ENHANCING FERTILIZER EFFICIENCY IN PERENNIAL RYEGRASS SEED CROPS WITH UREASE INHIBITORS

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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, but the cost of this valuable input has been steadily increasing over time.

The enzyme urease catalyzes the reaction of urea to ammonia, thereby making applied N susceptible to losses through volatilization. Results indicate that the greatest losses occur when there is dry weather for several days following fertilizer application.

The loss of applied N through ammonia volatilization can represent a significant economic cost. Nitrogen use efficiency is reduced by volatilization losses, and seed growers might not be getting maximum benefit from all of the N that they apply. Losses of 5 to 25% of the total N applied have been measured recently in western Oregon wheat and pasture systems (Anderson et al., unpublished report). Seed growers might be able to obtain greater seed yields with the same or less amount of applied N if volatilization were controlled, thereby reducing the cost of production.

Ammonia lost through volatilization is also an environmental pollutant. In the atmosphere, the reaction of ammonia with nitrous oxide (N_2O) and sulfur oxide (SO_2) creates particulate aerosols that scatter light, resulting in haze. This has been a concern in the Columbia Basin, where deposition of inorganic N has been measured from N originating from livestock operations and fertilizer applications on crop fields (Fenn et al., 2007). The potential for reduction in emissions of greenhouse gases such as NO_x exists with urease inhibitors. The application of urease inhibitors in irrigated pastures in New Zealand reduced NO_x emissions by up to 12% (Dawar et al., 2011).

A urease inhibitor [N-(n-butyl) thiophosphoric triamide] (NBPT), known by the trade name Agrotain, has been shown to reduce N losses due to volatilization and increase 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 urease inhibitor in perennial ryegrass in New Zealand (Rolston et al., unpublished data). It is not known whether a urease inhibitor could be effective under Oregon conditions.

The objectives of this study were to (1) determine the effect of urease inhibitors on seed yield and seed weight in perennial ryegrass seed crops, (2) measure the effects of urease inhibitors on biomass production, N uptake, and N use efficiency in perennial ryegrass seed crops, and (3) develop recommendations for use of urease inhibitors in grass seed production based on research results and disseminate this information to seed growers and industry practitioners.

Methods

Large-scale field trials were conducted in first-year perennial ryegrass seed fields at three on-farm sites in 2014–2015 and 2015–2016. The experimental design for the trials was a randomized complete block with three replications at each site. Plot size was approximately 25 feet x 300 feet.

Treatments included two N rates applied as dry urea and representing the range of recommended rates for perennial ryegrass seed crops in western Oregon, with and without the urease inhibitor product Agrotain. A split treatment of dry urea with Agrotain (80 lb N/acre) plus urea ammonium nitrate solution (UAN 32 at 80 lb N/acre) was also included.

Treatments included:

- 120 lb N/acre
- 160 lb N/acre
- 120 lb N/acre + Agrotain
- 160 lb N/acre + Agrotain
- 160 lb N/acre split + Agrotain

Fertilizer applications were made on March 11 and 18 in 2014 and 2015, respectively. UAN 32 fertilizer (80 lb N/acre) was applied to the split treatment plots approximately 1 month after dry fertilizer application.

Weather was monitored to determine timing and amount of rainfall that occurred after the fertilizer was applied. This information is important since the greatest amount

of ammonia is lost from volatilization in the first week following urea applications.

Three above-ground biomass samples were taken from each plot near peak anthesis, and dry weight of the standing crop was determined by drying and subsequent weighing of the harvested material. Seed was harvested with grower combines, and seed yield was determined by use of 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.

Results and Discussion

An average of 0.19 and 0.17 inch of rainfall was recorded approximately 3 days after fertilizer application in 2014 and 2015, respectively. More than 0.5 inch of rainfall was recorded within 5 days at all sites in both years.

Seed yield was affected by N rate in 2014 (Table 1) but not in 2015 (Table 2). In 2014, the higher N rate (160 lb/acre) increased seed yield by 7% over the lower rate (120 lb/acre) without Agrotain. At the 160 lb N/acre rate, there was no significant difference between a single or split application in either year.

