



Technical Update:

PRS™-probes: a cost-effective and reliable measure of soil N mineralization

Plant Root Simulator™ (PRS)-probes are a proven tool for providing an integrated assessment of soil nitrogen (N) supply. The ion exchange membrane, encapsulated in a plastic probe, acts as a sink for nitrate and ammonium that is slowly released from soil organic matter or organic amendments. When buried *in situ*, the PRS™-probe can measure the N supply as it varies with soil moisture and temperature over the entire burial period. Moreover, the PRS™-probe is sensitive enough to monitor the net N release as affected by other factors such as the type of organic substrate or the impact of weed competition for N. As a result, the PRS™-probes are very effective at assessing the rate of N release as it is influenced by management practices aimed at improving soil organic matter, soil quality, and long-term site productivity.



Figure 1. PRS™-probes (orange and purple probes are anion- and cation-exchange probes, respectively) used to measure the effects of different organic amendments on soil N supply in dryland potato production.

Organic Amendments in Potato Production

The Organic Agriculture Centre of Canada (OACC) currently is evaluating potato varieties for performance under organic management regimes. In a 2003 study, PRS™-probes were used to assess the soil N supply rate in potato fields (cv. Shepody) amended with compost or manure (Figure 1). The amendments were broadcast applied and incorporated prior to planting at rates of 0, 150, or 300 kg /ha. These application rates provided an equivalent N supply of 0, 90, and 180 kg N/ha (assuming a 15% conversion of total organic N in the compost and 30% in the manure). Immediately following planting, four pairs of PRS™-probes were inserted into root exclusion cylinders to measure soil N supply in the absence of root competition. The buried PRS™-probes were removed weekly

and fresh probes replaced in the same soil slot. Summing the weekly measures from the PRS™-probes yielded a cumulative N supply rate over the first month. A strong correlation existed between the cumulative N supply rate and final plant N uptake measured at topkill (Figure 2). Such a relationship is not surprising, considering the PRS™-probes are sensitive to the same edaphic factors influencing N uptake by plant roots, thereby yielding a biologically-meaningful measure of soil N supply over time.

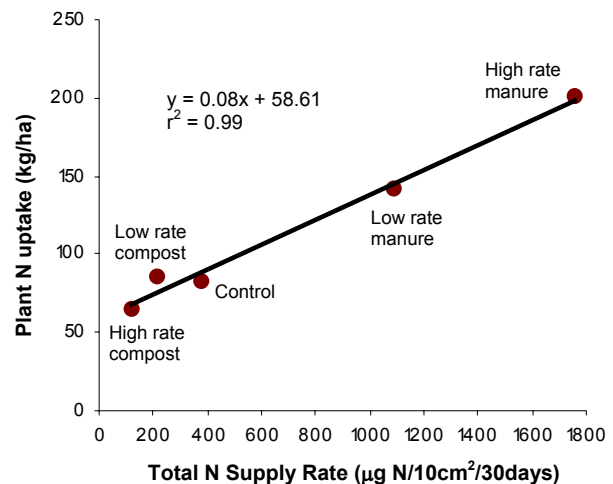


Figure 2. Relationship between cumulative N supply rate measured using PRS™-probes during the first 30 days after planting and potato plant N uptake at time of topkill. Source: Dr. Derek Lynch, OACC, Truro, NS. (dlynch@nsac.ns.ca), and Dr. Bernie Zebarth, AAFC, Fredericton, NB.

N Release from Manure Amendments

Manure contains organic forms of N that will be slowly released as the crop grows. Given this temporal nature of soil N supply, one would expect the relationship between PRS™-probe N supply rate and final crop N uptake to become stronger as the burial duration increases. Research conducted at the University of Saskatchewan exemplifies this relationship between PRS™-probe data and crop uptake. A growth chamber study on two contrasting soil types examined the effect of 13 different solid manure amendments on N uptake by canola plants. Manures with C:N ratios ranging from 6.6 to 21.7 were applied to pots, with and without canola, at a rate of 100 mg N/kg. To avoid the confounding effects of root competition, PRS™-probes were used in pots without canola plants to measure N dynamics over time. The canola was grown for a total of 67 days, during which time the PRS™-probes were replaced



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periodically. For both soil types, it is apparent that the longer the PRS™-probes were left in soil, the stronger the ensuing correlation with canola N uptake (Table 1). This was true especially for the sandy loam Haverhill soil, which probably experienced an initial period of immobilization followed by net mineralization. Conversely, the higher organic matter content of the clay loam Blaine Lake soil probably compensated for any immobilization early on. These evidently stronger correlations with canola N uptake with increasing PRS™-probe burial length data indicate that the N mineralized from manure contributed significantly to plant N uptake.

