

Atlantic Grains Council

Agri-Innovation Project

Focused Research for Atlantic Grain and Oilseed
Producers

Cereal and Corn Management Trials
2020 Summary



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Summary

Management trials for cereal and corn were conducted in both small plot and on-farm trials in 2020 under the Atlantic Grains Council Agri-Innovation Project. The Cereal and Oilseed Research Group (CORG) of the Faculty of Agriculture, Dalhousie University in Truro, NS was responsible for the design, setup, seed packaging, data analysis, and report preparation.

Normally, cooperation from Agriculture and Agri-Food Canada, Harrington PEI, and NBSCIA Hartland NB allowed for duplicate trials to be conducted on the other 2 Maritime Provinces.

However, due to challenges related to the global pandemic (COVID-19), not all trials that were originally planned could be conducted. Due to COVID-19 restrictions, all field trials in Nova Scotia conducted by Dalhousie University in 2020 were conducted in the Annapolis Valley of NS.

Summaries for each of the trials carried out in 2020 are presented here with details of the trial treatments, trial locations, site information and data collected.

A weather summary for 2020 trial sites is found in Table 1. The dates of the weather data are from the earliest planting date of any of the trials to the end of September, representing the date on or close to the first killing frost.

A comprehensive multi-year, multi-site analysis of the trials will be conducted at the end of year 3. The data shown in this report is for year 2 only and should be considered preliminary in nature. At the end of the 2021 testing, data will be pooled from all sites and years to provide reliable information for the final analysis, as well as reports and fact sheets for dissemination to growers.

However, there are some preliminary takeaway lessons from the 2020 trials:

1. Results from both the management trials and the seeding date by seeding rate trials indicate that AAC Synergy is a responsive, adaptable cultivar with flexibility on seeding date and ability to utilize increased nitrogen fertility.
2. Priestly winter wheat has demonstrated a greater responsiveness to management including nitrogen than the other cultivar in the trial, Pioneer 25R34.
3. Underseeding winter wheat in the spring with red clover had a positive impact on yield of the following corn crop without negatively affecting the yield of the wheat.

Table 1. 2020 Weather Summary Atlantic AGC Trial Site –

Site	Dates	GDD*(5 °C)	CHU**	Precipitation (mm)
Canning, NS	May 21 st – Sept.30 th	1540	2100	604.6

**Growing degree days (base temperature 5 °C) **Corn Heat Units*

Weather data compiled by <https://www.weatherstats.ca> and reported by Environment and Climate Change Canada

Management of New Cultivars of Spring and Winter Wheat & 2-Row Barley

Introduction

The objective of this trial is to determine the individual and interactive effects of N levels and management techniques (fungicides & plant growth regulator (PGR)) on newly recommended cultivars of spring wheat, winter wheat, and 2-row barley. Newly recommended cereal varieties have been chosen based on their growth characteristics in Atlantic Canada that show potential economic response to inputs for local farmers. Due to the recent release of these cultivars, there are questions concerning the optimal growth and management techniques needed to maximize yield and grain quality within the maritime climate. Best management practices related to cereal growth and production have been based on older varieties that do not exhibit the yield and quality potential that newly bred varieties have shown.

To better define the fertility and management requirements of these new varieties, a 2-factor study was designed that varied the nitrogen application levels based on previous recommendations and applications of recommended fungicide and a plant growth regulator. Note that the winter wheat trial was initiated in the autumn of 2019 in both Canning, and Truro; however, due to the research restrictions imposed by the Covid 19 pandemic, the Truro location had to be abandoned.

Materials & Methods

The study was carried out in one location in NS due to the impact of COVID-19 restrictions. Trials were run on a small plot basis as a factorial randomized complete block design as shown in Table 2. Three nitrogen levels were used to determine N fertility response; these were, the

recommended level of nitrogen (1N), half the recommended level of nitrogen (0.5N), and one and a half the recommended level of nitrogen (1.5N). Four management techniques were chosen to determine the management requirements; these were no application of fungicide or PGR; fungicide application only; PGR application only; both fungicide and PGR application (Table 2).

