AIM Trial Report: Quantifying Nitrogen Credits from Forage Legumes - Impact of Reduced Nitrogen on Potato Yield and Quality
Working Group: Soil Improvement (ACS Living Labs)
Crop Year: 2024
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Published: March 17th, 2025

Project Rationale:

Currently, most potato acres grown in Prince Edward Island are preceded with a forage crop, often with one or more legume species included in a mix. Historically, double-cut red clover has been a popular choice; however, usage of alfalfa has grown significantly in recent years. A popular reason for including forage legumes in rotation ahead of potatoes is their ability to fix atmospheric nitrogen through the action of beneficial root-colonizing bacteria, providing a nitrogen credit to next year's crop.

In talking with several PEI potato growers, there is a large diversity of opinion on how to account for nitrogen credits in nutrient management for potatoes. Likewise, published guides and recommendations from multiple Eastern Canadian sources differ greatly.

Over-application of nitrogen can have a negative impact on both potato yield and quality. Potato plants can delay tuberization in the presence of excess soil nitrate availability. In a relatively short growing season like on PEI, this can reduce yield, size profile, and specific gravity. In addition, over-use of nitrogen can result in nitrate leaching to groundwater and nitrous oxide off-gassing to the atmosphere, both of which are environmental concerns. At the same time, it is important that the potato crop has sufficient nitrogen to achieve optimum yield and quality.

In past Living Labs research, increased potato yields and decreased soil nitrate levels following the use of fall cover crops ahead of potatoes have been observed. It is thought that these fall covers crops are scavenging free soil nitrate that might otherwise be lost without a living crop, subsequently carrying over some of this nitrogen to be available to the next crop. No work has been done in PEI to quantify how much nitrogen can be carried over by a winter-terminated fall cover crop ahead of potatoes.

In this project, the Board is working with Agriculture & Agri-Food Canada and the PEI Department of Agriculture to quantify the nitrogen contributed by forage legumes in the year before potatoes, both with and without the use of a winter-terminated fall cover crop.

Project Overview

Four fields were contributed to this trial by participating producers:

A: Wallace Properties (WP) in Fortune Cove.

- 6 acre field planted to 80% alfalfa/20% timothy in 2022 (underseeded under barley).
- Terminated with glyphosate on August 25th, 2023.

- Seeded with tillage radish on September 1st, 2023, at 10 lbs/acre seeding rate.
- "No Cover Crop" control treatment sprayed with glyphosate on September 20th, 2023.

B: Oyster Cove Farms (OCF) in Hamilton.

- 16 acre field planted to 60% alfalfa, 20% white clover/alsike clover and 20% grass species in 2022 (underseeded under barley).
- Terminated with glyphosate on August 10th, 2023.
- Seeded with spring barley on September 1st, 2023 at 120 lbs/acre seeding rate on majority of field.

C: Spring Valley Farms (SVF) in Spring Valley.

- 20 acre field planted to 100% alfalfa in 2022.
- Terminated with glyphosate in early August 2023.
- Seeded the first week of September 2023 at 150 lbs/acre of barley and 12 lbs of tillage radish on majority of field.
- Manure (pen-pack beef manure, stored in the field) was spread after baseline soil sampling but before the cover crop was established in the fall of 2023.

D: Mull Na Bienne Farms (MNB) in Grahams Road.

- 17 acre field planted to 80% alfalfa and 20% timothy in 2022 (underseeded under barley).
- Terminated with glyphosate on September 1st, 2023.
- Seeded with spring barley (broadcast) on September 15th, 2023 at 175 lbs/acre seeding rate on majority of field.

Baseline soil sampling for soil chemistry and biological nitrogen availability was conducted in August 2023 before establishment of the cover crop. Six georeferenced sampling locations were established in each treatment (cover crop and no cover crop) and fields were flagged for the growers to indicate where no cover crop strip was to be located. The same points were then soil sampled in spring 2024 prior to potato planting. The control treatment was placed across the width of the field perpendicular to the direction of potato planting so that each nitrogen rate strip would include both cover and no cover treatments.

