Effects of cover crop type, planting date and removal on nitrogen dynamics in a cucumber cover crop cucumber rotation

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Introduction

Short season crops, such as cucumbers, provide an opportunity for growers to plant a cover crop. Beyond soil quality considerations, cover crops absorb soil mineral N over the fall growing season reducing potential leaching losses during a time when the field would otherwise be left fallow. Although knowledge of N uptake and release in Ontario vegetable production has increased recently[1,2], there is still a large knowledge gap in the contribution of cover crops to N cycling in the subsequent crop. In May 2008, a field study in a cucumber – cover crop – cucumber rotation was initiated with the objective of characterizing N dynamics of various cover crops and two different cover crop planting dates over the rotation.

Materials and Methods

Field experiment established in a cucumber – cover crop – cucumber rotation from May 2008 to July 2010.

- Randomized split-split plot design with 4 replicates, plot size (4.5 x 9 m).
- Main effect: cover crop type — Seeding rate (kg ha^{-1})
  - No cover control — -
  - No cover + 84 kg N ha^{-1}* — -
  - Oilseed radish: *Raphanus sativus* var. *oleoferus* — 13
  - Cereals: - Oats: *Avena sativa* L. — 81
    - Cereal rye : *Secale cereale* L. — 134
  - Legumes: - Forage peas: *Pisum sativum* L. — 224
    - Hairy vetch: *Vicia villosa* L. — 28
  - * Nitrogen fertilizer was preplant applied to the cucumber crop in June 2009 and 2010, while all other treatments received 0 kg N ha^{-1}.
- Secondary effects: cover crop planting date; spring rye biomass removal
  - Early- and late-planted cover crops were sown in early Aug. and early Sept. 2008/2009.
  - Rye biomass was removed with a lawn mower on Apr. 27 2009 and May 12 2010.

- After cucumber harvest, the crop was stock-chopped, incorporated, and cover crop seed drilled in with no fertilizer.
- Cover crop aboveground biomass from two ½ m^2 areas per plot and soil mineral N from 0-15, 15-30, 30-60 and 60-90 cm was collected during the cover crop season from Sept. to April and the cucumber season from June to July.
- Plant available N (PAN) was the sum of soil mineral N at 0-60 cm depth and above ground plant N content in kg N ha^{-1}.
- Data were analyzed using the Tukey-Kramer multiple means comparison procedure (p=0.05).

