Forage and Livestock Research

Performance Evaluation of Two-Row and Six-Row Forage Barley Mixtures

Background:

Many areas in Alberta have experienced some of the worst droughts in recent years. Severe and sustained drought is particularly stressful for beef cattle operations, which rely heavily on sufficient and timely rainfall to grow forage for their herds. Many perennial grass and legume forage species enter dormancy when faced with heat and water shortages. Therefore, selecting suitable drought-tolerant forage species is of prime importance during periods of frequent rainfall deficiencies. Spring cereals used as annual forages tend to perform better during hot and dry years when most perennial forages are less suited. Barley is one of the most common annual cereal forage crops in Alberta, offering better feed quality than oats, wheat, or triticale.

In 2024, a field trial was established at the LARA Research Farm in Fort Kent, Alberta, to investigate whether mixed cultivation of two-row and six-row barley in varietal seed mixtures could increase forage yield and nutritional quality compared to their component varieties grown in pure stands. The treatments included two two-row varieties (AB Maximizer and AAC Lariat) and two six-row varieties (AB Tofield and AB Standswell) grown both in pure stands and in twelve possible binary mixtures with 1:1, 1:3, and 3:1 seeding ratios. CDC Austenson was included as a check variety. The results indicated that mixed cultivation of a high-yielding two-row variety with a low-yielding six-row variety in a 3:1 seeding ratio could increase overall forage dry matter (DM) yield and nutritional quality, providing a diet capable of meeting the dietary requirements of different classes of beef cattle. However, as this study was conducted in a single environment during one growing season, the ability to draw broad conclusions was limited.

Further research is needed to explore how variety selection, seeding ratios, and trials under diverse environmental conditions affect the potential of these mixtures to stabilize forage productivity and quality over time.

Consequently, the same study was replicated in the 2025 growing season with the following principal objectives.

Objectives:

i. To determine the performance of two-row and six-row barley pure stands as well as their mixtures in three seeding ratios (1:1, 1:3, and 3:1) for forage dry matter (DM) yield.
ii. To determine the performance of two-row and six-row barley pure stands as well as their mixtures in three seeding ratios (1:1, 1:3, and 3:1) for forage nutritional quality.
iii. To assess the effect of weather conditions on forage DM yield and quality of two-row and six-row barley mixtures.

Materials and Methods:

The trial was carried out at the LARA research farm (54° 18'N, 110° 37'W; NE 25-61-5-W4) in Fort Kent, Alberta, during the 2025 growing season. Before seeding, soil samples were taken to a depth of 0-6 and 6-12 inches to determine the nutrient level at Element Lab, Edmonton. The treatments were comprised of 2 two-row (AB Maximizer and AAC Lariat) and 2 six-row (AB Tofield and AB Standswell) varieties in pure stands as well as in twelve possible binary mixtures of 1:1, 1:3, and 3:1 seedling ratio (Table 3d-1 & 2). CDC Austenson was seeded as a check variety. Seeding rate (g/plot) was calculated using the formula: 1000 kernel weight*(desired plants/m^2/1000) *plot area m^{2*} (100/germination%) *1.05. The factor 1.05 was used during calculations to take care of seedling mortality. Desired plant density was set to 300 plants/m^2 for all plots.

Table 3d-1. Variety list for the project.

Two-Row	Seeding Rate (lb/acre)	Six-Row	Seeding Rate (lb/acre)
AB Maximizer	149	AB Tofield	134
AAC Lariat	149	AB Standswell	111

Table 3d-2. Treatment list for the project.

Treatment	% Two-Row Inclusion	% Six-Row Inclusion
AAC Lariat	100	0
AB Maximizer	100	0
AB Standswell	0	100
AB Tofield	0	100
AAC Lariat-AB Standswell 1:1	50	50
AAC Lariat-AB Standswell 1:3	25	75
AAC Lariat-AB Standswell 3:1	75	25
AAC Lariat-AB Tofield 1:1	50	50
AAC Lariat-AB Tofield 1:3	25	75
AAC Lariat-AB Tofield 3:1	75	25
AB Maximizer-AB Standswell 1:1	50	50
AB Maximizer-AB Standswell 1:3	25	75
AB Maximizer-AB Standswell 3:1	75	25
AB Maximizer-AB Tofield 1:1	50	50
AB Maximizer-AB Tofield 1:3	25	75
AB Maximizer-AB Tofield 3:1	75	25

