OAK BOLE-WOOD CHEMISTRY RESPONSE TO FERTILIZATION AT TWO OZARK SITES

David R. DeWalle, William E. Sharpe, and Bryan R. Swistock[1]

INTRODUCTION

Bole-wood chemistry can be a useful indicator of the nutrient status of trees. Liming generally increases Ca and/or Mg and decreases Mn concentrations in bole-wood. Acidifying treatments, such as ammonium sulfate or nitrogen fertilizers without lime, generally cause Mn increases and concomitant decreases in Ca and Mg. Bole-wood concentration ratios of Ca/Mn have been found to be good indicators of soil alkalinization or acidification trends (DeWalle and others 1999). Whether the timing of past chemical changes in soil is accurately preserved in tree rings remains uncertain. In this study we had an opportunity to study bole-wood chemistry in *Quercus* spp. two decades after an acidifying N-only (AR site) and NPK+liming (MO site) treatment.

METHODS

Multiple wood cores were removed at breast height from ten trees on control and treated plots at each site in 1995. At the Arkansas site, 336 kg N/ha had been added as ammonium nitrate fertilizer to *Q. rubra* trees in 1977-78. At the Missouri site, NPK+lime (1345 kg N/ha as urea) had been added to *Q. velutina* trees in 1973. Destructive chemical analysis (ICP) was performed on composite wood samples for tree core segments formed before and after treatment. Significant growth responses to fertilization were previously reported at each site (AR-Graney and Murphy 1993, MO-Harris and others 1980).

RESULTS

Arkansas

At the AR site, fertilization only caused a significant reduction in Ca concentrations in bole-wood formed in the 5-yr segment after treatment. No other significant changes in Ca and Mn concentrations and Ca/Mn ratios were detected. Regardless, Ca/Mn ratios in red oak appeared to be reduced by treatment in bole-wood formed 5-yr after and up to 20 years prior to treatment (fig. 1).

Missouri

At the MO site, significant decreases in Mn concentrations and increases in Ca/Mn ratios (fig. 2) occurred in nearly all segments of bole-wood of black oak due to treatment. Ca/Mn ratios were increased in bole-wood formed up to 20 years prior to and up to 20 years after fertilization. Ca concentrations were not significantly affected, but appeared to be increased by treatment.

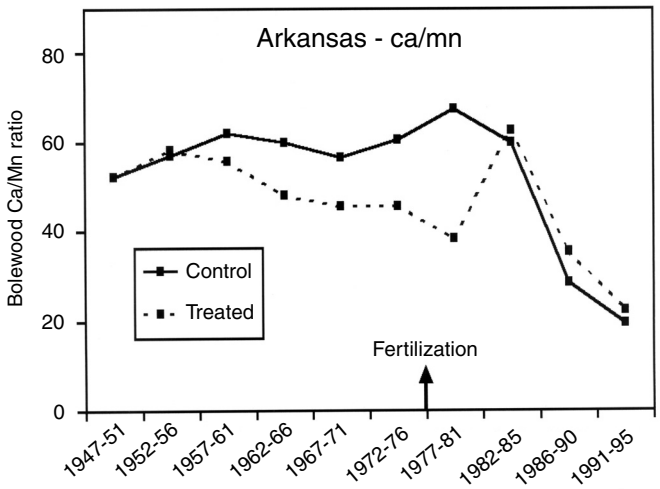

Figure 1—Molar Ca/Mn concentration ratios in bole-wood of red oak in 1995 at an AR site that had been fertilized with ammonium nitrate in 1977-78.

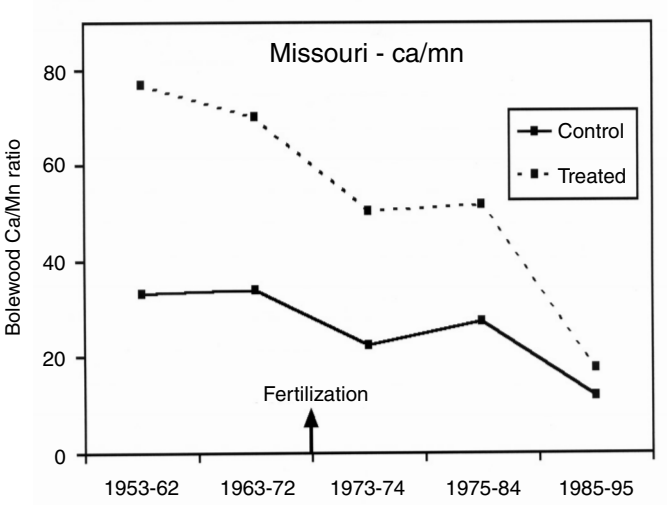

Figure 2—Molar Ca/Mn concentration ratios in bole-wood of black oak in 1995 at a MO site that had been fertilized with NPK+lime in 1973.

[1] Professors of Forest Hydrology and Extension Associate, School of Forest Resources and Penn State Institutes of the Environment, Penn State University, University Park, PA 16801, respectively.

Citation for proceedings: Spetich, Martin A., ed. 2004. Upland oak ecology symposium: history, current conditions, and sustainability. Gen. Tech. Rep. SRS–73. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 311 p.

CONCLUSIONS

Nitrogen fertilization without liming in AR caused slight, short-lived soil acidification that could be detected in bole-wood of red oak trees 20 years after treatment. In contrast, urea N-fertilization with lime in MO had a long-lasting effect on bole-wood chemistry of black oak. Bole-wood chemistry changes were evident in a wide band of wood formed prior to treatment, limiting the usefulness of dendrochemistry to precisely chronicle soil changes.

LITERATURE CITED

DeWalle, D.R.; Tepp, J.S.; Swistock, B.R. [and others]. 1999. Tree-ring cation response to experimental watershed acidification in West Virginia and Maine. J. Environ. Qual. 28(1): 299-309.

DeWalle, D.R.; Tepp, J.S.; Swistock, B.R. [and others]. [In press]. Dendrochemical response to soil fertilization. In: Spetich, M.A., ed. Upland oak ecology symposium: history, current conditions, and sustainability. Gen. Tech. Rep. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station.

Graney, D.L.; Murphy, P.A. 1993. Growth response of upland oak stands in the Boston Mountains to nitrogen fertilization. Proc. 7th Biennial Southern Silvicultural Conf., pp. 485-495, USDA, Gen. Tech. Rep. SO-93.

Harris, A.R.; Urie, D.H.; McQuilkin, R.A.; Sander. I.L. 1980. Water quality implications of forest fertilization in the Missouri Ozarks. Proc., Central Hardwood Forest Conf. III, U. Mo., Columbia, Sept. 16-17, 1980, pp. 21-37.