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Long-term Cover Cropping & Soil Health

Laura L. Van Eerd

School of Environmental Sciences

University of Guelph Ridgetown Campus

@LauraVanEerd

lvaneerd@uoguelph.ca

ses school of environmental sciences

Long-term Cover Crop Experiment

Two sites, separate years

Site A	B	Main crop followed by cover crop	Publication/Mtg
2007	2008	processing pea – cover crop	
2008	2009	sweet corn – cover crop	O'Reilly et al. 2011 Weed Techn, 2012 CJSS
2009	2010	spring wheat – cover crop	
2010	2011	processing tomato – cover crop	Belfry et al. 20xx PlosOne submitted
2011	2012	field corn	VanEerd + Vyn 2014 SSSA Mtg

4-yr yield + $

1) No cover crop **0**
2) Oat (*Avena sativa*) **80** kg ha^{-1}
3) Cereal rye (*Secale cereale*) **67**
4) Oilseed radish (OSR) **12**
   (*Raphanus sativus* var. *oleiferus*)
5) mix OSR and rye (OSR+Rye) **9+34**

4 yr Crop Yield and Profit Margins

Sweet corn, spring wheat, tomatoes, field corn

	Treatment	4 yr **total** yield (tonne ha^{-1})	4 yr **ave** profit margins ($ ha^{-1})
Cover crop	Oilseed radish OSR		
	OSR+Rye		
	Rye		
	Oats		
	None		
N fertilizer	full N rate to main crop		
	zero N rate		
Effects (*P* values)	cover crop		
	N rate		
	interaction		
Contrasts	all cc vs none		
	OSR vs none		
	grass vs none		

*,** p values significant at 0.05, 0.01

negative numbers means no-CC was lower than with cc.

Nitrogen Dynamics

Belfry et al. 20xx PlosOne submitted

- In fall, cover crops immobilize N (50 to 150 kg ha^{-1})
- Next growing season, higher plant available N (PAN) with cover crop than without.

PAN = soil mineral in 2-ft depth + aboveground plant N content

Table 1. At harvest, impact of cover crop type on plant available nitrogen (PAN) at tomato harvest in 2010-11.

Cover crop	PAN (kg N ha^{-1})
Oilseed radish	216 a
Oat	204 ab
Rye	187 bc
OSR+Rye	186 bc
No cover	165 c

No cover crop by N rate interactions ($p \geq 0.3673$)
-Tomato yield
-Soil mineral N (0-30, 60, 90 cm)
-Fruit +shoot N % or content

Cover crop p=0.0004
N fertilizer rate p=<.0001
No interaction p=0.4067

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2012	2013	squash	Ouellette et al. 2016 SSSAJ

Soil – Carbon dynamics

Soil texture	75:18:7	Sandy loam
% OM	3.5	
pH	6.3	
CEC (cmol kg^{-1})	9.4	
Nutrients (mg kg^{-1}): P	52	
K	248	
Ca	927	
Mg	79	

Soil Health

Ouellette +Van Eerd, unpublished

Table 4. Impact of 4 years of annual cover crops on soil organic C and total N.

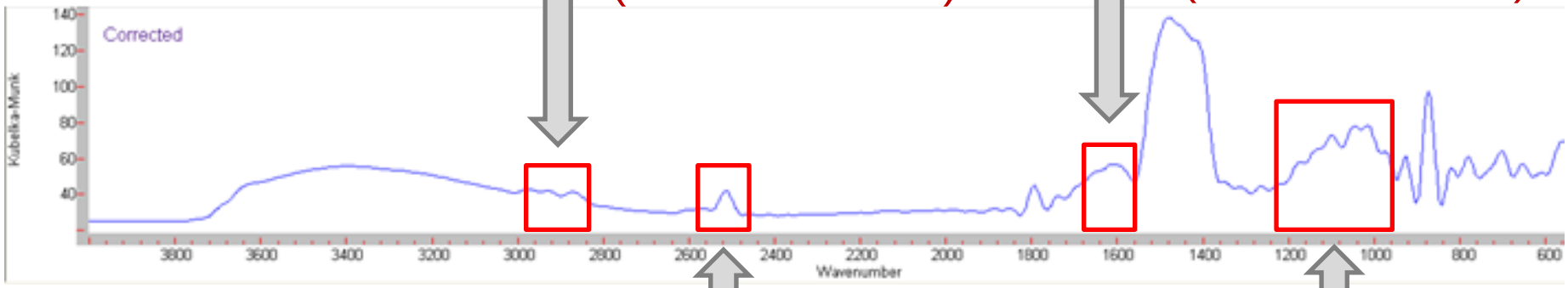
Cover crop
Radish + rye
Radish
Cereal rye
Oats
No cover
se
P value
For all paramet
crop by stover i

