Various Fertilizer Sources for Mitigation of Greenhouse Gas Emissions

Katy Nannenga and Kristie Walker
University of Minnesota, Crookston

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Objectives:

1. *Evaluate the impact of turfgrass species, cultivation practice, and fertilizer source on the emissions of greenhouse gases from cool-season turfgrass.*
2. *Evaluate the impact of turfgrass species, cultivation practice, and fertilizer source on the year end mineralizable nitrogen from cool-season turfgrass.*
3. *Evaluate the impact of turfgrass species, cultivation practice, and fertilizer source on overall turfgrass quality.*

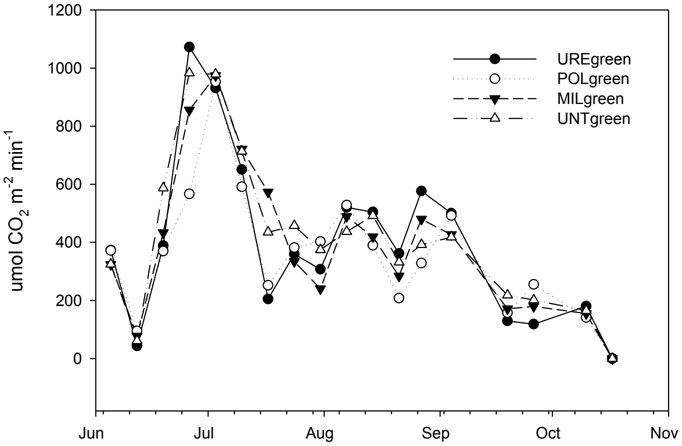
Nutrient cycling on golf courses has the capacity to sequester greenhouse gas (GHG) emissions through the accumulation of soil organic carbon (Qian and Follett, 2002; Milesi et al., 2005). However, cultural management practices can offset sequestration by mitigating GHG emissions directly (fertilization) or indirectly (maintenance equipment) (Barlett and James, 2011). Fertilizer application, irrigation, and other turfgrass management practices have the potential to contribute to emissions and mitigation of greenhouse gases, leading to uncertainties in the net contribution of turfgrass ecosystems to climate change (Zhang et al., 2013).

An ongoing field study evaluating fertilizer source (Urea, Encapsulated Polyon, and Milorganite), turfgrass species (Agrostis stolonifera and Poa pratensis), and site location (soil moisture regime) on GHG (carbon dioxide [CO_2], methane [CH_4], and nitrous oxide [N_2O]) emissions was initiated in June 2013. Samplings occurred weekly throughout the summer and fall of 2013 and will continue through 2014. Gas samples were taken using a vented closed gas chamber that was placed over the plots for 40 minutes following the USDA-ARS GRACEnet methods. Soil temperature, soil moisture, canopy greenness, and turfgrass quality were also collected.

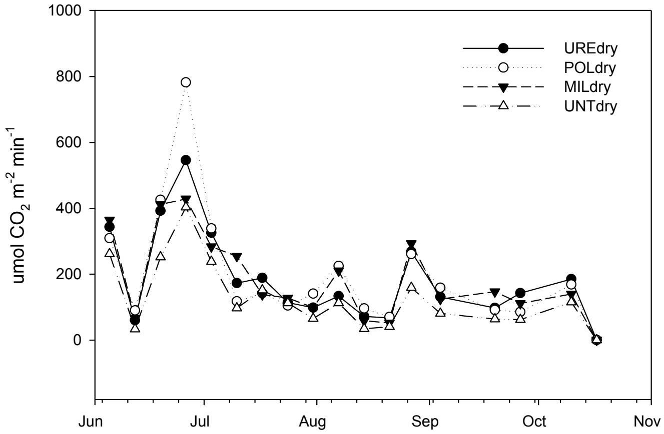
Greenhouse gas sample chambers were tamped into the ground flush with the soil surface. Gas samples were taken a 0, 20, and 40 minutes after the chambers were closed.

