Low N_2O Emissions by Different N Fertilizer Sources from Cotton Field under Plastic Mulched Drip Irrigation in Arid Xinjiang of China

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Introduction

- Previous studies showed the potential of enhanced efficiency N fertilizers to reduce nitrous oxides (N_2O) emissions from crop lands.
- Cotton production in NW China uses a system of plastic mulched drip irrigation to conserve moisture and improve nutrient efficiency.
- Limited regional studies are available to characterize GHG emissions from drip irrigated cotton production in arid NW China.

Objective

- To determine the effect of enhanced efficiency N fertilizers on seasonal and cumulative N_2O emissions from drip irrigated cotton production in NW China.
- To determine the driving environmental factors for production and emission of N_2O under plastic mulched drip irrigation system.

Materials and Methods

Study Site, Treatment and Experimental Design

- Field experiment was conducted on a grey desert agricultural soils near Urumqi of Xinjiang in 2015.
- Treatments were unfertilized control (CK), and application of 240 kg N ha^{-1} of granular urea (U), polymer-coated urea (ESN), and stabilized urea with combined urease (NBPT) and nitrification (DCD) inhibitors (U+I). Treatments were laid out in a randomized complete block design with four replicate plots.
- All ESN was added at planting while other N treatments were split-applied with 20% at planting and six in-season application with drip irrigation through the growing season.

N_2O Flux Measurement

- Gas samples were collected and analyzed twice per week using the static chamber-chromatography methodology.
- N_2O flux rates (ng N m^{-2} min^{-1}) were calculated using HMR package implemented with R language.
- Growing season area-scaled cumulative emissions (ΣN_2O, kg N ha^{-1}) were estimated from individual chambers by summation of daily estimates of N_2O emissions obtained by linear interpolation between sampling dates.
- N applied-scaled emission factor (EF) for the fertilizer treatments was calculated as:

  $(\Sigma N_2O_{fert} - \Sigma N_2O_{control}) /$ applied N $\times$ 100

Determination of Soil Conditions

- Soil concentrations of NH_4^+-N and NO_3^--N, moisture, and temperature were monitored through the growing season.

Plot layout

Soil temp. and moisture data collection

Results and Discussion

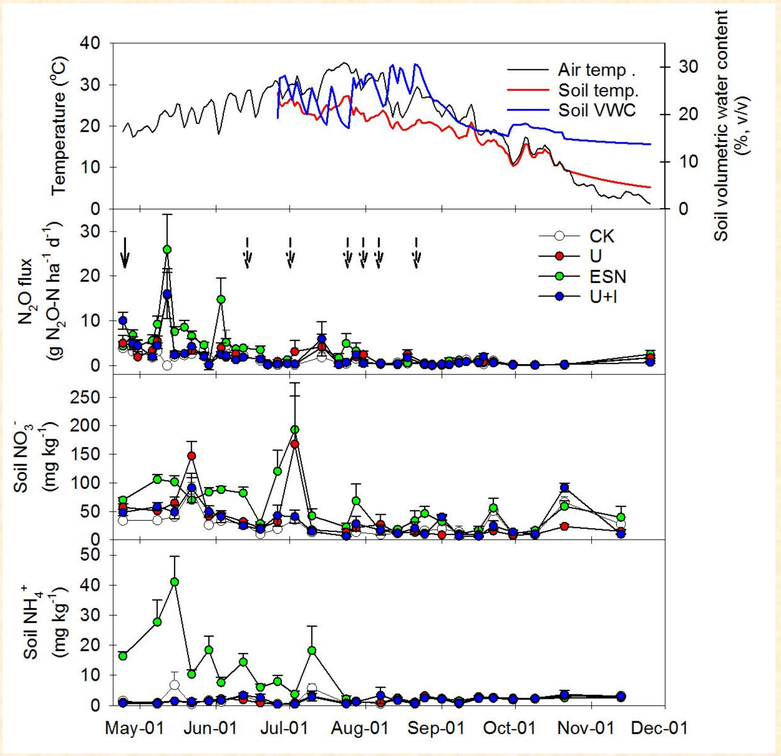

Fig. 1 Air and soil temperature, soil volumetric water content, mean daily N_2O flux, and soil concentrations of NO_3^- and NH_4^+ over the growing season. Solid line indicates date of fertilizer application at planting and dash line indicates dates of in-season N application with drip irrigation.

- A single application of ESN at planting induced maximum N_2O flux in 2~3 weeks, followed by urea and urea plus inhibitors. In-season application, however, did not result in large flux episodes.
- ESN resulted in highest concentrations of soil NO_3^- and NH_4^+, coinciding with increasing N_2O flux, suggesting soil N status determined N_2O flux.

Table. 1 Growing season cumulative N_2O emissions and emission factors of fertilizer treatments (mean±se, n=12).

Treatment	ΣN_2O (g N_2O-N ha^{-1})	EF (%)	Yield (kg ha^{-1})
CK	278.4±27.8 b	——	239.4±34.9 a
U	357.3±35.3 b	0.03 b	233.5±26.7 a
ESN	502.0±49.5 a	0.09 a	255.9±16.9 a
U+I	309.5±29.2 b	0.01 b	252.5±30.1 a

- ESN resulted in greater area-based ΣN_2O and applied N-based EF than other treatments. Use of inhibitors with urea did not reduce ΣN_2O and EF than urea. These results suggest a limited benefit of enhanced efficiency N fertilizers on N_2O mitigation for cotton production under plastic mulched drip irrigation.
- ΣN_2O ranged from 278 to 502 g N_2O-N ha^{-1}, generally lower than emissions reported for other agricultural ecosystems. This is due to drip irrigation successfully kept moisture conditions below levels for appreciable N2O emissions.
- Multiple in-season applications of N by drip irrigation was effective to lower emissions than all N applied at planting.
- Further site years are required to determine if nitrogen stabilizers further reduce N_2O emissions with drip irrigation.

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