A fertility plan was developed in partnership with each farm. Each field would have the following nitrogen application treatments:

GSP	Grower standard practice applied N rate. 160 lbs/ac for WP, SVF & MNB, 180 lbs/ac for OCF. Split evenly between planter blend (50%) and either pre-plant (Super U at WP/MNB/OCF) or top-dress at hilling (Urea at SVF).
75%	75% of GSP nitrogen. 120 lbs/ac for WP/SVF/MNB, 135 lbs/ac for OCF. Two-thirds from planter blend (80-90 lbs/ac), one third from pre-plant or top-dress
50%	50% of GSP nitrogen. 80 lbs/ac for WP/SVF/MNB, 90 lbs/ac for OCF. All from planter blend.
Zero N	No applied nitrogen in plot area 12 rows wide by 100 feet long. P, K, and other nutrients hand-applied at comparable rate to planter blend immediately before planting.

On August 19th and 26th plant and tuber samples were collected for each treatment combination to be used for total nitrogen accumulation. Samples were collected during the bulking phase after the plant had achieved peak above ground growth. Three replicates of three plants each were collected in each treatment combination (N rate x cover crop).

Prior to commercial harvest, tuber samples were collected from each treatment combination area. Four ten-foot strips were collected, stored at 10 C° at AAFC storage facilities and then graded at Cavendish Farms Central Grading on November 14th. Hundredweight per acre was calculated by multiplying pounds per 10 feet by a factor of 13.

WP – Dakota Russet:

Soil Samples prior to cover crop establishment: August 2023

Treatment	OM	pH	P_2O_5	K_2O	Active C	Soil Respiration	Aggregate Stability	BNA
	%		ppm	ppm	µg/g	mg/g	%	mg/kg
Cover	2.8	6.1	450.3	206.0	383.8	0.48	69.6	12.8
Check	2.7	6.1	424.5	177.2	367.2	0.40	67.6	11.8
Difference	0.1	0	25.8	28.8	16.6	0.08	2.0	1.0

Soil Nitrate Testing: May 2, 2024

	NO_3 (mg/kg)		pH
	0-6 in	6-12 in	
Cover	12.5	9.8	5.7
Check	10.7	8.7	5.8
Difference	1.8	1.1	-0.1

From these test results, we see that there was very little background difference in soil characteristics or fertility between the cover and check treatments at cover crop establishment. Soil nitrates were marginally higher in the cover treatment than the prior to potato planting, but this was not statistically significant.

WP Yield by Nitrogen Rate for 2024:

	GSP N	75% N	50% N	Zero N
Total Yield (cwt/ac)	244.6	234.3	221.7	156.3
Smalls (%)	15.7	13.0	13.8	15.3
> 10 oz (%)	2.3	3.2	2.0	1.9
Total Defects (%)	0.7	0.8	0.8	0.2
Specific Gravity	1.094 a	1.095 a	1.094 a	1.087 b
Market. Yield (cwt/ac)	205.3 a	202.7 a	189.8 a	132 b
Crop Value ($/ac)	3624 a	3586 a	3350 a	2300 b

Interestingly, there was no trend evident of the effect of N rate on the percentage of smalls or percent 10 ounce potatoes, and total defect rates were low. Specific gravity was significantly lower for the Zero N treatment than for the other three treatments. Marketable yield and crop value was also significantly lower for the Zero N treatment than for the other three treatments, which was to be expected. There was no statistical difference between the marketable yields or crop value across the GSP, 75% and 50% treatments. It is likely that potential differences may have been masked by severe drought in this field, which did not receive much appreciable rainfall after late July and visibly suffered through August and September.