Results from 2013 show a trend indicating higher CO_2 emissions on the green and wet rough than on the dry rough. For the green, there were four dates that showed statistical differences between treatments (Figure 1a). Milorganite had significantly higher flux than Polyon and Urea on July 17. On August 7, all fertilized treatments showed significantly higher flux than the unfertilized treatments. Milorganite also showed significantly higher flux than Polyon on August 27. Urea and the Polyon had significantly higher emissions than the other treatments on September 4. Similarly, on the wet rough there were seven dates showing statistically

a. 2013 CO_2 Flux in Green



b. 2013 CO_2 Flux in Dry



c. 2013 CO_2 Flux in Wet

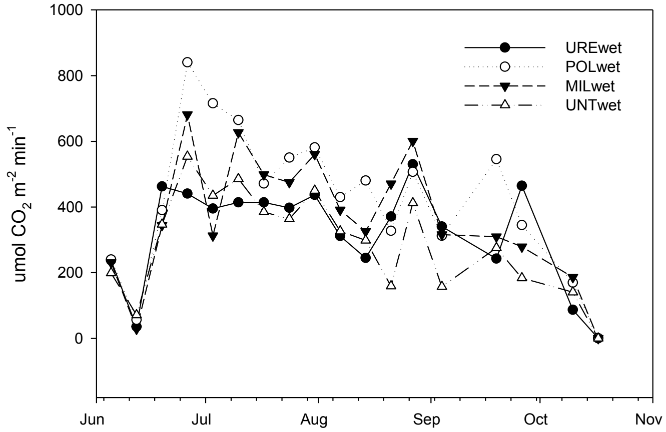
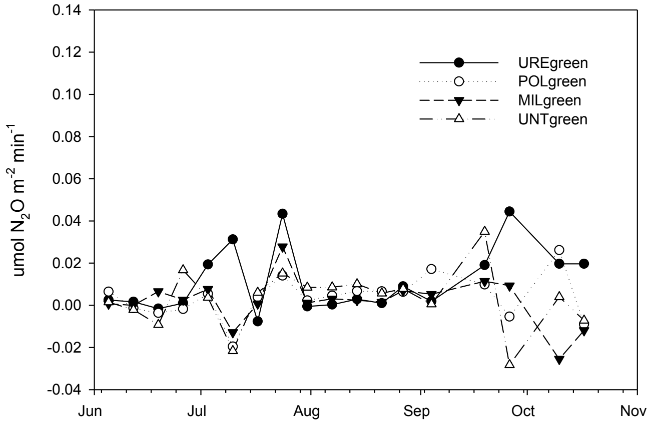
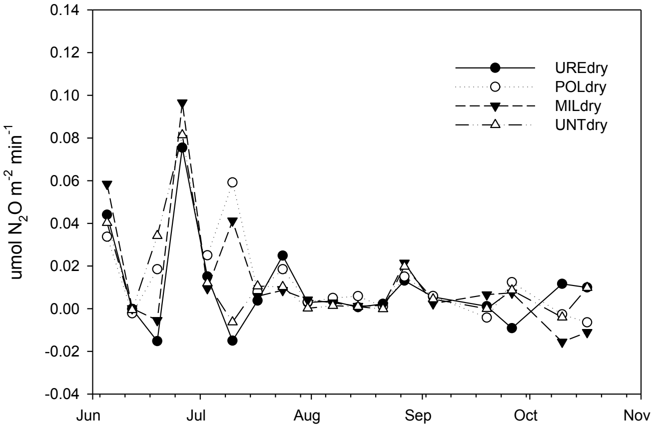


Figure 1. a) CO_2 flux by fertilizer treatment for the green during the 2013 growing period. b) CO_2 flux by fertilizer treatment for the dry rough during the 2013 growing period. c) CO_2 flux by fertilizer treatment for the wet rough during the 2013 growing period. (URE=Urea, POL=Polyon, MIL=Milorganite & UNT=Untreated control).

a. 2013 N_2O Flux in Green



b. 2013 N_2O Flux in Dry



c. 2013 N_2O Flux in Wet

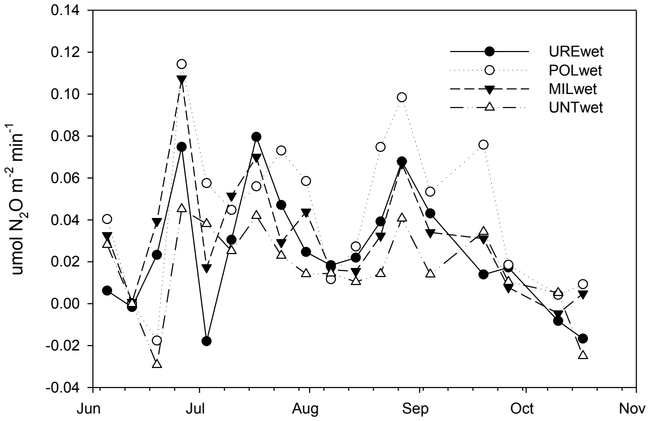


Figure 2. a) N_2O flux by fertilizer treatment for the green during the 2013 growing period. b) N_2O flux by fertilizer treatment for the dry rough during the 2013 growing period. c) N_2O flux by fertilizer treatment for the wet rough during the 2013 growing period. (URE=Urea, POL=Polyon, MIL=Milorganite & UNT=Untreated control).

