2019 Research Report

from the

Saskatchewan Barley Development Commission

Project Title: Malt versus Feed Barley (Resubmission with variety change)
(ADOPT#20180456)

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Project Identification

1. **Project Number:** 20180456
2. **Producer Group Sponsoring the Project:** SaskBarley
3. **Project Location(s):** Yorkton, Prince Albert, Indian Head, Melfort, Redvers, Outlook, Scott and Swift Current, SK
4. **Project start and end dates (month & year):** April 2019 to Winter 2020
5. **Project contact person & contact details:**

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Objectives and Rationale

6. **Project objectives:**
    - To demonstrate that newer malt varieties can provide comparable yields to the best feed varieties.
    - To demonstrate the importance of adequate plant populations for yield and malt acceptance.
    - To demonstrate the differences in nitrogen (N) management for malt versus feed barley varieties.

7. **Project Rationale:**

Growing barley for malt can be a gamble because if rejected, a large amount of yield is potentially lost compared to growing a feed variety. Work by AgriProfits would suggest that feed, rather than malt varieties, should be grown if the chance of making malt is less than 50%. However, this recommendation is not going to be applicable when the newer, higher yielding malt varieties become widely accepted by maltsters. AC Metcalfe is a popular variety for maltsters; however, there are a number of feed varieties which yield 15 to 20% higher. According the 2018 Saskatchewan Seed Guide, the popular feed variety CDC Austenson yields from 118 to 121% of AC Metcalfe. The malt variety AAC Synergy, which is gaining traction in the market, is more comparable to CDC Austenson as it also yields 118% of AC Metcalfe. If a widely selected malt variety can produce similar yields to the best feed varieties, then there

would be little reason to grow a feed variety. Yields of feed varieties are not likely to stay ahead of malt varieties as funding for feed variety development is decreasing. The Saskatchewan Barley Development Commission wants to get the message out that newer malt barley varieties can yield as well as feed varieties. As this becomes the case, producers will need to be aware they can grow malt varieties without sacrificing feed yields if their grain is rejected for malt. Those who continue to grow feed varieties will be forfeiting potential economical opportunities with the maltsters.

Producers need to be aware of the importance of seeding rate and nitrogen management for malt and feed varieties. Higher seeding rates have been found to both maximize yield and improve acceptance for malt. Work by John O'Donovan determined 300 seeds/m^2 was the optimum seeding rate for malt barley. This resulted in a plant stand of around 220 plants/m^2. Lower seeding rates increase tillering which can lead to more variable maturity and non-uniform kernels which is undesirable to maltsters. Increasing the seeding rate to 300 seeds/m^2 may slightly reduce kernel plumpness but produces more uniform kernels which is an acceptable trade off. Using a higher seeding rate also has the advantage of hastening maturity by 2 to 3 days and slightly lowers protein. For feed barley, the optimum seeding rate is often somewhat higher than it is for malt.

Managing nitrogen is particularly important for malt barley where protein levels must not exceed 12.5%. High protein barley means there is less carbohydrate for the malting process which may result in cloudy beer. Nitrogen rates for feed barley can be higher as high protein is not a concern. This project was intended to illustrate those differences by demonstrating basic agronomic practices for newer malt varieties and to help barley producers stay competitive in a changing market.

Methodology and Results

8. Methodology:

Trials were established at all eight AgriARM research sites across all the major soil zones of Saskatchewan. Locations included Yorkton, Redvers, Indian Head, Swift Current, Scott, Outlook, Prince Albert and Melfort.

Each trial was designed as a 3 order factorial with 4 replicates. Plot size and row spacing varied between locations depending on equipment. The first factor compared AAC Synergy (malt variety) vs the Feed variety CDC Austenson. Based on past research the yield for the newer malt varieties should be comparable to the popular feed variety (CDC Austenson) for a given input level. The second factor evaluated seeding rates of 200 and 300 seeds/m^2. Both varieties should yield better at the higher seeding rate (300 seeds/m^2) and the higher seeding rate should improve the kernel uniformity and improve the chance of the malt variety making the grade. The 3rd factor examines nitrogen rate. The impact nitrogen rate has on protein levels, yield, and

selection for malt were determined from these treatments. Table 1 lists the treatments that were established and dates of operations are included in Table 2.

Table 1. Treatment List for Malt versus Feed Barley (Resubmission with variety change) Trial

Trt #	Variety	Seeds/m^2	Lb N/ac soil + Fertilizer
1	AAC Synergy (Malt)	200	80
2	AAC Synergy (Malt)	200	120
3	AAC Synergy (Malt)	200	160
4	AAC Synergy (Malt)	300	80
5	AAC Synergy (Malt)	300	120
6	AAC Synergy (Malt)	300	160
7	CDC Austenson	200	80
8	CDC Austenson	200	120
9	CDC Austenson	200	160
10	CDC Austenson	300	80
11	CDC Austenson	300	120
12	CDC Austenson	300	160

Table 2. Dates of operations in 2019 for the Malt versus Feed Barley Management (Resubmission with variety and N change)								
				----------Date----------				
Activity	**Indian Head**	**Melfort**	**Outlook**	**Prince Albert**	**Redvers**	**Scott**	**Swift Current**	**Yorkton**
Pre-seed Herbicide Application	May 12 Roundup Weathermax 540 (0.67 L/ac)	May 24 Glyphosate 540 (0.5 L/ac) + Heat LQ (21 mL/ac)	N/A	N/A	N/A	May 19 Glyposate 540 (1L/ac) + AIM (35mL/ac)	May 13 (glyphosate)	n/a
Seeding	May 6	May 14	May 14	May 23	May 4	May 14	May 14	May 7
Emergence Counts	May 28	June 18	N/A	June 12	June 3	June 5	June 3	May 28 and May 29
In-crop Herbicide Application	June 13 Prestige XC A (0.17 L/ac) + Prestige XC B (0.8 L/ac) + Axial BIA (0.5 L/ac)	June 27 Axial (0.5 L/ac) July 4 Prestige XCA (0.13 L/ac)+ Prestige B (0.6 L/ac)	June 13 Infinity (0.33L/ac) + Assert (0.67L/ac) + pH adjuster (155 g/ac)	June 27 Stellar	June 10 Buctril M (0.4L/ac)	June 26 Axial (0.5 L/ac) + Buctril M (0.4L/ac) @10gpa	June 20 Liquid Achieve (200ml/ac + Infinity (330ml/ac) + Turbo Charge (500ml/100L spray volume**)**	June 10 Axial + Frontline June 25 (MCPA)
In-crop Fungicide Application	July 4 Trivepro A (0.4 L/ac) + Trivepro B (0.12 L/ac)	N/A	July 23 Caramba (400 mL/ac)	N/A	N/A	June 13 Propel (200 mL/ac) @gpa	July 10 Aceplla	July 3 Acapella
Lodging Rating	N/A	Sept 4	Completed as treatments matured individually	N/A	N/A	Aug 26	Aug 19	Sept 3
Harvest	Aug 16	Sept 18	Sept 24	Sept 16	Aug 19	Sept 18	Aug 22	Sept 4

9. Results:

Growing Season Weather

Mean monthly temperatures and precipitation amounts for 8 locations are provided with the long-term averages in Table 3 and 4. The 2019 season was cooler than average at all sites. Rainfall was below average for all sites except Scott and Swift Current. Irrigation applied to the Outlook site included 8 mm in May, 62.5 mm in June, 45.5 mm in July and 12.5 mm in August.

Table 3. Mean monthly temperatures amounts along with long-term (1981-2010) normals for the 2019 growing seasons at 8 sites in Saskatchewan.

