

Influence of Controlled-Release Urea (Polymer-Coated ESN) on Seed Yield, Soil Nitrate-N and Nitrous Oxide Gas Emissions in Northeastern Saskatchewan

S. S. Malhi¹, C.A Grant² and R. Lemke³

¹Agriculture and Agri-Food Canada, P.O. Box 1240, Melfort, Saskatchewan, Canada S0E 1A0

(E-mail: malhis@agr.gc.ca)

²Agriculture and Agri-Food Canada, Brandon, Manitoba, Canada R7A 5Y3

³Agriculture and Agri-Food Canada, Saskatoon, Saskatchewan, Canada S7N 5A8

Background

- In the Canadian prairies, most soils are deficient in plant-available N and application of N fertilizer is essential for high crop production.
- If the supply of N is not synchronized with crop uptake, risk of nitrous oxide (N₂O) and ammonia (NH₃) emission, eutrophication of surface water through erosion and runoff, and leaching of nitrate-N to the groundwater will increase.
- Controlled-release N fertilizers have shown predictable N release patterns, and are designed to closely match N release from fertilizer products to crop uptake. Thus, improving N use efficiency, lowering accumulation of nitrate-N in soil, and reducing the risk of N movement to water or N loss into the air.

Objective

To determine the influence of controlled-release/coated urea (CRU) versus conventional urea on seed yield, nitrate-N accumulation in soil and gaseous N₂O-N loss to the atmosphere.

Materials and Methods

- Field experiment was established in 2004 near Star City, Saskatchewan on a Dark Gray Luvisol (Typic Cryoboralf) clay loam soil.
- For this area, mean annual precipitation is 425 mm, and growing season (May to August) precipitation is 244 mm. Precipitation from May to August was 290 mm in 2004, 372 mm in 2005 and 220 mm in 2006.
- The experiment was a split-plot design, with four replications. Conventional (CT) and zero (ZT) tillage systems were the main plots, while two sources of N (conventional urea and CRU), placement methods (side banded – SB, banded – B, broadcast, blend, split), N rates (0, 30, 60 and 90 kg N ha⁻¹) or timing of application (fall and spring) in different combinations were the subplots.
- The tillage and fertilizer treatments were maintained on the same plots for a three-year cropping cycle (wheat cv. AC Barrie in 2004, canola cv. Invigor 2573, Liberty Link in 2005, barley cv. AC Rosser in 2006), although there were no fall-applied N treatments for 2004 crop (N fertilizers instead were applied in spring to keep similar residual mineral N in the soil).

- The 10 treatments were: 1. Control (0 N); 2. Urea @ 30 kg N ha⁻¹ SB in spring; 3. Urea @ 60 kg N ha⁻¹ SB in spring; 4. Urea @ 90 kg N ha⁻¹ SB in spring; 5. CRU @ 30 kg N ha⁻¹ SB in spring; 6. CRU @ 60 kg N ha⁻¹ SB in spring; 7. Urea banded @ 60 kg N ha⁻¹ in fall; 8. CRU banded @ 60 kg N ha⁻¹ in fall; 9. Urea split @ 30 kg N ha⁻¹ SB at seeding + 30 kg N ha⁻¹ broadcast at tillering; and 10. Blend application banded in spring @ 30 kg N ha⁻¹ urea + 30 kg N ha⁻¹ CRU. The treatments are numbered as 1 to 10 under ZT and as 11-20 under CT.
- All treatments received a blanket application of 9-13 kg P, 42 kg K and 17 kg S ha⁻¹ at seeding. The controlled-release urea (CRU) was a special polymer-coated ESN fertilizer with a N content of 44%.
- Crop was harvested for biomass and seed yield at maturity, and the plant samples were analysed for total N content to calculate N uptake. Only seed yields are reported in this poster.
- Soil samples from the 0-15, 15-30 and 30-60 and 60-90 cm depths were taken usually in early spring, at seeding, anthesis, harvest, and in fall.

