2021 Research Report

from the

East Central Research Foundation

Project Title: Barley MAX Experiment 1
SFP #20190403

Principal Investigators:

Mitchell Japp[1], Shannon Chant[2], Mike Hall[3], Heather Sorestad[3] Robin Lokken[4], Brianne McInnes[5], Jessica Enns[6], Kayla Slind[7] Bryan Nybo[7] and Amber Wall[7]

[1]Saskatchewan Barley Development Commission
[2]Saskatchewan Ministry of Agriculture, Swift Current, SK.
[3]East Central Research Foundation, Yorkton, SK.
[4]Conservation Learning Centre, Prince Albert, SK
[5]Northeast Agriculture Research Foundation, Melfort, SK
[6]Western Applied Research Corporation, Scott, SK
[7]Wheatland Conservation Area Inc., Swift Current, SK

Project Identification

1. **Project Number:** SFP #20190403
2. **Producer Group Sponsoring the Project:** Saskatchewan Barley Development Commission
3. **Project Location(s):** Yorkton, Melfort, Prince Albert, Scott, and Swift Current, SK
4. **Project start and end dates (month & year):** April 2020 to February 2023
5. **Project contact person & contact details:**

Mike Hall, Research Coordinator

East Central Research Foundation/Parkland College
Box 1939, Yorkton, SK, S3N 3X3
Phone: 306-621-6032
Email: m.hall@parklandcollege.sk.ca

Objectives and Rationale

6. **Project objectives:**

New barley varieties offer higher yields, improved disease resistance and increased straw strength to prevent lodging compared to older varieties. Standard management practices for older varieties may not be suitable to maximize the opportunity for increased production with these varieties. Experiment 1 will determine the optimum agronomic package for new varieties in comparison to a recent industry standard variety.

7. **Project Rationale:**

Western Canadian barley acres have shrunk by more than 50 per cent in the past 20 years. With the lowest rate of gain among major crops and competition with other low-cost feed options, fewer producers are choosing to grow barley. Yet, there remains optimism that barley can be competitive with other cropping options.

Compared to other crop types, the acceptance of new varieties with improved disease resistance and higher yields is limited. As a result, the majority of barley production is with 20-year-old technology. There are strong indications that the industry is shifting to newer varieties with improved agronomics, but the optimum agronomic input packages are not known for these newer varieties.

Barley is generally either malt or feed, with a significant price difference sometimes in place. As a result, producers are incentivized to manage for malt and sacrifice yield in order to do so. Research is needed to help producers increase their yields, while maintaining malt quality.

Significant advancements in barley agronomy were made under one of the recent barley clusters, but the inputs investigated have not been looked at in a comprehensive package in Saskatchewan, with the most up-to-date varieties.

8. Methodology:

Trials were established in 2020 and 2021 at Melfort, Prince Albert, Scott, Swift Current and Yorkton. Trial design at each location was a Randomized Complete Block Design (RCBD) with 21 treatments and 4 replicates. Seeding rates, fertilizer applications, PGR and fungicide varied between treatments as described in Table 1. Nitrogen applications were adjusted to meet target rates of soil (0-24") + applied N. This means rates of applied N varied between locations as residual soil N varied between locations. Plot size and row spacing varied between locations depending on available equipment. However, all trials were small plot (approx. 10 by 30 ft). Where possible, only the middle section of plots were harvested with a small plot combine to avoid edge effects. Herbicides and insecticides were applied at the discretion of the site manager to ensure adequate control of pests. Dates of key operations for each site are listed in Table 2 and 3 for 2020 and 2021, respectively. Note that PGR application was missed at Prince Albert in 2021.

Table 1. Treatment List for the "Barley MAX Experiment 1" Trial

Trt #	Variety	Seeding Rate	Seed Trt	N (soil + fert)	P	K	PGR	Flag Leaf fung.	FHB fung.
1	AC Metcalfe	200 seeds/m2		90 kg N/ha	15 kg P2O5/ha				
2	AC Metcalfe	300 seeds/m2		120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
3	AC Metcalfe	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
4	AC Metcalfe	300 seeds/m2	yes	90 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
5	AC Metcalfe	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
6	AC Metcalfe	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes		yes
7	AC Metcalfe	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes	yes	yes
8	AAC Synergy	200 seeds/m2		90 kg N/ha	15 kg P2O5/ha				
9	AAC Synergy	300 seeds/m2		120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
10	AAC Synergy	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
11	AAC Synergy	300 seeds/m2	yes	90 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
12	AAC Synergy	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
13	AAC Synergy	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes		yes
14	AAC Synergy	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes	yes	yes
15	CDC Bow	200 seeds/m2		90 kg N/ha	15 kg P2O5/ha				
16	CDC Bow	300 seeds/m2		120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
17	CDC Bow	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
18	CDC Bow	300 seeds/m2	yes	90 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
19	CDC Bow	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
20	CDC Bow	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes		yes
21	CDC Bow	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes	yes	yes

Table 2. Dates of operations for the 2020 "Barley MAX Experiment 1" trial.					
Operations in 2020	**Melfort**	**Prince Albert**	**Scott**	**Swift Current**	**Yorkton**
Pre-seed Herbicide Application	May 24 (Heat LQ + Glyphosate)	N/A	May 15 (Glyphosate + AIM)	May 4 (Glyphosate + AIM + Merge)	N/A
Seeding Date + Seed Treatment	May 22 + Raxil Pro	May 23 + Raxil Pro	May 18 + Raxil Pro	May 16 + Raxil Pro	May 8 + Raxil Pro
Emergence Counts	June 11	June 9	June 10	May 28	May 28
In-crop Herbicide	June 23 (Prestige XC) & July 3 (Axial)	June 10 (Infinity)	June 15 (Axial Ipak)	May 29 (Liquid Achieve + Buctril M + Turbocharge)	June 2 (Prestige) & June 8 (Axial)
Plant Growth Regulator Application	July 3 Moddus	June 22 Moddus	June 19 Moddus	June 16 Moddus	June 16 Moddus
Flag Leaf Fungicide Application	July 11 Trivapro	July 3 Trivapro	July 6 Trivapro	June 24 Trivapro	July 1 Trivapro
Heading Date	July 22	July 13-24	July 14-20	July 21	July 6
Fusarium Head Blight Fungicide Application	July 24 (Caramba)	(Caramba)	July 20 (Caramba)	July 21 (Caramba)	July 13 Caramba
Days to Maturity	Aug 17	Aug 13-22	Aug 10-18	Aug 6	July 30
Heads Counts	Aug 4	N/A	N/A	Aug 10	N/A
Kernel/Head Counts	Aug 12	N/A	N/A	Aug 25	N/A
Lodging Rating	Sept 1	Sept 2	Aug 14	N/A	N/A
Harvest	Sept 1	Sept 4 & 9	Aug 25	Aug 17	Aug 24

Table 3. Dates of operations for the 2021 "Barley MAX Experiment 1" trial.					
Operations in 2021	**Melfort**	**Prince Albert**	**Scott**	**Swift Current**	**Yorkton**
Pre-seed Herbicide Application	May 14 (Glyphosate + Heat LQ)	N/A	May 16 (Glyphosate +AIM)	May 3 (Glyphosate + AIM + Merge)	N/A
Seeding Date + Seed Treatment	May 10 (Raxil PRO)	May 22 (Raxil PRO)	May 17 (Raxil PRO)	May 11 (Raxil PRO)	May 10 + Raxil PRO
Emergence Counts	June 1	June 14	June 9	June 9	June 4
In-crop Herbicide	June 8 (Prestige) June 22 (Axial)	June 15 (Dyvel)	June 13 (Axial Ipak) June 24 (Buctril M)	June 7 (Liquid Achieve + Buctril M + Turbocharge)	June 7 (Prestige) June 16 (Axial)
Plant Growth Regulator Application	June 18 Moddus	N/A	June 24 Moddus	June 22 Moddus	June 16 Moddus
Flag Leaf Fungicide Application	July 5 Trivapro	July 5 Trivapro	July 5 Trivapro	June 29 Trivapro	June 28 Trivapro
Heading Date	July 12	July 19	July 29 – Aug 3	July 19	July 16
Fusarium Head Blight Fungicide Application	July 13 (Caramba)	July 16 (Caramba)	July 22 (Caramba)	July 20 (Caramba)	July 14 (Caramba)
Days to Maturity	Aug 4	Aug 25	Aug 9 -11	Aug 7	July 26
Heads Counts	July 23	N/A	N/A	July 23	N/A
Kernel/Head Counts	July 23	N/A	N/A	Aug 30	N/A
Lodging Rating	Aug 13	Sept 8	Aug 9	N/A	N/A
Harvest	Aug 13	Sept 8	Aug 16	Aug 30	Aug 27

