

Table 1. Cumulative ammonia loss (% of applied N) from urea as affected by NBPT from surface-applied urea following late-fall, winter, and early-spring applications to winter wheat fields.

Season	Fertilizer application		Trial duration	Cumulative NH ₃ loss		NBPT mitigation
	timing	date		Urea	Urea + NBPT	
			d	---- % applied N † ----		%
2011-2012	late-fall	29-Nov	87	13.4	5.9	56.0
	mid-winter	28-Feb	49	13.0	4.1	68.5
	spring	24-Apr	21	1.2	0.0	-
2012-2013	late-fall	12-Dec	106	19.3	5.3	72.5
	mid-winter	8-Feb	48	10.6	3.6	66.0
	spring	12-Apr	55	4.2	1.4	66.7
2013-2014	late-fall	1-Dec	103	16.3	6.2	62.0
	mid-winter	21-Feb	62	10.6	4.9	53.8
	spring	18-Apr	26	0.2	0.0	-
\bar{x}	late-fall			16.3	5.8	
	mid-winter			11.4	4.2	
	spring			1.9	0.5	

† N application rate = 100 kg N ha⁻¹; NBPT added as Agrotain® at 0.1%

Table 2. Cumulative NH₃ loss from surface-applied urea (100 kg N ha⁻¹) following application post-plant and pre-plant to a no-till winter wheat field at four trials in Hill County, Montana. Surface soil moisture on the date of seeding.

Trial	Fertilization date	Trial duration	Surface soil moisture content (0-2 cm depth)	Cumulative NH ₃ loss	
				post-plant N	pre-plant N
		d	g/g	---- % applied N † ----	
1	15-Sep-2010	64	15.0	13.8	18.7
2	27-Sep-2010	71	12.6	24.7	20.6
3	7-Oct-2010	62	3.3	5.6	4.7
4	16-Sep-2011	83	4.5	7.2	11.9
\bar{x}				12.8	14.0



Figure 1. Field peas were terminated at the early-pod stage in 2011 (top) and flowering in 2012 (bottom) at field sites near Havre, Montana. A mast with Leuning samplers was erected inside of the circular plots to trap NH_3 loss according to the integrated horizontal flux method.