Location	Year	May	June	July	August	Avg. / Total
		----------*Mean Temperature (°C)* ----------				
Indian Head	2019	8.9	15.7	17.4	15.8	14.4
	Long-term	***10.8***	***15.8***	***18.2***	***17.4***	***15.6***
Melfort	2019	8.8	15.3	16.9	14.9	14.0
	Long-term	***10.7***	***15.9***	***17.5***	***16.8***	***15.2***
Outlook	2019	9.9	16.0	18.0	16.2	15.0
	Long-term	***11.5***	***16.1***	***18.9***	***18.0***	***16.1***
Prince Albert	2019	9.5	15.8	17.4	15.1	14.5
	Long-term	***10.4***	***15.3***	***18.0***	***16.7***	***15.1***
Redvers	2019	9.5	16.3	18.5	16.6	15.2
	Long-term	***12***	***16***	***19***	***18***	***16.3***
Scott	2019	*9.1*	*14.9*	*16.1*	*14.4*	*13.6*
	Long-term	***10.8***	***14.8***	***17.3***	***16.3***	***14.8***
Swift Current	2019	*9.5*	*15.8*	*17.7*	*16.8*	*15.0*
	Long-term	***11***	***15.7***	***18.4***	***17.9***	***15.8***
Yorkton	2019	8.6	16	18.3	16.1	14.8
	Long-term	***10.4***	***15.5***	***17.9***	***17.1***	***15.2***

Table 4. Precipitation amounts along with long-term (1981-2010) normals for the 2019 growing seasons at 8 sites in Saskatchewan.

Location	Year	May	June	July	August	Avg. / Total
		---------- *Precipitation (mm)* ----------				
Indian Head	2019	13.3	50.4	53.1	96.0	212.8
	Long-term	***51.7***	***77.4***	***63.8***	***51.2***	***241.4***
Melfort	2019	18.8	87.4	72.7	30.7	209.6
	Long-term	***42.9***	***54.3***	***76.7***	***52.4***	***226.3***
Outlook	2019	13.2	90.2	43.8	39.6	186.8
	Long-term	***42.6***	***63.9***	***56.1***	***42.8***	***205.4***
Prince Albert	2019	30.0	54.4	57.4	16.8	158.6
	Long-term	***44.7***	***68.6***	***76.6***	***61.6***	***251.5***
Redvers	2019	18.0	79.0	54.0	88.0	239
	Long-term	***60***	***91***	***78***	***64***	***293***
Scott	2019	12.7	97.7	107.8	18	236.2
	Long -term	***38.9***	***69.7***	***69.4***	***48.7***	***226.7***
Swift Current	2019	13.3	156	11.1	42.6	223
	Long-term	***42.1***	***66.1***	***44***	***35.4***	***187.6***
Yorkton	2019	11.1	81.6	49.1	32.2	174
	Long-term	***51***	***80***	***78***	***62***	***272***

Table 5 lists soil test results from each location. Levels of soil N were high at Melfort, Redvers and Swift Current. Soil N tested low at Outlook.

Table 5. Soil Test Nitrate Levels for each location.								
Nitrate Levels (lbs NO_3-N/ac)	**Indian Head**	**Melfort**	**Outlook**	**Prince Albert**	**Redvers**	**Scott**	**Swift Current**	**Yorkton**
0-15cm (0-6in)	15 lb/ac	23 lb/ac	6 lb/ac	20 lb/ac	34 lb/ac	14 lb/ac	17 lb/ac	14 lb/ac
15-30cm (6-12in)		22 lb/ac		15 lb/ac				
15-60cm (6-24in)	27 lb/ac		9 lb/ac		51 lb/ac	18 lb/ac	66 lb/ac	18 lb/ac
Total 0-60cm (0-24in)	42 lb/ac	67.5 lb/ac	15 lb/ac		85 lb/ac	32 lb/ac	83 lb/ac	32 lb/ac
Total 0-30cm (0-12in)				35 lb/ac				

As expected, increasing seeding rate from 200 to 300 seeds/m^2 significantly increased plant emergence at all reporting locations (Table 6). Emergence data was not available from Outlook. When averaged across locations, 200 and 300 seeds/m^2 resulted in plant populations of 158 and 211/m^2, respectively; however, emergence varied between locations (Table 7). Plant densities were lower at Melfort and Prince Albert, averaging 84 and 125/m^2 when seeding 200 seeds/m^2 and 111 and 164/m^2 when seeding 300 seeds/m^2, respectively. Stand establishment at the remaining sites was as expected. The goal was to produce similar emergence rates for AAC Synergy and CDC Austenson and this was essentially achieved. Emergence between varieties did statistically differ by 10% at Yorkton, however, this difference is unlikely to have favored or hindered one variety over the other. Increasing N rates significantly decreased emergence at Melfort, Prince Albert, Redvers, Scott and Swift Current but not at Indian Head or Yorkton (Table 7). The impact was quite large at Melfort, where increasing N levels from 80 to 160 lb/ac (includes soil N) decreased emergence from 117 to 69 plants/m^2, respectively. The impact was also relatively large at Prince Albert, where emergence was decreased from 162 to 126 plant/m^2 in response to increasing N levels from 80 to 160 lb/ac.

Barley grain yields varied between locations. The highest yielding sites were Outlook and Yorkton averaging 7734 and 7308 kg/ha, respectively. Soil moisture reserves were good at Yorkton and Outlook was under irrigation. The lowest yielding site was Swift Current averaging 3146 kg/ha. Prince Albert was the second lowest yielding site at 4350 kg/ha and the remaining sites produced yields in the range of 5000 kg/ha.

Averaged across location, the yield of AAC Synergy and CDC Austenson were within 0.16% of each other. While yields were virtually identical overall, their ranking did vary substantially

between locations even though the same seedlot was used at all locations. The malt variety AAC Synergy significantly yielded 2.6, 5.1 and 11.9% more grain than the feed variety CDC Austenson at Indian Head, Redvers and Swift Current, respectively (Table 9 and 10). In contrast, CDC Austenson was significantly higher yielding by 9.5 and 16.7% at Melfort and Prince Albert, respectively. Yields did not statistically differ between varieties at Outlook, Scott or Yorkton.

Yield differences between seeding rates were minor and none were significant at the 5% level of confidence (Table 9 and 10). However, the lower seeding rate at Redvers resulted in 3.7% more yield at the 6.3% level of confidence. Numerically, the lower seeding rate resulted in 7% more yield at Swift Current. Lower seeding rates tend to be more beneficial if conditions are dry due to less interplant competition. This was certainly the case for many locations in early spring. Overall, seeding rate had little effect on yield when considering all locations.

Increasing nitrogen levels from 80 to 160 lb/ac, which includes soil N (0-24 inches), significantly increased yield at Melfort, Scott and Yorkton by 13, 18 and 24%, respectively (Table 9 and 10). At Redvers, added N significantly reduced yield by 7%. For the remaining sites, yield was unresponsive to added N and no significant differences were detected.

Treatment means for quality factors are listed in tables 12 to 14. Data for test weight % plump, protein, and germination were combined together using site for replication to determine if seeding rate or rate of N impacted those variables. Only N rate significantly increased protein content of grain. On average, N levels of 80, 120 and 160 lb/ac resulted in grain proteins of 11.8, 12.6, and 13.1 percent, respectively. Increasing seeding rate did not significantly reduce protein or % plumps, however there was a trend for % plumps to decrease from 91.8 to 90.2% as N rates were increased from 80 to 160 lb N/ac. When averaged over location, the bushel weights for AAC Synergy and CDC Austenson were 48.7 lb/W bu (314 g/0.5l) and 50.4 lb/W bu (325 g/0.5l), respectively. For feed barley bushel weight should be above 48 lb/W bu.

Malt barley grain protein was based off of a bulked sample from the 4 replicates for each treatment. While the data cannot be analyzed statistically, grain protein tended to increase with added N at all locations (Table 12). However, the level of grain protein and the response to N level differed substantially between locations. Malsters typically want barley with a protein content between 11 and 12.5%. Even at the lowest level of N, % protein was too high for the grain to be selected for malt at Prince Albert and Swift Current. This likely occurred because the yield potential at these sites was relatively low. High yields are needed to produce starchy kernels which dilutes the protein. The remaining sites all had at least one treatment which produced grain protein within acceptable limits for malt. The highest level of N which still provided an acceptable level of grain protein varied between the remaining locations. When averaged across seeding rates, the highest N level which produced grain with an acceptable protein concentration for malt was 80 lb N/ac at Indian Head (12.3% protein), 120 lb N/ac at Redvers (11.7% protein) and 160 lb/ac at Melfort, Scott and Yorkton resulting in average grain proteins of 10, 12.5 and 11.4, respectively. Determining the highest N level for Outlook was difficult as % grain protein hovered at the end of the acceptable range regardless of N level.

