Issue 2001-2

Technical Update:

PRS™-probes add interpretative power to soil research.

Plant Root Simulator (PRS™) probes are a useful tool for measuring soil nutrient supply rates *in situ*. The ion exchange membrane encasement in plastic makes the probes particularly convenient for in-field use. The flat resin membrane allows complete contact between the ion exchange surface and the soil, mimicking the contact between a plant root surface and the surrounding soil.

While chemical extractions are useful for quantifying various ion pools in the soil, *in situ* supply rates measure ion release from those pools to the bio-available pool under specific soil conditions. In this way, a more complete understanding of what the plant root "sees" in different soil environments and/or treatments is gained.

An in situ measure of PRS™ soil nutrient supply rates allows researchers to measure another "piece of the nutrient supply puzzle".

An advantage offered by ion exchange techniques is the ability to measure several ions at once. The PRS™ membrane adsorbs any ion in proportion to its ionic activity in the soil solution and in equilibrium with the labile ion pool. This makes it relatively simple and economical to consider the supply rates of several different ions when interpreting results. Since the sample is already collected, the only extra labour involves eluate analysis for additional ions.

PRS™-probes were recently used to measure NO_3-N, NH_4-N, P, S, K, Ca, Mg, and Al supply rates in a study of the long-term effects of fertilizer addition to cassava grown on a low fertility soil from Northern Vietnam. Using PRS™-probes, researchers documented decreasing soil supply rates of non-fertilizer elements as various fertilizers were applied.

For instance, nine years of P fertilizer application resulted in decreased soil N and K supply rates (Fig.1). In these weathered soils, P is extremely limiting to cassava yield. On plots where P was added over the long term, cassava growth and nutrient uptake increased, depleting the native soil N and K supply. This occurred despite annual applications of 80kg ha^{-1} of N and K_20.

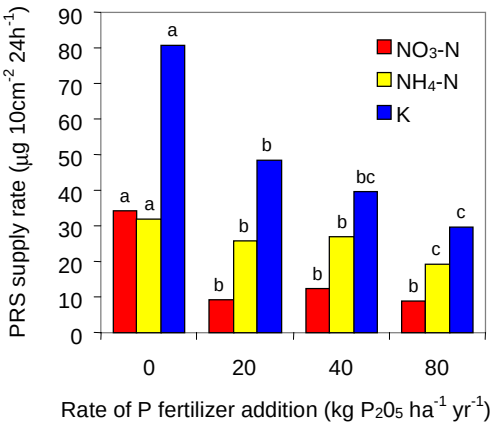

Figure 1. Soil N and K supply rates measured after 9 years of P fertilizer application to a low fertility soil.

Source: Nguyen et al., 2001. Can. J. Soil Sci. 8(3)

Addition of N, P and K fertilizers also affected soil Mg supplying power. As fertilizer blends were added, yields increased and demand for Mg increased beyond the buffering capacity of the soil (Figure 2). In fact, by the 6th year of the study, soil Mg supply rates had decreased so much that severe Mg deficiency symptoms were observed in the cassava. Applications of 50kg $MgSO_4$ ha^{-1} yr^{-1} were made in each of the 6th, 7th and 8th years of the study to correct the deficiency and boost yields. Despite these applications, after the 9th year of the study, lower soil Mg supply rates could still be detected where N-P-K fertilizer was applied. These lower supply rates corresponded to lower Cassava tissue Mg concentrations.

This research demonstrates the importance of considering a range of nutrient ion supply rates

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when interpreting research data, as well as the requirement for balanced fertilization to maintain soil quality.

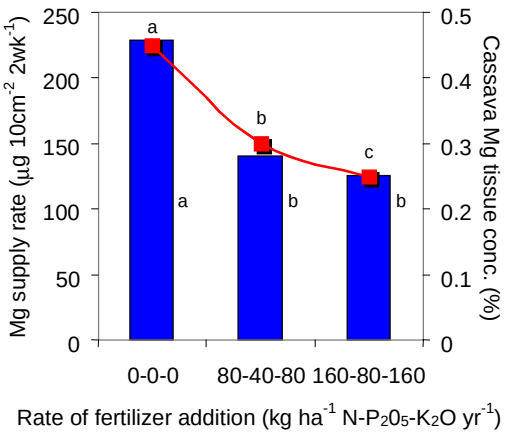

Figure 2. Influence of increasing rates of N, P and K on soil Mg supply rates (columns) and Cassava tissue Mg concentrations (line) after 9 consecutive years (1990-98) of fertilizer addition.

Ion supply rates are sensitive to the soil conditions under which they are measured. Thus, it is essential that soil conditions be considered when interpreting supply rate measurements. Any soil physical, chemical or biological factor influencing ion movement or bioavailability should be considered.

Soil moisture content has a large influence on physical movement, biological uptake and chemical reaction of ions in the soil, which in turn influence ion fluxes to plant roots. An example of how soil moisture affects PRS™ nutrient supply rates is shown in Table 1. A clear decrease in nutrient supply rates occurs as the soil moisture content decreases.

Table 1. Effect of soil moisture content on measured PRS™ soil nutrient supply rates. (Means of 3 replicates)

Soil moisture content	PRS™ soil nutrient supply rate (µg 10 cm^{-2} h^{-1})			
	N	P	K	S
Saturated	282	4.5	218	50
100% F.C.	200	2.7	181	39
70% F.C.	196	1.4	155	37
45% F.C.	113	0.9	93	26
15% F.C.	24	0.3	48	12

Source: U.S. Patent #6242261

For short-term burials, where a "snapshot" of the soil ion supplying power is desired, it is often recommended that water be added to the soil in the vicinity of the PRS™ to achieve a moisture content near field capacity. This ensures that adequate moisture is available for ions to move and adsorb to the PRS™ membrane so that significant treatment comparisons can be made.

During longer duration burials, it is more difficult to maintain the soil at field capacity and to guarantee equivalent moisture contents between treatments over time. Longer duration burials are often performed to assess ion supply rates under true field conditions. Water additions to the soil would alter the true field conditions and therefore artificially alter the study results. Soil water content should be monitored during extended PRS™ burials to effectively explain variations in soil ion supply rates over the burial period.

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

- **PRS Operation's Manual** – a complete guide to using PRS™-probes and interpreting the results obtained, including a comprehensive bibliography of ion exchange related research.
- **PRS 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 ion supply rate measurements to plant uptake and/or soil characteristics.
- **PRS Analysis through Western Ag** – an attractive alternative for researchers with limited lab resources or those wishing to analyze several ions at once.

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

Or visit us in person at Tradeshow Booth #424 at the:

ASA-CSSA-SSSA Annual Meetings in Charlotte, North Carolina, Oct. 21-25, 2001