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Technical Update:

PRS™-probes: a sensitive soil monitoring tool for nutrient studies

Measuring soil nutrient supply remaining after a growing season is essential for crop nutrition planning. Plant Root Simulator (PRS)™-probe measurements of the nutrient supply correlate well with plant uptake providing a valuable estimate of the contribution of nutrient supply to yield. PRS™-probes, when placed in the soil, are a nutrient sink that adsorb dissolved nutrients from the soil solution. They exchange sodium and bicarbonate ions from the recharged PRS™ cation and anion probe, respectively, for soluble nutrients in the direct vicinity of the membrane surface. Given these properties, the PRS™-probe is a sensitive tool with which to measure the impact of a treatment or management practice on the soil supply of nutrients.

PRS™-probes effectively measure result of P fertilizer placement.

The above principle was demonstrated in a long-term study by Karamanos *et al*. (2007). The research site was established in 1982 and was last cropped to barley in 2004. The site was kept in chemical fallow through to August 2006 when PRS™-probes were buried on the row and inter-row spaces between 0-10 cm.

Understanding P placement and site preparation of this experiment is key to interpreting the results. Phosphorus was either drilled with the seed (2.5 cm depth) or deep banded (approximately 12.7 depth) prior to seeding. Each spring before any treatments were applied the top 5 cm of soil was roto-tilled to mix P from prior seed-drilled treatments over the entire plot. However, P in deep bands was not disturbed by tillage. The P supply rates and Olsen P are reported in Figure 1.

For the seed-drilled P treatment (dark circles), P supply rates, measured with *in situ* PRS™-probe burials in the seed row, were lower than those between rows because of P uptake by plant roots in the seedrow. However, between rows the soil in the seed-drilled P treatment supplied a higher rate of P because the roto-tilling redistributed P each year throughout the plot and the roots did not access this P. In contrast, for the deep banded treatment (light circles) in the seed row, the supply rate was higher than between rows because throughout the 20 year study, P was placed in the same deep-band location below the roto-till depth resulting in a significant accumulation of residual P. Between rows the deep banded P treatment supplied a lower rate of P because the P was not mixed between rows as it was in the seed-drilled treatment. The data demonstrate the phosphorus drawdown in the areas of high root activity and zones of residual P.

In the same study, the P supply rate, measured by the PRS™-probe, was compared with Olsen soil test P. Soil samples were collected every inch across two rows of the plots and the P concentration quantified using Olsen soil test P protocol. As before, PRS™-probes were buried on the seed row and between rows. The level of Olsen soil test P is indicated by the lines drawn across the graph (dark for seed-drilled and light for deep banded P). The P supply rates measured by the PRS™-probe are indicated by the color-coded circles as previously described.

PRS™-probe P supply rates explained 93% of the 2004 barley grain yield compared to 68% for the Olsen soil test P. Figure 1 shows that the Olsen P soil test does not detect the difference in soil P between the seed row and between rows, whereas the PRS™-probe measured the subtle differences in soil P supply due to fertilizer placement and P drawdown by the roots.

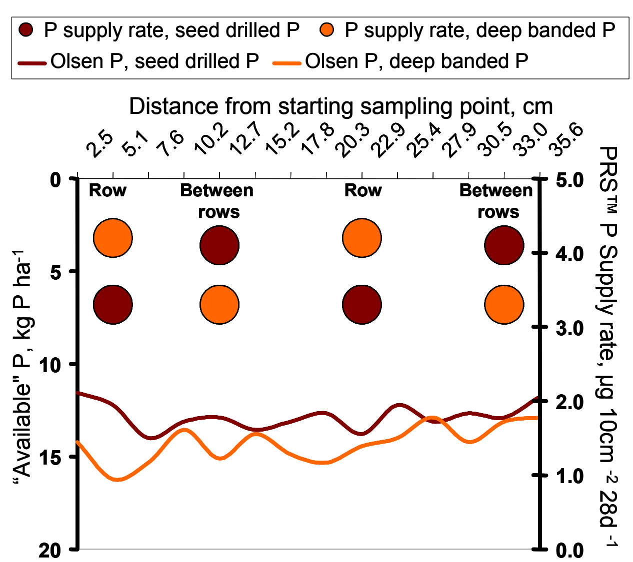

Figure 1. Distribution of P supply rates (cirles), measured with *in situ* PRS™-probe burials, and Olsen P (lines) in the 30 kg

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P_2O_5/ha seed drilled treatment and 30 kg P_2O_5/ha deep banded treatment. Source: Karamanos *et al.*, 2007. Acknowledgement: Thanks to Dr. Rigas Karamanos for editing this section.