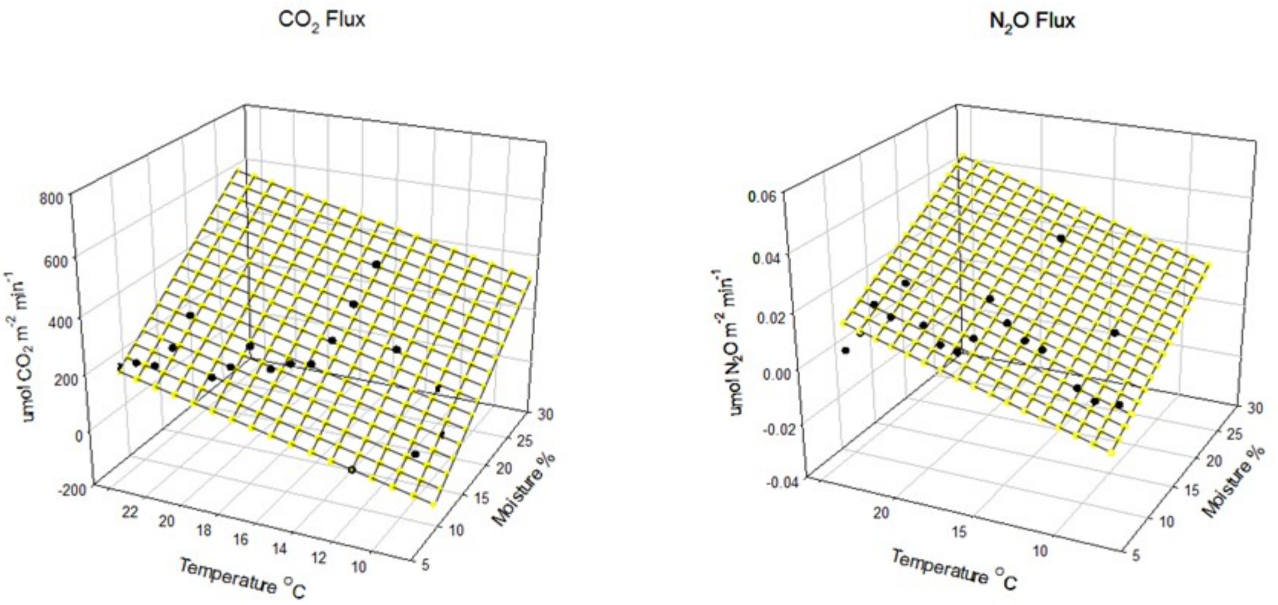


Figure 3. Soil temperature and soil moisture plotted against soil CO_2 and N_2O flux. The black dots represents the data points and the matrix represents the model generated using SAS to explain 99.99% of the data.

$CO_2 = [(0.09201)*temperature + (0.05011)\ moisture + 1.29697]^4$;

$N_2O = [(-0.000316)*temperature + (-0.0002943)\ moisture + 0.13343]^{(-1/3)} - 2$.

