



# Technical Update:

## PRS<sup>TM</sup>-probes: An essential tool in agronomy, forestry, and environmental research.

The Plant Root Simulator (PRS)<sup>TM</sup>-probe (Fig. 1) is a novel *in situ* approach to measuring the bioavailability of ionic elements and compounds in soil and other heterogeneous media. The PRS<sup>TM</sup>-probe exhibits surface characteristics and sorption phenomena that are analogous to a plant root and provides a dynamic flux measurement by continuously adsorbing charged ionic species over the burial period. The use of the PRS<sup>TM</sup>-probe *in situ* integrates all of the principal edaphic factors affecting nutrient and contaminant bioavailability in all soil types.

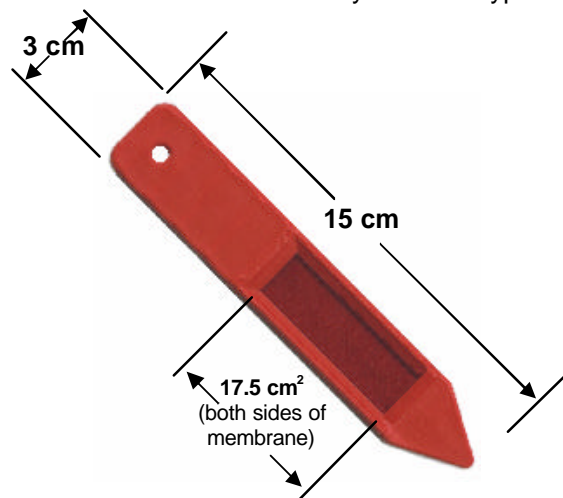


Figure 1. Anion-exchange PRS<sup>TM</sup>-probe pre-treated with EDTA allows for the measurement of all anions and polyvalent metals *in situ* with minimal soil disturbance.

### Agronomy Research

The PRS<sup>TM</sup>-probe measurement is an integrated and dynamic assessment of the potential soil nutrient supply to plant roots over the entire burial period, unlike a soil extraction that offers a static determination of nutrient concentration at the time of sampling. One of the greatest benefits provided by the PRS<sup>TM</sup>-probes is the ability to continuously monitor nutrient fluxes *in situ* during the growing season. This technique was used recently by researchers in Washington State to assess soil N supplies at various locations in a grape vineyard.

In the study, PRS<sup>TM</sup>-probes were placed at sites representing various soil organic matter contents (%OM). The PRS<sup>TM</sup>-probes were replaced bi-weekly for a total of 20 weeks. At the end of the growing season, graphs of cumulative N supply (Fig. 2) revealed greater N bioavailability at

locations with higher %OM. With this information, the researchers hope to develop nutrient management strategies that will lead to more efficient fertilizer use in the vineyard.

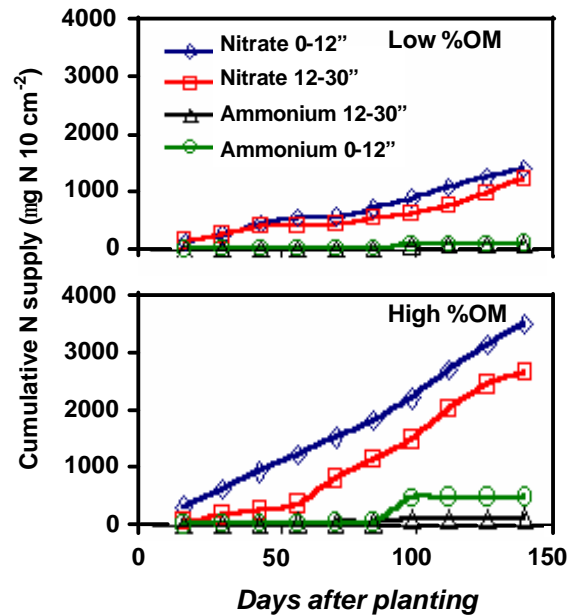


Figure 2. Nitrogen flux at two soil depths for sites with low and high soil organic matter contents (%OM). Data courtesy: Dr. J.R. Davenport, Washington State University, Irrigated Agriculture Research and Extension Center, Prosser, WA. (jdavenport@tricity.wsu.edu)

### Forestry Research

Accurately measuring nutrient availability within forest soils is hindered by large spatial variability and temporal fluctuations. It is prudent then to employ a research tool capable of quantifying inherent micro-scale variations, while sensitive to the edaphic effects controlling bioavailability over time. Compared to traditional soil testing methods, the PRS<sup>TM</sup>-probe is a relatively convenient and economical means of quantifying both spatial and temporal variations in soil fertility; therefore, making it an effective tool for measuring forest soil nutrient dynamics *in situ*.

Huang and Schoenau (1997) examined the spatial patterns of soil N and P availability in a boreal aspen forest by measuring nutrients (using PRS<sup>TM</sup>-probes and conventional water extractions) inside and outside PVC cylinders. They used the difference between the two as an index of plant nutrient uptake (Figure 3).



