2013 Research Report

Impact of Cover Crops and Field Corn Stover Removal on Squash Yield.

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Introduction: Maintaining healthy, productive soil is critical to enhancing the long term profitability of agriculture. The anticipated demand for crop residue (corn stocks/cobs or wheat straw) for the bio-economy may have a negative effect on soil quality and crop productivity. For instance, previous research has shown that removing winter wheat straw lowered tomato yields the following year but no yield reductions were observed when cover crops were in the rotation. Thus, cover crops may play a significant role maintaining soil and crop productivity, especially in production systems where crop residues are removed.

Objectives: The goal of the research was to evaluate the effect of field corn stover removal and the role of cover crops on soil and crop productivity.

Methods:

LOCATION: Ridgetown Campus research plots on a sandy loam soil (Table 1)

DESIGN: Split-split-plot randomized complete block design (RCBD) with four replications **at 2 sites**:

- Main effect: **Cover crop species** (plot size 6 x 16 m)
- Split-plot: Corn stover residue removal (plot size 3 x 16 m) **– removed or retained**
- Split-split-plot: N fertilizer rate (plot size 6 x 8 m) **– 0 N or 98 lb N/ac**

PEST CONTROL: According to typical grower practice
Trial was scouted for insect and disease every two weeks and at harvest

ROTATION at two sites: 2007-2010, 2008-2011 fall-planted cover crops
2011, 2012 commercial corn –stover removed or retained
2012, 2013 squash

COVER CROPS:
1) no cover crop
2) oat (seeding rate 72 lb/ac)
3) oilseed radish (14)
4) cereal/ fall rye (60)
5) oilseed radish & fall rye (8 + 30)

Table 1. Soil characteristics* for both sites at Ridgetown Campus.

Soil characteristics:		*Nutrients (ppm):*	
Soil texture	Sandy loam	P	30
% sand:silt:clay	75:18:7	K	179
pH	6.5	Ca	908
% Organic Matter	3.8	Mg	120
CEC (MEQ/100g)	7.2		

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

Table 2. Management practices and rainfall at Ridgetown Campus in 2010-13.

Management Practices	Site 1: 2010-2012	Site 2: 2011-2013
Cover crops	2007, 2008, 2009	2008, 2009, 2010
Cover crop planting	08 Sept 2010	16 Sept 2011
Cover crop termination	06 May 2011	04 May 2012
Commercial corn planting (cv. DKC52-59, ppa=30 800)	31 May 2011	18 May 2012
Commercial corn harvest and stover removed/retained	16 Nov 2011	24 Oct 2012
Squash growing season	2012	2013
Glyphosate sprayed	28 May	02 May
N Fertilizer: 98 lb N ac^{-1} 27-0-0	31 May	03 June
Cultivation	31 May	31 May
Squash planting	31 May	31 May
Squash harvest	10-11 Sept	27 Aug

Table 3. Monthly weather conditions during growing season.

	Rainfall (mm)			Temperature (˚C)		
Month	2012	2013	30 yr	2012	2013	30 yr
May	34	64	75	15.5	15.1	14.8
June	45	102	83	22.6	18.6	20.2
July	155	78	86	22.1	21.2	22.5
August	73	53	86	19.8	19.3	21.4
September	67	89	93	15.5	15.9	17.6

Results 2012-2013:

Squash Yield (Table 4):

- Squash yield was 18.2 and 16.0 ton/ac with and without N fertilizer. As expected, the N fertilizer application of 98 lb N/ac had a positive impact on squash yield.
- There was no interaction of N rate with cover crops or corn stover removal. This indicates that cover crops and corn stover residue on their own did not provide enough N nor did the crop residues (corn or cover crops) tie up too much N in the squash crop.
- None of the cover crops had a negative effect on squash yield and there was no difference in squash yield between corn stover retained or removed from the site (Table 4). This indicates that one time corn stover removal on a productive, high organic matter soil (%OM=3.8) did not affect following crop yield.

Table 4. In 2012-13, squash yield in cover cropping systems with or without corn stover removal.

Cover crop[z]	Stover removed	Stover retained
	Fruit yield (ton/ac)	
No cover	16.8	16.7
Oat	16.8	15.0
Oilseed radish	17.9	16.8
Oilseed radish + cereal rye	17.0	18.1
Cereal rye	17.3	18.1

[z] Cover crop means were not significantly different between treatment combinations (P=0.05). N=80.

Nitrogen dynamics at plant harvest (Table 5, Figure 1-2):

- There were no significant differences between corn stover management practices or between N rates in the N dynamics parameters at squash harvest (soil mineral N, N in squash fruit and shoot, plant available N). This suggests that the soil is highly productive.
- The only significant difference between cover crops for N uptake in squash fruit and shoots (residue), fruit biomass and residue biomass was that rye had a higher shoot weight and N uptake than all other cover crops and the no cover control treatment (Table 5).
- Soil mineral N (ammonium-N and nitrate-N) (0-60 cm) did not differ between the no cover control treatment and all cover crops (oats, oilseed radish, rye, radish&rye) but soil mineral N was higher with oats than the other cover crops (Figure 1).
- At squash harvest, plant available N (N in soil and squash plant) tended to be higher with rye but there were no significant differences among cover crops (Figure 2). This is interesting because cover crops were planted in autumn 2010-2011 and measurements were taken 2 years later in 2012-2013. Thus cover crops may have impacts after the first year.

