Tile Drainage in Vertisolic Clay Soils of Near-Level Southern Manitoban Landscapes –Implications for Runoff and Water Quality

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Introduction

- Climatic models predict an increased frequency of spring and summer storms in the Red River Valley (RRV).
- Tile drainage is expanding in the RRV
- On the other hand, the eutrophication of Lake Winnipeg and other freshwater bodies in the region is a current environmental issue
- Research from elsewhere indicates that clays are prone to preferential flow, which means more tile P into waterways

Objectives

- To assess the activation of runoff pathways relative to hydroclimatic drivers
- To quantify relative contributions of overland flow and tile flow to edge of field runoff and nutrient losses

Study Site & Methods

- A working farm field in Elm Creek, Manitoba
- Gleyed humic vertisols (Red River series)
- Canola in 2015, spring wheat in 2016 and soybeans in 2017
- Tilled to 15 cm in fall
- Mineral fertilizer application

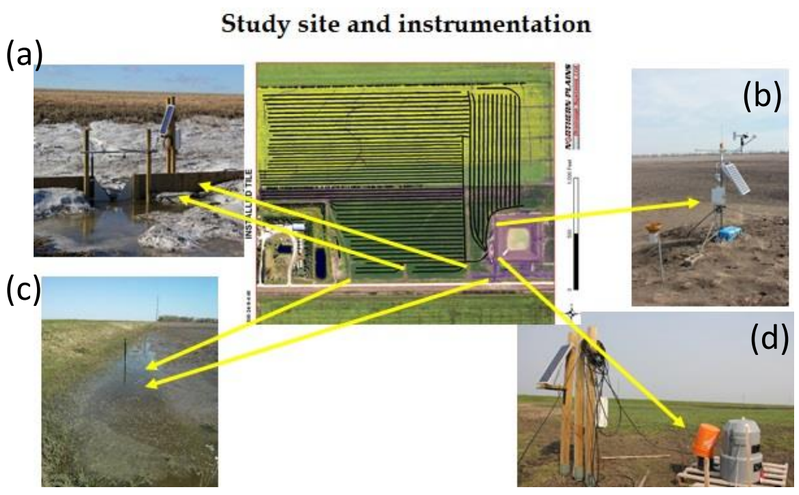

Figure 1. Study site and instrumentation. a. Overland flow monitoring station b. weather station c. ditch monitors d. tile flow monitoring station

- Runoff was monitored for quantity and quality from 2015 to 2017
- Events covered ranged from annual spring snowmelt to spring multiple-day storms to high-intensity thunderstorms

Acknowledgements

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Results & Discussion

Pathway Activation

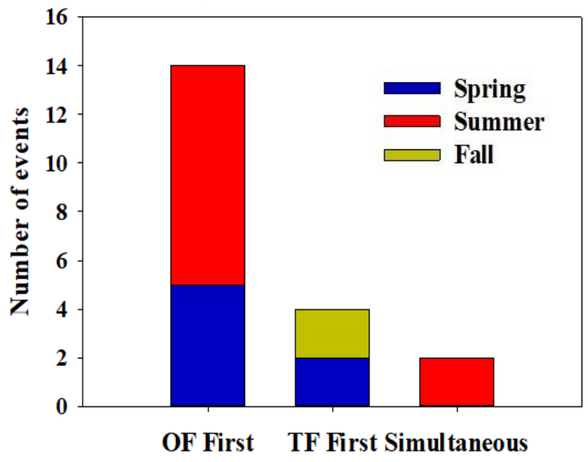

Figure 2. Relative activation of overland flow (OF) and tile flow (TF).