Table 1. Relationship between PRS™-probe N supply rate over time and N uptake by canola plants. Source: Qian and Schoenau, 2002. Can. J. Soil Sci. 82: 219-225.

Time (days)	Correlation coefficient (r)	
	Haverhill	Blaine Lake
4	0.42	0.68**
11	0.47	0.78**
25	0.56*	0.76**
39	0.64*	0.77**
53	0.69**	0.80**
67	0.73**	0.80**

*, ** indicate statistically significant correlations at $P < 0.05$ and $P < 0.01$, respectively.

Indicator of Sustainable Forest Management

Developing sustainable forestry relies on the continuous monitoring of specific soil quality indicators, in order to quantify any deleterious effects of timber management practices on long-term soil productivity. Measuring the rate of soil N mineralization commonly is used because of its sensitivity to disturbance. Unfortunately, traditional methods based on chemical extractions, *in vitro* or *in situ* incubations, bioassays, and isotopic dilution can be not only labour intensive and expensive, but also have practical limitations for use as routine monitoring tools. Consequently, it is prudent to employ a standard monitoring tool that causes minimal disturbance to the soil, provides a convenient and cost-effective means of quantifying both spatial

and temporal variations in N mineralization, but most importantly, provides data that is biologically-meaningful to growing trees.

Recently, PRS™-probes were used to measure the effects of shelterwood (SW) vs. clearcut (CC) harvesting systems and different vegetation management practices (control vs. herbicide) on growing season soil N supply rates and its relationship with conifer seedling N uptake (Figure 3) and growth ($r^2 = 0.88$, $P < 0.001$; data not shown).

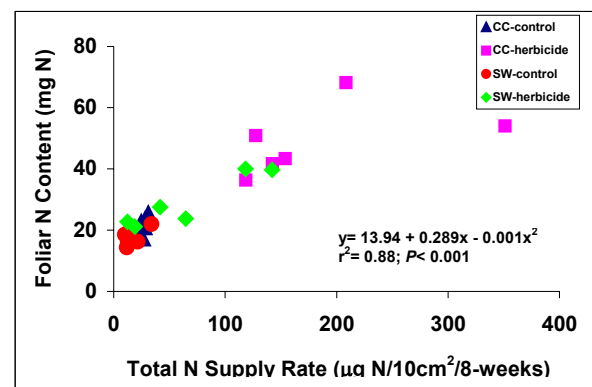


Figure 3. Relationship between PRS™-probe measured cumulative N supply rate and outplanted western hemlock N uptake. Source: Dr. Doug Maynard, Canadian Forest Service, Pacific Forestry Research Centre, Victoria, BC. (dmaynard@pfc.cfs.nrcan.gc.ca)

The effect of site disturbance on biologically-mediated soil processes, such as N mineralization, is complex and difficult to quantify. However, the results of this study illustrate the effectiveness of PRS™-probes to integrate all of the principal edaphic factors affecting growing season soil N bioavailability; therefore, making it a reliable method for use in accounting for temporal variations in forest soil N mineralization. Accurately measuring soil N dynamics following a disturbance facilitates adequate monitoring of the impact of forest management practices on soil quality and long-term site productivity. This allows for appropriate inferences to be made regarding the sustainability of current silvicultural practices and supports effective management strategies.

For more information please visit our website: <http://www.westernag.ca/innov/main.html>,

call TOLL FREE 1-877-978-1777 to speak with an R&D Co-ordinator,

or visit us in person at Tradeshow Booth #112 at the:

[ASA-CSSA-SSSA Annual Meetings in Seattle, WA, Oct. 31-Nov. 4, 2004](#)



While attending the Annual Meetings be sure to stop by the PRS™-probe information reception on Tuesday, Nov. 2 (6-8 pm) in Room 2B at the Convention Center. Please inform any colleagues that may be interested in attending and be sure to bring your appetite!