Summary and Conclusions

- There was a substantial increase in seed yield with increasing rate of applied N under both ZT and CT, and seed yields and response trends were similar for both tillage systems.
- The N-use efficiency (kg seed kg⁻¹ of applied N) was highest at 30 kg N ha⁻¹ rate, but it did not produce the highest seed yield.
- Fall-applied (banded) urea was less effective in increasing seed yield than spring-applied (side-banded) urea. The effectiveness of fall-applied urea was increased with CRU, where it produced higher seed yield than uncoated urea. This also suggests that CRU can be a good fit for winter wheat or other winter cereals or oilseed crops.
- For side-banded N in spring, CRU tended to produce higher seed yield than uncoated urea, suggesting CRU may have the potential to replace split applications under certain conditions.
- Split application of N (i.e., a half of N at seeding and the other half at tillering) tended to produce higher seed yields than uncoated urea.
- Spring 50:50 blend application of CRU and uncoated urea produced higher seed yield than uncoated urea. This suggests that blending urea with CRU may improve efficiency of applied N.
- Spring applied CRU, blended, and split application treatments all produced similar seed yields.
- Application of CRU resulted in lower accumulation of nitrate-N in soil in top 60 cm depth at harvest than uncoated urea, thus reducing the potential for N losses over the winter and in spring.
- CRU tended to reduce nitrous oxide emissions compared to uncoated urea.

- The findings suggest that under wetter soil moisture conditions in the Parkland region, CRU/coated urea can be an effective management tool in enhancing seed yield, while also minimizing potential for gaseous and/or leaching N losses over the winter and in early spring, particularly for fall-applied N. This may benefit both crop yield and environment.

Acknowledgements

The authors thank GAPS/ETAA program of AAFC for financial assistance; D. Leach, K. Fidyk, K. Hemstad-Falk, C. Nielsen and D. Schick for technical help; and Erin Cadieu for printing the poster.

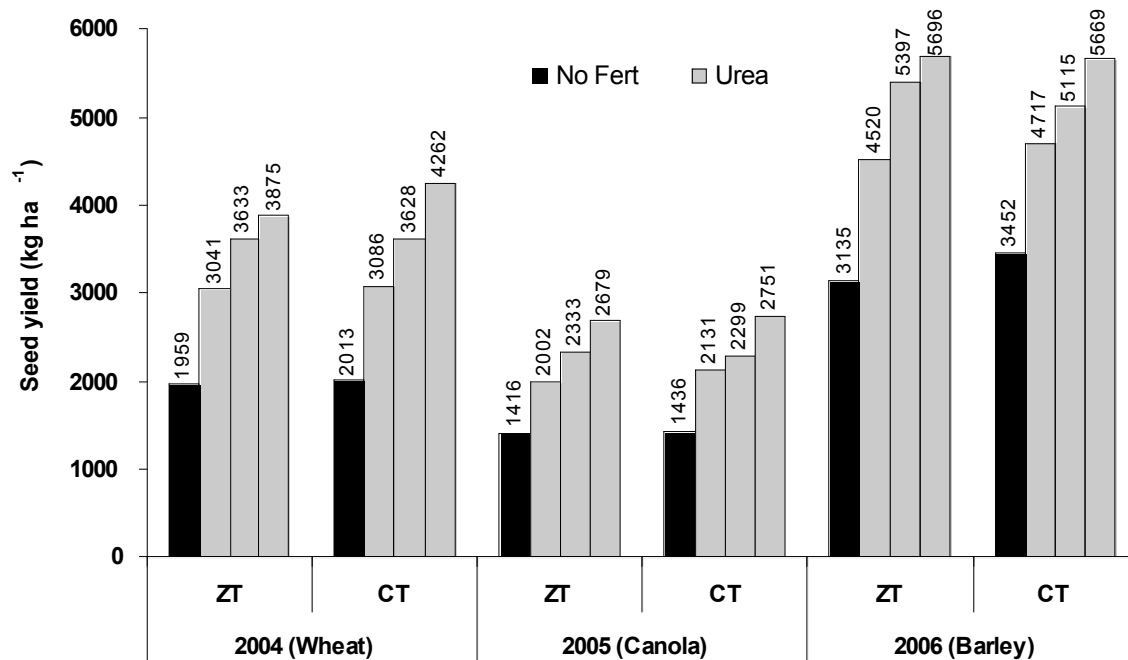


Figure 1. Seed yield of crops as affected by rate of SB urea N at Star City, Saskatchewan in 2004, 2005 and 2006 (Tr 1, 2, 3 and 4 for ZT; and Tr 11, 12, 13 and 14 for CT).