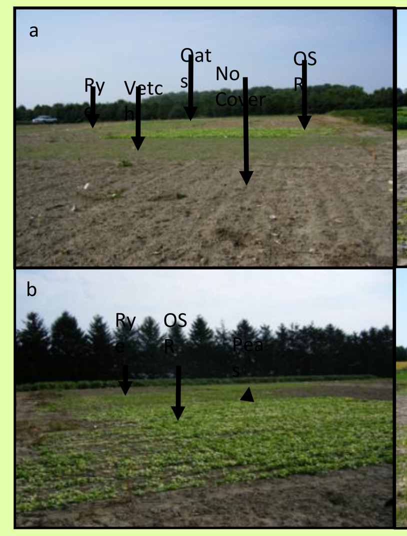

Figure 1. a,b) Early-planted cover crops 31 DAP

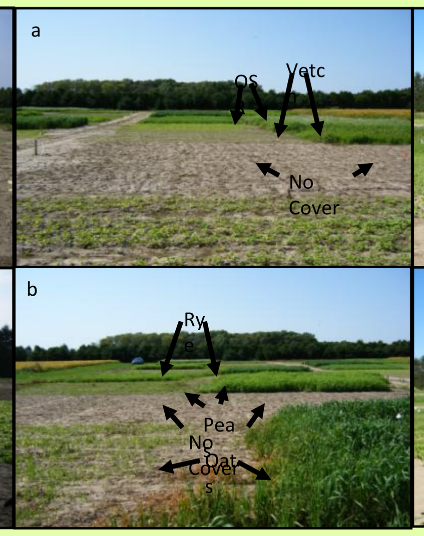

Figure 2. a,b) Early and late-planted cover crops 60 & 29 DAP, respectively

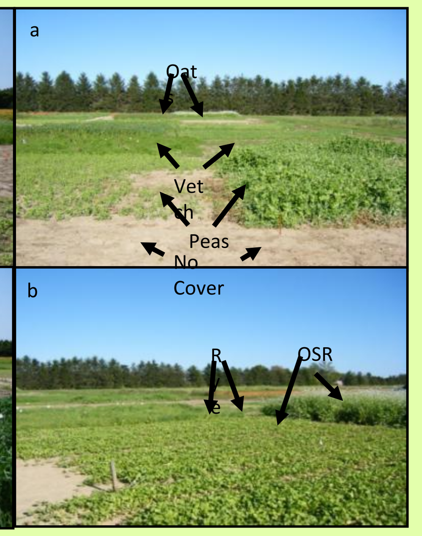

Figure 3. a,b) Early and late-planted cover crops 90 & 59 DAP, respectively

Acknowledgements and References

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[1]O'Reilly, K.A. and L.L. Van Eerd. 2008. Influence of cover crops on nitrogen cycling in a pea-cover crop-sweet corn rotation. Canadian Society of Soil Science Annual Meeting. 6-9 July 2008. Abstract #24. *Poster*.
[2] Van Eerd, L.L., D.E. Robinson, and A. Verhallen. 2007. Cover crops, nitrogen cycling and weed dynamics in subsequent cucumber (*Cucumis sativus* L.) crop. Plant Canada 2007, Saskatoon, SK. Abstract D1-1.

Results and Discussion

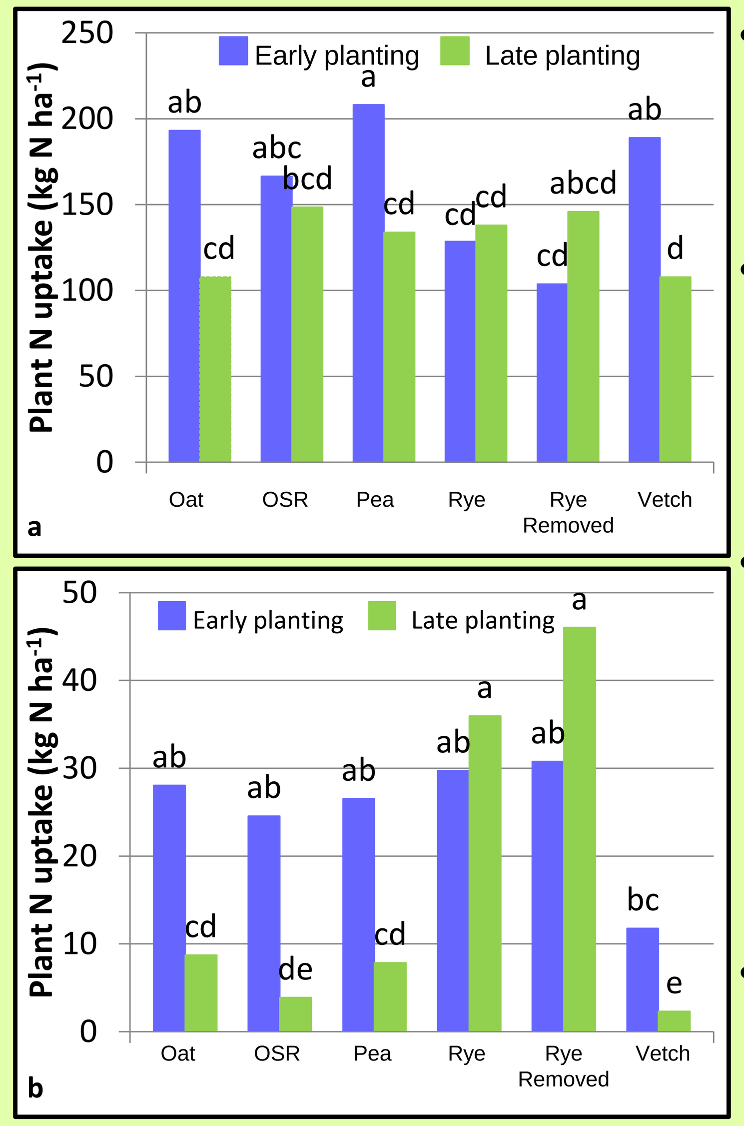

Figure 4. Quantity of nitrogen in cover crop aboveground tissues and recoverable residue collected in November (a) and April (b) 2008-2010. For each graph, bars with different letters indicate a difference among cover crops (p=0.05).