9. Results:

Growing Season Weather

Mean monthly temperatures and precipitation amounts with long term (1981-2010) averages for 5 sites are listed in Table 4. In 2020, seasons were warmer than the long-term average at Yorkton and Swift Current and cooler at Prince Albert. Melfort and Scott experienced near normal temperatures. In 2021, temperatures were well above the long-term average at all locations. In 2020, precipitation was near normal at most locations except Yorkton, which only received 66% of average long-term precipitation. In 2021, the drought was more widespread. Melfort, Prince Albert, Scott, Swift Current and Yorkton only received 61%, 72%, 66%, 74% and 54% of long-term average precipitation, respectively.

Table 4. Mean monthly temperatures and precipitation amounts along with long-term (1981-2010) normals for the 2020 and 2021 growing seasons at 5 sites in Saskatchewan.

Location	Year	May	June	July	August	Avg. / Total
		----------*Mean Temperature (°C)* ----------				
Melfort	2020	10.1	14.3	18.8	17.6	15.2
	2021	9.6	18.2	20.1	16.9	16.2
	Long-term	***10.7***	***15.9***	***17.5***	***16.8***	***15.2***
Prince Albert	2020	9.2	13.4	17.6	16.1	14.1
	2021	10.1	18.3	20.3	17.0	16.4
	Long-term	***11.4***	***15.9***	***18.5***	***17.1***	***15.7***
Scott	2020	10.2	14.6	17.1	16.0	14.5
	2021	8.9	17.3	19.6	17.2	15.8
	Long-term	***10.8***	***14.8***	***17.3***	***16.3***	***14.8***
Swift Current	2020	*10.9*	*16.6*	*18.2*	*19.5*	*16.3*
	2021	9.5	18.4	21.7	18.0	16.9
	Long-term	***10.9***	***15.3***	***18.2***	***17.6***	***15.5***
Yorkton	2020	10.5	16.4	19.9	18.3	16.3
	2021	8.9	19.1	21.0	17.3	16.5
	Long-term	***10.4***	***15.5***	***17.9***	***17.1***	***15.2***

		---------- *Precipitation (mm)* ----------				
Melfort	2020	26.7	103.7	52.4	18.5	201.3
	2021	31.4	37.6	0.2	69.3	138.5
	Long-term	***42.9***	***54.3***	***76.7***	***52.4***	***226.3***
Prince Albert	2020	68.4	91.4	32.2	33.2	225.2
	2021	30.1	80.3	8.6	59.9	178.9
	Long-term	***40.4***	***79.6***	***84.6***	***42.9***	***247.5***
Scott	2020	48.3	70.2	129.4	25.8	273.7
	2021	43.9	43.8	10.4	51.3	150.1
	Long-term	***38.9***	***69.7***	***69.4***	***48.7***	***226.7***
Swift Current	2020	36.3	80.0	62.5	6.5	185.3
	2021	35.0	29.6	38.9	55.8	159.3
	Long-term	***44.1***	***74.5***	***51.9***	***43.2***	***213.7***
Yorkton	2020	16.7	33.6	80.1	49.3	179.7
	2021	24.6	18.1	35.2	69.7	147.6
	Long-term	***51***	***80***	***78***	***62***	***272***

Soil test results for all sites in 2020 and 2021 are presented in Table 5. In 2020, background levels of soil N in the top 24 inches were relatively high for Melfort, Prince Albert, and Yorkton (60-69 lb N/ac). Levels were more moderate at Scott and Swift Current (35-47 lb N/ac). In 2021, background levels of soil N were very high at Yorkton and Melfort (92-93 lb N/ac), relatively high at Prince Albert (69 lb N/ac) and more moderated at Scott and Swift Current (31-44 lb N/ac). In 2020, phosphorus levels were low at Prince Albert, Scott and Yorkton (8-10 ppm). Phosphorus was at a moderate level at Melfort (12 ppm) and was fairly high at Swift Current (20 ppm). In 2021, phosphorus levels were low at Prince Albert, Scott, and Yorkton (6-8 ppm). At Melfort and Swift Current phosphorus levels were more moderate (10-13 ppm). Potassium levels were relatively high at all locations for both years.

Table 5. Soil Test Nitrate, Phosphorus and Potassium Levels for each location in 2020 and 2021.

Nitrate Levels (lbs NO_3-N/ac)	Melfort	Prince Albert	Scott	Swift Current	Yorkton
2020					
0-15cm (0-6in)	21	18	14	20	27
15-30cm (6-12in)	24	28		11	23
15-60cm (6-24in)			21		
30-60cm (12-24in)					10
Total N 0-60cm (0-24in)	68 est.	69 est.	35	47est.	60
Total N 0-30cm (0-12in)	45 lb/ac	46 lb/ac		31 lb/ac	
Phosphorus (Olsen)	12 ppm	8 ppm	8 ppm	20 ppm	10 ppm
Potassium	469 ppm	197 ppm	295 ppm	482 ppm	266 ppm
2021					
0-15cm (0-6in)	34	18	13	14	
15-30cm (6-12in)	28	28			
15-60cm (6-24in)			18	44	
30-60cm (12-24in)					18
Total N 0-60cm (0-24in)	93	69 est.	31	44	92
Total N 0-30cm (0-12in)	62	46			74
Phosphorus (Olsen)	10 ppm	8 ppm	6 ppm	13 ppm	6 ppm
Potassium	511 ppm	197 ppm	293 ppm	292 ppm	213 ppm

The following guidelines may be of service when trying to interpret the effects of management for Tables 6 to 17 found in the appendix:

- Management “A” vs “B”- a lower “A” suggests a positive response to either increasing seeding rate, increasing N, increasing P, added K or some combination of these inputs.
- Management “B” vs “C” – a lower “B” suggests a positive response to seed treatment
- Management “D” vs “E” – a lower “D” suggests a positive response to increasing N
- Management “C” vs “E” – a lower “C” suggests a positive response to FHB fungicide
- Management “E” vs “F” – a lower “E” suggests a positive response to PGR
- Management “F” vs “G” – a lower “F” suggests a positive response to fungicide at flag leaf

In 2020, average barley emergence was 209, 207, 160, 177 and 261 plant/m^2 at Melfort, Prince Albert, Scott, Swift Current and Yorkton, respectively. Emergence between barley varieties did not significantly differ at Prince Albert, Swift Current, and Yorkton (Tables 10, 14, and 16), which was desirable as the goal was to achieve similar stands between

varieties. At Melfort and Scott, emergence was a little higher for CDC Bow compared to AC Metcalfe and AAC Synergy (Table 8 and 12); however, the differences were still small and not of agronomic significance. In 2021, emergence averaged 206, 168, 169, 147 and 218 plants/m^2 at Melfort, Prince Albert, Scott, Swift Current and Yorkton, respectively. As desired, emergence between varieties did not significantly differ at Melfort, Scott and Yorkton (Tables 9, 13 and 17). At Prince Albert the emergence of AAC Synergy (132 plants/m^2) was significantly lower than AC Metcalfe (184 plants/m^2) and CDC Bow (188 plants/m^2). At Swift Current, CDC Bow at 167 plants/m^2 was significantly higher than AC Metcalfe at 150 plants/m^2, which in turn was significantly higher than AAC Synergy at 123 plants/m^2. These differences at Prince Albert and Swift Current in 2021 might be enough to cause some mild agronomic influence on results.