The experiment was planted in a randomized complete block design (RCBD) with four replications of 17 treatments. LARA Fabro five-row seeder was used for seeding with 9" row spacing. Plots were seeded to a depth of 1-1.5" depending on soil conditions and available moisture. As per the soil test, the recommended rate of fertilizers was side banded during seeding. Hand weeding occurred throughout the growing season to maintain the experimental area weed-free. The net plot size was 6.9 m^2 (1.15 m by 6 m). Harvesting was done when barley grains were at the soft dough stage. Individual plots were harvested with the LARA Alfalfa-Omega self-propelled forage harvester. For each treatment plot, ~ 400 g of freshly chopped forage (sub-sample) was dried to a constant weight and sent to A & L Canada Laboratories Inc. for quality analysis. A second sub-sample of ~ 250 g of freshly harvested material was taken from each plot and dried to a constant weight for dry matter calculations. The data for forage DM yield and each of the quality parameters were subjected to analysis of variance (ANOVA), and means were subsequently compared by the least significant difference (LSD) test at ≤0.05 probability level using the agricolae (version 1.3-7) package of the R (4.3.2) software.

Results & Discussion:

We did not observe any significant differences in yield among the treatments (Fig 3d-1 & Table 3d-3). Across all 16 treatments, including monocultures of two two-row and two six-row varieties as well as 12 binary mixtures established at 1:1, 1:3, and 3:1 seeding ratios, no treatment surpassed the check variety in yield. On average, the check variety CDC Austenson produced 3.01 t ac^{-1} of forage DM yield. The two-row varieties grown in monoculture, as well as their mixtures with six-row varieties at a 3:1 seeding ratio, produced yields close to, but slightly below, those of the check variety CDC Austenson. In contrast, six-row varieties grown in monoculture, particularly AB Standswell and AB Tofield, produced the lowest forage biomass (Fig 3d-1). This year represented the second year of the three-year study, and growing conditions were much drier than last year, leading most varieties to yield 25-30% below their full potential. In the first year (2024), which was wetter than the second year (2025), certain binary mixtures, particularly combinations of two-row and six-row varieties at a 3:1 seeding ratio, outperformed both monocultures and the check variety.

