Surface Nutrient Enrichment in a Long-Term Zero-Till Soil

Elliott Hildebrand[1], Edgar Hammermeister[1], and Eric. Bremer[2]
[1] Western Ag Professional Agronomy; [2]Western Ag Innovations, Inc.

Introduction

Long-term zero-till soils are characterized by surface nutrient enrichment from a lack of significant soil mixing.

- Ion exchange membranes, such as Plant Root Simulator (PRS™) probes, are useful for measuring soil nutrient bioavailability.
- A single site year in southern Alberta was studied to assess the nutrient supply contribution from various surface depths.

Materials & Methods

A field in southern Alberta that was under zero-till management for at least 25 years was sampled on June 11, 2015. Low disturbance openers had been used for the last 8 years.

- Soil samples were obtained from each sample location from an area of 0.2 m^2 at depths of 0-1”; 1-2”; 2-4”; 4-6” and 6-8”, and pH and EC were also measured at each depth (Table 1).

Table 1: pH and EC for each sampling depth.

Depth	pH	EC
0-1"	5.0	1.1
1-2"	4.9	0.3
2-4"	5.0	0.2
4-6"	5.4	0.2
6-8"	6.0	0.1

- The field was in peas in 2014 and flax in 2015.
- Nitrogen fertilizer (90 lbs N ac^{-1}) was broadcast in March, while other nutrients were applied at planting.
- No rainfall had been received in the week prior to soil sampling, and only 1.25” had been received in the previous month.
- Although there was a thick layer of crop residue at the surface, the top inch of soil was close to air-dry, while deeper layers were approximately at half of field capacity.
- Under controlled conditions, PRS probes were buried for a one-day period in unwetted (1 rep) and wetted (4 reps) samples.
- A weight (~10 lbs) was placed on unwetted samples to ensure effective soil:membrane contact.

Results & Discussion

Wetting of soil substantially increased nutrient supply rate of all nutrients in surface soil layers, but most nutrients had low supply rates at deeper layers, even if wetted (Figure 1). The only exceptions were Ca, Mg and S, which typically have large reserves at depth.

- Thus, soil surface layers are major contributors to crop nutrition, even in drought years. When unwetted, soil nutrient supply rates were as high or higher in the top 2” than at lower depths, despite being substantially drier. When wetted by a rainfall event, surface depths had large and rapid increases in nutrient supply rate.
- Soil sampling that missed the top inch of soil would have reduced soil nutrient supply rates by 32 to 46% for N and micronutrients (Table 2).
- Most of the N was present as NO_3-N (98%), but NH_4-N in surface inch of wetted samples was 3-fold higher than dry or lower depth samples.
- The dry spring elevated soil N supply in the surface inch due to surface drying (movement of ‘salt’ to surface , lack of root activity and rapid mineralization when dry soils are wetted.

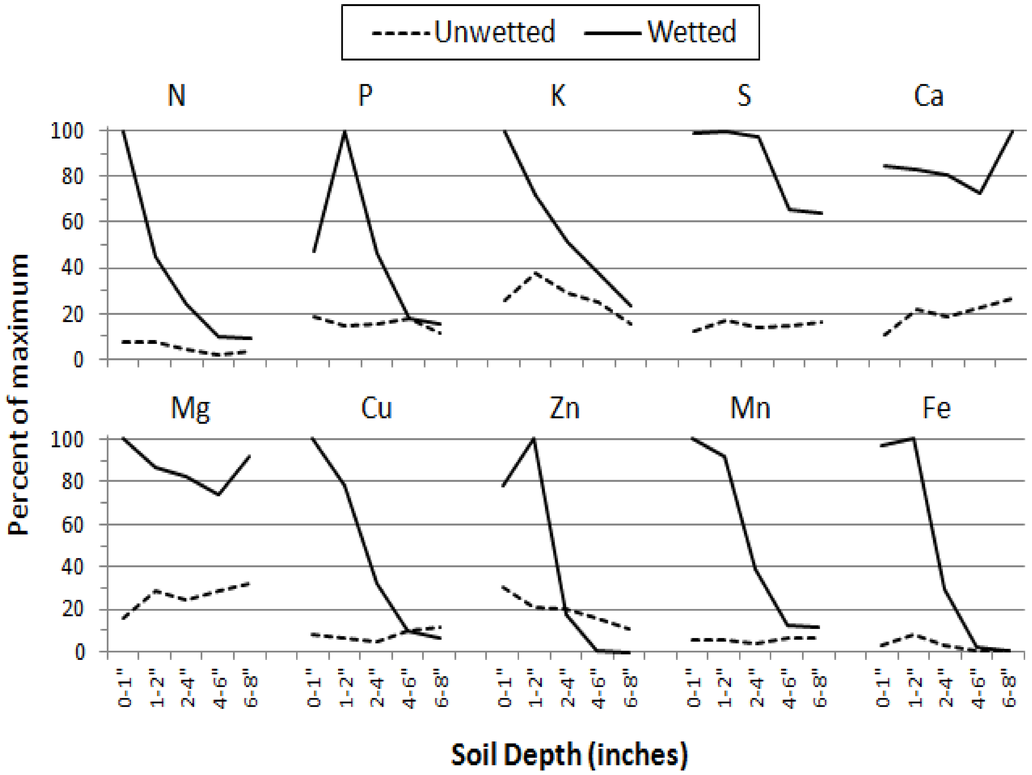


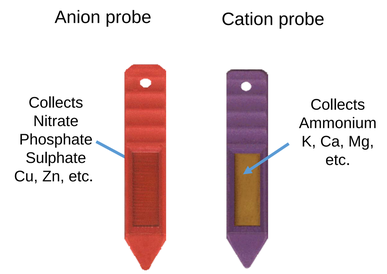
Figure 1 Relative rates of soil nutrient supply as affected by wetting and soil depth.

- High micronutrient supply rates in the surface inch attributed to acidic pH, low redox potential caused by pulse of microbial activity when dry soils are wetted, and high organic matter.

Table 2: Percent decline in soil nutrient supply rate if top 1" was missed*

Nutrient	%
N	46
P	12
K	23
S	8
Ca	4
Mg	7
Cu	37
Zn	37
Mn	37
Fe	32

*Compared to surface 4" sample



Conclusions

- ***The upper*** layers of long-term zero-till soil under a low disturbance management system are major contributors to crop nutrition, even in a dry year.
- PRS-probes detected a large increase in nutrient supply when soil was wetted.