AGTIV Mycorrhizal Inoculant Evaluation on Potato and Cereal Crops

Northeastern Ontario, Nipissing West/East Sudbury & Sudbury SCIA
OSCIA Tier 2 Project – Final Report

Purpose

The Ontario Soil & Crop Improvement Association (Northeastern SCIA, West Nipissing SCIA, Sudbury West SCIA) partnered with the Northern Ontario Farm Innovation Alliance (NOFIA) to study the effects of AGTIV Mycorrhizal inoculant on potato and cereal crops. This was an OSCIA Tier Two applied research project and was funded in part by the Ontario Ministry of Agriculture, Food and Rural Affairs through the Canadian Agricultural Partnership, a five-year federal-provincial-territorial initiative. The purpose of the study was to determine the impacts of mycorrhizal inoculants on soil health, plant health and crop yield in potato and cereal crops.

The mycorrhizal inoculant is said to improve plant growth and health, increasing overall yields and quality of the crop. With the added fungi in the soil, the mycorrhizal inoculant also improves soil health and structure by increasing vegetative root growth. This trial tested the effectiveness of the inoculant on improving crop production and soil health. If successful in doing so, the inoculant could improve the quality and yields of crops grown in Northern Ontario, therefore benefiting farmers with increased profits from these crops. Long-term benefits would also be provided from improved soil quality, resulting in higher-quality crops in the future.

Background

The Northeastern Ontario Soil and Crop Improvement Association, in partnership with the West Nipissing/East Sudbury and West Sudbury SCIAs and the Northern Ontario Farm Innovation Alliance, conducted a three-year study to test the effects of Premier Tech's AGTIV mycorrhizal inoculant on potato, soybeans, and oats between 2018 and 2020. The second phase focused only on the highest value crop, potatoes, and ran from 2021 to 2022.

Mycorrhizae are an important and overlooked aspect of soil health. They can improve nutrient uptake, carbon sequestration, water holding capacity of soil and soil tilth. Mycorrhizae are found in soils naturally and can be increased or maintained by practices such as no-till, cover crops, and reduced phosphorus inputs. These fragile underground threads spread like a web throughout soil to act as a path for nutrients over its glomalin network of hyphae and spores.

Due to the potential of increased yield, crop health and soil quality, there is interest in commercial products containing mycorrhizal spores. Over the past two decades, the industry has been able to develop crop and species-specific mycorrhizal amendments to boost the naturally occurring network.

Mycorrhizal fungi are naturally found in soils but farming and soil disturbance leads to a drastic decrease in the fungi population, therefore losing benefits from the symbiotic relationship that the mycorrhizae form with the plant roots. This relationship helps to stimulate plant growth and accelerates root development, producing more vigorous and healthy plants. The fungi can absorb nutrients and water from the soil that would otherwise be unavailable to the crops, transferring these resources to the plant roots, overall increasing plant access to nutrients and water. This positive interaction can increase plant growth and production. The mycorrhizae also help improve soil structure, increase organic matter, and play a positive role in soil aggregation. The mycorrhizal inoculant has been shown to have many benefits on plant growth, by stimulating more vigorous growth, producing healthier, disease-resistant plants and increasing yields. With the aid of water absorption, plants are more drought tolerant. The mycorrhizae also help to optimize fertilizer use by the plants by improving nutrient uptake and can contribute to soil erosion control through improved soil structure. Many trials done on the use of mycorrhizae inoculants on different crops have shown improvements in plant health and yields. Therefore, there is a strong possibility that this product would be a viable option for Northern Ontario farmers to help them improve their crop production.

Premier Tech offers the AGTIV line of biologically active treatments, which, through an inoculant applied at the time of planting, is intended to repopulate and re-establish mycorrhizal networks. The AGTIV line includes treatments optimized for different crops. This product line is of interest to farmers in the north, and as such, was selected as the mycorrhizal inoculant product to be used over the course of this project.

Methods

Three Premier Tech AGTIV mycorrhizal inoculant products were tested annually on their corresponding crops in four locations in Sudbury and West Nipissing regions between 2018 and 2022. The inoculant products tested were as follows:

1. AGTIV Potato Liquid Inoculant
2. AGTIV Field Crops Powder Inoculant
3. AGTIV Field Crops Liquid Inoculant
4. AGTIV Soybean Powder Inoculant

The AGTIV products contain rhizophagus irregularius spores in a liquid suspension (315 000 viable spores/fl.oz). Specifications state that 20-ac can be treated per case, with 2x 32 fl oz bottles per case. Clean, non-chlorinated water is required for dilution. Constant agitation in the tank to reduce settling and clogging is required with this product. It also contains non-soluble particles of <0.2mm, (70 mesh), and filters with openings of at least 0.28mm (50 mesh) are required for application.

