ENHANCING FERTILIZER EFFICIENCY IN WESTERN OREGON GRASS SEED CROPS WITH UREASE INHIBITORS

N.P. Anderson, T.G. Chastain, and C.J. Garbacik

Introduction

Nitrogen (N) is the most important fertilizer used in grass seed production (Hart et al., 2013). Applied N increases seed yield in grass seed crops by increasing the number of seeds produced and by increasing seed weight (Chastain et al., 2014). Nitrogen application increases the profitability of grass seed production enterprises. However, the cost of this input has been steadily increasing over time, so enhancing fertilizer N efficiency is important.

The enzyme urease catalyzes the reaction of urea to ammonia, thereby leaving applied N susceptible to losses through volatilization. The loss of applied N through ammonia volatilization not only has an environmental cost, but can also be a significant economic cost. Nitrogen use efficiency is reduced by volatilization losses; thus, seed growers may not receive the maximum benefit from all of the N that they apply. Losses of 5–25% of the total N applied have recently been measured in western Oregon wheat and pasture systems (Anderson, et al., unpublished report). Results indicate that the greatest losses occur when there is dry weather for several days following top-dress N fertilizer application. Controlling volatilization may allow seed growers to obtain greater seed yields with equal or lower N rates, thereby reducing the cost of production.

A urease inhibitor [N-(n-butyl) thiophosphoric triamide] (NBPT), known by the trade name Agrotain Ultra®, has shown considerable efficacy in reducing N losses due to volatilization and in increasing yield in crops such as corn (Hatfield and Parkin, 2014), but little is known about use of this product in grass seed crops (Hart et al., 2013). Seed yield was increased by 7% with use of a NBPT-containing urease inhibitor in perennial ryegrass in New Zealand (Rolston et al., unpublished report). However, it is not known whether NBPT urease inhibitors are effective under Oregon conditions. While seed yields may not increase substantially with the application of NBPT urease inhibitors, it is anticipated that the cost of N application will be reduced through greater N use efficiency, thus increasing profitability.

The potential for reduction in emissions of greenhouse gases such as nitrous oxide also exists with use of urease inhibitors. The application of urease inhibitors in irrigated pastures in New Zealand reduced nitrous oxide emissions by up to 12% (Dawar et al., 2011).

The potential of economic and environmental benefits for Oregon's grass seed industry makes the timely investigation of urease inhibitors for reduction of N losses a priority. The objective of this study was to determine the effect of NBPT-containing urease inhibitors on seed yield and seed yield components, biomass production, and N uptake in perennial ryegrass seed crops.

Materials and Methods

Trials were conducted in first-year perennial ryegrass seed fields at three on-farm sites in 2013–2014 in Marion, Yamhill, and Washington counties. The experimental design for the trials was a randomized

Table 1. Nitrogen application rates, source, timing, and urease inhibitor materials used in three first-year stands of perennial ryegrass grown for seed production.

Treatment	N application rate	Source	Timing	Urease inhibitor
	(lb/acre)			
1	120	40-0-0-6	March 11	—
2	160	40-0-0-6	March 11	—
3	120	40-0-0-6	March 11	Agrotain®
4	160	40-0-0-6	March 11	Agrotain
5	160 split	40-0-0-6 + UAN	March 11 + April 14	Agrotain (on 40-0-0-6 only)
6	120	40-0-0-6	March 11	N-Veil®[1]

[1]N-veil is a NBPT product similar to Agrotain Ultra. It was evaluated only at the Marion County trial site.

complete block with three replications at each site. Plot size was approximately 25 feet x 300–355 feet. Soil samples were taken prior to spring fertilizer application to measure pH and percent organic matter. Soil pH values ranged from 5.4 to 5.9, and organic matter ranged from 3.5 to 4.2%.

Fertilizer treatments included the following (Table 1):

- Two N rates applied as 40-0-0-6, representing the range of recommended rates for perennial ryegrass seed crops in Oregon (120–160 lb N/acre), with and without Agrotain Ultra
- A split application of 160 lb N/acre, with 50% applied as 40-0-0-6 with Agrotain Ultra and 50% applied as liquid UAN
- At the Marion County site only, an N application of 120 lb N/a, applied as 40-0-0-6 with N-Veil®, another NBPT-containing urease inhibitor

All dry fertilizer was applied as a single application on March 11, and the liquid UAN was applied on April 14. Agrotain Ultra and N-Veil were each applied at a rate of 3 qt/ton of N fertilizer.

Above-ground biomass samples were taken at peak anthesis, and dry weight of the standing crop was determined by drying and subsequent weighing of the harvested material. Total C and N in plant tissue samples were determined by using a LECO CNS analyzer. Seed was harvested with grower combines, and seed yield was determined with a weigh wagon. Seed weight was determined by counting two 1,000-seed samples with an electronic seed counter and weighing these samples on a laboratory balance.

Data were analyzed by using analysis of variance, and means were separated by using Fisher's Protected LSD values ($P = 0.05$).

Results and Discussion

N fertilizer rates and NBPT-containing urease inhibitors influenced seed yields differently among the three sites. At the Marion and Washington county sites, the 160 lb N/acre rate produced higher seed yields than the 120 lb N/acre rate with both single and split applications, while no difference in seed yield was evident among N rates at the Yamhill County site (Table 2).

