Within-field drainage flow and nitrogen loading variability following tile drainage installation

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Introduction

- Artificial agricultural drainage is required to sustain high productivity cropping systems across much of the U.S. Midwest.
- Nitrate loss through subsurface drainage systems has become a significant concern locally, regionally, and nationally.
- Although within-field drainage nitrogen (N) loss is known to be variable, few studies have assessed spatial N cycling process at the field scale.

Objective

- Evaluate within-field variability of drainage flow, nitrate load, soil nitrous oxide (N_2O) emissions, and Normalized Difference Vegetation Index (NDVI) of corn.

Materials and Methods

- Replicated drainage plots installed in Central IL (Fall 2016):
  - Soil series: Virden silty clay loam and Oconee silt loam
  - Sixteen individually drained plots (0.8 ha)
- 2017 cropping system management:
  - Pre-plant application on April 25th (168 Kg N/ha using 28% UAN + 0.5 L/ha of Verdict, BASF)
  - Wyffels hybrid corn planted on April 26th (80-85,000 seeds/ha in 76-cm row spacing]
  - Side-dress N application on June 14th (135 kg N/ha using 28% UAN)
- Drainage flow continuously monitored for each plot using a pressure transducer and WEIR equation
- Drainage samples were collected daily (ISCO 720 auto sampler) or weekly (grab samples), and analyzed for nitrate (Cd reduction, Lachat QuickChem 8500)
- Soil N_2O fluxes were measured weekly by the closed-static chambers method (USDA GraceNET Protocol)
- UAV imagery and plant tissue samples were collected at growth stage V5-V6
- Parrot Sequoia multispectral sensor (green, red, red edge, and near infra-red bands, plus a sunshine sensor)

