Measurement of N_2O Emissions from Drip Irrigated Soils in a Pomegranate Orchard

Suduan Gao[1], Aileen Hendratna[1]*, and Claude Phene[2]
[1] USDA-ARS, Parlier, CA; [2] SDI+ Consultant, Fresno, CA

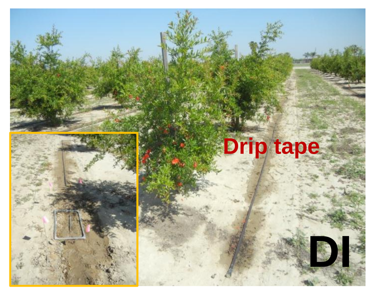
Introduction

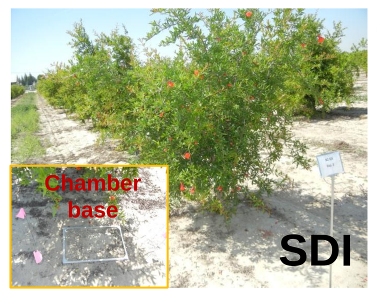
Agriculture is a major contributor to greenhouse gas Nitrous Oxide (N_2O) emissions. Developing sustainable crop production should consider minimizing N_2O emissions while increasing N use efficiency. In the San Joaquin Valley of California, pomegranate is an emerging high value crop due to its antioxidant property and health benefits. In order to develop productive and more environmentally sustainable orchards, subsurface drip irrigation (SDI) is tested for reduced N_2O emissions in comparison with surface drip irrigation (DI).

Objective

To determine if SDI is effective in reducing N_2O emission compared to DI in a 3-year old pomegranate orchard.

Materials & Methods

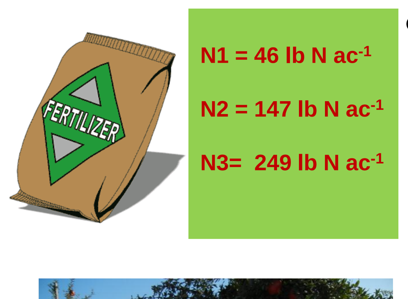




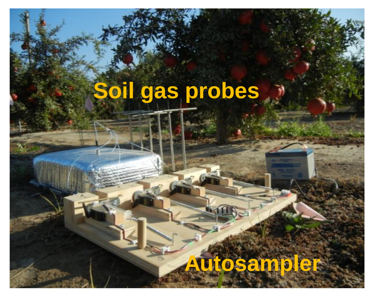
Soil: Hanford sandy loam (coarse-loamy, mixed, superactive, nonacid, thermic Typic Xerorthents);
pH=7.5 (1:2 0.01 M $CaCl_2$); $EC_{25°C}$=171 µS cm^{-1};
Field capacity ~ 17%

Treatments:

- Main Treatment: 2 irrigation systems
  - Surface drip irrigation (DI)
  - Subsurface drip irrigation (SDI) – drip tape at 2-ft depth

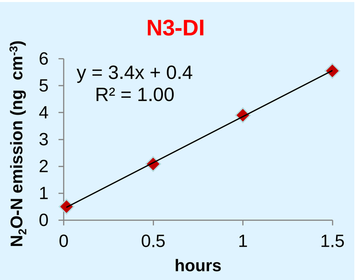


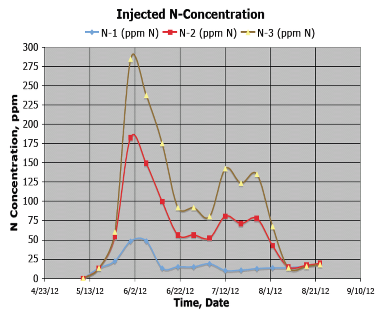
- Sub-treatment: 3 levels of N as N-pHURIC (urea, sulfuric acid) and AN-20 (Ammonium Nitrate 20% N)
  - N1 (low N), 46 lb N ac^{-1}
  - N2 (medium N), 147 lb N ac^{-1}
  - N3 (high N), 249 lb N ac^{-1}



- N-pHURIC was delivered as a part of irrigation system to N1, N2, N3 from 5/15 to 8/23/12. AN-20 was injected for the additional N in N2 and N3 from 5/24 to 8/2/12.
- Phosphorus (H_3PO_4) and Potassium (K2T, 25% K from K_2O and 17.5% S) were injected in N1, N2, N3 at rates of 28 lb/ac and 43 lb/ac, respectively.