However, the highest level of N that produced acceptable levels of grain protein is not necessarily the most economical rate of N.

The most economic rate of N for AAC Synergy (malt) and CDC Austenson (feed) was determined using their yield responses to added N (averaged over seeding rate) and the prices of $4.68/bu for malt and $3.70/bu for feed. The optimum rate of N was the point at which $1/ac of additional N (at 50 cents/lb) produced $1/ac of additional revenue. However, the optimum N rate for malt also had to take into consideration that grain protein above 12.5% would result in rejection for malt.

Based on the above criteria, the most economic level of N for Scott was 155 lb/ac for malt (AAC Synergy) and 123 lb/ac for feed (CDC Austenson) (Figure 1). At Melfort, the most economic rate of N for feed was 116 lb/ac (Figure 2). Calculating the most economic rate of N for malt was questionable as the response curve was linear. This means the rate of return is same for every pound of added N which is not likely. Unfortunately, it was not possible to determine the most economic rate of N for either variety at the rest of the sites. At Yorkton, rates of N tested did not go high enough to determine the most economic rate for either variety (Figure 3). The yield response to N was very steep and very similar for both varieties at Yorkton. This means the most economic rate of N was somewhere beyond the level of 160 lb/ac. Even for malt, additional N would have been economical at Yorkton as protein was only 11.35% at the 160 lb N/ac level. For the remaining sites, N levels tested did not go low enough and the optimum level of N for both feed and malt was below 80 lb/ac. At Swift Current, Prince Albert and Outlook, even the lowest level of N at 80 lb/ac would not have produced malt as protein levels were above 12.5% (Figures 4, 5 and 6). Moreover, yields for both malt and feed were unresponsive to levels of N beyond 80 lb/ac. While an N level of 80 lb/ac did result in acceptable levels of grain protein at Indian Head and Redvers, further increases in N did not significantly increase yield of feed or malt (Figures 7 and 8). Thus the most economic level of N at Swift Current, Prince Albert, Outlook, Indian Head and Redvers was somewhere below 80 lb/ac for both AAC Synergy (malt) and CDC Austenson (feed).

