Trial Report- BMP2: Cover Cropping After Potatoes

Trial Overview:

In the BMP2 trials established in 2021, we examined fall cover crops seeded in early to mid- October after potato harvest. In each field we compared one or more cover crops to a bare check strip or different rates of the same cover crop to a check. The purpose of the research was to assess how well the crop(s) cover the ground, hold soil to prevent nitrate leaching and erosion, relative to bare ground leading into the winter. We did not have any methods of establishment comparisons in this set of trials.

There were 6 fields set-up in the fall of 2021, including 1 in the Kensington North Watershed region, 2 in East Prince and 3 in the Souris and Area Watershed. They were planted between October 1- October 12, 2021. The treatment comparisons by trial are outlined below in order from the earliest to latest planting dates:

Trial #1: Winter Barley (136 lb/ac) vs Winter Wheat (165 lb/ac) vs Bare Check Strip (Barley Planted October 1, Wheat Planted October 6, 2021)

Trial #2: Winter Wheat (165 lb/ac) vs Bare Check Strip (Planted October 6, 2021)

Trial #3: Oats at 90, 120 and 150 lb/ac vs Bare Check Strip (Planted October 8, 2021)

Trial #4: Fall Rye vs Winter Barley (Each at 170-190 lb/ac) vs Bare Check Strip (Planted October 8, 2021)

Trial #5: Winter Barley (120 lb/ac) vs Winter Wheat (200 lb/ac) vs Bare Check Strip (Planted October 11, 2021)

Trial #6: Spring Barley (100 lb/ac) vs Bare Check Strip (Planted October 12, 2021)

Methods:

Fields were visited and the splits between treatments were flagged in the headlands and marked with GPS apps for future reference. A subset of the trials were selected for soil erosion testing based on topography and consistency between treatment areas. Soil sampling was done at three time points in the fall each spaced roughly 2 weeks apart, spanning October and November for soil nitrates to 3 depths, including 0-6”, 6-12” and 12-18”. The nitrate analysis was done by staff at the PEI Analytical Laboratories in Charlottetown. The Canopeo phone app was used to take and analyze replicate ground cover photos in each treatment [crop(s) vs bare check] to determine the percentage of green coverage provided at each of 3 time points over the fall, each spaced roughly 2 weeks apart, also spanning over the months of October and November. Photos were taken at the same waist height each time, pointed directly overtop of the cover crop.

Considerations:

Before looking at the results, it is important to note that there were two strips of winter wheat in Trial #1, although for consistency, the same strip was sampled repeatedly throughout the fall. Also noteworthy, the treatment design of Trial #3 was adjusted from the original plan. The check strip was only added to that trial later in the season - which impacted the quality of the data collection - but samples were still collected to the best of the crew’s ability given those circumstances, sampling from spots where the oats did not germinate or develop as thickly. Futhermore, Trials #2 and #6 had check

strips set-up along the edges of fields, which is not ideal to compare treatments due to the potential edge effect adding variability compared to the rest of the field, but it is understandable that putting check strips in the middle of the field is not a conventional practice for commercial fields.

Results - Soil Nitrates:

Below is a table to show the soil nitrate levels (ppm) at the last date range of sampling in mid-November comparing each cover crop to the check by trial (Table 1). This point in the season shows the final fate of the soil nitrates leading closest into the winter. There was a range of positive and negative differences between treatment crops and the checks at the end of the season, but the differences were within 10 ppm of each other, with one exception observed in the winter barley from Trial #4 showing closer to 15 ppm difference (higher in the cover crop). Trial #5 showed no difference between treatments at the 0-6" depth, but more soil nitrates in the cover crops at the lower 2 depths measured than the check strip. Trial #1 and #6 showed more soil nitrates in the checks across all 3 depths. A visual of the soil nitrate levels by treatment over the fall season is provided below for Trial #1 (Figure 1).

