Optimal N Fertilizer Source and Placement for Canola Yield and N_2O Footprint Reduction in Manitoba

Mikhail Maslov and Mario Tenuta

Department of Soil Science, University of Manitoba
E-mail: Mikhail.Maslov@umanitoba.ca

Background

Nitrous oxide (N_2O) emissions from croplands have doubled in the past decades, because of a rise in fertilizer use and higher N use by crops. As a result, the Canadian government has committed to reduce N_2O emissions by 30% in 2030 from the 2020 level. Thus, finding ways to mitigate N_2O emissions without compromising farm profits is urgently important.

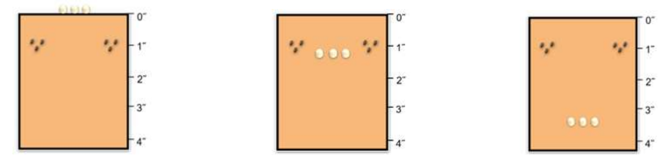
In Western Canada, farmers have increasingly adopted shallower granular urea placement for shallow-seeded crops like canola, reducing depths from 4″ to as shallow as 1″. This represents a departure from the recommended practice of deep banding and may lead to changes in crop fertilizer use efficiency, yield, and N_2O emissions from the soil.

Our purpose was to evaluate the effects of fertilizer source and banding depth on N_2O emissions and canola grain yield depending on soil texture

Experimental Design

Two field trials were established on commercial fields in southcentral Manitoba, one on **clay** soil near Rosser and the other on **sandy** soil near Roseisle.

Treatments were a factorial combination of ***surface broadcasting***, ***shallow-*** and ***deep*** mid-row banded urea, as well as urea and nitrification inhibitor eNtrench NXTGEN™ (active ingredient – Nitrapyrin, 26%).



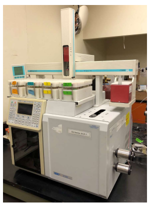
Surface broadcasting **Shallow band** **Deep band**

Canola seeds Urea or Urea + eNtrench

There were **127 kg N / ha** applied for clay soil, while for sandy soil - **118 kg N / ha**. For both sites, **1.75 L / ha** of nitrification inhibitor eNtrench NXTGEN™ was applied according to manufacturer recommendations. A no-nitrogen control was also included. The experimental design of each site was four blocks of completely randomized treatment plots. Canola was sown on May 25th, 2023 in the Rosser site and May 29th, 2023 in the Roseisle site. Harvest was on September 12th, 2023 (Rosser) and September 13th, 2023 (Roseisle). Thus, canola was grown for 108-111 days.

Planting and fertilizer application

Gas sampling

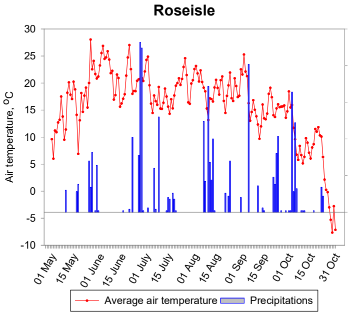


Gas sample analysis

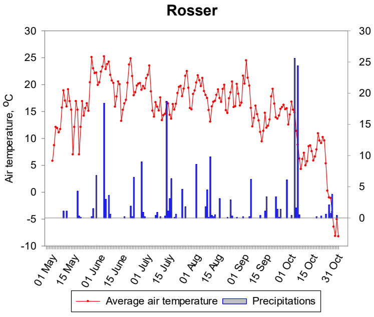
Canola harvesting

Mean daily air temperature and precipitation throughout the 2023 growing season

Roseisle



Rosser



Mean monthly air temperature and precipitation throughout the 2023 growing season

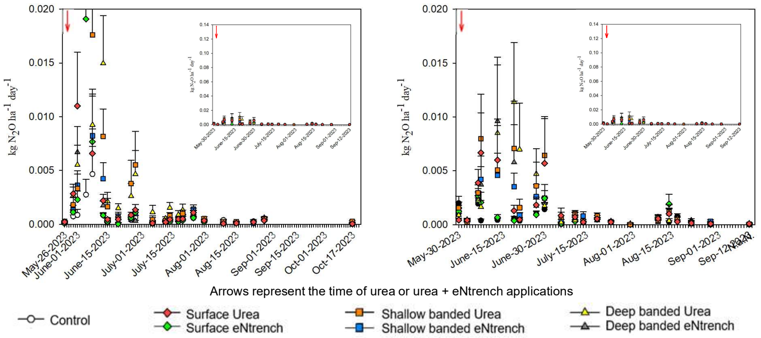
	May	June	July	August	September	October	May-October
Roseisle							
Mean air temperature (˚C)	16.3	21.3	18.5	18.9	15.8	6.3	16.2
Total precipitation (mm)	35.0	64.4	28.6	69.0	52.0	41.4	290.4
Rosser							
Mean air temperature (˚C)	15.5	20.2	17.3	18.0	15.2	5.4	15.3
Total precipitation (mm)	15.4	44.3	38.1	32.6	23.7	60.6	214.7
Normal (1981-2010) *							
Mean air temperature (˚C)	11.6	17.2	19.4	18.5	13.4	5.4	14.2
Total precipitation (mm)	67.7	96.4	78.6	74.8	49.0	38.2	404.7

*Climate normal conditions were calculated using Environment and Climate Change Canada historical datasets for Carman, MB 1981– 2010.