Figure 1. Scott- Yield/Protein of AAC Synergy vs Yield of CDC Austenson 2019

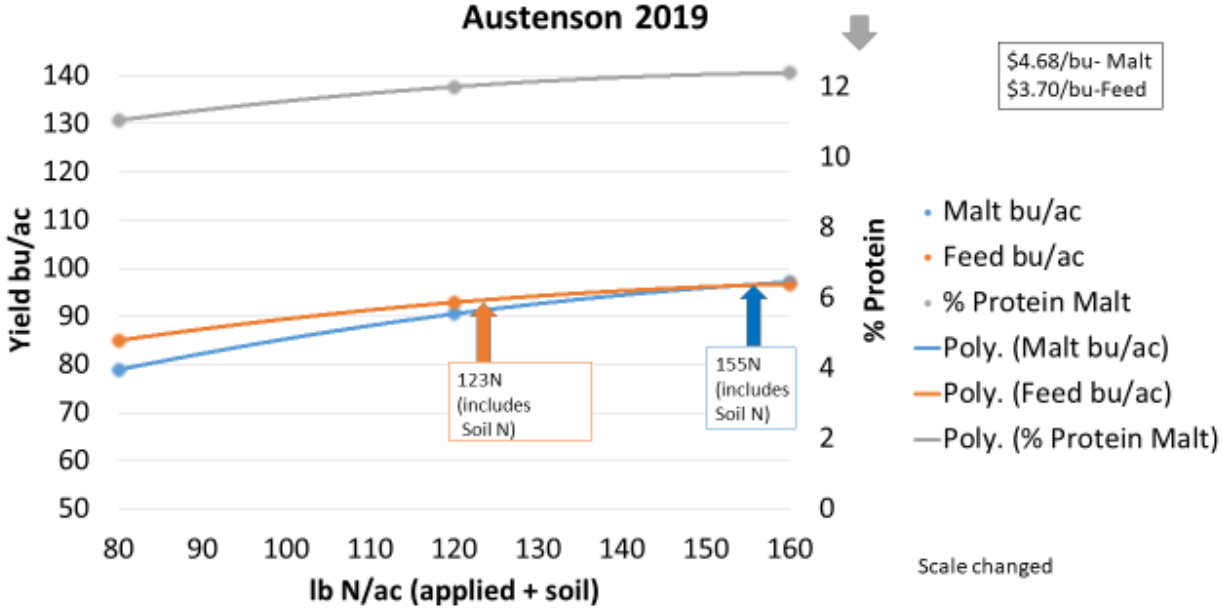


Figure 2. Melfort Yield/Protein of AAC Synergy vs Yield of CDC Austenson 2019

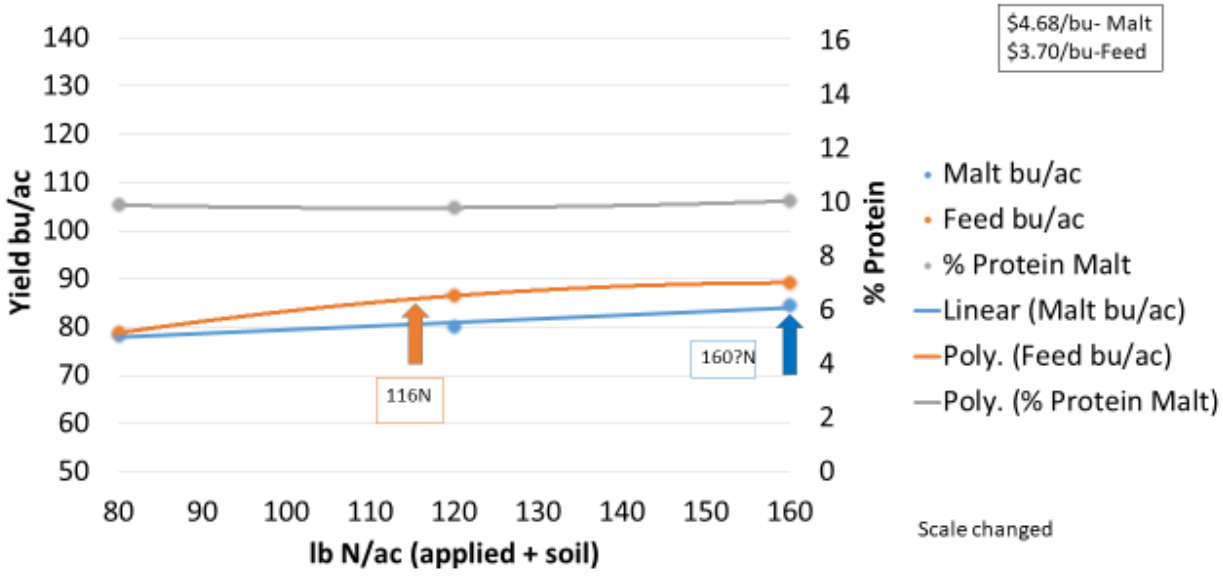


Figure 3. Yorkton- Yield/Protein of AAC Synergy vs Yield of CDC Austenson 2019

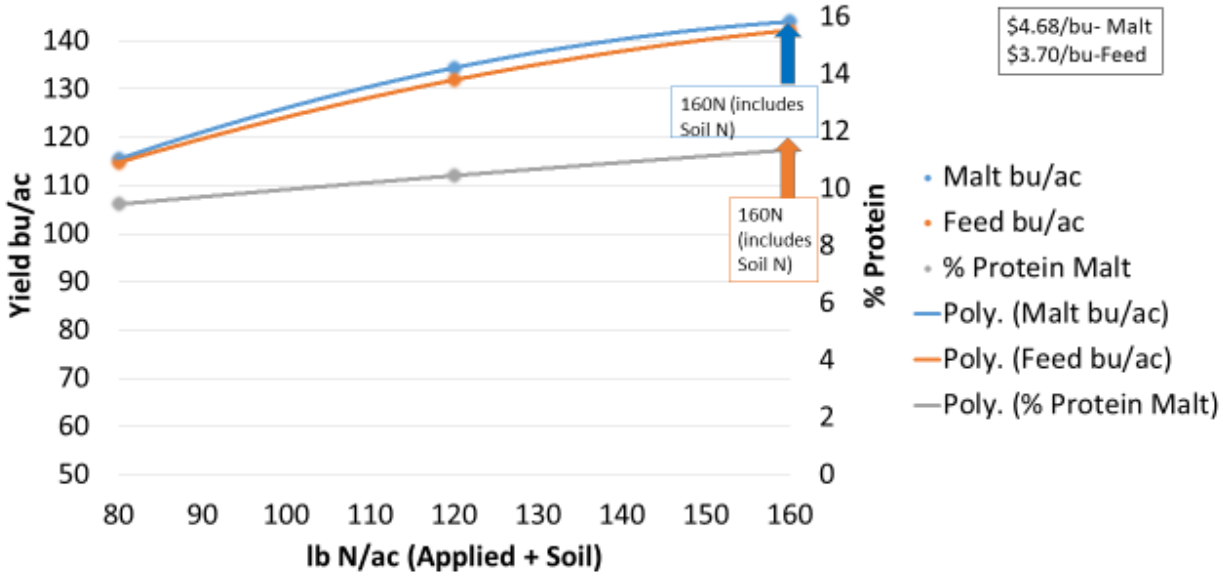


Figure 4. Swift Current- Yield/Protein of AAC Synergy vs Yield of CDC Austenson 2019

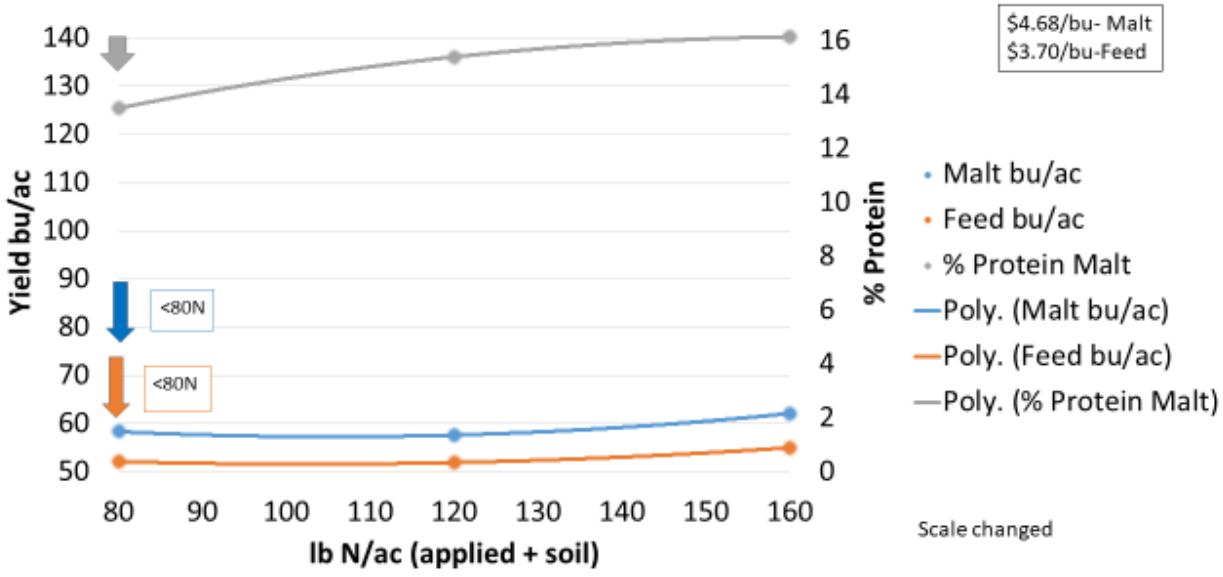


Figure 5. Prince Albert- Yield/Protein of AAC Synergy vs Yield of CDC Austenson 2019

