

Response of residual soil available N to polymer-coated urea (ESN) application in a canola-barley cropping system

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Introduction

- To attain high crop yields, high rates of commercial N fertilizer are applied to agricultural soils
- High rates of N fertilizer use could lead to negative environmental impacts through N leaching and runoff to surface water and gaseous N₂O emission
- Polymer-coated urea, such as ESN, is a controlled release N fertilizer that synchronizes nutrient release with crop demand, thereby increasing fertilizer efficiency and potentially reducing impacts on the environment

Objective

Evaluate changes in soil available N following four-years use of ESN in canola-barley production

Materials & methods

Experimental locations and duration

- Melfort, SK, Lethbridge, AB, Lacombe, AB, and Beaverlodge, AB (See Table 1 for basic soil properties)
- 2005-2008 for three Alberta sites
- 2006-2009 Saskatchewan site

Experimental treatment

- Two spring canola (C) varieties (InVigor5020 and 2393LL) in rotation with two barley (B) varieties (Ac Lacombe and Vivar) in either CBCB or BCBC sequences over four years.
- All crop phases exist each year
- Two types of N fertilizer: urea and polymer-coated urea (ESN)
- Two rates of N application: 1 X and 1.5 X recommended agronomic N fertilizer rates (Table 2)
- 50 and 100% of registered in-crop herbicide rates
- Total of 32 treatments and 128 plots

Residual soil available N assessment

- Soil samples (0 to 120 cm depth) were collected after four years fertilizer application from four sites
- Available N (2M KCl extraction NO₃) was measured

Table 1. Soil characteristics at the four study sites.

| Site | USDA soil description* | Canadian soil classification* | Sand† | Clay† | OC | TN | pH |
|--------------------|------------------------|-------------------------------|-------|-------|------|------|-----|
| g kg ⁻¹ | | | | | | | |
| Melfort, SK | Typic Haplustoll | Black Chernozem | 170 | 410 | 55.0 | - | 6.1 |
| Lethbridge, AB | Typic Haplustoll | Dark Brown Chernozem | 370 | 330 | 17.5 | 1.95 | 7.7 |
| Lacombe, AB | Typic Haplustoll | Black Chernozem | 350 | 250 | 55.1 | 5.32 | 7.2 |
| Beaverlodge, AB | Molic | Dark Gray Luvisol | 270 | 350 | 34 | 3.67 | 5.7 |

† Blackshaw *et al.* (2010a)

Results & discussion

Table 2. Crop target yield and agronomic fertilizer application rate

| Site | Target yield | 1 X N | | 1.5 X N | |
|---------------|--------------|---------------------|----------|----------|----------|
| | | Required | Applied† | Required | Applied† |
| Crop | Bu/ac | kg ha ⁻¹ | | | |
| Canola | | | | | |
| Melfort | 45 | 160 | 112 | 240 | 172 |
| Lethbridge | 30 | 110 | 68 | 165 | 116 |
| Lacombe | 45 | 160 | 97 | 240 | 166 |
| Beaverlodge | 40 | 145 | 110 | 218 | 169 |
| Barley | | | | | |
| Melfort | 80 | 135 | 61 | 202 | 122 |
| Lethbridge | 50 | 85 | 43 | 128 | 81 |
| Lacombe | 80 | 135 | 65 | 202 | 120 |
| Beaverlodge | 60 | 100 | 73 | 150 | 111 |

† The amount of N fertilizer applied was the difference between what the crop required and what was available in soil in spring each year

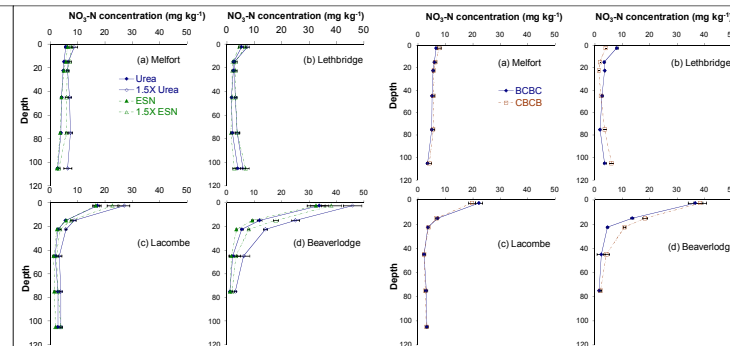


Fig. 1. Effect of fertilizer type application rate on residual soil NO₃ concentrations after four years canola-barley production

Fig. 2. Effect of crop sequence on residual soil NO₃ concentrations after four years canola-barley production

Effect of N fertilizer type and rate on residual soil NO₃ concentration after 4-year production

- At the recommended agronomic rate, residual soil NO₃ concentration was similar (P>0.05) among ESN and urea treatments for all locations (Fig. 1a-d).
- At the 1.5x recommended agronomic rate, residual soil NO₃ concentration was lower (P<0.05) in ESN than urea treatments for Beaverlodge (0-60 cm) and Lacombe (0-5 cm), suggesting ESN fertilizer could reduce the amount of N left in the soil, but the reduction is soil type/location dependent
- For both urea and ESN, residual NO₃ concentration was higher (P<0.05) when N fertilizer were applied at 1.5 X in surface soil (NO₃-N at 23 – 27 mg kg⁻¹) at Lacombe and in 0-30 cm soil (NO₃-N at 8 – 46 mg kg⁻¹) at Beaverlodge than applied at the recommended rate (Lacombe: NO₃-N at 17 mg kg⁻¹ and Beaverlodge: NO₃-N at 3 – 34 mg kg⁻¹) at (Fig. 1c-d),

- Our results suggest applying more N fertilizer than the current recommended rate should be avoided, particularly at Beaverlodge
- The smaller increases in crop yield (222 kg ha⁻¹ yr⁻¹) at Beaverlodge with 1.5X N rate than 1X N rate compared to other three sites (300 – 349 kg ha⁻¹ yr⁻¹) (Blackshaw 2010a, b) suggest extra N supplied was not used by crops but remained in soil

Effects of crop sequence on residual soil NO₃-N concentration after 4-year production

- The residual soil NO₃-N concentration in crop sequence of barley-canola-barley-canola (BCBC) from 5 to 30 cm was higher (P<0.05) at Beaverlodge while lower in 0 to 30 cm at Lethbridge than canola-barley-canola-barley (CBCB) with no differences at the other two locations (Fig. 2). The different suggests N uptake is affected by crop sequences and location / soil type

Conclusions

There is little difference in residual soil NO₃ concentration between ESN and urea when applied at the recommended agronomic rate

Higher residual soil NO₃ concentrations were observed when applied at 1.5 X than the 1 X recommended N rate although NO₃ levels from in ESN were lower than from urea treatment at Lacombe (0-5 cm soil) and Beaverlodge (0-30 cm soil); over application, particularly urea at Beaverlodge, should be avoided

The similar residual soil NO₃ concentrations between the 1.5 X and 1 X recommended N application rates suggest that the rate of N fertilizer application for canola and barley production could be higher than current recommendation for Melfort, Lethbridge and Lacombe and this was confirmed with greater yield increases for these three sites

References

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- Blackshaw, B. E., X. Hao, N. Harker, J. T. O'Donovan, E. N. Johnson, and C. Vera. 2010b. Barley response to ESN applied in a four-year zero-tillage study. *Can. J. Plant Sci.* (submitted)

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