WP Yield Samples for 2024: Comparing Cover Crop with No Cover Crop (Check):

	With Fall Cover Crop					**No Cover Crop**			
	GSP N	**75% N**	**50% N**	**Zero N**		**GSP N**	**75% N**	**50% N**	**Zero N**
Total Yield (cwt/ac)	243.4	220.1	221.3	172.3		245.5	248.3	222.2	140.1
Smalls (%)	13.3	13.0	14.7	15.8		18.0	13.0	12.8	14.7
> 10 oz (%)	2.0	2.8	2.0	1.0		2.5	3.5	2.0	2.8
Total Defects (%)	1.3	1.0	0.5	0.0		0.0	0.5	1.0	0.3
Specific Gravity	1.095	1.094	1.095	1.089		1.092	1.095	1.092	1.085
Market. Yield (cwt/ac)	208.4	189.6	187.0	144.8		202.1	215.7	192.5	119.2
Crop Value ($/ac)	3661	3352	3299	2534		3586	3820	3400	2066

When comparing Cover Crop with No Cover Crop (Check) for each fertilizer rate, there only appeared to be an improvement in yield for the Zero N rate. It may be that the nitrogen carried over by the cover crop was surplus to the crop's ability to uptake it in the other treatments.

In terms of kg/ha of nitrogen taken up by plants in the Zero N plot, it was 66 kg/ha (59 lbs/ac) in the no cover treatment and 53 kg/ha (47 lbs/ac) in the cover treatment. This is the opposite to what would have been expected and may indicate some sampling error or the impact of variability.

Post-Harvest Soil Nitrates: September 20

	Soil Nitrates (ppm) - Cover		**Soil Nitrates (ppm) - Check**	
	0-6 in	**6-12 in**	**0-6 in**	**6-12 in**
Zero N	5.8	6.8	6.6	9.7
50%	13.4	19.6	6.6	10.4
75%	14.7	30.8	10.3	17.7
GSP	24.1	30.9	18.7	27.6

Unsurprisingly, soil nitrate levels gradually increased across both depths as applied nitrogen increased. The exception to this was in the 50% rate in the check treatment, which had largely the same nitrate levels as in the Zero N treatment.

Summary notes for WP field:

- This trial was significantly impacted by drought.
- There was no significant difference in marketable yield or specific gravity between the GSP, 75% and 50% treatments.
- Residual nitrate levels indicate that all the fertilizer treatments provided N in excess of plant needs; however, this is also tied to the reduction in yield and reduction in N uptake due to low soil moisture.

MNB – Ranger Russet:

Soil Tests prior to cover crop establishment: August 2023

Treatment	OM	pH	P_2O_5	K_2O	Active C	Soil Respiration	Aggregate Stability	BNA
	%		ppm	ppm	µg/g	mg/g	%	mg/kg
Cover	2.6	6.5	468.3	68.5	418.5	0.55	63.2	31.6
Check	2.3	6.3	458.8	56.3	383.0	0.57	76.5	24.6
Difference	0.3	0.2	9.5	12.2	35.5	-0.02	-13.3	7.0

While efforts were made to choose representative areas of the field when choosing sampling points, based on recently developed SWAT maps of the field, there does appear to be slightly better organic matter, pH, and BNA levels in the cover crop treatment area. Aggregate stability averages are quite high for a potato field (according to the PEI Soil Lab scoring function). High BNA levels are likely to reflect a history of manure use in the field.

Soil Nitrates: November 2023

Treatment	Soil Nitrate (ppm) by Sampling Depth (in.)		
	0-6 in	6-12 in	12-18 in
Cover	7.3	5.1	5.3
Check	10.0	11.2	14.8
Difference	-0.7	-6.1	-9.5

There was a noticeable reduction in soil nitrate levels in the cover crop treatment than in the no cover check, particularly at the 6-12 and 12-18 inch depths.

Spring Soil Sampling: April 29

	NO_3 (mg/kg)		pH
	0-6 in	6-12 in	
Cover	33.4	32.9	5.7
Check	20.0	13.9	6.0
Difference	13.4	19.0	-0.3

Nitrate levels were noticeably higher at both depths for the cover crop sampling locations compared with the check. This would reflect residual nitrate carried over by decomposition of the 2023 cover crop.

