

Water Quality Gains Improve over Time in No-Till Systems: But Fall Broadcast Phosphorus Still Drives Losses

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Background

- No-till systems reduce soil disturbance, maintaining surface residue cover that protects soil from erosive forces.
- No-till systems also reduce surface runoff and sediment losses by enhancing infiltration, resulting in smaller particulate phosphorus (P) losses.
- However, stratification of P in the topsoil can occur in long-term no-till systems, potentially increasing soluble reactive P (SRP) losses.
- Some standard management practices in no-till systems, such as fall P broadcast, can also affect water quality.

Research Questions

- Does no-till implementation impact topsoil soil test P (STP) concentrations over time?
- Does no-till adoption reduce P, sediment and nitrate concentrations in tile drainage?
- What are the implications of fall P fertilizer broadcast to runoff water quality?

Materials and Methods

- Long-term soil and water quality monitoring at two adjacent working farms (Merlin A and Merlin B) in Chatham, Ontario, under On-Farm Applied Research and Monitoring (ONFARM) and Lake Erie Advanced Analysis of Agricultural Practices (LEEAAP) initiatives.
- Merlin A followed conventional tillage until the 2023 spring. The grower adopted no-till since then. Monoammonium phosphate (MAP) is broadcast every fall.
- Merlin B is a long-term no-till grower field. This field did not receive the fall P application in 2024. However, P was applied in the fall of 2025 before winter wheat planting.
- Water samples are being collected at two tile outlets from each field and analyzed for SRP, total P (TP) and nitrates.
- Topsoil samples (0-15 cm) are collected from sites in the spring and analyzed for Olsen STP.



Figure 1. Study sites at Merlin: (a) Merlin with runoff monitoring instrumentation housed in small protective shelters; (b) Merlin B, a long-term no-till site. Both sites are cropped with winter wheat for 2026.