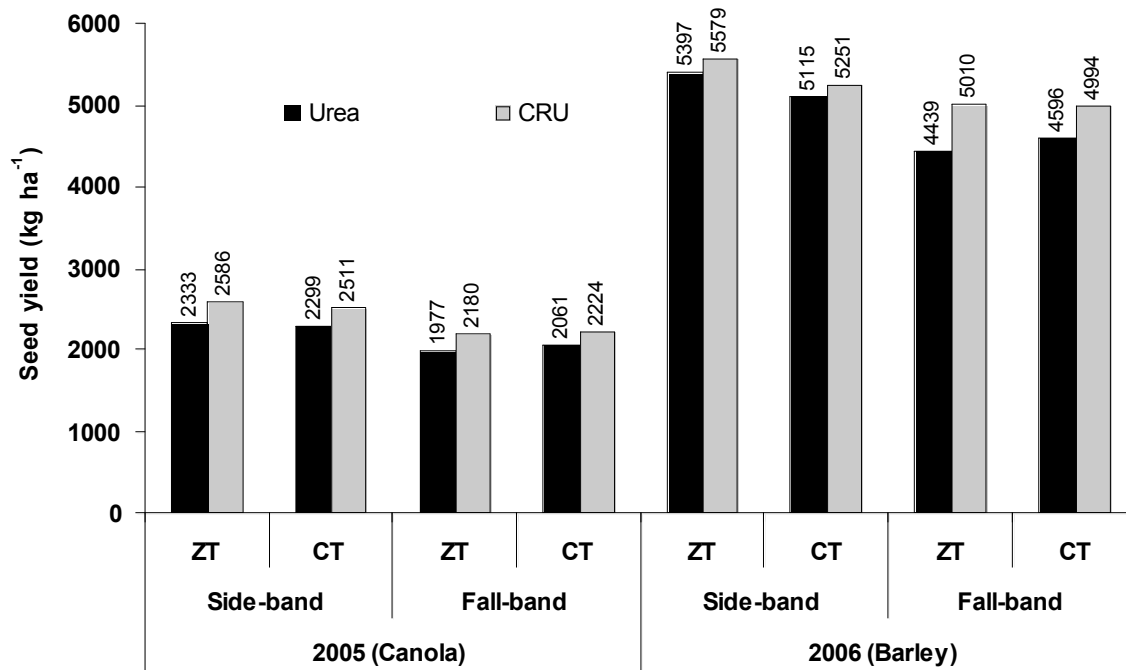


Figure 2. Seed yield of crops as affected by timing of application for uncoated versus coated urea at Star City, Saskatchewan in 2005 and 2006 (Tr 7, 3, 8 and 6 for ZT; and Tr 17, 13, 18 and 16 for CT).

