Trial Report – BMP2: Cover Cropping After Potatoes

Trials Overview:

In the BMP2 trial in 2020, we examined different fall cover crops seeded after potatoes were harvested. In each field, we compared one or two cover crops against a bare check strip. The purpose of these trials is to assess the success of different cover crops following potato harvest in providing ample ground cover before winter, reducing the risk of soil erosion, and mitigating the risk of soil nitrate leaching.

There were eight trial fields established in the fall of 2020. The fall cover crops were seeded between the third week of September and the second week of October. Of those eight trials, there were two set-up in the Souris & Area Watershed region, three in East Prince and three within the Kensington North Watershed Region. The treatment comparisons by trial are outlined below in order from earliest to latest planting date:

Trial #1- Oats (200 lb/ac) vs Oats (140 lb/ac) vs Bare Check Strip <u>(Planted Sept. 22, 2020)</u>

Trial #2- Winter Wheat (190 lb/ac) vs Winter Barley (125 lb/ac) vs Bare Check <u>(Planted Sept. 28, 2020)</u>

Trial #3- Winter Barley vs Spring Barley (Both @100 lb/ac) vs Bare Check Strip <u>(Planted October 1, 2020)</u>

Trial #4- Fall Rye (100 lb/ac) vs Bare Check Strip <u>(Planted October 1, 2020)</u>

Trial #5- Fall Rye (150 lb/ac) vs Winter Barley (100 lb/ac) vs Bare Check Strip <u>(Planted October 2, 2020)</u>

Trial #6- Fall Rye Broadcast Before or After Harvest (Both@200 lb/ac) vs Check <u>(Planted Oct. 3 & 9, 2020)</u>

Trial #7- Winter Barley vs Spring Barley (Both @ 100 lb/ac) vs Bare Check Strip <u>(Planted October 8, 2020)</u>

Trial #8- Spring Barley (@ 3 rates including 90, 120 and 150 lb/ac) vs Check <u>(Planted October 12, 2020)</u>

Methods:

Soil sampling was done at each site in the fall of 2020 for soil nitrate analysis at three time points to three depths, namely (0-6”), (6-12”) and (12-18”). The first set of samples was used as a baseline analysis before the crops were established, as compared to the other dates of sampling by treatment later in the fall. Most trials were sampled in both October and November if seeded early. Nitrate concentrations were analyzed by the PEI Analytical Lab in Charlottetown.

The Canopeo iPhone app was used to take and process three pictures in each treatment at multiple time points during the fall and averaged to compare the percentage of living ground cover at each date. Photos were taken at the same height each time (3.0 feet), with the camera pointed directly down at the soil surface.

Soil erosion was tested in a handful of trials using either splash pans or metal rebar pins. The supplies were divided up to use some in all three participating regions of the province, allowing for three pans/treatment, or four pins/treatment as compared to a check. Each site’s topography, grade of elevation/slope and consistency between soil treatment areas were assessed to choose which trials were better suited to test pans or pins. Typically, pans should be used on flatter fields, and pins used on more sloped fields. Within BMP2 for 2020, Trials #4 and #7 had splash pans, while Trial #5 had erosion pins.

Most of the participating fields just happened to be fairly flat, resulting in fewer opportunities to test erosion with the pins.

Results - Soil Nitrates:

General trends across the trials were that soil nitrates were typically highest in the top depth (0-6") at the earliest sampling dates in the fall (mid-October) and decreased as the season progressed, with higher amounts appearing in lower depths, demonstrating the potential for nitrate leaching. However, there were a few exceptions where winter barley had more nitrates at greater depths. A few of the trials were seeded later in the fall, or had the check strip added later than the other treatments in the same trials, making earlier fall nitrate-sampling comparisons not possible. Therefore, results for the third date of sampling supplied the fullest dataset, as shown below by site **(Table 2).**

Table 2: Soil nitrates (ppm) by treatment during early to mid-November 2020 (Nov. 6-12th)

