Using a Process-based Model to Evaluate the Effects of Several Nitrogen Fertilizer Management Practices on Nitrous Oxide Emissions and Grain Yield

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INTRODUCTION

- Agricultural production is the main contributor to nitrous oxide (N_2O) emissions
- Corn crops receive high amounts of nitrogen (N) fertilizer which leads to high N_2O emissions
- Proper N fertilizer management can reduce significant amounts of N_2O emissions
- The process-based model , DeNitrification DeComposition (DNDC), can predict the outcomes of different agricultural management practices
- The hypothesis tested was that using a combination of management practices for N fertilizer application will reduce N_2O emissions and simultaneously increase grain yield

METHODS

- Two data sets of field measurements were used in this study
- The first data set corresponds to a study carried out at the Elora Research Station in Ontario, Canada[1]
- The second data corresponds to a study that took place in Woodslee, Ontario, Canada[2]
- The model was calibrated and validated using the Woodslee and Elora data
- The 9 scenarios ran through DNDC differ in: the timing of fertilizer application, fertilizer rate, number of applications, fertilizer type, method of application, and use of inhibitors
- These management scenario s were ran for the original crop rotations, short-term monocultures and then for long-term monocultures
- Yield-scaled emission factors were calculated for long-term scenarios, which is done by dividing cumulative N_2O emissions by grain yield

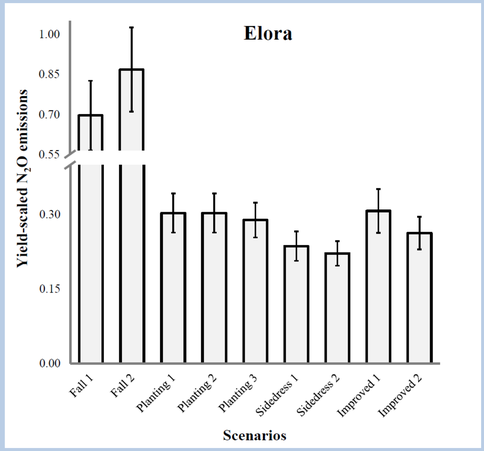
REFERENCES

1. Wagner-Riddle, C., A. Furon, N.L. Mclaughlin, I. Lee, J. Barbeau, S. Jayasundra, G. Parkin, P. von Bertoldi, and J. Warland. 2007. Intensive measurement of nitrous oxide emissions from a corn–soybean–wheat rotation under two contrasting management systems over 5 years. Global Change Biology 13:1722-1736.

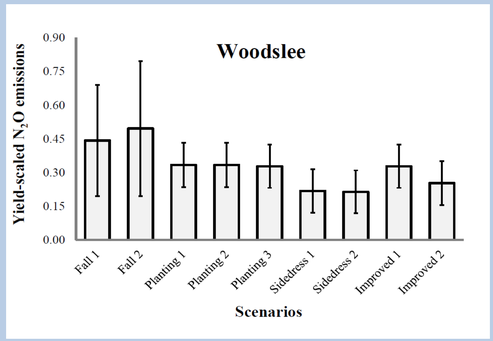
2. Drury, C.F., W.D. Reynolds, C.S. Tan, T.W. Welacky, W. Calder, and N.B. McLaughlin. 2006. Emissions of nitrous oxide and carbon dioxide. Soil Science Society of America Journal 70:570-581.

RESULTS

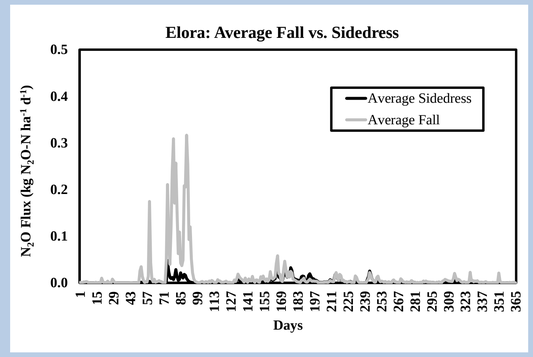
- The N_2O emissions and grain yields were simulated by DNDC with reasonable root mean square error values
- Grain yields were close to optimum values (for the region under study) for all scenarios
- These N fertilizer management scenarios do not appear to have much effect on grain yield



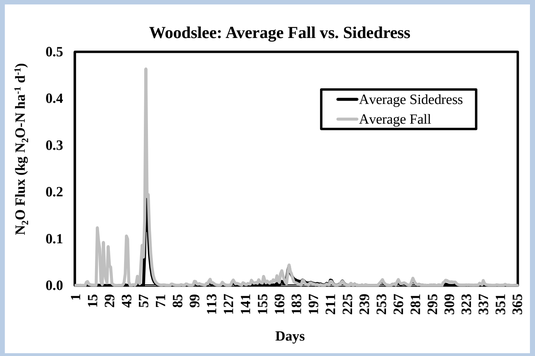
Yield-scaled N_2O emissions (kg N_2O-N Mg yield^{-1}) for long-term simulations in Elora for each practice. The bars represent standard error between the simulated years to show yearly variation



Yield-scaled N_2O emissions (kg N_2O-N Mg yield^{-1}) for long-term simulations in Woodslee for each practice. The bars represent standard error between the simulated years to show yearly variation.



The average of Elora's Fall 1 and Fall 2 daily N_2O emissions vs. the average of Side-dress 1 and Side-dress 2 daily N_2O emissions from the long-term simulations. This figure shows the differences in spring-thaw emissions (November to April) between management practices.



The average of Woodslee's Fall 1 and Fall 2 daily N_2O emissions vs. the average of Side-dress 1 and Side-dress 2 daily N_2O emissions from the long-term simulations. This figure shows the differences in spring-thaw emissions (November to April) between management practices.

CONCLUSIONS

- Practices that should be encouraged:
  - Side-dress applications of N fertilizers
  - Use of urease and nitrification inhibitors
  - Slight reductions in N rates
- This study shows that when multiple N_2O mitigation practices are combined they may be able to mitigate larger amounts of N_2O than when only one is implemented