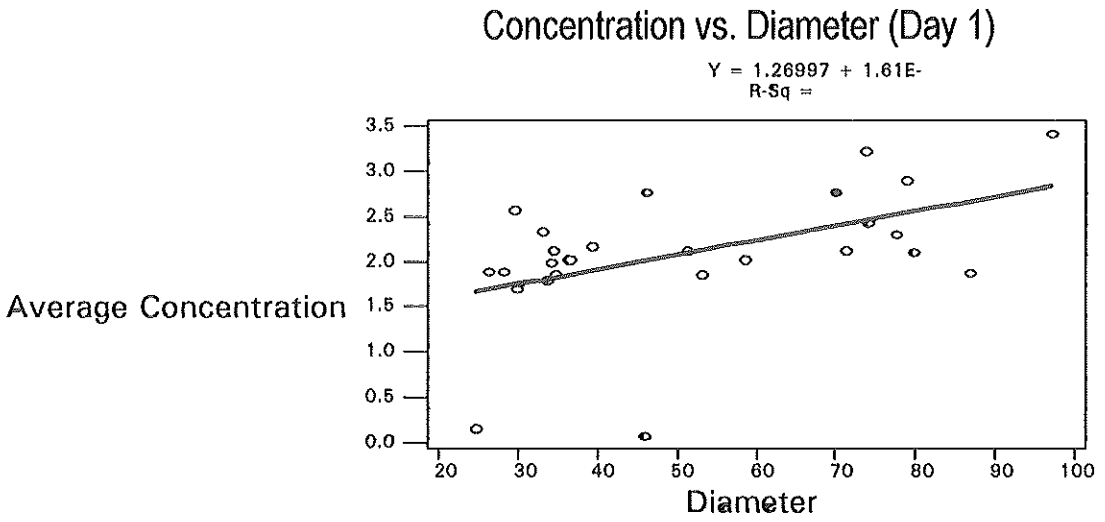

Figure 1. Shows that maple tree diameter(cm) has a significant effect upon sugar-water concentration(%) for day 1.

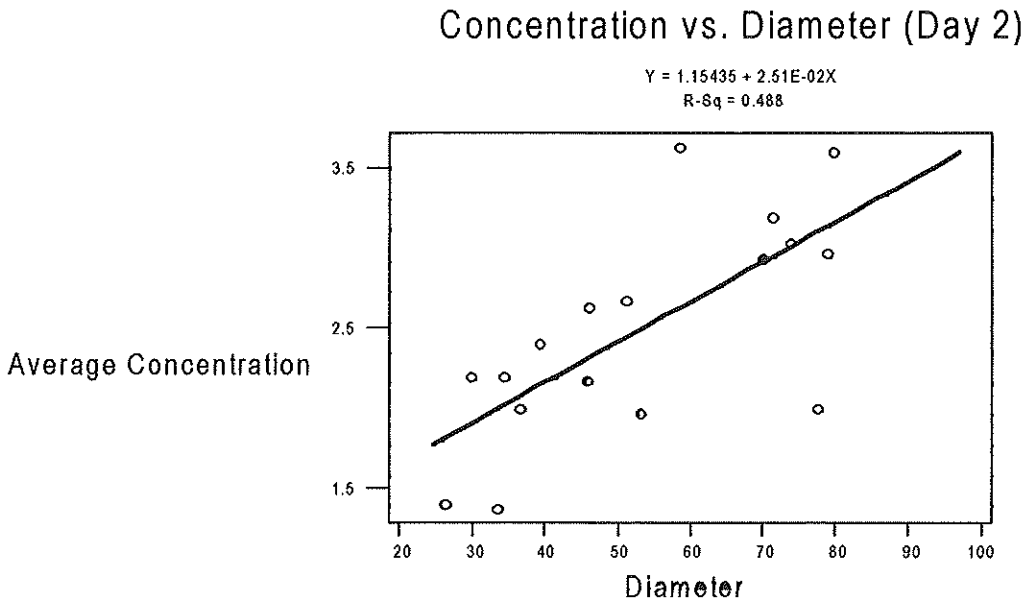

Figure 2. Shows that maple tree diameter(cm) has a significant effect on sugar-water concentration (%) for day 2.

