A NOTE ON SAP pH IN EASTERN REDCEDAR (*JUNIPERUS VIRGINIANA* L.)[1]

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ABSTRACT

Twelve eastern redcedar (*Juniperus virginiana* L.) trees were sampled for the sap pH of the sapwood at three locations along the bole and one location on the roots. Soil pH measurements were taken at each tree site for comparison with sap pH. Sap pH was positively correlated with soil pH. A regression model using mean soil pH as the independent variable accounted for 71% of the variation of the mean sap pH. There was a decreasing gradient in sap pH from crown to stump.

Keywords: Eastern redcedar, *Juniperus virginiana* L., sap, pH, soil.

INTRODUCTION

Sap and soil pHs are measurable factors that have bearing on many aspects of tree physiology, species distribution, and growth. Of considerable interest to researchers involved in making environmental inferences from radial element concentrations (Bondietti et al. 1989) is the role of sap pH in the radial distribution of elements in the tree bole. Solubility reactions and the exchange reactions within the wood are a function of sap pH and may influence the movement of elements within the wood. The range of many species of trees is dependent on soil pH (Fletcher and McDermott 1957). Air pollution is know to affect wood properties, such as density (Pozgaj and Kurjatko 1986), which are related to heartwood formation.

Fengel and Schulz (1986) found that sap is more acid than normal in trees dying from the effects of air pollution and acid deposition. These authors are sparing in their description of the actual method of pH measurement. The purpose of the research reported in this note is to describe some of the within tree variation in sap pH and some of the variation between eastern redcedar (*Juniperus virginiana* L.) trees on sites with different soil pHs.

METHODS

Twelve trees of eastern redcedar were sampled from sites in the University of Missouri–Columbia's Ashland Wildlife Research Area to give a wide range of soil pH. The trees ranged in age from 20 to 60 years. The pH of the sap was measured at three places on the bole: at the middle of the crown, at the base of the crown, and at stump height (1 foot). [For Trees 7 and 8, the live crown extended to the base of the tree and the stump samples were the crown base samples.] Root samples were taken from large (>2 cm) roots within one meter of the tree. Sapwood cubes approximately 2.5 cm square were cut from the cross-sections and trimmed to

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TABLE 1. *Geologic site information.*

Tree no.	Slope	Aspect	Parent material	Soil type	Soil depth
1	2%	south	limestone	silt loam	1–2 m
2	2%	south	limestone	silt loam	1–2 m
3	10%	east	limestone	cherty clay	3–7 m
4	10%	east	limestone	cherty clay	3–7 m
5	10%	east	limestone	cherty clay	3–7 m
6	10%	east	limestone	cherty clay	3–7 m
7	20%	east	sandstone	sandy loam	0.1–0.3 m
8	20%	east	sandstone	sandy loam	0.1–0.3 m
9	15%	west	limestone	cherty silt loam	0–1 m
10	10%	west	limestone	cherty silt loam	1–3 m
11	25%	west	sandstone	sandy loam	0–1 m
12	25%	west	sandstone	sandy loam	0–1 m

remove the cambium and phloem layers. The cubes were squeezed in the tangential direction with a portable vise to express the sap. The sap was collected in clean 30 cc plastic containers. Care was taken to keep the sample clean and free of soil particles in order to obtain a pure sample of expressed sap. The full radial extent of the sapwood was always sampled.

When approximately 10 cc of sap was obtained, the pH was determined using a battery-operated pH meter (Cole-Parmer Model 5985-80).[2] The sap was immediately stirred with the pH electrode until the lowest possible pH reading was reached. This reading, always taken within the first minute, was then recorded. Delay of measurement by 15 minutes caused an increase in pH of from 0.2 to 0.4 units, which may not be representative of the sap as it exists in the tree. This change is surmised to be the result of dissolved CO_2 degassing from the sap.

Soil was sampled from three different horizons at each tree site for the determination of soil pH. Composite samples of the organic horizon (O), the eluvial horizon (A), and the illuvial horizon (B) were taken at each site. The soil was sifted through a 10-mesh screen, and then 10 g of the soil was mixed with 10 ml of 0.01 M $CaCl_2$. Calcium chloride reduces extraneous junction potential and suspension effects (Bohn et al., 1985). After 30 minutes had elapsed and the sample had been mixed twice for 10 minutes, the pH of each sample was measured and recorded for each site.