Ouellette et al. 2016 SSSJ

DRIFT Incubation: soil + cover crop biomass from long-term trial to study C dynamics

Aliphatic-C bands (2838-2996 cm^{-1})

Aromatic-C bands (1581-1686 cm^{-1})



Internal $CaCO_3$ standard (2523 cm^{-1})

Polysaccharide-C bands (975-1223 cm^{-1})

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2011	2012	field corn – retain/remove stover	VanEerd + Vyn 2014 SSSA Mtg
2012	2013	squash – cover crop	Ouellette et al. 2016 SSSAJ
2013	2014	soybeans – winter wheat	
2014	2015	retain/remove straw – cover crop	
2015	2016	processing tomato yield + soil	Chahal + VanEerd 2016 CSSSmtg
2016	2017	processing pea – cover crop	

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Haney Soil Health Test

Chahal and Van Eerd. 2016 CSSS mtg.

Cover crop	Overall Score
No cover	28.1 a
Oat	19.7 b
Oilseed Radish	16.8 b
Radish+Rye	**29.2 a**
Rye	14.9 b
SE	2.608
P value	**<0.0001**

SOLVITA®

Cornell Soil Health Assessment

Chahal and Van Eerd. 2016 CSSS mtg.

Cover crop	Overall Score
No cover	65b
Oat	64b
Oilseed Radish	68.5ab
Radish+Rye	**70.3a**
Rye	66.7ab
SE	1.312
P value	**0.0051**

Cornell Soil Health Assessment

[redacted]

Agricultural Service Provider:
None
Cedar Basin Crop Consulting
cbcc@earthlink.net

Sample ID: L_555
Field/Treatment: Tenge E
Tillage: 1-7 inches
Crops Crown: COG, COG, SOY
Date Sampled: 12:00:00 AM
Given Soil Type: Muscatine
Given Soil Texture: Silty Clay Loam
Coordinates: [redacted]

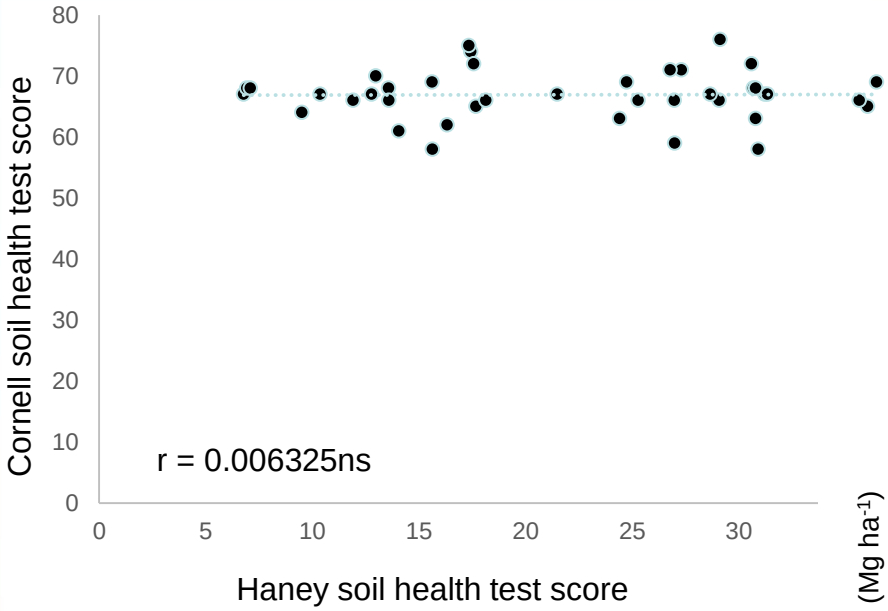
Measured Soil Textural Class: Silt Loam Sand: 28% Silt: 56% Clay: 16%

