



Module 9.1-3 Comparing urea and anhydrous ammonia for nitrous oxide emission from Minnesota corn.

A long-term (15-year) continuous corn (C/C) and corn-soybean (C/S) rotation study (each phase occurred each year) located in southeastern Minnesota, USA, was used to measure full growing-season emissions of nitrous oxide (N_2O ; a potent greenhouse gas) associated with nitrogen (N) fertilization; comparing urea versus anhydrous ammonia. The N was applied at 146 kg/ha only for the corn phase, one to two weeks before planting in 2005-2007. The anhydrous ammonia was knife-injected 15 to 20 cm below the soil surface and urea was surface broadcast and disc-incorporated 15 cm deep, the same day of application. The study was designed so that fertilizer N was applied to the same subplot treatments in the same 12-row subsections of each main plot each year. Soil-to-atmosphere emissions of N_2O and carbon dioxide (CO_2) were measured twice per week from April to October each growing season, using static chambers.

During the three growing seasons, there was no evidence that differences in crop residue inputs from the previous growing season (i.e., corn versus soybean) affected N_2O emissions. Crop residue from the prior year had no measurable effect on soil inorganic N or dissolved organic carbon in the subsequent season. However, in both C/C and C/S systems, N_2O emissions from anhydrous ammonia-fertilized corn were twice the emissions with urea-fertilized corn. Emissions of N_2O increased and reached a peak 4 to 6 weeks following anhydrous ammonia application, then declined to pre-application levels. Following urea application, N_2O emissions increased but displayed more erratic and short-lived patterns.

This study illustrates that fertilizer-induced N_2O emissions per unit of N applied may be reduced with different N choices. A full accounting of greenhouse gas impacts, however, would require a more complete life cycle analysis including production and transport factors.

Table 1. Three-year average, corn-phase, growing-season N_2O emissions for a corn-soybean rotation compared with continuous corn, with the corn phase fertilized using anhydrous ammonia or urea at 146 kg of N/ha, in southeastern Minnesota, USA. **Adapted from** tables and figures in Venterea et al., 2010.

Two-year crop rotation	Fertilizer N source	N_2O -N emission, kg/ha	Mean corn grain yield, t/ha	N_2O emissions intensity per tonne of yield	
				kg N_2O -N	kg CO_2 -eq
Corn-corn	anhydrous ammonia	2.15	7.36	0.29	142
	urea	1.01	7.92	0.13	62
Corn-soybean	anhydrous ammonia	1.37	8.26	0.17	81
	urea	0.80	9.14	0.09	43

Source: Venterea, R.T., M.S. Dolan, and T.E. Ochsner. 2010. Soil Sci. Soc. Am. J. 74:407–418.

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