Sampling and Analysis:

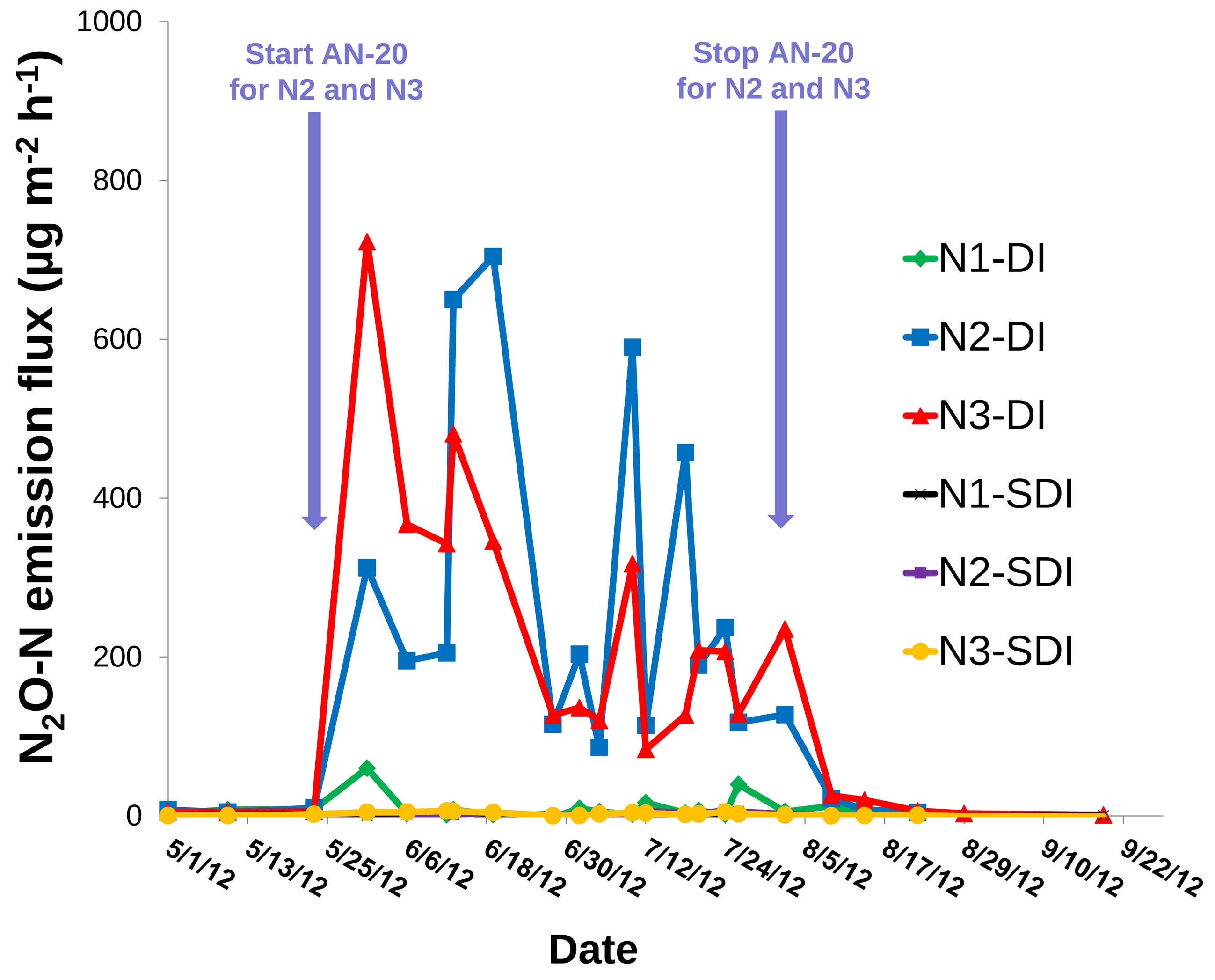




- Static flux chambers with manual and semiautomatic sampling system; samples taken every 30 minutes for 1.5 hours. Flux was calculated from linear regression of N_2O concentration increase inside chamber.
- Soil gas probes at depths: 15, 30, 45, 60, 80, 100 cm
- Air sample is preserved in 12 ml headspace vial
- Samples were analyzed using GC 6890 with µECD, Headspace Sampler G1888, Column: HP-PLOT/Q (Agilent Technologies)