Excluding Yorkton in 2021, there were no variety by management interactions for the emergence data. The interaction at Yorkton was mild and inconsequential, so only main effects of management will be the focus for all site/years. As desired, the lowest seeding rate of 200 seeds/m^2 in management "A" resulted in significantly lower plant populations at most locations and years compared to all other management regimes where 300 seeds/m^2 were seeded (Tables 8-17). At Yorkton 2020 (Table 16), the lowest seeding rate had the lowest emergence but it was not significantly different from a couple treatments. For the vast majority of site/years, no difference in emergence could be detected between management regimes B to G. This means there were no detectable influences of seed treatment or fertilizer application on emergence at these site/years. However, differences were detected at Melfort in 2020 and 2021. At Melfort in 2020, emergence for management B, where no seed treatment was applied, was significantly higher than several of the treatments receiving seed treatment (Table 8). This is not an uncommon observation when seedling disease levels are low. There may be some phytotoxic effects of seed treatment particularly if the product is not applied evenly on seed. In 2021 at Melfort, there were some significant differences in emergence between management, but they were likely the result of random variation (Table 9).

For the majority of site/years, significant differences in maturity between barley varieties were not detected and no interactions with management were detected for any site/year. Where differences between varieties were detected, the trends were somewhat inconsistent. However, AAC Synergy was always one of the earlier maturing varieties, even if the difference was small. At Melfort 2020, AAC Synergy was 2 days earlier maturing than CDC Bow and AC Metcalfe (Table 8). At Swift Current and Yorkton in 2020, AAC Synergy and AC Metcalfe were no more than a day earlier maturing than CDC Bow (Tables 14 and 16). At Swift Current in 2021, AAC Synergy and CDC Bow were less than a day earlier than AC Metcalfe (Table 15). Overall, maturity differences between varieties were small and inconsequential.

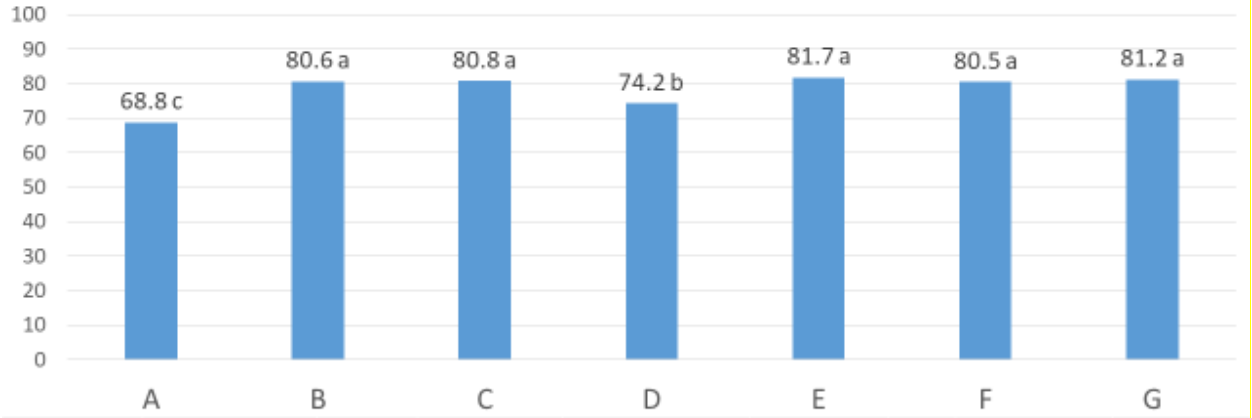
For lodging, the discussion can focus on main effects of variety and management as there were no interactions between these factors at any site/year. Lodging was not an agronomic issue for any site/year in this study, but a few significant, albeit small differences, were observed at Prince Albert. In 2020, AC Metcalfe lodged a little more than the other varieties, and in 2021, AC Metcalfe and AAC Synergy lodged a little more than CDC Bow. Level of management had no significant effects on lodging. Differences in fertility, fungicide and even plant growth regulators had no effect on lodging because there was essentially no lodging pressure. Moreover, PGR was not applied at Prince Albert in 2021.

Barley yield and protein varied greatly between site/years, but low protein was typically associated with high yield. In 2020, the high yielding sites with low grain proteins were Scott, Swift Current, Prince Albert, and Melfort, averaging 5394 kg/ha (10% protein), 4134 kg/ha (11% protein), 3948 kg/ha (11.3% protein), and 3838 kg/ha (10.4%), respectively. Yorkton suffered drought in 2020 and yields were lower at 2333 kg/ha with a higher grain protein of 15.1%. In 2021, drought was more widespread and low yields and high grain proteins of 934 kg/ha (16.7% protein), 1407 kg/ha (17.1% protein) and 1986 kg/ha (15% protein) were observed at Swift Current, Yorkton and Scott, respectively. However, Prince Albert and Melfort achieved relatively high yields and low proteins of 4375 kg/ha (10.9% protein) and 3356 kg/ha (12.4%), respectively. Combined analysis was done on high yielding and low yielding site/years separately, as high inputs are more likely to increase yields when growing conditions are favorable. The high yielding site/years grouped together for analysis were Scott 2020, Swift Current 2020, Prince Albert 2020 and 2021, and Melfort 2020 and 2021 (Table 6). The low yielding site/year analysis combined were Scott 2021, Swift Current 2021 and Yorkton 2020 and 2021 (Table 7). Protein is included in these tables only for reference, as values are based on single samples bulked over replication without any statistical analysis.

The combined analysis for the high yielding site/years found AAC Synergy at 4313 kg/ha (80.2 bu/ac) was significantly higher yielding than AC Metcalfe at 4184 kg/ha (77.8 bu/ac) and CDC Bow at 4125 kg/ha (76.7 bu/ac) (Table 6). No interactions between variety and management were detected. The yield increase of only 3.1% for AAC Synergy over AC Metcalfe was much lower than anticipated, as AAC Synergy is typically 10-15% higher yielding. The lack of a substantial yield difference between varieties also resulted in similar grain protein levels between varieties (Table 6), which is also atypical. AAC Synergy usually has lower grain protein but this was not observed in this study. On average, protein levels for the high yielding site/years were at acceptable levels for malt (approximately 11%) and did not vary much between varieties or management level. A few significant yield differences between management levels were detected, when averaged over the high yielding site/years (Table 6, Figure 1). Management “A” was significantly lower than management “B” suggesting a significant response to either increasing seeding rate, increasing phosphorus, added potassium or some combination of these inputs. The trial was not designed to detect the difference between these inputs, in order to maintain a reasonable trial size. Management “D” produced a significantly lower yield compared to “E”, which

suggests yield increased when rate of N was increased from 90 to 120 kg/ha. No significant yield differences were detected between managements “B”, “C”, “E”, “F” or “G”. This means there were no significant effects of seed treatment, FHB fungicide, PGR or flag leaf fungicide on yield nor did there appear to be any substantial effects on protein. It would appear that only increasing fertility and possibly seeding rate had any yield increasing effects on barley for the high yielding site/years. However, when analyzed separately, some site/years “bucked the trend”.

