

AIM Trial Report: **Long-Term Effect of Cover Crops on Soil Health and Potato Yield**
Working Group: Soil Improvement (ACS Living Labs)
Crop Year: 2024
Author: Ryan Barrett & Bethany Visser
Date: January 17th, 2025

Project Rationale:

Under the first Living Labs project in PEI, we completed four years of trials investigating both the use of fall covers ahead of potatoes (following crop harvest or forage termination) as well as fall covers after potato harvest. Both projects were successful in exploring best management practices related to the use of fall cover crops, as well as understanding some of the benefits of employing fall cover crops. We were able to show that fall cover crops reduce free nitrate levels in the soil by late fall, thereby carrying over nitrogen to the following year that would otherwise be lost. We also saw indications of reduced potential for soil erosion with use of fall covers, even with relatively low levels of biomass. Finally, we saw an increase in yield in potatoes following a cover crop compared to no cover crop, particularly when the cover crop was planted early and achieved significant levels of ground cover.

Nonetheless, we were unable to show any clear effects of fall cover crops on soil health characteristics such as soil organic matter or soil respiration due to the nature of the trial. It is very difficult to show changes in soil organic matter or other soil health metrics in a short period of time; therefore, this project was proposed to follow fields over 4-5 years and assess soil health metrics, as well as greenhouse gas emissions, under a rotation that uses fall cover crops every year compared with a rotation with minimal or no cover cropping. The project team hopes to have a better understanding of the long-term impacts of fall cover crop usage at the end of this project.

In this report, we intend to share data from the first two years of collection under this project. This project was initiated in fall 2023 with two initial fields:

- Island Holdings Ltd. (IH) – New London, PEI
- Hilltop Produce (HTP) – Newton, PEI

A third field was added in 2024: Mooney Farms (MNY) – Souris, PEI.

Island Holdings (IH):

The IH field was selected in the summer of 2023, when it was established with an alfalfa/grass forage crop. While not directly measured for biomass, the establishment of the forage crop was described by the producer as average to poor. Forage was terminated in August and a fall cover crop of tillage radish was planted on August 15th on the whole field at a rate of 10 lbs/ac. A portion of the field was then terminated (glyphosate plus shallow tillage pass) in mid-September before the cover crop fully established to be used as the no-cover crop check. This portion of the field was largely bare by late October, compared with the cover crop treatment having largely full ground cover.

Prior to cover crop establishment, the field was grid sampled for soil chemical, soil health and soil carbon (with soil density cores). The field was also scanned for electroconductivity to create a SWAT map to create management zones for the field. A graduate student from UPEI measured greenhouse gas emissions using a LiCOR instrument in the fall of 2023 according to management zone.

Soil samples were taken again on April 30th prior to potato planting. The cover crop was fully winter killed.

Potatoes (Mountain Gem variety) were planted on May 14th. UPEI continued to measure GHG emissions throughout the growing season and following. Immediately before the field was harvested, ten-foot yield samples were collected on September 24th, with six samples collected in each of the cover and non-cover treatment areas. Sampling locations were chosen close to previous soil sampling locations in an effort to ensure similar background soil characteristics between treatment and control. These samples were placed in storage until November, when they were graded at Cavendish Farms Central Grading. The fall cover crop (spring barley) was broadcast in the treatment area prior to harvest and incorporated during harvesting. Following harvest, soil nitrate data was collected in late November in each treatment area. In addition, percent ground cover was estimated using photography and image processing.

Table 1: IH Selected soil chemistry characteristic before and after 2023 cover crop establishment.

Treatment	Cover				No Cover (Control)			
	P ₂ O ₅	K ₂ O	OM	pH	P ₂ O ₅	K ₂ O	OM	pH
	ppm	ppm	%		ppm	ppm	%	
Summer 2023	592.0	174.2	3.4	5.6	608.3	233.5	3.0	5.8
Spring 2024	537.5	198.1	3.2	5.6	531.8	197.8	2.7	5.9
Difference	-54.5	+23.9	-0.2	0.0	-76.5	-35.7	-0.3	+0.1

Table 2: IH potato yield and quality measurements.

