Issue 2002-1

Technical Update:

PRS™-probes add interpretative power to forestry-related research.

Quantifying the impact of timber harvesting or management practices (i.e., site preparation, herbicides, biosolid amendments, etc.) on soil nutrient dynamics often can be problematic. Accurate assessment of nutrient availability within forest soils is hindered by high spatial variability and temporal fluctuations. Considering that disturbed forest ecosystems are in a state of flux, why is the convention to use static measures of soil fertility within these systems? Conventional soil nutrient analyses, based on chemical extractions, historically have been poorly correlated with outplanted seedling nutrient uptake and growth. Herein lies the need for a nutrient management tool that is sensitive to the various mechanisms affecting nutrient bioavailability.

Figure 1. PRS™-probes: an effective tool for measuring forest soil nutrient dynamics *in situ*.

Extraction of nutrient ions from soil using ion exchange resins (IER) can provide a reliable index of nutrient bioavailability. The use of IER *in situ* integrates all of the dynamic factors affecting nutrient uptake by plants (i.e., soil moisture and temperature, mineralization, immobilization, free ion activities, buffer power, ion diffusion, etc.), independent of soil type. Consequently, IER are an effective surrogate for *bio-mimicking* nutrient absorption by plant roots as they remove soil nutrients through ion exchange.

Unfortunately, adoption of the IER technology for routine monitoring of forest soil nutrient dynamics has been limited. Primarily, this is due to the practical limitations of using mesh bags containing IER beads that often rupture and/or are difficult to wash free of fine roots or soil particles. The use of the Plant Root Simulator (PRS)™-probes, comprised of cation or anion exchange resin membranes encased in a plastic probe, greatly facilitate the use of IER technology in the field (Figure 1).

Advantages of the PRS™-probes include: easy insertion with minimal soil disturbance; flat structure ensuring a constant (i.e., quantifiable) adsorptive surface area; direct contact exchange with no secondary ion diffusion through mesh required; mechanistically similar to a plant root in its natural environment; easy removal and cleaning; and, reusable. The PRS™-probes routinely are analyzed for either cations or anions or all nutrient ions including:

NH_4 NO_3 P K S Ca Mg Mn Fe Cu Zn B Cd Pb

Researchers often will determine a cumulative measure of nutrient supply rate by removing buried PRS™-probes after some weeks and re-inserting fresh PRS™-probes in the same soil slot. Given that the PRS™-probe measurement accounts for the principal edaphic factors controlling nutrient flux to plant roots, it is not surprising that these cumulative nutrient supply rates correlate well with outplanted seedling nutrient concentration (Figure 2).

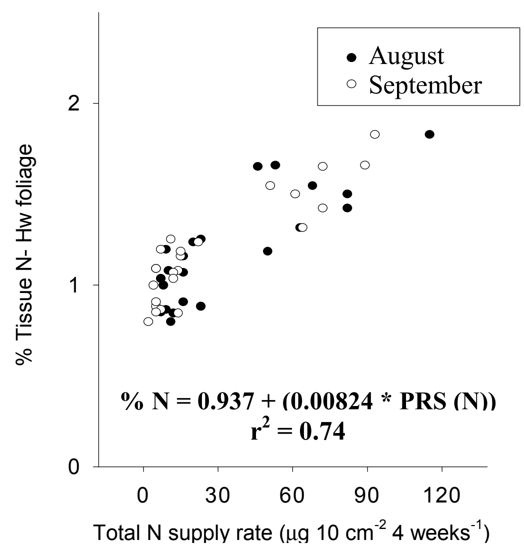

Figure 2. Relationship between PRS™-probe measured N (i.e., NH_4^+ and NO_3^-) supply rates and outplanted western hemlock (Hw) N concentration. *Source: Dr. Doug Maynard, Pacific Forestry Research Centre, Victoria, BC, Canada. (dmaynard@PFC.Forestry.CA)*

Issue 2002-1

Technical Update:

The PRS™-probe measurement is an integrated assessment of the potential soil nutrient supply to plant roots over the entire burial period. Conversely, a conventional soil analysis provides only a static determination of the extractable nutrient concentration at the time of sampling. The significance of this is evident below when comparing the soil N, P, and K analyses for different forest floor horizons using a traditional water extraction to that of a PRS™-probe *in situ* burial (Figure 3).

