

4R Nitrogen Rate Management Principles in Spring Wheat

Developing Best Management Practices (BMPs) for nutrient applications has long been focused on the 4R principles which refer to using the: 1) right source, 2) right rate, 3) right time and 4) right placement. The objectives of this project were to demonstrate the feasibility of varying N management strategies and response to N rate on spring wheat. A field demonstration with CWRS AAC Brandon spring wheat was established in the spring of 2019 at Scott, Saskatchewan with fertilizer treatments applied in the fall of 2018. The demonstration was managed as two separate studies for ease of management.

The first component of the demonstration, all nitrogen was side-banded urea at seven varying rates; 0x, 0.5x, 0.75x, 1x, 1.25x, 1.5x and 1.75x of the soil test recommended rate of (1x) 125 kg of N/ ha (includes residual NO₃-N + fertilizer N). The second component focuses on nitrogen management options and consisted of a factorial combination of three timing/placement options (fall broadcast, side-band, and spring surface broadcast) and four nitrogen sources (untreated urea, ESN®, Agrotain® treated urea, and SuperU®).

Plant densities were slightly influenced by N application rates in which the highest N rates resulted in the lowest plant densities (187 plants/m²) while the lowest N rates had the highest plant densities (227 plants/m²). The application timing (fall vs. spring) and placement of ESN, SuperU, Agrotain and Urea did not largely influence plant densities as a small range between 184 plants/m² to 193 plants/m² was noted.

Early season vigor captured through NDVI indicated the importance of applying the right rate. The greatest vegetation produced (highest NDVI value) occurred when N rates were applied based on the recommended rate or slightly lower (Figure 1). Applying excessive amounts of N was equivalent to no N applied, as both methods resulted in the lowest NDVI. This highlights the importance of utilizing the right rate as over applying N can cause more damage than if no fertilizer was applied at all. The use of enhanced efficiency fertilizers (EEF) used at the right time and placement also played a role in early season vigor. EEF such as volatilization inhibitors (Agrotain) and volatilization / nitrification inhibitors (SuperU) can reduce the potential risks associated with applying N well ahead of peak crop uptake (i.e. fall applications) or sub-optimal placement methods (i.e. surface broadcast). These benefits were quickly realized as the two highest NDVI ratings were recorded when SuperU was fall and spring broadcasted while urea fall broadcasted resulted in the one of the lowest NDVI (Figure 2).

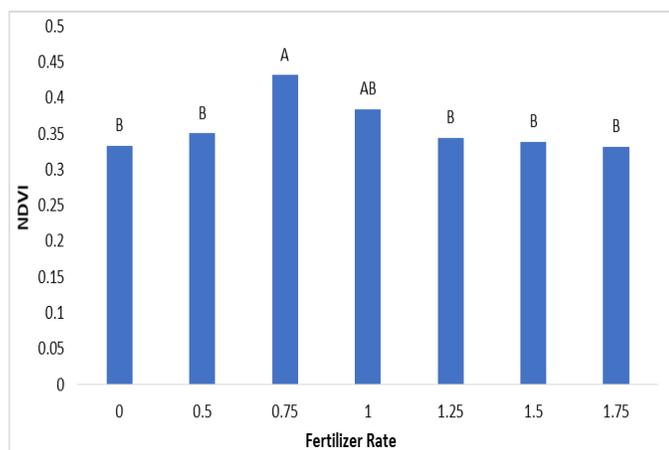


Figure 1. Comparison of NDVI four weeks after crop emergence between fertilizer rates (0x, 0.5x, 0.75x, 1x, 1.25x, 1.5x and 1.75x

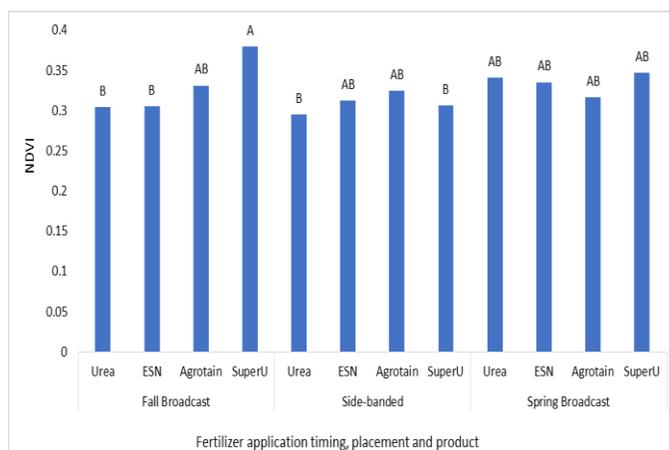


Figure 2. Comparison of NDVI four weeks after crop emergence between fertilizer products (ESN, Urea, SuperU and Agrotain) and application timing (fall vs. spring)

