MHPEC Living Root Research Report 2022

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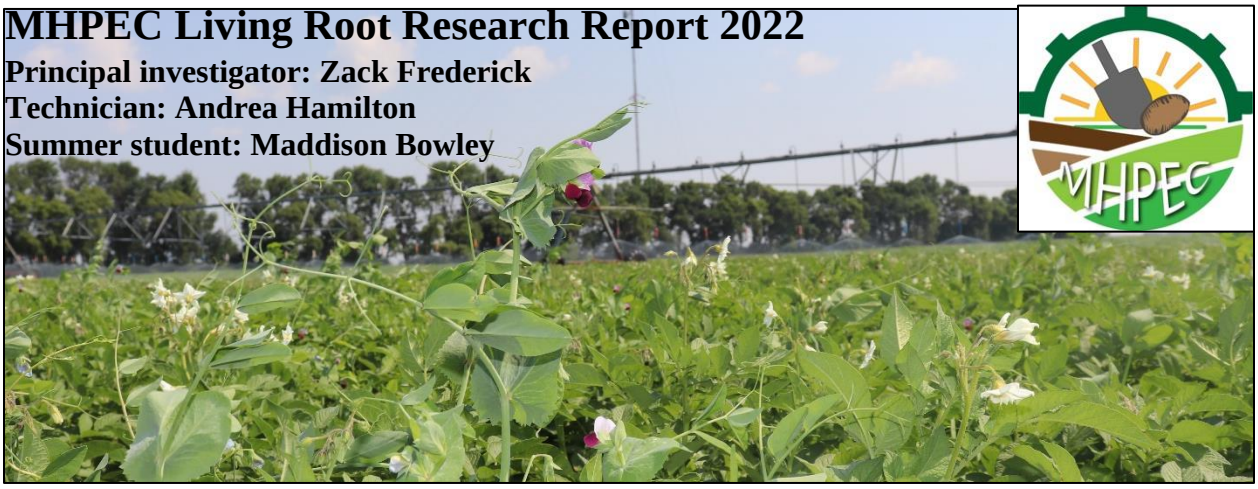


Many thanks to our industry and grower cooperators! Including Northstar Seed and Union Forage!

Introduction: There has been significant interest in soil health and input efficiency within the agricultural sector over the last few years. This has included the idea of trying to keep a living root and soil armor for as much of Manitoba's frost-free period as possible. This is to help with the four ecosystem processes: nutrient and water cycling, energy flow, and rotation diversity. Soil doesn't usually have any living plants during pre-seeding and post-harvest periods of the year, otherwise known as the shoulder seasons. Cover crops, nurse crops and companion crops are all great options to increase the number of days with a living root during these shoulder seasons. **The overall goal is to help producers find different options that could help with keeping a living root in the soil for as long as possible while creating soil armor. All while increasing soil health and decreasing different social and economical issues within the potato industry.** This created two projects with a different focus: the spring shoulder season with nurse and companion crops and fall shoulder season with cover crops.

Nurse/Companion Crop Demonstration

Background: While looking at what could be grown in the later spring shoulder season the discussion came to using nurse and companion crops. The main objectives were to decrease sand blasting, losing hill formation in wind events and to see if using a season long companion crop could help with supplementing nitrogen that year via fixation or to help increase organic nitrogen in the rotation. Spring wheat was chosen for the nurse crop because it is fast growing which creates a living root and soil cover quickly. While the forage peas were chosen for the companion crop because they are fast growing, high nitrogen fixing plants and could survive the herbicide applications. The fertilizer rate was cut in half for the companion crop to help promote nitrogen fixation of the peas. The seeding rates were 42% of a full seeding rate for each crop. Therefore, the nurse crop of spring wheat was a seeding rate of 48 lb/ac, and the companion crop of forage peas was 84 lb/ac. The forage peas were treated with granular inoculant as well. These

were then broadcasted just in front of the planter and incorporated by the planting of the potato crop.

Observations: In the early season the plants emerged at the same time as trials that were planted the same day and kept pace with the rest of the crop throughout the season. The population of the peas and wheat were decreased due to the hilling operation done. This increased herbicide application efficacy, which was a single application of Sencor that provided expected control on broadleaves. The spring wheat was supposed to be controlled with a post-emergence application of Centurion, but this herbicide was missed, limiting the control on monocot weeds within the plots. The application of Centurion, or another suitable graminicide, would have been important on the field scale to prevent serious economic loss from the spring wheat and/or other monocot weeds.