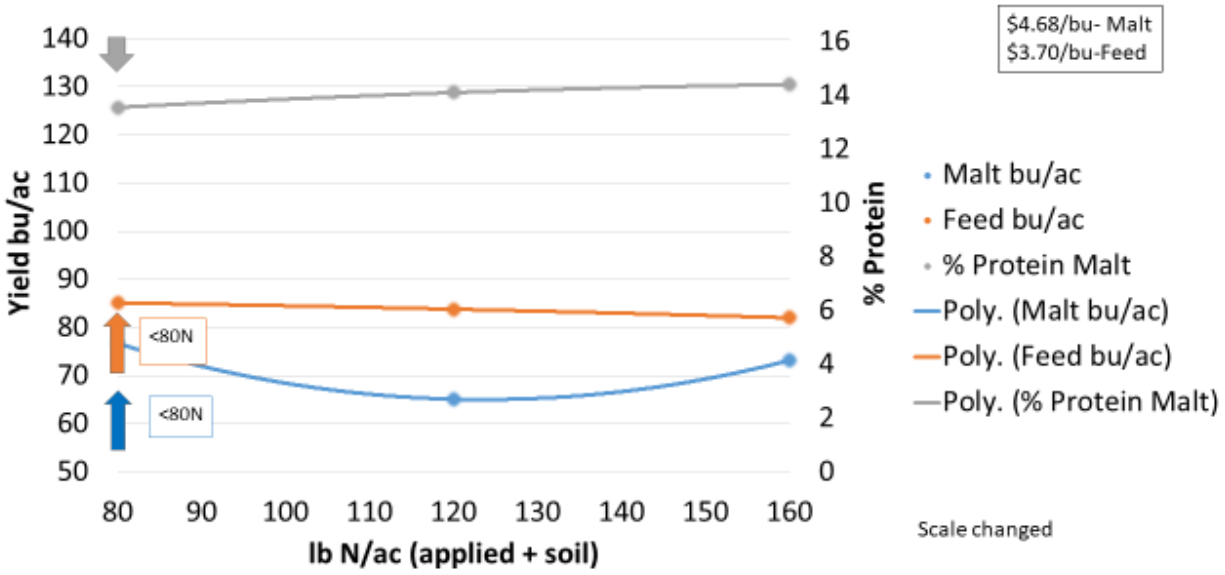


Figure 6. Outlook Yield/Protein of AAC Synergy vs Yield of CDC Austenson 2019

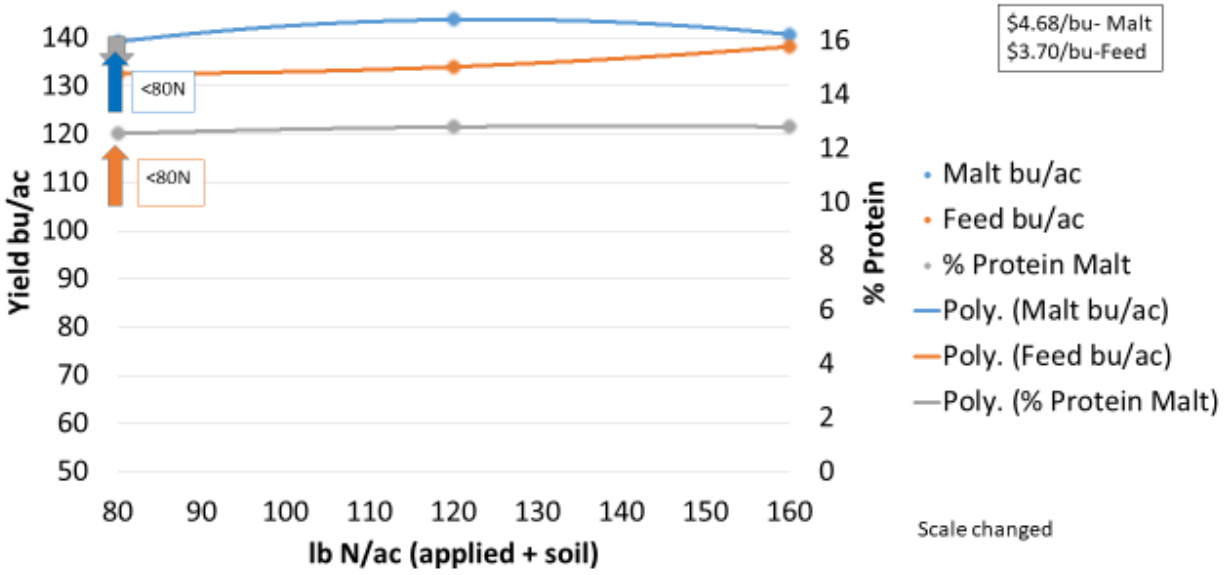


Figure 7, Indian Head Yield/Protein of AAC Synergy vs Yield of CDC Austenson 2019

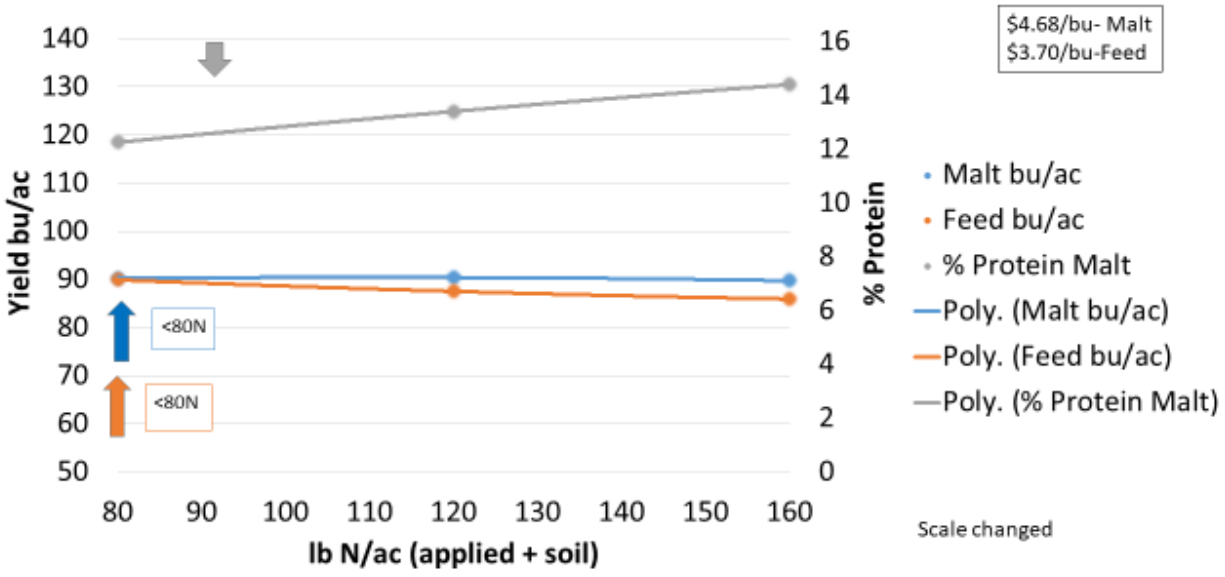
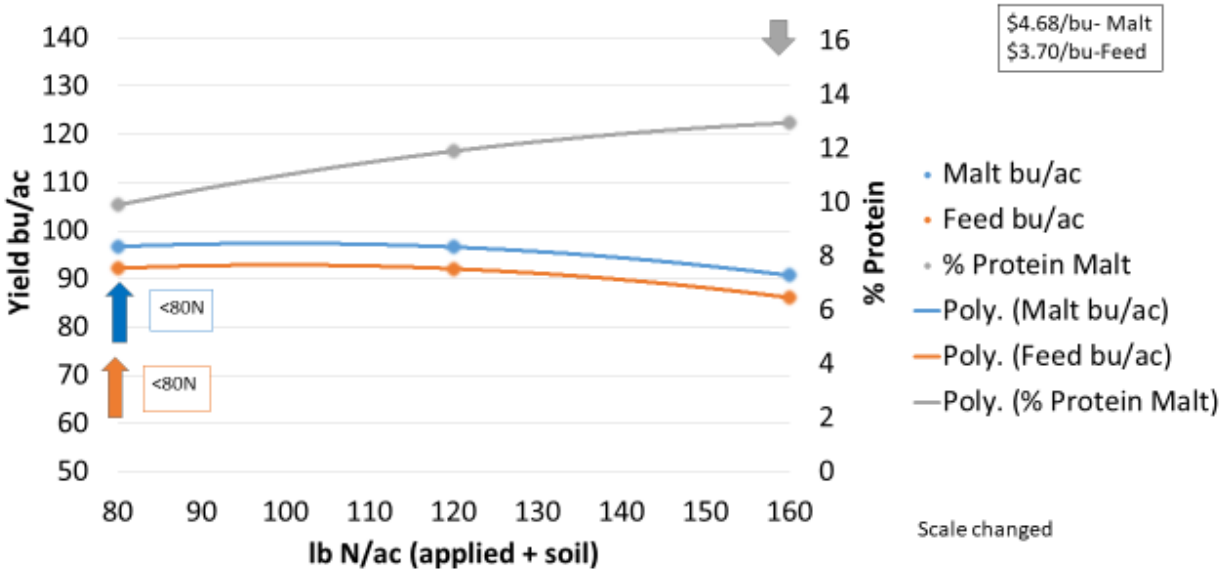


Figure 8. Redvers- Yield/Protein of AAC Synergy vs Yield of CDC Austenson 2019



The trial was toured at Swift Current on July 9, 10, and 30 at private tours (total of 44 attendees) and during WCA's Annual Field day on July 18 (120 attendees). The trial was also promoted on Swift Current's Facebook page and CKSW's weekly program "Walk the Plots" reaching thousands of listeners in southwest Saskatchewan. The trial was showcased at Indian Head's Indian Head Crop Management Field Day on July 16 (125 attendees), Melfort's Annual Field Day on July 24 (80 attendees) and Outlook's CSIDC tour on July 11 (200 attendees). The trial was also discussed in an article called "Should you be growing feed or malt barley?" in a Spring 2019 SaskBarley Newsletter. Yorkton toured the trial at their Annual Field Tour on July 23 (100 attendees) and at a private industry tour involving 40 producers. Mike Hall discussed the trial's results during his presentation called "Oats and Barley: Are we managing N properly?" at the AgriARM Update at the Saskatoon Crop Production Show on January 16, 2020 (50 attendees)

10. Conclusions and Recommendations

The yield difference between the malt variety AAC Synergy and feed variety CDC Austenson did vary between locations. However, when averaged across location, there was little yield difference between the varieties. There may be little reason to grow a feed variety over AAC Synergy which has a similar yield to the best feed varieties. However, it should be noted that the bushel weight of CDC Austenson was significantly higher than AAC Synergy which is an important criteria for feed. AAC Synergy was gaining acceptance with maltsters but recently Canada Malt indicated they will not be contracting AAC Synergy for 2020. Increasing seeding rate did not increase yield, decrease protein or improve any quality factors for malt barley. However, increasing N did increase protein and tended to decrease % plump. In many cases it was not possible to compare the optimum level of N between the feed and malt varieties. At 5 locations, the yield of both varieties was unresponsive to increasing N levels above 80 lb/ac (soil + applied N). This means the economic level of N for these sites was below 80 lb/ac for both the feed and malt barley varieties. At Yorkton, the most economic level of N for both varieties would have been above 160 lb/ac as yield was highly responsive to added N and protein levels remained relatively low. A fair comparison of the most economic rate of N was only possible at Scott, where the most economic N rate for the malt and feed varieties were 155 and 123 lb/ac, respectively. While there is more risk associated with applying too much N to malt barley, there was little evidence to suggest the most economic rate of N is higher for feed than malt.