The form of inoculant used (e.g. liquid versus powder) was dictated by the equipment available to the farmers conducting the trials. The trials were conducted on two farms in the Sudbury district area and two farms in the West Nipissing area. Each farm conducted trials on 5-acre plots of alternating strips of inoculated and non-inoculated crops. Each farm had two plot sites – one on high fertility soil and one on low fertility soil, selected based on the farmer's knowledge of their fields. The size and spacing of these strips was determined by each farmer's equipment, but each plot had at least four strips of both inoculated and non-inoculated crops. Two farms tested the inoculant on potatoes and two farms tested the inoculant on oats and soybeans.

Trials were, where possible, conducted on the same plots each year in order to measure the effect of three consecutive years of mycorrhizal development in the soil. In order to adhere to farmers' existing crop rotations, the crop grown was changed each year as necessary. In addition to the mycorrhizal inoculant, the crops also received standard fertilizer and pesticide treatments.

The inoculant was either mixed with the seed at planting or applied in-furrow with a starter or pesticide application. Soil samples were taken before the first planting and then taken annually in the fall to observe soil fertility changes. Fields were mapped out and soil samples tracked using the app "Sirrus". Soil samples were sent to A & L Labs for the VitTellus℠ Soil Health Test. Lab results were interpreted and formatted into field maps by Ben Schapelhouman, CCA-ON from TECC Agriculture Ltd.

Plant tissues samples were taken at appropriate times during the season to measure plant health. Regular measurements of plant growth and development were taken throughout the season to compare plant development between the treated plants and the controls. Yield measurements were taken at harvest to measure the overall impact of the mycorrhizal inoculant. To accommodate for crop rotations, soil samples were taken from each replication in years when potato crops were not grown.

2018

Planting in 2018 was delayed due to project approvals, so the inoculant was only applied at one site. Baseline soil samples were obtained from the cooperator and a fall soil sampling event occurred on the inoculated site.

2019

It was planned to take plant tissue samples throughout the growing season but due to timing and lack of labour these samples were not obtained. Regular measurements of plant growth and development were taken throughout the season to compare plant development between the treated plants and the controls. Yield measurements were taken at harvest and crop quality testing was done to measure the overall impact of the mycorrhizal inoculant. To accommodate for crop rotations, soil samples were taken from each replication in years when potato crops are not grown.

2020

During the growth stage of the trials, tissue samples for both inoculated and non-inoculated crops were gathered and analyzed for comparison. Upon harvest, differences in yields between inoculated and non-inoculated strips were recorded and soil samples were taken in both inoculated and non-inoculated plots to gauge the effect of the inoculant on overall soil health. All soil and tissue sample analyses were conducted by A&L Canada Laboratories in London, Ontario. Lab and yield results were interpreted and formatted into field maps by Ben Schapelhouman, CCA-ON of TECC Agriculture Ltd.

2021

In 2021, the inoculant was tested on two potato fields in the Sudbury region.

Within each field, strips of inoculated and non-inoculated potatoes were alternated. The size and spacing of these strips were determined by each farmer's equipment, but each plot had at least four strips of both inoculated and non-inoculated crops. In addition to the mycorrhizal inoculant, the crops also received standard fertilizer and pesticide treatments.

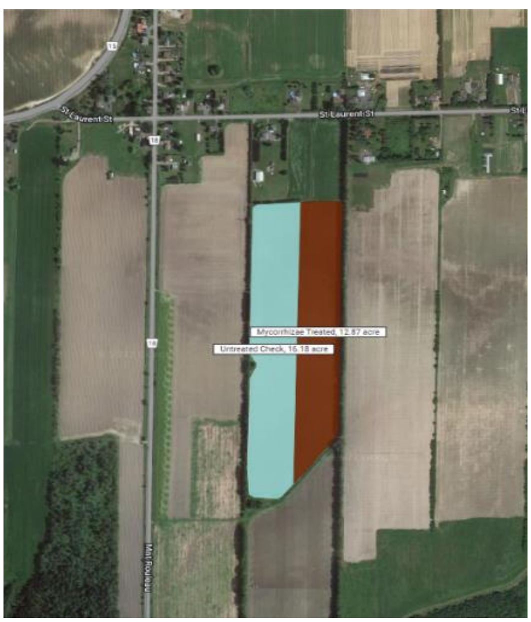
During the growth stage of the trials, tissue samples for both inoculated and non-inoculated crops were gathered and analyzed for comparison. Upon harvest, differences in yields between inoculated and non-inoculated strips were recorded to gauge the effect of the inoculant on crop productivity. All soil and tissue sample analyses were conducted by A&L Canada Laboratories in London, Ontario.