Figure 1. Effect of Management on Barley Yield (bu/ac) for High Yielding Sites



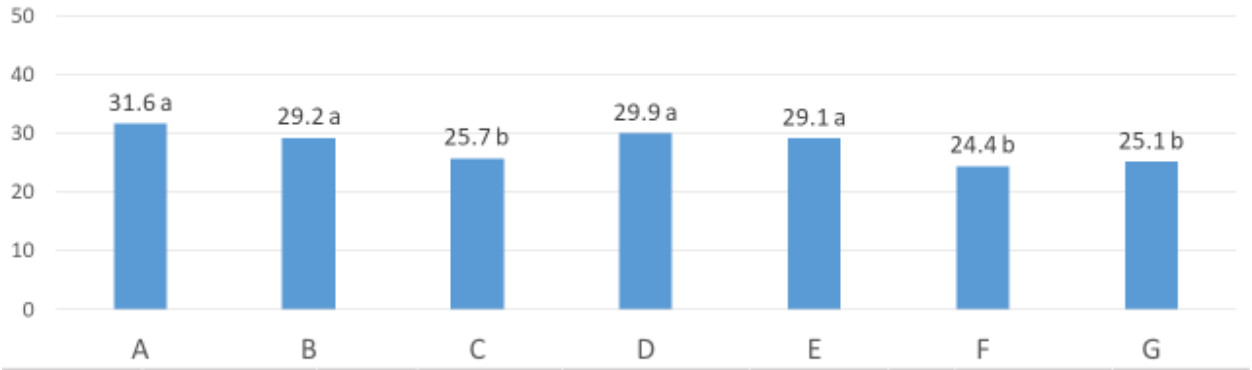
Management[1]	Seeding Rate	Seed Trt	N (soil + fert)	P	K	PGR	Flag Leaf fung.	FHB fung.
A	200 seeds/m²		90 kg N/ha	15 kg P2O5/ha				
B	300 seeds/m²		120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
C	300 seeds/m²	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
D	300 seeds/m²	yes	90 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
E	300 seeds/m²	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
F	300 seeds/m²	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes		yes
G	300 seeds/m²	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes	yes	yes

At Prince Albert 2021 (Table 11), management “A” representing the lowest level of inputs yielded numerically more than all other management levels. Management “E” was higher yielding than “F” which is odd as no PGR was applied at Prince Albert. Increasing inputs at this location did not benefit yield and in some cases may have been a detriment. At Swift Current 2020 (Table 14), Management “E” yielded significantly more than “C” suggesting FHB fungicide may have increased yield. However, a benefit from additional fungicide applied at flag could not be detected (“F” vs “G”).

When averaged over low yielding site/years (Table 7), AAC Synergy at 1806 kg/ha (33.6 bu/ac) was again significantly higher yielding than AC Metcalfe at 1637 kg/ha (30.4 bu/ac) and CDC Bow at 1551 kg/ha (28.9 bu/ac). Despite the low yield potentials, AAC Synergy managed a 10.3% yield increase over AC Metcalfe, which resulted in Metcalfe having a substantially higher grain protein. Grain proteins for all varieties, averaged over low yielding site/years, were too high to be acceptable for malt. There were some significant yield differences between management levels; however, some of the differences do not make intuitive sense (Table 7, Figure 2). The yield for management “C” was significantly lower than anticipated and is probably due to experimental variation. It is significantly

lower than “B” which suggests a detrimental effect of seed treatment and significantly lower than “E” suggesting a positive response to FHB fungicide. A real response to FHB fungicide among the low yielding, drought stricken site/years is not likely. Management “E” was significantly higher yielding than “F” which suggests there were detrimental effects of PGR being applied during drought. Management “G” which also received PGR is significantly lower yielding than management “E”. Treatments using PGR also tended to have the highest protein levels, which occurs when yield potential has been reduced. The detrimental effect of PGR during drought is supported by anecdotal reports from field scale experiences near Yorkton in 2021. There is no reason to use a PGR to reduce plant height during a drought as lodging is typically not an issue under those conditions. Numerically, management “A” produced the highest yields, which suggests no added inputs were of benefit to yield for the low yielding site/years.

Figure 2. Effect of Management on Barley Yield (bu/ac) for Low Yielding Sites



Management[1]	Seeding Rate	Seed Trt	N (soil + fert)	P	K	PGR	Flag Leaf fung.	FHB fung.
A	200 seeds/m²		90 kg N/ha	15 kg P2O5/ha				
B	300 seeds/m²		120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
C	300 seeds/m²	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
D	300 seeds/m²	yes	90 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
E	300 seeds/m²	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
F	300 seeds/m²	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes		yes
G	300 seeds/m²	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes	yes	yes

Other seed quality parameters important for malting were also measured, but values are based on the samples bulked over replication and therefore no statistical analysis is possible. For Prince Albert in 2020 and 2021, germination was extremely poor for all varieties, but was particularly poor for CDC Bow in 2020 (Tables 10 and 11). Effects of management on germination were unclear. Percent thins were high at Swift Current 2020, and tended to go up with increasing inputs (Table 14). Germination (8 ml) were also poor at Swift Current in 2021. At Yorkton 2020, germination was only poor for the 8 ml test (Table 16); however, germinations were extremely poor in 2021 for Yorkton (Table 17). The reason for the poor germ is unclear but it was present at a number of low and high

yielding site/years. All other parameters not mentioned for each site/year were good and no obvious trends of management were observed.

At Melfort and Swift Current additional measurements of kernels/head and heads/m^2 were taken in 2020 and 2021 (Tables 18 and 19). Significant differences in yield between varieties seemed related to significant differences in kernels/head. In contrast, management effects causing significant yield differences tended to be the result of changes in heads/m^2. At Melfort 2020, AC Metcalfe had the highest yield (Table 8). AAC Synergy had the highest yield at Melfort 2021 and at Swift Current in 2020 and 2021 (Tables 9, 14 and 15). In every case, the highest yielding variety also had the greatest number of kernels/head (Table 18 and 19). The number of heads/m^2 did not differ between varieties with the exception of Swift Current 2020 where AAC Synergy had the lowest level. This is a little counter intuitive and implies the increase in kernels/ head more than compensated for the lower head count. In 2020, the lowest seeding rate (management "A") resulted in the lowest yield and lowest head count at both locations. Management "D" provided the next lowest yield at both sites and this treatment also resulted in the second lowest head count. Management "D" had a low rate of N, which would have reduced tillering. It is well understood that much of the yield response from added nitrogen comes from secondary tillers.

Extension

- ECRF will be presenting the results from this trial at WARC's Crop Opportunity webinar on March 2, 2021. The video from that presentation will then be available from ECRF and potentially WARC websites.
- Some information is being used in presentations by SaskBarley.
- SaskBarley has posted videos on their YouTube channel, which includes a presentation made for Top Notch Farming Webinar last winter. Barley MAX information was also included in a AgriVisions meeting (approx. Feb 7, 2022). https://www.youtube.com/channel/UCKVWV8OUR_ocevE-al5LFEg/playlists

  https://www.lloydex.com/_files/ugd/2ab3f7_90040d7445c04d2c96e75c1254320b11.pdf

- SaskBarley wrote about the Barley MAX trial in their Spring 2021 Newsletter https://barleybin.ca/wp-content/uploads/2021/08/Spring2021-SB-Newsletter.pdf

10. Conclusions and Recommendations

Based on a combined analysis, AAC Synergy was 3.1% higher yielding than AC Metcalfe when averaged across the high yielding site/years, and 10% higher yielding when averaged across the low yielding site/years. The effect of management did not significantly differ between varieties in either the high or low yielding site/year analysis. For high yielding site/years, barley yield responded to increasing N from 90 to 120 kg/ha. Yields also increased in response to some combination of increasing seeding rate, increasing phosphorus and added potassium. No positive yield responses to seed treatment, FHB

fungicide, PGR or fungicide at flag leaf could be detected, as environmental conditions were not conducive for plant disease or lodging. For the low yielding site/years, yield did not increase in response to any added inputs. In fact, yield significantly declined in response to PGR, suggesting that the application of PGR under severe drought can reduce yield.

Supporting Information

11. Acknowledgements:

This project was funded through the Strategic Field Program (SFP) and Saskatchewan Barley Development Commission.