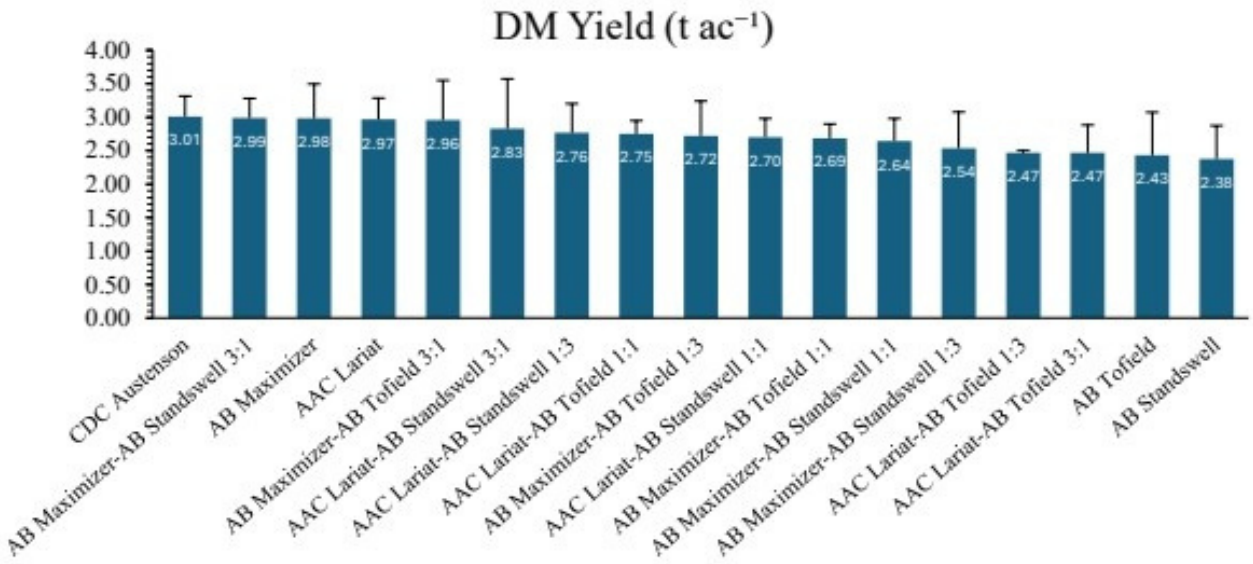

Figure 3d-1. Forage dry matter (DM) yield for variety mixtures and monocultures.

As a general guideline, dietary crude protein (CP) levels of 7%, 9%, and 11% are recommended to meet the nutrient requirements of beef cows during mid-gestation, late gestation, and lactation, respectively. All monocultures and mixtures evaluated in this study contained CP levels of approximately 11% or higher, which is sufficient to meet the requirements of lactating beef cattle. Similarly, total digestible nutrients (TDN), the simplest method for estimating feed energy, follow the 55-60-65 rule, where beef cows in mid-pregnancy, late pregnancy, and post-calving require 55%, 60%, and 65%, respectively. Our results showed that all monocultures and mixtures contained more than 65% TDN, indicating they would meet the energy demands of lactating beef cattle. Overall, most monocultures and mixtures contained adequate levels of magnesium (Mg; 0.19–0.3%), potassium (K; 0.78–0.91%), sodium (Na; 0.23– 0.37%), sulfur (S; 0.12–0.15%), iron (Fe; 113.83–191.77 mg kg^{-1}), and manganese (Mn; 35.76–59.98 mg kg^{-1}) to meet the requirements of beef cows during gestation and lactation (Table 3d-4 & 5). However, none of the monocultures or mixtures contained sufficient copper (Cu) or zinc (Zn) to meet the recommended requirements for beef cattle, which are 10 mg kg^{-1} for Cu and 30 mg kg^{-1} for Zn. Therefore, free-choice mineral supplementation, particularly of Cu and Zn, would be necessary when these feeds are included in beef cattle diets.

Table 3d-3. Forage dry matter (DM) yield, crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), and total detergent fiber (TDN) for all cropping treatments.

Treatment	DM Yield (% of Check)		CP (% DM)		NDF (% DM)		ADF (% DM)		TDN (% DM)	
CDC Austenson	100	a	11.60	bcd	47.10	a	22.69	ab	71.23	bc
AB Maximizer – AB Standswell 3:1	99	ab	11.67	bc	45.66	ab	21.63	abc	72.10	abc
AB Maximizer	99	ab	11.61	bcd	45.40	ab	21.61	abc	72.10	abc
AAC Lariat	99	ab	10.89	d	45.62	ab	22.01	abc	71.75	abc
AB Maximizer – AB Tofield 3:1	98	ab	11.90	abc	44.84	ab	21.26	abc	72.34	abc
AAC Lariat – AB Standswell 3:1	94	ab	11.29	cd	46.38	a	22.84	ab	71.10	bc
AAC Lariat – AB Standswell 1:3	92	ab	11.29	cd	44.59	ab	20.90	bc	72.62	ab
AAC Lariat – AB Tofield 1:1	91	ab	11.66	bcd	45.10	ab	22.17	abc	71.63	abc
AB Maximizer – AB Tofield 1:3	91	ab	11.52	bcd	43.71	ab	21.17	abc	72.41	abc
AAC Lariat – AB Standswell 1:1	90	ab	11.23	cd	46.56	a	22.74	ab	71.19	bc
AB Maximizer – AB Tofield 1:1	89	ab	11.88	abc	46.31	ab	22.41	abc	71.45	abc
AB Maximizer – AB Standswell 1:1	88	ab	11.77	abc	45.64	ab	21.90	abc	71.83	abc
AB Maximizer – AB Standswell 1:3	84	ab	11.50	bcd	46.96	a	22.78	ab	71.15	bc
AAC Lariat – AB Tofield 1:3	82	ab	11.38	bcd	46.53	a	23.42	a	70.65	c
AAC Lariat- AB Tofield 3:1	82	ab	11.44	bcd	45.40	ab	22.24	abc	71.58	abc
AB Tofield	81	ab	12.16	ab	45.89	ab	22.68	ab	71.23	bc
AB Standswell	79	b	12.43	a	42.37	b	20.44	c	72.98	a
Pr (>F)	0.5638.		0.0614.		0.559		0.405		0.404	

Note : Significance Codes : 0 '***' 0.001 '**' 0.01 '*' 0.05 '.'.