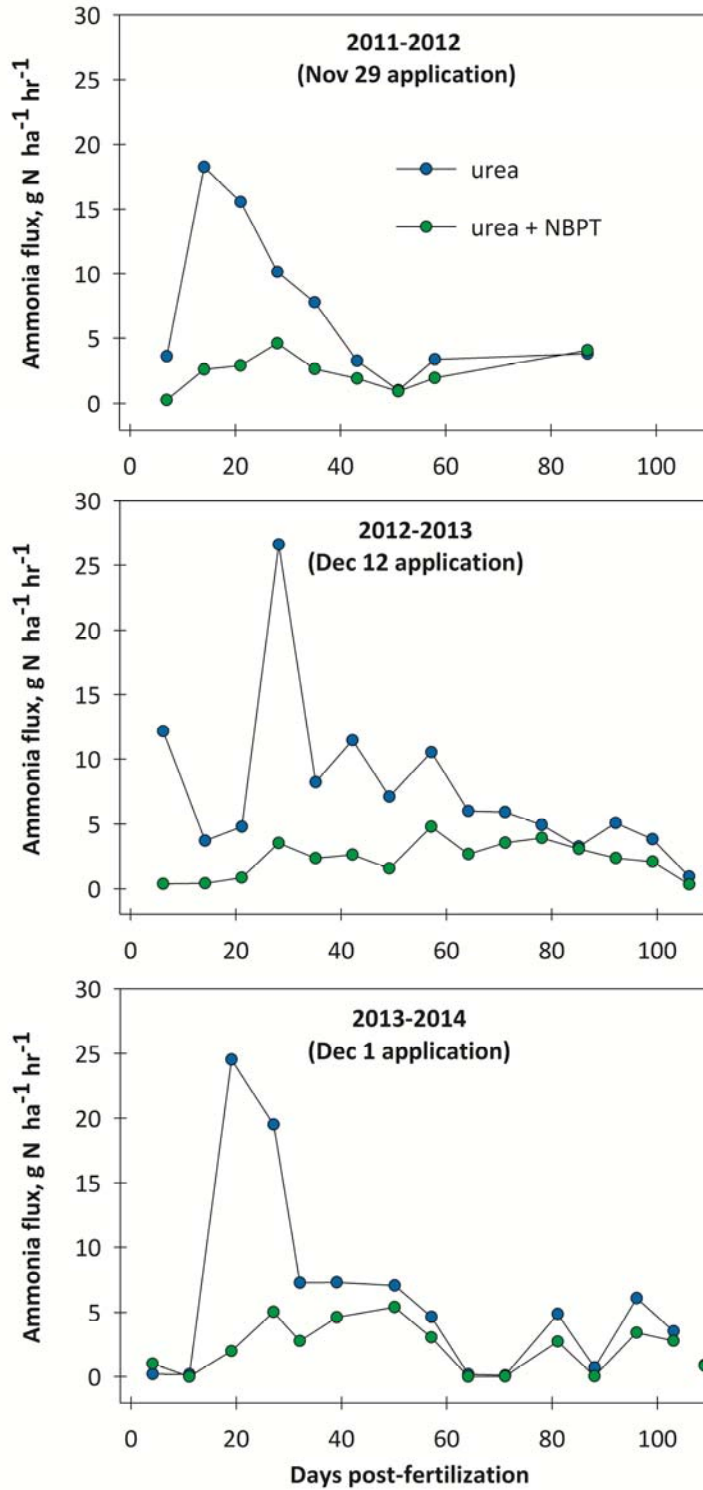


Figure 2. Ammonia flux vs. day post-fertilization following the late-fall applications of urea and urea + NBPT in 2011-2012, 2012-2013, and 2013-2014.

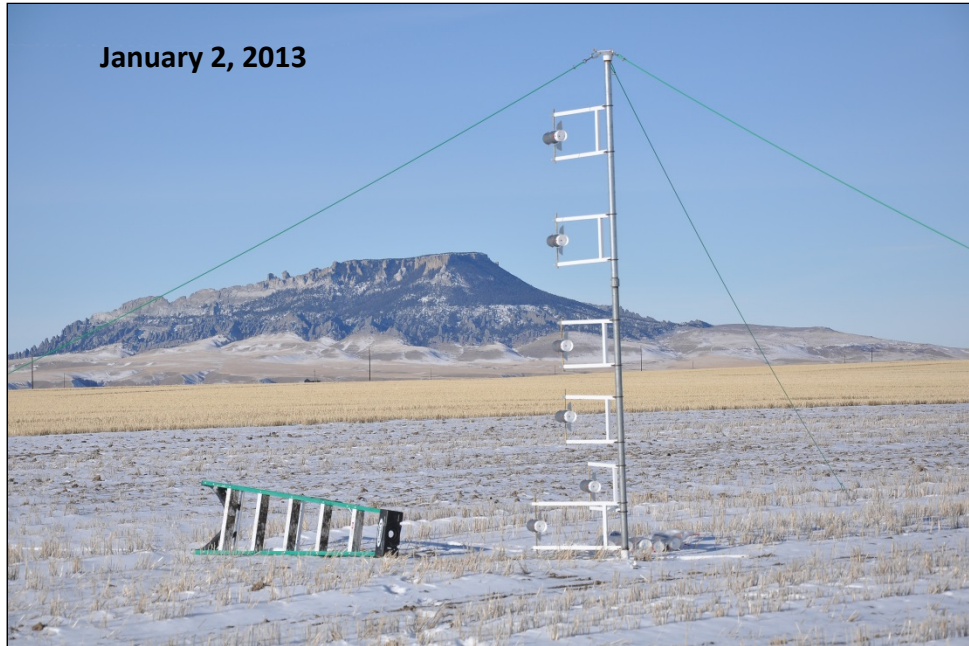


Figure 3. These photographs illustrate the change in field conditions over a 1-wk period in January 2013, and following the late-fall application during season 2012-2013 for the Fergus County site. Highest ammonia losses from fertilizer were typically associated with wet to dry cycles. During this period, 4.5 kg N ha^{-1} (4.5% of applied N) was lost to the atmosphere as ammonia (see emission peak at 28 d in Figure 2 - middle).