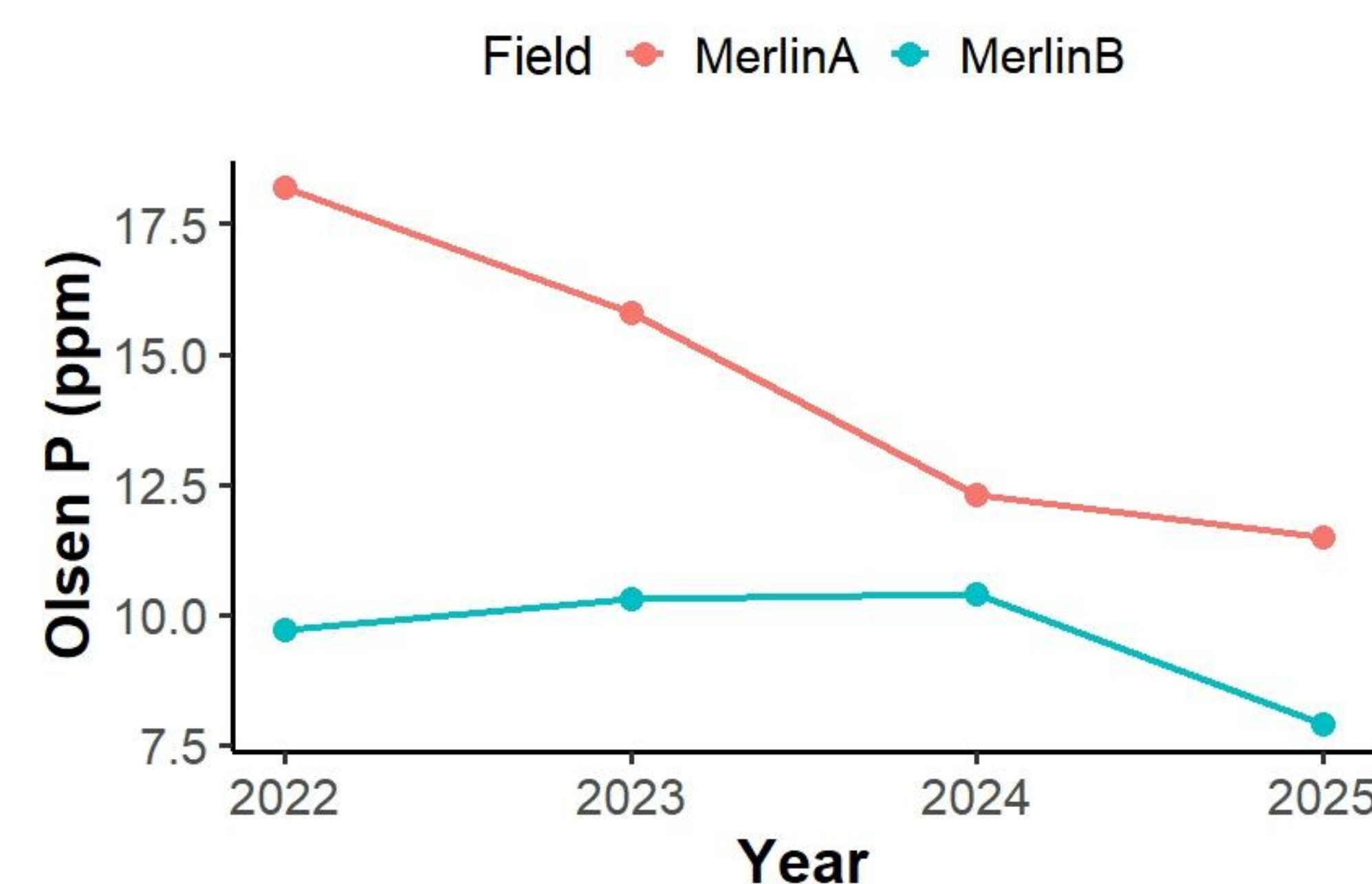


Figure 2. Topsoil Olsen P concentrations of Merlin A and Merlin B

- ✓ Olsen P concentrations from the recent no-till field (Merlin A) declined over the years. Long-term no-till field (Merlin B) Olsen P was relatively small and did not show P accumulation (Figure 2).
- ✓ The decrease in Olsen P concentrations did not correspond to tile flow, as the non-growing season (NGS) soluble reactive phosphorus (SRP) concentrations in 2024 and 2025 were significantly higher in Merlin A compared to 2019, when conventional tillage was used (Figure 3).
- ✓ Interestingly, a decline in Total Suspended Sediments (TSS) concentrations indicated reductions in runoff sediment losses due to no-till (2024 and 2025) and winter wheat (2025).
- ✓ However, fall broadcasting of MAP appeared to be increasing SRP losses from this site during the NGS.

