

AIM Research Trial Report: **Comparison of Early Manure Application vs Late Manure Application**
 Working Group: Soil Improvement
 Crop Year: 2022
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Project Rationale:

For many potato producers, it is standard practice to apply solid manure in the late fall directly ahead of moldboard ploughing. Conventional wisdom is that this would conserve nutrients (especially nitrogen) in the manure while incorporating manure sufficiently ahead of food safety application deadlines. In recent years, there has been an increased use of alternative tillage implements (Lemken, Synkro, etc) at an earlier time in the year (late summer or early fall). In addition, there is interest in determining whether solid manures applied on a living crop would have the potential to conserve nitrogen and other nutrients while also reducing the need for late season tillage.

Project Overview:

Following discussions with Troy and Luke Rennie of Dock Corner Farms about manure management and potential alternations to manure application timing, a simple trial was devised to compare early manure application (early September) compared with late manure application (late Oct/early Nov) before ploughing, which is standard practice for this farm. Two fields were used for this trial: a 20 acre field in Montrose (denoted MT) and a 16 acre field in Mill River East (denoted MR).

Montrose Field:

On this field, glyphosate was applied to the majority of the field on August 25th, 2021. No glyphosate was applied to a small strip on the north edge of the field and left green. The preceding crop was a mix of alfalfa, red clover and timothy. On the strip that was left green, solid beef manure was applied at a rate of 8 MT/acre on September 6th. Manure was then applied on the remainder of the field at the same rate in late October immediately before the entire field was moldboard ploughed.

Soil samples were collected on September 9th, 2021 and then immediately before potatoes were planted in mid-May 2022. Samples for both soil nutrients and soil health were collected. Four soil samples were taken from the non-manure applied part of the field next to the treatment area of the field at specific GPS coordinates in September 2021, and these same points were revisited for both the May soil sampling and the potato yield sampling in September 2022. Four additional points were sampled in the treatment area in May, with the same points used for potato yield sampling in September. Baseline fertility from soil tests in September 2021 for this field were:

			ppm							
	OM %	pH	P ₂ O ₅	K ₂ O	Mg	Ca	S	Zn	B	CEC
Sept 2021	1.6	5.6	853	69	68	739	18	3.0	0.4	7.8

This field has a low level of organic matter, relatively low pH, and low levels of K, Mg, and Ca.

The following averages are from follow up sampling in May 2022:

			ppm							
	OM %	pH	P ₂ O ₅	K ₂ O	Mg	Ca	S	Zn	B	CEC
Early Manure	1.8	5.7	937	202	96	836	47	2.5	0.2	10
Late Manure	1.6	5.9	959	205	89	876	59	3.0	0.2	9

From fall to spring, there was a noticeable increase in potassium, magnesium and sulfur concentrations. This is likely as a direct result of the manure that was applied over both parts of the field. There wasn't a big difference between early and late manure treatments for most variables. There is a 0.2% different in average organic matter between the early and late manure treatments; however, we do not have average OM from the fall of 2021 from this side of the field, so it is difficult to tell whether this is a treatment effect or just an existing difference within the field.

Note that phosphorus (P) levels are extremely high for this field. If pH levels were brought to 6.0 or higher for this field, significant reductions in applied P fertilizer could likely be made without sacrificing yields.

Soil Health samples were also taken at the same points in the field, with the results shown below:

	Sand %	Silt %	Clay %	Active C ug/g	Soil Resp. mg/g	Agg. Stab. %	BNA mg/kg
Late Man (Sept)	66.8	19.5	13.8	197 (5)	0.33 (4)	20.6 (6)	15.5 (24)
Late Man (May)	67.4	20.2	12.4	296 (13)	0.32 (2)	24.3 (14)	14.6 (21)
Early Man (May)	67.1	21.0	12.0	298 (13)	0.36 (8)	22.8 (8)	18.0 (32)

Active C: Active Carbon. Soil Resp.: Soil Respiration. Agg. Stab. : Aggregate Stability. BNA: Biological Nitrogen Availability. Numbers presented here are the units for each test, with a score out of 100 in brackets which is based on how test results compare with other PEI fields in a similar crop rotation.

As with organic matter, there is a notable increase in Active Carbon, which makes sense given the additional of manure. The only slight difference between the late manure and early manure treatment for soil health metrics is for Biological Available Nitrogen (BNA), where there may be a slight advantage to the earlier applied manure treatment.

The field was planted with Prospects for processing in late May 2022, destined for French fry processing. Fertilizer application was consistently applied across the entire field. There was no observed difference in emergence or disease between the two sides of the field.

Potato Yield and Quality:

Treatment	Total Yield cwt/ac	Smalls %	> 10 oz %	Total Defect %	Specific Gravity	M. Yield cwt/ac	Payout \$/acre
Late Manure (Check)	412.2	1.2	48.5	5.7	1.083	386.0	5686
Early Manure	426.7	1.2	56.4	9.6	1.086	387.2	5740
Difference	+14.5	0	+7.9	+3.9	+0.003	+1.2	+54

Four 10 foot yield samples were obtained from treatment area of the field at the same GPS points were soil samples had been previously taken. There was no statistical difference in yield or quality observed between the late manure check and the early manure treatment areas. Therefore, we can say that there was no detriment to the potato crop by having manure applied earlier on a green crop than by applying it late.