MNB Yield by Nitrogen Rate for 2024:

	GSP N	75% N	50% N	Zero N
Total Yield (cwt/ac)	309.7	278.9	272.9	248.4
Smalls (%)	17.3	17.8	20.5	19.7
> 10 oz (%)	3.0	4.0	3.0	0.4
Total Defects (%)	2.6	5.7	12.3	17.5
Specific Gravity	1.097	1.093	1.093	1.093
Market. Yield (cwt/ac)	250.5 a	213.8 ab	190.2 b	156.7 b
Crop Value ($/ac)	4457 a	3813 ab	3397 b	2794 b

Both the 50% and Zero N treatments in this trial had much higher levels of tuber defects (primarily scab damage) than the GSP and 75% treatments; as a result, this may have had a confounding impact on marketable yield. The percentage of smalls and 10 ounce tubers was relatively consistent across all N rates. Marketable yield was highest in the GSP N rate, with each N rate having sequentially lower yields; however, the 75% N rate was not statistically significant from the GSP, 50% and Zero N rates.

MNB Yield Samples for 2024: Comparing Cover Crop with No Cover Crop (Check):

	With Fall Cover Crop					No Cover Crop			
	GSP N	**75% N**	**50% N**	**Zero N**		**GSP N**	**75% N**	**50% N**	**Zero N**
Total Yield (cwt/ac)	315.0	269.7	240.0	263.9		304.4	288.0	305.7	232.8
Smalls (%)	17.7	17.7	22.0	21.3		16.8	18.2	19.0	18.0
> 10 oz (%)	2.2	3.0	0.7	0.0		3.7	5.0	5.2	0.7
Total Defects (%)	4.5	6.8	21.0	22.0		0.7	4.5	3.5	13.0
Specific Gravity	1.097	1.090	1.091	1.093		1.096	1.095	1.095	1.092
Market. Yield (cwt/ac)	247.7	204.8	143.1	153.6		253.2	222.8	237.2	159.8
Crop Value ($/ac)	4403	3641	2550	2747		4510	3985	4244	2841

The effect of the fall cover crop on yield and quality was far from consistent in this field. While there appears to be a slight increase in total yield due to the cover crop in the Zero N rate, changes in total defects and percent smalls erase that difference for marketable yield. Surprisingly, the check (no cover crop) had higher yields than the cover crop treatment for both the 75% and 50% N rates.

In terms of nitrogen taken up by plants in the Zero N plot, it was 104 kg/ha (93 lbs/ac) in the cover treatment and 107 kg/ha (95 lbs/ac) in the no cover treatment. This is equal to 0.35 lbs/cwt of total yield for the cover crop treatment and 0.41 lbs/cwt for the no cover check.

MNB Post-Harvest Nitrate Sampling: October 3

	Soil Nitrates (ppm) in Cover		Soil Nitrates (ppm) in Check	
	0-6 in	**6-12 in**	**0-6 in**	**6-12 in**
0	9.8	10.0	5.4	5.6
50	24.3	25.8	13.4	11.6
75	28.0	26.3	14.9	13.0
GSP	26.1	23.8	20.9	24.0

Levels of residual soil nitrates was generally higher in the cover crop treatment than in the no cover check across all N treatments. There was not much difference in residual soil nitrate between the three applied N treatments (50%, 75%, GSP). This may indicate that the higher yields removed at the increasing applied N rates equalized the amount of residual nitrate left over. However, all of these residual nitrate amounts are considerable.

Summary notes for MNB field:

- This trial was impacted by drought but not by the same degree as the WP field.
- Variability in common scab amounts may have had a confounding effect on marketable yield data.
- The highest yield was observed in the GSP N rate.
- Residual nitrate levels indicate that all the fertilizer treatments provided N in excess of plant needs.
- There were inconsistencies in the response to the use of a cover crop in terms of crop yield; however, soil nitrate levels were generally higher in both the spring and the fall following use of a cover crop.

OCF – Mountain Gem Russet

Soil Samples at the time of cover crop establishment (August 2023):

Treatment	**OM**	**pH**	**P_2O_5**	**K_2O**	**Active C**	**Soil Respiration**	**Aggregate Stability**	**BNA**
	%		**ppm**	**ppm**	**µg/g**	**mg/g**	**%**	**mg/kg**
Cover	2.6	6.7	433.0	75.8	422.5	0.63	48.6	29.3
Check	2.7	6.8	400.5	80.8	438.3	0.64	52.7	29.6
Difference	-0.1	-0.1	32.5	-5.0	-15.8	-0.01	-4.1	-0.3

There was very little difference observed in soil OM, pH, or soil health metrics between the cover crop and check treatments at the time of cover crop establishment.