Potato vine and tuber growth was watched closely throughout the growing season. With the extra cover from the nurse and companion crop, fewer potato heat runners were seen in this trial compared to the surrounding trials. Around mid-bulking, there was distinct colour difference in the canopy and smaller plant size that is characteristic of low nitrogen availability. The set size was comparable within these two treatments for the first set but there were more tubers in the second/third set seen in the nurse crop treatments that had potential to increase yield if there was enough time in the late season to bulk. There was no difference seen in Colorado potato beetle pressure between the treatments and the beetles appeared to be randomly scattered throughout the whole experiment. No significant disease pressure was noted within the trial. Pea nodules were formed later in the season after potato row closure, and these nodules remained small through early August but developed a nice red colour (red nodules indicates nitrogen fixation was occurring).

The nitrogen levels were checked in the preseason, row closure, and late bulking. Post-season sampling wasn't done. It shows in figure 1 that the nurse crop trial had more nitrate fertilizer applied had a larger portion of nitrogen in the 6-12" profile than the 0-12" while the companion treatment has a similar amount within the two profiles. At row closure the nurse crop treatment had twice the nitrogen as the companion crop treatment which is the trend that would be assumed with half the fertilizer applied. At row closure the nitrate was found to be sufficient in the petioles.

Harvest operations were no different than the rest of our trials. There were no issues root masses or extra vegetation in either treatment. All experiments have the tops chopped which could have been significantly helpful in this case. After harvest yield and quality were taken. The yield of the two treatments were compared to a conventional treatment of a trial in close proximity. This treatment was from the fertigation trial, and it had the same fertilizer application as the nurse treatment. These all had the same maintenance treatments even though they were different trials. The yield was very equal between the companion and nurse crop treatments, but both were significantly better than the conventional treatment in the adjacent trial this is shown in figure 2. Figure 3 shows the companion crop yield had 80% within the greater than 6 oz profile and the nurse crop had 72% while the conventional only had 46%. Of that 80% of the companion crop

51% was within the 6-9.9 oz size profile of this yield. The nurse crop had 24% of the over 12 oz size profile which is at a level to receive deductions.

After harvest the peas and the wheat were reseeded with the season's matured grain. This provided quick cover for the bare earth after harvest that would nullify the cost and time spent on a fall cover crop. This method would only work well if the hills were disked immediately after harvest to ensure there is no tillage kill of germinated seedlings. These seedlings showed limited frost damage even after a severe frost.

Conclusions: The secondary species population is very important to control to ensure the potatoes can out compete. For the nurse crop to work appropriately planting at the same time as the potato crop is the main point so having the right seeding rate is very important. The 42% of a full seeding rate of spring wheat might be a little high if there is more than sufficient moisture or if post hilling isn't done. If there is high weed pressure this has a similar early season effect because there is early cover but ensuring control of the population is important. The companion crop could be planted at planting or hilling but the seeding rate would change to ensure the population isn't too high to out compete the potatoes. For both treatments the herbicide application needs to be on time to ensure the canopy isn't too dense that it decreases the herbicide efficiency. Sencor caused no issues as peas are on the label, but prism is not so proper timing will be important for weed control. Different species have been discussed for the companion crop, but it is important to look at the growth structure of the secondary species picked. This includes the typical season length, root system/above ground biomass, disease or pest cycles and limitations of field operation.

The nitrogen levels were consistently lower in the companion crop treatments, but yield wasn't significantly impacted. The extra nitrogen was seen in the nurse crop and conventional treatments to have leached into lower profiles compared to the nitrogen in the companion crop which was in more of the top 0-6". There are no signs that extra nitrogen was put into the soil by nitrogen fixation but with no yield drop off there is speculation it could have helped throughout the season. The yield and size profile of both treatments were both desirable, but the companion crop had half the nitrogen. This shows the possibility of being very cost effective. The extra cost of the fertilizer in the full application is more than double the cost of the pea seed. This would increase the margin/ac between the conventional, nurse and the companion crop treatment. There is more experimentation needed to ensure this possibility.