Treatment	Total Yield	Smalls	>10 oz.	Total Defects	M. Yield	Payout
	cwt/ac	%			cwt/ac	\$/ac
Cover	553	5.3	25	1	519.5	9411.95
Check	545	5	17	0.7	514.3	9204.50
Difference	8	0.3	8	0.3	5.2	207.45
p value	0.86	0.75	0.17	0.77	0.90	0.77

Table 3: Soil nitrate samples taken on April 30, October 10 and November 21, 2024. Values listed as under 5 ppm were assumed to be 5 ppm.

	Spring		Fall (Oct)		Fall (Nov)	
Depth	Cover	Check	Cover	Check	Cover	Check
0-15	8.4	5.7	19.0	13.4	8.0	5.0
15-30	8.1	6.1	14.2	11.1	11.5	5.4
30-45	N/A				12.8	6.5

Table 4: IH percent green ground cover in fall cover treatment area. Data provided by Soyeon Shim, UPEI.

Date	Percent Green Cover
	%
November 10	9.1
November 28	16.0

Table 5: IH Biomass measurements collected November 21, 2024

Treatment	Dry Matter	Dry Matter	Nitrogen
	g/0.25 m ²	kg/ha	
Cover	50.8	2033.2	33.3

Key Points from IH Trial thus far:

- There were no clear trends from soil chemical analysis between treatments. Additional years may show a clearer trend.
- There were no significant differences in yield or quality between the two treatments. There was an 8% difference in 10 oz percentage in favour of the cover crop treatment but was not statistically significant.
- At all time periods, soil nitrate levels were higher in the cover crop treatment area than in the no-cover check. This may be due to the higher organic matter level in the cover crop treatment area mineralizing more nitrogen.
- Percent green cover in November 2024 and total accumulated biomass was below expected values for a relatively early harvest date. Use of a winter cereal species is recommended following potatoes in 2027

Hilltop Produce (HTP):

The HTP field was selected in the summer of 2023, when it was established with ryegrass forage crop that was harvested for seed in early August. Unfortunately, excessive rain in August and September made it difficult to remove the ryegrass straw from the field, delaying tillage and establishment of the cover crop, in addition, there was some regrowth in ryegrass, requiring further termination with glyphosate which also delayed cover crop establishment. A spring wheat cover

crop was sowed on most of the field on October 12th but achieved a very minimal level of establishment given the late seeding date. A portion of the field was not seeded with a cover crop, with this strip serving as the no-cover check for the rest of the trial.

Prior to cover crop establishment, the field was grid sampled for soil chemical, soil health and soil carbon (with soil density cores). The field was also scanned for electroconductivity to create a SWAT map to create management zones for the field. A graduate student from UPEI measured greenhouse gas emissions using a LiCOR instrument in the fall of 2023 according to management zone. Soil samples were taken again on April 30th prior to potato planting. The cover crop was fully winter killed.

Potatoes (Ranger Russet variety) were planted on May 22nd. UPEI continued to measure GHG emissions throughout the growing season and following. Immediately before the field was harvested, ten-foot yield samples were collected on October 2nd, with six samples collected in each of the cover and non-cover treatment areas. Sampling locations were chosen close to previous soil sampling locations in an effort to ensure similar background soil characteristics between treatment and control. These samples were placed in storage until November, when they were graded at Cavendish Farms Central Grading. The 2024 fall cover crop (spring barley) was broadcast in the treatment area ahead of harvest and incorporated by harvest equipment. Following harvest, soil nitrate data was collected in late November in each treatment area. In addition, percent ground cover was estimated using photography and image processing.

Table 6: HTP selected soil chemistry characteristic before and after 2023 cover crop establishment.

Treatment	Cover				No Cover (Control)			
	P ₂ O ₅ ppm	K ₂ O ppm	OM %	pH	P ₂ O ₅ ppm	K ₂ O ppm	OM %	pH
Summer 2023	779.8	109.6	2.9	6.4	768.0	77.3	2.8	6.4
Spring 2024	606.3	185.3	2.9	6.2	725.0	200.2	2.6	6.7
Difference	-173.5	+75.7	0.0	-0.2	-43.0	+122.9	-0.2	+0.3

Table 7: HTP potato yield and quality measurements.

Treatment	Total Yield	Smalls	>10 oz.	Total Defects	M. Yield	Payout
	cwt/ac	%			cwt/ac	\$/ac
Cover	285	10.8	3.6	19.8	197.0	3563
Check	309	11.5	1.5	18.2	217.9	3917
Difference	-24	-0.7	2.1	1.6	-20.9	-354
p value	0.16	0.77	0.74	0.86	0.50	0.51

Table 8: Soil nitrate samples taken on April 30, October 10 and November 21, 2024. Values listed as under 5 ppm were assumed to be 5 ppm.

