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EEFs did not reduce nitrous oxide emissions in winter wheat

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Three enhanced efficiency nitrogen (N) fertilizers applied at seeding or in split applications between fall and spring did not reduce nitrous oxide emissions compared to conventional urea or UAN fertilizer when applied at 80% of recommended rate. A split application of 30% N at seeding and 70% broadcast in-crop in late fall resulted in higher cumulative non-winter N_2O emissions, emission factors, and yield-scaled N_2O emissions compared with split applying in the spring or 100% side-banded at seeding.

Nitrous oxide, N_2O, is a potent greenhouse gas that contributes to global warming. One source is emission from agricultural soils, partly related to nitrogen (N) fertilizer application. These emissions are also an economic loss as the N applied as fertilizer is not utilized by the crop.

The objective of this study was to determine if split fertilizer application and enhanced efficiency fertilizers (EEFs) altered N_2O emissions, emission factors, and yield-scaled N_2O emissions when compared with conventional fertilizer applied 100% at planting in rain-fed winter wheat crops.

Field trials were conducted near Brandon, Manitoba where the long-term total annual precipitation is 18.6 inches (472 mm). The trial took placed over two winter wheat growing seasons. Year 1 was planted during the fall of 2014 and harvested in the summer of 2015. Year 2 was planted in the fall of 2015 and harvested in the summer of 2016. Winter wheat was sown into standing canola stubble.

There were 2 trials in each year, one with granular fertilizers and the other with both granular and liquid fertilizers.

Trial 1 had four N treatments using urea, urea with nitrapyrin (Instinct, NI), urea with dicyandiamide (DCD) as the nitrification inhibitor and N-(n-butyl)-thiophosphoric triamide (NBPT) as the urease inhibitor (SuperU, UI + NI), and polymer-coated urea (PCU). Each N treatment had three application methods: 100% side-banded at planting; split-applied as 30% side-banded and 70% broadcast in-crop in late fall; and 30% side-banded and 70% broadcast in-crop in spring at Feekes growth stage 4 (GS4).

Trial 2 treatments used liquid N fertilizers urea–ammonium nitrate (UAN); UAN with the nitrification inhibitor nitrapyrin (Instinct, NI); UAN with the urease inhibitor NBPT (UI); and UAN with urease and nitrification inhibitors NBPT and DCD (UI + NI). Trial 2 also had two granular N fertilizer treatments of urea and PCU. Granular fertilizers were applied 50% side-banded at planting and 50% broadcast in-crop at GS4 in the spring. UAN treatments were applied 50% sprayed at planting and 50% sprayed in-crop at GS4 in the spring.

All fertilizer treatments targeted an 80 bu/ac (5380 kg/ha) winter wheat yield and were applied at 80% of recommended soil test rate. Total fertilizer applied was 75 lbs/ac (84 kg/ha) in Year 1, and 64 lbs/ac (72 kg/ha) in Year 2. Fertilizer applied at seeding was side-banded. Granular fertilizer applications were broadcast, and liquid fertilizers were applied using a sprayer equipped with liquid fertilizer nozzles.

Nitrous oxide fluxes were measured over 27 days in the fall between seeding and the onset of winter, and for 159 days after winter until harvest in year 1. In Year 2, they were measured over 49 days in the fall and 106 days in the spring.

N_2O emission factors (N_2O-N emitted as % of N applied) were calculated by subtracting the cumulative control N_2O emissions (no N application) from the cumulative N_2O emissions for each N fertilizer treatment. This value was divided by the total N applied as fertilizer and multiplied by 100.

Yield-scaled N_2O emissions were calculated by dividing cumulative area-scaled emissions (kg N/ha) by yield (kg/ha).

In Year 1, fall precipitation was 70.1 mm and spring/summer precipitation was 173 mm. Year 2 fall precipitation was 103.8 mm and spring/summer was 231.3 mm.

EEF fertilizers did not reduce emissions

Cumulative N_2O emissions from fertilized soils ranged from 0.101 to 0.433 kg/N ha across all treatments, which was relatively low. Using enhanced efficiency fertilizers did not reduce or alter the cumulative N_2O emissions or yield-scaled emissions compared with conventional fertilizers in both Trial 1 and Trial 2.

The researchers thought that since fertilizers were applied at 80% of the rate of the target yield, this tempered differences in N_2O emissions between conventional fertilizers or EEFs. However, in this study, the additional cost of EEFs did not provide N_2O reduction benefits.

There was one difference in application timing. Split application of 30% side-banded and 70% broadcast in-crop in late fall resulted in higher cumulative non-winter N_2O emissions, emission factors, and yield-scaled emissions compared with split applying in the spring. Otherwise, there were no differences for 100% N applied at seeding, or 30% side-banded and 70% broadcast in-crop in spring at Feekes growth stage 4 (GS4) compared to the compared to the unfertilized control.

The researchers concluded that for the lower N fertilization rates used in this study, applying all fertilizer N as conventional urea or UAN at seeding would be a best management practice for minimizing N_2O emissions. In areas of higher rainfall or with higher N rates, EEF fertilizers may provide a benefit.

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Photo by Xiying Hao

