# Viable Management Practices to Reduce $N_2O$ Emissions From a Conventionally Managed Corn Field

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## Introduction

- Nitrous oxide ($N_2O$) emissions contribute about 1/3 of the total greenhouse gas (GHG) emissions from California's agricultural sector.
- Environmental and Economic Concern
  - Global warming potential 300 times greater than $CO_2$
  - The development of Cap and Trade Markets provide economic opportunities for farmers to reduce inputs while maintaining profitability

## Objective

**Research Objectives:**

- Identify easily adoptable management practices to reduce $N_2O$ emissions while maintaining yields

**Hypotheses:**

- Spatially reducing the concentration of $NH_4^+$ will reduce $N_2O$ emissions compared to concentrated $NH_4^+$ fertilizer
- Synchronizing fertilizer application with plant N uptake reduces $N_2O$ emissions

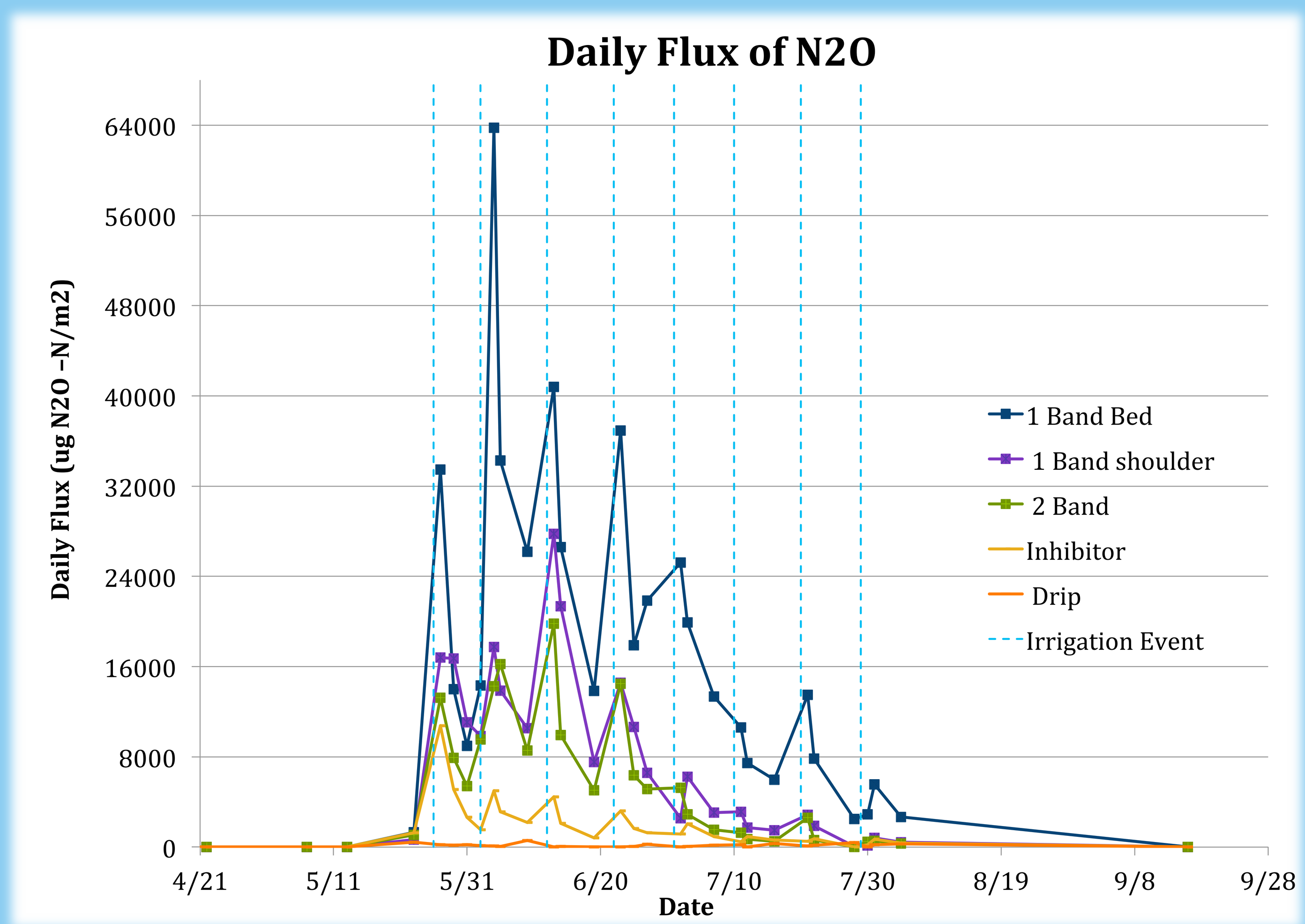
**Experimental Objectives:**

- Sub Surface Drip vs. Furrow Irrigation
- Split banding (standard treatment) vs. single banding
- Banding placement: Shoulder vs. Bed
- Fertilizer Efficiency Enhancer: urease and nitrification inhibitor
- Nitrogen was applied at 250 kg N/ha as Urea, Ammonium, Nitrate (UAN)