PRS™-probes measure differences in P supply rate between pulse crops.

Another example of the sensitivity offered by PRS™-probes is the study conducted by Adderley (1998). He studied the nutrient supply from pulse residues when recropping to cereals with a series of consecutive, *in situ,* two week PRS™-probe burials in plots of spring wheat. Adderley's research showed that P supply rates over the first two 2-week periods of spring wheat growth were significantly higher on pea stubble as compared to lentil stubble at the Goodale Farm near Saskatoon in 1997 (Figure 2). These results demonstrate that pulse crops have nutrient benefits in addition to nitrogen fixation and these benefits may be significant early in the growing season.

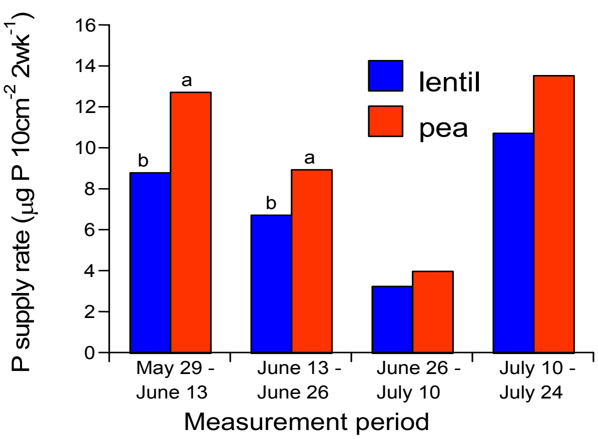

Figure 2. Mean P supply rates, measured with *in situ* PRS™-probe burials, on lentil and pea stubble over a 56 day period. Means with different letters were significantly different at P = 0.10. Source: Adderley, 1998.

N supply rate across the landscape correlates with N uptake by canola.

To evaluate the influence of landscape position on N supply rate, Greer (1997) determined N supply rates using a two-week, post-harvest burial. He regressed PRS™-probe N supply rate with the N uptake of the canola crop grown during the previous growing season. Figure 3 shows that the N measured by these post-harvest, *in situ* burials of PRS™ anion probes correlated significantly with the N uptake by canola at different landscape positions. The PRS™-probes are sufficiently sensitive to measure the nutrient supplying power, and therefore, the productive potential of the soil.

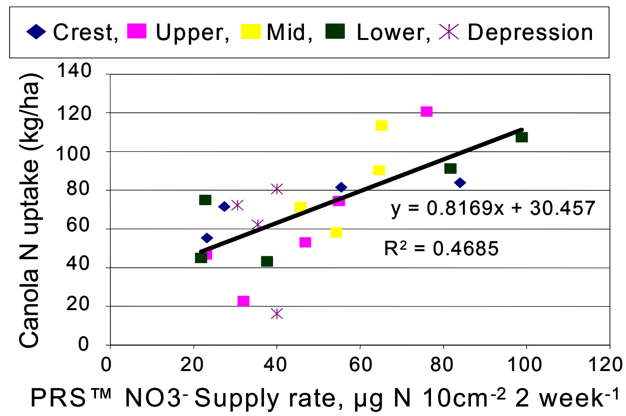

Figure 3. Nitrate supply rate, measured with *in situ* PRS™-probe burials, on a hummocky landscape in relation to Canola N uptake. Source: Greer, 1997 (unpublished data).

The PRS™-probe is a sensitive tool for detecting subtle differences in nutrient supply from residual treatment effects as well as the inherent changes in fertility associated with different positions across the landscape. The sensitivity of the PRS™-probe proved superior in comparison to chemical extractant-based soil tests. By simultaneously adsorbing all bioavailable cations and anions from the soil solution, data collected with the PRS™-probe can also explain treatment effects that may have otherwise been missed if the soil was analyzed using a static, chemical extractant-based soil test which measures only a single nutrient.

Literature Cited:

Adderley, D.R. 1998. Nutrient cycling and herbicide persistence in reduced tillage pulse-cereal rotation. M.Sc. Thesis, University of Saskatchewan, Saskatoon, SK.

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Karamanos, R.E., Harapiak, J.T. and Kruger, G.A. 2007. Impact of discontinuing phosphorus fertilization after 20 years on barley yields and soil phosphorus status . Manitoba Soil Science Meeting, Winnipeg, MB. Jan 20-21, 2007.

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