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Utilizing the 4R principles to improve early season vigor can often translate into increased development and productivity to ultimately enhance yields. Placement, time and product played a significant role in spring wheat yield ($P=0.0345$). The two highest yields which corresponded with the highest NDVI were achieved with a fall and spring broadcast application of SuperU while side-banding SuperU was the least productive placement. Urea efficacy was also influenced by timing and placement with the largest yield losses occurring with fall broadcast applications (7% yield loss) compared to spring broadcast and side-banded applications (Figure 3). Protein was not significantly influenced by product or placement but a general trend can be noted. The protein levels amongst the four different fertilizers were slightly elevated for ESN > Agrotain > urea > SuperU. The lower protein recorded for SuperU is likely a function of the inverse relationship between yield and protein (high yield results in lower protein).

Yield was also largely influenced by N application rate. A significant linear trend ($P=0.0011$) was reported and indicates that the higher rates of nitrogen resulted in the greatest yields and that yield may have continued to increase if N rates exceeded 219 kg N/ac (1.75x). The yield difference between the highest N rate and the recommended N rate was 4 bu/ac. This yield gain would not offset the costs incurred from the additional 94 kg/ha of fertilizer applied. Protein remained relatively stable among the higher N rates applied (1.75x to 1x) with an average protein of 14.9%. Yield remained relatively stable with a slight decline (1 bu/ac) when N rates were reduced by 25% of the recommended rate, however, protein dropped dramatically from 14.8% to 14.0%. When the N rates were dropped by 50% and 100% the yield declined by 10 /ac and 16 bu/ac. Protein followed a similar trend with a 7% and 11% reduction at 0.5x and 0x rate compared to the recommended rate (1x) (Figure 4). Reducing the fertilizer rates by half would not be economically profitable or environmentally sustainable. Applying too low of a nitrogen rate can deplete soil nutrient reserves to ultimately result in future yield losses. Ensuring that all four principles are utilized together is essential to maximize productivity and profitability.

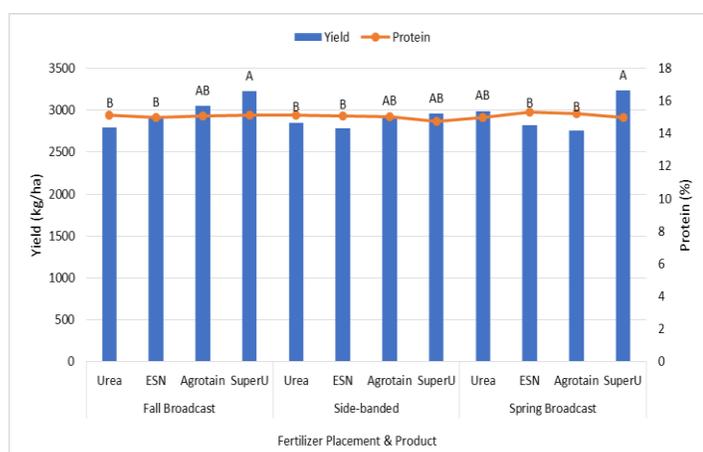


Figure 3. Comparison of yield (kg/ha) and protein (%) between fertilizer products (ESN, Urea, SuperU and Agrotain) and application timing (fall vs. spring) on spring wheat production at Scott, SK 2019.

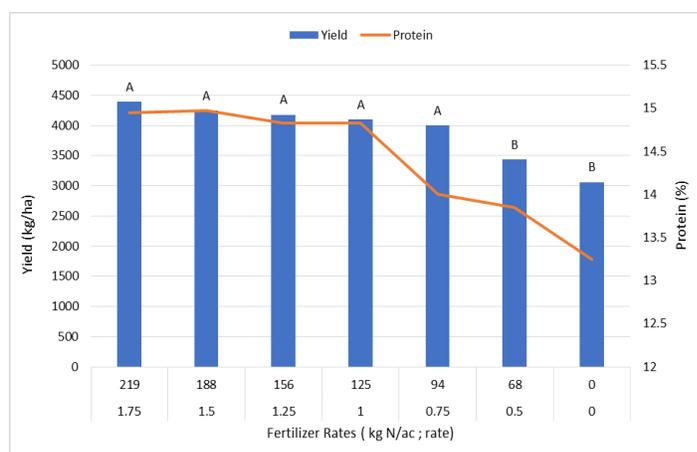


Figure 4. Comparison of yield (kg/ha) and protein between fertilizer rates (0x, 0.5x, 0.75x, 1x, 1.25x, 1.5x and 1.75x) of the soil test adjusted rate of 125 kg/ha total nitrogen (residual NO₃-N + fertilizer N) in spring wheat in Scott, SK 2019.

The full report will be available at: www.warc.ca. This project was co-funded by the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Government of Saskatchewan and the Government of Canada under the Canadian Agricultural Partnership and Fertilizer Canada.