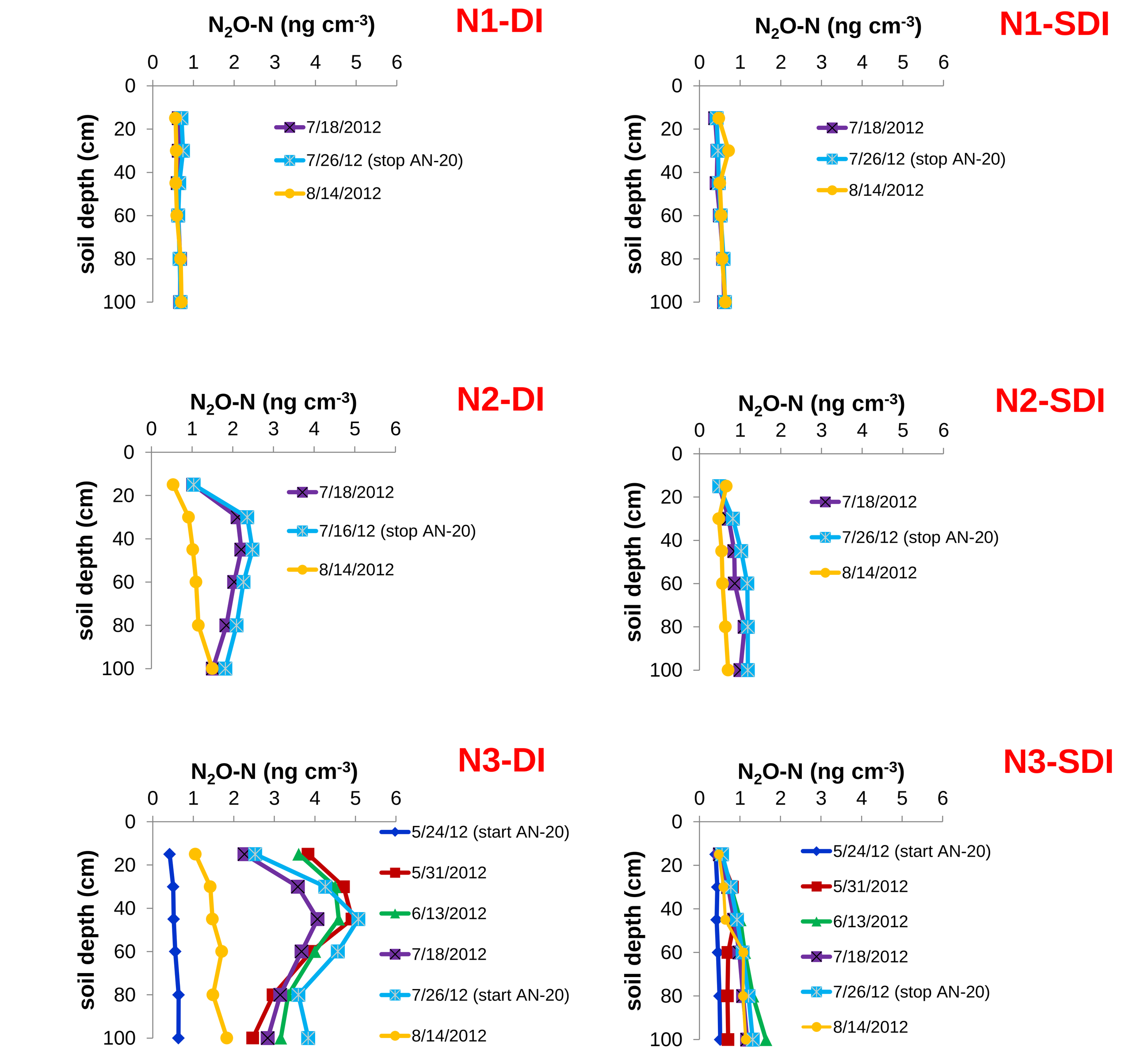
Results & Discussions

N_2O Emission Flux



- N_2O emissions is highly related to N fertilization; N_2O emission was very low before and after N application
- DI resulted in much higher N_2O emissions than SDI; N_2O emission from SDI was below 10 µg N m^{-2} h^{-1} at all times.