Table 1: Soil nitrates (ppm) by treatment within each trial during last date of fall sampling (Nov.10- Nov. 20, 2021)

	Sampling Depth					
Trial # & Treatment	**0-6"**	**Diff. to Check**	**6-12"**	**Diff. to Check**	**12-18"**	**Diff. to Check**
Trial 1: Winter Barley (136 lb/ac)	7.05	**-5.27**	14.33	**-3.53**	11.0	**-5.47**
Trial 1: Winter Wheat (165 lb/ac)	11.05	**-1.27**	17.48	**-0.38**	13.65	**-2.82**
Trial 3: Oats @ 90lb/ac	6.52	**-0.27**	9.17	**+0.35**	9.24	**+2.23**
Trial 3: Oats @ 120 lb/ac	6.7	**-0.09**	8.88	**+0.06**	10.99	**+3.98**
Trial 3: Oats @ 150 lb/ac	6.53	**-0.26**	6.58	**-2.24**	6.73	**-0.28**
Trial 4: Fall Rye (170-190 lb/ac)	<5.00	**-0.66**	24.63	**+10.41**	17.55	**+4.18**
Trial 4: Winter Barley (170-190 lb/ac)	11.89	**+6.23**	19.78	**+5.56**	28.08	**+14.71**
Trial 5: Winter Barley (120 lb/ac)	<5.00	**+0.00**	17.13	**+10.52**	15.97	**+7.30**
Trial 5: Winter Wheat (200 lb/ac)	<5.00	**+0.00**	8.24	**+1.63**	11.42	**+2.75**
Trial #6: Spring Barley (100 lb/ac)	11.84	**-3.18**	17.33	**-5.91**	15.61	**-4.18**

Note: Diff=Difference. Differences were calculated by subtracting the amount of nitrates in the check from each corresponding treatment crop at the same depth by site. Difference values that are positive indicate that the amount of nitrates were greater in the treatment crop. Difference values that are negative indicate that the amount of nitrates were greater in the check strip. Trial #2 is excluded from this table because due to time constraints, samples were not collected there at this late date in the fall season.

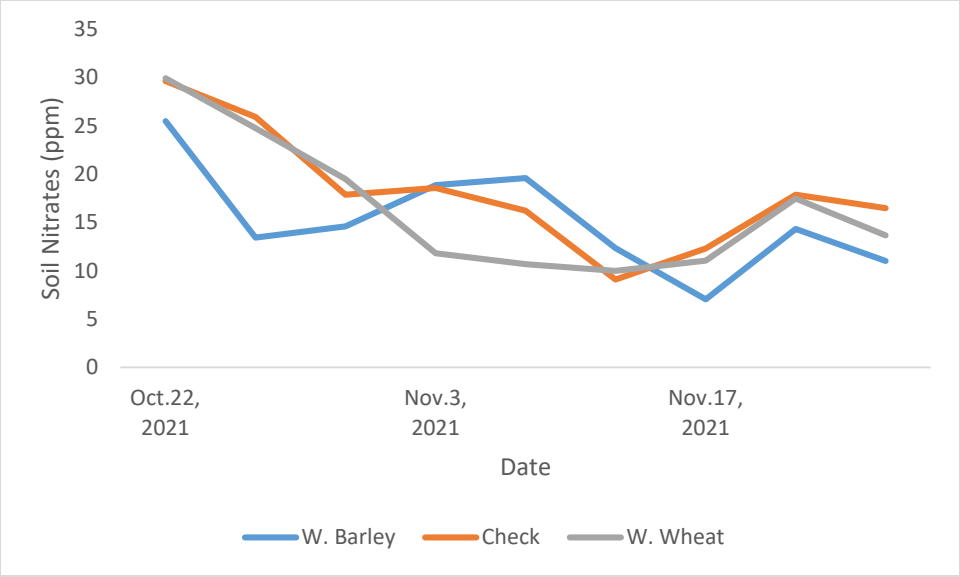
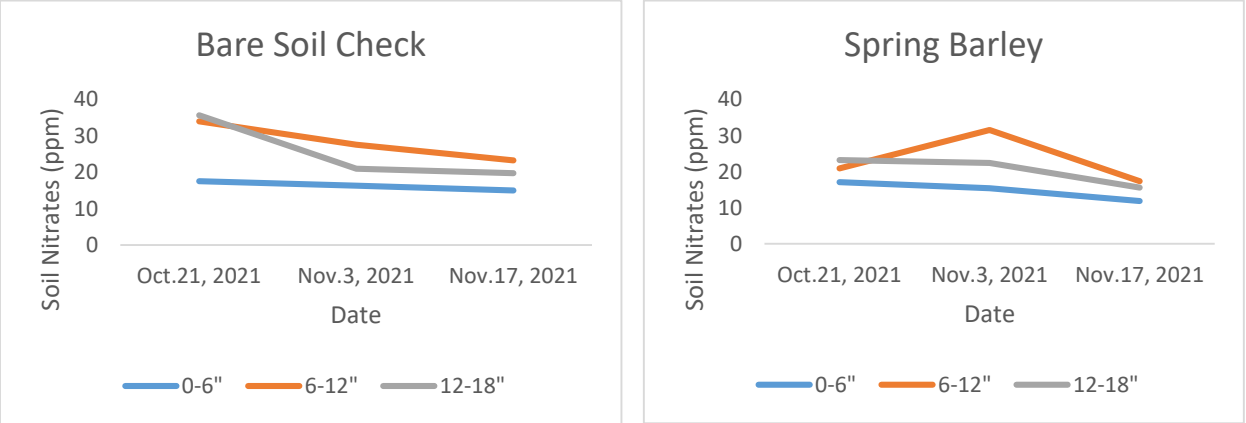


