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Nitrous oxide emissions from irrigated cotton in north eastern Australia

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Cotton is one of many agricultural industries in Australia heavily reliant on nitrogenous fertilizers and water storages to maintain high levels of production. Cotton-based farming systems are therefore labelled as potentially high-risk agricultural systems with respect to gaseous losses of nitrogen to the atmosphere.

The on-farm study was undertaken at Dalby in the Darling Downs region of Queensland in north eastern Australia. The field was furrow irrigated and had been under continuous cotton (with winter bare fallow) for 10 years. The block was conventionally tilled, with a spraying regime typical for cotton production in this area. The black clay (with a surface clay content of 68%) and soil organic carbon content (0-10 cm) of 1.0% and a pH of 8.5, is typical of the region.

During the the 2006/07 season, soil water (0-50 cm with Enviroscan), mineral nitrogen (0-10 cm) and crop production data was also collected to develop accurate models for predicting greenhouse gas emissions as a function of key chemical, physical and biological processes and specific management events. The 2006/07 experiment also attempted to directly measure the specific losses of N_2O and N_2 from a single application of N fertiliser using ^{15}N isotopically labelled urea.

The automated greenhouse gas measuring system (developed by Butterbach-Bahl et al.) consists of six chambers connected to sequential sampling unit, a gas chromatograph (equipped with both electron capture and flame ionization detectors for nitrous oxide and methane analysis respectively), and a Licor for carbon dioxide. To meet the demand for high mobility, the sample acquisition and analysis system is trailer mounted.

During a normal sampling period, the chambers were closed for 90 minutes (unless temperatures within the chambers exceeded 55^{o}C). The sampling program ensured that that a single gas sample was drawn back from each chamber every 20 minutes. To facilitate ^{15}N gas sampling, Swagelok T-pieces were inserted into the the sampling lines and used as sampling ports for manual removal of ^{15}N labelled gas using evacuated Exetainers for determination of ^{15}N-N_2O and ^{15}N-N_2 via mass spectrometry. Samples for ^{15}N gas analysis we removed at 15 and 60 minutes during a single cycle for each chamber, and the flux rate of $^{15}N_2O$ and $^{15}N_2$ calculated from the linear increase in N emission over that time period.

As there was little residual N in the profile after the previous crop, the grower applied 200 kg starter N in August 2006, and planted in late October, 2006. An application of ^{15}N labelled urea (99% atom excess ^{15}N) was made on 2 November in three (of the six) gas sampling chambers equivalent to 120 kg N/ha (treatment A), and 60 kg N/ha equivalent in the remaining three chambers (Treatment B). The grower applied 23 and 46 kg N as urea in the irrigation water, 98 and 135 days after the ^{15}N urea was applied.

A total of 1027 and 688 g N_2O-N were emitted from Treatments A and B respectively during the 150 days after ^{15}N application (with 36 days of missing data). The highest emissions were recorded after application of water run urea at day 135. A simple multiple regression model from the N_2O data based on surface soil moisture (0-10 cm) and minimum daily air temperature (^{o}C), estimated 1475 and 617 g N_2O-N/ha were emitted over the full 150 days, equivalent to 1.2 and 1.0% of the applied ^{15}N from Treatments A and B respectively. However, the ^{15}N gas samples obtained 2 months after ^{15}N application indicate the N_2O from the ^{15}N application were only one-tenth of the total amount of N_2O (from all sources) lost on that day.