2022

In 2022, AGTIV Potato Liquid by Premier Tech was studied in the field on potatoes. Data was gathered at harvest in late September to early October 2022 in Sudbury, by Ben Schapelhouman, CCA-ON & Founder of TECC Agriculture Ltd., New Liskeard.

A 29-acre field was split into two zone of mycorrhizal-treated (12.87 ac) and untreated potatoes (16.18 ac).

Figure 1 - 2022 Mycorrhizae Treated & Untreated potato plots – (Schapelhouman)



Yields

Oats were grown on one farm in 2019 and two farms in 2020.

Table 1. 2019 Oat yields

	Fertility	Treatment	Harvested Area (ac)	Yield (mt/ac)	Yield (bu/ac) *38lbs/bu
West Nipissing Site 1	Null – Field 1	Inoculated	1.38	2.100	121.78
		Non-inoculated	1.38	2.063	119.63
	Null – Field 2	Inoculated	1.39	1.980	114.84
		Non-inoculated	1.38	1.971	114.31

In 2019, all oat yields together averaged 117.64 bushels per acre. Inoculated plots averaged 118.31 bushels per acre, while non-inoculated plots yielded 116.97 bushels per acre, a difference of 1.34 bushels per acre.

Table 2. 2020 Oat Yields

	Fertility	Treatment	Harvested Area (ac)	Yield (mt/ac)	Yield (bu/ac) *38lbs/bu
West Nipissing Site 2	Low Fertility	Inoculated	3.09	1.476	85.63
		Non-inoculated	3.07	1.447	83.94
	High fertility	Inoculated	1.71	2.590	150.26
		Non-inoculated	1.70	2.588	150.14

In 2020, the difference in yield between high and low fertility fields was significant. The average yield for all oats in 2020 was 117.49 bushels per acre. Inoculated plots averaged 117.94 bushels per acre, while non-inoculated plots averaged 117.04 bushels per acre, a difference of 0.90 bushels per acre.

The oats from West Nipissing Site 1 had poor yields in 2020 due to significant lodging and regrowing. The corresponding yield data was left out of this report. However, prior to these issues, tissue samples were taken and are reported below, followed by tissue samples from West Nipissing Site 2. The purpose of the tissue sample analysis was to determine whether the mycorrhizal inoculant application correlated with increased nutrient and mineral uptake, which would be evident by higher concentrations of nutrients and minerals in the tissue of plants. Increased nutrient and mineral concentrations would be an indicator of the positive effects of the mycorrhizal inoculant, and a sign of healthier, more vigorous, and more disease resistant crops. For oats, samples of the flag leaf at the head emergence from the boot stage were gathered in early July 2020.

Table 3. 2020 Oats Tissue Sample Analysis – West Nipissing Site 1

Measurement	Average of Inoculated Samples	Average of Non-inoculated Samples	Normal Range
Nitrogen (%)	4.61	4.53	2 – 3
Sulfur (%)	0.44	0.39	0.15 - 0.40
Phosphorus (%)	0.28	0.25	0.20 – 0.50
Potassium (%)	1.43	1.40	1.5 – 3
Magnesium (%)	0.41	0.35	0.15 – 0.50
Calcium (%)	1.22	1.08	0.20 – 0.50
Sodium (%)	0.09	0.07	-
Boron (ppm)	9.91	8.71	5 – 10
Zinc (ppm)	22.5	19	15 – 70
Manganese (ppm)	74	59	30 – 100
Iron (ppm)	100.5	121.5	40 – 150
Copper (ppm)	7.13	6.37	5 – 25
Aluminum (ppm)	24	22	-

At West Nipissing Site 1, inoculated oat tissue had higher concentrations of all nutrients and minerals than non-inoculated tissue, with the single exception of iron. This suggests the inoculant does improve plant uptake of nutrients and minerals.