	Sampling Depth					
Trial/Treatment	**0-6"**	**Diff. to Check)**	**6-12"**	**Diff. to Check**	**12-18"**	**Diff. to Check**
Trial 1: Oats (140 lb/ac)	5.0*	-17.1	12.6	-11.3	9.7	-7.3
Trial 1: Oats (200 lb/ac)	5.0	-17.1	9.0	-14.9	14.4	-2.6
Trial 2: Winter Wheat	5.0	0.0	6.3	-5.1	5.2	-4.9
Trial 2: Winter Barley	10.6	5.6	12.9	1.5	6.0	-4.1
Trial 3: Spring Barley	16.1	2.7	17.1	2.1	13.4	-1.0
Trial 3: Winter Barley	16.9	3.5	19.2	4.2	14.4	0.0
Trial 4: Fall Rye	5.0	0.0	5.0	-0.9	7.3	-1.6
Trial 5: Winter Barley	6.9	-6.4	5.6	-11.5	21.5	+11.0
Trial 5: Fall Rye	5.0	-8.3	13.0	-4.1	10.8	+0.3
Trial 6: Fall Rye (Before Harvest)	6.2	-9.2	8.6	-9.5	5.0	-10.8
Trial 6: Fall Rye (After Harvest)	5.0	-10.4	7.7	-10.4	10.6	-5.2
Trial 7: Winter Barley	14.1	-15.0	22.5	-7.9	18.6	-1.7
Trial 7: Spring Barley	25.5	-3.6	11.7	-18.7	18.0	-2.3
Trial 8: Barley @90 lb/ac	13.6	-12.2	9.9	-12.7	14.8	-6.1
Trial 8: Barley @150 lb/ac	9.4	-16.4	10.1	-12.5	9.8	-11.1
Average	**10.0**	**-6.9**	**11.4**	**-7.4**	**12.0**	**-3.2**

Note: Diff= Difference. Differences were calculating by subtracting the amount of nitrates in the check from each corresponding amount in a treatment crop from the same site at the same depths for comparison. *Values of 5.0 represent results of <5.00ppm, because that is how the lab reports those amounts. Five is used in this table in order to calculate differences from the other treatments.

Nitrate Observations:

Most of the differences between treatment crops and the check were negative, indicating that the nitrates were higher in the check than in the cover crop. This seems to indicate that the growing cover crop succeeded in taking up some amount of residual soil nitrates which would otherwise be vulnerable to leaching during heavy rainfall events in the fall and early winter. Averages by fall cover crop across trials and treatments are shown below **(Table 3).**

Table 3: Average nitrate levels (ppm) by treatment crop shown for three depths in soil profile

	Sampling Depth					
Treatment	**0-6”**	**Diff. to Check**	**6-12”**	**Diff. to Check**	**12-18”**	**Diff. to Check**
Spring Barley	16.2	-7.4	12.2	-10.5	14.0	-5.1
Spring Oats	5.0*	-17.1	10.8	-13.1	12.1	-5.0*
Winter Barley	12.1	-3.1	15.1	+3.4	15.1	+1.3
Winter Wheat	5.0*	0.0	6.3	-5.1	5.2	-4.9
Fall Rye	5.3	-7.0	8.6	-6.2	8.4	-4.3

Note: *Values of 5.0 represent results of <5.00ppm, because that is how the lab reports those amounts. 5 ppm is used in this table in order to calculate differences from the other treatments.

Looking at the averages by species across all sites, winter wheat and spring oats appeared to have lower levels of nitrates in the top depth (0-6”) compared to both barley species. The largest difference to the check was observed for the oats crop; however, there was oats in only one of the trials. In the middle depth (6-12”), the winter barley had the highest average nitrate concentration by a slight amount compared to the average check in those four fields. All of the other species had a lower nitrate concentration in the cover crop than the check strip. Similarly, winter barley also had the highest concentrations (marginally) and higher concentrations than the check at the deepest depth measured (12-18”). All the other four crop species had similar levels of nitrate reduction from the check.

The soil nitrate levels were subject to considerable variation depending on the varieties of potatoes growing in those fields during the summer of 2020, the types, amounts and forms of fertilizers used, and the fact that dry conditions may have resulted in less nitrogen uptake by the crop, resulting in more left in the soil leading into the fall months. However, as noted in previous reports, this is only data from one fall season, which had quite different conditions from the fall prior in 2019. Therefore, with changing climatic conditions, further site-years in these trials would be useful to examine trends over a larger data set.

Results - Green Ground Coverage:

The average Canopeo results are shown below for the last time point taking pictures in the fall **(Table 4).** Check strip comparisons are generally not relevant, as bare ground accounted for nearly zero coverage if not for some weed growth. Averages across treatments are also provided below **(Table 5).**

Table 4: Average percent (%) green ground cover of treatments across trials in third week of November 2020

Trial/Treatment	Percent Green Cover (%)
Trial 1: Oats (140 lb/ac)	41.3
Trial 1: Oats (200 lb/ac)	51.0
Trial 2: Winter Wheat	31.6
Trial 2: Winter Barley	49.6
Trial 3: Spring Barley	43.7
Trial 3: Winter Barley	39.9
Trial 4: Fall Rye	38.6
Trial 5: Fall Rye	42.0
Trial 5: Winter Barley	40.1
Trial 6: Fall Rye (Before Harvest)	18.5
Trial 6: Fall Rye (After Harvest)	12.6
Trial 7: Spring Barley	19.3
Trial 7: Winter Barley	39.7
Trial 8: Spring Barley @90 lb/ac	3.6
Trial 8: Spring Barley @ 120 lb/ac	4.0
Trial 8: Spring Barley @150 lb/ac	4.6
Average	**30.0**

