Effects of residual N management on economics of wheat and canola

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Outline

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  - Residual contribution of N and legume crops
- **Objective**
- **Materials and Methods**
- **Results**
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Research background

- Studies have shown that N fertilizer application has residual effects for crops in subsequent years
- Legumes have also long-term N fixation abilities
- But knowledge on their short- and long-term residual effects on the profitability of subsequent crops is limited

Objectives

The objective of this study was to analyze the effects of N fertilizer residuals and legume and non-legume residuals on the profitability of wheat with no N application grown on the fourth year after PC and canola with no N application grown on the fifth year after preceding crops.

MATERIALS AND METHODS

Research time:

- 2009 through 2014

Research sites:

- Beaverlodge, Lacombe and Lethbridge located in Alberta
- Indian Head, Scott and Swift Current in Saskatchewan, and
- Brandon in Manitoba

MATERIALS AND METHODS

Preceding crops (PC) grown in 2009:

- pea (CDC Golden) grown for seed
- lentil (CDC Imperial) grown for seed
- faba bean (Snowbird) grown for seed
- faba bean (Snowbird) grown as a green manure
- canola (45H73) grown for seed
- wheat (CDC Imagine) grown for seed

MATERIALS AND METHODS

Study period was divided into two phases:
During phase I, canola was seeded in 2010, barley in 2011, and canola again in 2012 with fertilizer N applied at 0, 30, 60, 90 and 120 kg ha^{-1} for each crop. In phase II, spring wheat was grown in 2013 and canola in 2014, without fertilizer N application.

Methodology: Revenue/Cost Analysis

- Revenue/Cost analysis
  - Budgeting techniques to measure economic performance of management practices in regard to costs of production, gross revenue, and net revenue
  - Net revenue calculation by subtracting all production and input expenses from gross revenue.

Methodology:

- Statistical analysis
  - Statistical analysis was conducted using PROC Mixed of SAS (Littell et al., 1996).
  - The analysis was done by site and by N rates and by preceding crop types.
  - Treatment effects were considered significant at $P<0.05$, with values of $P<0.1$ reported as a possible trend.

RESULTS AND DISCUSSION

ANOVA P values for residual effects of preceding crops grown in 2009 and residual nitrogen applied from 2010 to 2012 on net revenue of wheat in 2013 and canola in 2014 at seven sites in western Canada

Site	Effect	2013Wheat	2014Canola
Beaverlodge	N rate	<0.0001	0.0822
	Preceding crop	0.0203	0.3437
Brandon	N rate	<0.0001	0.0004
	Preceding crop	0.5442	0.6027
Indian Head	N rate	<0.0001	0.001
	Preceding crop	0.0506	0.0072
Lacombe	N rate	<0.0001	0.0951
	Preceding crop	0.0499	0.3056
Lethbridge	N rate	<0.0001	0.0087
	Preceding crop	0.2326	0.4283
Scott	N rate	<0.0001	0.01
	Preceding crop	0.5312	0.4946
Swift Current	N rate	<0.0001	0.1967
	Preceding crop	0.5184	0.6393

Effects of preceding crop residual on net revenue of 2010, 2012, and 2014 canola crop years

Preceding crop	2010	2012	2014
	---------- Mean ± SE ($ ha^{-1})† ----------		
Preceding crop (2009)			
Canola	324±21a	235±20b	225±10b
Faba bean	455±28a	276±24b	239±10b
Faba bean green manure	647±29a	314±28b	267±13b
Field pea	366±17a	272±24b	244±11b
Lentil	436±22a	246±19b	242±10b
Wheat	428±27a	281±23b	244±12b
Average	443±18a	271±21b	244±9b

†Means and standard error (SE) of preceding crop followed by the same letter in a row are not significant ($p > 0.05$)

Comparison of average net revenue between phase I (2010-2012) and phase II (2013-2014) by residual nitrogen application

Effect	Phase I (2010-2012)	Phase II (2013-2014)	P value
	----- Mean ± SE ($ ha^{-1}) -----		
N rate (kg ha^{-1})			
0	260±12c	217±8c	0.0033
30	293±14bc	222±8c	<0.0001
60	334±13ab	244±9c	<0.0001
90	344±13a	278±9b	<0.0001
120	320±11ab	343±11a	0.1363
Average	310±15	261±10	0.0061

Means and standard errors (SE) followed by the same letter in a column in each section are not significant ($p > 0.05$)

Effect of preceding crop residual and nitrogen application on average net revenue of the entire 2009-2014 crop rotation