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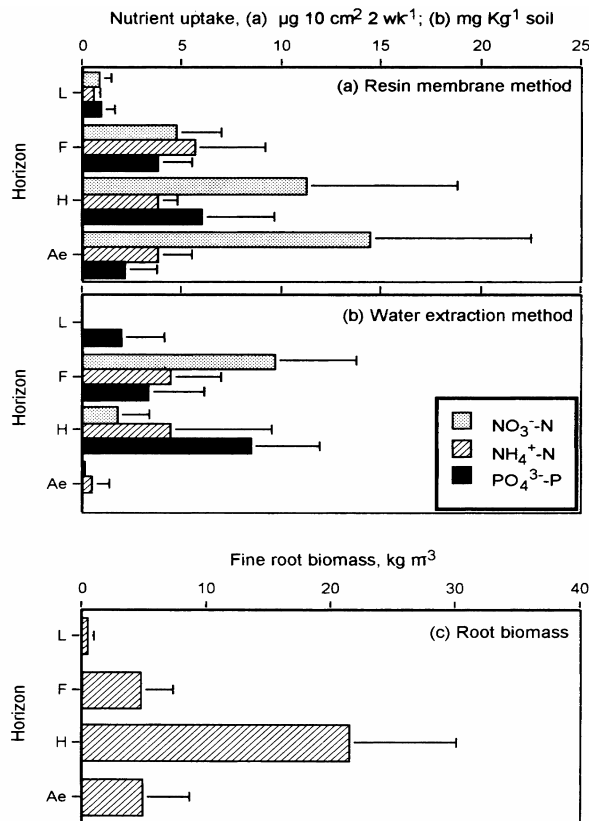


Figure 3. Spatial patterns in N and P uptake by vegetation and fine root biomass in different horizons. Bars refer to one standard deviation. Source: W.Z. Huang and J.J. Schoenau, 1997. *Can. J. Soil Sci.* 77: 597-612.

Using this index, plant uptake of NH<sub>4</sub><sup>+</sup>-N, NO<sub>3</sub><sup>-</sup>-N, and P was highest in the H horizon, followed by the F and Ae horizons, with lowest uptake apparent in the L horizon. These results were consistent with plant fine root distribution: H horizon (68%); Ae and F horizons (15% each); and, the L horizon (2%). The PRS<sup>TM</sup>-probe supply rates exhibited a greater sensitivity in measuring differences in plant N and P uptake among horizons compared to a traditional water extraction and also were better correlated to plant fine root distributions. This is because the PRS<sup>TM</sup>-probe is used *in situ* and has the advantage of being mechanistically similar to a plant root in its natural environment.

## Environmental Research

Current methods for assessing heavy metal bioavailability in soil (i.e., chemical extractions or *in vitro* bioassays) often introduce artifacts into

the analysis, due to the chemical properties of the extractant or the artificial nature of the experimental design. Using PRS<sup>TM</sup>-probes *in situ* to quantify heavy metal bioavailability precludes such concerns, because they are inserted with minimal disturbance and they are also an effective surrogate for bio-mimicking heavy metal absorption by plant roots through ion-exchange.

A growth chamber experiment using oats, radish, and lettuce was set up to determine the phytotoxic levels of heavy metals at varying spike rates and comparing these to PRS<sup>TM</sup>-probe supply rates. Given that the PRS<sup>TM</sup>-probe measurement accounts for all of the principal edaphic factors affecting heavy metal availability, it is not surprising that these measured supply rates were highly correlated with plant uptake (Table 1).

Table 1. Coefficient of determination values for the relationship between radish heavy metal uptake and spike rate, DTPA-extractable, and PRS<sup>TM</sup>-probe supply rate. Source: J. Liang and J.J. Schoenau, 1995. *Intern. J. Environ. Anal. Chem.* 59: 265-275.

Heavy Metal	Spike Rate	DTPA	PRS <sup>TM</sup> -Probe
Cd	0.988*	0.986*	0.989*
Cr	1.00**	0.995**	0.998***
Ni	1.00***	1.00***	1.00***
Pb	0.617	0.656	0.670

\*, \*\*, \*\*\*, Significant at the 0.05, 0.01, and 0.001 levels, respectively.

Considering that PRS<sup>TM</sup>-probe supply rates are highly correlated to traditional DTPA extraction, their use supersedes the need to laboriously collect soil samples for analyses. Beyond simplifying the process of physically collecting a soil sample, the PRS<sup>TM</sup>-probe's greatest benefit is its ability to measure all contaminant ions simultaneously.

In simulating the uptake mechanism of plant roots, the PRS<sup>TM</sup>-probe greatly improves the accuracy of measuring the biological supply of soil nutrients and contaminants. Compared with traditional soil testing methods, the PRS<sup>TM</sup>-probes are a convenient and economical means of quantifying both spatial and temporal variations in all nutrient and contaminant ions *in situ*; making them an essential tool in agronomy, forestry, and environmental research.

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