OCF: Soil Nitrate (ppm) in November 2023.

Treatment	Sampling Depth (in.)		
	0-6	**6-12**	**12-18**
Cover	8.4	6.4	6.5
Check	14.7	21.1	25.2
Difference	-6.3	-14.7	-18.7

Soil nitrate levels were significantly lower in the cover crop treatment than in the no cover check treatment at all three sampling depths. This indicates that a substantial cover crop biomass was able to take up soil nitrate rather than being lost to the environment.

OCF: Soil Nitrate (ppm) on April 29, prior to potato planting.

	NO_3 (mg/kg)		pH
	0-6 in	**6-12 in**	
Cover	15.8	17.3	6.5
Check	19.1	9.8	6.6
Difference	-3.3	7.5	-0.1

Interestingly, soil nitrate levels were slightly lower at 0-6 inches in the cover crop treatment in the spring, indicating that much of the nitrate taken up by the cover crop was either lost or had not yet mineralized in the soil. Nitrate levels were higher in the 6-12 inch depth, which was expected; however, levels were lower than observed in the MNB field.

OCF Yield by Nitrogen Rate for 2024:

	GSP N	**75% N**	**50% N**	**Zero N**
Total Yield (cwt/ac)	261.5	274.3	283.5	239.7
Smalls (%)	12.5	10.4	14.2	11.4
> 10 oz (%)	7.8	8.3	9.7	3.2
Total Defects (%)	0.75	1.8	0.2	0.5
Specific Gravity	1.106 b	1.106 b	1.110 a	1.107 b
Market. Yield (cwt/ac)	227.1 ab	241.8 a	243.4 a	211.1 b
Crop Value ($/ac)	4067 a	4307 a	4328 a	3721 b

Bearing in mind that applied N rates were slightly higher in this trial than in the other three trials, the highest marketable yields were achieved in the 75% (135 lbs/ac N) and the 50% (90 lbs/ac N) treatments. At the GSP rate (180 lbs/ac N), there appeared to be some level of yield suppression due to excess N. A considerable yield of 240 cwt/ac was achieved with no applied N. Percent smalls and total defects were similar across all treatments, with percent 10 ounce lower in the Zero N treatment compared to the three applied N treatments.

OCF Yield Samples for 2024: Comparing Cover Crop with No Cover Crop (Check):

	With Fall Cover Crop					No Cover Crop			
	GSP N	**75% N**	**50% N**	**Zero N**		**GSP N**	**75% N**	**50% N**	**Zero N**
Total Yield (cwt/ac)	253.9	277.2	283.2	269.8		269.0	271.3	283.9	209.5
Smalls (%)	13.5	9.5	14.3	11.8		11.5	11.3	14.0	11.0
> 10 oz (%)	9.0	12.2	4.5	3.3		6.5	4.3	5.2	3.0
Total Defects (%)	1.5	2.5	0.0	0.7		0.0	1.0	0.3	0.3
Specific Gravity	1.105	1.105	1.110	1.107		1.106	1.107	1.109	1.107
Market. Yield (cwt/ac)	217.0	246.4	242.8	236.0		237.2	237.2	244.0	186.1
Crop Value ($/ac)	3905	4419	4319	4164		4228	4195	4336	3278

While there was negligible yield or quality difference between cover crop and the check for the applied N treatments, there was a 60 cwt/ac increase in total yield in the Zero N plot between the cover crop and check. It may be that the cover crop provided additional nitrogen mineralization that was needed where no additional nitrogen was applied, but under the three applied N treatments this additional nitrogen was excess to plant uptake ability.

In terms of nitrogen taken up by plants in the Zero N plot, it was 120 kg/ha (107 lbs/ac) in both the cover treatment and the no cover treatment at the time of plant and tuber collection. This equates to 0.40 lbs/cwt in the cover crop and 0.51 lbs/cwt in the no cover crop treatment. The plants in the no cover crop treatment were at a later stage of senescence, which may explain some of the difference in nitrogen uptake per cwt.