Acknowledgements

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Results and Discussion

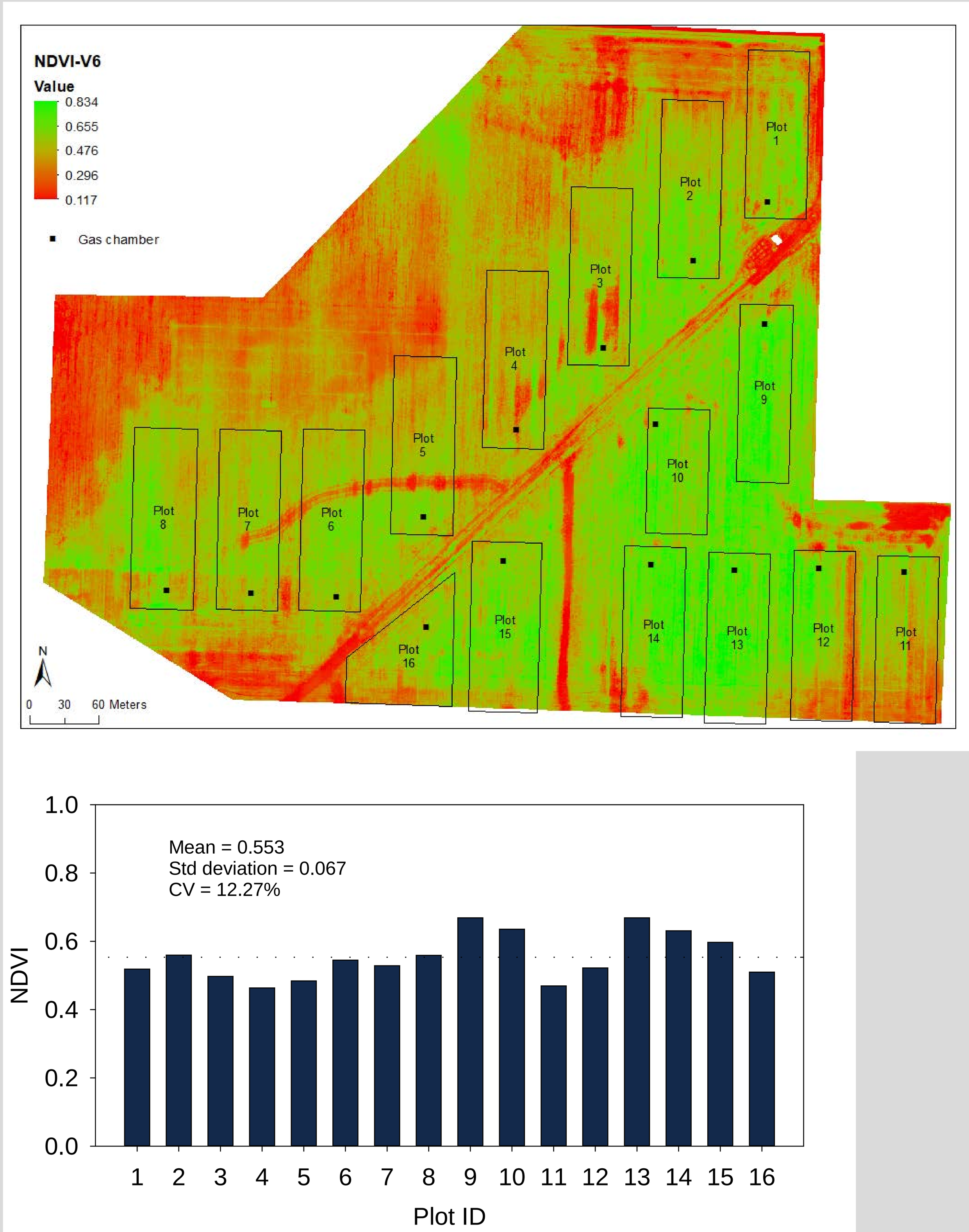

Figure 1. Normalized Difference Vegetation Index (NDVI) of corn at growth stage V5-V6 (upper) and average NDVI of each plot (bottom).

- Excessive rainfall within 10 days after planting (177 mm) caused long period of ponding across the field
- Dark red areas had poor seed germination and plant emergence
- The variability decreased when NDVI was averaged for each plot

