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Enhanced efficiency fertilizers cut nitrous oxide emissions in spring wheat

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Nitrification-inhibitor products – either alone or in combination with an urease inhibitor – reduced N_2O emissions by 38% to 43% compared to untreated urea in spring wheat in southern Manitoba. However, there were few yield or grain protein benefits to using the EEFs products.

Environment and Climate Change Canada has set a goal to reduce the amount of greenhouse gas emissions from nitrogen (N) fertilizer by 30% below 2020 levels by 2030. Reducing nitrous oxide N_2O emissions will be a key strategy to meeting this goal, while maintaining or increasing crop yields.

A Canadian Prairie research study examined the effect of fall and spring application timings of urea and anhydrous ammonia treated with enhanced efficiency fertilizers (EEFs) on spring wheat performance and N_2O emissions. This paper evaluated the impact of using multiple EEF sources compared to conventional urea, and fall and spring application timings, on spring wheat yield and protein content in Manitoba over three years, along with the impact on N_2O emissions.

Research was carried out in southern Manitoba at Warren and Glenlea in 2015, Carman and La Salle in 2016, and Kelburn and Ridge in 2017. All sites had residual nitrate-N soil test levels less than 89 lbs./ac. (100 kg/ha), and were on soybean stubble.

Nitrogen fertilizer sources compared were an unfertilized control, untreated urea, and four EEFs including urea plus a urease inhibitor (Limus); polymer-coated urea (environmentally smart nitrogen [ESN]); urea plus a nitrification inhibitor (eNtrench); and a urea plus nitrification and urease inhibitors (SuperU). Application timing included a late fall banding at 1 to 2 inch (2.5 to 5 cm) depth and a spring banding at seeding in a one-pass operation at 1 to 2 inches, both done in a mid-row band placement.

Fertilizer rates were based on provincial soil test recommendations. All plots were seeded to AAC Brandon, and were managed with standard agronomic practices.

Few differences in wheat yield

At 5 of 6 site years, wheat yield and protein content were not affected by N fertilizer source. The only site where N source impacted yield and protein content was Kelburn-17. At this site, the controlled-release product ESN produced significantly higher yield than urea and urea + Limus. It also produced grain protein content significantly higher than urea, SuperU, and urea + Limus.

The impact of application timing on wheat yield and protein content was variable. Three of 6 site-years had lower yield with fall application compared to spring application, while 1 site had higher yield with fall application, and the other 2 sites had similar yields with fall and spring applications. Four of 6 sites had similar protein content for both spring and fall application, while fall application had lower protein content at the other 2 sites.

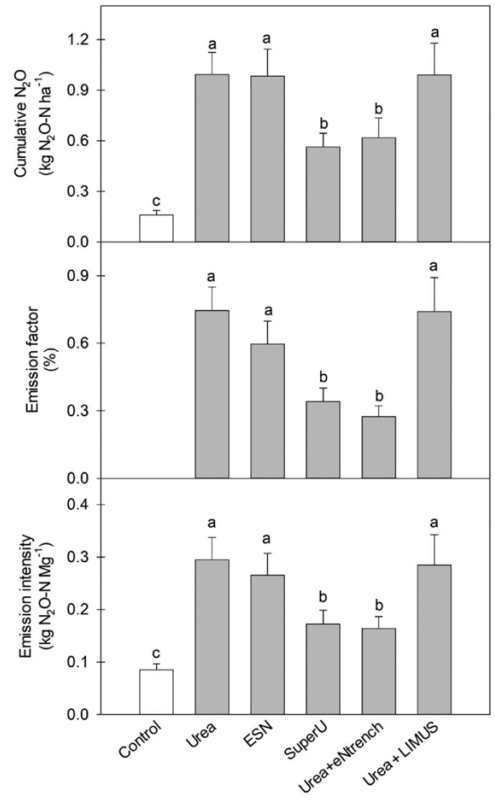
Reduced emissions with some EEFs

Urea + Limus did not significantly reduce N_2O emissions compared to untreated urea. ESN also did not significantly reduce emissions.

However, products containing a nitrification inhibitor significantly and consistently reduced N_2O emissions. Urea + eNtrench reduced cumulative N_2O emissions by 47% to 64% at 4 of 6 site-years irrespective of application timing. SuperU also reduced N_2O emissions by 37% to 57% at 3 of 6 site-years. ESN significantly reduced emissions at Warren-15 by 44% compared to untreated urea, but reductions were variable at other site-years.

Application timing also impacted N_2O emissions. Overall, fall application produced 33% to 67% higher N_2O emissions at 3 of 6 site years compared to a spring application. This was mainly due to emissions during the spring thaw. There wasn't any interaction between source and timing at 5 of 6 site-years.

Mean cumulative N2O emissions, applied-N scaled emission factor, and yield-scaled emission intensity of fertilizer treatments across fall and spring applications at all site-years.



Source: Tenuta et al. 2023

Overall, compared to untreated urea across all site-years, the products containing nitrification inhibitors significantly reduced cumulative N_2O emissions by 38% for urea + eNtrench, and 43% for Super U, irrespective of application time. The effectiveness of these nitrification inhibitor products was attributed to the slower conversion of NH_4^+ to NO_3^-, reducing nitrification and subsequent N_2O emissions.

The research provides guidance to policy makers on developing cost-share programs to encourage the use of EEFs to reduce N_2O emissions. Currently, under the On Farm Climate Action Fund program, dual-inhibitor products are eligible for incentives, but single nitrification inhibitor products have not qualified to date. The results of this study show that single nitrification inhibitors are as effect as dual inhibitors for urea fertilizers.

The study also advances the understanding of 4R nutrient management as it relates to N management practices, and how EEF fertilizers can play a role in helping to reduce greenhouse gas emissions. However, since few yield or protein content increases were found in the research, other policy mechanisms to encourage the use of EEFs need to be investigated.

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