Do Soils at Russell Ranch Have a Memory?

The Effect of Fertilization History on Nitrous Oxide Emissions

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Introduction

• Nitrous oxide (N_2O) is a potent greenhouse gas and a major cause of stratospheric ozone depletion (Ravishankara *et al*. 2009)

• Emissions of N_2O from agriculture are responsible for about 6% of the world's greenhouse gas effect (Guo *et al.* 2013)

• The majority of N_2O emissions come from agricultural soils and are associated with N fertilizer use (IPCC 2007)

• The drivers of N_2O emissions are fairly well understood, but historical N fertilization effects may not be accounted for and may contribute significantly to N_2O emissions

• This study will use soils from unique N fertilization treatments at Russell Ranch to enhance our understanding of the effect of historical N fertilization on N_2O emissions

Rotation	Current Year	Historical Treatment	Laboratory Treatment
Wheat-Fallow	Wheat	+ N	+ N
Wheat-Fallow	Wheat	+ N	– N
Wheat-Fallow	Fallow	+ N	– N
Wheat-Fallow	Wheat	– N	+ N
Wheat-Fallow	Wheat	– N	– N
Wheat-Fallow	Fallow	– N	– N
Wheat-Legume	Wheat	Legume N	+ N
Wheat-Legume	Wheat	Legume N	– N

Table 1: Description of crop rotation, current crop, historical fertilization, and fertilization done in this experiment for each treatment. Highlighted treatments have already been analyzed.

Materials and Methods

• Soil samples were taken from 0-15 cm deep in three rainfed wheat systems (See Table 1)

• Soil were air-dried in the lab, passed through a 2-mm sieve, and repacked in cores to a bulk density of 1.25 g/cm^3

•Cores were wetted to 80% Water-filled Pore Space (WFPS) from below by capillary action with dH2O and incubated in 2-L mason jars for ten days at 25°C

• 25 mL gas samples were taken at 0, 20, 40, and 60 minutes, analyzed for N_2O and CO_2 concentrations, and converted to fluxes using linear regression

• Analysis of variance was done with a REGWQ means separation of the cumulative flux over ten days for each treatment.

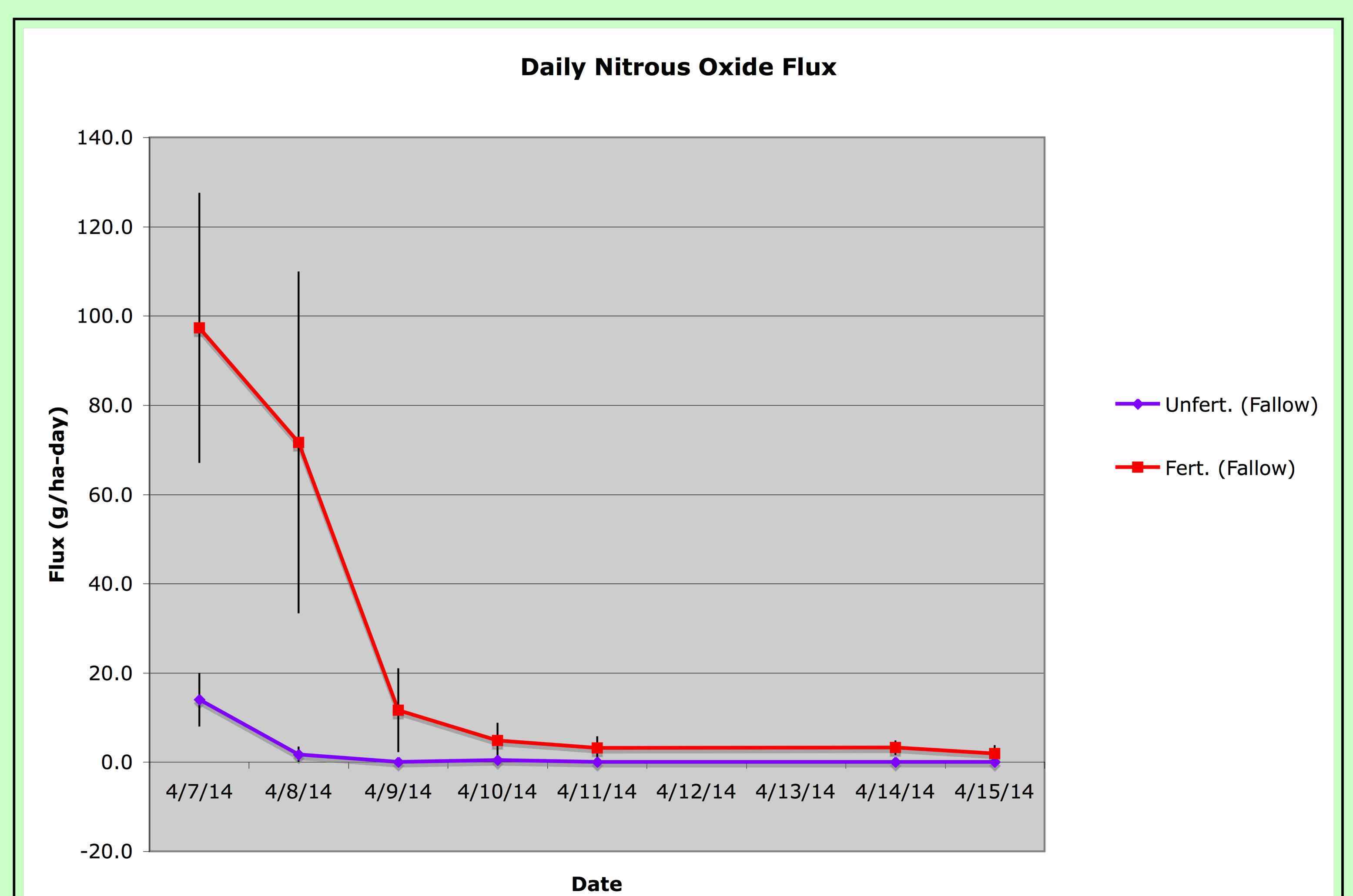

Figure 1: Daily N2O flux for the historically fertilized and historically unfertilized fallowed wheat plots.

