NUTRIENT UPTAKE BY TUPELO GUM AND BALD CYPRESS FROM SATURATED OR UNSATURATED SOIL

by RICHARD E. DICKSON, T. C. BROYER, and C. M. JOHNSON

Department of Soils and Plant Nutrition, University of California, Berkeley

SUMMARY

Seedlings of tupelo gum (*Nyssa aquatica* L.) and bald cypress (*Taxodium distichum* L. Rich.) were grown in pots containing a sphagnum moss-peat soil mix. Plants approximately 20 to 25 cm tall were subjected to three moisture treatments, saturated-aerated, saturated, and unsaturated soil; and three nitrogen fertilization treatments, control (no N added), urea (a reduced N source), and nitrate (an oxidized N source).

Data include dry weights (g/culture) of leaves, stems, and roots; concentrations (percentage of dry weight) and contents (mg/culture) of N, P, K, Ca, and Mg in leaves, stems, and roots. Total dry weight was greater for plants grown in saturated-aerated soil than in either saturated or unsaturated soil. Differences in nutrient absorption and distribution between the plants and among the water treatments were principally the result of growth differences produced by the water treatments. Element contents and often the concentrations of P, K, Ca, or Mg were highest in both species when grown on the saturated-aerated soil and lowest when grown on unsaturated soil. The low levels of N in plants grown on saturated soils were probably the result of denitrification, as shown by the greater content of N in plants grown on soil fertilized with urea as opposed to nitrate. Thus, urea would appear to be a better N source than nitrate for fertilization in swamp forests. Growth of, and nutrient uptake by cypress was restricted less than that of tupelo when the plants were grown on saturated as compared to saturated-aerated soil. Thus, cypress appeared more tolerant than tupelo to the anaerobic root environment found in saturated soil.

INTRODUCTION

Tupelo gum (*Nyssa aquatica* L.) and bald cypress (*Taxodium distichum* L. Rich.) are bottomland tree species which are very tolerant to extended periods of flooding. The locations in which these trees grow may be flooded throughout a year or for a period of several years. Studies have been made on the growth and survival of bottomland tree species under flooded conditions but few
studies have considered the relationships between flooding and nutrient uptake.

Under these flooded conditions, oxygen concentrations in the soil would be relatively low and carbon dioxide conversely high. Labanaukas et al. found that decreasing soil-oxygen supply significantly decreased the concentrations of nutrients in shoots of citrus seedlings. High carbon dioxide concentrations around roots can also limit nutrient uptake.

The nutrient uptake observed when plants are grown in saturated soil will depend on the relative tolerance to anaerobic conditions exhibited by a particular species. In a comparative study of the effect of saturated soil on 14 bottomland hardwoods, tupelo gum, pumpkin ash (Fraxinus profunda Bush.), willow (Salix nigra March.), and cottonwood (Populus deltoides Bartr.) absorbed larger amounts of N, P, K, Ca, and Mg from saturated than from unsaturated soil, while hackberry (Celtis occidentalis L.) and red gum (Liquidambar styraciflua L.) absorbed smaller amounts of these elements from saturated soil. In a similar study of four species, only tupelo exhibited significantly greater uptake of N, P, K, and Ca when grown in saturated soil as compared to soil returned daily to the moisture equivalent. It is apparent from the above studies that tupelo is tolerant to saturated soil and is capable of absorbing adequate amounts of nutrients under these anaerobic conditions. Bald cypress is also tolerant to saturated soil but the effect of flooding on nutrient uptake has not been studied.

The present study was conducted (a) to compare the nutrient uptake of tupelo and cypress when grown in saturated or unsaturated soil, (b) to determine the effect of nitrogen fertilization with urea or nitrate on nutrient uptake, and (c) to determine if growth differences obtained under these water and N treatments could be related to differences in mineral nutrition.

METHODS AND MATERIALS

This greenhouse experiment consisted of three water regimes, three nitrogen treatments, and two tree species arranged in a complete factorial design with five replications. The dependent variables were dry weight of leaves, stems, and roots; concentration; total uptake; and distribution of N, P, K, Ca, and Mg among plant organs of tupelo and cypress. At the end of the experiment, differences among the three independent variables and their interactions