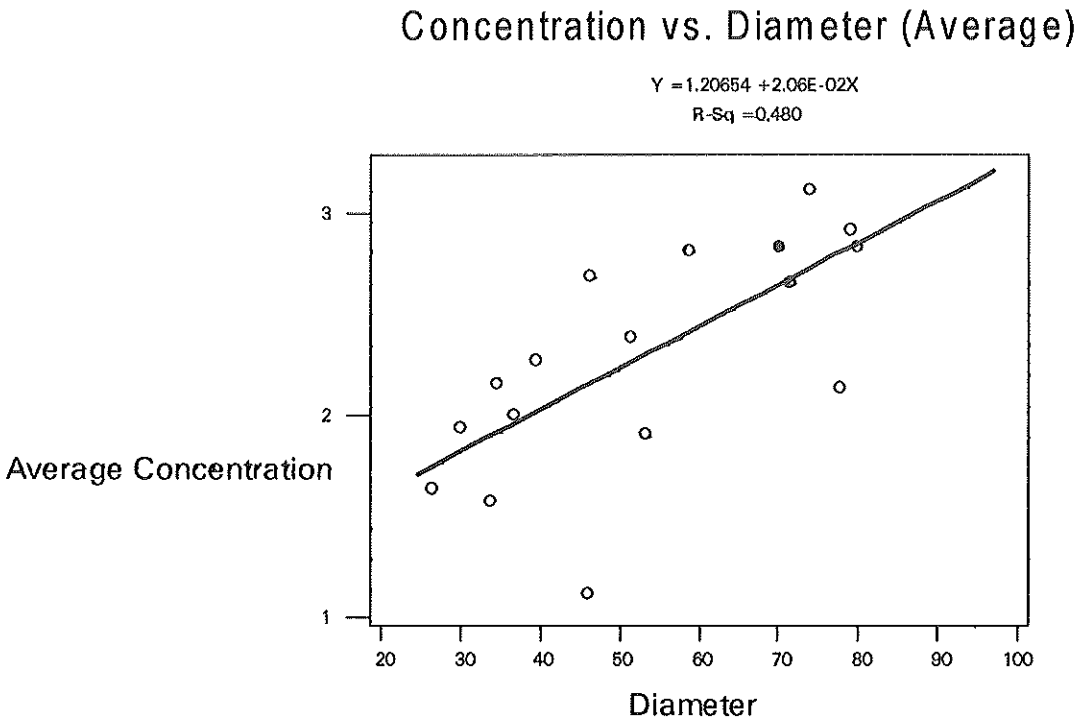

Figure 3. Shows that maple tree diameter (cm) has a significan effect on mean sugar-water concentration (%) for both days combined.

DISCUSSION

Our results showed that only tree diameter was significantly correlated with sugar-water concentration. This was true on both sampling days, singly or in combination. However, the regression for day 2 was more similar to that for both days combined than was the regression for day 1. Perhaps this was because we were unable to take samples from 10 trees on Day 2 because the taps had run dry.

Through this study, future ecology classes will be able to monitor sugar maples found at Raystown Field Station as a long term project. If results of future studies still find a significant correlation between sugar-water concentration and tree diameter, we recommend that only large diameter trees should be selected for tapping, thus ensuring a high quality maple syrup with less boiling.

ACKNOWLEDGMENTS

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LITERATURE CITED

Heath, D. 1995. An introduction to experimental design and statistics for biology. UCL Press, University of Essex, England.

Molesevitch, M. 1977. Soil study of the Raystown Field Station. Independent Study, Biology Department, Juniata College, Huntingdon, Pennsylvania, USA.