AN INVESTIGATION OF SOME FACTORS THAT MAY INFLUENCE THE DEVELOPMENT OF FALL FOLIAGE COLOR IN SUGAR MAPLE

Abby K. van den Berg

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Abstract

Fall foliage development is an important part of Vermont's economy and [redacted] of fall color. In this exploratory study, leaf tissue from ten sugar maples was [redacted] collected periodically during the period of September 4 through October 8, 1998 [redacted]

months (Kozlowski and Pallardy 1997). As chlorophyll breaks down, the yellow [redacted]

the entire growing season, as they aid chlorophyll in light absorption for [redacted] formation of anthocyanin pigments but [illegible]

[illegible]

support this claim. Anecdotal information provided on a Vermont tourism website (www.vtweb.com) also suggests that "trees that begin to turn very early are usually diseased or stressed... ". This site did not provide any information to

[illegible]

Kozlowski and Pallardy (1997), suggest that fall foliage development is related to the ratio of soluble to insoluble carbohydrates, but provide no quantitative data to support this. Dr. C.R. Bell (www.ncnatural.com/fall-color/bell.html) asserts that, since anthocyanins are byproducts of carbohydrates, the amount of red color observed is dependent on the amount of carbohydrates left in the leaf when the abscission layer develops just before senescence. Another website (www.waterw.com/~science/october.html) suggests that excess glucose in the leaf is turned to red pigments when photosynthesis ceases. This same assertion was also presented in an article by Klein in the Stowe, Vermont Reporter (1971).

Environmental Conditions

Several sources cite specific environmental conditions necessary for the development of brilliant fall color. These conditions seem to be most related to the belief that excess carbohydrates are necessary for anthocyanin development color development, studies have indicated a role of metals in the nature of

anthocyanin content produced different colors. Harborne (1963) showed that metal chelation to anthocyanins, especially by iron and aluminum, changed the observed color in flowers. Harborne (1963) also showed that copigmentation, especially with flavones, flavonols, and flavans, changed the absorption spectra of the anthocyanins, resulting in a bluer shade of flower color.

the Vermont Department of Forests, Parks, and Recreation. The remaining five were on sites at the edge of the forest and have no longterm records. Each tree was between 50 and 90 feet tall. Beginning September 4, 1998, samples were collected weekly. Three leaves were collected from a single branch selected from each cardinal direction in the lower crown of each tree. Branch samples were obtained using a shotgun loaded with steel shot. At the time of collection, each

leaf was rinsed with distilled water to remove particulate matter. One leaf was retained for moisture analysis (these leaves were blotted dry to avoid affecting the moisture analysis). Tissue was removed with a hole-punch from the [illegible]

Data from the following three sampling dates were examined: the first, middle, and last week (September 4, 25, and October 9) of the study. Data were blocked [illegible]

performed between each parameter and color data to determine if moisture, nutrient and/or carbohydrate concentrations were correlated with the amount of leaf color. The acceptable level of significance was considered 0.05.

RESULTS AND DISCUSSION

Leaves of forest grown trees were generally much greener than open grown trees. No red pigment was detected in any forest-grown samples over the entire study period. In contrast, many samples from open-grown trees were very physiologically advanced, close to senescence, and exhibited large amounts of red fall coloration.

Statistical tests were performed to see if correlations existed within each location, Forest Grown

Green	Yellow	Red

Although these statistical relationships are strong, it seems that nothing can be deduced from them as data were not gathered during a full growing season. [illegible]

[illegible] coloration. As nitrogen is an important constituent of the chlorophyll molecule and not of the carotenoid or anthocyanin pigments, it seems intuitive that trees with greener leaves would contain more chlorophyll and thus more nitrogen [illegible]

In both open- and forest-grown trees, the amount of aluminum was negatively correlated with the amount of green. In contrast, aluminum concentrations were positively correlated with the amount of red in leaves of open-grown trees and the amount of yellow in leaves of forest-grown trees (Table 1). This relationship supports the hypothesis outlined earlier that larger amounts of aluminum would

be associated with more reds, oranges, and yellows due to the requirement of

Other interesting observations were made with some parameters. These parameters did not show statistically significant relationships with the amount of leaf color. Instead, they showed interesting patterns when examined as mean levels of that parameter over time and between locations. [redacted]

While levels of manganese increased over time in leaves of trees from both [redacted]

Manganese is an important activator of many plant enzymes (Salisbury and Ross 1997). Levels were consistently higher in open-grown trees, and a

consistent increase over time was observed in leaves of trees from both locations. However, no explanation for these observations can be deduced at