Table 5: Average percent (%) green ground cover by treatment in third week of November 2020

Crop Species	Average Percent Green Cover (%)
Spring Barley (#5 trt)	31.5
Spring Oats (#2 trt)	46.2
Winter Barley (#4 trt)	44.8
Winter Wheat (#1 trt)	31.6
Fall Rye (#4 trt)	40.3

Note: *#Trt= Number of Treatments

Percent Ground Cover Observations:

It is important to examine each field on a site-specific basis. There are a considerable number of variables that differ by field which are out of the control of the research team, including but not limited to the amount of residual nitrates, topography/slope, quality /germination rate of cover crop seed, accuracy of planting equipment, and the date of potato harvest/cover crop planting. However, we are interested in comparing the effect of different crop species and establishment dates on the success of cover crop establishment.

The average coverage across all fall crops in Trials 1-7 (13 treatments) was 36.0%, or 30.0% when including Field 8, which was seeded later with spring barley. The percent of green ground cover was quite acceptable for most of the trials, with the exception of Trial #8 seeded on October 12, 2020, which appears to have been too late for spring barley. The higher seeding rate in that trial only slightly improved the percent green ground cover. This is quite instructive in demonstrating to growers that spring cereals may not be well suited for use as a cover crop for establishment after the early days of October.

In Table 5, the comparative percentage of green coverage by crop species is shown. On average, winter barley looked to provide the most green cover, and the least from spring barley. However, all of the averages were in a similar range (between 30 and 46%), confirming that the fall conditions were conducive to good establishment across species. Given the range of dates and the number of fields involved it is difficult to draw strong conclusions for one species holding an advantage over another. Ground cover data from 2019 BMP2 trials was significantly impacted by challenging fall weather and poor emergence and was generally not comparable to data from 2020.

Looking at Trial #1, the higher rate of oats resulted in roughly 10% greater green cover compared to the lower rate oats. However, given that it was not a more noteworthy increase in coverage may not justify the added cost of seeding this crop at the higher rate. An economic analysis comparing them would be useful to determine which is the best seeding rate option.

In Trial #2, the winter barley provided a percentage of green cover almost 20% higher than winter wheat, despite them both being planted the same day. It should be noted that residual nitrate levels were higher on the winter barley side of the field, so this may have improved establishment of winter barley in comparison with the winter wheat.

In Trial #3, the difference between the two species of barley was very minimal, with a 3.8% difference between them. Spring barley showed a slightly higher amount of coverage at this date, which may have been a random result where the crop germinated a little thicker in some places than others.

In Trial #4, the fall rye provided a good catch with 39% green cover compared to a bare check.

In Trial #5, fall rye performed slightly better than the winter barley, but again the differences were quite minimal (1.9% difference in green cover).

In Trial #6, fall rye broadcast before potato harvest and incorporated by the harvest equipment appears to have showed higher ground cover establishment levels compared to fall rye broadcast after harvest and leveled. The six days between seeding dates most likely explains some of this difference; however, the improved level of seed to soil contact may also have provided an advantage to the pre-harvest broadcast treatment.

In Trial #7, the winter barley resulted in double the ground coverage (39.7%) compared to spring barley (19.3%). In that trial, the winter barley was seeded with a grain drill while the spring barley was seeded by broadcast, so the method of seeding may have played an important role in the level of growth after seeding.

In Trial #8 the spring barley seeded at 90 lb/ac resulted in 3.6% green ground cover, compared to 4.0% seeded at 120 lb/ac, and 4.6% seeded at 150 lb/ac. This showed that increasing the seeding rate increased the percent green cover; but only by small amount in this trial.

Below are some photos to visually show examples of differences within trial between different cover crops **(Figure 1: a,b),** different methods of establishment **(Figure 2: a,b)** and different species of the same crop **(Figure 3: a,b)** in these BMP2 research trials. There is one example from each of the three participating watershed regions in the province.

Figure 1 (a,b): Comparison of winter wheat (left) and winter barley (right) growing side by side in the same trial, both photographed November 20, 2020.

Figure 2 (a,b): Comparison of fall rye broadcast after (left) and before (right) potato harvest in the same trial, both photographed November 17, 2020.

Figure 3 (a,b): Comparison of winter barley (left) and spring barley (right) in the same trial, both photographed November 17, 2020.

