Effects of Different Nitrogen Stabilizers on Two Durum Varieties

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Introduction

Nutrient stewardship has become an important part of modern agriculture as the use and misuse of synthetic fertilizers increases. The push for higher yields has been reliant on ensuring that the crop has sufficient nutrients to reach the maximum potential. The nutrient with the highest use rates being applied in agriculture today is nitrogen. Nitrogen, however, is also at high risk for losses in the environment due to denitrification, volatilization and leaching. Nitrogen fertilizers are always at risk of being lost to the environment through volatilization, especially when applications are made to wet soils, surface applied or applied in the fall before seeding (Whetter, 2022). The weather in southern Alberta, over the past few growing seasons has not been conducive to nitrogen loss. Drought conditions have persisted in many parts of the province, which has led producers to change fertilization practices and reduce usage. There are also several products available to producers that have been developed to mitigate nitrogen losses when applying fertilizer when there is high risk of loss. These products are often referred to as Enhanced Efficiency Fertilizers (EEF). Products containing urease inhibitors such as NBPT (N-(n-butyl) thiophosphoric triamide) and duromide have long been used to reduce nitrogen volatilization loss by inhibiting the urease enzyme responsible for converting urea into ammonia. Slow release or controlled release polymer coatings, such as ESN, on urea prills are another way that losses can be mitigated as these products reduce the amount of free nitrogen in the soil to be denitrified or leached down the soil profile. In this study, the Chinook Applied Research Association (CARA) attempted to show the effects of different Enhanced Efficiency Fertilizer (EEF) products on two varieties of durum wheat.

Materials and Methods

A site was selected based on standard rotations in the Oyen area of Special Area 3. The trial was seeded into canola stubble on May 16, 2023, using CARA's custom Henderson 500 seed drill. Two durum varieties and three EEF products were tested against untreated urea as a control, resulting in a total of eight treatments for the trial as outlined in Table 1. Urea was treated with Agrotain and Anvol at 3.1L and 1.55L per tonne, respectively. The untreated urea, treated urea and ESN products were then blended with monoammonium phosphate, potash, and ammonium sulfate to create a fertilizer blend. The final fertilizer blend analysis was 26-9-7-8S and applied at 210 pounds per acre based on soil test recommendations. Durum varieties were selected based on crop insurance reported acres for 2022. Transcend occupied the most acres in Risk Area 9 with seeded acres decreasing each year and CDC Alloy acres were increasing in 2022 in the same area. Treatments were randomized using Microsoft Excel and organized into three replications to produce the plot plan (Figure 1). Two passes were made to apply the treatments. The first pass was made at a depth of 2.5 inches, applying the EEF treatments to the plots. The second pass planted the variety treatments at a depth of 1.5 inches.

Plots were sprayed with Barricade II © and Bison 400L © three and a half weeks after seeding. All replicated blocks were trimmed to a final length of 5 meters prior to harvest. In-field height measurement was carried out on August 8, 2023 by measuring the height of four random plants per plot and averaging the results. Harvest occurred on August 16, 2023, using CARA's Wintersteiger Classic small plot combine. The harvested product from each plot was cleaned using a tabletop Clipper sieve shaker and the cleaned material was weighed and moisture was

taken using a Dimo's Labtronics Model 919 moisture meter. Thousand kernel weight (TKW) was obtained using a Seedburo 801 Count-A-Pak to count two 1000 seed envelopes and averaging the weight. The test weight was determined using a 0.5L measure and recording the weight of seed. A sub-sample from each plot was sent for protein analysis.