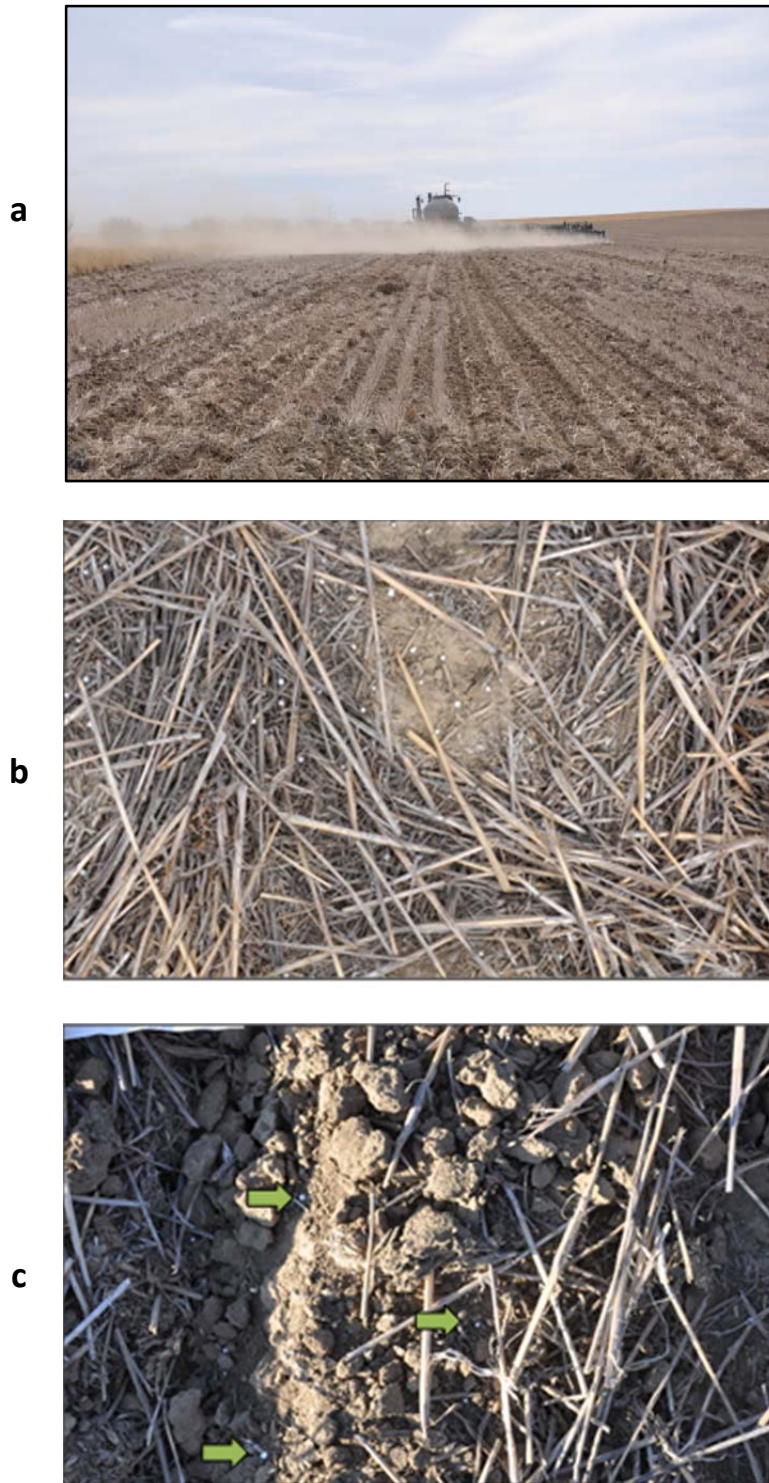


Figure 4. Seeding into dry soil conditions at a field site in Hill County, Montana. September 16, 2011. Trial 4 (a). Soil disturbance at this site was insufficient to cover urea granules and protect against volatility losses. A narrow style opener was used at this field site. Urea granules on surface before (b) and after (c) seeding from the same microsite in the field. Arrows indicate visible granules.