- Rapid overland flow (OF) activation observed during high intensity rainfall events (> 15 mm/hr) or during rain on partially frozen ground.
- Tile flow (TF) activation hastened by both antecedent moisture and rainfall intensity
- Soil profile wetted up from "top down"
- Early TF due to vertical preferential flow through desiccation cracks was uncommon

Runoff

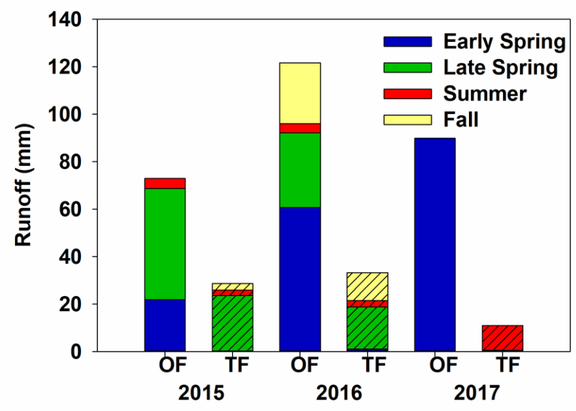

Figure 3. Comparison of runoff from overland flow (OF) and tile flow (TF).

- OF >>> TF
- OF significantly contributed to snowmelt runoff with little TF (< 2% of snowmelt runoff).
- TF volumes were comparable to OF during warmer periods
  - 36 % in 2015
  - 35 % in 2016
  - 100 % in 2017

Phosphorus Losses

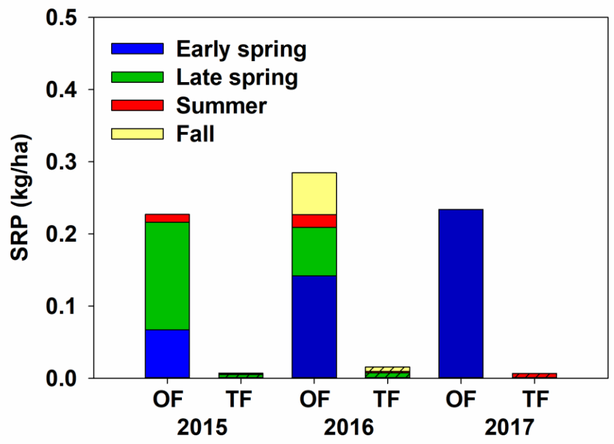

Figure 4. Annual soluble reactive phosphorus (SRP) loads from OF and TF

Nitrogen Losses

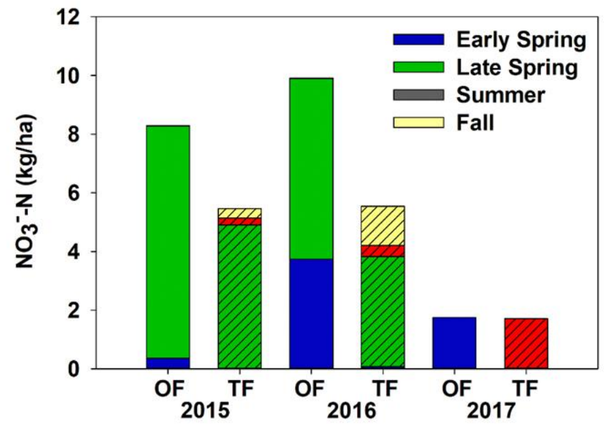

Figure 5. Annual nitrate (NO_3-N)loads from OF and TF

- OF SRP and TP concentrations were significantly greater than TF (5 – 6 times). Therefore, OF was responsible for > 95 % of the annual edge of field P losses (Figure 4).
- But, TF nitrate concentrations were generally greater than OF. TF was responsible for 40-50 % annual edge of field nitrate losses despite contributing to 11- 28 % annual edge of field runoff

Conclusions

- Installation of tile drainage in the vertisolic soils of this region did not affect the frequent activation of OF.
- OF was still the major runoff pathway for runoff and edge of field P losses.
- Tile contribution to the edge of field P losses is minimal when compared with OF. However, tiles may increase N losses.
- Further research is needed in this region to asses the role of tile drainage with conjunction with other farm management practices (e.g. tillage, manure).

References

[1] Kokulan, V., Macrae, M.L., Lobb, D.A., & Ali, G.A. (2019). **Contribution of overland and tile flow to runoff and nutrient losses from Vertisols in Manitoba, Canada**. J. Enviro. Qual. 48(4):959-965.

[2] Kokulan, V., Macrae, M.L., Ali, G.A., & Lobb, D.A. (2019). **Hydroclimatic controls on runoff activation in an artificially drained, near-level vertisolic clay landscape in a Prairie climate**. Hydrol. Process. 33(4):602-615.