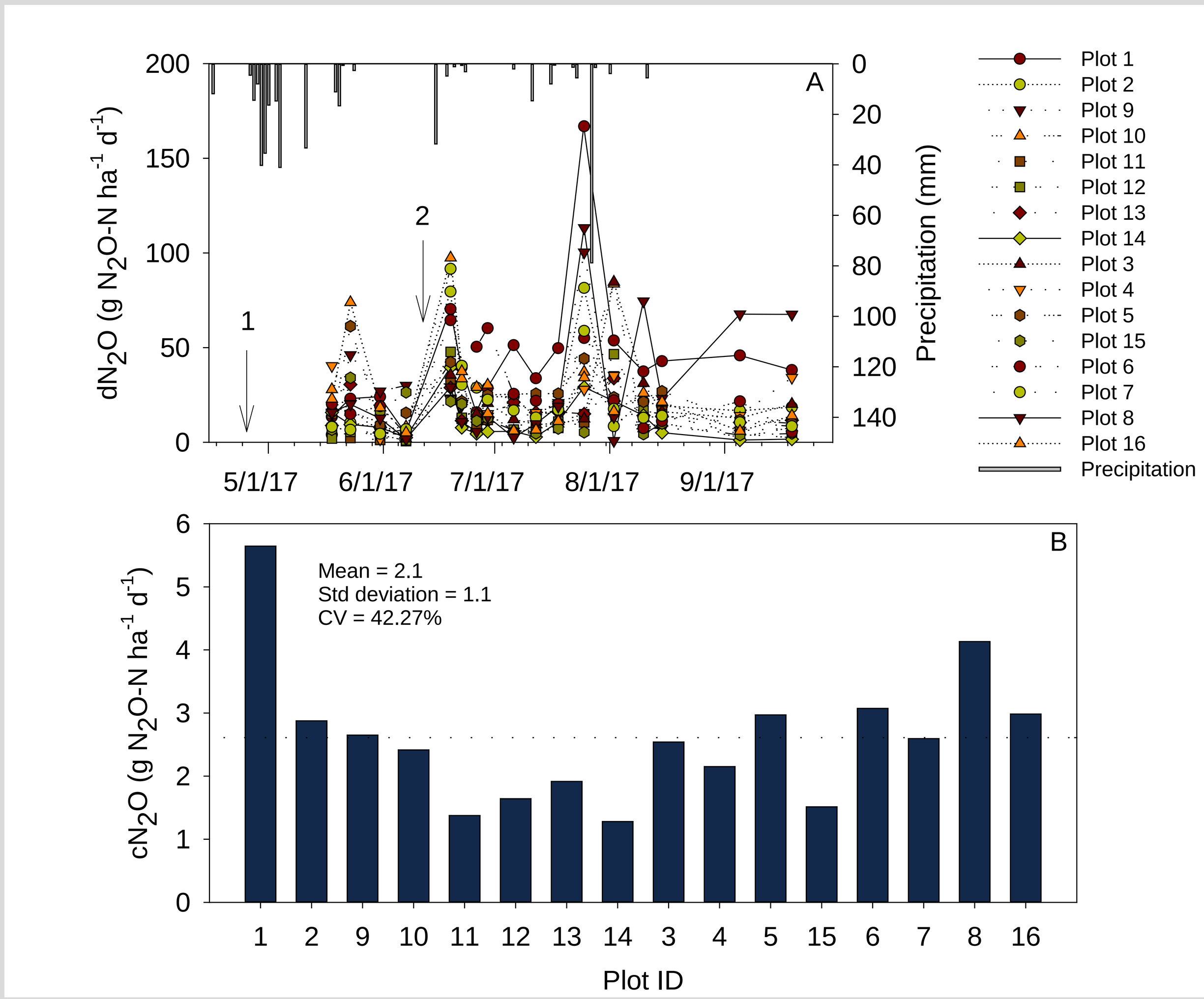

Figure 2. Daily (dN_2O) and cumulative emissions (cN_2O) of each plot. (Dash line in B represents the mean cN_2O across all plots; 1, pre-plant N and corn planting; 2, N side-dress application)

- High variability was seen in dN_2O between plots
  - Plots 1 and 8 tended to have higher dN_2O throughout the growing season and consequently higher cN_2O
  - In contrast, plots 11 through 15 had lower emissions

Results and Discussion

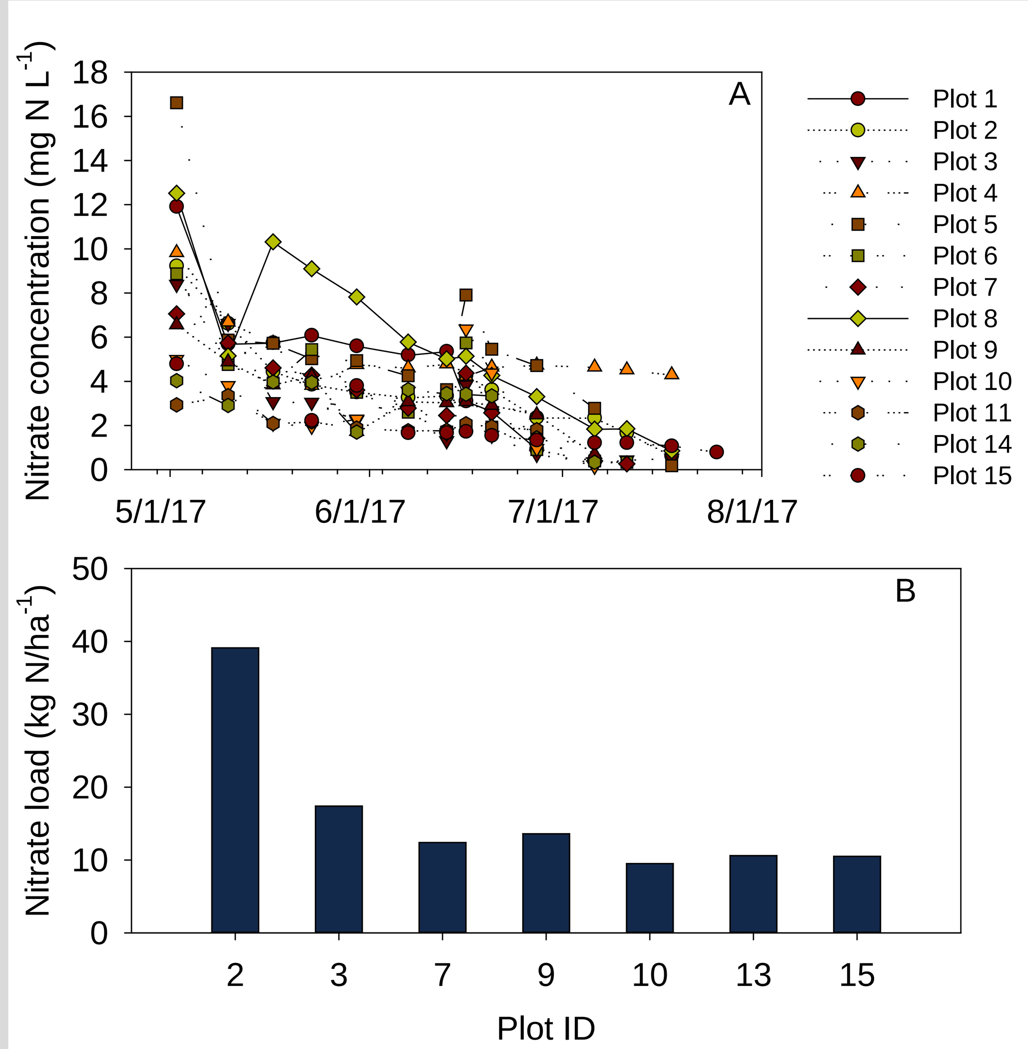

Figure 3. Nitrate concentration from drainage samples (A) and nitrate load (B) at the end of the growing season.