Table 4. 2020 Oats Tissue Analysis – West Nipissing Site 2 Low Fertility Field

Measurement	Low Fertility Inoculated Samples	Low Fertility Non-inoculated Samples	Normal Range
Nitrogen (%)	4.44	4.28	2 – 3
Sulfur (%)	0.46	0.35	0.15 - 0.40
Phosphorus (%)	0.33	0.27	0.20 – 0.50
Potassium (%)	1.71	1.71	1.5 – 3
Magnesium (%)	0.41	0.41	0.15 – 0.50
Calcium (%)	1.59	1.32	0.20 – 0.50
Sodium (%)	0.13	0.20	-
Boron (ppm)	7.91	9.78	5 – 10
Zinc (ppm)	15	12	15 – 70
Manganese (ppm)	19	17	30 – 100
Iron (ppm)	129	107	40 – 150
Copper (ppm)	7	5.97	5 – 25
Aluminum (ppm)	15	15	-

At the low fertility field of West Nipissing Site 2, inoculated oat tissue had higher concentrations of nitrogen, sulphur, phosphorus, calcium, zinc, manganese, iron, and copper than non-inoculated samples. Both inoculated and non-inoculated samples had the same potassium, magnesium, and aluminum concentrations, while non-inoculated samples had higher concentrations of sodium and boron than did inoculated samples.

One of the most significant differences in nutrient and mineral content between inoculated and non-inoculated crops was seen in oats in the low fertility field at West

Nipissing Site 2. This may suggest that the mycorrhizal inoculant is most effective in low fertility fields.

The yield results from that field would seem to agree with that suggestion, as the inoculated oats yielded 85.63 bushels per acre, while the non-inoculated oats yielded 83.94 bushels per acre, a difference of 1.69 bushels per acre. This increase is well above the total average for increased oat yields in this project of 0.92 bushels per acre. However, the soybean results from that same field in the previous year show only a modest increase in yield of 0.15 bushels an acre, so asserting that the inoculant benefits low fertility fields over high fertility fields may not be appropriate.

Table 5. 2020 Oats Tissue Analysis – West Nipissing Site 2 High Fertility Field

Measurement	High Fertility Inoculated Samples	High Fertility Non-inoculated Samples	Normal Range
Nitrogen (%)	3.80	4.10	2 – 3
Sulfur (%)	0.34	0.40	0.15 - 0.40
Phosphorus (%)	0.25	0.26	0.20 – 0.50
Potassium (%)	2.19	2.10	1.5 – 3
Magnesium (%)	0.36	0.34	0.15 – 0.50
Calcium (%)	1.11	1.08	0.20 – 0.50
Sodium (%)	0.05	0.07	-
Boron (ppm)	5.70	8.77	5 – 10
Zinc (ppm)	18	20	15 – 70
Manganese (ppm)	12	14	30 – 100
Iron (ppm)	98	98	40 – 150
Copper (ppm)	5.9	6.6	5 – 25
Aluminum (ppm)	17	20	-

The least positive tissue sample results came from the high fertility field of West Nipissing Site 2, where non-inoculated oat tissue had higher concentrations of nitrogen, sulphur, phosphorus, sodium, boron, zinc, manganese, copper, and aluminum than inoculated samples. Both inoculated and non-inoculated samples had the same iron concentrations, while inoculated samples had higher concentrations of potassium, magnesium, and calcium.

Soybeans were grown on two farms in West Nipissing in 2019 and at one farm in West Nipissing in 2020.

Table 6. 2019 Soybean Yields

<table>
<tr><th></th><th>Fertility</th><th>Treatment</th><th>Harvested Area (ac)</th><th>Yield (mt/ac)</th><th>Yield (bu/ac) *60lbs/bu</th></tr>
<tr><td rowspan="4">West Nipissing Site 1</td><td rowspan="2">Null – Field 1</td><td>Inoculated</td><td>1.42</td><td>1.392</td><td>51.17</td></tr>
<tr><td>Non-inoculated</td><td>1.42</td><td>1.367</td><td>50.23</td></tr>
<tr><td rowspan="2">Null – Field 2</td><td>Inoculated</td><td>1.42</td><td>1.367</td><td>50.23</td></tr>
<tr><td>Non-inoculated</td><td>1.38</td><td>1.280</td><td>47.06</td></tr>
</table>

West Nipissing Site 2	Low Fertility	Inoculated	3.09	0.828	30.42
		Non-inoculated	3.07	0.824	30.27
	High fertility	Inoculated	1.70	0.953	35.01
		Non-inoculated	1.71	0.970	35.64

At West Nipissing Site 1, the higher fertility plots had higher measured levels of potassium and organic matter, while the lower fertility plots had lower potassium and phosphorus levels. A site visit on July 9, 2019 showed visible differences in in the root development between the inoculated and non-inoculated soybean plants, as can be seen in figure 2 below.

Figure 2. July 9, 2019 – root comparison of inoculated soybeans (right) versus non-inoculated roots (left).

The 2019 soybean plots were harvested on October 12. Together, all yields averaged 41.25 bushels per acre. Inoculated plots averaged 41.70 bushels per acre, while non-inoculated plots yielded 40.8 bushels per acre, a difference of 0.9 bushels per acre.