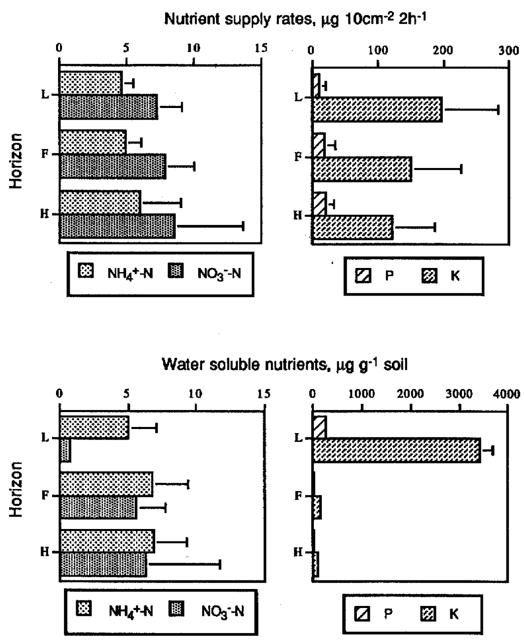

Figure 3. Comparison of PRS™-probe nutrient supply rates and water-soluble nutrient concentrations. *Source: W.Z. Huang and J.J. Schoenau, 1996. Commun. Soil Sci. Plant Anal. 27: 2895-2908*

Measured nutrient levels exhibited large micro-scale variability among sampling points, which is expected given the heterogeneous nature of forest soils. However, the N supply rates measured with the PRS™-probes had a significantly narrower NH_4^+:NO_3^- compared to the water extraction values. This was attributed to capability of the PRS™-probes to capture short-term pulses of NO_3^- passing through the profile during the two hour burial period, which was missed when a single point in time soil sample was collected and water-extracted. Similarly, fluxes of water-soluble K from the surface litter (L) horizon into the F and H horizons were measured using the PRS™-probes but not when samples were collected and water-extracted. Given the marked differences between these two analyses after a two hour burial, imagine the discrepancies after a four week PRS™-probe burial compared to a single soil extraction at the end of that period.

Collecting, handling, and analyzing a large number of soil samples is not conducive for studying soil nutrient dynamics throughout a growing season. Considering the PRS™-probes are used *in situ*, they are a relatively convenient and economical means of quantifying both spatial and temporal variations in nutrient supply rates for **all nutrient ions simultaneously**. It is prudent to employ a research tool capable of quantifying inherent micro-scale variations in soil fertility, while sensitive to the edaphic effects controlling nutrient availability over time. Accurately measuring soil nutrient dynamics facilitates adequate monitoring of the impact of forest management practices on soil quality. This allows for appropriate inferences to be made regarding the sustainability of current practices, while supporting effective nutrient management decisions.

The following resources are available to researchers using the PRS™-probes:

- **PRS™-Probe Operation's Manual** – complete guide to using PRS™-probes and interpreting the results obtained; including a comprehensive bibliography of PRS™-probe- and IER-related research.
- **PRS™-Probe Lab in a Box** – designed for use in introductory soil fertility classes. Gives students lab and/or field experience with the technique as well as the opportunity to relate soil nutrient supply rate measurements to plant uptake and/or edaphic properties.
- **PRS™-Probe Analysis** – an attractive alternative for researchers with limited analytical resources. A wide range of nutrients and ionic species measured using colourimetry/ICP/GC-Mass Spec.
- **Graduate Student Discount** – introductory offer available for qualifying graduate student research.

For more information, please visit our website: ***http://www.westernag.ca***

NEW! **Prototyping available to suit your desired IER delivery mechanism.** NEW!