Nitrogen, Tillage, and Crop Rotation Effects On Nitrous Oxide Emissions From Irrigated Cropping Systems

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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); Strip-till CC (ST-CC); NT corn-dry bean (NT-CDb); and NT corn-barley (NT-CB). In 2005, half the N fertilizer rate was subsurface band applied as liquid urea-ammonium nitrate (UAN) at planting to the corn and dry bean plots with the second half of the N rate applied as a surface broadcast polycoated urea (ESN®, environmentally smart nitrogen produced by Agrium Inc.[1]) in mid-June. All of the UAN was applied at planting on the NT-CB barley plots in 2005. All plots were planted to corn in 2006, with ESN being applied at half the N rate at corn emergence and a second N application as dry urea about the V6-V7 corn growth stage, both banded on the soil surface in the corn row followed by irrigation. N_2O fluxes were measured from each treatment two to three times weekly from planting until crop harvest using static, vented chambers and gas chromatograph analyzer. N_2O emissions were generally greater from the NT-CDb system than the other cropping systems. Tillage system had little effect on N_2O emissions. N_2O emissions increased linearly with increasing N rate both years. The spikes in N_2O emissions following N fertilizer application were much greater with UAN and Urea than with ESN® fertilizer. ESN® shows potential for reducing N_2O emissions from irrigated cropping systems.

Tillage, Nitrogen, Crop Rotation Study near Fort Collins, CO

Collecting Gas Samples for Analysis

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.

Cropping Systems:

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

Nitrogen Rates:

0, 67, and 134 kg N/ha all years plus:
201 kg N/ha in 2002;
224 kg N/ha in 2003 and 2004, and
246 kg N/ha in 2005 and 2006.

N Sources:

2002 – 2004: UAN band applied before planting;

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

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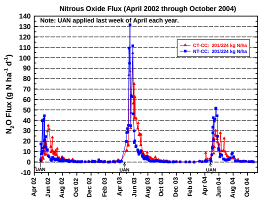
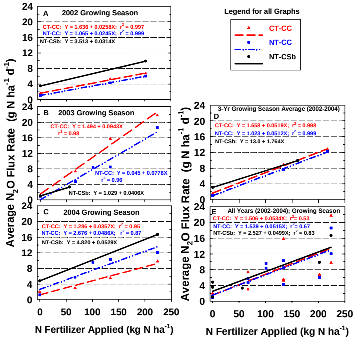
Nitrous Oxide Fluxes (April 2002 – October 2004) (Mosier et al., 2006)





(Adapted from Mosier et al. 2006 JEQ 35:1584-1598)

Trends in N_2O Fluxes from 2002-2004

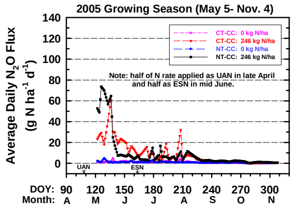
1) N_2O emissions from UAN application were maximized within 1 to 2 weeks after application, then declined to near background levels in about 4 to 6 weeks after application.
2) N_2O emissions varied with year within a given cropping system.
3) N_2O emissions did not vary much between tillage systems.
4) N_2O emissions tended to be greater in the corn-soybean rotation than in the continuous corn systems.
5) N_2O emissions increased linearly with increasing rate of N application.

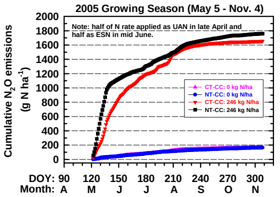
Additional Study Information:

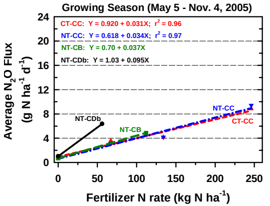
- Halvorson et al., 2006 Agron. J. 98:63-71.
- Halvorson and Reule, 2006 Agron. J. 98:1367-1374.
- Mosier et al., 2006 JEQ 35:1584-1598.

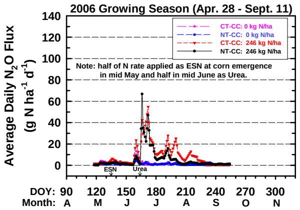
[1]Trade names and company names are included for the benefit of the reader and do not imply any endorsement or preferential treatment of the product by the authors or the USDA-ARS.

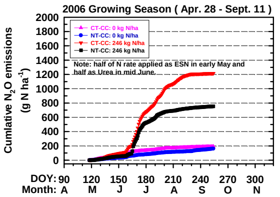
N_2O Fluxes during 2005 and 2006 Growing Seasons

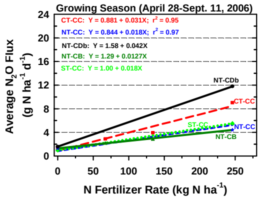












Trends in N_2O Fluxes During 2005 and 2006 Growing Seasons

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.