Figure 1: Soil nitrates in Trial #1 by treatment over the fall 2021 season averaged over depths. Note: ppm=parts per million

The figure above shows a general trend of decreasing soil nitrates throughout the progression of the fall season. The initial soil nitrates were lowest in the winter barley crop on October 22, 2021 compared to either the check or winter wheat. The levels then dipped for all three treatments during the last week of October, (most notably for winter barley), which then started to rise to levels slightly above the check during the first week of November, both around 20 ppm. However, the winter wheat showed lower levels closer to 10 ppm at that time. Between early and mid November the soil nitrates dropped again in all treatments, being lowest in the winter barley on November 17, 2021 with the check showing the most at the end of the season, followed closely by the winter wheat. Also below is an example to show the soil nitrate levels in Trial #6 by depth over the fall season, comparing a spring barley crop to a bare check strip (Figure 2).



(Figure 2a,b): a) Left: Check, and b) Right: Spring Barley. Soil nitrates by treatment and by depth in Trial #6 over the fall season of 2021 after potato harvest.

The baseline soil nitrates collected on Oct.21, 2021 were higher in the bare soil check at all 3 depths measured compared to spring barley. The cover crop established slowly, which may have explained why

there was little difference in the nitrate levels between treatments leading into early November. However, by the middle of November, the amounts were higher in the check at all 3 depths, suggesting that having something planted there to hold soil nutrients was beneficial over no cover at all. Had the barley established earlier and thicker, it may have showed bigger reductions in soil nitrates compared to the check.

Then the soil nitrate values were averaged across trials by treatment vs check to assess for trends by cover crop **(Table 2).** Some of the treatments were tested more than others (across multiple sites), some only at one site, and the baseline levels varied by site, so those points are kept in mind when assessing these differences. Although examining the dataset this way still showed small differences between treatment and check. There was lower initial soil nitrates in the oats treatments relative to some of the other treatments, so it contributed to explaining why the levels reported were also lower for that cover crop by the end of the season. At both the mid-and late season sampling periods**,** the top depth observed across treatments tended to have lower soil nitrate levels than the lower two depths. The winter wheat soil nitrates were fairly consistent across all 3 depths at both the mid and late season sampling, generally having lower amounts than the winter barley at the lower two depths**.**

