

## Abstract

Loblolly pine plantations are often fertilized with Nitrogen (N) two to three times during a ~30 year rotation with up to 500 kg-N/ha. The amount of nitrous oxide (N<sub>2</sub>O) efflux, a potent greenhouse gas, in response to N fertilization is of interest as is the interaction of fertilization with changing climate (i.e., reduced rainfall). N<sub>2</sub>O efflux was measured in a throughfall exclusion x fertilization study with four replicates of control, fertilized only, throughfall exclusion only, and fertilized and throughfall exclusion. The study was initiated in a 6-year-old loblolly pine plantation near Washington, Georgia (Fig. 1). Sampling began in 2012 and has continued through 2014 using a static chamber approach (Fig. 2). Gas sampling occurred every three months after fertilization. A small secondary study sampled a ~18-year-old loblolly pine site in Athens, Georgia to assess N<sub>2</sub>O efflux response to different N fertilizers. The site received treatments of urea, diammonium phosphate (DAP), and ammonium nitrate (NH<sub>4</sub>NO<sub>3</sub>), all compared to a control (no fertilizer). Gas samples were collected intensively after fertilization in July 2013 and once in July 2014. Results of the fertilizer trial found increased N<sub>2</sub>O efflux from all forms of fertilizer but no difference between forms (Fig. 3 and Table 1). In the throughfall x fertilization experiment there was no main effect of fertilization or exclusion detected (Fig. 4 and Table 2).



**Figure 1.** A map of the Tier III site in Washington, Georgia. Each block identified by color consists of four treatments: control (C), fertilized only (F), throughfall exclusion (drought) only (R), and fertilized and throughfall exclusion (FR). Blocks were established by basal area and height of delineated plots. Plum Creek provide access to this stand and partnered on the experiment

## Introduction

- Loblolly pines (*Pinus taeda* L.) have a high commercial demand and are adapted to most of the soils throughout the Southeast United States.
- Due to the use of N fertilizers that are being added to soils to improve the growth of loblolly pine trees, it is important to determine their impact on greenhouse gas emissions.
- The aim of this study is to estimate the amount of N<sub>2</sub>O being released into the atmosphere after the application of N fertilizers on loblolly pine plantations.



**Figure 2.** The static chamber approach was used to collect gas samples at 0, 10, 30, 50, and 70 minutes. Chambers are PCV pipe (6in X 5in) with a vented cap and septa for sampling with 10 mL syringe.

## Materials and Methods

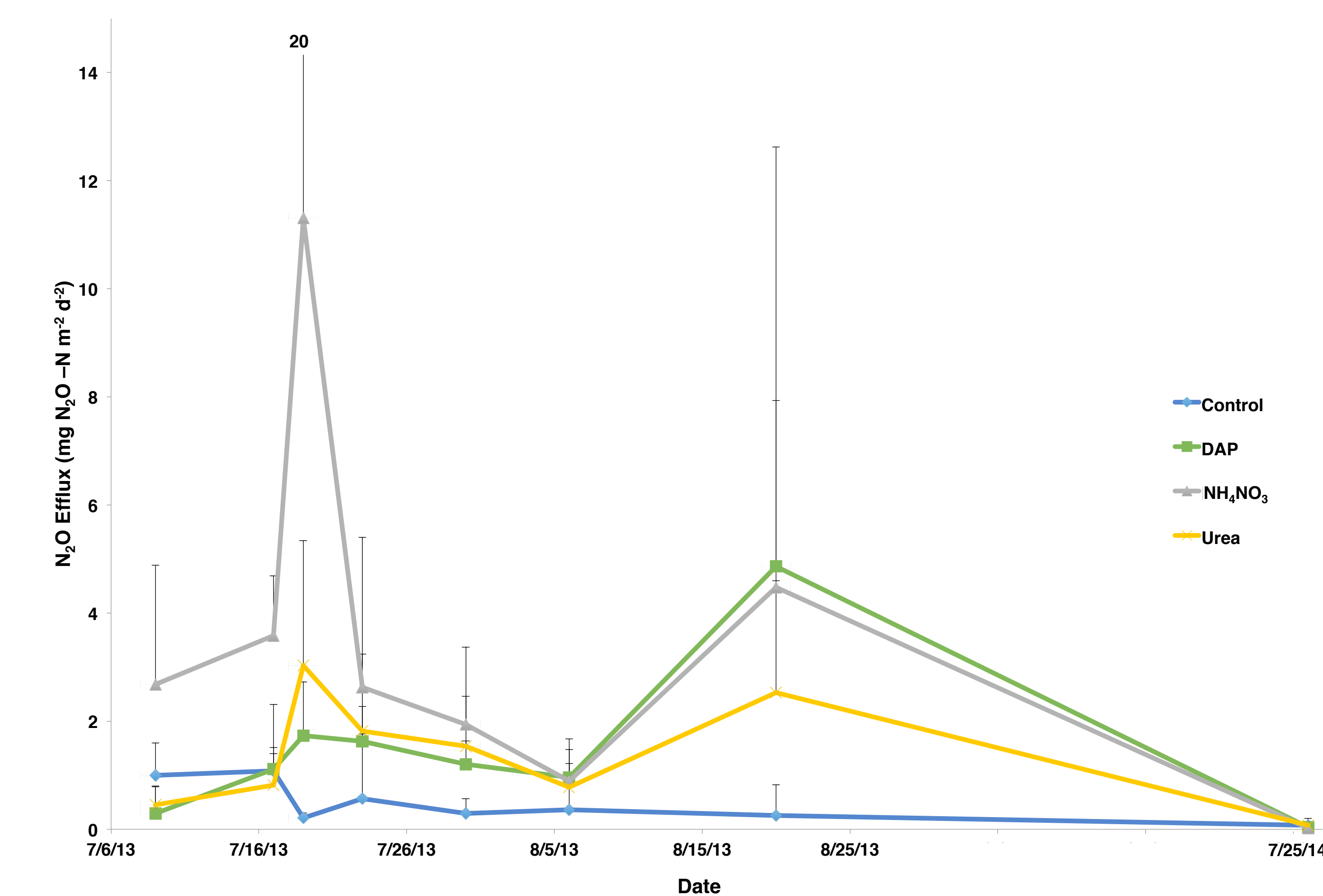
### Whitehall Forest, Athens, Georgia:

