ANNUAL REPORT

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TITLE: Nitrogen stabilizers to improve nitrogen fertilizer efficiency in winter wheat in high rainfall zones of Idaho.

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ACCOMPLISHMENTS:

Two field trials were conducted during the 2020-2021 growing season to evaluate the use of nitrogen stabilizers to decrease nitrate leaching and improve wheat yields. The trials included five rates of nitrogen fertilizer at planting (0, 50, 100, 150 and 200 lb N/A), each with and without Instinct® II (nitrapyrin, Corteva Agriscience) nitrogen stabilizer. Each location included two replicated trials, one with soft white winter wheat cv LCS Hulk and the second with hard red winter wheat cv LCS Jet. Replicated field trials were seeded at Cavendish and Greencreek, ID using a custom AgPro direct seed drill equipped with Bourgault paired-row openers on 12' spacing. Urea ammonium nitrate (UAN) was used as the source of nitrogen. Soil samples were collected at four different time points throughout the growing season and plant tissue samples were collected at harvest to follow ammonium and nitrate. Agronomic measurements included stand establishment, reproductive tiller counts, plant height, grain yield, test weight, and grain protein. In addition, NDVI measurements were collected from each plot at biweekly intervals throughout the growing season.

Soil sampling consisted of a late fall sample just as the soil temperature was reaching freezing. The second was in the spring just as the soil temperatures were beginning to warm back up above freezing and wheat was beginning to break dormancy. For each of these samples, a 0-6 and 6-12 inch sample were collected. Once the field was dry enough to enter with a tractor in the spring, 4 foot samples were removed at 1 ft intervals using a Giddings probe. A similar sampling strategy was used to collect another soil sample just after harvest. For all soil samples, KCl extractions were performed and analyzed using a Lachat Analyzer to quantify ammonium and nitrate.

Soil samples collected in the spring months (March and May) from both Cavendish and Greencreek revealed that in the 0 to 6 in depth, there was significantly more ammonium retained in samples removed from plots with nitrogen stabilizer (Figure 1). Within these spring samples, the quantity of nitrate was correspondingly lower in response to nitrogen stabilizer, although this difference was not significant. There were no differences in ammonium or nitrate concentrations in soil samples collected between depths of 6 in to 48 in with regard to stabilizer treatment. There was also not a measurable difference in any soil sample collected at any depth after harvest.

Averaged across all nitrogen rates, there was not a significant difference in yield between plots treated with stabilizer and those that were not, as was observed in 2020 (Table 1). As with other studies in 2021, the winter wheat yield was negatively impacted by extreme drought in spring and summer. Aside from yield, a potential benefit of nitrogen stabilizers could be increased protein accumulation in hard winter wheat due to less leaching during the winter and more ammonium available for conversion to nitrate in the spring. An analysis revealed that protein was not significantly influenced by the application of nitrogen stabilizer except for the hard red winter wheat trial in Cavendish in which there was a 0.8% increase in protein following application of stabilizer (Table 2). In this incidence, it made the difference in reaching the 11.5% protein required for hard red winter wheat in the plots where stabilizer was added. Test weights were lower in 2021, with an average of 54 to 57 lb/bu. However, there was no difference in test weight between

treatments. NDVI measurements were recorded every 2 weeks throughout the growing season beginning in early May. These data are still being analyzed, but preliminary evidence suggests that NDVI readings were higher in plots treated with nitrogen stabilizer, indicating denser vegetation in plots treated with nitrogen stabilizer.

