

Project Title:

Legume cover crops – minimizing nitrogen loss in the fall and supplying N in the next season

Final Report: 31 January 2015

Submitted to: Farm and Food Care Ontario
WAMQI project

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Promotion Summary: Planting red clover or alfalfa at a 6 lb ac⁻¹ seeding rate and terminating in the spring prior to corn planting is recommended to lower the risk of nitrogen loss over the winter, increase nitrogen availability in the spring and provide a yield increase to the following corn crop.

Introduction: Cover crops are a significant component of OMAFRA's nutrient management plans and best management practices. Cover crops hold onto nutrients in the fall. Ideally cover crops hold onto nutrients over winter and release nutrients to the following crop, thereby minimizing losses and fertilizer needs. The project aimed to build on previous research to better understand the role of three legume cover crops (crimson clover, red clover, and alfalfa) in terms of nitrogen (N) use efficiency and providing cover crop management recommendations.

Objectives: The objectives of the proposed project were to:

- 1) Determine the N credit to field corn from 3 legume cover crops (red clover, crimson clover and alfalfa)
- 2) Predict N losses (could be losses to surface or ground water or greenhouse gases) from the field over the rotation (from cover crop planting to field corn harvest)
- 3) Evaluate the effect of fall or spring tillage for cover crop termination on overwinter N losses

Methods

Three legume cover crops were compared with no-cover plots to determine how alfalfa and crimson clover compare to red clover regarding N loss and availability. Red clover is well used in Ontario, however on occasion, it fails to establish and grow. We wanted to know if alfalfa or crimson clover could be used as a substitute. In 2012-13 and 2013-14, the trial was conducted at two sites (Table 1). The experiment was a split-split-plot design with four replications. The cover crop type (red clover, crimson clover, alfalfa and no cover crop control) was the main factor, cover crop seeding rate (3, 6, 12 lb/ac) as the second factor and cover crop termination

(fall or spring tillage) as the third factor. The split-split plot size was 6 field corn rows by 16.4 ft.

The N credit red clover to corn has been well documented. Therefore, we used red clover as an industry control treatment. The no cover crop control treatment plots were split and preplant N fertilizer was applied at either 0, 100 or 200 lb N/ac. The no-cover with and without N allowed for comparison and to determine the N credit.

Soil and plant sampling was conducted at cover crop planting, before late fall tillage (freeze up), before corn planting, during corn season in June (time of side dress), July, Aug., and at corn harvest. Soil from the 0-1, 1-2 ft depths were collected from all plots and analyzed for nitrate and ammonium. Cover crop plant samples were collected from two $\frac{1}{4}$ m² quadrats. Throughout the corn growing season, 3 to 5 corn plant samples were collected. Corn grain was mechanically harvested from the middle two rows of each split-split plot. All plant material was weighed and analyzed for N content by combustion.

Table 1. Select soil characteristics at the field sites at Ridgetown in 2012-2014.

Characteristic	R18	L
pH	7.4	6.2
Soil texture	Loam	Sandy Loam
Sand:silt:clay (%)	47:44:09	76:17:07
OM (%)	5.1	3.3
Cation exchange capacity (Meq 100 g ⁻¹)	26	6.8
Preplant nutrients (mg kg ⁻¹)		
Phosphorus	36	32
Potassium	59	107
Calcium	4634	872
Magnesium	169	119

*All soil parameters were taken from a composite of over ten cores to 15 cm depth.

Key Findings and conclusions:

Crimson clover: Production recommendations gained from this project for crimson clover, a relatively new legume cover crop in Ontario include: 1) Crimson clover should be considered a warm season cover crop, so planting should be delayed until late spring when temperatures are warm. 2) Crimson clover is not very competitive compared to red clover or alfalfa; attention to planting is needed to get good growth. Do not use an oat nurse crop. Prepare the seed bed without weed and it is best to drill it in. 3) Crimson clover does not overwinter well. Fall-planted crimson clover is not recommended for those farmers looking for spring growth. But some plants will survive so be prepared with termination plan in the spring. 4) Positive results from farmers in the area have been reported when crimson clover is used in a mix.

Cover crop seeding rate: Cover crops were seeded at 3, 6 and 12 lb/ac. Most cover crop biomass and N content analyses resulted in no differences between the three rates. Visually, it was difficult to distinguish between the 6 and 12 lb/ac seeding rates but the 3 lb/ac seeding rate had patch growth. Cover crop seeding rate did have an impact on following corn yield. Thus, balancing seed costs, with the results from this project, a 6 lb/ac seeding rate is recommended for the cover crop tested (crimson clover, alfalfa and red clover).

