Nitrous Oxide Emissions From Irrigated Cropping Systems In Colorado

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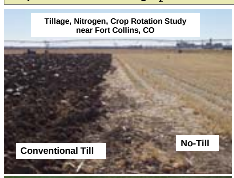
Abstract:

Little information is available on the effects of irrigated crop management practices on nitrous oxide (N_2O) emissions. Nitrous oxide emissions were monitored from several irrigated cropping system plots receiving N fertilizer rates ranging from 0 to 246 kg N ha^{-1} during the 2005 and 2006 growing seasons. Cropping systems included: conventional-till (CT) continuous corn (CC) (CT-CC); No-till (NT) CC (NT-CC); NT corn-dry bean (NT-CDb); and NT corn-barley (NT-CB). In 2005, half the N fertilizer rate was applied as urea-ammonium nitrate (UAN) at planting to the corn plots with the second half of the N rate applied as a surface broadcast polymer-coated urea (ESN®) in mid-June. All of the UAN was applied at planting on the NT-CB barley and NT-CDb dry bean plots in 2005. All plots were in corn in 2006, with ESN® being applied at half the N rate at corn emergence and half as dry urea about the V6-V7 corn growth stage, both surface banded in the corn row followed by irrigation. Fluxes of N_2O were measured from planting until crop harvest using static, vented chambers, one to three times per week, and a gas chromatograph analyzer. Growing season N2O emissions increased linearly with increasing N-fertilizer rate each year in all cropping systems, but emission amounts varied with years. Growing season N_2O emissions were generally greater from the NT-CDb system during the corn phase of the rotation than the other cropping systems. Tillage system had little effect on N_2O emissions. Crop rotation and N fertilization rate had more effect than tillage system on N_2O emissions. The amount of N_2O emitted from N fertilizer application ranged from 0.3 to 0.75% of N applied. Spikes in N_2O emissions following N fertilizer application were much greater with UAN and Urea than with ESN® fertilizer. ESN® showed potential for reducing N_2O emissions from irrigated cropping systems.



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Cropping Systems:

- CT-CC = Conventional till, continuous corn
- NT-CC = No-till, continuous corn
- NT-CDb = No-till, corn-dry bean
- NT-CB = No-till, corn-barley

Nitrogen Rates: 0, 67, 134, and 246 kg N/ha both years.

N Sources:

2005: UAN band applied before planting at half total N rate, with remaining N applied broadcast as ESN at V7 growth stage;

2006: ESN applied at planting at half of total N rate and remaining N applied as Urea at V7 growth stage, both band applied on the surface.

Soil: Fort Collins Clay Loam

Irrigation: linear-move sprinkler system

N_2O Measurements: Made 1 to 3 times per week using static, vented chambers during growing season and GC analyzer to determine concentration.

[1]Trade names and company names are included for the benefit of the reader and do not imply any endorsement or preferential treatment of the product by the authors or the USDA-ARS.

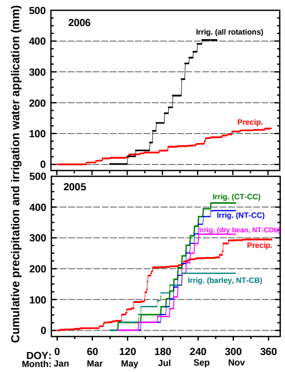
Field Operations:

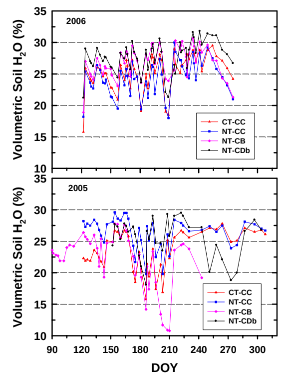
No-Till (NT):

1. Plant
2. Spray
3. Harvest

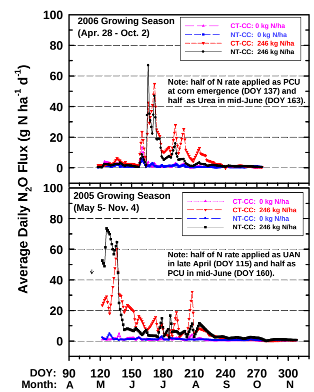
Conventional Till (CT):

1. Shred corn stalks
2. Disk
3. Moldboard plow
4. Disk
5. Roller Harrow
6. Landplane (2 operations)
7. Plant
8. Spray
9. Harvest.

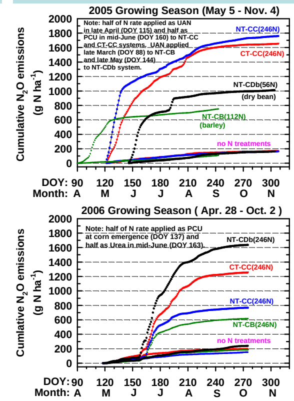




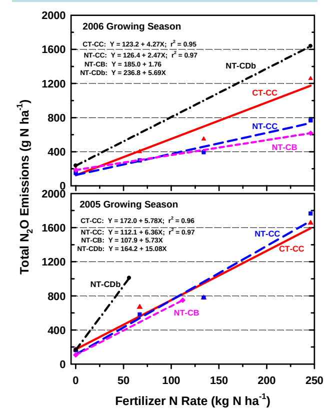
N_2O Fluxes during 2005 and 2006 Growing Seasons



N_2O Cumulative Emissions During Growing Season



Daily N_2O Flux as Function of N Rate



Trends in N_2O Fluxes During 2005 and 2006 Growing Seasons

1) N_2O emissions following ESN® application increased very little compared to that from UAN application in 2005.
2) N_2O emissions following ESN® application increased very little compared to that from UREA application in 2006.
3) N_2O emissions did not vary between CT-CC and NT-CC in 2005, but CT-CC had slightly greater N_2O emissions than NT-CC in 2006.
4) N_2O emissions tended to be greater in the NT-CDb rotation than in the CT-CC and NT-CC systems, similar to the NT-CSb rotation.
5) N_2O emissions increased linearly with increasing rate of N application in all cropping systems in 2005 and 2006, similar to that observed from 2002-2004.

Conclusions After 5 Years:

1) Increased N_2O emissions from UAN and Urea application occur mostly during the 30 days following fertilizer application, with N_2O fluxes declining to very low levels 30 to 40 days after N application.
2) There does not appear to be any residual affects of N fertilization on N_2O emissions late in the growing season or during the non-crop period.
3) Total growing season N_2O emissions vary with year, but are proportional to the amount of N applied.
4) Tillage system does not appear to have much affect on N_2O emissions, but inclusion of soybean or dry bean in the rotation increases N_2O emissions.
5) ESN® shows potential for reducing N_2O emissions in irrigated systems, but more research is needed to verify this observation. Studies in 2007 confirmed reduced N_2O emissions with ESN compared to urea (Halvorson and Del Grosso, unpublished data, October 1, 2007).

For Additional Study Information See References Below:

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- Mosier, A.R., A.D. Halvorson, C.A. Reule, and X.J. Liu. 2006. Net global warming potential and greenhouse gas intensity in irrigated cropping systems in northeastern Colorado. J. Environ. Qual. 35:1584-1598.