Table 2. Cereal management treatments

Factor - A Nitrogen level	
1	0.5 X Recommended Rate (0.5N)
2	1.0 X Recommended Rate (1N)
3	1.5 X Recommended Rate (1.5N)
Factor B – Fungicide & PGR	
1	Check: No Fungicide or PGR application
2	Fungicide application only
3	PGR application only
4	Both Fungicide and PGR applied

Specific management for spring cereals:

Nitrogen levels applied were as follow:

- 0.5N seeding rate - 45 kg/ha N, applied pre-seeding;
- 1N seeding rate - 45 kg/ha N, applied pre-seeding + 45 kg/ha applied at ZGS30.
- 1.5N seeding rate - 45 kg/ha N, applied pre-seeding + 89 kg/ha applied at ZGS30.

PGR applied was Ethrel at 1 L/ha (*Ethephon 240 g/L*),

Fungicide used was Prosaro XTR at 800 mL/ha (*Prothioconazole 125 g/L, Tebuconazole 125 g/L*).

Note: All plots received a pesticide application of Malathion 85E @ 1075 mL/ha: on June 17, 2020 to combat infestation by cereal leaf beetle.

Specific management for winter wheat:

Nitrogen levels applied were as follows :

- No application was made in the fall.
- Farmer applied 60 lb/ac (67 kg/ha) of ATS on April 26 which is 8 kg/ha N. to all plots

This was topped up to the 45 kg/ha N on May 15 by applying 80 kg/ha urea (46-0-0). This met the lower nitrogen application level of 0.5N.

-Applications for the 1N and 1.5N were made on June 1st. There were 97 kg/ha urea for the 1N and 195 kg/ha urea for the 1.5N rate.

The PGR Ethephon was applied June 2nd at 1.75 L/ha. The fungicide Prosaro XTR was applied June 16 at 800 mL/ha.

Data collection consisted of days to emergence, plant stand count (ZGS13), head count (ZGS83), plant height (ZGS 87) lodging, disease ratings (FHB, *Septoria*), maturity date, yield (kg/ha @ 13% moisture), test weight (kg/hl), thousand kernel weight (TKW), lodging score (based on the Belgian Lodging Scale), and disease ratings (based on rating the presence of common leaf diseases). Information for each site, including base soil analysis, plot size, seeding date, management, and harvest dates are presented in Table 3.

Table 3. 2020 Trial Information Canning Nova Scotia

	Spring cereals	Winter wheat
Previous Crop	Soybeans	Soybeans
pH	5.62	5.73
Organic Matter (%)	2.8	2.8
P ₂ O ₅ (kg/ha)	1314	1276
K ₂ O (kg/ha)	400	387
Seeding Date	22/5/2020	23/9/2019
Seeding Rate	Barley:350/m ² Wheat:400/m ²	350/m ²
Cultivar	Barley: AAC Synergy Wheat: AAC Scotia, Helena	Priestly Pioneer 25R34
Fertility	Varied based on trial	Varied based on trial
Seeded Area	6x1.25 = 7.5m ²	6x1.25 = 7.5m ²
# Rows	8	8
Row Spacing	15cm	15cm
Harvest Date	19/8/2020	7/8/2020
Harvest Area	5X1.25 = 6.25m ²	5X1.25 = 6.25m ²
Pesticide Rate and Date	Malathion 85E @ 1075 mL/ha 17/6/2020	

Results / Conclusions

This is the second year of testing of these cultivars in response to management inputs and nitrogen level. The following tables outline the results obtained during the 2020 growing season. Tables 4, 6 and 9 show the statistically significant results, with significance based on a $P < 0.05$. Values that show significance are emphasized with bold type.

Spring cereals

The spring wheat and barley cultivars responded differently to the treatments at the site. Table 4 shows the result for the 2-row barley cultivar, AAC Synergy. It responded significantly to the nitrogen applications for every parameter other than thousand kernel weight (TKW). While there are indications that yield was increased by the application of both fungicide and PGR, this cultivar did not respond significantly to the cultural management factor for any of the parameters. This may be due to the exceptionally dry summer of 2020. Similarly, there were no significant interactions of the two factors (management and nitrogen). Table 5 shows the means for the significant effects for AAC Synergy. Note that the grain yield was significantly increased with the 1.5N treatment. Although there was an increase in lodging at this higher nitrogen level, it was not a significant problem for harvest. This indicates that this cultivar may be one that could utilize increased nitrogen fertility.

. Table 7 shows the means for variables for AC Helena. This spring wheat variety showed little response to the treatments. However, it should be noted that there was difficulty in obtaining good seed for this trial. The seed that was used was 2 years old resulting in poor emergence and vigor. There is little doubt that this had an impact on the overall response of the cultivar to the treatment inputs. New vigorous seed is required for this trial to be repeated. Table 8 shows AAC Scotia is responsive to both nitrogen and management techniques, with significant results seen across every parameter except for TKW for the N level factor. It also showed significant effects for yield and height for management practices, all other metrics for management practices had no effect. Although, the nitrogen treatment affected yield, the 1.0N treatment proved equivalent to the higher level of nitrogen application. There are indications that the application of fungicide on its own and potentially fungicide with PGR is a benefit to this cultivar. This will have to be confirmed in 2021. There were no significant interactions between nitrogen application and management.

Table 4. P-values for nitrogen and management effects on 2-row barley cultivars Canning NS site

Cultivars	Factor	Yield (Kg/ha)	Height (cm)	Lodging	Kg/hl	TKW (g)
AAC Synergy	N Level	<0.005	<0.005	<0.005	<0.005	0.154
	Cultural practice	0.309	0.072	0.680	0.950	0.604
	Interaction	0.463	0.526	0.684	0.804	0.951

*note significance level $\alpha=0.05$

Table 5. Comparison of significant results for 2-row barley, AAC Synergy

Factor	sub factor	yield	test weight	TKW	height	Lodging
N Level	0.5N	2762C	57.1B	38.1A	60.5B	0.3B
	1.0N	3434B	58.3A	38.2A	66.6A	1.1B
	1.5N	3880A	58.8A	37.0A	69.6A	4.9A
Mgmt	None	3280A	58.2A	38.4A	67.8A	2.4A
	Fungicide	3227A	58.0A	37.8A	66.4A	2.1A
	PGR	3387A	57.9A	37.6A	64.0A	1.7A
	Fungicide and PGR	3541A	58.1A	37.5A	64.1A	2.0A

*note means that share the same letter are not significantly different from each other

Table 6. P-values for nitrogen and management effects on spring wheat cultivars

Cultivars	Factor Response	Yield (Kg/)	Height (cm)	Lodging	Kg/hl	TKW (g)
AC Helena	N Level	0.606	0.652	n/a	0.002	0.201
	Management	0.624	0.035	n/a	0.225	0.199
	Interaction	0.971	0.096	n/a	0.884	0.441
AAC Scotia	N Level	0.036	0.004	<0.001	<0.001	0.463
	Management	0.044	0.002	0.092	0.871	0.837
	Interaction	0.973	0.221	0.742	0.842	0.482

*note significance level $\alpha=0.05$

Note: AC Helena did not lodge across any of the treatments.

Table 7. Comparison of significant results for spring wheat, AC Helena

Factor	Sub Factor	Yield (Kg/ha)		Kg/Hl		TKW		Height		Lodging	
N level	0.5N	3805	A	69.8	A	30.4	A	99.96	A	n/a	n/a
	1.0N	3930	A	67.7	B	29.4	A	102.4	A	n/a	n/a
	1.5N	4057	A	67.4	B	29.4	A	101.3	A	n/a	n/a
Mgmt technique	None	3771	A	69.2	A	30.5	A	102.1	A, B	n/a	n/a
	Fungicide	3916	A	68.1	A	29.3	A	105.4	A	n/a	n/a
	PGR	3889	A	67.5	A	29.3	A	96.1	B	n/a	n/a
	Fungicide & PGR	4146	A	68.3	A	29.9	A	100.0	A, B	n/a	n/a

*note means that share the same letter are not significantly different from each other

Table 8 Comparison of significant results for spring wheat, AAC Scotia

Factor	Sub Factor	Yield (Kg/ha)		Kg/Hl		TKW		Height		Lodging	
N level	0.5N	4191	B	74.0	A	34.1	A	104.3	A	1.3	A
	1.0N	4503	A	72.7	B	33.9	A	107.2	A B	2.3	A
	1.5N	4479	A	72.2	B	33.6	A	111.1	A	5.2	B

Mgmt technique	None	4182	B	73.0	A	33.9	A	109.2	A	3.1	A
	Fungicide	4399	A, B	73.1	A	33.8	A	111.3	A	3.7	A
	PGR	4360	A	72.8	A	33.8	A	101.9	B	2.3	A
	Fungicide & PGR	4624	A, B	73.0	A	34.2	A	106.7	A, B	4.5	A

***note means that share the same letter are not significantly different from each other**



Figure 1: Lodging in the spring wheat AAC Scotia management trial September 1

Winter wheat

Two cultivars of winter wheat (Priestly and Pioneer 25R34) were tested on the farm of Tim Ansems near Port Williams Nova Scotia in 2020. Figure 2 shows a view of the treatments cut out of the commercial field of Mr. Ansems.