Cover crop termination timing: Cover crops were terminated by tillage in the fall (late October) or in the spring (mid-May). The no-cover crop plots were also tilled. Termination timing had no influence on N cycling or corn crop yield. Thus growers should make their management decision on when to control the cover crop according to their goals (minimizing erosion vs. preparing seedbed). To get the most cover crop growth in the fall, it is recommended that termination should not occur before the end of October.

Nitrogen cycling: Nitrogen losses from the field are an agronomic, economic, and environmental concern. In late October, the legume cover crops reduced the amount of soil mineral nitrogen (SMN = nitrate and ammonium) by 8.9 lb/ac compared to the no-cover plots (Figure 1). Thus these cover crops should be used by growers to minimize N available for loss in the non-growing season.

In the following spring there was no difference in SMN between any of the plots.(Figure 2) However, there were differences in total plant available nitrogen (PAN) between the two different termination timings (Figure 2). In the spring, there was significant alfalfa and red clover growth and at least 17.8 lb/ac more N accounted for compared to the no-cover plots. Spring-terminated red clover and alfalfa had 33 lb/ac more N compared to the fall-terminated plots of red clover and alfalfa (Figure 2). Thus to maximize N, growers should use red clover or alfalfa with a spring termination.

The amount of N in the system (soil and crop) throughout the corn growing season was measured each month from June-October. Though the legume cover crops can increase the amount of N accounted for in the system, there was little effect on the N dynamics throughout the corn growing season. Total N in the system fluctuated between the months but was not affected by the presence of a cover crop compared to no cover crop nor a difference between cover crop species.