RESULTS AND DISCUSSION

Site information is given in Table 1, while pH data are shown in Table 2. It is interesting to note that there is more variability in the soil pH than in the tree sap pH. Whereas the soil pH ranged from 4.00 to 7.05, the pH of the sap was from 5.28 to 6.83. This indicates that the trees are either (1) altering the soil solution acidity in the rhizosphere, the zone of soil influenced by the roots, before the solution enters the root, or (2) buffering the solution after it enters the root and becomes sap.

[2] Mention of specific trade names does not constitute an endorsement by the University of Missouri–Columbia.

TABLE 2. *Tree and soil pH data.*

Tree no.	Height (ft)	Sample height: Crown (ft)	Sample height: Base (ft)	Sample pH: Crown	Sample pH: Base	Sample pH: Stump	Sample pH: Root	Soil horizon pH: O	Soil horizon pH: A	Soil horizon pH: B
1	30	25	12	6.83	6.69	6.38	6.29	7.05	6.87	*
2	23	20	12	6.79	6.56	6.45	6.36	7.04	6.31	*
3	27	19	11	6.09	5.89	5.69	5.63	6.49	4.17	4.48
4	26	18	11	5.90	5.81	5.86	**	6.49	4.17	4.48
5	26	14	8	5.67	5.57	5.64	5.55	6.39	4.76	4.48
6	27	14	9	5.75	6.02	5.83	5.58	6.93	4.76	4.48
7	18	7	#	6.01	#	5.85	6.03	4.00	*	5.30
8	26	13	#	6.35	#	6.17	6.14	6.10	5.50	*
9	31	27	14	6.11	5.86	5.69	5.97	6.15	6.51	6.61
10	30	26	14	6.25	5.93	5.66	5.76	5.43	4.92	5.68
11	22	16	8	5.50	5.28	5.31	5.45	5.24	4.13	4.10
12	20	16	8	5.57	5.49	5.47	5.55	4.42	4.17	4.22

* No horizon present.
** Insufficient amount of root sap obtained.
# Base of crown extended to base of tree. In these cases, the stump pH is the base of the crown pH.

In some of the trees growing on the more acid soils, the pH of the crown sap is raised more than one pH unit above that of the soil solution. A fraction of this is due to the measurement of soil pH with calcium chloride. The sapwood, with its complex of soluble sugars, dissolved metallic ions, and other organic and inorganic compounds (Shortle and Bauch 1986) may act to buffer the sap. On the other hand, on some of the less acidic (near pH 7) soils, the sap solution is more acid than the soil solution. This could indicate an acidification of the rhizosphere for nutrient intake.

There was an increasing pH gradient from stump to crown for all but one of the trees sampled. This appears to be a function of position in the tree and not soil pH. There was segregation of stem pH according to parent soil material. Root sap pH was not consistently either more or less acid than stump sap pH. The stem pH gradient is probably dependent on many factors such as tree height, evapotranspiration rates, soil moisture conditions, soil pH, the pH of the wood, time of day and season of year. In our study, all sampling was done before the growing season. Taller tree heights may allow for greater buffering action by the wood. The moisture content of the individual soil horizons (often with very different soil pHs) determines much of where the moisture uptake of the tree is taking place and thereby may change the effective root environment, the rhizosphere, and sap pH.

The variability of sap pH between trees was correlated with the pH of the soil horizons. The highest correlations between sap pH and soil pH were with the middle of the crown and illuvial (B) soil horizon. The correlation coefficients for this horizon pH (B) were 0.80 with the crown sap pH, 0.77 with the bole sap pH, and 0.89 with the stump sap pH. These correlations were all statistically significant at the $P \geq 0.01$ level. A simple linear regression equation (Eq. 1) between mean sap pH (mean of the sap pH values measured for each tree) and mean soil pH (mean soil pH of the horizons measured) had a coefficient of explained variance (r^2) of 0.71, significant at the $P \geq 0.01$ level.

$$\text{Mean sap pH} = 3.9984 + (0.3535 * \text{Mean soil pH}) \quad (1)$$

CONCLUSIONS

Based on the data obtained in this study, the following points can be made:

1. There is an increasing gradient in pH from the tree base to the crown.
2. No pH gradient was established between root sap and stem sap.
3. Sap pH of roots and stems are correlated with the pH of the soil solution.
4. Sap pH in redcedar may be predicted from the soil pH of the site.

The measurement of sap pH may be a significant tool in examining the effects of soil pH on trees. It may have uses in studying wood formation, the effects of acid precipitation, growth stresses, and ecological distribution.

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