Results and Discussion

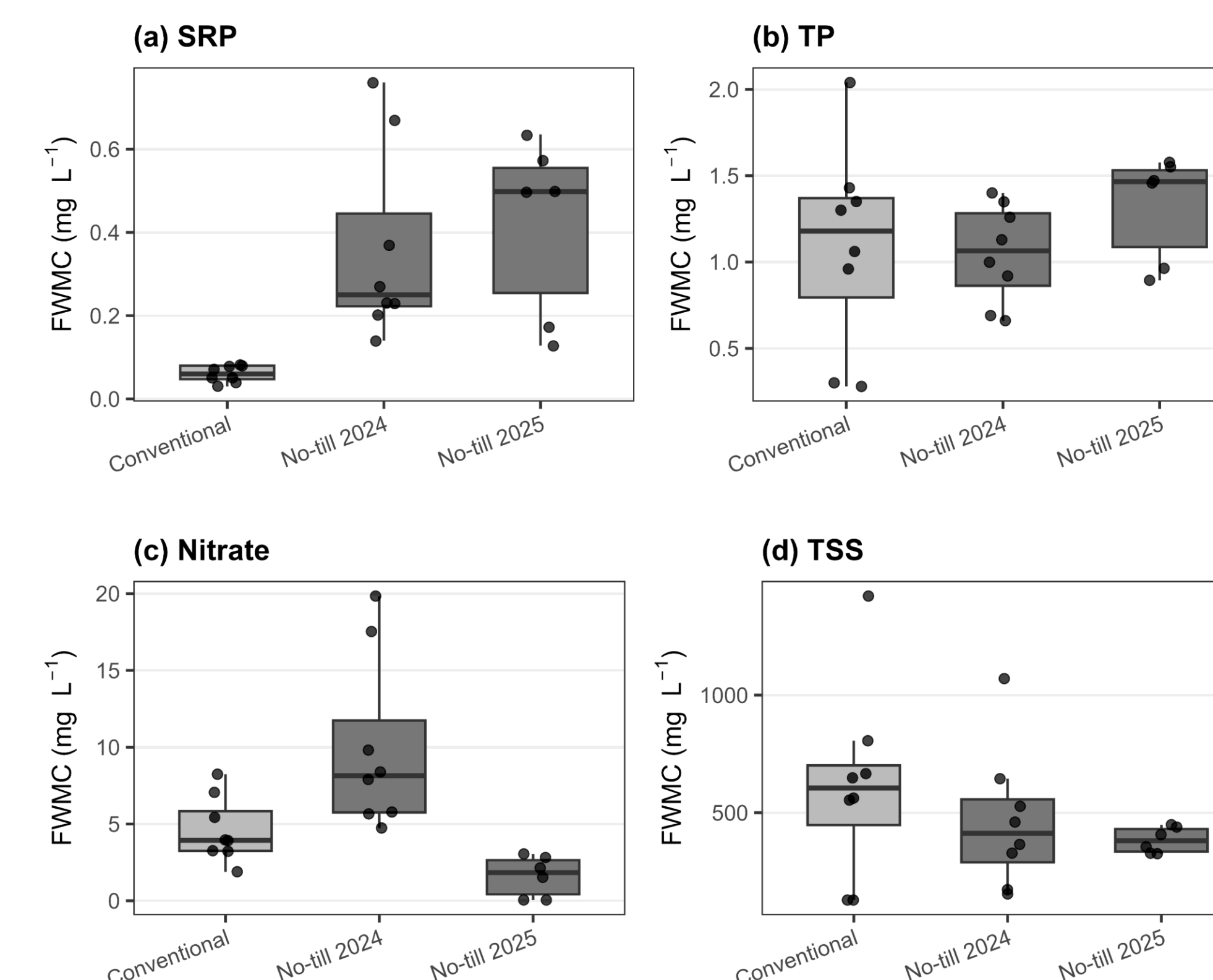


Figure 3. Flow-weighted mean concentrations (FWMC) of tile TP (a), SRP (b), nitrate (c), and total suspended sediments (TSS) for the non-growing season events in 2019 (under conventional tillage) and 2024 and 2025 (under no-till) at Merlin A.

