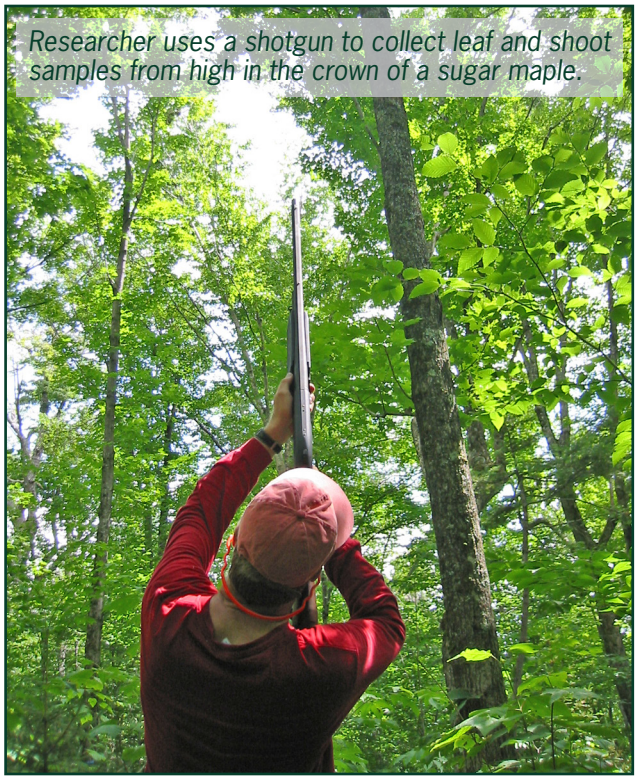
Project Impacts

NSRC-FUNDED RESEARCH FINAL REPORT

Calcium Depletion and Aluminum Toxicity May Contribute to Maple Decline



Researcher uses a shotgun to collect leaf and shoot samples from high in the crown of a sugar maple.

PROJECT AWARD YEAR AND TITLE:

2007

Calcium Depletion and Shoot Freezing Injury as Contributors to Sugar Maple Decline

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Soil acidification caused by acid rain and other human-caused factors can induce soil calcium depletion and increased bio-availability of aluminum. Tree declines associated with calcium depletion and increased aluminum toxicity in forest soils occur throughout the world including the Northern Forest region. Changes in soil calcium and aluminum availability may trigger stress and disruptions in carbohydrate relationships in forest trees.

NSRC researchers measured nutrient levels and antioxidant enzyme activities in leaves, calculated carbohydrate levels in leaves and woody shoots of sugar maple, and analyzed soil enzyme activities at a long-term nutrient addition study in the Hubbard Brook Experimental Forest, New Hampshire. Treated plots received calcium to increase soil concentrations above ambient depleted levels or aluminum to further reduce calcium availability.

Additions of calcium to soil were associated with greater foliar calcium concentrations compared to leaves from maples in untreated and aluminum-addition plots. Soil aluminum additions were associated with lower foliar phosphorus concentrations relative to foliage from maples in calcium-addition plots. Additions of aluminum to soil were associated with greater antioxidant enzyme activities in foliage and lower sugar concentrations in woody shoots relative to trees in calcium-addition and untreated plots. Aluminum accumulations in trees likely induced an oxidative stress that triggered changes in enzyme and carbohydrate physiology. Soil enzyme activity levels were greatest in aluminum-addition soils in fall but were elevated in calcium-addition soils in spring compared with untreated soils. Early indications of response in sugar maple forests (tree and soil communities) to calcium and aluminum manipulation could foreshadow broader ecosystem alterations as disruptions of soil calcium and aluminum continue.

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