Soybean tissue samples were gathered in early July 2020. Samples were taken from recent fully developed leaves at the full bloom stage of growth.

Table 7. 2020 Soybeans Tissue Sample Analysis – West Nipissing Site 1

Measurement	Average of Inoculated Samples	Average of Non-inoculated Samples	Normal Range
Nitrogen (%)	4.62	4.78	5.10 – 6.20
Sulfur (%)	0.23	0.24	0.20 – 0.50
Phosphorus (%)	0.39	0.4	0.30 – 0.50
Potassium (%)	1.78	1.68	2 – 2.6
Magnesium (%)	0.36	0.35	0.40 – 0.60
Calcium (%)	1.03	1.03	0.80 – 2
Sodium (%)	0.03	0.05	-
Boron (ppm)	18.75	28.48	20 – 70
Zinc (ppm)	51.5	46	20 – 60
Manganese (ppm)	51	42.5	20 – 100
Iron (ppm)	82	82.5	50 – 300
Copper (ppm)	12.3	12.3	7 – 15
Aluminum (ppm)	5	3.3	-

At West Nipissing Site 1, inoculated soybean tissues had higher concentrations of potassium, magnesium, zinc, manganese, and aluminum than non-inoculated tissue samples. Both inoculated and non-inoculated samples had the same calcium and copper concentrations, while non-inoculated samples had higher concentrations of nitrogen, sulphur, phosphorus, sodium, boron, and iron than did inoculated samples.

Potato plots were grown on two farms in 2019, and on one farm in 2020, all of which were in Sudbury district.

2019 Potato Yields

Due to mechanical issues at harvest, exact yield measurements could not be conducted. However, the farmers estimated an approximately 15 percent greater yield in the inoculated potatoes compared to the non-inoculated potatoes. This would correspond to site visits conducted in July 2019 that showed increased root and foliage development in inoculated versus non-inoculated potato plants.

Figure 3. A comparison of root development in non-inoculated (left) and inoculated potato plants. July 2019.

Figure 4. A comparison of foliage development in inoculated (bottom) and non-inoculated (top) potato plants. July 2019

2020 Potato Yields

In 2020, yield measurements were conducted just prior to harvest at Sudbury Site 1. The field was subdivided into four equal sections lateral to the length of the field. Within these divisions samples of both inoculated and non-inoculated strips were gathered by digging up 1 metre lengths of the potato row, weighing the resulting potatoes, and returning them to the soil for harvest a day or two later. In this way, 48 samples of inoculated potato strips and 48 samples of non-inoculated potatoes were measured, representing samples evenly distributed across the entire field.

The inoculated samples ranged in weight from 4.9 kg/m to 7.4 kg/m, and had an overall average weight of 5.981 kg/m. The non-inoculated samples ranged in weight from 4.0 kg/m to 7.9 kg/m and had an overall average weight of 5.945 kg/m. this represents a yield difference of 0.6%.

2019 - 2020 Yield Analysis

Over the course of the project, all crops showed increased yields which correlated with the application of the mycorrhizal inoculant. Inoculated soybeans, in the two years of data gathered, showed an average increase of 0.825 bushels per acre over non-inoculated soybeans. Inoculated oats showed an average increased yield of 0.92 bushels per acre over non-inoculated oats. Potato yields were harder to quantify due to the combination of qualitative and quantitative data. In 2019, farmers reported an estimated 15% increase in yield in inoculated potatoes over non-inoculated potatoes. In 2020, the yield sampling showed a more modest increase of 0.6% in inoculated over non-inoculated potatoes.

Potato tissue samples were gathered 70 days after emergence in mid July 2020. Samples were collected from the fourth petiole from the top of the potato plants.

Table 8. 2020 Potatoes Tissue Analysis – Sudbury Site 1

Measurement	Average of Inoculated Samples	Average of Non-inoculated Samples	Normal Range
Nitrogen (%)	4.80	3.80	2.49 – 3
Nitrate Nitrogen (%)	2.38	2.90	0.80 – 1.10
Sulfur (%)	0.26	0.23	0.24 – 0.35
Phosphorus (%)	0.27	0.34	0.24 – 0.35
Potassium (%)	11.58	11.89	8 – 11
Magnesium (%)	0.41	0.36	0.30 – 0.80
Calcium (%)	0.55	0.53	1.40 – 3.
Sodium (%)	0.03	0.02	0.03
Boron (ppm)	17.23	17.19	36 – 60
Zinc (ppm)	53	51	35 – 60
Manganese (ppm)	63	46	60 – 200
Iron (ppm)	109	78	49 – 100
Copper (ppm)	21.82	17.19	10 – 30
Aluminum (ppm)	42	31	-

At Sudbury Site 1, the inoculated potato tissue samples had higher concentrations of nitrogen, sulphur, potassium, magnesium, calcium, sodium, boron, zinc, manganese, iron, copper, and aluminum. Non-inoculated samples had higher concentrations of nitrate nitrogen, phosphorus, and potassium.