In mid-late November within the top 0-6" sampling depth, the soil nitrates were highest in the spring barley (1 treatment) and lowest in the fall rye (1 treatment). At the 6-12" and 12-18" depths, the levels were highest in the fall rye and lowest in the oats. The only difference between treatments over 10ppm was observed for the fall rye in the middle soil depth, having more nitrates than the check. For this site, it showed that the fall rye intercepted the nitrogen quickly in the top depth, and particularly earlier in the season with its fast emergence and lush green cover, but there was likely still some left in the soil that the crop didn't utilize that made its way deeper into the soil profile over time. The winter barley showed additional soil nitrates at increasing depth in mid-November, perhaps explained by the crop's slower growth rate at that point, with some leftover nitrates left to move to deeper depths of the soil profile. The winter wheat treatment showed lower nitrate levels at all depths relative to spring barley.

Table 2: Average nitrate levels (ppm) in mid-late November by treatment crop across trials at 3 depths in the soil profile

	Sampling Depth by Treatment					
Treatment	**0-6"**	**Diff. to Check**	**6-12"**	**Diff. to Check**	**12-18"**	**Diff. to Check**
Spring Barley (1 Trt)	11.84	**-3.18**	17.33	**-5.91**	15.61	**-4.18**
Oats (3 Trt)	6.58	**-0.21**	8.21	**-0.61**	8.99	**+1.98**
Winter Barley (3 Trt)	9.47	**+0.32**	17.08	**+4.18**	18.35	**+5.51**
Winter Wheat (2 Trt)	11.05	**-0.64**	12.86	**+0.63**	12.54	**-0.04**
Fall Rye (1 Trt)	<5.00	**-0.66**	24.63	**+10.41**	17.55	**+4.18**

Note: Diff=Difference. Trt= #Treatments. Differences were calculated by subtracting the amount of nitrates in the check from each corresponding treatment crop at the same depth and site. Difference values that are positive indicate that the amount of nitrates were greater in the treatment crop. Difference values that are negative indicate that the amount of nitrates were greater in the check strip. The lab does not report values less than 5.00ppm, so 5.00ppm is used in places were the exact amounts were not detected to calculate differences compared to other treatments.

Results-Canopeo Analysis:

The average green ground coverage is shown below for the last time point taking photos in mid to late November 2021 within a 10 day range across sites (Table 3). Average values were also compared by treatment across trials during mid to late November (Table 4).

Table 3: Average percentage (%) green cover by treatment within each trial during the last date of analysis in November 2021 depending on planting date (between Nov.10-20, 2021)

Treatment	Av. Percent Green Cover (%)
Trial 1: Winter Barley (136 lb/ac)	**52.5**
Trial 1: Winter Wheat (165 lb/ac)	25.6
Trial 2: Winter Wheat	15.6
Trial 3: Oats @ 90lb/ac	11.4
Trial 3: Oats @ 120 lb/ac	11.3
Trial 3: Oats @ 150 lb/ac	14.7
Trial 4: Fall Rye (170-190 lb/ac)	**42.4**
Trial 4: Winter Barley (170-190 lb/ac)	12.4
Trial 5: Winter Barley (120 lb/ac)	15.9
Trial 5: Winter Wheat (200 lb/ac)	17.3
Trial 6: Spring Barley (100 lb/ac)	14.0
Average	21.2

Percent Ground Cover Observations:

Good fall weather conditions in October throughout potato harvest season supported timely planting of these cover crops, which resulted in a nice variety of different types of trials, and a few comparisons of winter species in different parts of the province. The winter barley in Trial #1 established really well, being the earliest planted, and the fall rye in Trial #4 also had a great coverage planted in the first week of October, over 40% by the middle of November. All the other treatments showed 25% coverage or less. The average cover across all 6 trials (11 treatments) was 21.2%, accounting for many values in the low to mid-teens.