Figure 2: Winter wheat management trial, June 2, showing flags for individual treatments

Tables 9a and 9b show the P values for the treatments on these 2 winter wheat cultivars. Nitrogen had an effect on both test weight and thousand kernel weight for the Pioneer variety, while management affected plant height significantly and there was an interactive significant effect on thousand kernel weight. Tables 10 A, B, C show the means for these significant effects. Nitrogen had a significant effect on Priestly yield and the test weight while management affected only plant height. 2020 was a very dry summer and there was no lodging or significant leaf or head disease seen in any of the treatments. Tables 11 a, b, and c show the means for significant effects for Priestly.

In general, Priestly appears to be more responsive to management than does Pioneer25R34. Despite the dry conditions, Priestly showed significant response to nitrogen, although it appears that moisture limited the response.

Table 9a: P values for nitrogen and management effects on Pioneer 25R34 winter wheat

Factor Response	Yield (Kg/ha)	Plant Height (cm)	Kg/hl	TSW (g)	Lodging	Disease (Septoria)
N Level	0.153	0.987	<0.001	0.010	0.088	0.440
Cultural practice	0.113	0.002	0.248	0.453	0.514	0.524
Interaction	0.284	0.281	0.377	0.036	0.498	0.440

Table 9b: P values for nitrogen and management effects on Priestly winter wheat

Factor Response	Yield (Kg/ha)	Plant Height (cm)	Kg/hl	TSW (g)	Lodging	Disease rating (Septoria)
N Level	0.020	0.813	0.006	0.227	0.368	0.070
Cultural practice	0.053	<0.001	0.361	0.916	0.357	0.446
Interaction	0.464	0.485	0.209	0.882	0.899	0.804

*note significance level $\alpha=0.05$

Pioneer 25R34

Table 10 a: Table of means for N effects Kg/Hl (test weight) Pioneer 25R34

N Level	Test weight	TKW
1.5N	77.0 A	37.9 A
1.0N	76.5 A	37.8A
0.5N	75.5 B	36.3 B

Means that do not share a letter are significantly different.

Table 10b: Table of means for management effects Height (cm) Pioneer 25R34

Management	Mean
Fungicide	80 AB
Fungicide + PGR	76 BC
PGR	75 C
None	80a

Means that do not share a letter are significantly different.

Table 10 C: Table of interaction means for TSW (g) for Pioneer 25R34

Means that do not share a letter are significantly different.

N Level * Cultural Practice	Mean
1.5N * Fungicide	39.6 A
1.0N * Fungicide	38.8 AB
1.5N * Fungicide + PGR	38.2 ABC
1.0N * PGR	37.7 ABC
1.0N * None	37.3 BC
1.0N * Fungicide + PGR	37.2 BCD
0.5N * None	36.9 BCD
1.5N * PGR	36.8 BCD
0.5N * Fungicide + PGR	36.8 BCD
1.5N * None	36.7 CD
0.5N * PGR	36.6 CD
0.5N * Fungicide	35.0 D

Priestly

Figure 11a: Table of means for N effects on yield, and test weight for Priestly winter wheat

N Level	Yield (kg/ha)	Test weight
1.5N	5411 A	78.8 A
1.0N	5287AB	79.1 A
0.5N	4763B	77.0 B

Means that do not share a letter are significantly different.

Figure 11b: Table of means for management effects on Height (cm) for Priestly winter wheat

Management	Plant height
Fungicide	81 AB
Fungicide + PGR	79 ABC
PGR	77 ABC
None	83 A

Means that do not share a letter are significantly different.

Response of Spring Wheat and 2-Row Spring Barley to Seeding Rates and Seeding Dates

Introduction

The objective of this trial is to determine the individual and interactive effects of seeding at different dates and rates on growth and yield of one new recommended cultivar of 2-row barley and one of spring wheat. New recommended cereal varieties have been chosen based on their beneficial growth characteristics in Atlantic Canada and potential benefit to local farmers. Due to the relatively recent release of these cultivars, there are questions concerning the optimal growth and management techniques needed to maximize yield and grain quality within the maritime climate. Best management practices related to cereal growth and management have been based on older varieties that do not exhibit the yield and quality potential that newly bred varieties have shown.