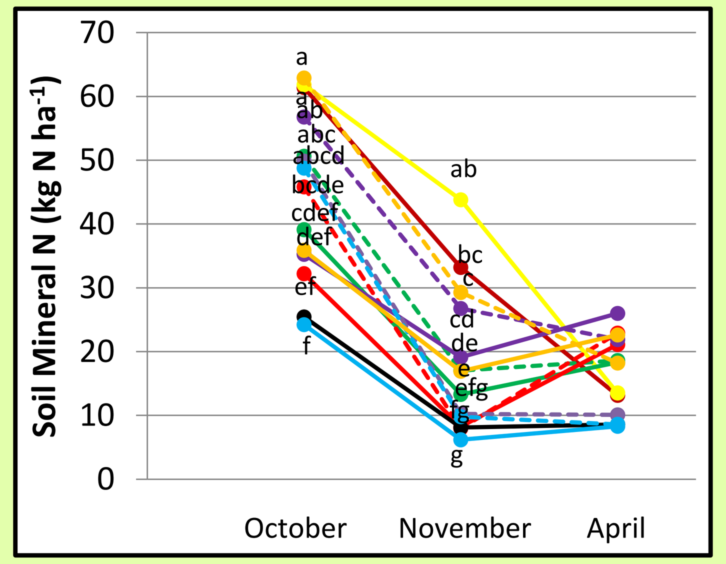

Figure 5. Soil mineral N (SMN) (nitrate-N and ammonium-N) content from 0-60 cm depth during the cover crop growing season from 2009 and 2010. At each sample date, cover crops with different letters indicate a difference (p = 0.05).

- By November, early-planted oat, pea and vetch took up more N than the same cover crop planted one month later (fig. 4a).
- The following spring, late-planted rye and rye-removed took up more N compared to all other late-planted and was not different from all early-planted cover crops (fig.4b).
- By November, all early- and late-planted cover crops, with the exception of late-planted legumes (peas and vetch) had lower soil mineral nitrogen levels compared to the no cover and no cover + N treatments (fig. 5 a).
- By April, all early-planted cover crops, with the exception of rye removed had higher PAN compared to the no cover (Table 1).
- By April, early-planted pea had significantly higher PAN compared to the no cover, no cover + N, late-planted oat, OSR and vetch (Table 1).
- There was no cover crop type x planting date interaction for total yield (p = 0.8967) and marketable yield income (p = 0.8282).
- In the following cucumber crop, oat, OSR, pea and vetch treatments yielded and returned an income as high as the no cover + N treatment (Table 2).
- Rye and rye-removed returned significantly lower marketable cucumber yield income compared to the all other cover crops planted (Table 2).

Table 1. Plant available N (PAN) (kg N ha^{-1}) as affected by cover crop type and planting date over the cover cropping season 2008-2010. Different letters within a given column indicate a difference (p = 0.05).

	Planting Date	PAN October	PAN November	PAN April
Cover crop				
kg N ha^{-1}				
No cover	-	188 abc	58 b-e	53 ef
No cover + N	-	186 abc	91 a-e	67 c-f
Oat	Early	258 ab	113 abc	130 abc
	Late	184 abc	53 cde	90 b-f
OSR	Early	208 abc	69 b-e	137 ab
	Late	200 abc	52 cde	102 b-f
Pea	Early	268 a	145 a	157 a
	Late	195 abc	96 a-d	106 a-e
Rye	Early	155 c	35 de	110 a-d
	Late	190 abc	41 de	128 abc
Rye Removed	Early	171 bc	26 e	106 a-e
	Late	197 abc	53 cde	135 ab
Vetch	Early	205 abc	126 ab	138 ab
	Late	206 abc	60 a-e	88 b-f
P value		0.0202	0.0081	0.0001

Table 2. Cucumber total yield (kg ha^{-1}) and marketable yield income ($ ha^{-1}) as affected by cover crop treatment from 2009 and 2010. Cover crops with different letters within a given row indicate a statistically significant difference (p = 0.05).

	Total Yield	Marketable Yield Income
Cover crop		
	t ha^{-1}	$ ha^{-1}
No cover	19 ab	966 bc
No cover + N	23 a	1548 a
Oat	20 abc	1142 ab
OSR	20 abc	1319 ab
Pea	21 abc	1131 ab
Rye	18 c	596 c
Rye Removed	19 bc	645 c
Vetch	22 ab	1208 ab
P value	< 0.0001	< 0.0001

Conclusions

- Early planting is preferred for optimizing cover crop biomass (data not shown) and higher N uptake.
- Planting date had a significant influence on N dynamics over the rotation, however this did affect cucumber yield.
- Lower yield in the rye and rye removed treatments may have been influenced by poor cucumber emergence and slug feeding.
- No difference in yield between the rye and rye removed treatments indicate that spring foraging may be an option with a livestock system.