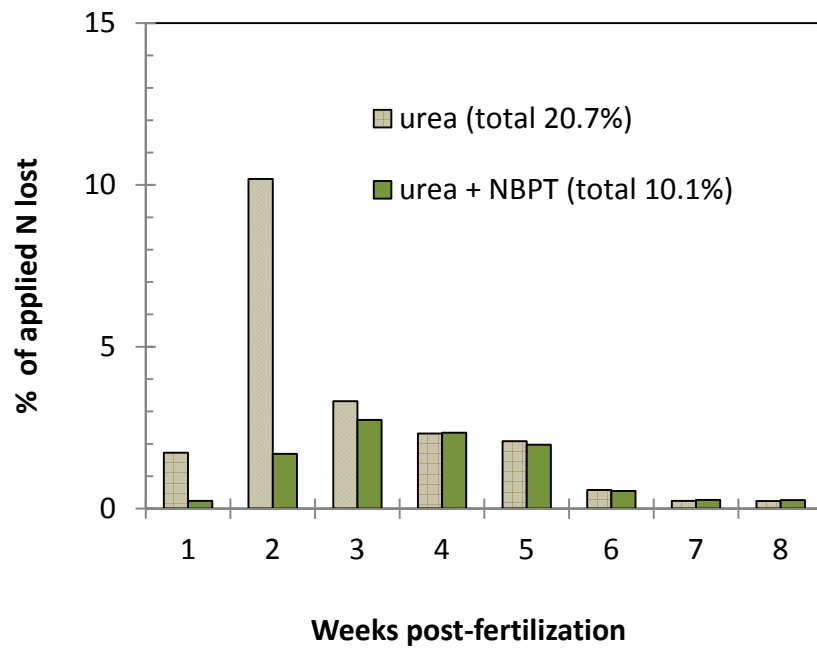
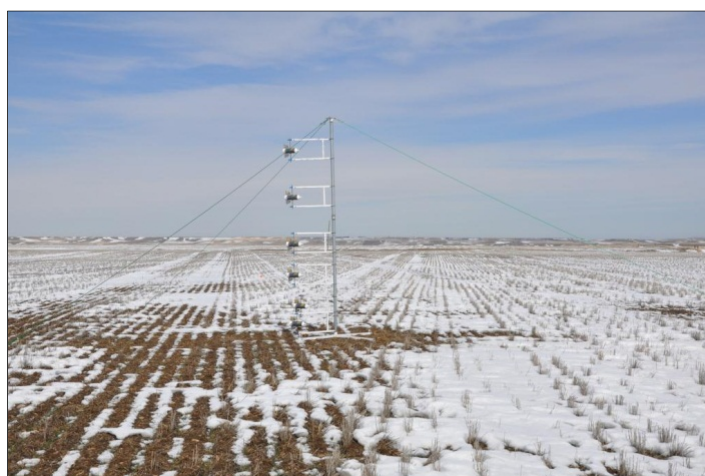


Figure 5. Weekly NH₃ losses (expressed as a percentage of applied N) from surface-applied urea and Agrotain-coated urea at field site in Fergus County, Montana. Fertilizer was applied on 02-March 2011.

a.
March 2, 2011
(fertilization
date)



b.
March 8, 2011
(1 wk post-
fertilization)



c.
March 15, 2011
(2 w post-
fertilization date)

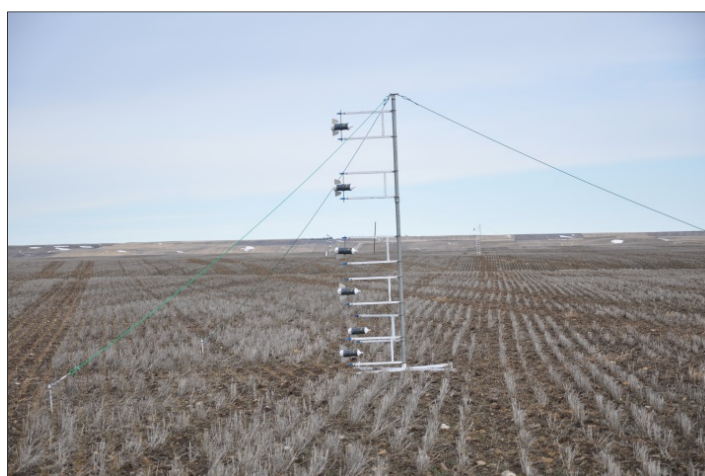


Figure 6. Urea was surface-applied to a snow-covered (0.89 cm water) winter wheat field site in Fergus County, Montana on March 2, 2011 (a). Field site 1-wk (a) and 2-wk (b) post-fertilization.