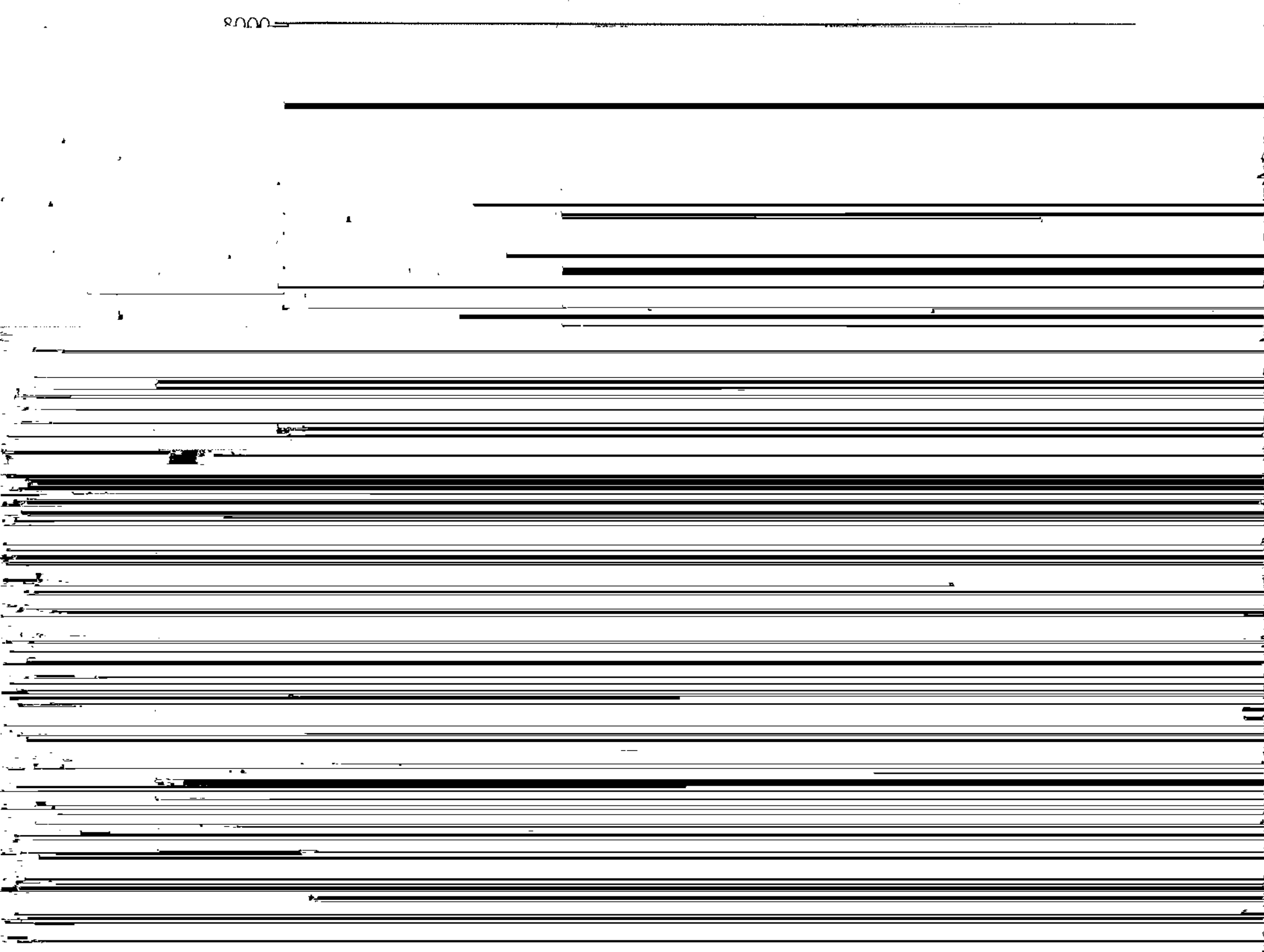
Calcium

Mean calcium levels increased with time in leaves of trees from both locations (Figure 2) and were consistently higher in open grown trees.

Most of calcium's functions, such as cell wall structure, would lead one to think the opposite: more physiologically active tissue should contain more calcium. This was not observed. In addition, calcium was only positively correlated with the amount of yellow in forest-grown trees (Table 1). The reasons for these findings are unknown.

Potassium

Mean levels of potassium were consistently lower in leaves of open grown trees than in leaves of forest grown trees (Figure 3).



In addition, levels decreased over time in leaves of trees from both locations. An explanation for these observations is unavailable using these data. These [redacted]

Definitive relationships between parameters and differential development of fall color are difficult to state using these data. Although interesting relationships [redacted]

ACKNOWLEDGEMENTS

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[redacted]

LITERATURE CITED

Harborne, J.B. 1965. In "Chemistry and Biochemistry of Plant Pigments" (T.W. Goodwin, ed.), pp. 247-277. Academic Press, London.

[illegible]

Forest Grown

	Green	Yellow	Red