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SUGAR-WATER DENSITY IS UNRELATED TO THE SIZE OF SUGAR-MAPLE TREES (*ACER SACCHARUM*) AT THE RAYSTOWN FIELD STATION

Gretchen Booker, Susan Topping, Dana Hornyak and Bruce Ketrick

ABSTRACT

We found no correlation between sugar-water density and the size or condition of sugar-maple trees (*Acer saccharum*) at the Raystown Field Station (Entriken, PA). Sugar-water density was unrelated to tree height, basal diameter, crown size, crown condition, and biomass volume. We conclude that tree size and condition cannot be used to predict sugar-water density in maple trees. Other factors may be more important.

INTRODUCTION

The purpose of this study was to determine whether the sugar-water density of sugar maple trees (*Acer saccharum*) at the Raystown Field Station (Entriken, PA) is related to tree size or condition. Our null hypothesis was that maple trees have the same sugar density, regardless of their size or condition. Our working hypothesis is that should be a positive correlation between the sugar-water density of maple trees and the condition and overall size, including height and basal diameter, of the trees. If such a correlation exist, it enable a more efficient means of sugar collection. During maple sugaring season one could determine by the size and condition (both generally visible qualities) of the trees which are the most productive. Thus, one could more efficiently collect the most concentrated sugar water instead of wasting energy and time tapping less productive trees.

FIELD SITE

The Raystown Field Station is located in the Ridge Valley region of Pennsylvania. It includes a 365-acre woodland dominated by sugar maples. Historically oaks have dominated the ridge tops while hemlock and other moisture-seeking vegetation has flourished in the valleys. There are also a few red maple and locust trees in the lowlands. In 1925 the largest sugar maples at the Raystown Field Station were tapped for the first time. In the 1940's the land underwent succession from rye pasture to maple forest. For this study we sampled twenty-five maple trees in a valley between the Field Station building and Raystown Lake.

METHODS AND MATERIALS

To test our hypothesis it was important to keep constant several variables that might have an effect on sugar-water density. These included soil type, drainage, elevation, and temperature. In order to do this we used a topographical map of the Raystown Field Station to find a sampling site where these variables were nearly constant. We chose to sample in a sugar-maple grove located along a stream running between the Field Station building and Juniata Bay. All data were also collected under approximately the same temperature conditions.

Data were collected on March, 24, 1998, a warm (75° F), sunny day following a period of cooler days. Tapped trees were chosen randomly. To do this we first set up a grid on the map and then used a random numbers table to determine the areas to be tested. Twenty-five trees were tested from these areas, making up our sample group.

Physical data such as basal diameter, height, crown condition, and crown size and shape were recorded for every tree in our sample. A flexible tape-measure was used to measure tree diameter at waist height. Tree height was measured using an inclinometer used by surveyors to determine heights of buildings using simple geometric principles. We measured the angle from our eye to the height of the tree when standing 25 meters from the tree. The height (m) of the tree was calculated as

25(tangent of the angle) + height of person taking measurement.

Condition was categorized as follows. Excellent trees were those which were the healthiest, i.e., those which had no broken or dead limbs. Good trees were those with few broken or dead limbs. Fair trees were those with many broken and dead limbs. And trees were classified as poor if a majority of the limbs were dead, and they had many damaged limbs.

Crown size was categorized as tight, loose, narrow or wide. We observed this because not only was it a measure of tree size, but also it was a measure of how much light each tree received. We were interested in knowing whether differing crown sizes and shapes influenced sugar-water concentration possibly because of their effects on light penetration and photosynthesis.

A refractometer was used to estimate sugar-water in the field. Three readings were made for each tree, and the average was used when making calculations. Much care had to be taken to minimize error. Sugar-water samples were taken using a dropper directly from the tap. We decided to take our samples directly from the taps rather than from the buckets because we thought that this method would give us more accurate readings of sugar-water density, the density of the sugar water actually coming from a tree. Sugar density of the water in the buckets could have been altered by evaporation.

Using a pipette, drops of sugar water were placed directly on the refractometer and spread out to cover the entire reading area. The guard was than placed on top of the sample and measurements were taken and recorded. To avoid contamination from one sample to the next both the refractometer, and pipette were thoroughly rinsed with distilled water, and dried after each sample was read.