- Similar trends were observed for nitrate concentration
  - Plots 11, 14, and 15 had consistently lower concentrations, whereas plot 8 had higher concentrations
  - Nitrate concentration at first sampling date varied from 2.9 to 16.6 mg/L
  - Slightly peak in concentrations after N side-dress application (June 20th)
  - With exception of plot 2, nitrate load was consistent between plots

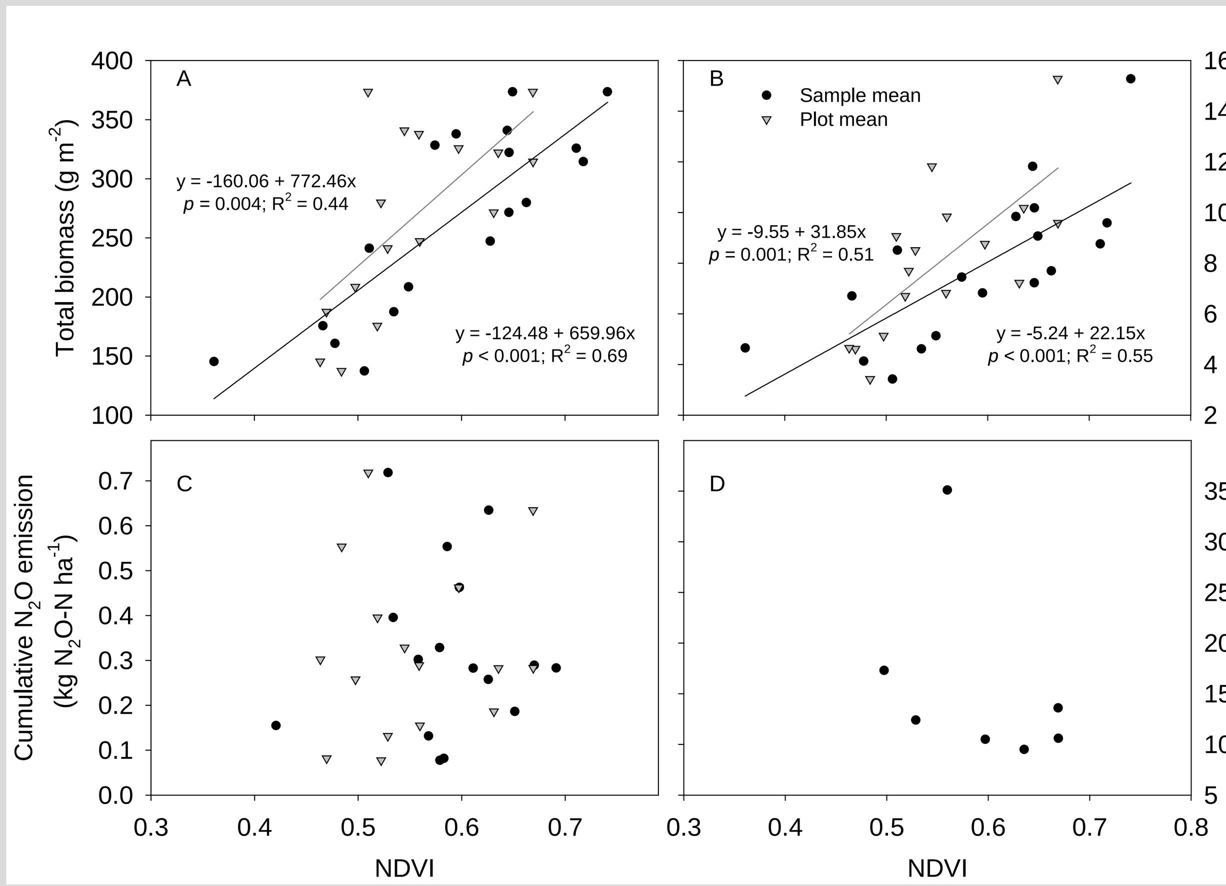

Figure 2. Total biomass (A), N uptake (B), and cumulative N_2O (C) at growth stage V5-V6, as well as nitrate load (D) as a function of NDVI. (Sample mean and plot mean indicate the mean NDVI of the sampling area and the mean NDVI of the plot, respectively)

Conclusions

- UAV mounted with passive multispectral sensor was able to capture early season differences in plant biomass and N leaf status
- Total biomass and N uptake was correlated with both sample and plot NDVI
- Nitrate load and cN_2O were not correlated with NDVI
- Further analysis with final grain yield and total N uptake is necessary to fully assess N cycling at field scale