Long-term Trends in Soil Calcium and Magnesium Levels in Experimental Mesocosms at the Northern Forest Research Station, South Burlington, Vermont

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Introduction

Amounts of soil Calcium (Ca), Magnesium (Mg) and other cations can have significant effects on forest ecosystem health (1) including:

-Winter injury susceptibility (2)
-Stomatal opening (3)
-Carbon metabolism (3)
-Chlorophyll development (3)
-Enzymatic reactions (3)

The Northern Forest Mesocosm (NFoRM) climate change experiment, initiated in 2013, aims to quantify possible atmospheric warming, decreased snow pack and other climate-induced effects on northern forest ecosystem processes. Long-term Ca and Mg levels may allow researchers to more adequately understand signals that future experimental data may suggest.

Background

Mesocosms present at the Northern Forest Research Station in South Burlington, VT (Fig.1) contain either the "Kullman", a high calcium soil, or "Milton", a low calcium soil. Initial soil samples were taken in 1996 from the bulk soils before they were separated into individual mesocosms. From 1997-2001 each mesocosm was planted with 2 of 4 possible tree species: red pine, white pine, red maple and gray birch (4). Between 2002 and 2013 they were intermittently planted but for the majority of time were weedy or bare. Plantings included red pine, sunflowers and other species. Sampling occurred in 2004 and efforts have resumed as the mesocosms are now being used for the NForM climate change experiment.

Figure 1. Experimental Mesocosms, South Burlington VT. Planted for the NForM climate change experiment.

Results

Figure 2. ICP/AES used for Mg and Ca analysis

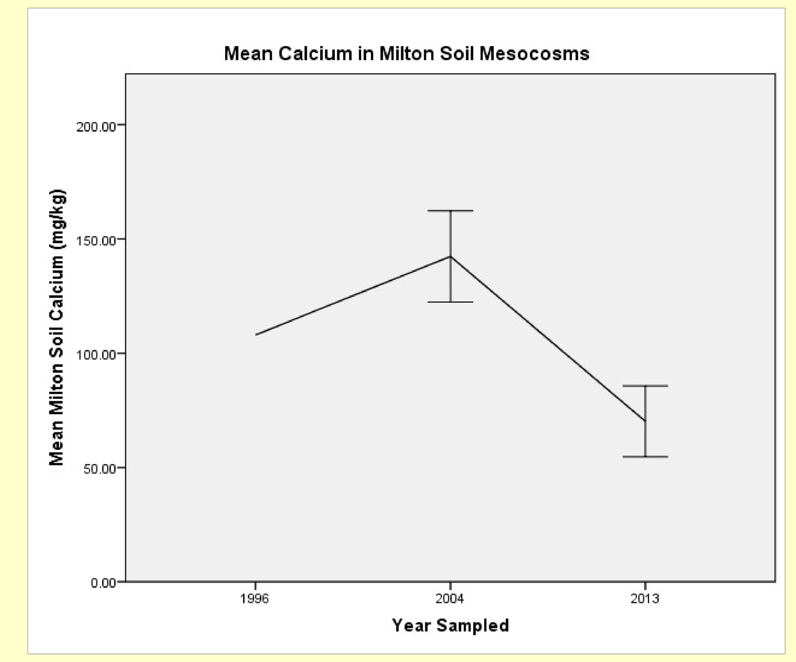

Figure 4. Mean calcium in Milton soils.