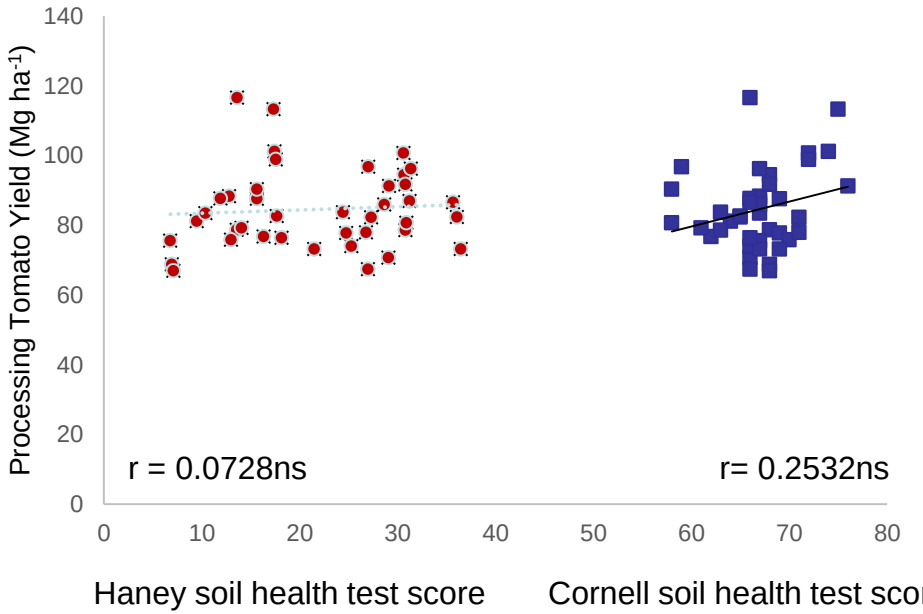
Test Report

	Indicator	Value	Rating	Constraint
Physical	Available Water Capacity	0.31	100	
Physical	Surface Hardness			Not Rated: No Field Penetrometer Readings Submitted
Physical	Subsurface Hardness			Not Rated: No Field Penetrometer Readings Submitted
Biological	Aggregate Stability	49.5	78	
Biological	Organic Matter	4.6	79	
Biological	ACE Soil Protein Index	5.8	29	Organic Matter Quality, Organic N Storage, N Mineralization
Biological	Root Pathogen Pressure	4.7	54	
Biological	Respiration	0.58	4	Soil Microbial Abundance and Activity
Chemical	Active Carbon	744	76	
Chemical	pH	6.0	66	
Chemical	Phosphorus	10.9	100	
Chemical	Potassium	164.5	100	
Chemical	Minor Elements (Mg: 456 Fe: 0.8 Mn: 9.2 Zn: 0.4)		100	
	Overall Quality Score		71	High

No Correlations

Chahal and Van Eerd. 2016 CSSS mtg.





Preliminary Conclusions

Leads to more research questions.

What is the mechanism?

Other sites? Other soils?

Current Soil Projects

By Dr. Laura L. Van Eerd

Term	Title	Role	Funding source
2014-17	Long-term cover crop research: Maintaining and monitoring soil health	Principal Investigator	OMAFRA-UoG, GFO OTRI & OPVG
2015-18	Usefulness of Haney soil health test in Ontario	Principal Investigator	Grain Farmers of Ontario (GFO)
2015-17	Assessing soil organic matter quality as an attribute of soil health in long-term tillage and crop rotation experiments	**PI: A. Diochon** Lakehead U Co-PI: LVE	GFO
2015-18	Interseeding cover crops options for grain corn and their effects on soil health in Southern Ontario	**PI: M. Sharifi,** Trent U Collaborator: LVE	GFO
2015-20	Soil-BOL: Exploring the link between soil biodiversity and soil health	**Co-PI: K.E. Dunfield + R. Hanner** UoG Collaborator: LVE	GFO & OMAFRA-UoG
2015-19	Improved metrics of carbon storage and greenhouse gas emission reduction: Lysimeters	**PI: C Wagner-Riddle** UoG Collaborator: LVE	OMAFRA New Directions + many matching

Soil Health Publications

By Dr. Laura L. Van Eerd

Long-term tillage systems + field crop rotation trials

- Cornell Soil Health Assessment (CSHA) at 4 sites:
  Congreves et al. 2015 Soil & Tillage Research 152:17-25
  Funding: WAMQI Farm and Food Care, Grain Farmers of Ontario in 2009
- Ontario Soil Organic Carbon (SOC) meta-analysis:
  Congreves et al. 2014 Can. J. Soil Sci. 94:317-336
- SOC, total N, CSHA at Ridgetown:
  Van Eerd et al. 2014 Can. J. Soil Sci. 94:303-315
  Funding: Grain Farmers of Ontario in 2006
- SOC, total N influenced by N fertilizer at Ridgetown:
  Congreves et al. 2016 Plant and Soil *In press*
  Funding: Grain Farmers of Ontario in 2006

Long-term cover crop trial

- Active carbon (polysaccharides) at Ridgetown:
  Ouellette et al. 2016 Soil Sci. Soc. Am. J. 80:284–293
  Funding: OMAFRA-UoG, ON Processing Vegetable Growers, Grain Farmers of ON

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Grower/Farm Associations

- Grain Farmers of Ontario Processing Vegetable, Fruit and Vegetable, Sugarbeet, Seed Corn,
- Ontario Soil and Crop Improvement Association
- Farm and Food Care

Provincial - OMAFRA

- New Directions
- UoGuelph –Environmental Sustainability, Knowledge Translation and Transfer

Federal

- Agricultural Adaptation Council
- Pest Management Centre
- Soil Conservation Council of Canada