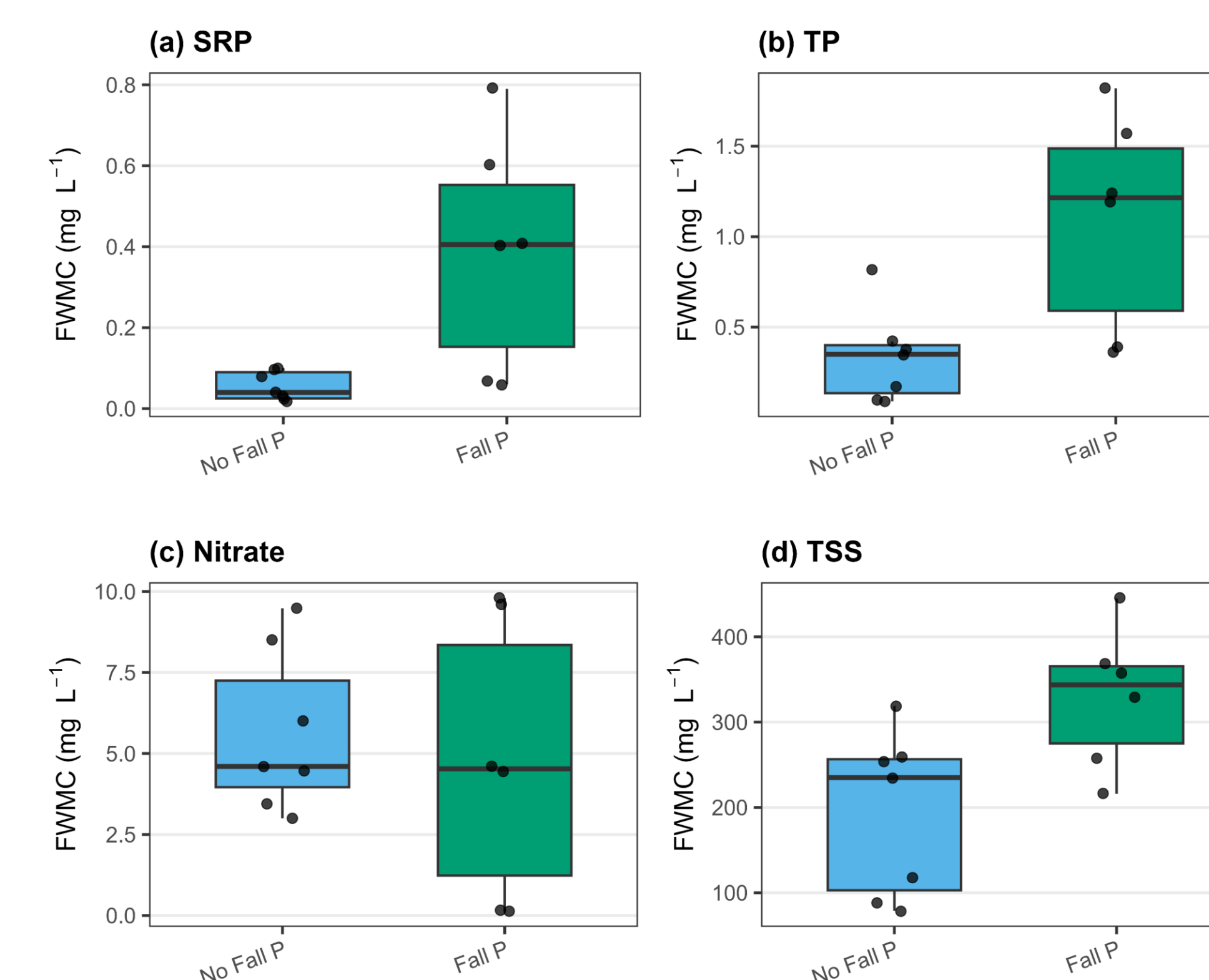


Figure 4. Flow-weighted mean concentrations (FWMC) of tile TP (a), SRP (b), nitrate (c), and total suspended sediments (TSS) for the non-growing season events in 2024 (no-till, no fall P) and 2025 (no-till, fall P) at Merlin B.

- ✓ Both SRP and TP concentrations and loads were substantially lower for Merlin B in 2024, when compared to Merlin A (Figures 3 and 4). However, P concentrations and loads increased in 2025 for Merlin B, potentially due to Fall P application (Figure 4).