Supporting Information

11. Acknowledgements:

This project was funded through the Agricultural Demonstrations of Practices and Technologies and Saskatchewan Barley Development Commission.

12. Appendices

Table 6. Significance of variety, seeding rate and nitrogen fertilizer effects on barley emergence at multiple locations in 2019.

	Emergence							
	Indian Head	**Melfort**	**Outlook**	**Prince Albert**	**Redvers**	**Scott**	**Swift Current**	**Yorkton**
Effect	----------p-values [z] ----------							
Variety (V)	NS	NS	N/A	NS	NS	NS	NS	0.004129
Seeds/m^2 (S)	<0.00001	0.000374	N/A	0.00123	<0.00001	<0.00001	<0.00001	<0.00001
V x S	NS	NS	N/A	NS	NS	NS	NS	NS
Nitrogen rate (R)	NS	<0.00001	N/A	0.038526	0.075299	0.035497	0.020234	NS
V x R	0.00213	NS	N/A	NS	0.038526	NS	NS	NS
S x R	NS	NS	N/A	NS	0.012684	NS	NS	0.032719
V x S x R	NS	0.049375	N/A	NS	NS	NS	NS	NS

[z] p-values ≤ 0.05 indicate that a treatment effect was significant and not due to random variability

Table 7. Main effects of variety, seeding rate and nitrogen rate on barley emergence at multiple locations in 2019.								
Main effect	**Emergence**							
	Indian Head	**Melfort**	**Outlook**	**Prince Albert**	**Redvers**	**Scott**	**Swift Current**	**Yorkton**
Variety	---------- plants/m^2 ----------							
AAC Synergy	268	95.2	N/A	147	189	186	188	213
CDC Austenson	259	99.7	N/A	141	179	194	186	235
LSD	NS	NS	N/A	NS	NS	NS	NS	14.2
Seeds/m^2								
200	226	83.8	N/A	125	158	160	158	193
300	301	111	N/A	164	210	221	216	254
LSD	15.4	14.2	N/A	22.8	12	9.4	12.7	14.2
lbs N/ac								
80	267	117	N/A	162	191	197	198	225
120	263	106	N/A	145	186	191	189	225
160	260	69	N/A	126	175	182	175	221
LSD	NS	17.9	N/A	28.6	14.5	11.9	16	NS

Table 8. Variety by Seeding rate by N fertilizer rate interactions on barley emergence at multiple locations in 2019.								
Main effect	**Emergence**							
	Indian Head	**Melfort**	**Outlook**	**Prince Albert**	**Redvers**	**Scott**	**Swift Current**	**Yorkton**
V × S x R	---------- plant/m^2 ----------							
AAC Synergy – 200 seeds/m2 – 80 lbs N/ac	236	84 bcd	N/A	137	348	165	174	174
AAC Synergy – 200 seeds/m2 – 120 lbs N/ac	217	111 abc	N/A	147	348	160	160	184
AAC Synergy– 200 seeds/m2 – 160 lbs N/ac	233	54 d	N/A	115	281	151	156	189
AAC Synergy – 300 seeds/m2 – 80 lbs N/ac	338	127 ab	N/A	182	475	218	215	254
AAC Synergy – 300 seeds/m2 – 120 lbs N/ac	281	112 abc	N/A	163	381	215	214	246
AAC Synergy – 300 seeds/m2 – 160 lbs N/ac	302	85 bcd	N/A	138	429	207	210	234
CDC Austenson – 200 seeds/m2 – 80 lbs N/ac	214	124 ab	N/A	139	297	162	171	196
CDC Austenson – 200 seeds/m2 – 120 lbs N/ac	240	74 cd	N/A	97	339	164	155	200
CDC Austenson – 200 seeds/m2 – 160 lbs N/ac	217	57 d	N/A	114	285	155	134	218
CDC Austenson – 300 seeds/m2 – 80 lbs N/ac	280	134 a	N/A	190	408	244	232	278

CDC Austenson – 300 seeds/m2 – 120 lbs N/ac	317	127 ab	N/A	172	414	226	225	271
CDC Austenson – 300 seeds/m2 – 160 lbs N/ac	287	83 bcd	N/A	137	406	214	201	244
L.S.D.	50.5	46.8	N/A	75.0	74.8	31.0	41.9	46.9

Table 9. Significance of variety, seeding rate and nitrogen fertilizer effects on barley grain yield at multiple locations in 2019.

	Yield							
	Indian Head	**Melfort**	**Outlook**	**Prince Albert**	**Redvers**	**Scott**	**Swift Current**	**Yorkton**
Effect	----------p-values [z] ----------							
Variety (V)	0.006068	0.029177	NS	0.005565	0.015619	NS	0.006621	NS
Seeds/m^2 (S)	NS	NS	NS	NS	0.063075	NS	NS	NS
V x S	NS	NS	NS	NS	NS	NS	NS	NS
Nitrogen rate (R)	NS	0.045437	NS	NS	0.012684	<0.00001	NS	<0.00001
V x R	NS	NS	NS	NS	NS	NS	NS	NS
S x R	NS	NS	NS	NS	NS	NS	NS	NS
V x S x R	NS	NS	NS	NS	NS	NS	NS	NS

[z] p-values ≤ 0.05 indicate that a treatment effect was significant and not due to random variability

Table 10. Main effects of variety, seeding rate and nitrogen rate on barley grain yield at multiple locations in 2019.								
Main effect	**Yield**							
	Indian Head	**Melfort**	**Outlook**	**Prince Albert**	**Redvers**	**Scott**	**Swift Current**	**Yorkton**
Variety	---------- Kg ha^{-1} ----------							
AAC Synergy	5048	4537	7909	4014	5302	4975	3323	7354
CDC Austenson	4916	4969	7559	4685	5046	5126	2968	7261
LSD	92.6	390	NS	467	208	NS	253	NS
$Seeds/m^2$								
200	5001	4817	7660	4288	5270	5073	3249	7349
300	4963	4689	7807	4411	5078	5029	3041	7265
LSD	NS	NS	NS	NS	NS	NS	NS	NS
lbs N/ac								
80	5046	4416	7613	4532	5288	4590	3090	6449
120	4984	4845	7778	4171	5284	5136	3068	7457
160	4916	4998	7810	4346	4950	5427	3279	8016
LSD	NS	490	NS	NS	261	216	NS	195

Table 11. Variety by Seeding rate by N fertilizer rate interactions on barley yield at multiple locations in 2019.								
Main effect	**Yield**							
	Indian Head	**Melfort**	**Outlook**	**Prince Albert**	**Redvers**	**Scott**	**Swift Current**	**Yorkton**
V × S x R	---------- Kg ha^{-1} ----------							
1. AAC Synergy – 200 seeds/m2 – 80 lbs N/ac	5114	4242	7263	4278	5450	4473	3307	6378
2. AAC Synergy – 200 seeds/m2 – 120 lbs N/ac	5102	4819	8287	3840	5624	5107	3208	7579
3. AAC Synergy– 200 seeds/m2 – 160 lbs N/ac	5032	4868	7875	4212	5149	5382	3627	8146
4. AAC Synergy – 300 seeds/m2 – 80 lbs N/ac	4994	4531	8333	4312	5381	4362	3220	6559
5. AAC Synergy – 300 seeds/m2 – 120 lbs N/ac	5030	4158	7816	3453	5198	5034	3246	7471
6. AAC Synergy – 300 seeds/m2 – 160 lbs N/ac	5014	4602	7881	3991	5011	5492	3330	7988
7. CDC Austenson – 200 seeds/m2 – 80 lbs N/ac	5046	4442	7259	4495	5266	4777	3058	6412
8. CDC Austenson – 200 seeds/m2 – 120 lbs N/ac	4938	5209	7159	4413	5143	5273	3087	7446
9. CDC Austenson – 200 seeds/m2 – 160 lbs N/ac	4775	5320	8119	4491	4990	5426	3209	8133
10. CDC Austenson – 300 seeds/m2 – 80 lbs N/ac	5029	4449	7596	5042	5057	4747	2774	6447