OCF: Post-harvest soil nitrates (ppm) on September 23

	Soil Nitrates (ppm) in Cover		Soil Nitrates (ppm) in Check	
	0-6 in	**6-12 in**	**0-6 in**	**6-12 in**
0	6.6	6.6	7.1	8.1
50	10.3	13.1	10.2	9.5
75	11.1	12.9	9.9	10.4
GSP	15.1	18.8	9.2	11.2

There only appears to be a noticeable difference between the cover and check treatments at the GSP rate of N. There were more residual nitrates in the GSP rate treatment area than in the 50% and 75% rate treatment areas, reflecting a higher rate of applied N as well as smaller total yield (and N removal).

Summary notes for OCF field:

- This trial was impacted by drought but not by the same degree as the WP field. Tuber bulking in September was only incremental compared to yields found in late August.
- Marketable yield was very similar in the 50% and 75% N rate treatments, and these were significantly higher than the yield in the Zero N plot. While the GSP rate was statistically

similar to the other two applied N rates, there was a definite trend toward reduced yield, possibly due to over application of N.

- Residual nitrate levels were lower in the OCF than in the MNB field, despite slightly higher applied N rates and a similar range of potato yields. This may be reflective of the difference in the preceding forage mix (80% alfalfa in the MNB field, 60% alfalfa in the OCF field).
- The cover crop only appeared to provide a yield response in the Zero N plot.

SVF – Payette Russet

Soil Sampling: August 2023 before cover crop establishment.

Treatment	OM	pH	P_2O_5	K_2O	Active C	Soil Respiration	Aggregate Stability	BNA
	%		ppm	ppm	µg/g	mg/g	%	mg/kg
Cover	2.1	6.5	631.2	206.3	363.5	0.42	54.9	19.5
Check	2.2	6.5	674.2	206.8	387.7	0.41	57.5	19.2
Difference	-0.1	0	-43.0	-0.5	-24.2	0.01	-2.6	0.3

Soil chemistry and health variables were largely consistent between the cover and check treatments prior to cover crop establishment in this field. This field had the lowest averages for soil organic matter, but had higher BNA values than the WP field (which had higher soil OM means).

SVF Soil Nitrates (ppm) in November 2023:

Treatment	Sampling Depth (in.)		
	0-6	6-12	12-18
Cover	5.1	5.0	5.0
Check	8.7	8.8	13.8
Difference	-3.6	-3.8	-8.8

Similarly to the other fields in this trial, there were lower soil nitrates detected in the cover crop treatment compared with the check, indicating an ability of the cover crop to uptake free soil nitrate. It should be noted that the lower limit for sensitivity for the soil nitrate test from the PEI Analytical Lab is 5.0 ppm; therefore, any results recorded as "< 5 ppm" were recorded as 5.0 ppm for the purposes of this study.

SVF Spring Soil Nitrate (ppm): April 29

	NO_3 (mg/kg)		pH
	0-6 in	6-12 in	
Cover	33.9	21.3	6.4
Check	23.2	14.7	6.4
Difference	10.7	6.6	0

Very similarly to results from the MNB field, soil nitrates were approximately 50% higher in the cover treatment compared to the check, reflecting mineralization of N from the winter-killed cover crop.

SVF Yield by Nitrogen Rate for 2024:

	GSP N	75% N	50% N	Zero N
Total Yield (cwt/ac)	303.3	302.5	315.0	240.9
Smalls (%)	9.4	9.5	10.3	15.1
> 10 oz (%)	11.3	9.5	6.8	6.1
Total Defects (%)	0.25	0.5	0.9	0.75
Specific Gravity	1.096	1.096	1.098	1.098
Market. Yield (cwt/ac)	274.1 a	274.1 a	281.0 a	203.3 b
Crop Value ($/ac)	4900 a	4882 a	4982 a	3632 b

There was no difference in yield, percentage of smalls or crop value between the three applied N rates. In fact, the highest numerical yield was found in the 50% N rate treatment. The GSP rate treatment appeared to produce a slightly better percentage of 10 ounce potatoes, but this was not reflected in a difference in crop value. 241 cwt of total yield was produced with no applied N, which was higher than expected by the project team.