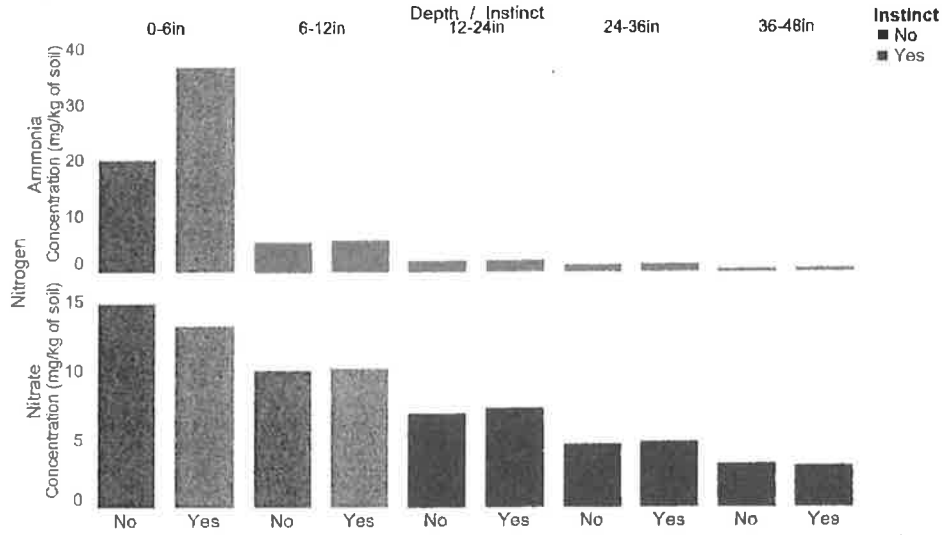

Figure 1. Ammonium and nitrate concentrations with or without nitrogen stabilizer from soil samples collected in the spring from soft white winter wheat and hard winter wheat trials at Greencreek and Cavendish in 2020 and 2021.

Table 1. Yield of soft white winter wheat and hard red winter wheat at test sites in Cavendish and Greencreek to evaluate the effectiveness of a nitrogen stabilizer.

	Cottonwood SWWW	Cottonwood HRW	Cavendish SWWW	Cavendish HRW
Treatment	Yield (bu/A)			
Instinct	48	49	49	44
No instinct	46	48	47	45
LSD (0.05)	ns	ns	ns	ns

Table 2. Grain protein of soft white winter wheat and hard red winter wheat at test sites in Cavendish and Greencreek to evaluate the effectiveness of a nitrogen stabilizer.

	Cottonwood SWWW	Cottonwood HRW	Cavendish SWWW	Cavendish HRW
Treatment	Protein (%)			
Instinct	12.7	12.3	11.2	12.0 a
No instinct	13.1	12.4	10.7	11.2 b
LSD (0.05)	ns	ns	ns	0.4

In addition to agronomic and soil chemistry measurements, the quantity of nitrifying bacteria and archaea were assessed about 1 month after treatment with nitrogen stabilizer (November) and again in the spring when soil temperatures were beginning to warm (March). The microorganisms were quantified by extracting total DNA from the soil and using quantitative PCR to amplify the ammonia-oxygenase gene (*amoA*). This procedure gives a gene copy number for each soil sample than can be used to compare the relative abundance of the microorganisms between samples. Averaged across both years and locations, the copy number for bacteria and archaea were similar in soils treated with nitrogen stabilizer and soils that were not treated. The exception was a significant reduction in copy number for bacteria in the spring in

soils treated with stabilizer. This could indicate a negative impact of nitrogen stabilizers on populations of nitrifying bacteria, but these analyses were only recently completed, and further validation of the data is needed before drawing definitive conclusions.

Data collected from two years of this study indicates that when using Instinct II nitrogen stabilizer and UAN for the form of nitrogen, the stabilizer does not significantly impact yield. Soil data suggest that more ammonium is retained in the spring in soils treated with nitrogen stabilizer, so theoretically the stabilizer prevented the oxidation to nitrate and there would be less nitrogen lost to leaching. Other data such as NDVI measurements and protein concentrations suggest that additional nitrogen was available to plants in the spring, but this did not translate into a significant yield response. One concern expressed by growers is that nitrogen stabilizers could be negatively impacting populations of microorganisms. The copy numbers of nitrifying bacteria and archaea were approximately 3.3 and 6.7 million copies per gram of soil. The populations were not drastically influenced by the addition of nitrogen stabilizer into the soil and any potential negative impact of the stabilizer would likely be short lived.

PROJECTIONS:

There is a tremendous amount of data that has been generated by this study and there is still data analysis that needs to be completed. This work will continue into the spring of 2022 and will include the writing of a graduate student thesis. We plan to take the findings from this study to write a manuscript for publication. No additional field trials are planned at this time.

PUBLICATIONS:

Seubert, S., and Schroeder, K. Nitrogen stabilizers to improve nitrogen application efficiency in winter wheat in high rainfall zones in northern Idaho. In: *2021 Dryland Field Day Abstracts: Highlights of Research Progress* (pp. 43-45). Idaho Agricultural Experiment Station, Technical Report UI-2021-1.

Philpott, S., Tao, H., and Schroeder, K. L. 2021. Nitrogen stabilizer effect on nitrogen application efficiency in winter wheat in high precipitation zones in northern Idaho. ASA-CSSA-SSSA Annual Meeting, Nov. 7-10, Salt Lake City, UT.