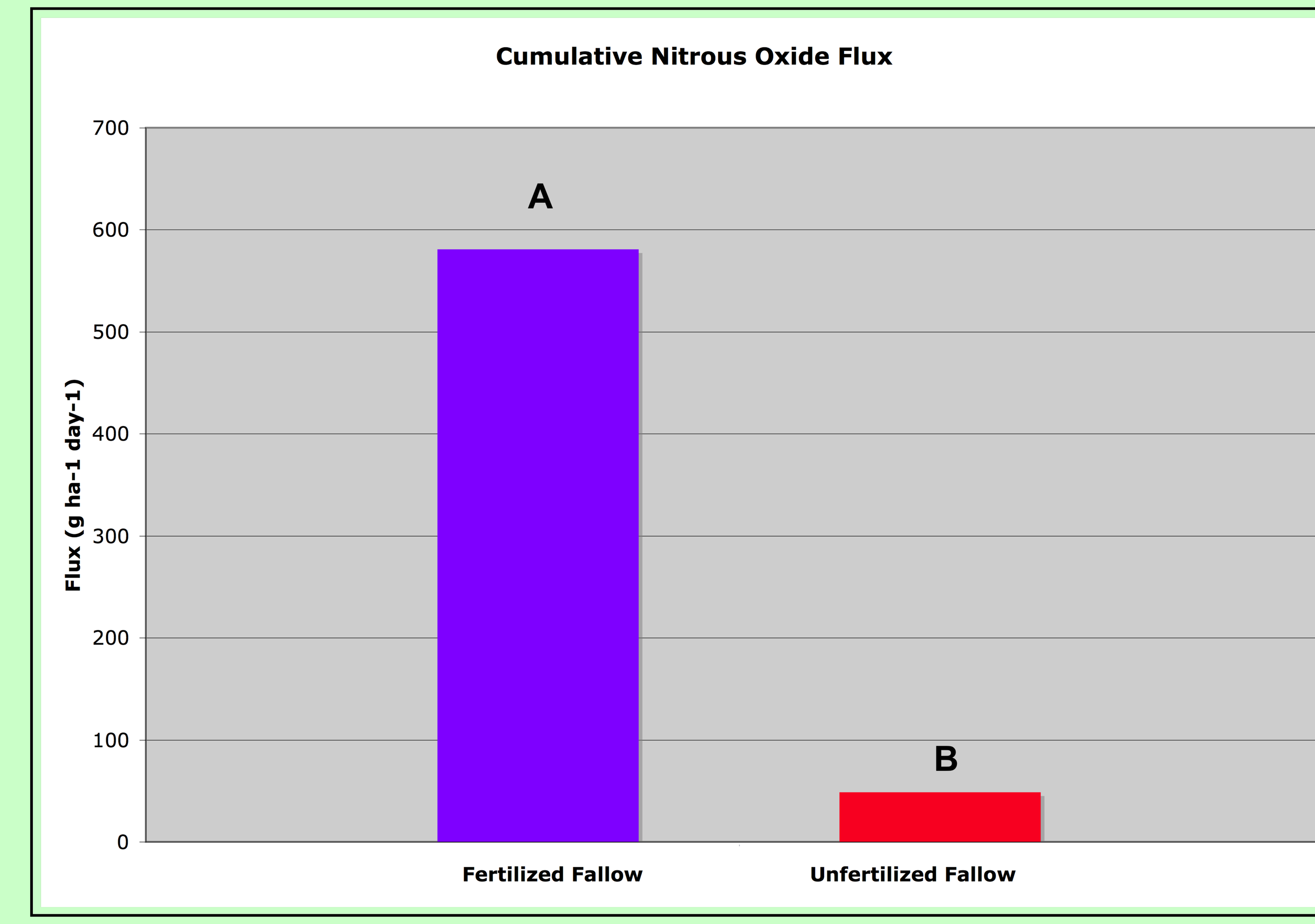

Figure 2: Cumulative N_2O flux for the historically fertilized and historically unfertilized fallowed wheat plots.

Preliminary Results

• N_2O emissions in soils from the fallowed fields peaked on either the first or second day following wetting and subsequently declined (Figure 1)

• The historically fertilized fallowed wheat plots had significantly higher cumulative N_2O emissions than the historically unfertilized fallowed wheat plot (Figure 2)

• Since no N fertilizer was applied to either plot this year, the difference in N_2O emissions represents a significant "memory effect" caused by past fertilization history

• We plan to analyze differences in N_2O emissions from soils with different fertilization histories with and without the addition of N fertilizer in the current year

• Further research is also needed to determine whether the presence of a memory effect and its relative importance in the laboratory incubations is consistent with N_2O emissions in field conditions.

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References

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