RESULTS

Tree height and basal area were significantly correlated (Fig. 1). Therefore, we were able to use both factors together to calculate biomass volume. Sugar water density was unrelated to tree height, basal diameter and biomass volume (Figs. 2-4). Biomass volume was an index of overall tree size and condition, combining measurements of basal diameter, crown size, crown condition, and height. It was calculated as

$$2\pi rh + C,$$

where r is tree radius, h is tree height, and C is a measure of crown size (calculated by adding the ranks of crown size, 1-4, to the ranks for crown condition, 1-3).

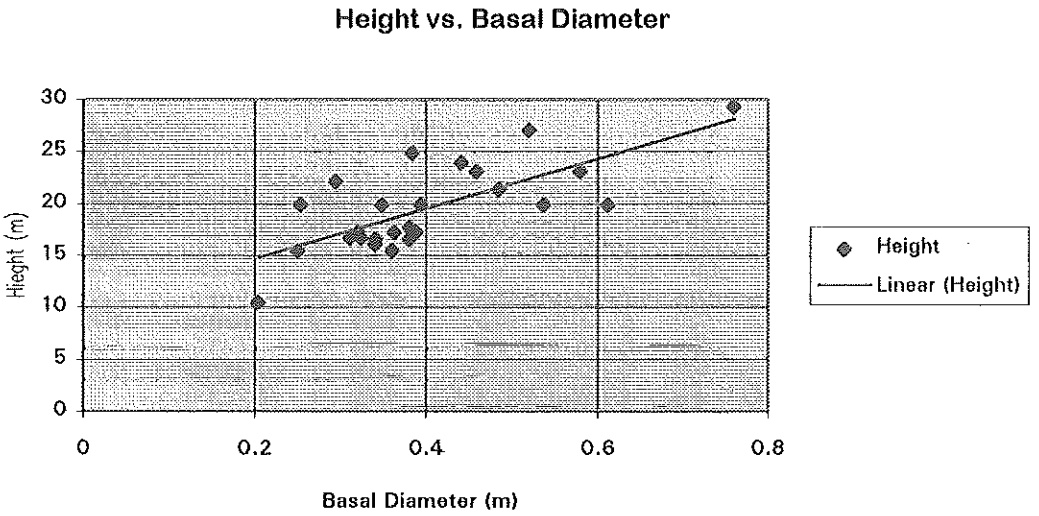

Figure 1. Correlation between height and basal diameter in sugar maples ($P < 0.01$).

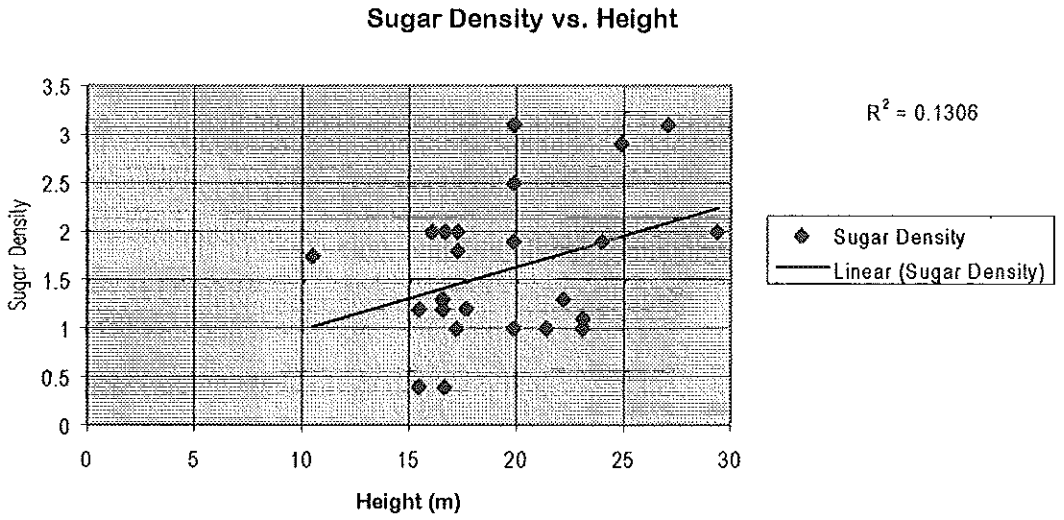

Figure 2. Sugar water density (%) vs. height of sugar maples. The correlation is not significant ($P > 0.05$).