Table 4: Average percent green ground cover (%) by treatment across trials in mid-late November 2021

Treatment	Av. Percent Ground Cover (%)
Spring Barley (1 Trt*)	14.0
Winter Barley (3 Trt)	26.9
Winter Wheat (3 Trt)	19.5
Fall Rye (1 Trt)	42.4
Oats (3 Trt)	12.5

Legend: *Trt= #Treatments

It was harder to make comparisons across trials with only 1 treatment in each of spring barley and fall rye, but looking at the winter species each with 3 treatments, the winter barley performed better than winter wheat on average. It was very wet in November of 2021 in addition to shorter day-lengths at that time of the year, which may have slowed down the growth of these crops in some fields, particularly if they already had adequate moisture levels. There were a lot of rainy days in the month of November.

In Trial #1, the seeding rate of the winter barley was lower than that of the winter wheat (difference of 29 lb/ac), but the winter barley was seeded 5 days ahead of the winter wheat. The winter barley had nearly double the green coverage next to that of winter wheat, by November 20. All other factors aside, for this particular site, it may indicate that the planting date was more influential on the establishment of these cover crops compared to the rate they were seeded at. In Trial #2, the winter wheat did reasonably well; a little slow germinating, but it resulted in roughly 15% green coverage nearing the end of November, relative to none with a bare check strip.

In Trial #3, there was not much difference in the Canopeo percentages between the 90 and 120 lb/ac rates, and only a 2-3% gain in green coverage from the 150 lb/ac rate compared the lower rates. The highest rate may not be the most cost effective option. The oats was broadcast during a dry period in October, and therefore the lack of rain slowed down emergence.

In Trial #4, the fall rye and winter barley were planted on the same date and at the same rate, but the fall rye established quicker and thicker compared to winter barley. The fall rye had over 3x more green coverage than the winter barley.

In Trial #5, both winter cover crops were planted on the same day in mid-October. By November 20, the amount of green cover was similar between both species, but slightly higher for the winter wheat.

In Trial #6, the spring barley established quickly being seeded close to the middle of the October. It provided about 14% ground coverage compared to a bare check strip.

Below are some pictures to show visual differences between winter cover crop species (Figure 1: a,b) and (Figure 2:a,b) as well as comparisons between different rates of the same cover crop (Figure 3: a,b). In Figure 1, the fall rye was noticeably thicker than the winter barley, seeded at the same rate. In Figure 2, the winter barley appeared to show a thicker green cover than the winter wheat. In Figure 3, there were not obvious visual differences between the various oats seeding rates, and the oats generally appeared to germinate a little patchy, thicker in some spots than others regardless of rate. This may be due to method of establishment broadcast on if not distributed evenly, or possibly due to weather or other environmental factors. The only clear visual difference was that between having an oats cover crop vs bare ground, as shown.

Figure 1: a,b: Left(a): Winter barley and Right (b): Split between bare check and fall rye. Both photos were taken the same day on October 15, 2021 a week after planting.

Figure 2: a,b: Left (a): Winter wheat and Right(b): Winter barley growing side by side in the same field. Both pictures taken the same day on November 17, 2021.

Figure 3: a,b: Left (a): Oats spanning across wide field. Right(b): Check Strip among oats treatments. Both pictures were taken November 20, 2021.

Results- Soil Erosion:

Total soil accumulations are shown below for 3 splash pan experiments through this BMP (Table 5). Two sites were located in the Souris watershed, and the third was located in Kensington North region.

Table 5: Dry soil accumulations (g) over fall season from splash pan erosion testing by treatment area

Trial # and Treatment	Crop Area-Total Soil Dry Weight (g)	Check Area- Total Soil Dry Weight (g)	Difference (g)	Percentage Reduction (%)
Trial 3: Oats	64.7	72.5	-7.8	10.8
Trial 4: Fall Rye	19.6	40.9	-21.3	52.1
Trial 4: Winter Barley	32.4	40.9	-8.5	20.8
Trial 5: Winter Wheat	34.6	49.2	-14.6	29.7
Trial 5: Winter Barley	47.8	49.2	-1.4	2.8

Soil Erosion Observations:

In all 3 splash pan experiments from this BMP, the accumulated soil from the check strip areas was higher than the amounts from the treatment crop areas. This result supports the use of fall seeded cover crops after potato harvest to reduce soil erosion. The difference between treatments was greatest in Trial #4 for the fall rye, in favor of planting it instead of leaving the ground bare for the winter months. The difference was lowest in Trial #5 for winter barley, having just marginally less accumulated soil than that from the bare check strip. The pans were spaced close together in Trial #5 because the check strip was fairly small, and due to limitations to splash pan supplies, there were only enough to put 2/treatment instead of 3/treatment so perhaps these reasons may help explain why there was less difference detected between cover vs check strip. The percent reduction was most noticeable for Trial #4 with 52.1% for the fall rye, and smallest for Trial #5 with 2.8% for the winter barley.