12. Appendices

Table 6. Main effects of variety and management on protein and yield averaged over all high yielding sites (Scott 2020, Swift Current 2020, Prince Albert 2020 and 2021, Melfort 2020 and 2021.)

	Protein (%)	Yield (kg/ha @13.5%)
Variety (V)		
AC Metcalfe	11.0	4183.7 b
AAC Synergy	11.1	4313.4 a
CDC Bow	10.9	4124.7 b
LSD	N/A	63.4
Management (M)[1]		
A	10.8	3696.6 c
B	10.9	4332.6 a
C	11.0	4343.6 a
D	11.0	3991.6 b
E	11.1	4392.9 a
F	11.1	4327.7 a
G	11.1	4363.9 a
LSD	N/A	96.7
V by M interaction	N/A	

Management[1]	Seeding Rate	Seed Trt	N (soil + fert)	P	K	PGR	Flag Leaf fung.	FHB fung.
A	200 seeds/m^2		90 kg N/ha	15 kg P2O5/ha				
B	300 seeds/m^2		120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
C	300 seeds/m^2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
D	300 seeds/m^2	yes	90 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
E	300 seeds/m^2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
F	300 seeds/m^2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes		yes
G	300 seeds/m^2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes	yes	yes

Table 7. Main effects of variety and management on protein and yield averaged over all low yielding sites (Scott 2021, Swift Current 2021, Yorkton 2020 and 2021)

	Protein (%)	Yield (kg/ha @13.5%)
Variety (V)		
AC Metcalfe	16.8	1637.2 b
AAC Synergy	15.5	1806.0 a
CDC Bow	15.5	1551.3 b
LSD	N/A	109.8
Management (M)[1]		
A	15.2	1696.8 a
B	16.1	1567.8 a
C	16.2	1381.8 b
D	15.4	1609.1 a
E	15.8	1565.6 a
F	16.5	1313.4 b
G	16.6	1350.3 b
LSD	N/A	167.8
V by M interaction	N/A	

Management[1]	Seeding Rate	Seed Trt	N (soil + fert)	P	K	PGR	Flag Leaf fung.	FHB fung.
A	200 seeds/m2		90 kg N/ha	15 kg P2O5/ha				
B	300 seeds/m2		120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
C	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
D	300 seeds/m2	yes	90 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
E	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
F	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes		yes
G	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes	yes	yes

Table 8. Main effects of variety and management on emergence, maturity, lodging, yield, grain protein, thins and plumps, 1000 kwt and germination of barley at Melfort in 2020.

	Emergence (plants/m^2)	Maturity (Julian days)	Lodging (1-10)	Yield (kg/ha @13.5%)	Protein (%)	Thins (>5/64",%)	Plumps (>6/64", %)	Thousand kernel Weight (g)	4ml Energy Germination (%)	8ml Water Sensitive Germination (%)
Variety (V)										
AC Metcalfe	201.1 c	234 a	1 a	4077 a	10.1	1.7	98.1	49.4	98.3	93.4
AAC Synergy	205.1 bc	232 b	1 a	3634 b	10.8	3.9	95.6	46.4	98.4	92.4
CDC Bow	219.3 a	234 a	1 a	3803 b	10.3	2.1	97.5	49.0	97.6	84.9
LSD	14.5	1.1	NS	247	N/A	N/A	N/A	N/A	N/A	N/A
Management (M)[1]										
A	157.5 d	237 a	1 a	2913 b	10.7	2.9	96.7	47.9	96.5	87.8
B	235.7 a	232 cd	1 a	4207 a	10.2	2.7	97.0	48.1	99.0	92.2
C	206.3 c	232 cd	1 a	4257 a	10.3	2.2	97.5	48.5	98.3	93.3
D	212.0 bc	235 ab	1 a	2970 b	10.5	2.2	97.5	48.1	98.0	86.5
E	229.1 ab	231 d	1 a	4169 a	10.2	2.0	97.7	48.2	98.8	91.8
F	217.5 abc	234 bc	1 a	4087 a	10.5	3.3	96.2	48.1	98.8	90.2
G	201.1 c	234 bc	1 a	4262 a	10.5	2.7	97.0	49.0	97.3	89.8
LSD	22.1	1.7	NS	377	N/A	N/A	N/A	N/A	N/A	N/A
V by M interaction	NS	NS	NS	NS	N/A	N/A	N/A	N/A	N/A	N/A

Management[1]	Seeding Rate	Seed Trt	N (soil + fert)	P	K	PGR	Flag Leaf fung.	FHB fung.
A	200 seeds/m2		90 kg N/ha	15 kg P2O5/ha				
B	300 seeds/m2		120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
C	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
D	300 seeds/m2	yes	90 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
E	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
F	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes		yes
G	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes	yes	yes

Table 9. Main effects of variety and management on emergence, maturity, lodging, yield, grain protein, thins and plumps, 1000 kwt and germination of barley at Melfort in 2021.

	Emergence (plants/m^2)	Maturity (Julian days)	Lodging (1-10)	Yield (kg/ha @13.5%)	Protein (%)	Thins (>5/64",%)	Plumps (>6/64", %)	Thousand kernel Weight (g)	4ml Energy Germination (%)	8ml Water Sensitive Germination (%)
Variety (V)										
AC Metcalfe	202.3 a	215 a	1 a	3234 b	11.7	1.5	98.2	47.4 b	95	92
AAC Synergy	210.5 a	214 a	1 a	3642 a	12.9	1.4	98.2	47.5 b	96	87
CDC Bow	205.5 a	215 a	1 a	3191 b	12.8	1.1	98.5	48.3 b	96	87
LSD	NS	NS	NS	185	N/A	N/A	N/A	0.6	N/A	N/A
Management (M)[1]										
A	153.3 c	215 a	1 a	3232 a	12.2	1.2	98.2	48.3 a	95	90
B	222.4 a	215 a	1 a	3477 a	12.3	1.2	98.4	47.6 bc	95	87
C	215.0 ab	214 a	1 a	3365 a	12.8	1.1	98.5	48.0 ab	95	86
D	212.5 ab	214 a	1 a	3235 a	12.2	1.3	97.5	47.3 ab	97	88
E	226.9 a	215 a	1 a	3373 a	12.6	1.2	98.4	47.5 abc	96	89
F	202.3 b	214 a	1 a	3500 a	12.7	1.7	97.7	46.5 cd	96	91
G	210.1 ab	215 a	1 a	3311 a	12.5	1.4	98.3	46.7 d	95	89
LSD	17.6	NS	NS	NS	N/A	N/A	N/A	0.9	N/A	N/A
V by M interaction	NS	NS	NS	NS	N/A	N/A	N/A	NS	N/A	N/A

Management [1]	Seeding Rate	Seed Trt	N (soil + fert)	P	K	PGR	Flag Leaf fung.	FHB fung.
A	200 seeds/m2		90 kg N/ha	15 kg P2O5/ha				
B	300 seeds/m2		120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
C	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
D	300 seeds/m2	yes	90 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
E	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
F	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes		yes
G	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes	yes	yes

Table 10. Main effects of variety and management on emergence, maturity, lodging, yield, grain protein, thins and plumps, 1000 kwt and germination of barley at Prince Albert in 2020.

	Emergence (plants/m^2)	Maturity (Julian days)	Lodging (1-10)	Yield (kg/ha @13.5%)	Protein (%)	Thins (>5/64" ,%)	Plumps (>6/64", %)	Thousand Kernel Weight (g)	4ml Energy Germination (%)	8ml Water Sensitive Germination (%)
Variety (V)										
AC Metcalfe	200.7 a	230 a	0.3 a	3784 b	11.7	2.7	96.6	51.7	70.6	41.9
AAC Synergy	204.9 a	230 a	0.0 b	4176 a	11.2	1.4	98.0	53.2	58.4	34.7
CDC Bow	215.6 a	230 a	0.0 b	3883 ab	11.0	1.3	98.1	52.2	22.9	11.1
LSD	NS	NS	0.18	298	N/A	N/A	N/A	N/A	N/A	N/A
Management (M)[1]										
A	150.5 b	232 a	0.1 a	3055 b	11.4	1.8	97.4	52.9	59.2	33.3
B	221.2 a	229 b	0.0 a	3870 a	11.3	2.0	97.3	52.1	55.3	27.2
C	224.5 a	229 b	0.2 a	4157 a	11.0	1.9	97.6	52.9	50.7	32.3
D	214.5 a	229 b	0.3 a	3961 a	11.3	1.7	97.7	52.9	46.8	26.8
E	207.5 a	229 b	0.0 a	4069 a	11.3	1.7	97.7	52.5	41.8	27.2
F	218.2 a	230 b	0.1 a	4255 a	11.3	1.9	97.5	51.5	51.7	29.5
G	213.0 a	230 b	0.0 a	4265 a	11.5	1.8	97.6	51.8	49.0	28.3
LSD	19.7	1.3	NS	455	N/A	N/A	N/A	N/A	N/A	N/A
V by M interaction	NS	NS	NS	NS	N/A	N/A	N/A	N/A	N/A	N/A

Management[1]	Seeding Rate	Seed Trt	N (soil + fert)	P	K	PGR	Flag Leaf fung.	FHB fung.
A	200 seeds/m2		90 kg N/ha	15 kg P2O5/ha				
B	300 seeds/m2		120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
C	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
D	300 seeds/m2	yes	90 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
E	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
F	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes		yes
G	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes	yes	yes

Table 11. Main effects of variety and management on emergence, maturity, lodging, yield, grain protein, thins and plumps, 1000 kwt and germination of barley at Prince Albert in 2021.

	Emergence (plants/m^2)	Maturity (Julian days)	Lodging (1-10)	Yield (kg/ha @13.5%)	Protein (%)	Thins (>5/64" ,%)	Plumps (>6/64", %)	Thousand Kernel Weight (g)	4ml Energy Germination (%)	8ml Water Sensitive Germination (%)
Variety (V)										
AC Metcalfe	184.6 a	237 a	0.7 a	4698.0 a	11.0	1.9	96.7	46.6	83.6	53.3
AAC Synergy	132.1 b	237 a	0.8 a	4447.9 a	10.9	2.2	96.5	46.5	85.5	49.1
CDC Bow	187.9 a	237 a	0.2 b	4573.8 a	10.8	1.9	96.9	46.2	82.4	45.4
LSD	14.2	NS	0.39	NS	N/A	N/A	N/A	N/A	N/A	N/A
Management (M)[1]										
A	144.2 b	237 a	0.5 a	4819.8 a	11.0	2.0	96.9	47.9	84.7	58.7
B	176.3 a	237 a	0.6 a	4652.9 ab	10.8	1.9	96.9	46.9	87.8	59.5
C	165.3 a	237 a	0.4 a	4573.2 ab	10.6	2.0	96.7	46.7	78.5	44.0
D	178.0 a	237 a	0.6 a	4757.0 ab	11.1	2.0	96.4	47.2	84.3	49.3
E	166.5 a	237 a	0.6 a	4573.1 ab	11.3	2.1	96.7	44.8	85.5	48.3
F	179.2 a	237 a	0.6 a	4181.4 c	10.9	2.0	96.8	45.8	82.8	47.0
G	168.0 a	237 a	0.7 a	4455.3 bc	10.6	2.0	96.5	45.8	83.2	38.0
LSD	21.7	NS	NS	321.6	N/A	N/A	N/A	N/A	N/A	N/A
V by M interaction	NS	NS	NS	NS	N/A	N/A	N/A	N/A	N/A	N/A

Management[1]	Seeding Rate	Seed Trt	N (soil + fert)	P	K	PGR	Flag Leaf fung.	FHB fung.
A	200 seeds/m2		90 kg N/ha	15 kg P2O5/ha				
B	300 seeds/m2		120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
C	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
D	300 seeds/m2	yes	90 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
E	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
F	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes		yes
G	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes	yes	yes

Table 12. Main effects of variety and management on emergence, maturity, lodging, yield, grain protein, thins and plumps, 1000 kwt and germination of barley at Scott in 2020.

	Emergence (plants/m^2)	Maturity (Julian days)	Lodging (1-10)	Yield (kg/ha @13.5%)	Protein (%)	Thins (>5/64" ,%)	Plumps (>6/64", %)	Thousand Kernel Weight (g)	4ml Energy Germination (%)	8ml Water Sensitive Germination (%)
Variety (V)										
AC Metcalfe	152.9 b	227 a	0.1 a	5172 b	10.6	5.6	93.9	45.2	98.6	85.9
AAC Synergy	157.5 b	227 a	0 a	5665 a	10.0	2.5	97.0	46.7	97.7	80.4
CDC Bow	168.6 a	228 a	0 a	5344 b	9.5	3.0	96.9	46.3	97.7	80.6
LSD	10.1	NS	NS	197	N/A	N/A	N/A	N/A	N/A	N/A
Management (M)[1]										
A	132.9 b	229 a	0 a	4437 c	10.0	3.2	96.3	45.5	98.0	80.3
B	165.0 a	227 a	0.1 a	5536 a	10.1	4.1	95.6	46.1	97.7	84.2
C	159.7 a	227 a	0.1 a	5582 a	10.1	4.3	95.5	46.1	98.5	84.8
D	169.8 a	227 a	0 a	4991 b	9.8	3.6	96.4	46.2	98.3	78.2
E	168.8 a	227 a	0 a	5793 a	10.0	3.7	96.1	46.7	98.0	85.5
F	156.0 a	228 a	0 a	5660 a	10.2	4.2	95.5	45.7	98.8	79.7
G	165.4 a	228 a	0 a	5757 a	9.9	2.9	96.2	46.3	96.7	83.2
LSD	15.4	NS	NS	300	N/A	N/A	N/A	N/A	N/A	N/A
V by M interaction	NS	NS	NS	NS	N/A	N/A	N/A	N/A	N/A	N/A

Management[1]	Seeding Rate	Seed Trt	N (soil + fert)	P	K	PGR	Flag Leaf fung.	FHB fung.
A	200 seeds/m2		90 kg N/ha	15 kg P2O5/ha				
B	300 seeds/m2		120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
C	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
D	300 seeds/m2	yes	90 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
E	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
F	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes		yes
G	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes	yes	yes

Table 13. Main effects of variety and management on emergence, maturity, lodging, yield, grain protein, thins and plumps, 1000 kwt and germination of barley at Scott in 2021.