Table 1: **Treatment List for EEF Demo Trial 2023**

Treatment	Variety	Nitrogen Fertilizer Product
TRT-1	Transcend	Untreated Urea
TRT-2	Transcend	Agrotain Treated Urea
TRT-3	Transcend	Anvol Treated Urea
TRT-4	Transcend	ESN
TRT-5	CDC Alloy	Untreated Urea
TRT-6	CDC Alloy	Agrotain Treated Urea
TRT-7	CDC Alloy	Anvol Treated Urea
TRT-8	CDC Alloy	ESN

Results

Treatment results are outlined in Table 2. In general, results were highly variable due to the adverse climactic conditions during the growing season (Table 3). The untreated urea and Agrotain treated urea treatments resulted in the highest yield for both varieties, although the differences were found to be insignificant across all treatments. Thousand kernel weights remained relatively consistent across the trial, with the untreated urea treatment resulting in the highest TKW for the Transcend variety and the Agrotain treatment resulting in the greatest TKW for CDC Alloy. When analyzed, the results of the TKW measurements were insignificant, however. Protein measurements showed that the ESN treatment gave the highest average percentages for both varieties but was not significant at the $p<0.05$ level. Overall, Transcend was found to be taller than CDC alloy on average, but these results were also not statistically significant. There was a significant difference found between EEF treatments regarding the test weight of the harvested grain. Test weight did not vary significantly between varieties, but for both Transcend and CDC Alloy, the Anvol treatment resulted in significantly higher test weights on average than the untreated urea and ESN treatments (Figure 2).

Figure 1 **SAS© Results of Anova MS Analysis of Test Weight Measurements for Durum Wheat**

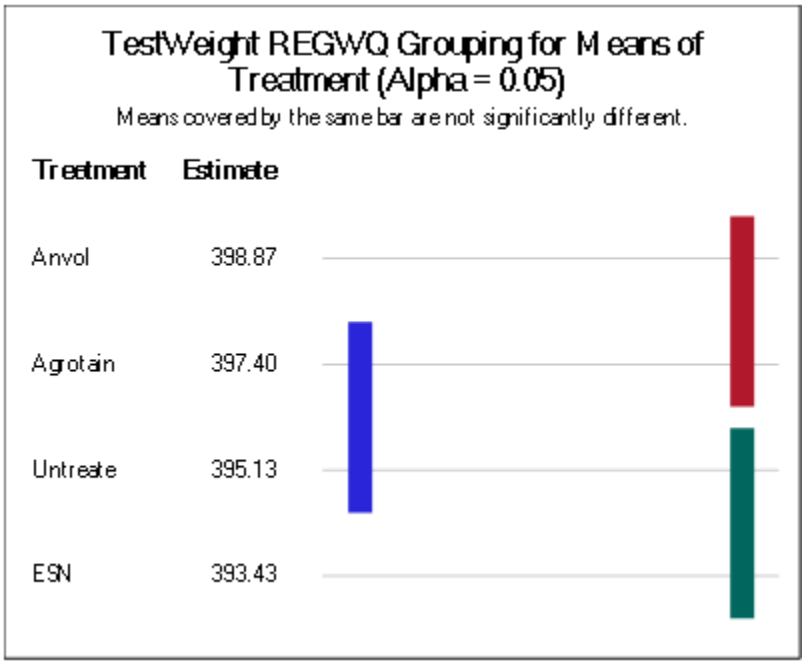

Table 2 **Data Averages for EEF Products and Crop Varieties from the 2023 Durum Wheat Trial**

Variety	EEF Product	Yield (g/plot)	Yield (lbs/ac)	Yield (bu/ac)	Height	Thousand Kernel Weight (g)	Test Weight (g/0.5L)	Moisture (%)	Protein (%)
Transcend	Untreated N	834.0	1063.0	17.7	50.3	42.6	392.7^{bc}	12.7	15.9
Transcend	Agrotain	848.0	1080.8	18.0	50.5	41.8	397.3^{ab}	12.5	16.0
Transcend	Anvol	784.0	999.2	16.7	50.1	41.1	399^{a}	12.4	16.0
Transcend	ESN	777.3	990.8	16.5	49.2	41.6	392.3^{c}	13.4	16.4
CDC Alloy	Untreated N	836.7	1066.4	17.8	42.8	42.4	397.6^{bc}	13.0	15.7
CDC Alloy	Agrotain	854.7	1089.3	18.2	49.3	43.2	397.5^{ab}	13.1	15.6
CDC Alloy	Anvol	836.1	1065.7	17.8	46.8	42.3	398.7^{a}	13.1	15.8
CDC Alloy	ESN	718.0	915.1	15.3	47.9	42.5	394.5^{c}	13.2	16.2
	Averages	811.1	1033.8	17.2	48.4	42.2	396.2	12.9	16.0
	p-value	0.69			0.20	0.56	0.0026	0.67	0.30