Summary and Future Direction:

The soil nitrate levels at the end of the fall season generally showed small differences between treatment crops and bare check strips; most with less than 5ppm difference, lower than the amounts observed in the middle of the fall. The oats crop (at either of the 3 rates seeded) consistently showed the least soil nitrates at all 3 depths measured during the fall season. This was likely due to that trial having low initial soil nitrate levels. However, there was no trend in the soil nitrate data specific to seeding rate observed there because the crop didn't establish as well as hoped. The fall rye treatment also showed low baseline soil nitrates, perhaps due to early establishment and nitrogen uptake by the crop, before its growth rate slowed down in November and resulted in some remaining soil nitrates moving below the top 6 inches. Winter wheat resulted in lower soil nitrate levels compared to spring barley at the mid-and late season sampling events. The winter barley appeared to do a better job preventing nitrates from moving to deeper positions in the soil profile compared to spring barley in the middle part of the fall. However, in late season, a few of the winter barley treatments showed higher levels in the lower two depths relative to the check, which may have been related to higher baseline amounts in those treatments at the beginning of the fall at those sites, and not all of it being intercepted by the crop.

The fall cover crops planted after potato harvest provided 21% green ground cover on average across 11 treatments. Winter barley was tested in 4 trials the year prior in 2020, but most of it died off over the winter, leaving no biomass salvageable to harvest seed to re-plant in future years. We will re-visit the 2021 planted winter barley fields again this spring in 2022 to visually assess how they fared over the winter. A different variety was purchased for planting in 2021 compared to 2020 so it will be good to know if variety has an impact, or if weather conditions on PEI is a more important factor in its longevity. The weather conditions were notably better (clear and sunny) in the fall of 2021 compared to those of the fall of 2020, and this was beneficial for getting potatoes harvested on schedule and seeding the cover crops on time. The month of November was fairly wet, with many cool damp days leading up to frost and snowfall events.

Fall rye and winter barley provided the best ground cover across trials, 42.4% and 26.9% respectively, while spring barley provided the least coverage (12%). Similar to 2020 trial results, planting date continues to be an important factor in getting successful crop establishment to allow for a long enough window for sufficient growth and development before the ground freezes up. Winter barley seeded 5 days ahead of winter wheat had nearly twice as much green above-ground biomass coverage. Also similar to previous Living Labs trials, increasing the seeding rate of the same crop did not necessarily positively correlate with

proportionally higher ground cover, relative to an increased seeding rate. Economic analysis (cost of production studies) are being done with other research collaborators to evaluate different methods for comparison. We did not have any trials in the fall of 2021 examining different methods of establishment within the same trial. However, we will continue to look at different types of comparisons in future research as time and resources permit. No cover crop clearly outperformed the others in all criteria measured, but all this information is useful to assess the results across sites over time.

We were fortunate to source additional splash pans for the 2021 season, compared to 2020, and that increased our capacity to measure erosion with additional sites and replicates. The splash pan data in the fall of 2021 supported the use of fall cover crops to hold soil in place to reduce erosion through heavy rainfall events.

Despite still being in the midst of a global pandemic, we have been able to continue with all the Living Labs fall cover cropping research work with some adaptations. The pandemic has reduced our ability to visit with growers more frequently in person or hold meetings in person to discuss trial details and results on a more on-going basis, but we feel more of those opportunities will open up soon.

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Submitted by: Morgan McNeil and Ryan Barrett **Date:** January 31, 2022