Results-Soil Erosion:

Total soil accumulations are shown below for two splash pan trials in the fall of 2020, comparing fall cover crops to a bare check **(Table 5).** Additionally, erosion pin results for one trial tested are provided below **(Table 6).**

Table 5: Soil splash pan accumulations over four weeks in fall season of 2020

Trial/Treatment	Treatment Crop Total Dry Weight Soil (g)	Check Strip Total Dry Weight Soil (g)	Difference (g)
Trial 4: Fall Rye	84.7	83.8	+0.9
Trial 7: Winter Barley	125.0	148.9	-23.9

Table 6: Soil erosion pin data at three time points in the fall of 2020 from Trial #5 (Average values)

	Average Height (cm)		
Treatment	**Oct. 23, 2020**	**Nov. 5, 2020**	**Nov. 17, 2020**
Check	25.2	24.8	25.3
Barley	24.9	25.1	25.1
Difference	**-0.3**	**+0.3**	**-0.2**

Soil Erosion Observations:

The splash pan trials provided more reliable data than erosion pins, due to less environmental disturbance to the pans over the fall season. However, the splash pan results between treatments were also quite site-specific since one trial showed a noticeable difference between the crop and check, and the other trial tested did not. This result was not expected.

After testing soil erosion pins for two fall seasons in a row, it appears that the data did not show any consistent differences between treatment crops and a check. Some of the pins were above the original height that the pins were installed, and some of them were below it, indicating that frost heaving or other environmental disturbances likely moved them between dates of taking measurements at different time points over the fall. There could have also been some human error associated with the data collection, as different people from the research team were involved in reading the measuring tape depending on the work-load and the number of staff available to help on a given day. However, a more user-friendly measuring tape in units of centimeters was used in the second fall to improve the accuracy of the data collection. The research team intends not use erosion pins to model erosion potential in future years of this project. Instead, more splash pans may be utilized, or another method of modelling/measurement may need to be employed.

Summary:

Fall cover crops helped intercept nitrogen from the soil, preventing nitrate leaching leading into the winter months as compared to the bare check strip. Most of the trials showed the highest nitrate levels in the top depth at the earliest time points of sampling, and gradually less with increasing depth in the profile. However, there was an exception seen with winter barley in Trial #5 showing higher levels of soil nitrates at the third depth in November. This could in part be explained by higher amounts of nitrates observed during baseline sampling, resulting in them working through the profile over the fall season.

The fall cover crops provided 30.0% coverage on average, across 15 treatments. New this year in 2020 was evaluation of winter barley as a cover crop, with the four winter barley treatments having an average cover of 44.8%. From the averages across treatments, it appeared that winter barley provided the best green cover, and spring barley provided the least green cover. Planting date was the most important factor (if weather conditions were suitable and potatoes were harvested in time) to get successful cover crop establishment. Increasing the seeding rate at later planting dates can help, but it is not always a promising practice if there are other constraining factors. It is important to assess all environmental factors on a site-specific basis. We look forward to exploring the economic analysis to be conducted using data from this BMP, particularly in comparing different cover crop species; and particularly cover crops that could be harvested the following year as a cash crop (ie. fall rye, winter wheat, winter barley) compared with simply establishing a cover crop.

There was a better variety in different types of research comparisons in 2020 compared to 2019, including different seeding rates of the same crop or different cover crops for comparison. The fall weather conditions were also more favourable in 2020, allowing for a longer window to get the trials set-up properly around potato harvest. There is potential to grow some different cover crops in future years of this BMP trial, such as winter triticale or winter canola, if there are some growers interested in planting some of these crops.

In 2019, soil erosion testing was conducted comparing data from two pans/treatment, but moving into 2020 a decision was made to increase the testing by using three pans/treatment. This increased testing capacity was possible after ordering additional equipment. Soil erosion pins (metal rebar) were also used to assess soil erosion in both years, but the results have been quite inconsistent, with no clear trends (some pin heights above the original and some below) so that method will likely be discontinued in future years of the project. The data from the splash pans was more reliable in both years.

In the spring of 2021, we intend to conduct soil sampling in fields where cover crops survived the winter to observe any difference between treatments. In addition, we intend to follow-up with growers that grew winter barley to assess winter survival rate and measure yields for any winter barley that is grown out to maturity later in the year.

Despite being in the middle of a global COVID pandemic, it has not greatly affected the data collection for projects led by the Potato Board to the same extent as some other Living Labs research partners. The main set-back to-date was sampling multiple trials at multiple dates in close timeframes and having to store them all in the same freezer with delayed submissions due to time constraints with travel time, trying to maximize collection efforts on field days and working within business hours of the labs. This required additional efforts reviewing labels and organizing samples in the freezer to keep them separate until submission.

Additionally, one adaptation was made moving most meetings online in 2020 (with a much smaller in-person component) to share results with larger audiences. However, it can be less interactive communicating over these technologies compared to in-person meetings, and small in-person meetings have gradually been re-introduced in 2021. Moving forward, the COVID circumstances will ultimately dictate the nature of future meetings.

The research team is going to meet with participating growers more regularly before, during and after the trial implementation in an effort to improve two-way communication on these trials as well as ensuring that we are collecting as much field data from the grower at one time, to avoid repeated calls/emails to collect information.

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