2021 Potato Yield

In 2021, yield measurements were conducted just prior to harvest at the trial site. The field was subdivided into four equal sections perpendicular to the length of the alternating inoculated and non-inoculated strips of potatoes. Within these divisions samples of both inoculated and non-inoculated strips were gathered by digging up 1 metre lengths of the potato row, weighing the resulting potatoes, and returning them to the soil for harvest a day or two later. In this way, 72 samples of inoculated potato strips and 72 samples of non-inoculated potatoes were measured, representing samples evenly distributed across the entire field.

The inoculated samples ranged in weight from 3.1 kg/m to 8.6 kg/m, and had an overall average weight of 5.665 kg/m. The non-inoculated samples ranged in weight from 3.4 kg/m to 8.0 kg/m and had an overall average weight of 5.311 kg/m. The inoculated potatoes had an average increased yield of 0.354 kg/m over the non-inoculated potatoes. This represents an increase of 6.67%.
Potato tissue samples were gathered 70 days after emergence in July 2021. Samples were collected from the fourth petiole from the top of the potato plants.

Table 9. 2021 Potatoes Tissue Analysis – Sudbury Site

Measurement	Average of Inoculated Samples	Average of Non-inoculated Samples	Normal Range
Nitrogen (%)	4.15	4.18	2.79 – 3.50
Nitrate Nitrogen (%)	1.23	1.34	0.79 – 1.10
Sulfur (%)	0.30	0.34	0.17 – 0.35
Phosphorus (%)	0.26	0.28	0.24 – 0.35
Potassium (%)	9.855	9.46	8 – 11
Magnesium (%)	0.27	0.30	0.29 – 0.80
Calcium (%)	0.46	0.45	1.40 – 2.50
Sodium (%)	0.03	0.025	0.03
Boron (ppm)	23.75	24.43	29 – 50
Zinc (ppm)	52	65	34 – 60
Manganese (ppm)	148.5	138.5	60 – 200
Iron (ppm)	63	55	99 – 200
Copper (ppm)	11.00	18.63	8 – 20
Aluminum (ppm)	30.5	26	300

The inoculated potato tissue samples had higher concentrations of potassium, calcium, sodium, manganese, iron, and aluminum. Non-inoculated samples had higher concentrations of nitrogen, sulphur, nitrate nitrogen, phosphorus, magnesium, boron, zinc, and copper.