- Higher N application rates led to significant increase in N_2O emissions in DI but not in SDI.

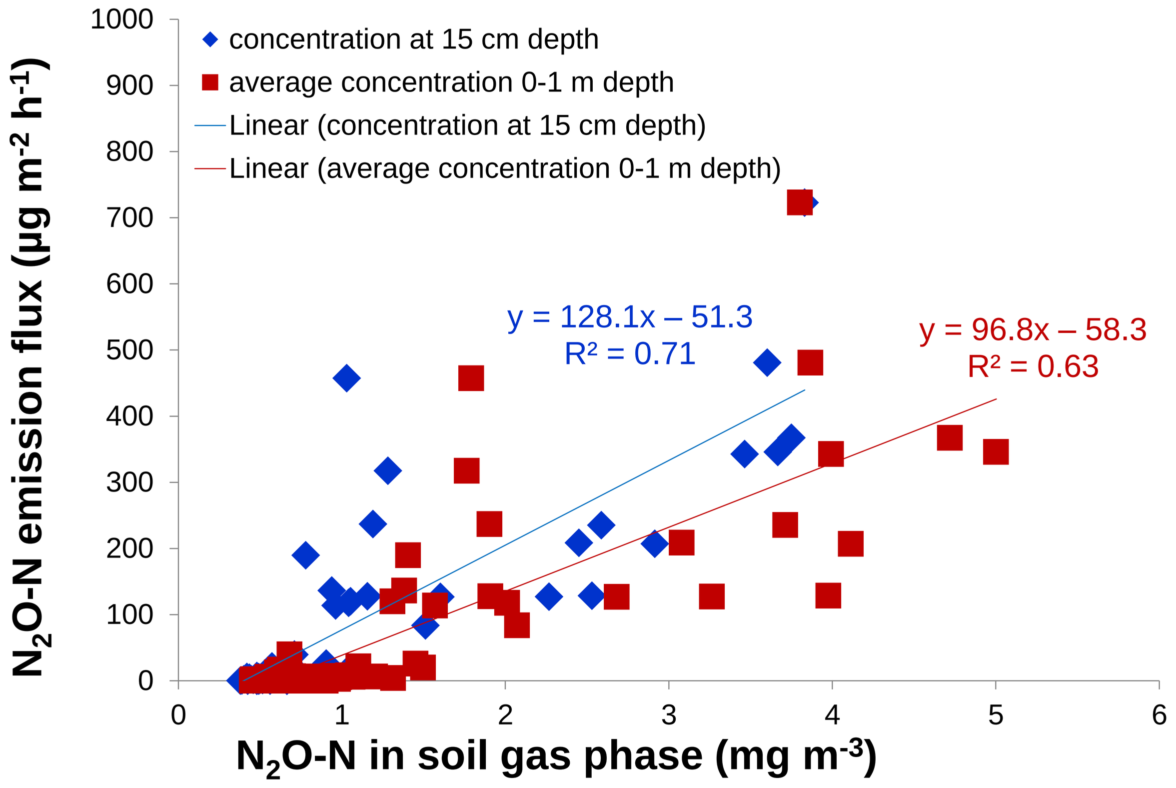
N_2O Concentration in Soil Profile



- N_2O concentrations in soil profile were higher in DI plots compared to SDI at the same application rate except no difference at the N1 rate.

