Ammonia Volatilization and Effect of an Alternative Nitrogen Source on Yield, Protein and Test Weight of Winter Wheat Crops in a High Rainfall Region

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Introduction

Winter wheat fields in the high rainfall region of western Oregon receive surface-applied nitrogen (N) fertilizers, mostly in the form of urea (46-0-0), in early spring when large amounts of precipitation are common. Nitrogen loss from ammonia (NH_3) volatilization has been measured in surrounding regions where annual precipitation is low, but little work has been completed in high rainfall environments. Several studies have indicated that treating urea with the urease inhibitor (N-(n-butyl) thiophosphoric triamide (NBPT), trade name Agrotain®, minimizes N loss to volatilization. Study objectives were to:

1) Determine if NH_3 losses occur from top-dress applications of urea fertilizer on winter wheat crops in western Oregon

2) Measure differences in grain yield, protein and test weight of soft white winter wheat (SWWW) and hard red winter wheat (HRWW) when urea is applied with and without Agrotain®.

Methods

The study was conducted for one year in Hillsboro, OR (2012) and two years in Corvallis, OR (2012, 2013) (Figure 1). The N mineralization soil test was used to determine the N fertilizer requirement for SWWW at each of the study locations.

Figure 1. Study site and rotating mast with flux samplers.

Ammonia volatilization

Ammonia volatilization was measured with a modified passive flux method which consists of a rotating mast (Figure 1) with glass tubes coated with oxalic acid at five heights (0.45, 0.75, 1.50, 2.25 m). At all locations, one rotating mast was placed in plots where either 140 or 170 kg ha^{-1} of urea was applied at Zadoks GS 30 and one mast was placed 91 m from the study locations where no N was applied.

Nitrogen Treatments

SWWW treatments included 1) control (no fertilizer), 2) N as urea at 100% recommended rate, 3) N as Agrotain® at 100% recommended rate, 4) N as urea at 75% recommended rate, and 5) N as Agrotain® at 75% recommended rate. All N was applied at GS 30.

HRWW treatments included 1) control (no fertilizer), 2) 300 kg N/ha^{-1} urea at GS 30, 2) 300 kg N/ha^{-1} Agrotain® at GS 30, 3) 200 kg N/ha^{-1} urea at GS 30 and 100 kg N/ha^{-1} urea at GS 37, and 4) 100 kg N/ha^{-1} urea and kg N/ha^{-1} Agrotain® at GS 30 plus 100 kg N/ha^{-1} urea at GS 37.

Results

Average N loss 22 days after N application was 6.6% and 30.5% of N applied in 2012 and 2013, respectively (Figure 2). The average precipitation during the study period at both sites was 45 mm and 266 mm in 2012 and 2013, respectively.

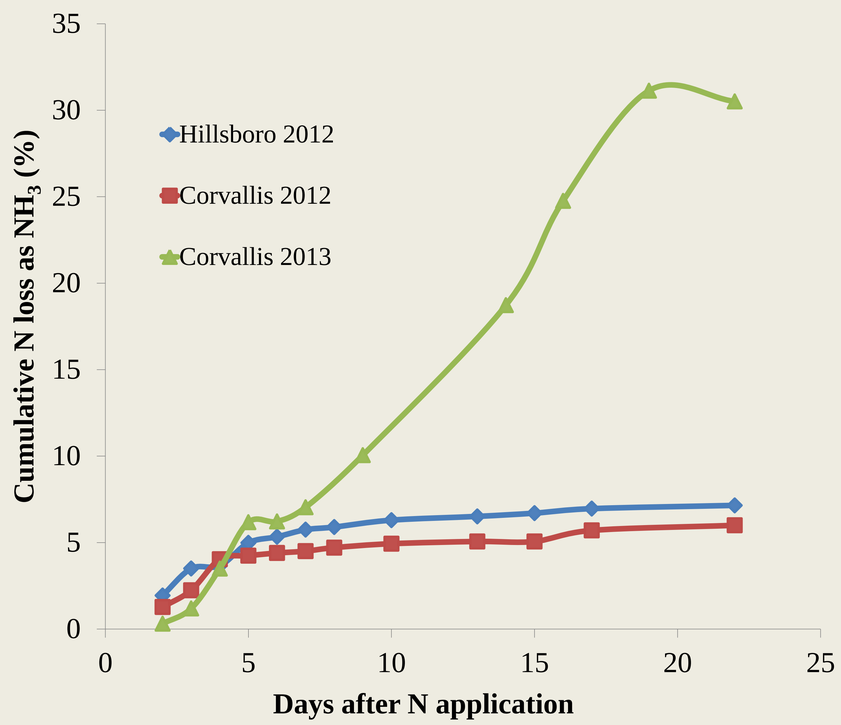

Figure 2. Percent N loss from NH_3 volatilization over 22 days.

In both years, higher N rates consistently increased grain yield, protein and test weight for both wheat market classes; however, use of Agrotain® treated urea only increased grain yield in 2013 for SWWW (Table 1). No differences in the measured parameters were found amongst N treatments in the HRWW study in either year (data not shown).

Table 1. Grain yield, protein and test weight of SWWW treated with two rates of N as urea and Agrotain® coated urea.

2012 Hillsboro

Treatment #	Yield	Protein	Test Weight
	(t/ha)	(%)	(kg/hL)
Control	6.6	8.0	78.5
100% N as Urea	12.5	9.4	80.1
100% N as Agrotain	12.3	9.2	79.7
75% N as Urea	11.6	8.8	79.6
75% N as Agrotain	11.6	8.6	79.2
LSD (0.05)	0.7	0.4	0.5
CV (%)	4.1	3.1	0.5

2012 Corvallis

Treatment	Yield	Protein	Test Weight
	(t/ha)	(%)	(kg/hL)
Control	4.1	6.3	76.8
100% N as Urea	10.9	8.2	78.6
100% N as Agrotain	10.3	8.2	78.6
75% N as Urea	8.6	7.8	77.8
75% N as Agrotain	8.5	7.7	77.8
LSD (0.05)	1.3	0.3	0.9
CV (%)	9.4	2.6	0.8

2013 Corvallis

Treatment	Yield	Protein	Test Weight
	(t/ha)	(%)	(kg/hL)
Control	6.0	6.9	76.6
100% N as Urea	10.0	8.9	78.6
100% N as Agrotain	10.3	9.3	78.8
75% N as Urea	9.5	8.3	78.3
75% N as Agrotain	9.6	8.4	78.1
LSD (0.05)	0.2	0.5	0.7
CV (%)	4.3	3.5	0.6

Conclusion

The measured difference in grain yield when Agrotain® treated urea was used is consistent with the amount of NH_3 volatilization measured. Precipitation amounts immediately following N application appear to heavily influence how much N loss from NH_3 volatilization occurs in Oregon's high rainfall region.