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Enhanced efficiency fertilizers had little impact on yield

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In this 2-year study, there was no significant benefit of a urease inhibitor, with or without a nitrification inhibitor, on canola and wheat N removal, N uptake, nitrogen use efficiency or yield. These inhibitors also did not significantly reduce the amount of leached nitrate in the soil.

Enhanced efficiency fertilizers are used to reduce nitrogen (N) losses from ammonia volatilization, nitrate leaching, nitrous oxide emission, and dinitrogen gas emission.

Urease inhibitors (N-(*n*-butyl) thiophosphoric triamide, NBPT) have been used to prevent volatilization losses of N. Nitrification inhibitors (NIs) inhibit the activities of ammonia-oxidizing organisms that convert ammonium to nitrite, to reduce N loss due to nitrate leaching and nitrous oxide emissions. NIs include dicyandiamide (DCD), 2-chloro-6 (trichloromethyl) pyridine (commonly known as nitrapyrin, NPN), 3,4-dimethyl pyrazole phosphate (DMPP), and 2-amino-4-chloro-6-methyl pyrimidine (AM).

A 2-year research study was conducted to determine which of the four common nitrification inhibitors (DCD, NPN, DMPP, and AM), when combined with NBPT, maximizes yield, N removal, and N uptake, as well as reduces nitrate leaching from surface-applied urea fertilizer.

The Manitoba research was conducted at Carman on a sandy loam soil and Portage la Prairie on a clay loam soil in 2019 and 2020. The Carman site had an annual cereal-canola rotation, and a perennial grass system. In the fall of 2018, soil nitrate-N tests found an average 26 lbs/ac (29 kg/ha) residual N at Carman. The Portage site had a canola-wheat-soybean rotation, and soil residual N averaged 84 lbs/ac (94 kg/ha) nitrate-N.

Nine fertilizer were surface applied at 71 lbs/ac (80 kg/N ha) on plots seeded to canola in 2019 and wheat in 2020. Nitrogen treatments were broadcast in the spring following seeding:

- Control – no fertilizer
- Untreated urea,
- NBPT-treated urea (Agrotain Advanced),
- NBPT + DCD
- NBPT + NPN
- NBPT + DMPP
- NBPT + AM
- Super U (NBPT + DCD)
- Urea + ARM U Advanced (NBPT + DMPP).

Plots at Carman had lysimeters installed to measure water and nitrate leaching.

Carman received 32% less precipitation than normal during May to August of 2019 and 38% less in 2020. Portage received 40% less precipitation than normal during May to August of 2019 and 38% less in 2020.

EEFs ineffective

Averaged over all fertilizer treatments, addition of N fertilizer significantly increased yield over the control without added N at the 4 site-years. Yields, though, in both years were impacted by the lower precipitation. In 2019, canola yield was 99% higher at Carman and 18% higher at Portage with added N fertilizer than without added N fertilizer. In 2020, wheat yield on N fertilized plots was 72% higher at Carman and 60% higher at Portage than the unfertilized control.

Effect nitrogen fertilizer on canola (2019) and wheat (2020) grain yields at Carman and Portage

	Canola (bu/ac)		Wheat (bu/ac)	
	Carman	Portage	Carman	Portage
Fertilized	37.9	37.7	45.5	60
Control	19	31.9	26.4	37.5

Source: Lasisi et al. 2022

Comparing NBPT and NI treatments, there was no significant benefit of NBPT or double inhibitor on grain yield at any site-year.

N-fertilized plots had significantly higher N uptake than unfertilized plots. Nitrogen uptake in seed and straw in fertilized plots ranged from 87 to 115 lbs N/ac (98 to 129 kg N/ha) compared to 40 to 75 lbs N/ac (45 to 84 kg N/ha) on unfertilized plots over the 4 site-years.

During the 2 years of study, nitrogen use efficiency (NUE) was not significantly different between the untreated urea and urea treated with inhibitors. Similarly, the NUE from urea treated with NBPT versus urea treated with double inhibitors was not different at Carman and Portage. At Carman, NUE ranged from 55% to 77%. At Portage, NUE ranged from 33% to 61%.

At the end of the two years, cumulative leached nitrate ranged from 17 to 36 lbs N/ac (19 to 40 kg/N ha). No significant differences were found between urea treated with and without inhibitors. The researchers suggest the reason was because more than 50% of the precipitation during the growing season occurred when the effectiveness of NI had elapsed.

Overall, the study found that nitrification inhibitors applied to broadcast urea in the spring were unable to provide agronomic and nitrate leaching reduction benefits in regions where growing season precipitation is below crop optimum need. The potential benefits of their usage will be dependent on taking a regional approach that takes weather patterns into consideration.

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Ahmed A. Lasisi, Olalekan O. Akinremi, and Darshani Kumaragamage. 2022. Nitrogen use efficiency of wheat and canola from urea treated with different types of double inhibitors. *Canadian Journal of Soil Science*. **102**(3): 673-684. https://doi.org/10.1139/cjss-2021-0159