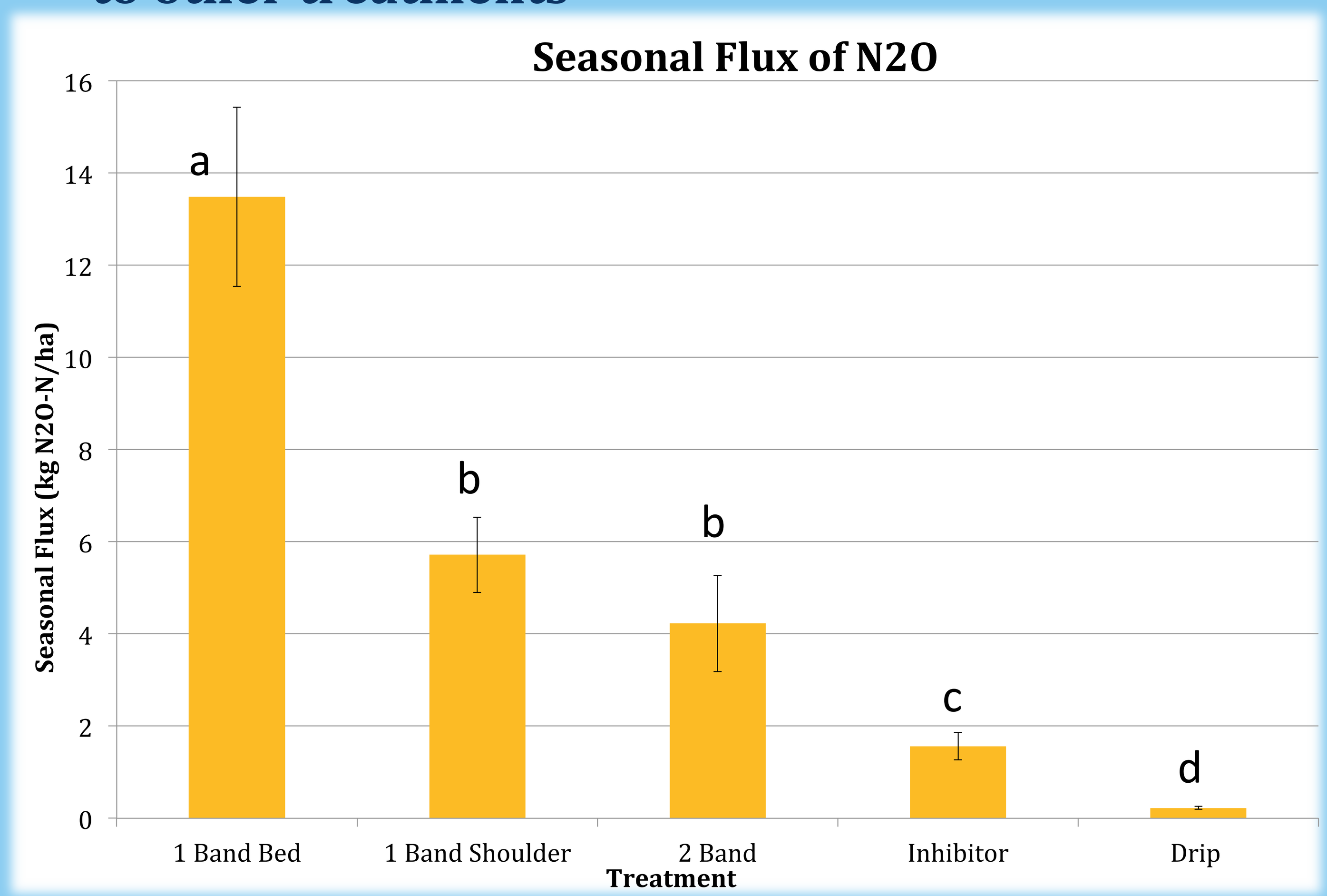
## Methods

- Daily fluxes were measured using the static chamber method at 0, 20, and 40 min
- Soil $NH_4^+$, $NO_3^-$, and $NO_2^-$ were measured
- Moisture data was collected using Decagon EC-5 sensors
- Plant yield and nitrogen measured at harvest