Different observations and measurements to improve and continue using should include the soil temperature and moisture differences in the early season with and without cover. Emergence and row closure timing with corresponding canopy densities at these times. Canopy density and row closure timing will be especially important in years with extreme heat to see if there is a reduction in heat runners which affects total yield. Calculating plant populations within a meter square will help define what the appropriate plant population for the secondary crop to ensure no yield loss. Measuring nutrient levels throughout the season will help define trends as well. Different treatments such as different planting times, seeding rates, and fertility is an important direction for theses practices to see how they can be applied at field scale.

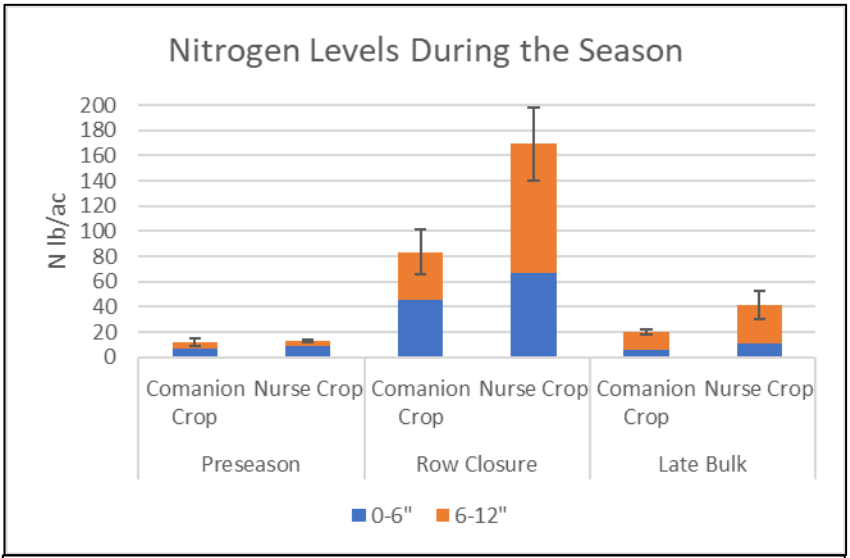


Figure 1. Nitrogen levels of the different treatments in lb/ac at 0-6", 6-12" and 0-12". This was sampled in the preseason, row closure, and late bulking

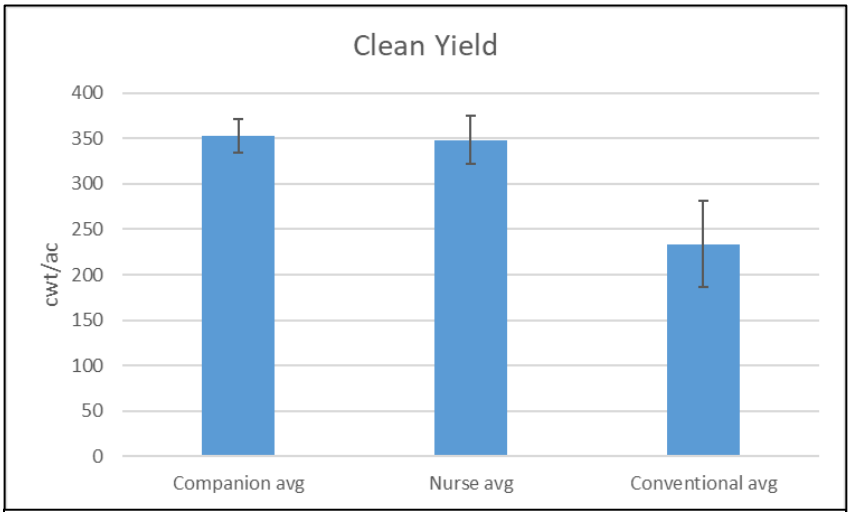


Figure 2. The total clean yield of the companion crop, nurse crop, and a conventional treatment.