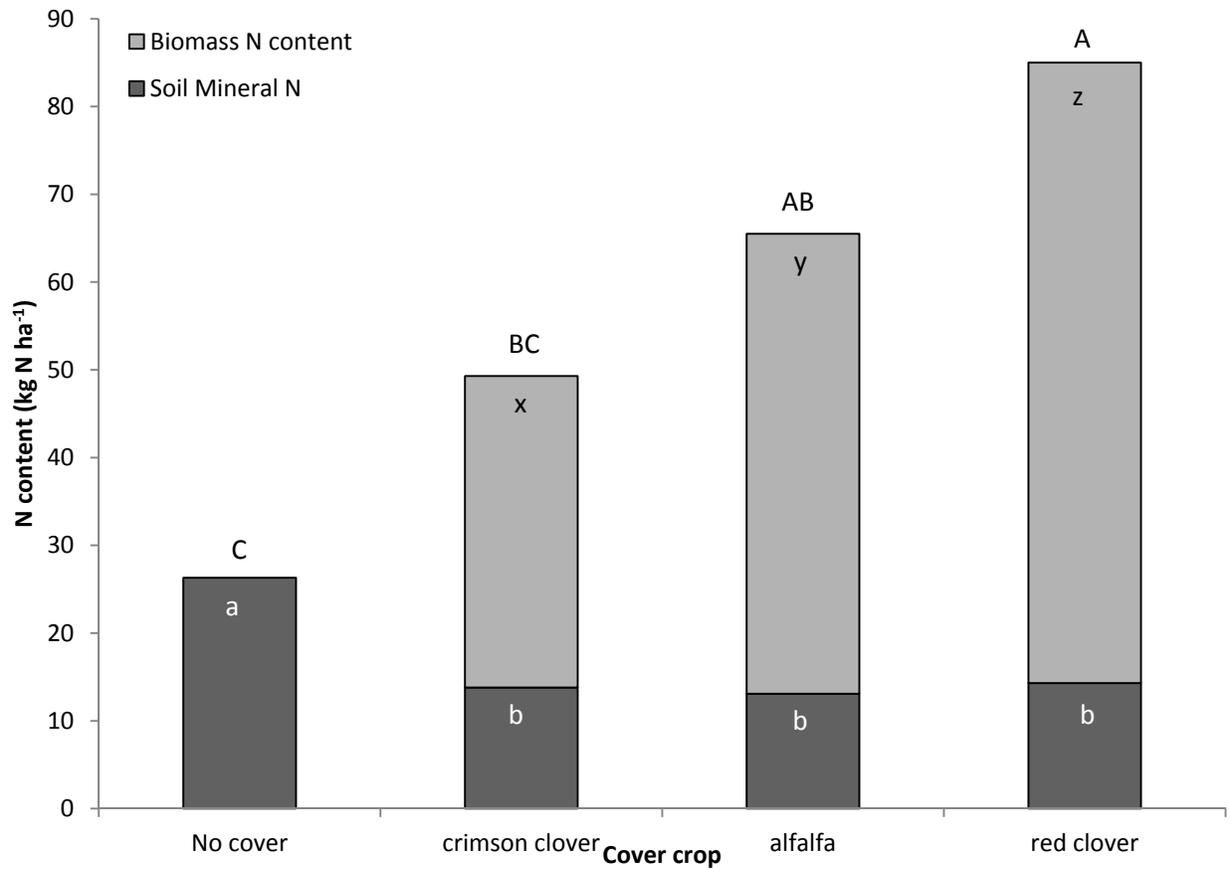


Figure 1: Effect of cover crop on plant available nitrogen (N in aboveground biomass and soil mineral N (SMN = nitrate and ammonium) in October. Bars with different letters indicates a statistical difference ($P < 0.05$). Lowercase letters a-b differentiate between SMN, while x-z denotes differences in plant N content. Upper case letters represent differences on total plant available nitrogen.

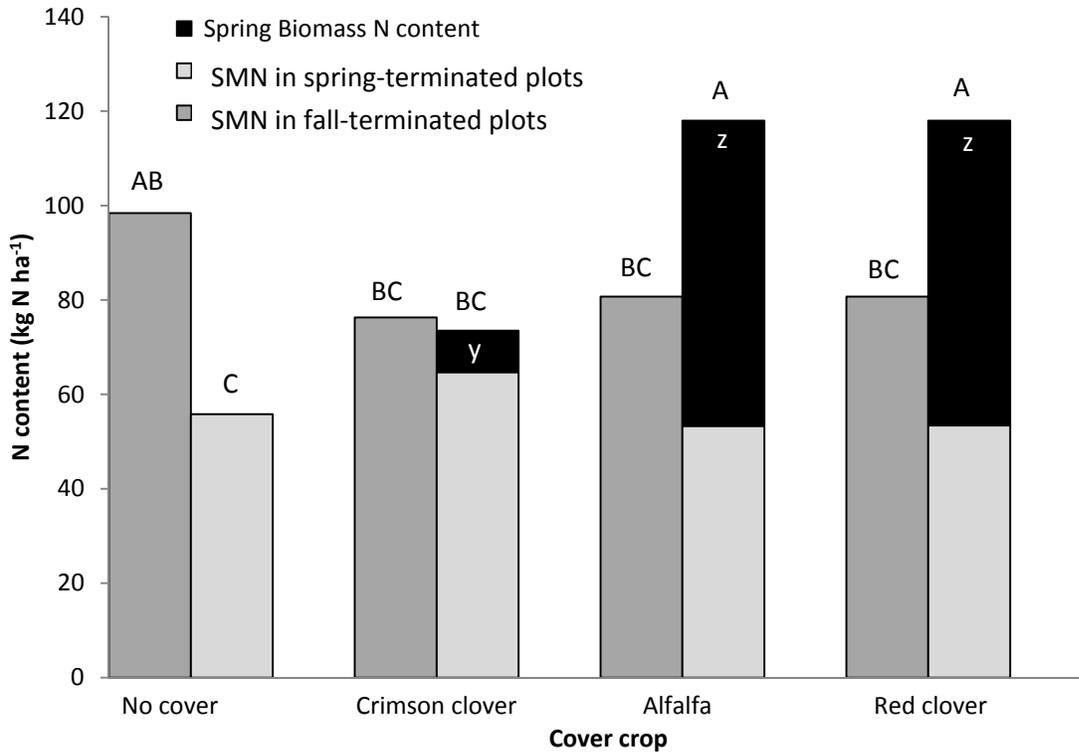


Figure 2: In May, effect of cover crop and termination timing on plant available nitrogen (N in aboveground biomass and soil mineral N (SMN = nitrate and ammonium)). Bars with different letters indicates a statistical difference ($P < 0.05$). Lower case letters represent SMN and upper case letters represent plant available N.

Following corn crop yield: Corn yield in no-cover plots with 200 lb/ac of N fertilizer was 230 bu/ac in 2013 and 190 bu/ac in 2014. In both years, commercial corn yield from all three cover crops without N fertilizer was not statistically different to the control (no-cover, non-fertilized) (Table 2). However, there was a slight but not significant yield boost to the red and crimson clover in one year and alfalfa in both years. Thus,

Table 2: Effect of legume cover crops on commercial corn yield in 2013-14 at Ridgetown, ON. Corn was grown without N fertilizer applied to evaluate contribution from cover crop.

Cover crop	2013	2014*
	Corn yield (bu/ac)	
No cover	174 ns	113 ab
Red clover	167	141 a
Alfalfa	178	128 ab
Crimson clover	171	86 b**

*Corn yield with different letters indicates a statistical difference ($P < 0.05$).