11. CDC Austenson – 300 seeds/m2 – 120 lbs N/ac	4867	5192	7852	4979	5171	5131	2733	7331
12. CDC Austenson – 300 seeds/m2 – 160 lbs N/ac	4843	5204	7367	4690	4650	5407	2949	7797
L.S.D.	305	1284	1735	1539	685	566	833	510

Table 12. Quality Parameters for Malt Barley								
Treatment	**Sprouted %**	**Plump %**	**Thins %**	**Foreign %**	**Peeled/Broken %**	**Moisture %**	**Protein %**	**Germ %**
Indian Head								
1. AAC Synergy – 200 seeds/m2 – 80 lbs N/ac	0	94	0.6	0	1	12.1	12.4	100
2. AAC Synergy – 200 seeds/m2 –120lbs N/ac	0	92.4	0.7	0	0.8	11.9	13.6	100
3. AAC Synergy – 200 seeds/m2 – 160s lb N/ac	0	92.8	0.6	0	0.8	12	14.4	100
4. AAC Synergy – 300 seeds/m2 – 80 lbs N/ac	0	95.1	0.6	0	0.8	12.2	12.1	100
5. AAC Synergy – 300 seeds/m2 – 120 lbs N/ac	0	93.6	0.6	0	1	12	13.2	100
6. AAC Synergy – 300 seeds/m2 – 160 lbs N/ac	0	92.4	0.7	0	0.5	12	14.4	100
Melfort								
1. AAC Synergy – 200 seeds/m2 – 80 lbs N/ac	0.3	98.2	0.2	0.2	5.4	10.4	10.3	99
2. AAC Synergy – 200 seeds/m2 – 120 lbs N/ac	0	98.4	0.1	0.3	3.8	10.4	9.7	97
3. AAC Synergy – 200 seeds/m2 – 160 lbs N/ac	0	98.4	0.2	0.2	2.6	10.4	9.8	97
4. AAC Synergy – 300 seeds/m2 – 80 lbs N/ac	0	98.1	0.1	0.2	5.8	10.4	9.5	100
5. AAC Synergy – 300 seeds/m2 – 120 lbs N/ac	0	98.2	0.1	0.1	5	10.4	9.9	99
6. AAC Synergy – 300 seeds/m2 – 160 lbs N/ac	0	98.5	0.1	0.1	3.9	10.4	10.3	97

Table 12 Continued. Quality Parameters for Malt Barley								
Treatment	**Sprouted %**	**Plump %**	**Thins %**	**Foreign %**	**Peeled/Broken %**	**Moisture %**	**Protein %**	**Germ %**
Outlook								
1. AAC Synergy – 200 seeds/m2 – 80 lbs N/ac	0	98.7	0.1	0	25.2	14.8	12.4	96
2. AAC Synergy – 200 seeds/m2 – 120 lbs N/ac	0	98.2	0.1	0	25.2	15.0	12.4	94
3. AAC Synergy – 200 seeds/m2 – 160 lbs N/ac	0	98.4	0.1	0	22.9	14.9	12.8	98
4. AAC Synergy – 300 seeds/m2 – 80 lbs N/ac	0	98.2	0.1	0	21.5	14.8	12.7	97
5. AAC Synergy – 300 seeds/m2 – 120 lbs N/ac	0	98.0	0.2	0.1	24.8	15.0	13.2	98
6. AAC Synergy – 300 seeds/m2 – 160 lbs N/ac	0	97.6	0.2	0	21.2	15.3	12.8	96
Prince Albert								
1. AAC Synergy – 200 seeds/m2 – 80 lbs N/ac	16.3	98.8	0.2	0.3	1.5	14.5	14.0	98
2. AAC Synergy – 200 seeds/m2 – 120 lbs N/ac	14.8	98.4	0.2	1.7	1.6	14.7	14.3	83
3. AAC Synergy – 200 seeds/m2 – 160 lbs N/ac	11.2	98.4	0.2	0.7	1.6	15.2	14.6	92
4. AAC Synergy – 300 seeds/m2 – 80 lbs N/ac	12.4	98.2	0.1	0.3	1.0	15.3	13.1	93
5. AAC Synergy – 300 seeds/m2 – 120 lbs N/ac	18.9	98.1	0.2	0.3	2.0	14.0	13.9	83
6. AAC Synergy – 300 seeds/m2 – 160 lbs N/ac	23.6	98.4	0.3	0.5	1.3	14.1	14.2	99

Table 12 Continued. Quality Parameters for Malt Barley								
Treatment	**Sprouted %**	**Plump %**	**Thins %**	**Foreign %**	**Peeled/Broken %**	**Moisture %**	**Protein %**	**Germ %**
Redvers								
1. AAC Synergy – 200 seeds/m2 – 80 lbs N/ac	0.4	95	0.3	0	2.8	10.5	10.2	100
2. AAC Synergy – 200 seeds/m2 – 120 lbs N/ac	0	91	0.8	0	2.0	10.6	11.6	99
3. AAC Synergy – 200 seeds/m2 – 160 lbs N/ac	0	89	0.9	0	3.3	10.8	13.0	99
4. AAC Synergy – 300 seeds/m2 – 80 lbs N/ac	0.5	92	0.5	0	2.0	10.6	9.6	99
5. AAC Synergy – 300 seeds/m2 – 120 lbs N/ac	0	90	0.9	0	3.7	10.9	12.2	100
6. AAC Synergy – 300 seeds/m2 – 160 lbs N/ac	0	85	2.1	0	3.2	10.7	12.9	98
Scott								
1. AAC Synergy – 200 seeds/m2 – 80 lbs N/ac	0.1	98.4	0.1	0	3.2	11.5	10.9	99
2. AAC Synergy – 200 seeds/m2 – 120 lbs N/ac	0.1	98.4	0.1	0	2.7	12.9	11.8	98
3. AAC Synergy – 200 seeds/m2 – 160 lbs N/ac	0.1	96.8	0	0.1	2.5	13.5	12.2	99
4. AAC Synergy – 300 seeds/m2 – 80 lbs N/ac	0.1	98	0	0	4.4	12	11.2	100
5. AAC Synergy – 300 seeds/m2 – 120 lbs N/ac	0	97.2	0.1	0	2.9	12.3	12.2	100
6. AAC Synergy – 300 seeds/m2 – 160 lbs N/ac	0.1	97.1	0.2	0	3	13.4	12.6	98

Table 12 Continued. Quality Parameters for Malt Barley								
Treatment	**Sprouted %**	**Plump %**	**Thins %**	**Foreign %**	**Peeled/Broken %**	**Moisture %**	**Protein %**	**Germ %**
Swift Current								
1. AAC Synergy – 200 seeds/m2 – 80 lbs N/ac	0	61.2	8.2	0.5	4.0	11.2	13.5	100
2. AAC Synergy – 200 seeds/m2 – 120 lbs N/ac	0	51.0	10.0	0.6	3.9	11.0	15.5	100
3. AAC Synergy – 200 seeds/m2 – 160 lbs N/ac	0	53.6	9.2	0.4	4.5	11.1	15.9	100
4. AAC Synergy – 300 seeds/m2 – 80 lbs N/ac	0	51.2	12.4	0.5	4.5	11.0	13.5	100
5. AAC Synergy – 300 seeds/m2 – 120 lbs N/ac	0	41.6	15.5	0.4	3.9	10.8	15.3	100
6. AAC Synergy – 300 seeds/m2 – 160 lbs N/ac	0	45.2	14.2	0.5	3.6	11.4	16.4	100
Yorkton								
1. AAC Synergy – 200 seeds/m2 – 80 lbs N/ac	2.8	99.1	0.1	0.1	1.4	15.2	9.6	99
2. AAC Synergy – 200 seeds/m2 – 120 lbs N/ac	1.4	98.0	0.1	0.1	4.3	15.3	10.3	97
3. AAC Synergy – 200 seeds/m2 – 160 lbs N/ac	0.3	98.2	0.1	0.1	3.5	15.2	11.1	95
4. AAC Synergy – 300 seeds/m2 – 80 lbs N/ac	3.5	98.6	0.1	0.1	3.0	15.1	9.3	96
5. AAC Synergy – 300 seeds/m2 – 120 lbs N/ac	0.4	97.5	0.2	0.1	3.9	15.1	10.6	99
6. AAC Synergy – 300 seeds/m2 – 160 lbs N/ac	0.7	96.5	0.3	0.1	3.4	15.3	11.6	97