There was a significant seed yield response when NBPT was used at one of the three trial sites. In Washington County, seed yield was increased by 15.4 and 10.1% with Agrotain Ultra at 120 lb N/acre and 160 lb N/a, respectively. The split application totaling 160 lb N/acre with Agrotain Ultra produced a 6.3% seed yield increase over the 160 lb N/acre without Agrotain Ultra. No significant seed yield response to NBPT urease inhibitor treatments, in either a single or split application, were observed at the Marion or Yamhill county sites.

There were no significant differences in seed weight, above-ground biomass, or total tissue C and N among N rate or urease inhibitor treatments at any of the sites (Table 2). Nonetheless, tissue N content tended to be elevated where NBPT was used. The lack of differences in seed weight at the trial sites indicate that increased seed number per unit area, rather than changes in seed weight, were responsible for the seed yield increases observed as a result of increasing N rate or use of NBPT.

No rain was measured in the Willamette Valley region for three days following N fertilizer application; however, approximately 0.45 inch of rainfall was measured during the four- to seven-day period following fertilizer application. Previous studies conducted in the Willamette Valley and elsewhere indicate that the amount of ammonia loss to volatilization following top-dress N applications is drastically reduced when a rain event occurs within seven days following N fertilizer application.

The relatively dry conditions that occurred during the study period likely resulted in some N loss to ammonia volatilization, resulting in a positive seed yield response when Agrotain Ultra was used at the Washington County site. Since there was no seed yield response when a higher N rate was used at the Yamhill County site, it is evident that the lower N rate sufficiently supplied the crop. Therefore, it is not surprising that there was no response to the addition of NBPT.

This is the first report on effects of NBPT-containing urease inhibitors on grass seed production in western Oregon. The results to date suggest that these particular urease inhibitors appear to have potential for improving N fertilizer use efficiency in grass seed crops produced under western Oregon conditions. Additional studies will be conducted in 2015, and updates will be provided when data is available.

Acknowledgments

The authors wish to thank the Oregon Seed Council and Koch Agronomic Services, LLC for their support of this

work. We also thank Marion Ag Service and our grower cooperators for their time and contributions.

References

Chastain, T.G., C.J. Garbacik, and W.C. Young III. 2014. Spring-applied nitrogen and trinexapac-ethyl effects on seed yield in perennial ryegrass and tall fescue. Agron J. 106:628–633.

Dawar, K., M. Zaman, J.S. Rowarth, J. Blennerhassett, and M.H. Turnbull. 2011. Urease inhibitor reduces N losses and improves plant-bioavailability of urea applied in fine particle and granular forms under field conditions. Agric. Ecosyst. Environ. 144:41–50.

Hart, J.M., N.P. Anderson, T.G. Chastain, M.D. Flowers, C.M. Ocamb, M.E. Mellbye, and W.C. Young III. 2013. *Nutrient Management Guide: Perennial Ryegrass Grown for Seed*. Oregon State University Extension publication EM 9086.

Hatfield, J.L. and T.B. Parkin. 2014. Enhanced efficiency fertilizers: Effect on agronomic performance of corn in Iowa. Agron. J. 106:771–780.

Table 2. Harvest characteristics and tissue analysis of three first-year perennial ryegrass fields on Marion, Yamhill, and Washington county sites under different N rates with and without the use of a NBPT-containing urease inhibitor, 2014–2015.

Marion County site

Treatment	Yield[1]	Cleanout	Seed weight	Biomass	C	N
	(lb/a)	(%)	(mg/seed)	(lb/a)	(%)	(%)
120 lb N/a 40-0-0-6	1,762 a	20.7	1.693	11,131	43.5	1.95
160 lb N/a 40-0-0-6	1,956 c	21.3	1.649	11,268	43.4	2.42
120 lb N/a + Agrotain	1,797 ab	20.2	1.603	10,515	43.9	2.48
160 lb N/a + Agrotain	1,898 bc	22.6	1.629	10,805	43.9	2.63
Split (160 lb N/a +Agrotain)	1,880 bc	21.6	1.629	11,879	43.4	1.97
120 lb N/a + N-Veil	1,848 abc	22.4	1.614	—	—	—

Yamhill County site

Treatment	Yield	Cleanout[1]	Seed weight	Biomass	C	N
	(lb/a)	(%)	(mg/seed)	(lb/a)	(%)	(%)
120 lb N/a 40-0-0-6	1,767	4.5 a	1.607	9,385	42.6	1.80
160 lb N/a 40-0-0-6	1,779	4.1 a	1.512	8,809	44.1	1.64
120 lb N/a + Agrotain	1,772	4.6 a	1.557	9,892	43.0	2.52
160 lb N/a + Agrotain	1,763	4.7 a	1.542	11,077	43.2	1.87
Split (160 lb N/a +Agrotain)	1,715	5.7 b	1.490	9,964	43.1	1.77

Washington County site

Treatment	Yield[1]	Cleanout	Seed weight	Biomass	C	N
	(lb/a)	(%)	(mg/seed)	(lb/a)	(%)	(%)
120 lb N/a 40-0-0-6	1,591 a	3.90	1.677	14,323	42.9	1.38
160 lb N/a 40-0-0-6	1,744 b	3.70	1.721	14,361	43.1	1.91
120 lb N/a + Agrotain	1,836 bc	3.60	1.716	14,253	43.1	2.13
160 lb N/a + Agrotain	1,920 c	4.10	1.701	14,032	43.3	2.19
Split (160 lb N/a+Agrotain)	1,853 c	4.40	1.720	14,083	42.9	2.12

[1]Means followed by the same letter are not significantly different from each other at LSD (0.05).