**There was poor establishment and very little growth of crimson clover. Thus, caution should be used in drawing conclusions from this treatment.

Objectives: Additional objectives of the proposed project were to:

- 4) Demonstrate cover crops in commercial grower fields
- 5) Compare cover crops in terms of water infiltration rate (potential to reduce overland flow), and % soil cover (potential to reduce soil erosion)
- 6) In terms of cover crop seeding rate, establishment and growth, evaluate a new, innovative grower-built cover crop seeder to plant into standing crop

Objective 4-6 were conducted as field day demonstrations, which are listed below. This project reached approximately 235 farmers, agronomists, extension personnel via various grower events. As well, results were presented to scientists and extension personnel at the Soil Science Society of America and at the Latonell Conservation Symposium, one of Ontario's premier annual environmental events.

Communication and Outreach:

Demonstration sites:

- Verhallen, A. and A. Hayes. 2014. Cover Crop Coffee Break. Talk to approx. 6 growers and agronomists. 29 October 2014. Kingsville.
- Verhallen, A. and A. Hayes. 2014. Cover Crop Coffee Break. Talk to approx. 20 growers and agronomists. 31 October 2014. Lambton county.

Cover Crop Open House:

- Verhallen, A. and A. Hayes. 2014. Cover Crop Tour and Open House. Talk to 20 growers and agronomists. 30 October 2014. Thamesville & Chatham.
- Van Eerd, L.L. and D.C. Hooker. 2014. Soil Health in the long-term experiment: crop rotation and tillage system. Cover Crop Tour and Open House. Ridgetown, Tour presenter to ca. 20 growers, agronomists, extension personnel and researchers. 30 October 2014. Ridgetown.
- Coombs, C. and L.L. Van Eerd. 2014. Value of legume cover crops for field corn. *for:* Vegetable Open House. Talk to approx. 60 growers, agronomists and industry personnel. 17 July. 2014. Ridgetown.
- Two freelance writers (Ontario Farmer) attended the cover crop open house and coffee breaks and wrote article(s), which greatly increased reach.

Grower/Industry Meeting Talks:

- Van Eerd, L. L., and Zink, M. 2014. Cover Crops in Seed Corn: Capturing an N credit. Ontario Seed Corn Industry Research Meeting. Oral Research Technical Report: Chatham, ON. Invited presentation to 8 growers and industry reps. March 26th 2014.
- Van Eerd, L. L., and Zink, M. 2014. Cover crops and seed corn. Seed Corn Growers Association SCGA annual meeting. Oral Research Technical Report: Cedar Springs, ON. March 3 2014. Invited speaker. Approx. 60 growers and crop advisors.

Field Day Talks:

- Coombs, C. and L.L. Van Eerd. 2014. Value of legume cover crops for field corn. *for:* Quebec Farmer tour. Presentation to 44 growers and extensionists from Quebec. 22 July 2014. Ridgetown.
- Van Eerd, L.L. 2014. Cover crops and soil health. *for:* Communities in Bloom. Presentation to 5 participants at the research plots at Ridgetown Campus. 29 July 2014.

Promotional Material:

Farm and Food Care Ontario -WAMQI promotional video. Claire Coombs. 2014. Cover Crops: Contributing Nitrogen. <http://youtu.be/oWDgwseKlXk> Produced by Farm and Food Care Ontario. Produced by Farm and Food Care Ontario. Available 26 May. 2014.

Scientific Contributions:

Coombs, C., Lauzon, J. D., Deen, B., and Van Eerd, L. L. 2014. The effect of legume cover crops on nitrogen availability and yield in commercial corn systems in Southern Ontario. *ASA/CSSA/SSSA, International Annual Meeting*. Long Beach, CA. November 4 2014. Oral Presentation.

Coombs, C., Lauzon, J. D., Deen, B., and Van Eerd, L. L. 2014. “Legume cover crops to reduce nitrogen losses in corn systems”, Latornell Conservation Symposium, Alliston, ON. November 2014. Poster Presentation.

Coombs, C. MSc Thesis. University of Guelph. *Anticipated defence Spring 2015*.

Coombs, C. Lauzon, J. D., Deen, B., and Van Eerd, L. L. 20xx. The effect of legume cover crops on nitrogen availability and yield in commercial corn systems in Southern Ontario. *Can. J. Soil Sci.* In preparation. *Anticipated submission Spring 2015*

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Submitted to Farm and Food Care and posted online at on Dr. Van Eerd’s Ridgetown Campus website

http://www.ridgetownc.on.ca/research/research_reports_profile.cfm?profile=vaneerd&name=Dr.%20Laura%20Van%20Eerd

Funding:

Funding for this project was provided by:

