J3.3 FIELD EVALUATION OF METHODS FOR REDUCTION OF N_2O EMISSIONS

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1. INTRODUCTION

Conservation tillage is being promoted as a means of carbon sequestration. There is currently some debate of the effects of no-till on nitrous oxide (N_2O) emissions. Mummey et al. (1998) noted that N_2O emissions increased with no-till while Kessavalou et al. (1998) found N_2O emissions to decrease with no-till. Increases in N_2O emissions with minimum tillage would counter benefits to carbon sequestration.

Possible mitigation strategies for reduction of N_2O emissions therefore need to be investigated. Understanding the factors controlling N_2O release will help predict and explain the final outcome of this study. Management practices influencing the nitrification and denitrification processes are of particular importance as they are the main source of N_2O in agricultural soils.

Micrometeorological methods are preferred in principle as they do not disturb the environment in which the emissions are studied. In addition, it is possible to take rapid, continuous measurements, providing an average flux integrated over a large area and permitting the study of gas fluxes with varying atmospheric and surface conditions (Fowler and Duyzer 1989).

The objectives of this study were to compare nitrous oxide fluxes from two different agricultural management systems (conventional and best management) and to quantify the differences between the two systems.

2. MATERIALS AND METHODS

2.1 Site description

Flux measurements were performed at the Elora Research Station (43^{o}9'N 80^{o}25'W, 376 m elev.), Ontario, Canada, since January 2000. The soil at the site is classified as a Woolwich Silt Loam (Typic Hapludaf) (29% sand, 52% silt, 19% clay), pH of 7.66, 2.69 % total organic C and 0.24 % total organic N.

The experiment is designed as a split plot with four locations with subsampling at each location. The four plots monitored were of 150 m by 100 m (1.5 ha) in size. The fluxes were measured in a corn/ soybean/ winter wheat rotation.

The experiment was comprised of two treatments: conventional practices and best management practices. The best management system included such practices as no-till, fertilizing as recommended by soil samples. The conventional treatment involved spring ploughing, fertilizing as recommended for the crop and fall discing when possible.

In the spring of 2000, corn was planted. The conventional plots were broadcast fertilized at a rate of 150 kg N ha^{-1} at planting. The best management plots were fertilizer injected at a rate of 50 kg N ha^{-1} at the 6 leaf stage. No N fertilizer was applied the following year on the soybean crop. The conventional plots were disced in the fall with one exception. Because of time and weather constraints, it was impossible to disc the plots in the fall of 2000. Best management practices employed a no-till strategy. For weed control, pesticides were used in both treatments.

3.2 Micrometeorological measurements

The vertical gas fluxes were calculated using the flux-gradient method:

$$\text{Flux} = -K\, \partial C/\partial z$$

where K is the eddy diffusivity coefficient
$\partial C/\partial z$ is the concentration gradient

The concentration gradient was determined by measuring the concentration difference, Δ C (ng N_2O m^{-3}), using a tunable diode laser trace gas analyzer (TDLTGA), over a vertical distance, Δ z (m). The N_2O fluxes were calculated as described by Wagner-Riddle et al. (1996). Cup and sonic anemometers were set up in two plots in order to determine K and stability corrections necessary to calculate the fluxes.

The air was sampled at 20 s intervals. Each hour the average nitrous oxide concentration and delta concentration of a particular site were recorded. The TDLTGA operated at a frequency of 10 Hz, resulting in 200 collected data points for each air intake. However, some of these values were discarded because they corresponded to the transition period between the low air intake and the high air intake.

3. RESULTS AND DISCUSSION

During the first year of the rotation (year 2000), highest fluxes were associated with spring thaw (day 60) and fertilizer application (day 160) (Fig. 1). Despite a difference of 100 kg N ha^{-1} applied between the two treatments, preliminary statistical analysis resulted in no significant differences between treatments. Total annual N_2O-N emissions were 4.82 kg N ha^{-1} for the conventional treatment and 4.17 kg N ha^{-1} for the best management treatment.

During the second year of the experiment (year 2001), peak fluxes occurred at spring thaw (day 100) (Fig. 2). Preliminary statistical analysis suggests that the fluxes from the conventional treatment are significantly higher than the fluxes from the best management treatment. The higher annual losses to N_2O emissions in conventional plots (3.25 kg N ha^{-1} vs. 1.82 kg N ha^{-1} in

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best management plots) may be attributed to a fertilization carry over effect from the previous year.

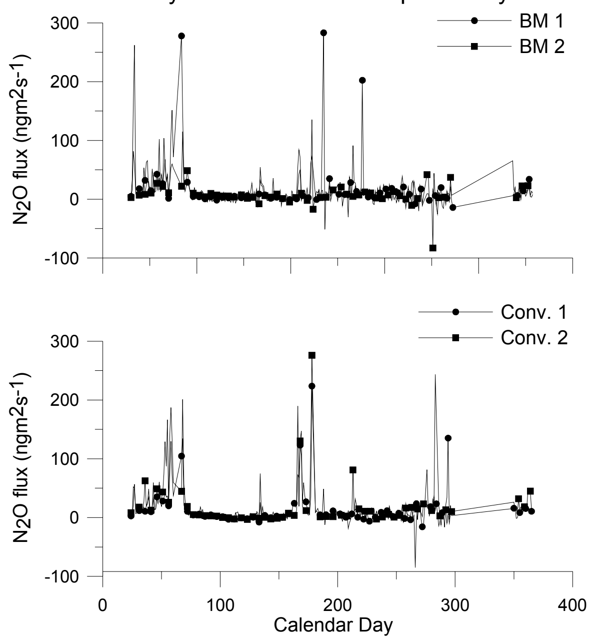

Fig. 1. Comparison of daily N_2O fluxes for year 2000 between the conventional treatment (Conv. 1, Conv. 2) and the best management treatment (BM 1, BM 2).

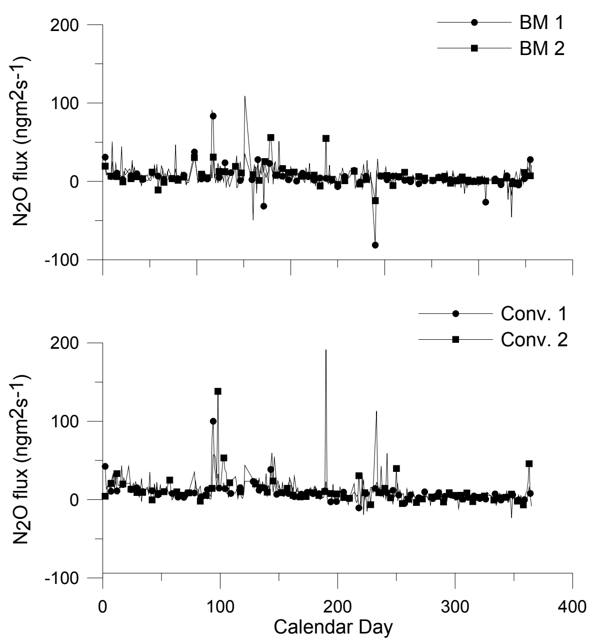

Fig. 2. Comparison of daily N_2O fluxes for year 2001 between the conventional treatment (Conv. 1, Conv.2) and the best management treatment (BM 1, BM 2).

High fluxes corresponding to spring thaw and fertilization have been well documented (Wagner-Riddle et al. 1997, Wagner-Riddle and Thurtell 1998, van Bochove et al. 2001).

The preliminary data analysis suggests that there are significant differences between the two management systems in certain years of a rotation. Further research and analysis is necessary for a more detailed explanation of the results.

4. ACKNOWLEDGMENTS

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