Trees and Grasses on Nitrogen and Phosphorus Filtration from Shallow Groundwater on a Rotational Grazing Hillslope Landscape

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Introduction

- Agricultural practices are known for nutrient and sediment export to water bodies via runoff and leaching.
- Elevated nitrogen (N) and Phosphorus (P) concentration in groundwater can affect human and ecosystem health.
- Once contaminated, groundwater treatments are costly.
- Therefore, low cost strategies that trap nutrients before groundwater contamination are essential for human and ecosystem health.

Objective

The main objective of this study was to determine the effects of agroforestry and grass buffers on N and P concentrations in shallow groundwater in two watersheds on a hillslope.

Materials and Methods

- The study watersheds are located at the Horticulture and Agroforestry Research Center (HARC), New Franklin, Howard County, MO (39°01'05" N, 92°45'34" W) (Fig. 1).
- The two study watersheds are under rotational grazing (each 107-m long and 75-m wide). The total width was divided into a 60-m wide grazing area and a 15-m wide buffer area.
- Buffers of the agroforestry (AG) and grass buffer (GB) watersheds contained tree+grass and grass only, respectively.
- The GB treatment consisted of tall fescue [*Schedonorus phoenix (*Scop.) Holub], red clover (*Trifolium pretense* L.), and lespedeza (*Lespedeza* Michx) and the AG treatment consisted of cottonwood (*Populus deltoides* Bortr. ex Marsh.) and the same grasses with the GB.
- Water samples were collected from 11/9/2019 to 24/11/2020 from three wells on each watershed, representing summit, backslope, and foot slope positions.
- Weekly water samples were analyzed for total nitrogen (TN), dissolved nitrogen (DN), total phosphorus (TP) and dissolved phosphate (DP) concentrations to evaluate treatment and landscape, and seasonal effects.

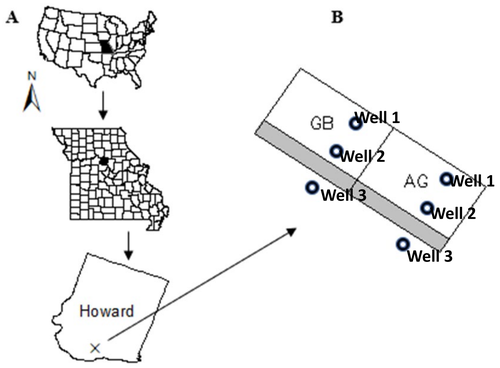

Fig. 1. The inset map shows the location of the Missouri State in USA, Howard County in Missouri, and the Horticulture and Agroforestry Research Center (HARC) in Howard County (A). Locations of the agroforestry (AG) and grass buffer watersheds (GB). The hollowed circles represent the well locations at three landscape positions summit (1), backslope (2), and foot slope (3) on the AG and GB watersheds (B). The gray polygons represent the buffers and the white polygons the grazing areas

Results and Discussion

- Dissolved and total N were consistently reduced after groundwater passed through the AG and GB treatments. The TN and DN were the parameters reduced the most, and the AG treatment showed the greatest N reductions (Fig. 2).
- The summit well in the AG treatment had average TN and DN concentration of 12.94 ± 2.95 and 4.34 ± 0.20 mg L^{-1}, respectively. In contrast, the foot slope well had average TN and DN concentrations of 1.72 ± 0.39 and 0.06 ± 0.01 mg L^{-1}, respectively (Fig. 3).
- The summit well on the GB treatment presented an average TN and DN concentration of 3.83 ± 0.37 and 2.18 ± 0.09 mg L^{-1}, while the foot slope well on the same treatment had average TN and DN concentrations of 1.49 ± 0.19 and 0.08 ± 0.01 mg L^{-1} (Fig. 3).
- Total P reductions were not consistent for both treatments. The average DP in the GB treatment in the summit well was 0.76 ± 0.11 and 0.47 ± 0.09 mg L^{-1} in the foot slope well (Fig. 3). In contrast, no DP reductions between the summit and foot slope well in the AG were reported.

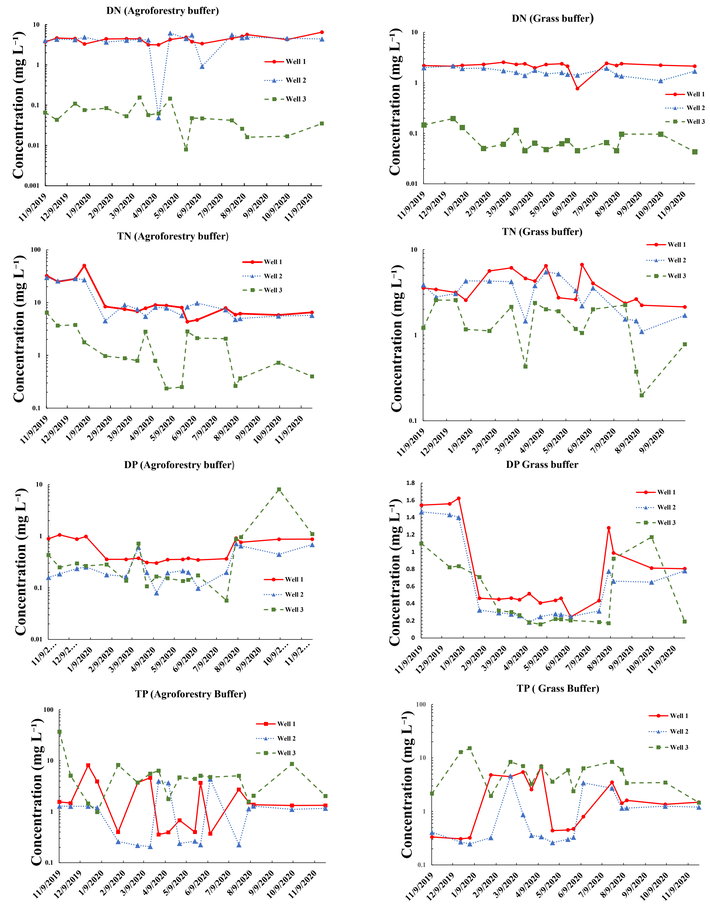

Fig. 2. The concentrations of TN, DN, TP, and DP in mg L^{-1} for the AG watershed (left) and the grass buffer watershed (right) at summit (1), backslope (2), and foot slope (3) wells.

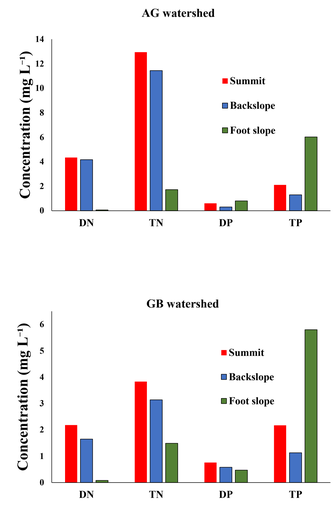

Fig. 3. The average concentrations of DN, TN, DP, and TP during the study period at three landscape positions of the two watersheds.

Conclusions

- The average concentrations of DN and TN after groundwater passed through the AG treatment were 98 and 87% lower than at the summit position.
- The average concentrations of DN and TN after groundwater passed through the GB were 96 and 61% lower than at the summit position.
- The average DP and TP concentrations in groundwater increased by 33 and 185 % after groundwater passed the AG buffers compared to the summit position.
- The average DP in groundwater at the summit position decreased by 38% after the GB, while the TP concentration increased by 167% after the buffer compared with the concentration at the summit position.
- The AG treatment showed slightly greater reductions that the GB.

References

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Acknowledgements

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