Mill River East Field:

On this field, no glyphosate was applied. The preceding crop was a mix of alfalfa, red clover and timothy. On a strip at the north side of this field, solid beef manure was applied at a rate of 8 MT/acre on September 6th. Manure was then applied on the remainder of the field at the same rate in late October immediately before the entire field was moldboard ploughed.

Soil samples were collected on September 9th, 2021 and then immediately before potatoes were planted in mid-May 2022. Samples for both soil nutrients and soil health were collected. Four soil samples were taken from the non-manure applied part of the field next to the treatment area of the field at specific GPS coordinates in September 2021, and these same points were revisited for both the May soil sampling and the potato yield sampling in September 2022. Four additional points were sampled in the treatment area in May, with the same points used for potato yield sampling in September. Baseline fertility from soil tests in September 2021 for this field were:

			ppm							
	OM %	pH	P ₂ O ₅	K ₂ O	Mg	Ca	S	Zn	B	CEC
Sept 2021	2.3	5.9	388	88	41	641	20	1.7	0.4	7

This field has a low level of organic matter, relatively low pH, and low levels of K, Mg, and Ca.

The following averages are from follow up sampling in May 2022:

			ppm							
	OM %	pH	P ₂ O ₅	K ₂ O	Mg	Ca	S	Zn	B	CEC
Early Manure	2.2	5.7	554	188	62	760	127	1.9	0.2	10
Late Manure	2.3	5.9	369	158	76	812	138	1.3	0.3	10

Once again, there was a noticeable increase in K, Mg and S concentrations. The sulfur concentrations in the spring of 2022 are off-the-charts high, which may indicate sampling or testing error. P and K levels are slightly higher from the early manure samples; however, this may still be sampling error or random variation. Phosphorus levels in this field are not as extremely high as in the Montrose field. There was essentially no difference in organic matter between the treatment and control.

Soil Health samples were also taken at the same points in the field, with the results shown below:

	Sand %	Silt %	Clay %	Active C ug/g	Soil Resp. mg/g	Agg. Stab. %	BNA mg/kg
Late Man (Sept)	67.7	19.3	13.1	329 (16)	0.35 (6)	47.3 (52)	14.4 (20)
Late Man (May)	67.9	21.6	10.6	318 (16)	0.26 (1)	37.2 (35)	11.9 (13)
Early Man (May)	67.7	21.7	10.7	331 (16)	0.26 (1)	43.0 (45)	13.2 (17)

Active C: Active Carbon. Soil Resp.: Soil Respiration. Agg. Stab. : Aggregate Stability. BNA: Biological Nitrogen Availability. Numbers presented here are the units for each test, with a score out of 100 in brackets which is based on how test results compare with other PEI fields in a similar crop rotation.

In this field, there was very little difference observed from fall to spring in soil health metrics, despite the addition of organic matter. It is telling that despite the addition of 8 MT/ac of solid manure, neither organic matter or Active Carbon have increased. This indicates that the tillage associated with incorporation of manure plus preparing the field for potatoes may counter-act the increased organic matter contributed by the manure. Aggregate stability levels for this field were much better than for the Montrose field. This may be due in part to the fact that average organic matter levels are higher, but it may also point to lower levels of soil compaction.

The field was planted with Prospects in late May 2022, destined for seed production. Fertilizer application was consistently applied across the entire field. There was no observed difference in emergence or disease between the two sides of the field.

Potato Yield and Quality:

Treatment	Total Yield cwt/ac	Smalls %	> 10 oz %	Total Defect %	Specific Gravity	M. Yield cwt/ac	Payout \$/acre
Late Manure (Check)	305.4	3.4	13.3	3.7	1.077	283.1	3900
Early Manure	317.2	2.1	29.0	1.2	1.074	306.4	4225
Difference	+11.8	-1.3	+15.7	-2.5	-0.003	23.3	325

Four 10 foot yield samples were obtained from treatment area of the field at the same GPS points where soil samples had been previously taken. There was no statistical difference for most yield and quality metrics. There was a borderline statistical significant ($p < 0.10$) for 10 oz percentage and payout to the favour of early manure. However, payout was calculated on a processing grade rather than a seed grade, so the value of having larger size tubers may not be as great for a seed lot.

Summary:

Key findings from this trial were:

- Additional of manure consistently increase soil concentrations of certain nutrients, including potassium, magnesium and sulfur.

- In the Montrose field, there are indications that early manure application on a green crop (followed by incorporation of green forage) increased soil organic matter and active carbon by a small amount. Additional levels of sampling would be required to ascertain this higher levels of confidence. There are also indications that the early manure treatment increased levels of biologically available nitrogen.
- The same trend was not seen in the Mill River East field, where the entire field was incorporated green. It may be that the difference observed in the Montrose field was actually more related to the ploughing of green forage as opposed to dead forage rather than a difference related to early versus late manure application. Additional trials and additional replications would be needed to confirm this.
- Across the two fields, there was no statistical difference in yield between the two manure applications. Therefore, we can surmise that there is no disadvantage agronomically to applying manure earlier in the growing season.
- In the Mill River field, there may have been a slight improvement in tuber size and total crop value in the early manure treatment. We would want to see this replicated in other trials before putting any confidence in these results.
- In the Mill River field, there was no increase in organic matter with the addition of manure. This may indicate that tillage performed in the fall and in the spring may negate the organic matter additions coming from the manure.

Thank you to Dock Corner Farms for participating in this trial this year. Thanks also to Cavendish Farms for providing access to Central Grading for grading of yield samples.