*Issue 2001-1*

# Technical Update:

## Measure soil nutrient supplies to crops *in situ*.

One of the biggest advantages of using PRS™-probes in research is the ability to bury them directly in the field. This provides assessment of nutrient dynamics under natural soil conditions.

The PRS™ are particularly effective for examining ion release over time – either from the soil itself or from soil amendments. While the total nutrient content of an amendment is often known, the rate that these nutrients become available for plant uptake, microbial immobilization and/or leaching is often of greater scientific interest. Use of the PRS™-probes in such treatments provides a dynamic measure of this ion flux.

An example comes from a study in Washington State where mulches were applied in a 4" layer to apple orchard soils to assess their effectiveness for weed control. One year later, PRS™-probes were used to measure $NO_3$-N supply rates under the treatments. Probes were buried in 5 replicates of each treatment and replaced every 2 weeks during the latter part of the growing season. Regenerated probes were placed into the same slots that preceding probes were removed from. In this way, supply rates measured from the same soil slot could be added together to obtain a cumulative measure of $NO_3$-N release.

Results indicated that the alfalfa mulch treatment released the most N during the growing season (Figure 1). This was attributed to its low C:N ratio (12:1). The living clover released the next highest amount of N, followed by the wood chip and control treatments, which generally did not release significant amounts of $NO_3$-N.

Higher $NO_3$-N release corresponded to higher extractable soil $NO_3$-N, greater apple leaf greenness (SPAD readings), shoot growth and delayed leaf senescence. PRS™-probes also detected increased soil $NO_3$-N supplies following $NH_4NO_3$ fertilizer application on Oct. 3 (last set of probes removed Oct. 6).

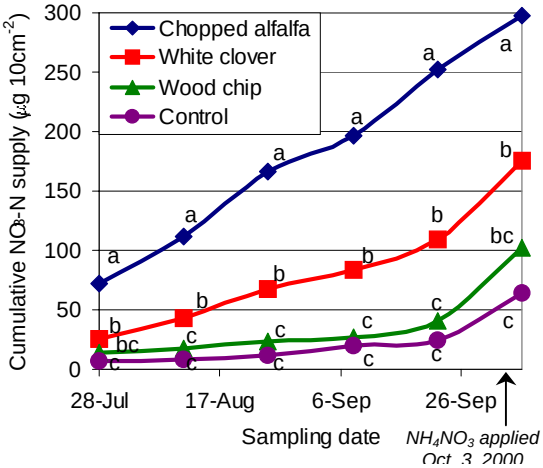


Figure 1. Effect of mulch treatment on the cumulative amount of $NO_3$-N adsorbed by PRS™-probes over the growing season (with mean separations by date).

Data courtesy:
J. Moore*, F. Peryea and D. Granatstein, Washington State University, Tree Fruit Research and Extension Center, Wenatchee, WA. *jmoore@tfrec.wsu.edu

In a separate example, researchers in Saskatchewan used probes to assess the effects of urea or hog manure addition on soil P supply. Amendments were applied at rates of 0 and 100mg N $kg^{-1}$ soil to pots of relatively fertile soil (3.7% OC). Canola was grown in one set of pots. Equivalent treatments were incubated without plants wherein PRS™-probes were buried and replaced several times during plant growth.

Canola grown in manured, urea amended or control soils next to PRS™-probes buried in equivalent treatments, incubated in a growth chamber for 84 days.

Plant ion uptake can be directly compared to ion uptake by PRS™-probes incubated under similar conditions.

Manure addition to the soil significantly increased soil P supply and P uptake by the probes relative to the other treatments.

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Urea addition actually decreased P supply relative to the control soil. The researchers suggested that this might have resulted from P immobilization created by surplus N available for microbial synthesis. It is also evident that some P mineralization occurred in the soil itself during the study as witnessed by the P supply over time in the control treatment.

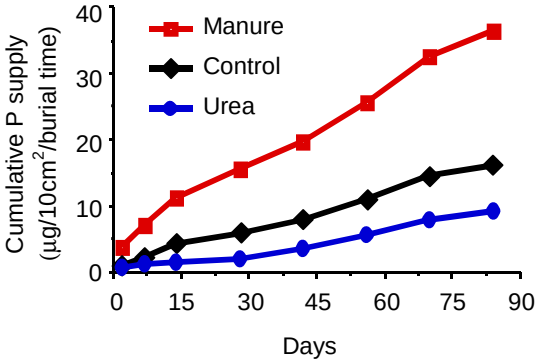


Figure 2. Cumulative available P over time in a clay loam control soil and in soil amended with hog manure and urea at 100mg N $kg^{-1}$ soil.

Data courtesy:
P. Qian* and J.J. Schoenau, Dept. of Soil Science, University of Saskatchewan. *qian@sask.usask.ca J. Plant Nutr. 23: 381-390.

Canola took up more P from the manured soils than the other treatments. However, even though P supply rates were lower, P uptake by canola was greater in the urea treatments than in the control soil. The researchers suggested that urea addition could have allowed greater root growth and demand for P, thus increasing P uptake.

When using the PRS™-probes to compare nutrient supply rates among treatments, it is critical that the probes be buried for equivalent times. Since supply rate is a flux measure, dependent on the time of burial, it would be invalid to compare a supply rate measured during a 1-day probe burial to that determined by a 2-week probe burial. It would also be invalid to take the 2wk burial supply rate and divide it by 14 to compare to the 1d burial since ion adsorption may not be linear over time.

This is apparent in Table 1. The supply rates determined by 1 and 24 hour burial are very different. Generally, the 24hr burial gives a higher supply rate measurement than the 1hr burial. In addition, if the 24hr burial supply rates are divided by 24, they do not resemble the 1hr burial supply rates, even though both have been found to correlate with plant uptake.

Table 1. Nutrient removal by ion exchange membranes buried in three Saskatchewan soils (means of 3 reps).

| Soil | Burial time | $NO_3$-N | $PO_4$-P | K | $SO_4$-S |
|---|---|---|---|---|---|
| | | µg $cm^{-2}$ burial $time^{-1}$ | | | |
| 1 | 1hr | 20.9 | 0.66 | 35.5 | 3.6 |
| | 24hr | 142.9 | 1.60 | 72.0 | 15.5 |
| 2 | 1hr | 4.7 | 0.07 | 17.6 | 10.1 |
| | 24hr | 84.1 | 0.23 | 28.3 | 106.6 |
| 3 | 1hr | 5.9 | 0.14 | 20.9 | 2.3 |
| | 24hr | 21.6 | 0.25 | 30.6 | 5.4 |

Data source:
European patent no. 0626066

On burying a PRS™-probe, ions in the labile pool are the first to be adsorbed. Thus a 1hr burial mostly measures the labile pool, while the 24hr burial measures both the labile pool plus more of the slowly released pool. *In situ* 2wk PRS™-probe burials capture even more of this slow release, which fluctuates with changing soil moisture and temperature. Such a measure of soil nutrient supply provides a dynamic integration of all factors moderating ion release and therefore should not be expected to be linear over time.

***For more information or to discuss use of the PRS™-probes in your research, please contact us at:***

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