* Statisical analysis performed on SAS OnDemand for Academics

Table 3: Oyen Weather Data May 16, 2023 to August 16, 2023

Date	Rainfall (mm)	Long-term Average Rainfall (mm)	Temperature (Celcius)	Long-term Average Temperature (Celcius)
May (16-31)	5.2	21.5	16.6	12.5
June (1-30)	13.6	75.5	18.0	15.1
July (1-31)	24.6	51.6	18.6	18.2
August (1-16)	8.6	24.9	19.7	18.3
Total	52	173.5	18.2	16.0

Discussion

Rainfall is required during the growing season to dissolve urea prills and allow the fertilizer nitrogen to enter the soil solution where crops can access it. In 2023, the trial site received 52 mm (about 2.05 in) of rainfall, nearly all in small events of less than 10 mm (about 0.39 in) at a time. This greatly affected the crop growth as well as the dissolution of the applied nitrogen treatments. Yield, height and kernel weight are all dependent on sufficient moisture conditions for the crop to reach its potential. Under the climactic conditions of 2023, this trial had less than sufficient moisture to grow. Therefore, yield, height and kernel weight were unaffected by treatment. Test weight is a quality parameter of all wheat classes and is used as a determinant of grade in wheat sales. The test weight is determined by kernel moisture, kernel density and shape, as well as other packing factors (Wang and Fu, 2020). Moisture levels of the grain samples did not vary significantly in this trial and ESN treatments had higher moisture levels than the Anvol and Agrotain treatments on average, suggesting that another factor must be the cause of the higher test weights of the Anvol and Agrotain treatments. Test weight can be affected by temperature and moisture stress that interrupts the transport, uptake or production of carbohydrates (Davidson, 2018). Studies have also shown that nitrogen fertilization in durum wheat can increase test weight to a point and at very high rates of nitrogen, test weight can decrease (Panayotova, et al., 2021). This suggests that differences in soil nitrogen levels between the treatments could explain the test weight variation, however, more extensive soil testing would be required to determine if the separate treatments had differing levels of plant available nitrogen. Although a significant difference was observed in test weight between the Anvol and ESN treatments, all test weights were sufficient to be graded as No.1 CWAD by the guidelines set in the Official Grain Grading Guide.

ESN is a polymer coated fertilizer, meaning that water must imbibe through the coating, dissolve the prill, and then diffuse back through the polymer into the soil solution (Nutrien, 2023). This means that the moisture requirement for ESN to release plant available nitrogen is greater than for untreated urea or urea that has been treated with a urease inhibitor. The lower overall yield and lower test weight in the ESN treatments can possibly be attributed to lower available nitrogen levels early in the growing season due to the delay in nitrogen release caused by the lack of moisture in 2023. This delay could also explain why the average protein levels of the ESN grain samples were higher than that of the other treatments, as more nitrogen may have been available later in the season than for the other treatments.

Conclusion

Climactic conditions in 2023 were not ideal for crop growth and were very challenging for small plot trials. Lack of rainfall and high temperatures contributed to greater variability between and within plots. The results suggest that, under the conditions of 2023, the use of EEF products to reduce nitrogen losses was unnecessary. Yield and other quality factors were unaffected by the use of the EEF products, suggesting that had an economic assessment had been performed, there likely would be no benefit to a producer for using one of these products in 2023. Test weight did vary significantly between the Anvol and the ESN treatments for both varieties, however, all test weights were sufficient to receive No. 1 CWAD grade when assessing overall sample quality. This trial represents conditions of the 2023 growing season only and subsequent trials would need to be undertaken to determine the validity of the trends determined during the trial.

July 17 at the site

Dr. Rigas Karamanos discussing fertility options

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