Table 13. Thousand Kernel Weights for Malt and Feed Barley								
Treatments	**Indian Head**	**Melfort**	**Outlook**	**Redvers**	**Prince Albert**	**Scott**	**Swift Current**	**Yorkton**
Thousand Kernel Weights (g)								
1. AAC Synergy (Malt); 200 seeds/m^2; 80 lbs/ac N	47.5	49.9	53.6	48.6	52.1	49.0	34.5	52.2
2. AAC Synergy (Malt); 200 seeds/m^2; 120 lbs/ac N	47.5	53.0	54.2	45.5	50.6	51.6	34.4	53.3
3. AAC Synergy (Malt); 200 seeds/m^2; 160 lbs/ac N	45.8	52.8	53.7	45.1	50.7	49.8	33.1	51.8
4. AAC Synergy (Malt); 300 seeds/m^2; 80 lbs/ac N	47.2	49.5	51.8	45.7	51.2	50.2	29.6	52.4
5. AAC Synergy (Malt); 300 seeds/m^2; 120 lbs/ac N	46.8	51.0	51.3	45.0	50.1	49.2	30.8	51.7
6. AAC Synergy (Malt); 300 seeds/m^2; 160 lbs/ac N	46.6	52.4	51.9	43.2	50.8	49.8	28.7	53.3
7. CDC Austenson (Feed); 200 seeds/m^2; 80 lbs/ac N	37.5	51.3	53.6	46.5	50.7	51.8	29.2	58.1
8. CDC Austenson (Feed); 200 seeds/m^2; 120 lbs/ac N	44.5	52.8	55.8	43.8	54.3	51.4	28.1	55.3
9. CDC Austenson (Feed); 200 seeds/m^2; 160 lbs/ac N	43.5	51.7	54.9	45.3	51.8	50.6	32.0	54.9
10. CDC Austenson (Feed); 300 seeds/m^2; 80 lbs/ac N	45.5	50.8	52.8	44.1	51.6	50.2	29.5	53.4
11. CDC Austenson (Feed); 300 seeds/m^2; 120 lbs/ac N	45.1	51.2	53.2	44.4	51.0	50.6	23.4	54.9
12. CDC Austenson (Feed); 300 seeds/m^2; 160 lbs/ac N	43.6	52.3	53.2	43.5	50.6	48.8	28.6	51

Table 14. Test Weights for Malt and Feed Barley								
Treatments	**Indian Head**	**Melfort**	**Outlook**	**Redvers**	**Prince Albert**	**Scott**	**Swift Current**	**Yorkton**
Test Weight (g/0.5 L)								
1. AAC Synergy (Malt); 200 seeds/m^2; 80 lbs/ac N	315.8	323.6	310.8	319.3	316.4	316.0	288.2	316.9
2. AAC Synergy (Malt); 200 seeds/m^2; 120 lbs/ac N	315.5	331.1	314.3	319.3	319.4	319.0	286.5	325.3
3. AAC Synergy (Malt); 200 seeds/m^2; 160 lbs/ac N	314.8	331.2	311.5	314.5	316.0	323.5	287.2	328.1
4. AAC Synergy (Malt); 300 seeds/m^2; 80 lbs/ac N	315.8	322.1	312.1	314.5	305.8	317.5	266.5	316.6
5. AAC Synergy (Malt); 300 seeds/m^2; 120 lbs/ac N	315.5	327.9	311.6	315.0	300.5	320.3	281.5	325.5
6. AAC Synergy (Malt); 300 seeds/m^2; 160 lbs/ac N	316.5	334.7	312.5	312.5	318.9	323.0	283.4	328.3
7. CDC Austenson (Feed); 200 seeds/m^2; 80 lbs/ac N	325.8	341.2	327.0	333.3	330.0	332.5	290.4	336.0
8. CDC Austenson (Feed); 200 seeds/m^2; 120 lbs/ac N	319.3	346.8	326.3	328.3	324.0	335.0	280.5	335.7
9. CDC Austenson (Feed); 200 seeds/m^2; 160 lbs/ac N	319.5	344.6	326.1	327.3	324.3	337.5	284.8	339.5
10. CDC Austenson (Feed); 300 seeds/m^2; 80 lbs/ac N	326.3	342.0	326.3	329.5	328.1	337.0	284.3	335.7
11. CDC Austenson (Feed); 300 seeds/m^2; 120 lbs/ac N	323.5	344.9	327.4	328.0	330.3	333.5	257.1	336.5
12. CDC Austenson (Feed); 300 seeds/m^2; 160 lbs/ac N	319.3	345.2	324.3	323.5	330.4	334.5	277.2	336.0

Abstract

13. Abstract/Summary:

Trials were conducted at Yorkton, Indian Head, Swift Current, Scott, Outlook, Prince Albert, Melfort and Redvers to compare the yield response of the malt variety AAC Synergy and the feed variety CDC Austenson to added N and seeding rate. Seeding rates of 200 and 300 seeds/m^2 were assessed at N levels of 80, 120 and 160 lb/ac, includes soil+applied (residual NO_3-N + fertilizer) N. The relative yields of the malt variety AAC Synergy and feed variety CDC Austenson varied between locations; however, when averaged across locations, yields were equal between the varieties, indicating there may be little reason to grow a feed variety over AAC Synergy. However, it should be noted that the bushel weight of CDC Austenson was significantly higher than AAC Synergy which is an important criteria for feed. Increasing seeding rate did not increase yield, decrease protein or improve any quality factors for malt barley; however, increasing N did increase protein and tended to decrease % plump. In many cases it was not possible to compare the optimum rate of N between the feed and malt varieties. At 5 locations, the yield of both varieties was unresponsive to increasing N levels above 80 lb/ac (soil + applied N). This means the economic level of N for these sites was below 80 lb/ac for both the feed and malt barley varieties. At Yorkton, the most economic level of N for both varieties would have been above 160 lb/ac as yield was highly responsive to added N and protein levels remained relatively low. A fair comparison of the most economic rate of N was only possible at Scott, where the most economic N rate for the malt and feed varieties was 155 and 123 lb/ac, respectively. While there is more risk associated with applying too much N to malt barley, there is little evidence to suggest the most economic rate of N is higher for feed than malt. The trial was toured at Swift Current on July 9, 10, and 30 at private tours (total of 44 attendees) and during WCA's Annual Field day on July 18 (120 attendees). The trial was also promoted on Swift Current's Facebook page and CKSW's weekly program "Walk the Plots" reaching thousands of listeners in southwest Saskatchewan. The trial was showcased at Indian Head's Indian Head Crop Management Field Day on July 16 (125 attendees), Melfort's Annual Field Day on July 24 (80 attendees) and Outlook's CSIDC tour on July 11 (200 attendees). The trial was also discussed in an article called "Should you be growing feed or malt barley?" in a Spring 2019 SaskBarley Newsletter. Yorkton discussed the trial at their Annual Field Tour on July 23 (100 attendees) and at a private industry tour involving 40 producers. Mike Hall discussed the trial's results during his presentation entitled "Oats and Barley: Are we managing N properly?" at the AgriARM Update at the Saskatoon Crop Production Show on January 16, 2020 (50 attendees)