Depth	Spring		Fall (Oct.)		Fall (Nov.)	
	Cover	Check	Cover	Check	Cover	Check
0-15	5.3	5.2	19.1	22.4	5.2	5.0
15-30	5.0	5.1	12.4	12.4	7.0	9.6
30-45	N/A				10.5	12.9

Table 9: HTP percent green ground cover in fall cover treatment area. Data provided by Soyeon Shim, UPEI

Date	Percent Green Cover
	%
October 26	5.2
November 26	23.1

Table 10: HTP Biomass measurements collected November 21, 2024

Treatment	Dry Matter	Dry Matter	Nitrogen
	g/0.25 m ²	kg/ha	
Cover	40.5	1619.3	17.1

Key Points from HTP Trial thus far:

- There are some observed differences in soil OM and pH between treatments from fall to spring; however, it is unlikely that this can be attributed to the cover crop, as the amount of cover crop present in 2023 was very minimal.
- There was no significant difference in yield or quality between the two treatments in the 2024 potato crop. Again, due to the minimal growth of the cover in 2023, this was expected. As well, variability in common scab incidence in this field is likely to have impacted yield and quality metrics.
- There was not much difference in soil nitrate concentrations between the two treatments at any time or depth in 2024.
- The percentage of green cover increased considerably between the 1st and 2nd assessment date.
- The total biomass was less for the HTP field than the IH field, however, the IH field was harvested first and the cover had more time to grow.

Mooney Farms (MNY):

Mooney Farms joined the trial this year with a field near Souris, PEI. For the purposes of the trial, the field was split into three sections. Immediately prior to potato harvest, the south side was planted with fall rye, and the north side of the field was planted with spring barley, leaving a middle strip in the field with no cover crop established.

These cover crops were spread before harvest by drone on September 30th at a rate of 100 lbs per acre. As the field was harvested, the seed was incorporated into the soil. Due to a lack of germination and coverage, some barley was again spread after harvest (via Bogballe spreader) across both cover crop sections on October 10th at a rate of 150 lbs per acre. However, as this seed was not incorporated and it was broadcast late, very little if any of this seed successfully germinated.

Nitrate soil samples were collected in each treatment area on November 21st, along with photos of each cover crop treatment (for percent green cover) and biomass samples in each treatment area.

Table 11: Soil chemistry and soil health sample results taken on October 18th.

Treatment	P ₂ O ₅	K ₂ O	OM	pH	Active C	Soil Respiration	Aggregate Stability	BNA
	ppm	ppm	%		µg/g	mg/g	%	mg/kg
Check	351.5	157.8	2.5	6.0	404.3	0.38	47.8	20.3
Rye	274.5	211.3	2.5	6.0	379.3	0.39	41.9	21.5
Barley	306.0	173.0	2.9	6.4	449.5	0.51	50.6	24.5

Table 12: MNY percent green ground cover in fall cover treatment area.

Date	Fall Rye	Spring Barley
	%	
October 18	0.2	0.3
November 21	8.6	6.8

Table 13: MNY Biomass measurements collected November 21, 2024

Treatment	Dry Matter	Dry Matter	Nitrogen
	g/0.25 m ²	kg/ha	
Barley	11.2	448.2	5.9
Rye	12.4	497.0	6.7

Table 14: Post harvest nitrate soil samples taken on November 21st at two different depths. Values listed as under 5 ppm were assumed to be 5 ppm.

	Depth	BAR	RYE	CHK
Nitrates (ppm)	0-6 in.	5.04	6.96	5.00
	6-12 in.	7.73	12.15	5.24

Key Points from MNY Trial thus far:

- Percent green cover and accumulated biomass was low for both cover crop treatments. This was the first time the grower was experimenting with seeding using a drone. There were some areas of the field with decent emergence, but there was next to no cover crop emerged in the compacted truck tracks in this relatively small field.

- Nitrate levels were higher in the fall rye treatment than the other two. We would have expected these numbers to be the inverse, given that the cover crop would uptake free nitrate. However, excessive rains in November 2024 may have already leached out most free soil nitrate, and the soil nitrate detected may include what has been taken up by the cover crop.