Agriculture Research and Development

Phosphorus Dynamics in Boreal Podzols Converted from Forestry to Agriculture in Newfoundland and Labrador

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Project Objectives

- Assess the level of total, available, and organic phosphorous, other relevant chemical species, and soil physical parameters in managed (farm fields) and non managed adjacent forested areas at selected sites across Newfoundland and Labrador;
- Compare and propose best phosphorous extraction methods used for available, organic, and total phosphorous; and
- Investigate phosphorous absorption kinetics, availability, and movement of added mineral and organic phosphorous fertilizer in soils typical for the province.

Abstract

Podzolic soils have low fertility and usually receive substantial amounts of fertilizers, both mineral and organic, to support consistent productivity. Phosphorus availability governs crop development, but adding too much phosphorus has negative impacts on both environmental and economic sustainability. We are evaluating the phosphorus chemical forms and the best protocols to assess phosphorus availability to plants for agricultural soils particular to Newfoundland and Labrador.

Background

Phosphorus is one of the three major crop nutrients – macronutrients – that together with nitrogen and potassium govern the capacity of a soil to provide nutrition for a growing plant. These macronutrients are the two most common cost inputs into crop production.

Commercial fertilizers and manure are the major sources of phosphorous in soil. Plant roots mainly utilize the dissolved fraction of phosphorous. However, phosphorous is very reactive and thus much of it, while present in soil, might be retained in stable chemical forms that make it unavailable for plant uptake. In acid soils common in the province, much of the phosphorous may be retained in iron phosphates and in humic organic complexes deeper in the soil. Thus, plants usually have access to only a small proportion of the phosphorous in the soil, including the newly added fertilizer phosphorous.

Because of this, long-term farming might lead to an accumulation of large amounts of phosphorous, which might not be immediately available to crops but might be carried away by erosion into rivers and lakes where it acts as a pollutant, a common cause for algal blooms (eutrophication) and lower water quality.

Beneficial management options can only be recommended based on the best understanding of the fluxes and pools of phosphorous in soil. There is a need for a basic understanding of what kind of phosphorous is in soils, where and how much, and the best way to measure and monitor phosphorous for Newfoundland and Labrador conditions.

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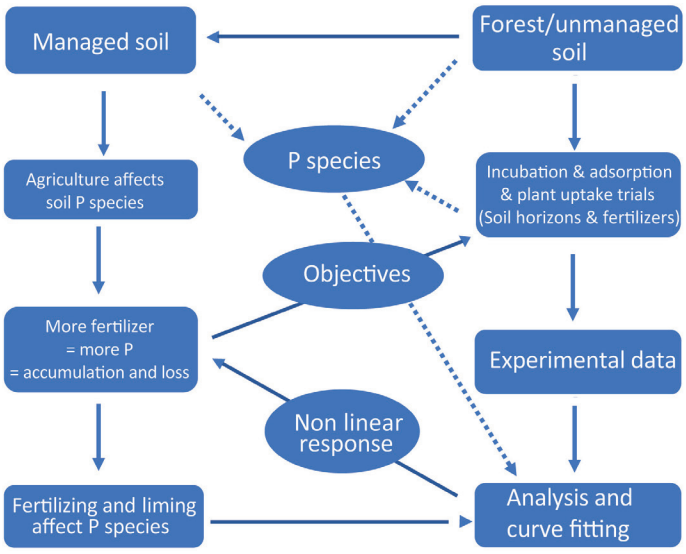

Figure 1: Conceptual framework for the experimental studies on phosphorus chemical forms in forest lands converted to agriculture use in Newfoundland and Labrador.

Technical Details

Soil samples were collected from St. John's Research and Development Center (eastern Newfoundland), Wooddale Provincial Tree Nursery (central Newfoundland), and Cormack and Codroy regions (western Newfoundland) to represent the diverse landscape and land-use across the island.

To date, basic soil parameters have been assessed:

- samples were air dried and homogenized by passing them through a 2 mm sieve;
- moisture content, organic matter content, pH and electrical conductivity were measured in 1:2 soil to two times distilled water and 1:5 soil to water for soils with high organic content; and
- texture was determined by using the hydrometer method.

For the next steps, extractions of total, available and organic phosphorous will be conducted using a wide range of methodologies to allow for cross-method comparisons. Spectroscopic and mineralogical analysis of selected soil will be conducted to understand the relevant mineralogy. These will include Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) and X-ray absorption near-edge spectroscopy (XANES) coupled with linear combination fitting (LCF).

Eventually speciation and availability of phosphorous to plants will be assessed in incubation trials, where soil-fertilizer mixes will be examined for changes in phosphorous chemical forms and capacity to provide phosphorous to plants.

A secondary survey will be carried out for a wider range of sites by employing the most informative methods as identified through the research activities summarized above. The work is expected to be carried out over a period of three years.

Preliminary Results

Sites were identified and basic analyses carried out. Analytical protocols are currently being calibrated.

Recommendations and Agriculture Industry Benefits

One of the expected outcomes of the project is recommendation of a comprehensive testing protocol or sets of methods to allow for the best assessment of the phosphorus fertility in soils on forest lands converted to agricultural use. This will support development of beneficial management practices for economic and environmental sustainability of land-based agriculture in the province. Moreover, it will also provide a body of knowledge applicable to similar regions in other boreal maritime jurisdictions around the world.

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