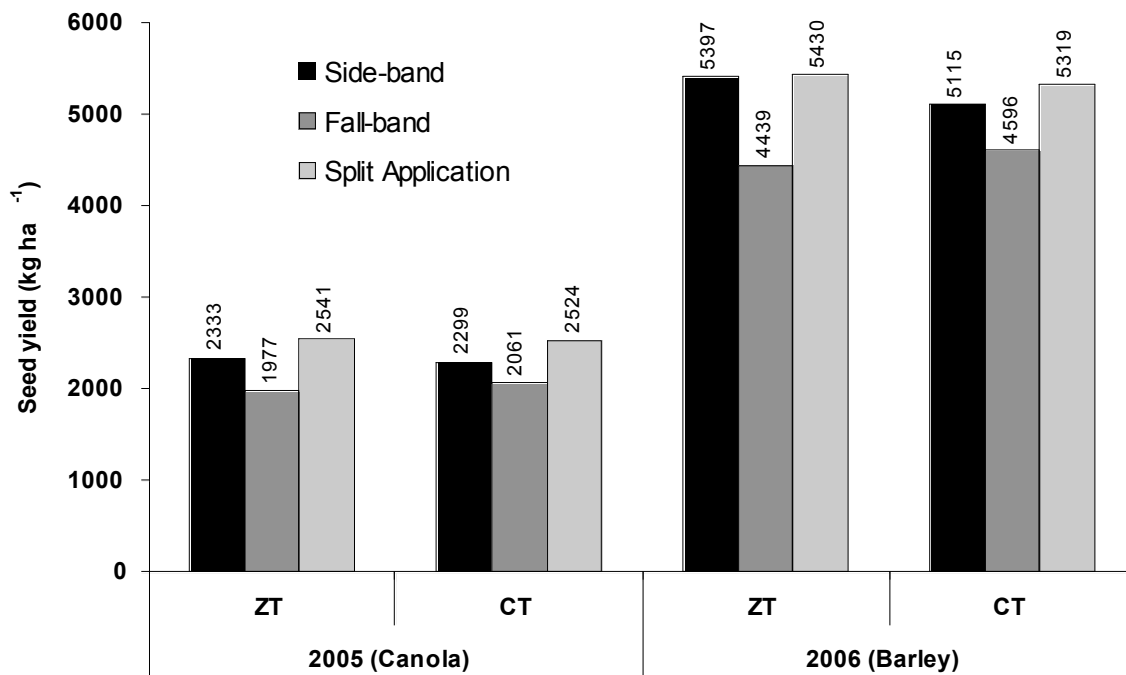


Figure 3. Seed yield of crops for FB urea, SB urea and split urea at Star City, Saskatchewan in 2005 and 2006 (Tr 7, 3 and 9 for ZT; and Tr 17, 13 and 19 for CT).

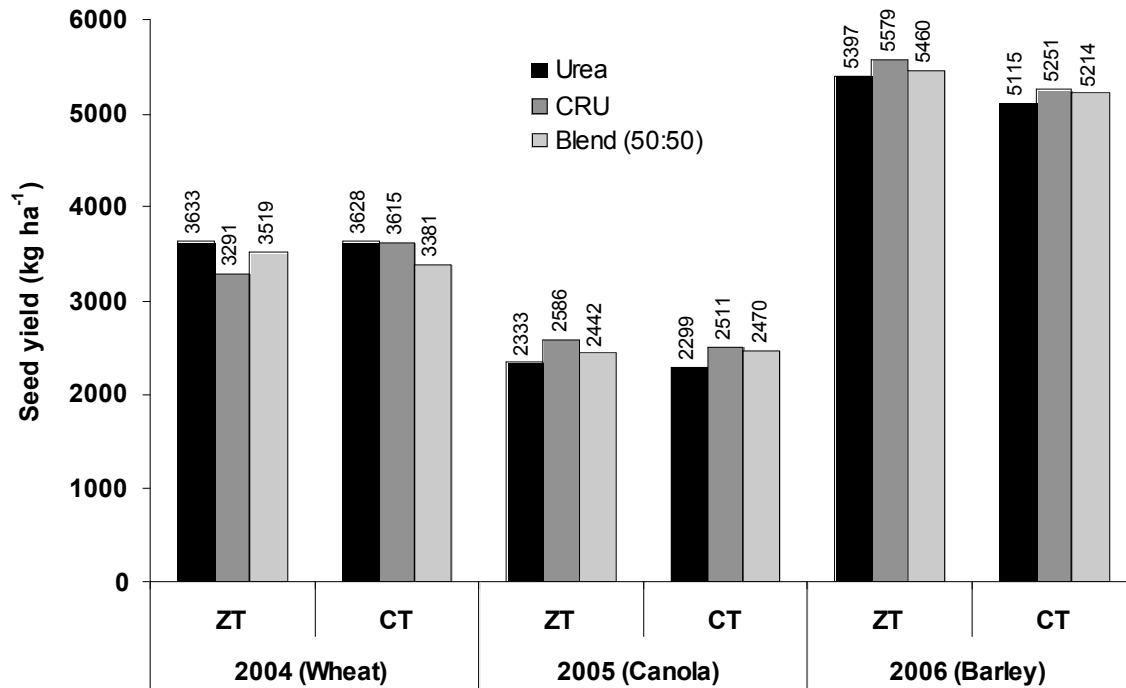


Figure 4. Seed yield of crops for SB uncoated urea, SB coated urea and blend at Star City, Saskatchewan in 2004, 2005 and 2006 (Tr 3, 6 and 10 for ZT; Tr 13, 16 and 20 for CT).