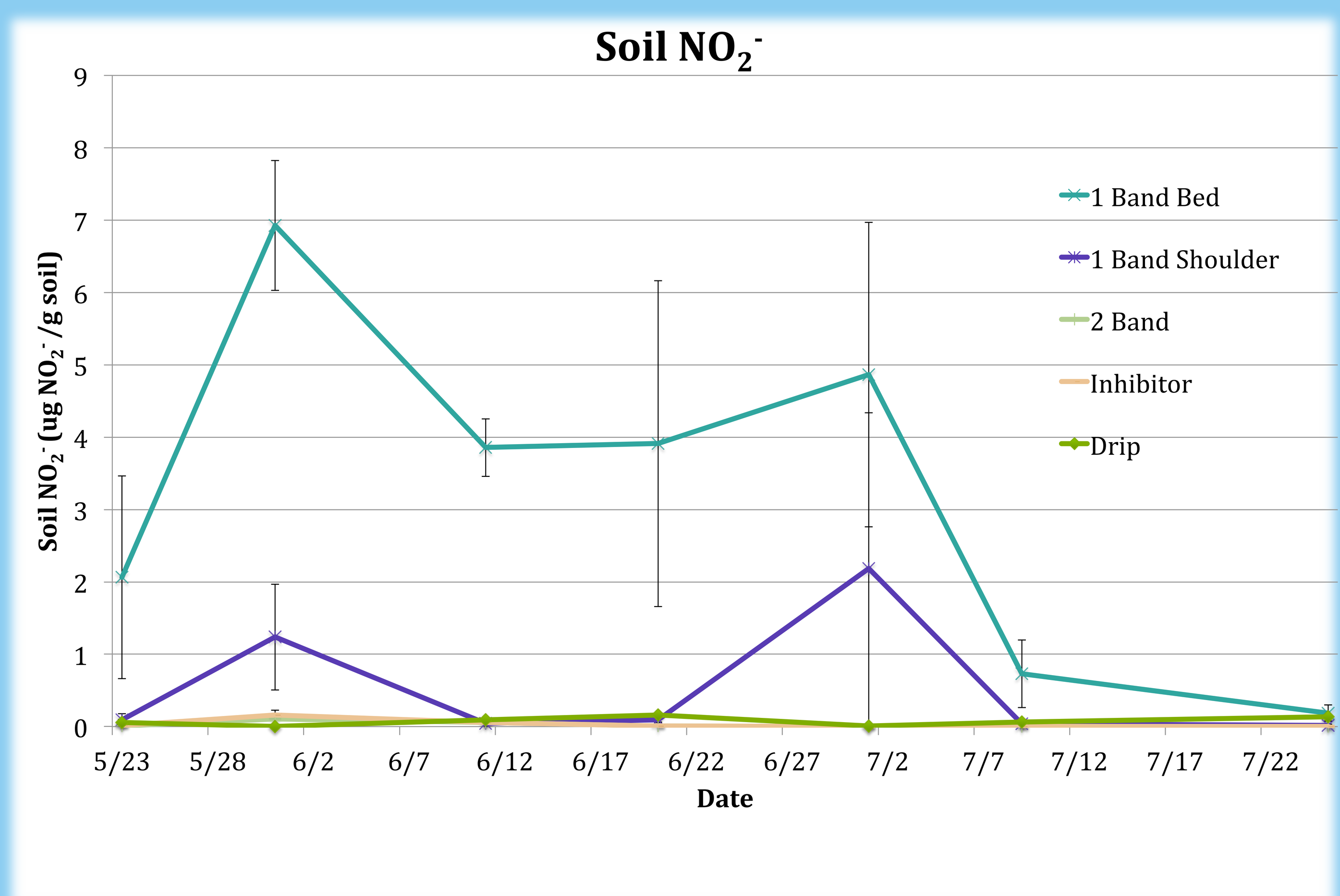
## Results




- Placement of 1concentrated fertilizer band in bed lead to higher and persistent emissions compared to other treatments




- Drip irrigation had the lowest emissions
- Single banding in the bed had the highest emissions
- Emissions in the inhibitor treatment significantly differed from those of the standard treatment
- Yields ranged from 28 tons/ha to 34 tons/ha silage and did not differ significantly between treatments




- Concentrated $NH_4^+$ lead to higher $NO_2^-$ levels

## Discussion

- High concentrations of $NH_4^+$ lead to higher levels of $NO_2^-$ in our field trial
- High $NH_4^+$ concentration can lead to the temporary decoupling of the two steps in nitrification due to an imbalance in the ratio of $NH_4^+$ oxidizers compared to $NO_2^-$ oxidizers leading to an accumulation of $NO_2^-$
- $NO_2^-$ is a substrate involved in multiple pathways of $N_2O$ production, thus explaining the higher emissions in the 1 band bed
- Possible discrepancies between the 1 band bed treatment and the 1 band shoulder could be due to higher moisture in the shoulder (data not shown)causing more diffusion of $NH_4^+$ and thus lower concentrations locally