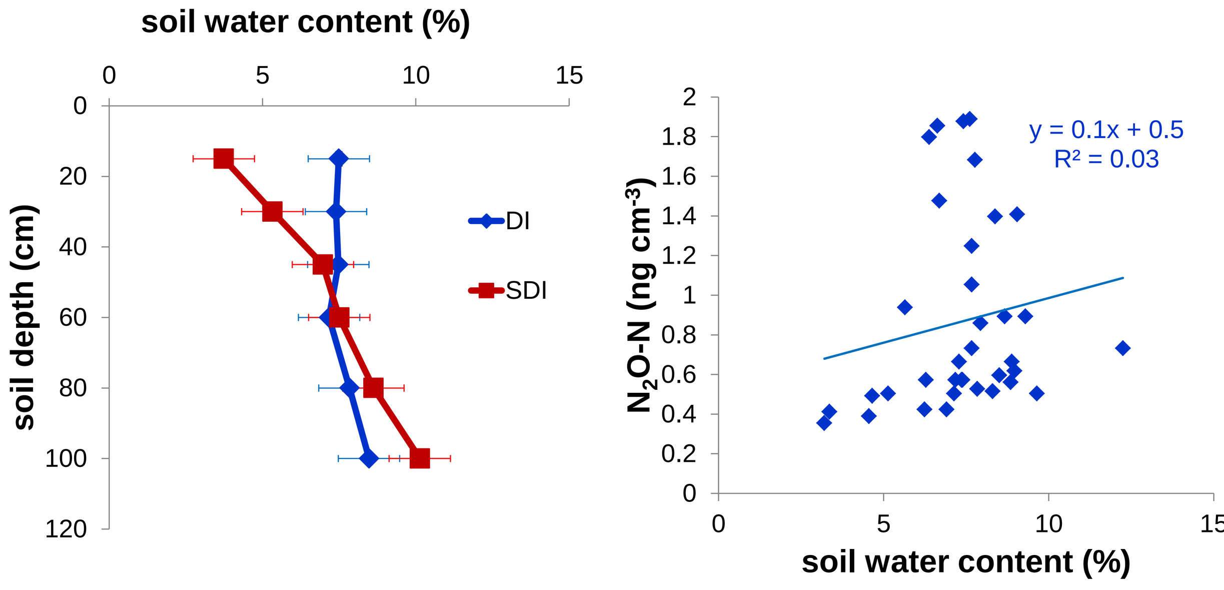
- As N application increased, N_2O concentration in soil profile increased with the highest in N3-DI treatment.
- N_2O concentrations peaked at 40 cm in DI plots and increased with depth in SDI.
- Low N_2O concentrations (< 1 ng N cm^{-3}) were measured before and after N applications during growing season

N_2O Emission Flux vs. Soil Concentration



- N_2O emission flux is positively correlated to N_2O concentration in soil-gas phase. Plotted are all measurements taken during the growing season.

Soil Water Content and Correlation with Soil N_2O Concentration



- DI resulted in a relatively uniform soil moisture profile with higher water content near surface, but lower in deeper depths than that from SDI.
- Higher soil water content appears to result in higher levels of N_2O concentration in soil profile, but the correlation appears weak based on one time measurement.
- N_2O production and emission, as affected by soil water content and soil N status that are associated with denitrification, will be better understood by further detailed examination of N transformation in soil and specific soil conditions.

* **Contact information: Aileen Hendratna (aileen.hendratna@ars.usda.gov)**

ASA, CSSA, and SSSA 2012 Annual Meetings, Oct 21-24, Cincinnati, OH
ID #: 72778