	Emergence (plants/m^2)	Maturity (Julian days)	Lodging (1-10)	Yield (kg/ha @13.5%)	Protein (%)	Thins (>5/64" ,%)	Plumps (>6/64", %)	Thousand Kernel Weight (g)	4ml Energy Germination (%)	8ml Water Sensitive Germination (%)
Variety (V)										
AC Metcalfe	165.3 a	209.4 a	1 a	2397 a	15.5	2.0	97.6	44.0	94.9	90.4
AAC Synergy	168.3 a	209.6 a	1 a	2262 a	14.2	3.1	96.5	43.7	99.1	98.7
CDC Bow	173.4 a	209.1 a	1 a	1299 b	15.4	2.2	97.5	43.6	98.1	94.9
LSD	NS	NS	NS	311	N/A	N/A	N/A	N/A	N/A	N/A
Management (M)[1]										
A	126.5 b	209.1 bc	1 a	2070 a	14.4	1.7	97.8	44.4	90.7	82.8
B	175.9 a	208.8 bc	1 a	2076 a	15.2	2.1	97.6	44.5	98.0	97.7
C	170.7 a	209.7 ab	1 a	1743 a	15.3	2.5	96.9	43.6	99.0	97.8
D	173.8 a	208.6 c	1 a	2172 a	14.1	2.1	97.5	44.1	98.8	96.7
E	182.0 a	208.2 c	1 a	2085 a	15.1	1.9	97.7	44.7	98.7	96.3
F	182.1 a	210.6 a	1 a	1895 a	15.6	3.6	95.9	42.5	98.8	95.8
G	172.0 a	210.6 a	1 a	1863 a	15.5	2.9	96.3	42.6	97.5	95.3
LSD	14.7	0.89	NS	NS	N/A	N/A	N/A	N/A	N/A	N/A
V by M interaction	NS	NS	NS	NS	N/A	N/A	N/A	N/A	N/A	N/A

Management[1]	Seeding Rate	Seed Trt	N (soil + fert)	P	K	PGR	Flag Leaf fung.	FHB fung.
A	200 seeds/m2		90 kg N/ha	15 kg P2O5/ha				
B	300 seeds/m2		120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
C	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
D	300 seeds/m2	yes	90 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
E	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
F	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes		yes
G	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes	yes	yes

Table 14. Main effects of variety and management on emergence, maturity, lodging, yield, grain protein, thins and plumps, 1000 kwt and germination of barley at Swift Current in 2020.

	Emergence (plants/m2)	Maturity (Julian days)	Lodging (1-10)	Yield (kg/ha @13.5%)	Protein (%)	Thins (>5/64" ,%)	Plumps (>6/64", %)	Thousand Kernel Weight (g)	4ml Energy Germination (%)	8ml Water Sensitive Germination (%)
Variety (V)										
AC Metcalfe	177.4 a	218.0 b	0 a	4101 ab	11.6	9.8	87.4	42.4	95.7	95.0
AAC Synergy	174.9 a	218.1 b	0 a	4253 a	10.4	6.6	91.2	44.8	96.4	97.0
CDC Bow	179.3 a	218.9 a	0 a	4047 b	10.9	8.8	88.2	43.7	86.4	95.8
LSD	NS	0.4	NS	158	N/A	N/A	N/A	N/A	N/A	N/A
Management (M)[1]										
A	139.1 b	218.9 a	0 a	3723 d	9.8	5.0	93.3	44.8	96.5	95.7
B	176.3 a	217.9 c	0 a	4253 abc	10.7	8.2	89.4	43.3	91.0	96.3
C	179.8 a	218.1 bc	0 a	4128 bc	11.2	10.1	86.8	43.1	93.2	96.0
D	188.9 a	218.1 bc	0 a	4036 c	11.0	7.6	89.9	44.3	88.8	96.8
E	191.6 a	218.2 abc	0 a	4380 a	11.4	8.0	89.5	44.2	92.2	94.3
F	183.3 a	218.8 ab	0 a	4283 ab	11.3	8.8	88.5	43.2	95.7	96.8
G	181.3 a	218.6 abc	0 a	4133 bc	11.2	11.1	85.3	42.6	92.3	95.5
LSD	22.7	0.7	NS	242	N/A	N/A	N/A	N/A	N/A	N/A
V by M interaction	NS	NS	NS	NS	N/A	N/A	N/A	N/A	N/A	N/A

Management [1]	Seeding Rate	Seed Trt	N (soil + fert)	P	K	PGR	Flag Leaf fung.	FHB fung.
A	200 seeds/m2		90 kg N/ha	15 kg P2O5/ha				
B	300 seeds/m2		120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
C	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
D	300 seeds/m2	yes	90 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
E	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
F	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes		yes
G	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes	yes	yes

Table 15. Main effects of variety and management on emergence, maturity, lodging, yield, grain protein, thins and plumps, 1000 kwt and germination of barley at Swift Current in 2021.

	Emergence (plants/m2)	Maturity (Julian days)	Lodging (1-10)	Yield (kg/ha @13.5%)	Protein (%)	Thins (>5/64" ,%)	Plumps (>6/64", %)	Thousand Kernel Weight (g)	4ml Energy Germination (%)	8ml Water Sensitive Germination (%)
Variety (V)										
AC Metcalfe	150.1 b	219.9 a	1	749.8 c	17.7	3.3	94.8	36.3 b	92.3	65.5
AAC Synergy	123.7 c	219.1 b	1	1107.2 a	16.4	3.5	94.8	41.6 a	94.9	80.3
CDC Bow	167.4 a	219.0 b	1	943.7 b	16.0	2.2	96.4	41.7 a	86.6	61.1
LSD	14.2	0.51	NS	127.5	N/A	N/A	N/A	2.0	N/A	N/A
Management (M)[1]										
A	107.3 b	218.8 cd	1	1010.2 a	15.8	2.2	96.4	43.0 ab	90.5	70.3
B	141.3 a	219.2 bcd	1	980.8 a	16.7	2.0	96.5	41.7 ab	90.7	70.7
C	154.4 a	219.6 ab	1	959.8 a	17.1	2.3	96.1	42.0 a	94.2	71.0
D	158.7 a	218.5 d	1	1000.5 a	15.5	2.2	96.0	41.3 b	89.8	63.8
E	158.4 a	219.3 bc	1	980.8 a	16.5	2.2	96.3	41.5 ab	89.7	71.0
F	154.0 a	219.9 ab	1	791.2 a	17.7	5.1	92.5	38.9 c	92.7	68.3
G	155.6 a	220.0 a	1	811.7 a	17.7	5.1	92.5	38.7 c	91.3	67.5
LSD	21.7	0.77	NS	NS	N/A	N/A	N/A	3.0	N/A	N/A
V by M interaction	NS	NS	NS	NS	N/A	N/A	N/A	NS	N/A	N/A

Management [1]	Seeding Rate	Seed Trt	N (soil + fert)	P	K	PGR	Flag Leaf fung.	FHB fung.
A	200 seeds/m2		90 kg N/ha	15 kg P2O5/ha				
B	300 seeds/m2		120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
C	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
D	300 seeds/m2	yes	90 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
E	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
F	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes		yes
G	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes	yes	yes

Table 16. Main effects of variety and management on emergence, maturity, lodging, yield, grain protein, thins and plumps, 1000 kwt and germination of barley at Yorkton in 2020.

	Emergence (plants/m2)	Maturity (Julian days)	Lodging (1-10)	Yield (kg/ha @13.5%)	Protein (%)	Thins (>5/64",%)	Plumps (>6/64", %)	Thousand Kernel Weight (g)	4ml Energy Germination (%)	8ml Water Sensitive Germination (%)
Variety (V)										
AC Metcalfe	242.5 a	210 b	0.4 a	2015 b	16.3	1.6	98.0	46.9	99.1	68.2
AAC Synergy	249.1 a	210 b	0.6 a	2511 a	14.5	1.3	98.3	48.7	98.7	87.2
CDC Bow	290.9 a	211 a	0.6 a	2472 a	14.4	1.2	98.4	48.7	98.9	54.9
LSD	NS	0.6	NS	232	N/A	N/A	N/A	N/A	N/A	N/A
Management (M)[1]										
A	199.7 b	211 a	0.8 a	2551 a	13.9	0.9	98.8	49.2	97.8	73.3
B	277.7 a	211 a	0.5 a	2361 a	15.5	1.0	98.6	48.8	99.3	71.2
C	277.9 a	210 a	0.5 a	2210 a	15.5	1.2	98.4	48.4	99.3	68.3
D	280.2 a	210 a	0.6 a	2215 a	14.8	1.1	98.5	48.6	98.2	62.3
E	271.7 a	211 a	0.8 a	2568 a	14.6	1.0	98.8	48.7	99.3	65.3
F	257.3 ab	211 a	0.4 a	2211 a	15.5	2.2	97.3	46.8	99.3	74.5
G	261.3 ab	211 a	0.3 a	2214 a	15.6	2.2	97.3	46.2	98.8	75.7
LSD	65.3	NS	NS	NS	N/A	N/A	N/A	N/A	N/A	N/A
V by M interaction	NS	NS	NS	NS	N/A	N/A	N/A	N/A	N/A	N/A

Management[1]	Seeding Rate	Seed Trt	N (soil + fert)	P	K	PGR	Flag Leaf fung.	FHB fung.
A	200 seeds/m2		90 kg N/ha	15 kg P2O5/ha				
B	300 seeds/m2		120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
C	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
D	300 seeds/m2	yes	90 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
E	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
F	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes		yes
G	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes	yes	yes

Table 17. Main effects of variety and management on emergence, maturity, lodging, yield, grain protein, thins and plumps, 1000 kwt and germination of barley at Yorkton in 2021.