- Due to the higher levels of $NO_2^-$ early in the season, nitrifier denitrification could be the predominant pathway during this period with denitrification occuring later in the season
- Due to the better synchronicity of fertilizer application and plant N uptake in the drip and inhibitor treatments, less N was available for microbial conversion to $N_2O$

## Conclusions

- Spatially distributing the concentration of $NH_4^+$ reduces $NO_2^-$ accumulation and can reduce $N_2O$ emissions
- Subsurface drip in corn is not a common practice, however adopting this practice could reduce emissions substantially
- Inhibitors can reduce $N_2O$ Emissions from nitrification
- Nitrification is a significant source of $N_2O$ emissions – management strategies targeting this process are promising in reducing emissions from agriculture

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- Zhu, X., Burger, M., Doane, T. a, & Horwath, W. R. (2013). Ammonia oxidation pathways and nitrifier denitrification are significant sources of N2O and NO under low oxygen availability. *Proceedings of the National Academy of Sciences of the United States of America*, *110*(16), 6328–33. doi:10.1073/pnas.1219993110
- Maharjan, B., & Venterea, R. T. (2013). Nitrite intensity explains N management effects on N2O emissions in maize. *Soil Biology and Biochemistry*, *66*, 229–238. doi:10.1016/j.soilbio.2013.07.015