- Three blocks contained two replicates of each of the four treatments: diammonium phosphate (DAP), ammonium nitrate (NH<sub>4</sub>NO<sub>3</sub>), urea, and control (C).
- Fertilizer was applied at a rate of ~240 kg-N/ha on July 6<sup>th</sup> 2013.
- Collars were established for each treatment and remained until the study was complete, July 2014.
- Samples were collected every 0, 10, 30, 50, and 70 minutes using a needle attached to a 10ml syringe. Samples were placed into a 7ml glass vacutainers.
- Gas samples were collected 1, 3, 7, 14, 21, 35, and 367 days after fertilization.

### Tier III, Washington, Georgia:

- Gas samples were taken from all 16 plots starting on March 8, 2012 before the fertilizer was applied (Fig. 1).
- Four collars were randomly distributed throughout each plot for every sampling period 24 hours prior to sampling (Fig. 2).
- Samples were collected every 0, 10, 30, 50, and 70 minutes using a needle attached to a 10ml syringe. The gas sample was placed inside a 7 ml glass vacutainer.
- The samples were run on a Shimadzu gas chromatography to determine the concentrations of N<sub>2</sub>O.

## Results/Discussion



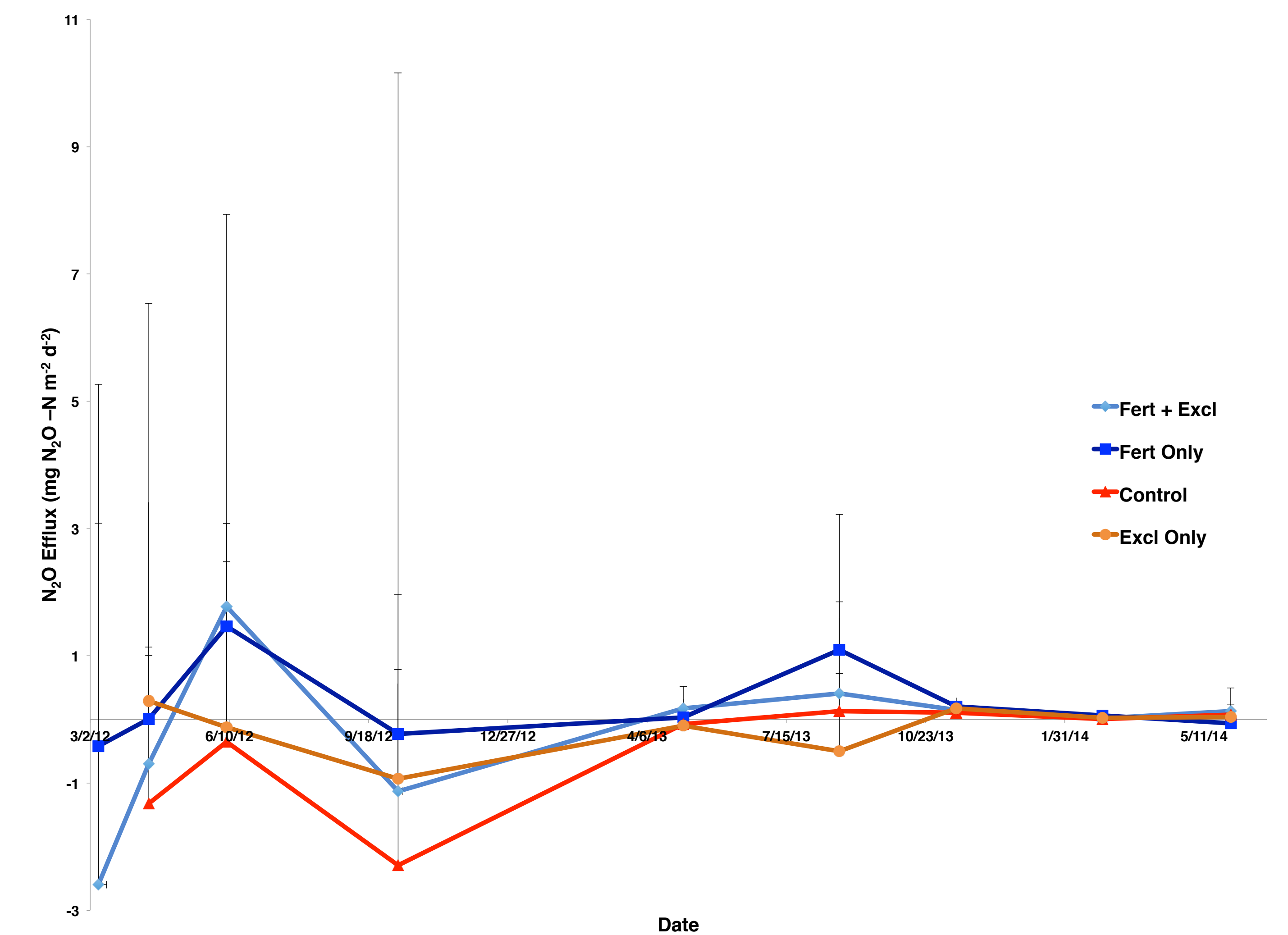
1 a)

Effect	P-value
Trt	< 0.0028
Date	< 0.0019
Trt * Day	NS
Control vs DAP	0.095
Control vs NH <sub>4</sub> NO <sub>3</sub>	0.001
Control Urea	0.056

1 b)

Soil Layer	N(%)	C(%)
Oi	0.906	46.2
Oe + Oa	0.906	23.9
0-10cm	0.154	2.38

**Figure 3 and Table 1a and b.** N<sub>2</sub>O efflux over time by treatment at the site in Athens, Georgia. The pre-treatment was used as a covariate to indicate a change in the amount of N<sub>2</sub>O efflux when the fertilizer was applied. The control was significantly lower than the DAP, NH<sub>4</sub>NO<sub>3</sub>, and