Table 3d-4. Forage calcium (Ca), phosphorous (P), potassium (K), magnesium (Mg), and sodium (Na) content for all cropping treatments.

Treatment	Ca (% DM)		P (% DM)		K (% DM)		Mg (% DM)		Na (% DM)	
CDC Austenson	0.34	abcd	0.10	abc	0.87	a	0.22	defg	0.23	bc
AB Maximizer – AB Standswell 3:1	0.28	d	0.10	bc	0.81	a	0.21	fg	0.23	c
AB Maximizer	0.27	d	0.10	abc	0.87	a	0.19	g	0.25	abc
AAC Lariat	0.31	bcd	0.12	a	0.79	a	0.26	abcd	0.29	abc
AB Maximizer – AB Tofield 3:1	0.27	d	0.11	ab	0.79	a	0.23	cdefg	0.29	abc
AAC Lariat – AB Standswell 3:1	0.40	abc	0.10	bc	0.87	a	0.26	abcde	0.26	abc
AAC Lariat – AB Standswell 1:3	0.31	bcd	0.10	abc	0.87	a	0.25	abcdef	0.29	abc
AAC Lariat – AB Tofield 1:1	0.35	abcd	0.10	bc	0.85	a	0.25	abcde	0.26	abc
AB Maximizer – AB Tofield 1:3	0.31	abcd	0.10	bc	0.82	a	0.28	ab	0.35	a
AAC Lariat – AB Standswell 1:1	0.42	a	0.10	bc	0.90	a	0.25	bcdef	0.24	bc
AB Maximizer – AB Tofield 1:1	0.35	abcd	0.11	abc	0.89	a	0.30	a	0.37	a
AB Maximizer – AB Standswell 1:1	0.29	cd	0.11	ab	0.91	a	0.21	fg	0.25	abc
AB Maximizer – AB Standswell 1:3	0.34	abcd	0.10	bc	0.78	a	0.22	efg	0.24	bc
AAC Lariat – AB Tofield 1:3	0.40	ab	0.09	c	0.90	a	0.29	ab	0.32	abc
AAC Lariat – AB Tofield 3:1	0.34	abcd	0.10	abc	0.89	a	0.25	abcdef	0.25	abc
AB Tofield	0.39	abc	0.09	c	0.79	a	0.27	abc	0.33	ab
AB Standswell	0.33	abcd	0.11	ab	0.88	a	0.24	bcdef	0.26	abc
Pr (>F)	0.112		0.0934.		0.962		0.00147**		0.346	

Note : Significance Codes : 0 '***' 0.001 '**' 0.01 '*' 0.05 '.'.

Table 3d-5. Forage copper (Cu), zinc (Zn), iron (Fe), and manganese (Mn) content for all cropping treatments