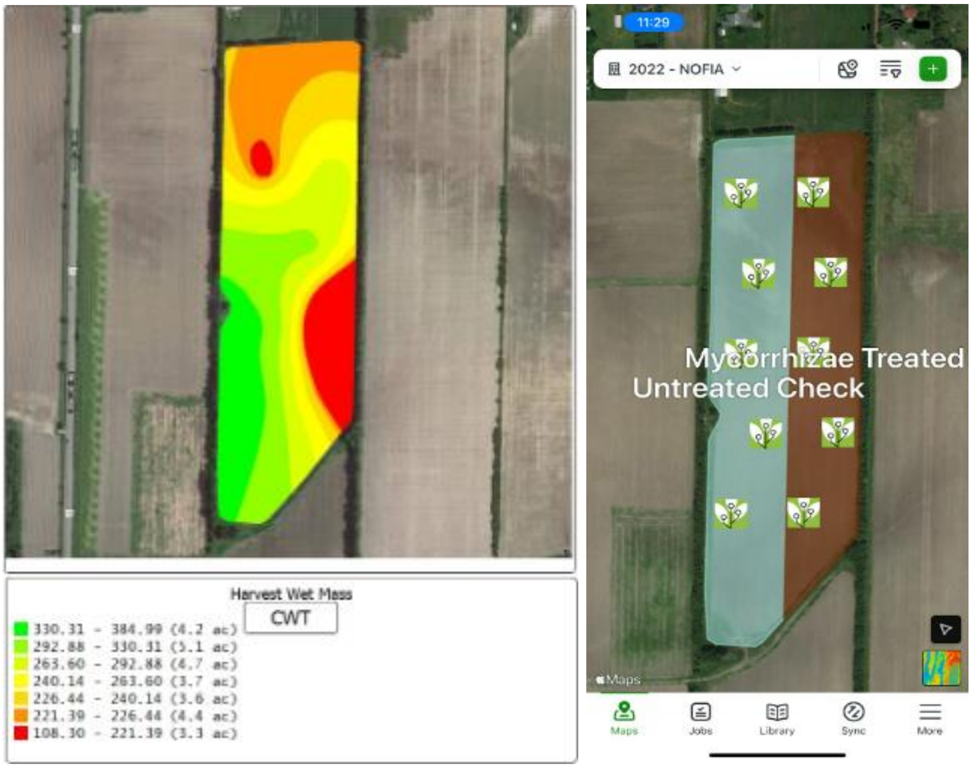
2022 Potato Yield

This trial did not show any benefit to applying the mycorrhizal inoculant to the potatoes. Treated yields averaged 233 lbs per acre cwt (or 36.05 lb per 22.5 row inches). The untreated potatoes yielded at 289 lbs per acre cwt (or 46.774 lb per 22.5 row inches). Results indicate that the inoculant product used did not have either a positive or negative impact on the crop.

Table 10. 2022 Potato Yield – Sudbury Site

Longitude	Latitude	Field	Name	Yield (lbs) per 22.5' of row	Yield per acre (cwt)
-81.087386	46.592373	Mycorrhizae Treated	Treated 1	N/A	N/A
-81.087101	46.591413	Mycorrhizae Treated	Treated 2	42.8	276
-81.087383	46.590453	Mycorrhizae Treated	Treated 3	46.8	302
-81.086984	46.589493	Mycorrhizae Treated	Treated 4	16.6	107
-81.087541	46.588532	Mycorrhizae Treated	Treated 5	38	245
-81.088542	46.592356	Untreated Check	Untreated 1	34.2	221
-81.088257	46.591396	Untreated Check	Untreated 2	33	213
-81.088539	46.590436	Untreated Check	Untreated 3	47.6	307
-81.08814	46.589476	Untreated Check	Untreated 4	50.07	323
-81.088697	46.588516	Untreated Check	Untreated 5	59	381
				Untreated Total	289
				Treated Total	233
				Field Average	**261**

Figure 5 – 2022 Harvest wet mass and treated vs untreated field boundaries



Economic Analysis

2020

Table 11. A Comparison of Increased Income and Cost of Inoculant Application

Crop	Cost of Inoculant Application per Acre	Income Increase Correlated with Inoculant Application per Acre	Net Income Result of Inoculant Application per Acre
Oats	$11.95	$4.23	- $7.63
Soybeans	$14	$11.55	- $2.45
Potatoes	$55	$31.05	- $23.95

The AGTIV field crops powder inoculant product, which was used for oats, costs $478 for a 2kg bucket, which covers 40 acres. The AGTIV field crops liquid inoculant costs $239 for a 950ml bottle, which covers 20 acres. Both products come out to an approximate application cost of $11.95 per acre. Given an oat price of $4.60 per bushel (approximate price of January 2021) the inoculant correlates with an average increase in income of $4.23 (0.92 bushels) per acre, which, subtracted from the $11.95 per acre application cost, results in a net decrease in income of $7.63 per acre.

The AGTIV soybean powder inoculant product costs $560 for 4.7kg bucket, which covers 40 acres. This results in an approximate cost of $14 per acre to inoculate. Given a soybean price of $14 per bushel (approximate price of January 2021), the inoculant correlates with an average increase in income of $11.55 (0.825 bushels) per acre, which, subtracted from the $14 per acre application cost, results in a net decrease in income of $2.45 per acre.

The AGTIV potato liquid inoculant product costs $550 for a 950ml bottle, which covers 10 acres. This results in an approximate application cost of $55 per acre. Potatoes are priced per hundredweight (cwt), or 100lbs. OMAFRA lists the 2018 (the latest year of data available) average potato yield to be 205 cwt per acre. At a price of $25.25 per cwt (approximate price of January 2021) average income for an acre of potatoes would be $5,176.25. In 2019 inoculated potato yields were estimated at 15% more than non-inoculated potatoes, while 2020 yield sampling showed a difference of 0.6% in inoculated over non-inoculated potato yields. Applying the 15% yield increase estimate to the $5,176.25/acre numbers would mean inoculation results in an increase in income of approximately $776.43 per acre. Applying the 0.6% yield increase measurement to the $5681.25/acre numbers would mean inoculation results in an increase in income of approximately $31.05. Given the $55 per acre application cost of the inoculant, the 15% estimate would result in a net increase in income of $721.43 per acre, while the 0.6% measurement would result in a net decrease in income of $23.95 per acre.