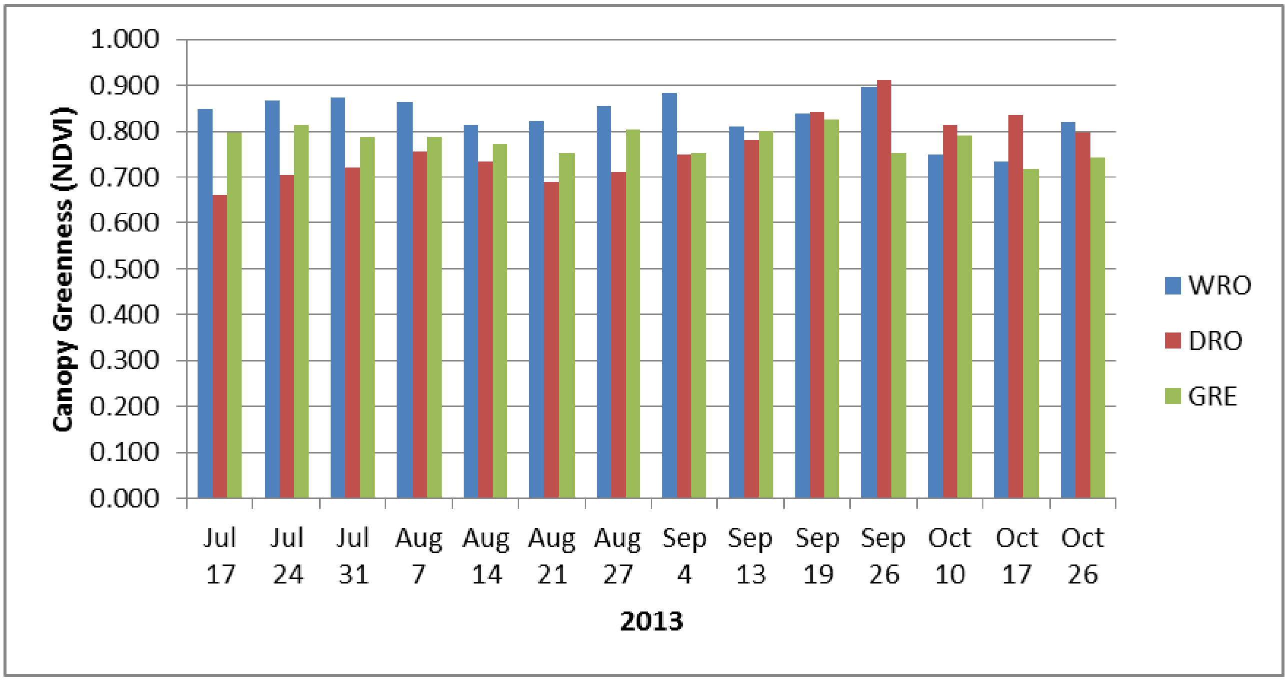


Figure 4: Canopy greenness (NDVI) by turfgrass area (WRO=Wet Rough, DRO=Dry Rough, GRE=Green) in 2013.

significant differences (Figure 1c). Polyon had the highest CO_2 emissions on 5 sampling dates, and was significantly higher than at least one other treatment on those dates (7/3, 8/14, 9/4, 9/14, and 10/17). On three of the sampling dates (9/4, 9/26, 10/17) urea was either not statistically different from the highest flux rate or was the highest flux rate. Milorganite had significantly higher emissions than Polyon on August 21. Methane (CH_4) emissions were not significantly different between treatments for any of the site locations. Nitrous oxide (N_2O) emissions was highest for the wet rough site location where Polyon had a higher emission rate than the other treatments on July 24 and August 21 (Figure 2c). Soil temperature and soil moisture were found to be significant predictors of CO_2 and N_2O emissions (Figure 3). Site location was significant for canopy greenness on all sampling dates in 2013 except for two dates in September following fertilization (Figure 4). Fertilizer source was significant on four of the sampling dates where turfgrass quality was significantly higher for the Milorganite and Urea treatments compared to the control.

The results from this study will provide information about turfgrass management practices that minimize greenhouse gas losses for cool-season turfgrasses which can be utilized to evaluate the environmental efficacy of our current cultural management practices.

Summary Points:

- Soil temperature and soil moisture were found to be significant predictors of CO_2 and N_2O emissions.
- Carbon dioxide (CO_2) emissions was highest in the green and wet rough site locations where Polyon and Urea treatments tended to show significantly higher emissions than other treatments.
- Nitrous oxide (N_2O) emission was higher for the wet rough than the other site locations where Polyon tended to show significantly higher emissions than other treatments.

References

Bartlett, M.D. and I.T. James, 2011: A model of greenhouse gas emissions from the management of turf on two golf courses. Science of the Total Environment. 409:1357-1367.

Milesi, C., S.W. Runnig, C.D. Elvidge, J.B Dietz, B.T. Tuttle, and R.R Nemani, 2005: Mapping and modelling the biogeochemical cycling of turf grasses in the United States. Environ Manage. 36:426–38.

Qian, Y.L. and R.F. Follett, 2002: Assessing soil carbon sequestration in turfgrass systems using long-term soil testing data. Agron. J. 94:930-935.

Zhang, Y., Y. Qian, D.J. Bremer, and J.P. Kaye, 2013: Simulation of nitrous oxide emissions and estimation of global warming potential in turfgrass systems using the DAYCENT model. J. Environ. Qual. 42:1100-1108.