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Urea fertilizer strategies for winter wheat

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On dryland sites that have low to moderate productivity, winter wheat growers should band all N at planting to ensure maximum grain yield and protein content. For irrigated winter wheat production or in dryland areas with high yield potential, a split application of fall banded urea and early-spring application of urea treated with NBPT+DCD is recommended to achieve high yield and grain protein. Untreated urea produced the highest greenhouse gas emissions when broadcast-applied early in the spring.

With the development of enhanced efficiency fertilizers (EEF), winter wheat growers have the opportunity to improve nitrogen use efficiency (NUE) and reduce greenhouse gas emissions. Research was conducted to see how N source and timing/placement impacts grain yield, grain protein content, and crop N use under irrigated vs. rain-fed environments. It also measured greenhouse gas emissions under rain-fed environments in winter wheat production systems.

Research was conducted over 5 years from 2013 through 2018 at dryland and irrigated sites across the Prairies. Irrigated sites took place at Agriculture and Agri-Food Canada Lethbridge, and Farming Smarter, Lethbridge, Alberta. Dryland sites included AAFC Lethbridge, Falher, Edmonton, and St.

Albert, Alberta, Indian Head, Saskatchewan, and Brandon, Manitoba. Not all sites were included in every year.

AC Flourish, a Canada Western Red Winter milling quality variety, was grown at each site with regular agronomic practices.

Soil testing was completed prior to seeding. Nitrogen fertilizer application rates were based on 80% of the recommended soil test rates. These rates ranged from 62 kg N/ha to 176 kg N/ha for rain-fed sites, and from 73 kg N/ha to 210 kg N/ha for the irrigated sites.

Twelve different N treatments were assessed with different N sources and timing/placements. Untreated urea and three EEF fertilizers were compared. The EEF fertilizers were a nitrification inhibitor Nitrapyrin (eNtrench) treated urea; urease inhibitor N-(n-butyl) thiophosphoric triamide (NBPT) plus nitrification inhibitor dicyandiamide (DCD) treated urea (i.e. SuperU; NBPT+DCD); and a polymer coated urea (i.e. Environmentally Smart Nitrogen; PCU).

Each source was applied with all N side-banded at planting; 30% side-banded at planting plus 70% broadcast in-crop in late-fall (split-applied late-fall); and 30% side-banded at planting plus 70% broadcast in-crop in early-spring at approximately the Feekes 4 growth stage (split-applied early-spring). A 0-N control was also included at each site.

Nitrous oxide (N_2O) and methane (CH_4) emissions were measured from planting in September to harvest in July for each treatment at the 'Lethbridge Dry' site from 2014 to 2017. These were expressed as net CO_2-equivalent emissions (CO_2-eq).

Yield varied with source and timing/placement

Under irrigation, NBPT+DCD had the statistically highest grain yield that was 3.9% higher than Nitrapyrin, 4.3% higher than untreated urea, and 4.7% higher than PCU. In regards to application timing, yield was similar for all N timing/placement treatments.

Grain protein content was higher with PCU under irrigation. Nitrapyrin and untreated urea had the lowest protein content.

On the dryland sites, yield was statistically highest when all N was side-banded at planting, while no differences occurred between split-applied early-spring and split-applied late-fall. Stability analysis found that all N sources produced high and stable yields when all-banded at planting, with the exception of PCU that had slightly elevated yield instability.

All N side-banded produced similar grain protein content as split-applied spring application timing, and higher than split-applied late fall under dryland conditions.

On both irrigated and dryland sites, there was an interaction between N source and timing/placement. The NBPT+DCD split-applied early-spring provided the highest grain yield.

EEF fertilizers reduced emissions

Net CO_2-eq emissions decreased in the order of untreated urea > NBPT+DCD > Nitrapyrin > PCU. Untreated urea split-applied early-spring had more than double the N_2O emissions compared to when it was all side-banded at planting under rain-fed environments.

Overall, under rain-fed environments, all N side-banded at planting performed better than split-applications and provided the highest NUE. However, untreated urea split-applied in early-spring more than doubled N_2O emissions compared to when it was all side-banded at planting.

For irrigated winter wheat production, a split-applied early-spring application of urea treated with NBPT+DCD is recommended to achieve high yield and grain protein. Additionally, in areas with high yield potential under rain-fed conditions, a similar split application strategy might be warranted.

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Dr. Zhijie Wang, Dr. Jennifer Owens, Dr. Ben W. Thomas, Dr. Xiying Hao, Mr. Ken Coles, Mr. Christopher Holzapfel, Miss Elham Rahmani, Dr. Rezvan Karimi, Dr. Kabal Singh Gill, and Dr. Brian L Beres. 2023. Winter wheat responses to enhanced efficiency granular nitrogen fertilizer in the Canadian Prairies. *Canadian Journal of Plant Science*. **Just-IN** https://doi.org/10.1139/CJPS-2022-0209