Treatment	Cu (mg kg^{-1})		Zn (mg kg^{-1})		Fe (mg kg^{-1})		Mn (mg kg^{-1})	
CDC Austenson	3.04	ab	18.43	ab	160.70	abcd	41.08	cde
AB Maximizer – AB Standswell 3:1	2.77	abc	17.91	ab	161.36	abcd	39.75	de
AB Maximizer	2.70	bc	15.48	b	148.10	abcd	35.76	e
AAC Lariat	2.72	bc	18.22	ab	140.03	bcd	39.02	de
AB Maximizer – AB Tofield 3:1	2.50	bc	18.11	ab	160.78	abcd	40.40	cde
AAC Lariat – AB Standswell 3:1	2.63	bc	19.78	ab	146.17	abcd	50.35	abcd
AAC Lariat – AB Standswell 1:3	2.65	bc	20.41	ab	132.90	cd	42.19	cde
AAC Lariat – AB Tofield 1:1	2.44	bc	20.25	ab	113.83	d	56.11	ab
AB Maximizer – AB Tofield 1:3	2.64	bc	17.97	ab	153.23	abcd	44.57	bcde
AAC Lariat – AB Standswell 1:1	2.60	bc	20.68	a	168.29	abc	48.59	abcd
AB Maximizer – AB Tofield 1:1	2.87	abc	17.14	ab	150.47	abcd	45.26	abcde
AB Maximizer – AB Standswell 1:1	3.31	a	17.90	ab	191.77	a	39.90	cde
AB Maximizer – AB Standswell 1:3	2.76	abc	19.34	ab	162.97	abcd	44.54	bcde
AAC Lariat – AB Tofield 1:3	3.03	abc	18.08	ab	177.35	abc	50.95	abcd
AAC Lariat – AB Tofield 3:1	2.40	c	19.37	ab	145.45	abcd	47.54	abcde
AB Tofield	2.60	bc	18.59	ab	183.99	ab	59.98	a
AB Standswell	2.65	bc	20.42	ab	146.98	abcd	52.22	abc
Pr (>F)	0.365		0.93		0.342		0.0303*	

Note: Significance Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.'; mg kg^{-1}: milligram per kilogram.

We also performed a direct comparison of the two-row and six-row varieties used in this study. Overall, two-row varieties yielded approximately 20% more than six-row varieties (Table 3d-6). On average, two-row varieties produced 2.98 t ac^{-1} of forage DM, whereas six-row varieties produced 2.40 t ac^{-1}. In terms of forage quality, six-row varieties had higher CP (12.30%) and TDN (72.11%) than two-row varieties, which contained 11.25% CP and 71.23% TDN (Table 3d-6); almost similar trends were observed last year.

Table 3d-6. Mean dry matter (DM) yield, crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), and total digestible nutrients (TDN) for two-row and six-row varieties used in the present study.

Type	DM Yield (tons/ac)		CP (% DM)		ADF (% DM)		NDF (% DM)		TDN (% DM)	
Check	3.01	a	11.60	ab	22.69	a	47.09	a	71.23	a
Two-Row	2.98	a	11.25	b	21.81	a	45.51	a	71.91	a
Six-Row	2.40	b	12.30	a	21.56	a	44.13	a	72.11	a
Pr (>F)	0.002148**		0.009106**		0.5471		0.2191		0.5465	

Note: Significance Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.'.

Table 3d-7. Mean calcium (Ca), phosphorus (P), potassium (K), magnesium (Mg), and sodium (Na) content for two-row and six-row varieties used in the present study.

Type	Ca (%DM)		P (% DM)		K (% DM)		Mg (% DM)		Na (% DM)	
Check	0.34	a	0.10	a	0.87	a	0.22	a	0.23	a
Two-Row	0.29	a	0.11	a	0.83	a	0.23	a	0.27	a
Six-Row	0.36	a	0.10	a	0.83	a	0.25	a	0.29	a
Pr (>F)	0.1268		0.3307		0.8725		0.2217		0.3934	

Note: Significance Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.'.

Table 3d-8. Mean copper (Cu), zinc (Zn), iron (Fe), and manganese (Mn) content for two-row and six-row varieties used in the present study.

Type	Cu (mg kg^{-1})		Zn (mg kg^{-1})		Fe (mg kg^{-1})		Mn (mg kg^{-1})	
Check	3.04	a	18.44	a	160.70	a	41.08	ab
Two-Row	2.71	a	16.85	a	144.10	a	37.39	b
Six-Row	2.62	a	19.20	a	165.48	a	55.54	a
Pr (>F)	0.1741		0.2887		0.494		0.001558**	

Note: Significance Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.'; mg kg-1: milligram per kilogram.

In conclusion, this study demonstrates that two-row barley varieties generally produce higher forage DM yields than six-row varieties, while six-row varieties may provide slightly higher forage quality in terms of CP and TDN. Mixing and planting two-row and six-row barley at a 3:1 ratio allows farmers to capture both high yield and improved forage quality, benefits that may be lost when planting either variety in monoculture.

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