Many newly bred cereal cultivars show reduced maturity dates and tillering which may lead to changes in the conventional seeding date and rate recommendations that growers should use. To determine the ideal date and seeding rate for these cultivars, three dates were chosen representing an early seeding (April 10 - 20), normal seeding (May 1 – 15), and late seeding (June 1-7). Three seeding rates (200 m², 400 m², and 600 m²) were applied at each date. Poor conditions early in the season of 2020 did not allow for the 1st seeding date to occur. This is the second year's trial data and is comprised only of one site; as such, patterns and emerging trends may only be visible when multiple site years can be analyzed together.

Materials & Methods

The cereal date by rate trial conducted in 2020 was severely limited by the COVID-19 restrictions. The trial was intended to be conducted across the three Atlantic Provinces at three planting dates. However, due to the Covid-19 restrictions and uncertain conditions, the Hartland, NB and Harrington, PEI sites were not able to run the trial. The trial took place only in one site,

Canning NS. using two planting dates (May 19 & June 1). Within these two planting dates, three seeding rates were applied: 200, 400, and 600 seeds per m²

The spring wheat cultivar AAC Scotia and 2-row barley cultivar AAC Synergy were seeded in small plots that were amended with 60 kg/ha N, P, K applied using 20-20-20 @ 300 kg/ha. The layout was designed in a split plot pattern with four replications and plots were seeded on May 19th and June 1st. Site information and list of treatments for this trial can be seen in tables 9 and 10. Plots were then monitored during the growing season for differences among emergence, plant stand, height, lodging, disease, and maturity dates. Harvest was September 20. Harvest data was then collected on yield, test weights, and TKW.

Table 9. 2020 Trial Site Information Date by Rate

	Truro, NS
Previous Crop	Mixed Forage
pH	6.24
Organic Matter (%)	2.7
P ₂ O ₅ (kg/ha)	957
K ₂ O (kg/ha)	329
Seeding Date	Varied based on trial
Seeding Rate	Varied based on trial
Cultivar	Barley: AAC Synergy Wheat: AAC Scotia
Fertility	60 kg/ha N, 60kg/ha P 60kg/ ha K
Seeded Area	6X 1.25 = 7.5m ²
# Rows	8
Row Spacing	15 cm
Harvest Date	2/9/2020
Harvest Area	5X 1.25 = 6.25m ²

Pesticide	MCPA sodium (0.3 L/ac), Refine SG (12 g/ac), Malathion 85E (0.4 L/ ac), Ag surf (0.2 % v/v).
Rate and Date	26/7/2020

Table 10. Cereal Date by Rate treatments 2020

Factor A: Date of Seeding	
1	Seeding Date 1 (May 19)
2	Seeding Date 2 (June 1)
Factor B: Seeding Density	
1	200 Seeds per m ²
2	400 Seeds per m ²
3	600 Seeds per m ²

Results / Conclusion

It was intended for this trial to have 3 seeding dates, an early, medium, and late. Poor conditions and COVID-19 restrictions early in the season did not allow for the 1st seeding date to occur. Therefore, the experiment was reduced to 2 seeding dates; May 19th and June 1st, combined with the 3 planned seeding rates.



Figure 3: June 2 AAC Synergy seeded on May 19 at 3 different seeding rates



Figure 4: June 2: ACC Scotia seeded on May 19 at 3 different seeding rates



Figure 5: July 2: AAC Synergy seeded on May 19 (left) and June 1 (right)



Figure 6: July 2: ACC Scotia seeded on May 19 (left) and June 1 (right)

Table 11 shows the P values for this seeding date and rate effects on both the spring wheat and barley trials. For AAC Synergy, the date of seeding significantly affected yield, test weight and TKW. The rate of seeding significant affected plant emergence, as one would expect, and eventual yield. No other measured variable showed any significant effects because of seeding date.

For AAC Scotia spring wheat, the date of seeding affected yield, test weight, TKW and plant height. Plant emergence was significantly affected by both seeding date and seeding rate.

Seeding rate had no significant effect on AAC Scotia parameters.