We highly appreciate the Manitoba Agriculture Weather Program for providing weather data

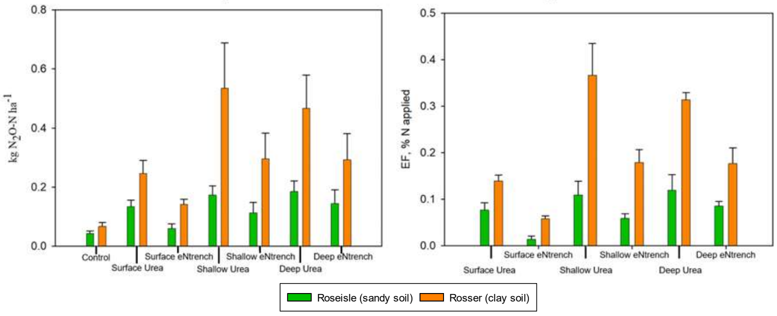
Results

Daily N_2O Fluxes



The highest daily N_2O fluxes were observed after urea application without eNtrench inhibitor. For sandy soil, flux peaks followed this order: surface broadcasting > shallow band > deep band. There was no such pattern for the clay soil. Emission peaks also occurred after heavy rains, affecting all sites.

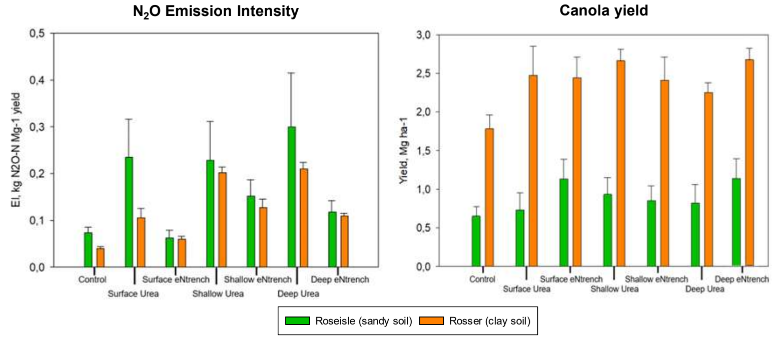
Cumulative N_2O Emissions **N_2O Emission Factors**



Clay soil emitted 1.5-3 times more N_2O than sandy soil. Urea without inhibitor increased emissions, while eNtrench reduced them by 21-54%, with effectiveness depth-dependent in the sandy, but not the clay soil.

The emission factor was affected by soil texture, inhibitor application, and banding depth. eNtrench reduced EF, most effectively when surface broadcasting, with decreasing effectiveness with application depth.

N_2O Emission Intensity **Canola yield**



Emission intensity was affected by soil texture, inhibitor application, and banding depth. Surface application of urea resulted in the least EI increase. eNtrench reduced EI by 37-48% in clay soil and 33-73% in sandy soil.

Canola grain yield was higher in clay than sandy soil, likely due to better water and nutrient retention. Inhibitor eNtrench and banding depth had no effect on yield compared to urea alone.

Results of Main Effects ANOVA (*p*-values)

Factor	$\sum N_2O$	EF	EI	Yield	Grain C : N	FGUE
Site	**<0.001**	**0.003**	**0.018**	**<0.001**	**<0.001**	**0.024**
eNtrench	**<0.001**	**0.016**	**<0.001**	0.169	0.951	0.176
Depth	**<0.001**	**0.035**	**<0.001**	0.076	0.089	0.286

Take Home Messages

- Cumulative N_2O emissions from the clay soil were 1.5-3 times higher than from the sandy soil. However, canola yield in the Rosser site (clay soil) was 2-3.4 times higher than those in the Roseisle site (sandy soil).
- Surface broadcasting of urea had the least increase in cumulative nitrous oxide emissions compared with deep and shallow banded applications. Nitrogen fertilizers banding depth did not affect canola yield.
- Inhibitor eNtrench was effective to reduce cumulative N_2O emissions: the reduction was 37-42% for clay soil and 21-54% for sandy soil. The effectiveness of eNtrench decreased with depth on sandy soil and did not depend on depth when applied to clay soil. Furthermore, the inhibitor application did not affect canola yield.

Funding