

What caused pervasive groundwater nitrate contamination in Prince Edward Island: fertilizer or forage legume?

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Summary

Excessive nitrate leaching from intensive potato production has been linked to pervasive groundwater nitrate contamination in Prince Edward Island (PEI). However, the controls of excessive nitrate leaching from the industry standard potato-grain-forages rotation remained poorly understood although the problem has been researched since the 1990s, limiting the development of effective mitigation strategies.

Theory / Method / Workflow

A field trial was conducted to identify the controls of nitrate leaching from the rotation in PEI from 2014 to 2017. A complete random split plot design with three replicates was adopted to assess nitrate leaching and potato yield under fall vs. spring forages plowing (main factor) and varying fertilizer N rate (second factor). A stainless steel lysimeter was installed in each plot to collect soil water to test nitrate concentrations in leachate. In addition, crop tissue and soil samples were collected and used to conduct nitrogen budget analysis.

Results, Observations, Conclusions

Nitrate leaching occurred primarily between late fall, after the potato harvest, and in spring. Fall plowing produced significantly higher nitrate leaching in the red clover phase than spring plowing, but the nitrate leaching in the following potato phase was 2 to 3 orders as much as those in the red clover and barley phases regardless of implementing fall or spring plowing. This highlights that mitigating nitrate leaching in the potato phase is more imperative than in the grain and forage phases. The N accumulation in the red clover (fixation plus uptake) was (176-252 kg N/ha) higher than the potato plant N uptake levels (111-154 kg N/ha). Nitrogen supply from the preceding red clover could be much higher than the current provincial recommended level (17 kg N/ha). This study demonstrated that fertilizing by following the current provincial recommendation (i.e. 185 plus 17 kg N/ha credit from the preceding red clover) significantly underestimated in-season N supply from the red clover to the potato crops, translating into over-fertilizing situations. These situations not only resulted in excessive nitrate leaching in the potato phase but also suppressed potato yield as over-fertilizing limited the commonly-planted long-season Russet Burbank potatoes from being fully mature under a shorter growing period in this temperate climate region.

Novel/Additive Information

These data imply that either reducing fertilizer input by accounting more N supply from the plowed-down forage legumes regardless of implementing spring or fall plowing or excluding legumes from the rotations is critical to mitigate nitrate leaching while enhancing potato productivity.

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References

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