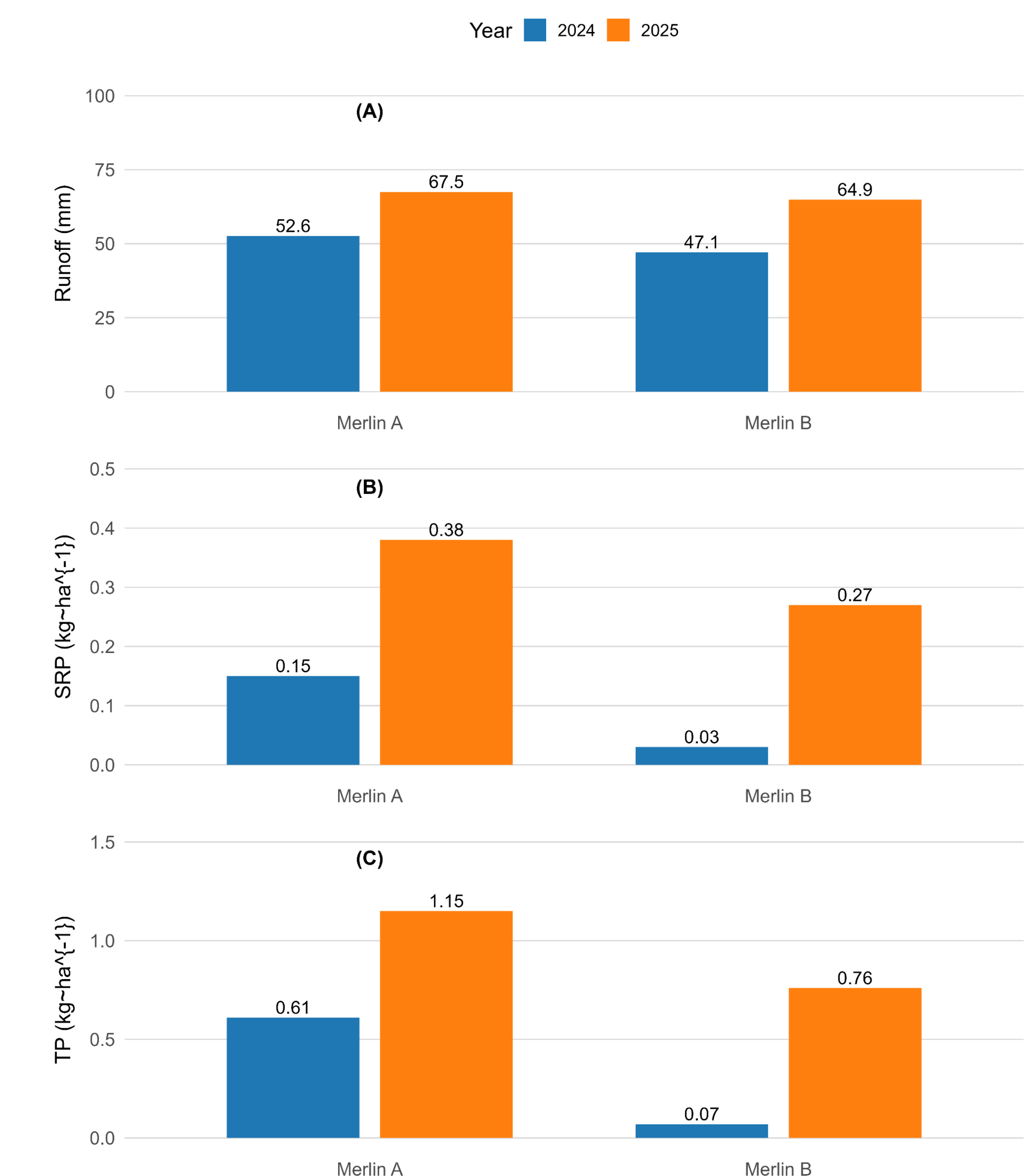


Figure 5. Tile runoff (a), SRP (b) and TP (c) losses from Merlin A and B during the three largest non-growing season events in 2024 and 2025.

Conclusions

- ✓ The adoption of no-till farming did not lead to an increase in soil test P concentrations at any of our sites.
- ✓ During the non-growing season, tile P losses were significantly reduced when no fall P fertilizer was applied.
- ✓ In contrast, broadcasting P fertilizers in the fall resulted in substantial increase in non-growing season SRP concentrations and losses.
- ✓ Applying P fertilizers in the spring or using subsurface placement may help reduce P runoff losses.
- ✓ The OSCIA and LTVCA will monitor soil and water quality at these sites through 2027.

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