Preceding Crop (PC)	Mean ± SE ($ ha^{-1})†
Canola	268±15c
Faba bean	275±14c
Faba bean green manure	235±14d
Lentil	372±14a
Field pea	323±13b
Wheat	276±16c
N rate (kg ha^{-1})	
0	252±13d
30	269±14c
60	299±14b
90	315±13a
120	324±13a

†Means and standard error (SE) followed by the same letter in a column are not significant ($p > 0.05$)

Residual effects of preceding crop grown in 2009 and residual nitrogen applied from 2010 to 2012 on average net revenue of six-year crops (2009-2014) across seven sites in western Canada

Applied N rate		Preceding crop (2009)					
2010-2012	2013-2014	Canola	Faba bean	Faba bean green manure	Lentil	Field pea	Wheat
--- kg ha^{-1} ---		---------- $ ha^{-1} ----------					
0	0	224±31CDd	219±30CDc	198±34Dd	340±33Ac	288±30Bc	240±31Cc
30	0	247±34CDc	253±35Cb	212±34Dc	354±33Abc	297±29Bc	250±35Cc
60	0	276±36CDb	297±34BCa	242±32Db	379±31Aab	322±27Bb	279±38Cb
90	0	288±31CDb	294±31CDa	263±33Da	390±31Aa	354±32Ba	300±34Cab
120	0	307±32Ca	311±31Ca	262±28Da	397±29Aa	353±30Ba	311±37Ca

Means and standard error (SE) followed by the same capital letter in a row or by the same lower letter in a column are not significant ($p > 0.05$)

CONCLUSIONS

- Positive effects of legume PCs on annual crop net revenue diminished over time and were almost nonexistent in phase II.
- Residual N rates applied in phase I had positive effects on annual NR of wheat in 2013 but the residual N effects diminished for canola in 2014 for most locations.
- In general, reliance on only residual N from fertilizer and residual N from PCs for growing crops was uneconomical compared to fertilizer applied annually.

CONCLUSIONS

- **Over the six-year crop rotation (2009-2014), lentil and pea grown for seed as preceding crops and higher rate of N in Phase I performed better as compared to other treatments.**

Khakbazan, M., Cynthia A. Grant, Jianzhong Huang, Elwin G. Smith, John T. O'Donovan, Robert. E. Blackshaw, K. Neil Harker, Guy P. Lafond, Eric N. Johnson, Yantai Gan, William E. May, T. Kelly Turkington, and Newton Z. Lupwayi. 2014. Economic Effects of Preceding Crops and Nitrogen Application on Canola and Subsequent Barley. Agronomy J. 106: 2055-2066.

Khakbazan, M., Cynthia A. Grant, Jianzhong Huang, Nathan J. Berry, Elwin G. Smith, John T. O'Donovan, Robert. E. Blackshaw, K. Neil Harker, Guy P. Lafond, Eric N. Johnson, Yantai Gan, William E. May, T. Kelly Turkington, and Newton Z. Lupwayi. 2016. Preceding crops and nitrogen effects on crop energy use efficiency in canola and barl**ey**. Agronomy J. x: xxxx-xxxx.

John T. O'Donovan, Cynthia A. Grant, Robert E. Blackshaw, K. Neil Harker, Eric. N. Johnson, Yantai Gan, Guy P. Lafond, William E. May, T. Kelly Turkington, Newton Z. Lupwayi, F. Craig Stevenson, Debra L. McLaren, **Mohammad Khakbazan**, and Elwin G. Smith. 2014. Rotational Effects of Legumes and Non-Legumes on Hybrid Canola and Malting Barley. Agronomy J. 106: 1921-1932.

Mervin St. Luce, Cynthia A. Grant, Bernie J. Zebarth, Noura Ziadi , John T. O'Donovan, Robert E. Blackshaw, K. Neil Harker, Eric N. Johnson, Yantai Gan, Guy P. Lafond, William E. May, **Mohammad Khakbazan**, Elwin G. Smith. 2015. Legumes can reduce economic optimum nitrogen rates and increase yields in a wheat–canola cropping sequence in western Canada. *Field Crops Research*. 179: 12-25.

Cynthia A. Grant, John T. O'Donovan, Robert E. Blackshaw, K. Neil Harker, Eric. N. Johnson, Yantai Gan, Guy P. Lafond, William E. May, T. Kelly Turkington, Newton Z. Lupwayi, Debra L. McLaren, Bernie Zebarth, **Mohammad Khakbazan**, and Mervin St. Luce. 2016. Persistence of Residual Effects of Preceding Crops and Nitrogen Fertilizer on Yield and Quality of Spring Wheat and Canola In Varying Environments on the Canadian Prairies Field Crops Research. Field Crops Research. x: xxxx-xxxx.

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