SVF Yield Samples for 2024: Comparing Cover Crop with No Cover Crop (Check):

	With Fall Cover Crop					No Cover Crop			
	GSP N	**75% N**	**50% N**	**Zero N**		**GSP N**	**75% N**	**50% N**	**Zero N**
Total Yield (cwt/ac)	310.2	302.5	364.5	275.4		296.4	302.4	265.4	206.5
Smalls (%)	8.3	9.5	8.5	12.2		10.5	9.5	12.0	18.0
> 10 oz (%)	13.0	11.5	10.8	11.5		9.5	7.5	2.8	0.7
Total Defects (%)	0.0	0.0	0.5	1.5		0.5	1.0	1.3	0.0
Specific Gravity	1.095	1.095	1.098	1.099		1.096	1.097	1.098	1.097
Market. Yield (cwt/ac)	284.1	274.5	331.8	237.5		264.1	273.7	230.2	169.1
Crop Value ($/ac)	5090	4915	5910	4276		4709	4848	4053	2987

This field was the only field in the trial where the cover crop provided a statistically significant yield improvement over the no cover crop check. This appears to be primarily evident in the 50% N rate and Zero N treatments. In fact, there was a 100 cwt/ac increase in total and marketable yield between the cover crop and check treatments in the 50% N rate, and a close to 70 cwt/ac increase in the Zero N rate.

In terms of nitrogen taken up by plants in the Zero N plot, it was 127 kg/ha (113 lbs/ac) in both the cover treatment and 100 kg/ha (89 lbs/ac) in the no cover check treatment. This equates to 0.41 lbs N/cwt of total yield in the cover treatment and 0.43 lbs N/cwt of total yield in the check treatment.

SVF Post-Harvest Soil Nitrates: October 7

	Soil Nitrates (ppm) in Cover		Soil Nitrates (ppm) in Check	
	0-6 in	**6-12 in**	**0-6 in**	**6-12 in**
0	13.9	11.3	13.3	13.1
50	16.5	13.9	26.6	23.8
75	36.1	44.4	33.0	40.6
GSP	27.7	28.8	31.5	27.0

Residual soil nitrates were similar between cover and check treatments in each of the N rate treatments except for the 50% N rate. This may reflect the significant increase in yield in this treatment. Residual soil nitrates in the 75% and GSP N rate treatment areas indicate applied N in excess of plant demands.

Summary notes for SVF field:

- This trial had the highest observed yields among 2024 trial fields. While the Payette Russet variety has high yield potential (similar to Mountain Gem), this variety is comparatively later to emerge, reach tuber initiation, and finish bulking. A dry end to the growing season is likely to have limited total yields.
- This field showed the greatest difference in yield between cover and no cover crop (up to 100 cwt/ac increase).
- There was no difference in yield or crop value between the three applied N treatments. The combination of yield results and residual nitrates indicates that N in excess of plant needs was applied in the 75% and GSP N rate treatments.
- This field had a 100% alfalfa preceding forage crop as well application of beef manure in fall 2023, which may have compensated for the lower starting soil organic matter in this field.

Combined Results:

Potato Yield and Quality by Nitrogen Rate Treatment in 2024, averaged over 4 trial fields.

	GSP N	**75% N**	**50% N**	**Zero N**
Total Yield (cwt/ac)	279.8	272.5	273.3	221.3
Smalls (%)	13.7	12.7	14.7	15.3
> 10 oz (%)	6.1	6.3	4.2	2.9
Total Defects (%)	2.1	2.2	3.5	4.8
Specific Gravity	1.098	1.097	1.099	1.096
Market. Yield (cwt/ac)	239.3 a	233.1 a	226.1 a	175.8 b
Crop Value ($/ac)	4262 a	4147 a	4014 a	3112 b

When comparing values across all four fields, there was no difference in yield, specific gravity or crop value between the three applied N treatments. As expected, yield and size profile were smaller for the Zero N applied treatment; however, the amount of yield achieved with no applied N

was somewhat surprising. Three of the four fields each had approximately 240 cwt/acre of total yield in the Zero N plot, with only the drought-afflicted WP field having substantially lower yields.

