Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

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

Xiying Hao[1*], Chunli Li[1], Robert E. Blackshaw[1], John O'Donovan[2], K. Neil Harker[2], Cecil Vera[3], and George W. Clayton[1]

Agriculture and Agri-Food Canada Research Centre, [1]Lethbridge, AB [2]Lacombe, AB. [3]Melfort, SK, [*]Corresponding author: xiying.hao@agr.gc.ca

Introduction

- To attain high crop yields, high rates of commercial N fertilize 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 N_2O 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 NO_3) 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 / Crop	Target yield	1 X N		1.5 X N	
		Required	Applied†	Required	Applied†
	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

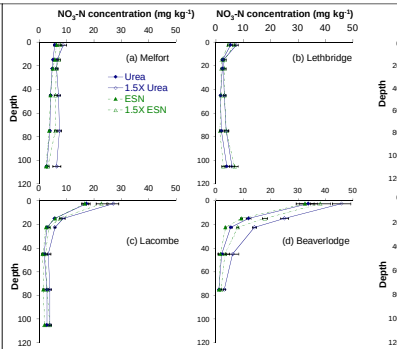

Fig. 1. Effect of fertilizer type application rate on residual soil NO_3^- concentrations after four years canola-barley production

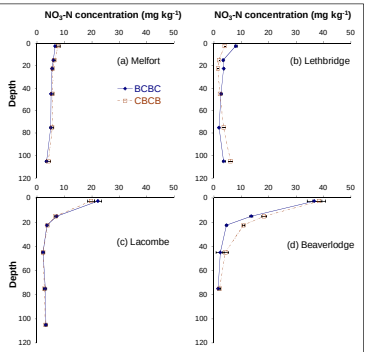

Fig. 2. Effect of crop sequence on residual soil NO_3^- concentrations after four years canola-barley production

Effect of N fertilizer type and rate on residual soil NO_3^- concentration after 4-year production

- At the recommended agronomic rate, residual soil NO_3^- 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 NO_3^- 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 NO_3^- concentration was higher ($P<0.05$) when N fertilizer were applied at 1.5 X in surface soil (NO_3-N at 23 – 27 mg kg^{-1}) at Lacombe and in 0-30 cm soil (NO_3-N at 8 – 46 mg kg^{-1}) at Beaverlodge than applied at the recommended rate (Lacombe: NO_3-N at 17 mg kg^{-1} and Beaverlodge: NO_3-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 NO_3-N concentration after 4-year production

- The residual soil NO_3-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 NO_3^- concentration between ESN and urea when applied at the recommended agronomic rate

Higher residual soil NO_3 concentrations were observed when applied at 1.5 X than the 1 X recommended N rate although NO_3^- 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 NO_3^- 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

Blackshaw, B. E., X. Hao, R. N. Brandt, G. W. Clayton, N. Harker, J. T. O'Donovan, and C. Vera. 2010a. Hybrid and open-pollinated canola response to ESN versus urea applied within a four-year zero-tillage study. Agronomy J. (in press)

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)

Acknowledgements

Funding for this study was provided by Agriculture and Agri-Food Canada, and by the Canola Council of Canada. We also acknowledge technical assistance from Brett Hill, Greg Travis, Pam Caffyn, Greg Semach, Larry Michielsen, Randall Brandt and Brett Mollison in carrying out field and laboratory work and Toby Entz in statistical analyses.

Canada