Table 11. P-values for seeding date and rate effects on spring wheat and barley

Cultivar	Factor	Yield	Kg/hl	TKW (g)	Height (cm)	Emer/m2
Barley: AAC Synergy	Date of Seeding	<0.000	<0.000	<0.002	0.571	0.217
	Rate of Seeding	<0.023	0.085	0.114	0.352	<0.000
	Interaction	0.566	0.881	0.303	0.244	0.058
Wheat: AAC Scotia	Date of Seeding	<0.000	<0.008	<0.001	<0.000	<0.000
	Rate of Seeding	0.048	0.073	0.393	0.474	<0.000
	Interaction	0.363	0.956	0.963	0.413	0.382

Table 12 shows the mean values for some of the key variables measured, with those significant differences indicated by different letters.

Table 12. Comparison of wheat and barley performance

Cultivar	Factor		Yield		TKW (g)		Kg/hl		Ht (cm)		Emergence /m ²	
			Mean		Mean		Mean		Mean		Mean	
AAC Synergy	Date	May 19	1970	A	42.6	A	60.7	A	67.3	A	591	A
		June 1	900	B	39.7	B	58.8	B	69.5	A	610	A
	Rate (plants /m ²)	200	1060	B	41.8	A	59.9	A	68.1	A	238	C
		400	1470	A B	41.7	A	60.1	A	67.2	A	473	B
		600	1774	A	40.0	A	59.9	A	66.6	A	619	A
	AAC Scotia	Date	May 19	1453	B	28.9	B	67.9	B	70.0	B	479
June 1			2215	A	32.6	A	70.1	A	90.7	A	481	B
Rate (plants /m ²)		200	1582	B	31.5	A	70.2	A	82.5	A	255	C
		400	1921	A B	30.8	A	71.0	A	80.7	A	467	B
		600	2000	A	29.9	A	72.8	A	77.7	A	696	A

Note. Means that share the same letter are not significantly different from each other

note: M = mean; T = Tukey comparison

Seeding AAC Synergy on June 1, 2 weeks after the May 19 seeding, caused a reduction in yield of more than 50%. TKW and test weights were also significantly reduced. Increasing the seeding rate from 200 seeds per square metre to 400 seeds per square metre increased the yield and a further yield was realized with the increase in seeding rate to 600 seeds per square metre. It was postulated that there would be an interaction between seeding date and seeding rate, since a

higher seeding rate at the later date of seeding might have ameliorated some of the late seeding problems. However, there was no significant interaction between the 2 factors.

By contrast to the spring barley results, AAC Scotia spring wheat produced higher yields at the June 1 seeding date than it did at the May 19 seeding date. In a similar fashion, the June 1 seeding had a higher TKW, test weight and taller plants. This was an unexpected result. One possible explanation for this anomaly is heavy predation by the cereal leaf beetle during the early stages of the wheat development. It was observed that there was preferential feeding by the cereal leaf beetle on the wheat rather than the barley. Considering the difference in the response on seeding date between barley and spring wheat, it appears that cereal leaf beetle prefers wheat over barley. Once the insecticide was applied, the later seeding date of the spring wheat was able to flourish.

As expected, the seeding rate had a significant effect on crop emergence but, surprisingly, not on head counts at harvest, indicating compensatory tillering. However, as with the spring barley, the seeding rate for the spring wheat also had a significant effect on eventual grain yield. As seeding rate increased, yield also tended to increase. More research is recommended using all three dates to understand which combinations of seeding date and rate would produce the highest yield and best crop.

AAFC Charlottetown 2019 results

Although the 2020 season did not allow for 3 seeding dates and 3 seeding rates at any site, the AAFC Charlottetown group led by Dr. Mills did succeed in completing the trial with both AAC Scotia and AAC Synergy in 2019. This data is now available and it is added to this report to enhance the overall understanding of the effect of seeding date by seeding rate.

The following tables show the P values for significant effects (bold) and the means for those variables affected significantly. The following from the 2019 trial should be noted:

1. AAC Scotia was overall positively affected by the early seeding date but not significantly different from the mid-time.
2. AAC Synergy appears to be more adaptable to seeding date, due to its ability to tiller when seeded later.

