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Nutrient retention potential of prairie filter strips on marginal lands within conventional farms

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Theory / Method / Workflow

Eutrophication has detrimental environmental and economic impacts globally. With greater food demands, inputs are predicted to increase, thus, highlighting one of the great needs in farm re-design: nutrient retention. The purpose of this study is to address whether incorporating native prairie tallgrass strips on farms have the potential to mitigate nutrient transport through surface and sub-surface flow paths in both clayey and sandy textured agricultural systems in southern Ontario. It was hypothesized that prairie tallgrass strips will reduce effects of nutrient leaching to groundwater through their greater rooting depths and dense rooting network, which facilitate nutrient uptake and water retention. To test this hypothesis, water quality on farms, both surface and sub-surface samples, were collected (July 2018 – October 2018; April 2019 – April 2020) from corn fields and adjacent prairie tallgrass strips and analyzed for dissolved nitrogen and phosphorus. Nitrogen and phosphorus concentrations in shallow groundwater of both the cropped field and downgradient tallgrass prairie strip were measured to quantify the nutrient retention abilities of native prairie strips. Additionally, in both corn and prairie areas, plant aboveground and belowground biomass, and plant and soil nitrogen and phosphorus were measured.

Results, Observations, Conclusions

Under sandy soil, shallow groundwater nitrogen transport from the crop field exceeded recommended guidelines for safe drinking water (related to nitrate-N; ~12 mg/L leached vs recommended levels < 10 mg/L). During peak biological uptake in 2018 (July – August), incorporating tallgrass prairie strips of buffer lengths: 2 m, 4 m, and 8 m, downgradient of the crop field, reduced nitrate concentrations by 56%, 58%, and 75%, respectively, relative to the values in the groundwater at the cropped edge. However, during peak biological activity in 2019, which was a year with greater precipitation than 2018 during the growing season, prairie strips showed no retention of nitrogen or phosphorus (Figure 1). During the 2019 growing season, phosphorus concentrations in shallow groundwater of both cover types exceeded recommended concentrations known to support algal blooms (related to orthophosphate; ~0.5 mg/L leached vs recommended total P levels < 0.05 mg/L).

Within a clayey soil, shallow groundwater nitrogen concentrations were minimal in both cover types (< 1 mg/L), highlighting the biogeochemical processes that govern nitrogen under those environmental conditions. Phosphorus concentrations in shallow groundwater of both cover types exceeded recommended levels (related to P; ~0.4 mg/L). There was no significant retention interaction between nitrogen and phosphorus concentrations and incorporated tallgrass prairie strips under clayey soil.

Novel/Additive Information

This study provided baseline measures of shallow groundwater leaching of soluble nitrogen and phosphorus under differing geologies in southern Ontario (sandy soil, clayey soil), and highlighted that phosphorus is more mobile in groundwater than previously thought, with observed concentrations above the provincial water quality objective. Additionally, tallgrass prairie strips were an effective strategy in improving agricultural sustainability through enhancing terrestrial nutrient retention under sandy soils. Nutrient retention abilities of prairie strips can be further enhanced by including prairie species with diverse phenologies in order to capture nitrogen and phosphorus leaching earlier in the spring where most nutrient loading occurs to aquatic systems.

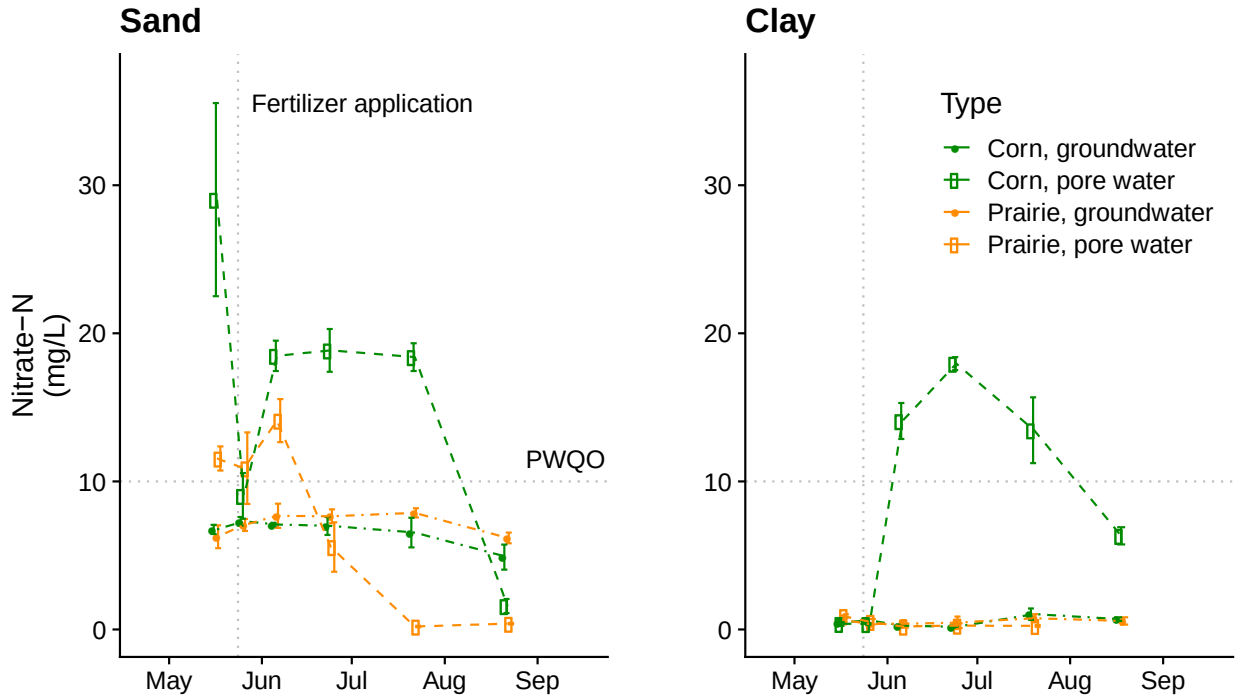

Figure 1. Nitrate-N concentrations of pore water and groundwater over the growing season in a sandy and clayey agricultural system in southern Ontario. Provincial Water Quality Objective (PWQO) of 10 mg/L nitrate-N. Fertilizer application on May 23rd at both sites.

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