Table 1. Urease inhibitor effects on harvest factors and N tissue concentration in perennial ryegrass seed crops, 2014.[1]

	Yield	Cleanout	Seed weight	Biomass	Tissue N
	(lb/a)	(%)	(mg/seed)	(ton/a)	(%)
Site					
Washington County	1,793	3.9 a	1.707 c	7.1 c	1.95
Yamhill County	1,763	4.7 b	1.541 a	4.9 a	1.92
Marion County	1,863	21.3 c	1.641 b	5.6 b	2.29
Treatment					
120 lb N/a	1,710 a	9.7 a	1.660	5.8	1.71
160 lb N/a	1,831 bc	9.7 a	1.627	5.8	1.99
120 lb N/a + Agrotain	1,806 b	9.5 a	1.625	5.8	2.38
160 lb N/a + Agrotain	1,865 c	10.5 b	1.624	6.0	2.23
Split (160 lb N/a) + Agrotain	1,820 bc	10.5 b	1.613	6.0	1.95

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

Table 2. Urease inhibitor effects on harvest factors and N tissue concentration in perennial ryegrass seed crops, 2015.[1]

	Yield	Cleanout	Seed weight	Biomass	Tissue N
	(lb/a)	(%)	(mg/seed)	(ton/a)	(%)
Site					
Washington County	2,182 b	7.6 b	1.638 a	8.8 c	2.24 b
Yamhill County	1,481 a	4.5 a	1.648 a	8.9 a	1.53 a
Polk County	2,120 b	8.3 c	1.693 b	11.3 b	1.62 a
Treatment					
120 lb N/a	1,978	7.0	1.674	9.5	1.65
160 lb N/a	1,885	6.7	1.650	9.4	1.94
120 lb N/a + Agrotain	1,892	6.9	1.659	9.4	1.83
160 lb N/a + Agrotain	1,926	6.9	1.655	10.2	1.75
Split (160 lb N/a) + Agrotain	1,958	6.4	1.658	10.0	1.82

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

In 2014, the addition of Agrotain increased seed yield at the 120 lb N/acre rate, but had no effect on either the single or split treatment of 160 lb N/acre. There were no seed yield differences between the 120 lb N/acre rate with Agrotain and the 160 lb N/acre treatments. In 2015, Agrotain had no effect on seed yield at either N rate.

Nitrogen rate had varied effects on percent cleanout in 2014 and no effect in 2015. Agrotain had no effect on seed weight either year. Above-ground biomass was generally lower in 2014 compared to 2015, but there were no significant differences between any treatments. Nitrogen tissue concentration was 12% higher in 2014 than in 2015, but was not affected by N rate or Agrotain.

Total plant N was higher in 2015 than in 2014 (Figure 1). This may explain why there was no seed yield difference between treatments in 2015. In 2014, when plant N levels were lower, the crop was responsive to N fertilizer application and produced a higher yield when an additional 40 lb N/acre was added. Seed yields plateaued when plant N was about 230 lb/acre. Since plant N was higher than 300 lb/acre for all treatments in 2015, N was not a limiting factor and therefore it is not surprising that there were no differences in seed yield between treatments.

Conclusions

NBPT-containing urease inhibitors, such as Agrotain, should be considered when conditions are favorable for ammonia volatilization to occur. A seed yield response is most likely to be measured when lower rates of N fertilizer are chosen and when plant N is less than 230 lb/acre. While seed yields might not be increased substantially by the use of urease inhibitors, the cost of N application may be lessened through greater N use efficiency.

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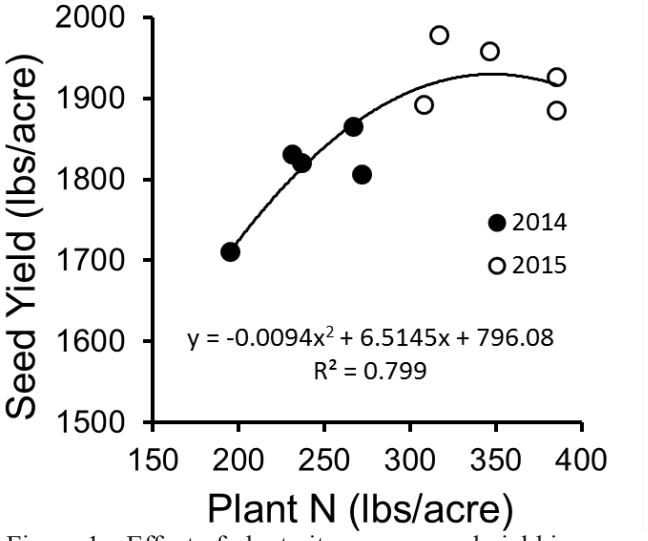

Figure 1. Effect of plant nitrogen on seed yield in perennial ryegrass from six on-farm trials conducted in 2014 and 2015.