3. Seeding date and rate had impacts on grain protein which should be further investigated.

Wheat (AAC Scotia)

Treatment	Yield (kg/ha)	Kg/Hl	NIR Protein (%)	Plant Height (cm)	Stand Count	Heading Date	Lodging	Disease Rating
Date	<0.001	<0.001	0.056	<0.001	0.786	0.001	0.850	n/a
Rate	0.415	<0.001	0.718	0.031	<0.001	0.916	0.528	n/a
Interaction	0.063	0.082	0.764	0.332	0.855	0.298	0.394	n/a

Note: All diseases were rated a "1" on a scale of 1-9 with 1 being the lowest rating
Significant interactions bolded with a significance rating of $\alpha=0.05$

Effects of seeding date on Yield (Kg/ha), Test weight (kg/hL), heading Date (Julien), plant height (cm)

Date	Yield	Test Weight	Heading date	Plant height
Early	3432 A	75.67A	206B	117A
Mid	3191A	74.71AB	204B	113A
Late	2571B	74.07B	215A	107B

Note: means that share the same letter are not significantly different

Effects of seeding rates on Test Weight (Kg/Hl), stand count

Rate (seeds/m ²)	Test weight	Stand count
200	73.97B	214C
400	75.09A	296B
600	75.38A	397A

Note: means that share the same letter are not significantly different

Barley (AAC Synergy)

Treatment	Yield (kg/ha)	Kg/Hl	NIR Protein (%)	Plant Height (cm)	Stand Count	Heading Date)	Lodging	Disease Rating
Date	0.059	0.179	0.100	0.041	0.089	<0.001	0.001	0.381
Rate	0.230	0.745	0.004	0.514	0.896	0.197	0.134	0.381
Interaction	0.525	0.757	0.009	0.462	0.761	0.869	0.621	0.425

Note: All diseases were rated a "1" on a scale of 1-9 with 1 being the lowest rating
Significant interactions bolded with a significance rating of $\alpha=0.05$

Effect of seeding date on Plant Height (cm), heading date (Julien) and lodging(1-9)

Date	Plant height	Heading date	Lodging
Early	67A	211C	1.5A
Mid	62B	213B	1.7A
Late	63B	217A	1.0B

Note: means that share the same letter are not significantly different

Interactive effects of seeding date and seeding rate on seed protein %)

Date * Rate	N	Mean	Tukey
Late 200	4	11.385	A
Late 400	4	10.582	A B
Mid 600	4	10.538	A B C
Early 400	4	10.480	A B C
Early 200	4	10.475	A B C
Mid 200	4	10.225	A B C
Mid 400	4	9.978	B C
Late 600	4	9.953	B C
Early 600	4	9.163	C

Note: means that share the same letter are not significantly different

Underseeding with Red Clover Effects on Rotation

Introduction

Red clover is used as a beneficial soil amendment, providing organic matter, stabilizing the soil, fixing nitrogen, and breaking disease cycles. It is most commonly underseeded with crops grown in a rotational cropping method to benefit the soil and crops grown after it. There is a need for more research comparing the crop quality and yield benefits associated with this growing practice when used in rotational cropping systems; as such, this trial examined the effects that winter wheat underseeded with red clover has on the quality of a corn crop grown the following year. The objective of this research is to determine the effects of underseeding red clover on a winter wheat crop yield, the following soil nutrient levels and the subsequent corn crop yield & quality. To be directly relatable to local producers within Atlantic Canada, this trial was performed on a field scale by a conventional farmer located in the Annapolis Valley as part of his field management practices.

Materials and methods

In the spring of 2019, red clover was frost seeded in replicated strips over a field of winter wheat that had been seeded in the fall of 2018 at 350 seed/m² with fertility applied based on recommendations from soil testing. The clover was seeded in 4 m wide strips at a rate of 12lb/ac for the length of the field. A comparison was made of the strips with and without the addition of red clover. Winter wheat was assessed for stand count, plant height, yield, and TKW. Twelve 1 m² areas of wheat were harvested, 6 from clover strips, 6 from non-clover strips and assessed for yield parameters.

In the 2nd year, the clover was sprayed with Roundup Weatherwax at a rate of 2L/ha to kill the clover before seeding corn. The farmer then strip tilled and seeded grain corn (Pride A5225) on May 28th, 2020 at a rate of 36,000 seeds per acre and fertilized at a rate of 160 kg/ha N, 80 kg/ha P, and 80 kg/ha K.

Leaf tissue was sampled prior to tasseling (August 6, 2020) from the first mature leaf below the whorl and sent for elemental analysis. Once plants matured, they were harvested on Oct 26, 2020 and assessed for yield and test weights. Harvesting was done by hand, with 20 ears of corn taken from each plot. In total, there were 6 clover plots and 6 no-clover plots, with each plot consisting of three rows of corn. From these three rows, only the center row was used for leaf tissue analysis or for harvesting ears.