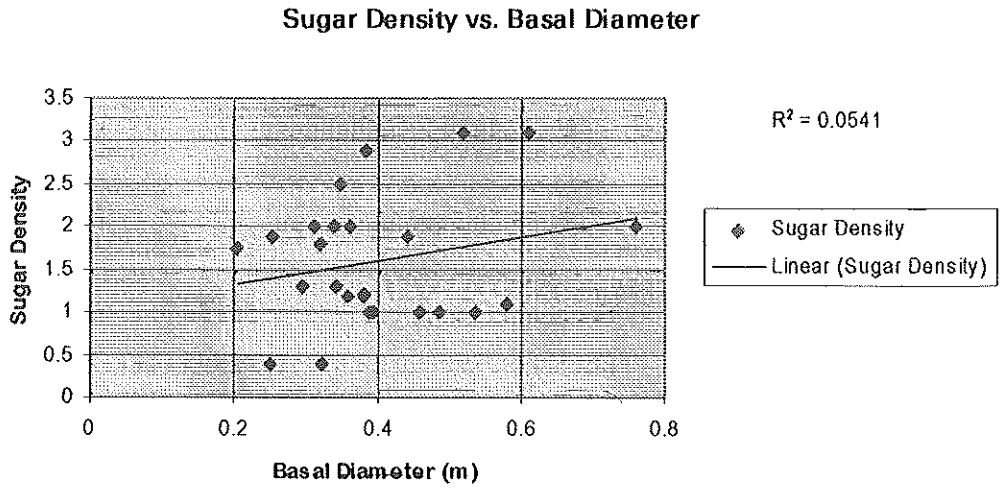

Figure 3. Sugar water density (%) vs. basal diameter of sugar maples. The correlation is not significant (P > 0.05).

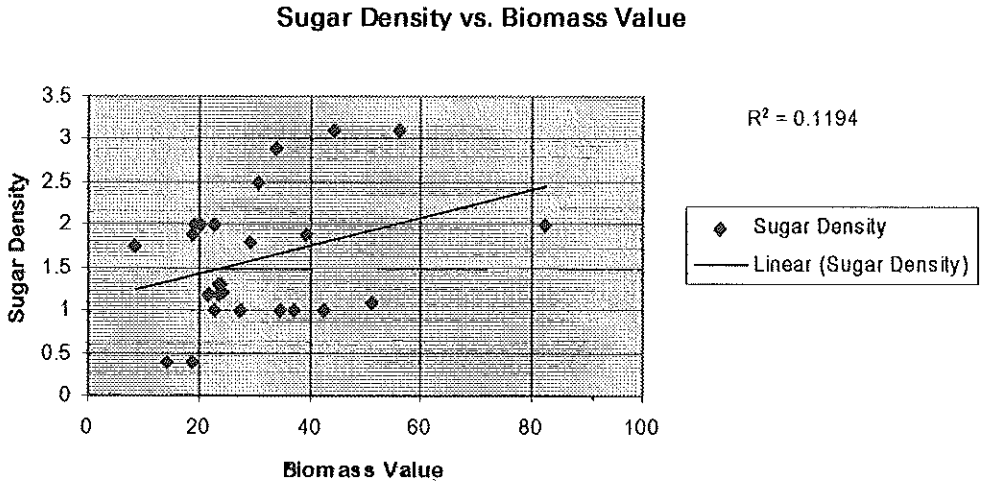

Figure 3. Sugar water density (%) vs. biomass volumr of sugar maples. The correlation is not significant (P > 0.05).

DISCUSSION

We have found that sugar-water density is not significantly related to the size of maple trees, as estimated by tree height, diameter, and biomass volume. Thus we feel that tree size cannot be used as a reliable predictor of sugar-water concentration. However, other factors may be important in causing variation in sugar-water density, including weather, time of the year, and soil conditions. Future work should consider these factors and also expnad the sampling to include other sugar maple groves. .

Nearing and Nearing (1970) have found that many of the conditions listed above for further research do have an effect on sugar density. The moisture, drainage, and presence of plenty of organic matter in the forest floor were found to importantly influence sap production. Also considered are the

extremes of day and night temperatures in the mountains, along with exposure to the proper points of the compass: in a cold country, to the south and west, and in a warm country to the north and east. Nearing and Nearing (1970) state that, "The only test we know thus far is a purely pragmatic one. Go over a wooded area, observe where hard maple grows abundantly, and accept nature's verdict as to sugar bush availability." (p. 75). Following their advice, the only pragmatic way to find maple trees to tap that have the greatest sugar-water density is to look for a wooded area that is abundant with maple trees.

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