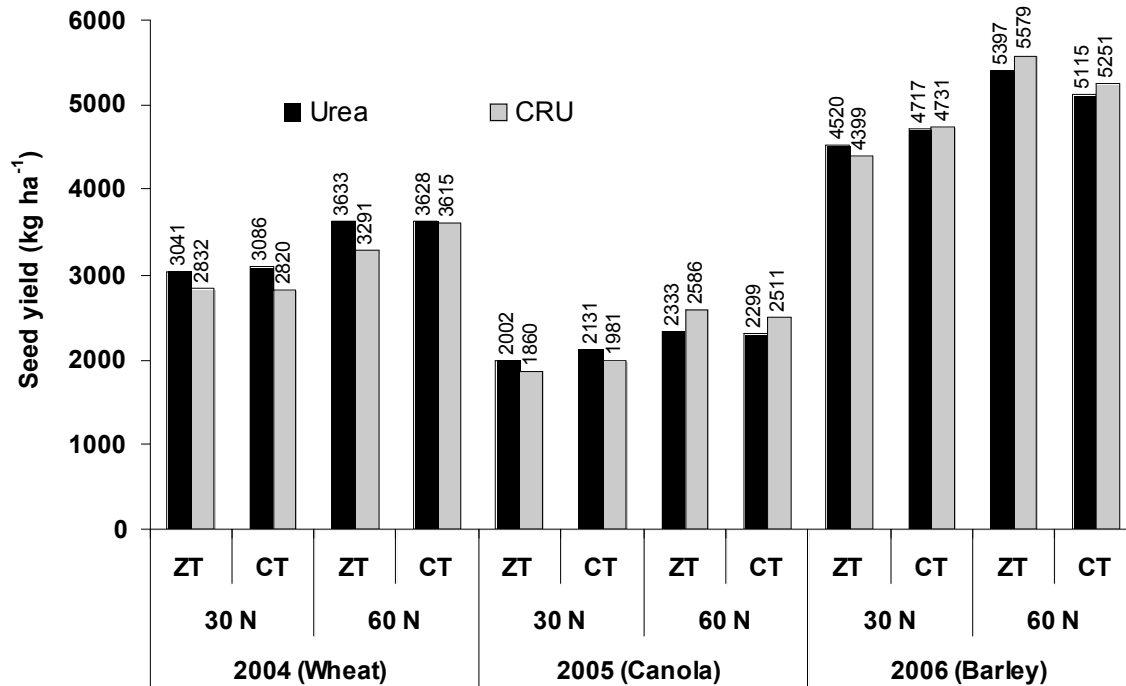


Figure 5. Seed yield of crops for uncoated and coated urea applied at 30 kg and 60 kg N ha⁻¹ rates at Star City, Saskatchewan in 2004, 2005 and 2006 (Tr 2, 5, 3 and 6 for ZT; and Tr 12, 15, 13 and 16 for CT).