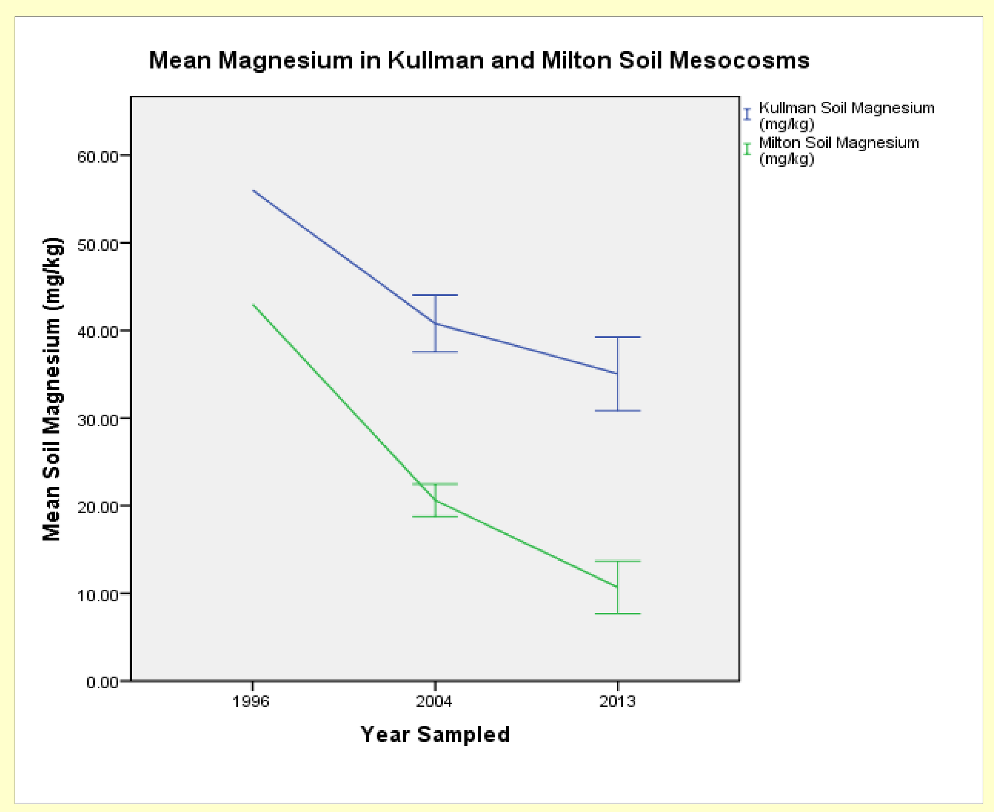

Figure3. Mean magnesium in Kullman and Milton soils.

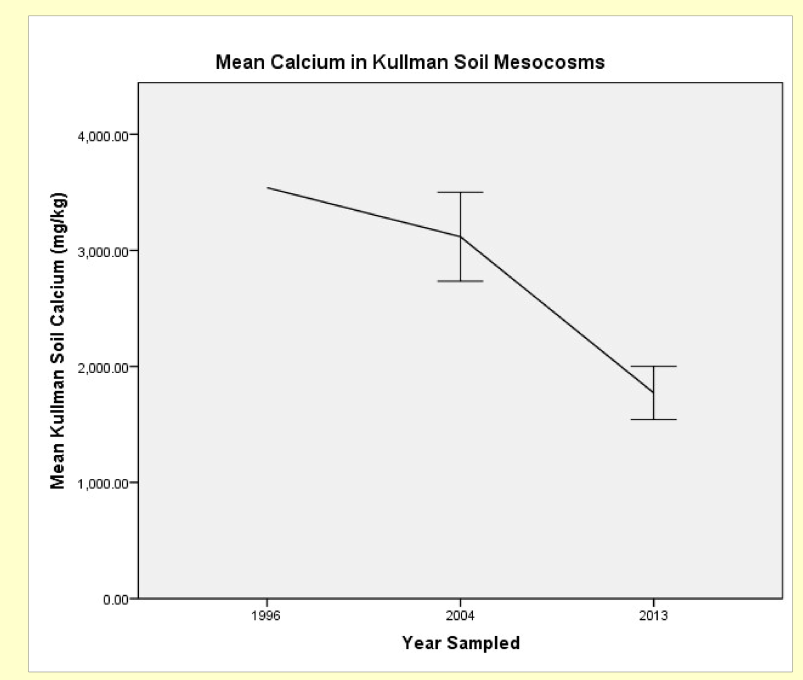

Figure 5. Mean calcium in Kullman soils.

Figure 6. A panoramic photograph of the 26 mesocosms planted for the NForM climate change experiment.

Materials and Methods

Three soil samples were extracted with a 1" diameter soil auger from each mesocosm for analysis. Each sample was sieved to 2mm to exclude rocks. Sieved soils were dried at 65°C for 24 hours and subsequently ground with a mortar and pestle. Ground soils were transported to the Agricultural and Environmental Testing Lab at UVM for analysis.

Soil cations were extracted with a Modified Morgan procedure (5) and analyzed with an Inductively Coupled Plasma Argon Emission Spectrophotometer (ICP/AES). Data were analyzed using SPSS.

Figure 7. Soil sampling tools.

Conclusions

Significant magnesium loss was observed between 1996 and 2004 for both Kullman (p=0.001) and Milton (p=0.000). However only the Milton soil sustained significant Mg loss between 2004 and 2013 (p=0.000) (Fig. 4). From 1996 to 2004 all Milton soil mesocosms had increased Ca; as a group, however, the increase was not significant as there was large Ca variability between mesocosms (Fig. 4). From 2004 to 2013 Ca significantly decreased ($p<0.05$). This initial increase in Ca is most likely due to plant-induced ammonium acetate extraction of Ca from the soil as there was low initial Ca availability. The Kullman soil Ca significantly decreased in both time periods ($p<0.05$), yet as no standard deviation was reported with the 1996 data, it is likely that there may be no true significant difference between 1996 and 2004 Ca levels (Fig. 5). Large variation among mesocosms in calcium and magnesium may be due to historic treatment effects as observed in the Beard et al. (2005) study. With only three sampling points ('96, '04 and '13) it is difficult to capture the true trend in soil Mg and Ca levels overtime. As the NForM climate change study includes high density plantings of deciduous trees, a litter layer and 2 distinct treatments, it will be interesting to observe the Ca and Mg cycling trends moving forward.

Literature Cited:

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