Phosphorus movement in frozen and unfrozen soil under no-till agricultural management with different fertilizer application strategies

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Background

- Phosphorus (P) from agriculture contributes to P loading of surface waters and supports algal growth
- Tile drains are an important pathway for P in no-till soils, particularly when P is broadcast [1]
- P losses to tile drains were not enhanced under no-till when P was applied in a subsurface band [2]

Objectives

1. To quantify the mobilization of P through the soil profile under different P application strategies (**surface broadcast vs subsurface placement**) on no-till soil, and determine if this differs between soil textures (**clay vs silt loam**)
2. To investigate the movement of water through soils under different antecedent temperature conditions (**frozen vs unfrozen**)

Methods

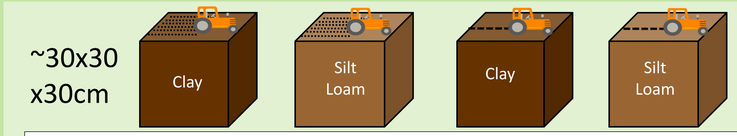

Fig. 1. Intact no-till clay and silt loam soil monoliths were fertilized via surface broadcast or subsurface placement in a laboratory.

Monoliths were fertilized (97kg/ha) (Fig. 1) and subjected to a simulated non-growing season, including 6 rainfall events and freeze thaw cycling (Fig.2)

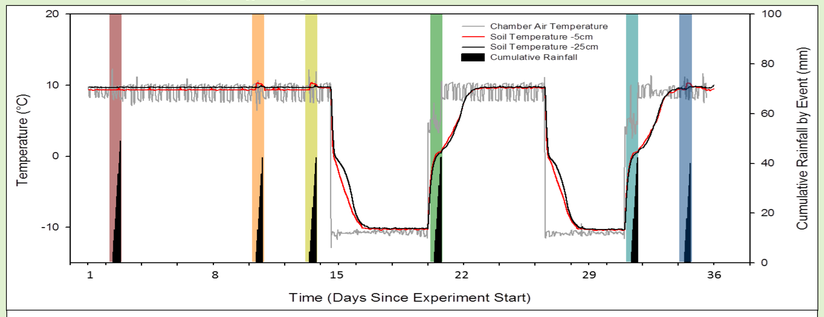

Fig. 2. Chamber air temperature, soil temperature, and rainfall events over the simulated non-growing season.

Results

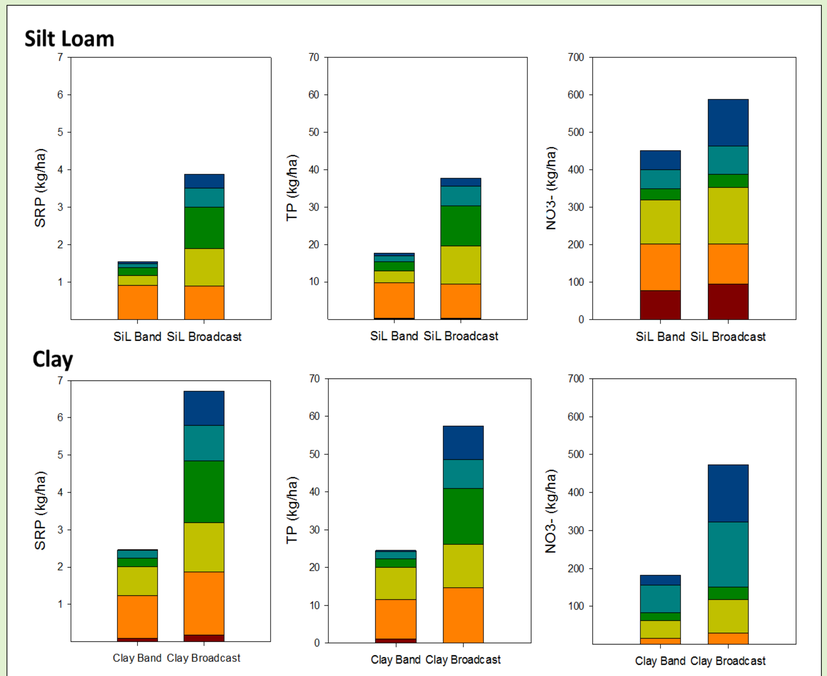

Fig. 3. Comparison of SRP, TP and NO_3^- (kg/ha) losses between fertilizer application method and soil type.

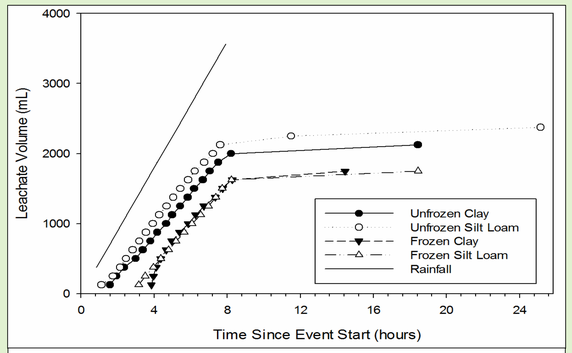

Fig. 4. Average timing of drainage of soil across unfrozen and frozen events, compared to rainfall inputs.

Events

1	2	3	4	5	6
• Saturated unfrozen soil. Unfertilized.	• Unfrozen soil.	• Unfrozen soil.	• Frozen soil.	• Frozen soil.	• Saturated unfrozen soil.

- Subsurface placement (banding) application resulted in reduced SRP, TP and NO_3^- loss across all events and soil types (Fig. 3)
- Drainage began later in frozen soil compared to unfrozen soil, and resulted in a lower volume of water collected (Fig. 4)

Conclusions

- Fertilizer placement in no-till soils influences subsurface nutrient losses
- Farmers in Ontario should consider **subsurface placement** of fertilizer to reduce nutrient losses on no-till fields, particularly when applying in the fall

Next steps

- To relate the movement of P and subsurface flowpaths through analysis of conservative water tracers on frozen and unfrozen ground.

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Works Cited

[1] Williams, M.R., King, K.W., Ford, W., Buda, A.R. and Kennedy, C.D., 2016. Effect of tillage on macropore flow and phosphorus transport to tile drains. *Water Resources Research*, *52*(4), pp.2868-2882.

[2] Lam, W.V., Macrae, M.L., English, M.C., O'Halloran, I.P. and Wang, Y.T., 2016. Effects of tillage practices on phosphorus transport in tile drain effluent under sandy loam agricultural soils in Ontario, Canada. *Journal of Great Lakes Research*, *42*(6), pp.1260-1270.