Results / Conclusion

The purpose of this trial is to determine if underseeding a nitrogen fixing legume (red clover) had any detrimental effects on the yield of the crop that it is underseeded into, and if there is benefit to the following years crop.

Table 13 shows the soil test results from May 15, 2020. Not surprisingly, the one year of under seeding with red clover in the wheat crop did not have a significant effect on the bulk soil constituents.

Table 13 soil test results taken May 15, 2020

Parameter	No-Clover	With-Clover
pH (pH Units)	5.62	5.61
Buffer pH (pH Units)	7.71	7.70
Organic Matter (%)	2.8	3.0
P2O5 (kg/ha)	1314	1371
K2O (kg/ha)	400	375
Calcium (kg/ha)	2155	2150
Magnesium (kg/ha)	210	215
Sodium (kg/ha)	35	35
Sulfur (kg/ha)	25	25
Aluminium (ppm)	1275	1273
Boron (ppm)	<0.50	<0.50
Copper (ppm)	9.12	9.12
Iron (ppm)	370	370
Manganese (ppm)	17	17

Zinc (ppm)	3.72	3.72
CEC (meq/100 g)	9.1	9.1
Base sat. K (%)	4.7	4.7
Base sat. Ca (%)	59.3	59.2
Base sat. Mg (%)	9.6	9.6
Base sat. Na (%)	0.8	0.8
Base sat. H (%)	25.6	25.6
LR CaCO ₃ (t/ha to pH 6.5)	3	3

Table 14 shows the results of the corn leaf tissue analysis. While there appears to be some upward trend in overall leaf nutrition as a result of the clover under seeding in the previous year, none of those trends are statistically significant. It should be noted that the land regularly receives applications of composted chicken manure and as such, there are adequate levels of nutrients regardless of treatment.

Table 14. Mean result for corn leaf tissue analysis with or without clover.

Nutrient	Factor	N	Mean	
Nitrogen %	Clover	6	3.8	A
Nitrogen %	No clover	6	3.6	A
Calcium %	Clover	6	0.47	A
Calcium %	No clover	6	0.45	A
Potassium%	Clover	6	2.3	A
Potassium%	No clover	6	2.2	A
Phosphorus%	Clover	6	0.37	A
Phosphorus%	No clover	6	0.36	A
Magnesium%	Clover	6	0.17	A
Magnesium%	No clover	6	0.18	A
Boron (ppm)	Clover	6	25.8	A
Boron (ppm)	No clover	6	28.1	A
Copper(ppm)	Clover	6	13.1	A
Copper(ppm)	No clover	6	11.9	A
Iron (ppm)	Clover	6	140.6	A
Iron (ppm)	No clover	6	141.9	A
Mang (ppm)	Clover	6	195.1	A
Mang (ppm)	No clover	6	166.7	A
Zinc (ppm)	Clover	6	105.97	A
Zinc (ppm)	No clover	6	102.21	A

Note. Means that share the same letter are not significantly different from each other

Table 15 describes the effects that winter wheat underseeded with clover had on both wheat yield (year 1) and corn yield (year 2). As seen in year 1 analysis of wheat yield, TKW, and test weight (kg/hl), the presence of intercropped clover had no negative effect on wheat performance. However, there was a significant increase in corn yield the following year (year 2) of more than 2 T/ha. These results show that there is a benefit to underseeding wheat with red clover on the following corn crop without negatively affecting the yield of the wheat. These results allow farmers to compare the economic cost of underseeding clover to the return from yield gains of the next year's crop.

Table 15. The effect of Underseeding Winter Wheat with Clover on winter wheat yield and subsequent Corn crop yield. (*Means* that share the same letter are not significantly different)

	Treatment	Yield (kg/ha @ 13%)		TKW (g)		Test weight kg/hl	
Year 1 Wheat	Clover	5102	A	38.5	A	75.4	A
Year 1 wheat	No Clover	5160	A	34.6	A	76.2	A
Year 2 Corn	After Clover	13,515	A	-	-	73.6	A
Year 2 Corn	No Clover	11,404	B	-	-	74.5	A

The reasons for the enhanced corn yield were not revealed by the analysis of soil or the leaf analysis. A possible explanation involves enhancement of the soil micro biome which had a positive effect on overall corn growth and resilience. This will be further explored in the next round of experiments.