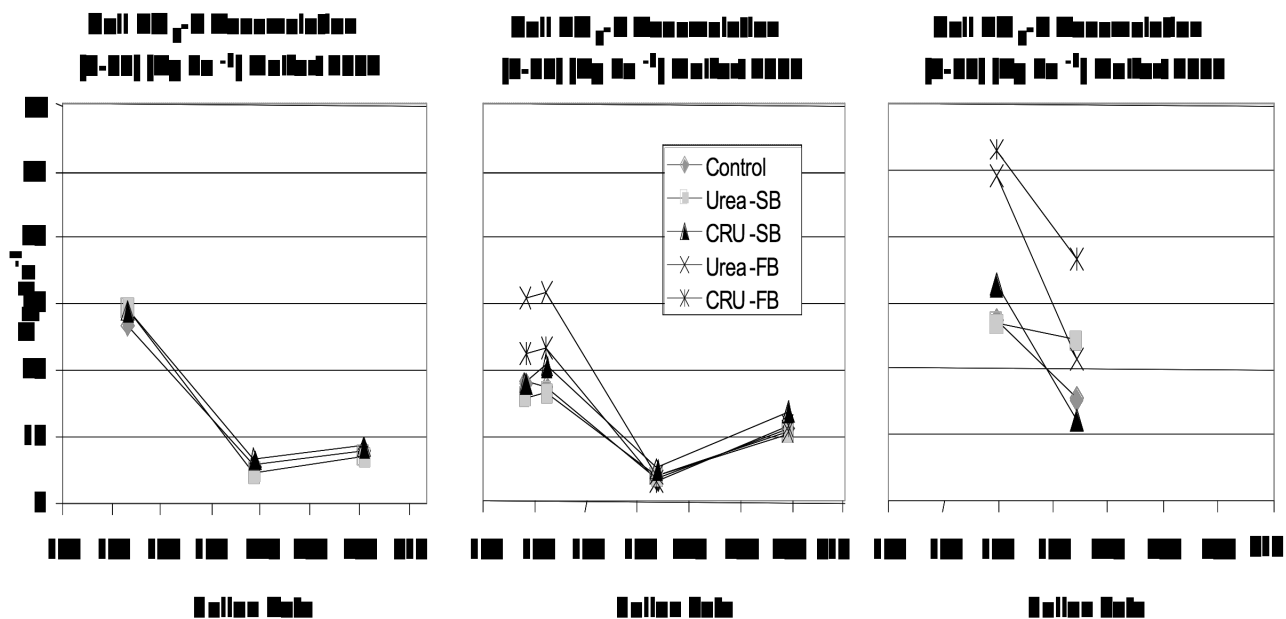


Figure 6. Soil nitrate-N in 0-60 cm soil as affected by timing of application for uncoated versus coated urea at Star City, Saskatchewan in 2005 and 2006 (Tr 7, 3, 8 and 6 for ZT; and Tr 17, 13, 18 and 16 for CT).

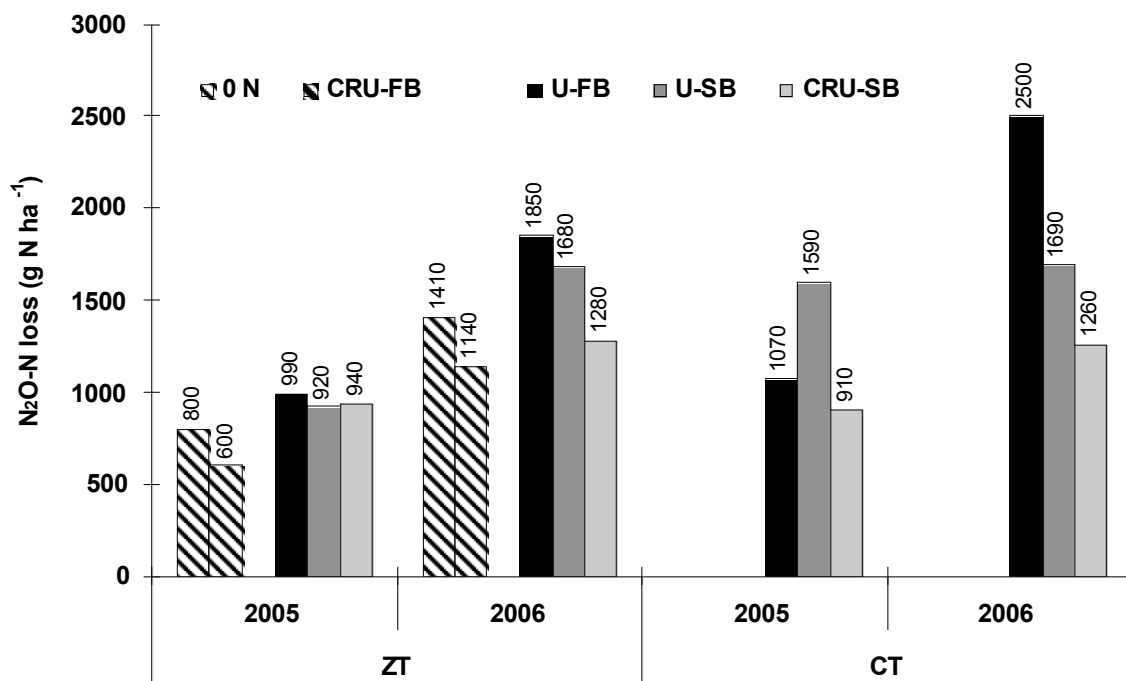


Figure 7. Nitrous oxide emissions from soil as affected by timing of application for uncoated versus coated urea at Star City, Saskatchewan (Tr 7, 3, 8 and 6 for ZT; and Tr 17, 13, 18 and 16 for CT).