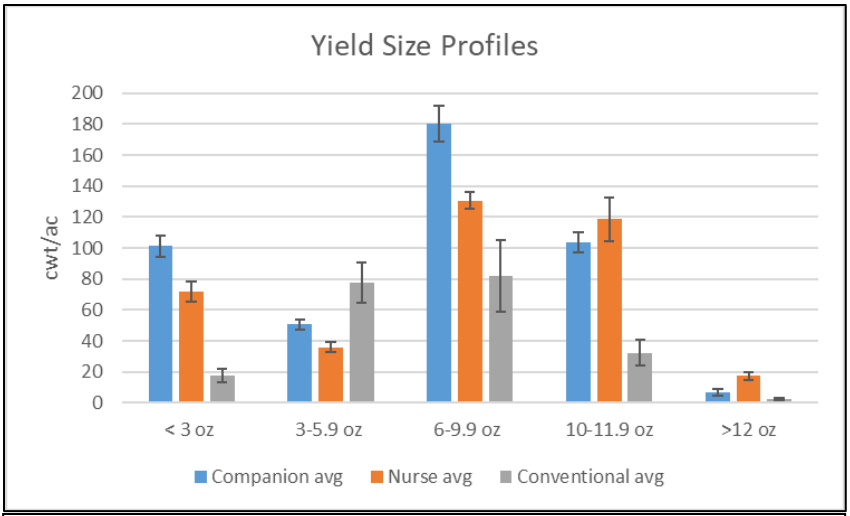


Figure 3. The breakdown of the yield size profile of the companion crop, nurse crop, and a conventional treatment.



June 15, 2022 **DAP:** 22



June 22, 2022 **DAP:** 29 Just after hilling

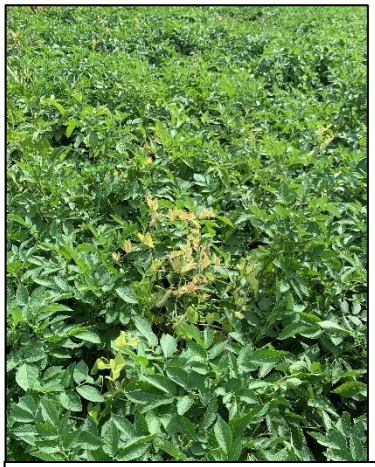

June 30, 2022 **DAP:** 37


July 18, 2022 **DAP:** 55


July 26, 2022 **DAP:** 63


August 2, 2022 **DAP:** 70

Companion Crop 50% N Nurse Crop full N
August 9, 2022 **DAP:** 77 3 plant sample




August 17, 2022 **DAP:** 85
Maturing secondary species





Oct 4, 2022 **Days after Harvest:** 27

Peas and wheat reseeded itself from season's seed production.


Oct 11, 2022 **Days after Harvest:** 34

A severe frost: Oct 6th (-5˚C) and Oct 7th (-7 ˚C) Limited frost damage

Cover Crop Trial and Demonstration

Background: After a potato harvest, there are vast areas of uncovered, dry, light-textured soil. Soil under these conditions is prone to blowing through out the fall and spring but more importantly it is disrupting the energy flow of photosynthesis. Many government programs are trying to promote the seeding cover crops in the fall to keep that living root and soil armour for as long as possible in the fall and potentially overwinter to grow in the early spring. These crops are often used to help diversify what is Manitoba's typical canola-wheat-potato rotation with limited pulse crops that has started to be incorporated in recent years. This diversity promotes missing species such as legumes and diversity of different grasses and broadleaves. There is much discussion on whether a single species or a poly-crop mixture is best for cover crops.

Fall planting is often concerning due because the days are constantly getting shorter, and the cooler as fall progresses which decreases potential growth as time goes on. This is concerning when most potato acres are dug in September other than some early varieties. This means that the growth potential of any species will be decreased with each passing month after August by about two hours per month. Two planting dates were decided upon for cover crops to represent either end of the potato post-harvest period where bare soil can be found in a given Manitoba field. These dates were the week of September 5th and September 26th. When discussing with collaborators, Northstar Seeds suggested varieties below in the trial breakdown. Union forage, who works with some potato producers in Alberta, had some success with a mix of white clover and Ethiopian cabbage and desired to see abilities of these crops locally in Manitoba. The demonstration area was just to be planted at the early seeding date (week of September 5th). This is structured as multiple-year study so baseline measurements such as soil fertility and bulk density were taken to see how things change.