Table 5: Nitrogen uptake and biomass of squash fruit and shoots in 2012-13 from Ridgetown, ON.

Cover crop type	Total Plant N content	Fruit N	Shoot N	Fruit weight	Shoot weight
	----------	lb N/ac	----------	------ lb/ac	------
No cover	170 ns	103 ns	67.0 b	4350 ns	3695 b
Oats	153	90.0	62.1 b	4291	3460 b
Radish & rye	148	91.0	56.9 b	4197	3310 b
Oilseed radish	192	116	76.3 b	4437	3776 b
Rye	213	96.2	115 a	4260	5357 a

[a-b]For each column, cover crops with different letters indicate a statistical difference ($P \leq 0.05$). N=80.
[ns] No significant statistical difference between cover crops

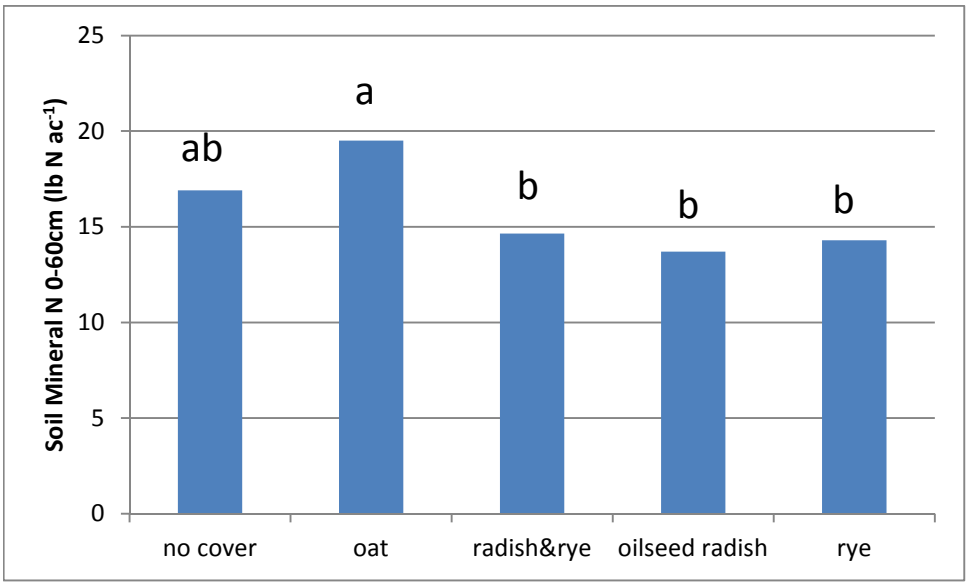

Figure 1: Effect of cover crop on soil mineral N (0-60 cm) at squash harvest in 2012-13 from Ridgetown, ON. Different letters indicate a statistical difference, $P \leq 0.05$. N=80.

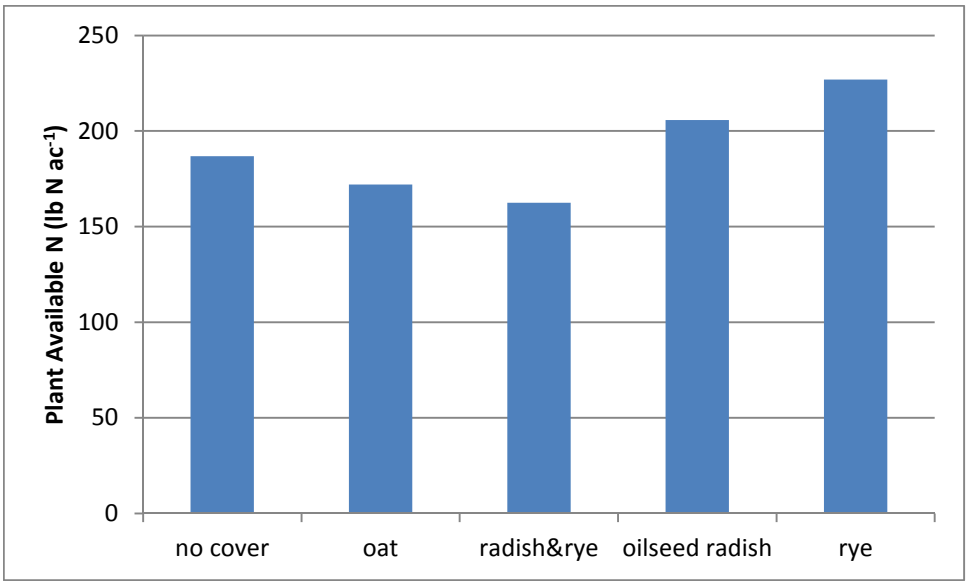

Figure 2: Effect of cover crop on plant available N (soil mineral N and squash plant N) at squash harvest in 2012-13 at Ridgetown, ON. No statistical difference, $P \leq 0.05$. N=80.