Urea treatments. The NH<sub>4</sub>NO<sub>3</sub> displayed the highest N<sub>2</sub>O efflux over the treatment period. Table 1a displays the p-values for tests of significance between treatment and date. Table 1b is the amount of carbon (C) and nitrogen (N) prior to initiation of the experiment.



2 a)

Soil Layer	N (%)	C (%)
Oi	0.761	43.4
Oe + Oa	1.333	20.6
0-10cm	0.087	1.77

2 b)

Effect	P-value
Fert	0.67
Excl	0.55
Fert * Excl	0.95
Date	0.14
Date * Fert	0.64
Date * Excl	0.01

**Figure 4 and Table 2a and 2b.** N<sub>2</sub>O efflux over time by treatment at the Tier III site in Washington, Georgia. There was no significant main effect of fertilization or exclusion and not interaction. There was also no main effect of date or interaction with fertilization. There was a date x exclusion interaction as exclusion plots were both higher and lower the non-exclusion depending on date, although the reason for this response is unknown. The fertilized plots were higher than not fertilizer on average, although as noted this was not significant. Table 2a displays the p-values for tests of significance. Table 2b is the amount of carbon (C) and nitrogen(N) prior to fertilization.

## Conclusion

- The Whitehall site near Athens, Georgia indicated an increase in N<sub>2</sub>O efflux with all forms on N fertilization.
- The highest N<sub>2</sub>O response was the NH<sub>4</sub>NO<sub>3</sub> fertilizer
- The Throughfall exclusion x Fertilization study in Washington, Georgia detected no response in N<sub>2</sub>O efflux in response to treatments.
- Fertilization within loblolly pines (*Pinus taeda* L.) plantations seems to increase the efflux of N<sub>2</sub>O but response appears to be of a short-duration..