This economic analysis takes into account only the application cost of the inoculant and the correlated increased yield. It does not account for other potentially positive outcomes from the inoculant, such as more disease-resistant plants and better uptake of soil nutrients. For example, it would not take into account the potential saved cost of additional spraying for a deficiency that these crops did not have because they received the inoculant.

2021

Table 12. Comparison of Increased Income and Cost of Inoculant Application 2021

Crop	Cost of Inoculant Application per Acre	Income Increase Correlated with Inoculant Application per Acre	Net Income Result of Inoculant Application per Acre
Potatoes	$55	$345.25	$290.25

In 2021, the inoculated potatoes had a yield that was 6.67% higher than the non-inoculated potatoes. Applying that 6.67% yield increase measurement to the average income per acre of potatoes of $5,176.25 would increase the income to $5,521.50/acre, suggesting that inoculation results in an increase in income of approximately $345.25 per acre. Given the $55 per acre application cost of the inoculant, 6.67% yield increase measurement would result in a net increase in income of $290.25 per acre.
This economic analysis takes into account only the application cost of the inoculant and the correlated increased yield. It does not account for other potentially positive outcomes from the inoculant, such as more disease-resistant plants and better uptake of soil nutrients. For example, it would also not take into account the potential saved cost of additional spraying for a deficiency that these crops did not have because they received the inoculant.

2022

In 2022, the inoculated potato yield did not show the same benefit as the year prior. The yield of the non-inoculated potatoes was higher by 8.06%. No economic benefit to application was observed, as the yield was lower for inoculated potatoes.

Applying that 8.06% yield decrease measurement to the average income per acre of potatoes of $5,176.25 would decrease the income by $417/ac to $4,759.05, at a price of $25.25 per cwt (approximate price of January 2021

Table 13. Comparison of Increased Income and Cost of Inoculant Application - 2022

Crop	Cost of Inoculant Application per acre	Income Decrease Correlated with Inoculant Application per acre	Net income result of inoculant application per acre
Potatoes	$55	-417.20	-417.20

Summary

The results of this project suggest that, while the mycorrhizal inoculant application can correlate with improved plant health and yield, that increased yield does not, on average, outweigh the cost of the inoculant application.

2019 trials had poorly tracked yield but did show a slight yield benefit from the inoculant in soy, oats and potatoes. In 2020, inoculated plant tissue from soy, oat and potato regularly had significantly higher concentrations of nutrients and minerals than non-inoculated plants, and only rarely had significantly lower concentrations. This suggests that the mycorrhizal inoculant does allow plants to become healthier and more vigorous. The yield benefits were not enough to offset the cost of application.

The 2021 trial tested only potatoes. Yield data showed promising results that suggested the mycorrhizal inoculant increased yield enough not just to cover the cost of application, but also to significantly increase the income from potatoes per acre.

In 2022, potatoes only were trialed again. Results in 2022 were not favorable to recommend the application of AGTIV for potato production and showed a potential economic and yield loss.

This product works in a way that supports the soil food web, and many factors need to be considered, including crop rotation, available and unavailable soil phosphorous, non-chlorinated water source, product agitation, tillage that might damage development, length of crop season and whether the crop species supports or inhibits mycorrhizal root colonization.

Next Steps

There may be benefit in exploring the usefulness of applying the inoculant to a crop that would require more mycorrhizal support, such as corn. Ben Schapelhouman (CCA-ON) suggests that a response may be seen from this product line in a rotation of canola followed by treated corn.

More work is currently being completed to better understand indigenous (naturally occurring) mycorrhizae, by University of Guelph professor Josh Nasielski in Temiskaming and Dr. Pedro Antunes from Algoma University, by collecting inoculum from sorghum-sudangrass for more sustainable and profitable canola-soybean rotations. We look forward to reporting on that study to determine how effective agricultural biologicals sourced from plant and soil microbiomes are for increasing crop productivity, and if they could be a substitute for synthetic fertilizers and pesticides (measuring environmental, economic and plant health impacts).

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References:

Hijri, M. 2016. Analysis of a large dataset of mycorrhiza inoculation field trials on potato shows highly significant increases in yield. Mycorrhiza 26, 209–214 (2016). https://doi.org/10.1007/s00572-015-0661-4

Douds Jr., D.D., Nagahashi, G., Reider, C., and Hepperly, P.R. 2007. Inoculation with Arbuscular Mycorrhizal Fungi Increases the Yield of Potatoes in a High P Soil, Biological Agriculture & Horticulture, 25:1, 67-78, DOI: 10.1080/01448765.2007.10823209

Location of Project Final Report:

www.nofia-agri.com

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