<u>Treatments Species Breakdown for Trial</u>

1. Italian Ryegrass (18 lb/ac)
2. Crimson Clover (18 lb/ac)
3. Tillage Radish (4 lb/ac)
4. Mix 1: Equal 42% of all 3 species
5. Mix 2: 55% Italian Ryegrass, 40% Crimson Clover and 30% Tillage Radish
6. Mix 3: 55% Crimson Clover, 40% Italian Ryegrass and 30% Tillage Radish
7. Negative Control no cover crop

<u>Species for Demonstration Area</u>

- White Clover (3 lb/ac)
- Ethiopian Cabbage (7 lb/ac)

Observation: Due to the late start of the season and logistics as the potatoes were harvested, the hills were disked the second week of September, which allowed only one seeding date to be accomplished. This reflected what this year looked like for most producers in Manitoba if they would have seeded a cover crop after their potato harvest as many started harvest 1-2 weeks later than normal. All plots were planted via broadcasting and harrowed afterwards on September 19th. The initial plan was to use a disk drill but due to labour and logistics broadcasting was the best

option. Fertilizer was broadcasted with the seed. There were 2 different rates 20 lb N/ac for treatments without legumes and 10 lb N/ac that do. Due to sufficient rainfall immediately after planting no irrigation was applied at planting.

Emergence was first seen two weeks post planting on October 3rd. In all the germination was good in the trial area but each species shined in different ways. In the demonstration area the seeding wasn't as easily distributed, and these species aren't as vigorous that late in the season, so the was emergence was patchy. Within the trail area the tillage radish was the most vigorous followed by crimson clover and then the Italian rye grass. The mixed plots showed the same trend. The tillage radish did show limited flea beetle damage on the cotyledons. There were severe frosts on October 6th (-5˚C) and 7th (-7˚C) which damaged a lot of the species excluding the Italian ryegrass which showed minimal to no damage. Some species were decimated such as the white clover and Ethiopian cabbage in the demonstration area along with the majority of the tillage radish. At this point the tillage radish had 1-2 true leaves which were the biggest plants other than the Italian ryegrass. A month after planting there were multiple nights that were continually under 0˚C with another severe frost on October 18th at -7˚C this severely damaged the crimson clover but the majority of the Italian ryegrass was still seemingly untouched. The largest the crimson clover got was 1-2 true leaves and the Italian ryegrass had 1 tiller. The Italian ryegrass was green until the beginning of November but hadn't progressed much in growth. Throughout the fall there was limited to no weeds seen within the plots.

Conclusion: Fall planting many different species will be highly difficult depending on when there are frost events and the severity of those events. Hardy grasses seem to be the best option which has been proven throughout the years with fall rye being the main choice for any cover crop that is planted after potatoes. This year there were no severe frosts until October but that isn't every season. With any cropping system using seeding equipment is more efficient than broadcasting which I think could have helped increase germination. The different mixes didn't show many differences other than the tillage radish is planted at the lowest seeding rate and is a large seed so the plant population is lower than the other species this means that the most coverage in the early season was the 42% equal split treatment (4) while also having a large amount of coverage as the fall continued due to the Italian ryegrass growing larger. The diversity within the cover crop showed to help with risk management in unforeseen weather. This caused better coverage throughout the season. No irrigation was applied due to timely rain events if those hadn't occurred irrigation would have been necessary.

With this being an observational year with limited baseline data there could be a continuation next year to look see if there are any changes. Also, it will be interesting to see if any of the biennials (Italian ryegrass and crimson clover) had enough establishment for any overwintering. This year showed the seeding date was very important as the other focus group trial showed the self planted species during harvest the week prior had superior growth. This goes to show incorporating planting a cover crop with either the harvesting operation or the discing down of the hills could be an important aspect of being able to plant a cover crop after a potato crop. There is need to continue to see what the best cover crop practices are for the potato ration or any later harvested crop.



Treatment 4	Treatment 5	Treatment 6

October 4, 2022



Treatment 1	Treatment 2	Treatment 3





October 11, 2022

Treatment 1	Treatment 2	Treatment 3



Treatment 4	Treatment 5	Treatment 6

October 19, 2022


Treatment 1	Treatment 2	Treatment 3: No plants



Treatment 4	Treatment 5	Treatment 6