Soil Quality (Table 6-7):

- The removal of corn stover and cover crop did not have a significant effect on soil aggregation in spring 2012 and 2013. There was no cover crop and corn stover interaction. Since, cover crops were not grown during the 2011-2012 autumn seasons, plant biomass inputs were minimal, thus contributing less to soil organic matter.
- Soil aggregation was, however, significantly different between the May and June sampling times in 2012 and 2013 (Table 6). Significant reduction in water stable aggregate between May and June sampling times may be attributed to the decomposition of organic matter due to tillage.
- In the lab study, there were differences in residue breakdown between different cover crops and corn stover residue either on their own or combined (Table 7). Corn stover break down was quicker (based on high decomposition rate and low half-life) or not different with no cover crop residue than with cover crop residues. Therefore, some cover crops may act to conserve soil organic matter. The mix of oilseed radish and cereal rye may be the most effective at conserving organic matter due to its low decomposition rate. However, results from the lab should be evaluated in the field.

Table 6. Impact of sampling time on soil aggregate stability in the spring of 2012 and 2013.

Sampling time	Water Stable Aggregates (%)	Dispersible Clay (mg ml^{-1})
May –before tillage and squash planting	47.5 a	0.46 b
June –one month after tillage	41.0 b	0.56 a
Effect	---------- *P value* ----------	
Year	0.0891	0.4490
Sampling time	**0.0058**	**0.0325**
Cover crop	0.8992	0.3431
Corn stover	0.1571	0.5818
All Interactions	≥0.3031	≥0.4623

a-b Means within a column followed by a different letter are significant at P<0.05

Table 7. Breakdown of cover crop and corn stover residues as indicated by polysaccharides (sugars) and evolved carbon dioxide (CO_2) in an incubation study.

		---- Polysaccharides* ----		-------- Evolved CO_2** --------	
Cover crop	Corn stover	Decomposition rate (KM d^{-1})	Half-life (d)	Decomposition rate (mg C g^{-1} C d^{-1})	Half-life (d)
No cover	None	0.298 a	2.47 abc	0.30 a	2.33 a
No cover	Added	0.340 a	2.03 a	0.32 a	2.18 a
Oat	None	0.210 bc	3.30 bcd	0.13 c	5.41 cde
Oat	Added	0.198 bc	3.49 bcd	0.22 b	3.26 ab
Oilseed radish	None	0.196 bc	3.54 cd	0.12 c	4.49 bcd
Oilseed radish	Added	0.146 cd	4.74 de	0.12 c	4.29 bc
Cereal rye	None	0.280 ab	2.47 ab	0.12 c	5.80 cde
Cereal rye	Added	0.153 cd	4.54 de	0.13 c	5.97 ed
Radish & rye	None	0.070 d	9.94 e	0.16 c	6.34 e
Radish & rye	Added	0.061 d	11.3 e	0.16 c	5.47 cde
	Effect	---------- *P values* ----------			
	Cover crop	<0.0001	<0.0001	<0.0001	<0.0001
	Corn stover	0.0123	0.0222	0.0556	0.0755
	Interaction	0.0016	0.0006	0.0012	0.0141

[a-e]In each column, different letters indicates a significant difference at P<0.05 (Tukey's).
*First order decay model ($y = C_1 + C_0(\exp^{-kt})$) for polysaccharide-C spectral peak area in soil amended with cover crops with and without corn stover
**First order decay model ($y = A(1-\exp^{-kt})$) for evolved C in soil amended with cover crops with and without corn stover \.

Conclusions:

- Cover crops planted for 4 years in the autumn (2007-2010 and 2008-2011for site 1 and 2) had no negative effect on marketable squash yield in 2012-13. Growers should not hesitate to plant cover crops. Cover crops tested: oat, oilseed radish, rye and mix of oilseed radish&rye.
- There were no significant differences observed in squash yield or N dynamics due to corn stover management (either removing or retaining stover). Therefore, the one-time removal of corn stover on a sandy loam soil with high organic matter (OM=3.8%).
- As expected, the application of N fertilizer at 98 lb N/ac had a positive impact on squash yield compared to the 0 N control.
- In a lab study, corn stover break down was quicker (based on high decomposition rate and low half-life) or not different with no cover crop residue than with cover crop residues. Therefore, some cover crops, particularly the mix of oilseed radish and cereal rye, may act to conserve soil organic matter.

Acknowledgements: The financial contribution of the following organizations to this research program was greatly appreciated: Ontario Processing Vegetable Growers, Ontario Ministry of Agriculture and Food, Ministry of Rural Affairs, Summer Experience Program, OMAF and MRA Summer Jobs Program. We sincerely thank our summer research assistants.