Combined Yield Samples for 2024: Comparing Cover Crop with No Cover Crop (Check):

	With Fall Cover Crop					No Cover Crop			
	GSP N	**75% N**	**50% N**	**Zero N**		**GSP N**	**75% N**	**50% N**	**Zero N**
Total Yield (cwt/ac)	280.7	267.4	277.3	245.3		278.8	277.5	269.3	197.2
Smalls (%)	13.2	12.4	14.9	15.2		14.2	13.0	14.4	15.4
> 10 oz (%)	6.6	7.4	4.5	3.9		5.6	5.1	3.8	1.8
Total Defects (%)	1.8	2.6	5.5	6.1		0.3	1.8	1.5	3.4
Specific Gravity	1.098	1.096	1.099	1.097		1.097	1.098	1.099	1.095
Market. Yield (cwt/ac)	239.3	228.8	226.2	193.0		239.2	237.4	226.0	158.5
Crop Value ($/ac)	4265	4082	4020	3430		4258	4212	4008	2793

For the three applied N treatments, there was no demonstrated increase in yield or quality following a cover crop compared with the no cover check treatment. The only obvious difference was for the Zero N treatment, where nitrogen was limited, and nitrogen carryover had more effect on yield.

Combined Post-Harvest Soil Nitrates:

	Soil Nitrates (ppm) in Cover		Soil Nitrates (ppm) in Check	
	0-6 in	**6-12 in**	**0-6 in**	**6-12 in**
Zero N	9.0	8.7	8.1	9.1
50%	16.1	18.1	14.2	13.8
75%	22.5	28.6	17.0	20.4
GSP	23.3	25.6	20.1	22.5

The residual nitrate levels indicate that as applied N rate increases, post-harvest soil nitrate level also increases. Given that we did not observe much difference in yield between the three applied N rates, less nitrogen was removed from the field in exported yield. There is a slight trend toward higher soil nitrate in the cover crop treatments than in the check treatments, but this did not appear to influence yields. There was no difference in residual nitrates between cover and check for the Zero N rate treatment, reflecting that yields were higher in the cover treatments in the Zero N plot.

Key Findings

- Across four fields in 2024, 221 cwt/ac of total yield and 176 cwt/ac of marketable yield was achieved with no applied nitrogen. Total yield was remarkably consistent (~240 cwt/ac) in three out of four fields.
- In the three field less impacted by drought, the combination of an alfalfa legume crop (terminated in the late summer) plus mineralization from organic matter provided more than 90 lbs/ac of nitrogen when looking at the uptake from the Zero N plots.

- The use of a cover crop only appeared to improve total and marketable yield in the Zero N treatment compared with the no cover check. In three of the four fields, there was no increased yield in the cover crop area in the three applied N treatments. This indicates that these plants had sufficient nitrogen available without mineralized nitrogen from the cover crop residue, particularly given the dry conditions of the year and relatively suppressed yields.
- Residual soil nitrates post-harvest appears to confirm the trend evident from the yield data.
- Additional fields will be added over the next couple of years to build on this data in order to make recommendations to producers expected N credits from legumes, expected N credits from cover crops, and optimum applied N rates for processing potatoes with these credits in mind.
- More data analysis is necessary to calculate total N balance, N use efficiency, and N credits as they relate to biological nitrogen availability (BNA).

Acknowledgements:

Thank you to:

- Dr. Judith Nyiraneza, Danielle Murnaghan, and the rest of the team at AAFC Charlottetown for their significant efforts in data collection and analysis.
- Bethany Visser, Humna Khan, and Morgan MacNeil for assistance in data collection and trial management.
- The participating farms: Wallace Properties, Mull Na Bienne Farms, Spring Valley Farms and Oyster Cove Farms
- Additional field assistance from the East Prince Agri-Environment Association, PEI Department of Agriculture, and Kensington North Watershed Association.