	Emergence (plants/m2)	Maturity (Julian days)	Lodging (1-10)	Yield (kg/ha @13.5%)	Protein (%)	Thins (>5/64",%)	Plumps (>6/64", %)	Thousand Kernel Weight (g)	4ml Energy Germination (%)	8ml Water Sensitive Germination (%)
Variety (V)										
AC Metcalfe	215 a	209.4 a	0 a	1386 a	17.8	2.8	96.6	40.4	7.3	7.0
AAC Synergy	219 a	209.6 a	0 a	1343 a	17.0	3.9	94.8	40.4	13.0	8.6
CDC Bow	221 a	209.1 a	0 a	1490 a	16.4	2.5	96.8	41.1	7.9	8.5
LSD	NS	NS	NS	NS	N/A	N/A	N/A	N/A	N/A	N/A
Management (M)[1]										
A	169 b	209.1 bc	0 a	1824.3 a	16.8	1.2	98.2	42.7	6.3	6.5
B	231 a	208.8 bcd	0 a	1521.3 ab	17.0	2.2	97.2	41.5	6.7	8.5
C	229 a	209.7 b	0 a	1282.6 bc	16.9	2.3	97.3	40.8	8.0	7.5
D	213 a	208.6 cd	0 a	1717.5 a	17.0	2.4	96.9	40.9	6.5	7.5
E	228 a	208.2 d	0 a	1297.6 bc	17.2	2.5	97.0	41.1	10.5	7.5
F	224 a	210.6 a	0 a	1024.2 c	17.3	5.1	93.1	38.3	13.5	9.0
G	233 a	210.6 a	0 a	1180.1 c	17.6	5.7	92.8	39.1	14.3	9.8
LSD	21.8	0.88	NS	329.5	N/A	N/A	N/A	N/A	N/A	N/A
V by M interaction	0.51	NS	NS	NS	N/A	N/A	N/A	N/A	N/A	N/A

Management[1]	Seeding Rate	Seed Trt	N (soil + fert)	P	K	PGR	Flag Leaf fung.	FHB fung.
A	200 seeds/m2		90 kg N/ha	15 kg P2O5/ha				
B	300 seeds/m2		120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
C	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
D	300 seeds/m2	yes	90 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
E	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
F	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes		yes
G	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes	yes	yes

Table 18. Main effects of variety and management on kernels/head/m^2, and heads/m^2 of barley at Melfort and Swift Current in 2020.

	Melfort		Swift Current	
	Kernels/head	**Heads/m^2**	**Kernels/head**	**Heads/m^2**
Variety (V)				
AC Metcalfe	22.8 a	421.6 a	18.3 b	558.1 a
AAC Synergy	22.0 b	445.9 a	19.4 a	521.4 b
CDC Bow	21.5 b	423.4 a	18.8 ab	555.6 a
LSD	0.5	NS	0.9	31.2
Management (M)[1]				
A	22.4 ab	300.2 c	19.5 a	458.9 d
B	22.3 ab	471.5 a	18.6 a	542.8 bc
C	22.4 ab	463.8 a	18.4 a	568.1 abc
D	21.9 abc	353.8 b	18.5 a	527.8 c
E	22.7 a	476.6 a	18.8 a	590.8 a
F	21.4 c	484.9 a	19.1 a	548.8 abc
G	21.8 bc	461.5 a	19.0 a	578.2 ab
LSD	0.8	34.4	NS	47.7
V by M interaction	NS	NS	NS	NS

Management[1]	**Seeding Rate**	**Seed Trt**	**N (soil + fert)**	**P**	**K**	**PGR**	**Flag Leaf fung.**	**FHB fung.**
A	200 seeds/m2		90 kg N/ha	15 kg P2O5/ha				
B	300 seeds/m2		120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
C	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
D	300 seeds/m2	yes	90 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
E	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
F	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes		yes
G	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes	yes	yes

Table 19. Main effects of variety and management on kernels/head, and heads/m2 of barley at Melfort and Swift Current in 2021.

	Melfort		Swift Current	
	Kernels/head	**Heads/m^2**	**Kernels/head**	**Heads/m^2**
Variety (V)				
AC Metcalfe	19.7 b	394.1 a	6.9 b	242.9 a
AAC Synergy	21.5 a	360.0 a	8.3 a	241.2 a
CDC Bow	18.1 c	368.7 a	7.0 b	257.3 a
LSD	1.1	NS	1.2	NS
Management (M)[1]				
A	20.3 a	345.4 a	8.6 a	218.3 a
B	19.4 a	386.0 a	6.8 a	251.2 a
C	20.4 a	381.6 a	7.8 a	253.8 a
D	19.2 a	344.0 a	8.4 a	241.3 a
E	19.3 a	374.9 a	7.3 a	258.8 a
F	19.5 a	388.7 a	6.2 a	248.1 a
G	20.2 a	399.3 a	6.6 a	258.3 a
LSD	NS	NS	NS	NS
V by M interaction	NS	NS	NS	NS

Management[1]	**Seeding Rate**	**Seed Trt**	**N (soil + fert)**	**P**	**K**	**PGR**	**Flag Leaf fung.**	**FHB fung.**
A	200 seeds/m2		90 kg N/ha	15 kg P2O5/ha				
B	300 seeds/m2		120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
C	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			
D	300 seeds/m2	yes	90 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
E	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha			yes
F	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes		yes
G	300 seeds/m2	yes	120 kg N/ha	30 kg P2O5/ha	15 kg K2O/ha	yes	yes	yes

Abstract

13. Abstract/Summary:

In 2020 and 2021, trials were conducted near Yorkton, Melfort, Scott, Swift Current and Prince Albert to determine the optimum agronomic package for AAC Synergy, CDC Bow and AC Metcalfe. Each variety was exposed to increasing levels of agronomic inputs. Environmental conditions varied substantially between site/years and so did yields. High and low yielding site/years were grouped together and analyzed separately, as site/years with better environmental conditions are more likely to benefit from higher levels of inputs. The high yielding site/years included Melfort 2020 and 2021, Scott 2020, Swift Current 2020 and Prince Albert 2020 and 2021; whereas, the low yield site/years included Yorkton 2020 and 2021, Scott 2021 and Swift Current 2021. On average the high yielding site/years yielded 4207 kg/ha (78.2 bu/ac) and produced grain with 11% protein. In contrast, the low yield site/years averaged 1665 kg/ha (31 bu/ac) of barley grain at 15.9% protein. AAC Synergy was the highest yielding variety when averaged over the high and low yielding site/years. While AAC Synergy was 10% higher yielding than AC Metcalfe when averaged over the low yielding site/years, it was only 3.1% higher yielding when averaged over the high yielding site/years. The effect of management did not interact with variety for either the high or low yielding analysis. For the high yielding site/years, barley yield increased with increasing N and some combination of increasing seeding rate, increasing phosphorus and added potassium. In contrast, barley yield did not respond to seed treatment, FHB fungicide, PGR or fungicide at flag. For the low yielding site/years, barley yield did not increase in response to any added inputs. In fact, yield significantly declined in response to PGR, suggesting that the application of PGR under severe drought may reduce yield.