



Agriculture and
Agri-Food Canada

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Condiment Mustard Breeding: Update

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Agriculture and Agri-Food Canada, Saskatoon Research and Development Centre

Canada 

Outline of the Presentation

- **Mustard Adaptation Test**
- **Group II herbicide IMI-tolerant brown and oriental mustard hybrid varieties**
- **Group II herbicide IMI-tolerant yellow mustard**
- **Clubroot resistant brown and oriental mustard, and yellow mustard**
- **Acknowledgement**



Mustard Adaptation Test

Entries:

Brown mustard: Centennial Brown (check), AAC Brown Elite and candidate hybrid B4253

Oriental mustard: Cutlass (check) and candidate hybrid O3856

Yellow mustard: Andante (check), AAC Yellow 80, candidate composite lines Y4213 and Y4214

Trial sites:

Saskatchewan: AAFC-Saskatoon farm, AAFC-Scott farm, AAFC-Swift Current farm, Redvers, Avonlea

Manitoba: Melita

Alberta: Coaldale



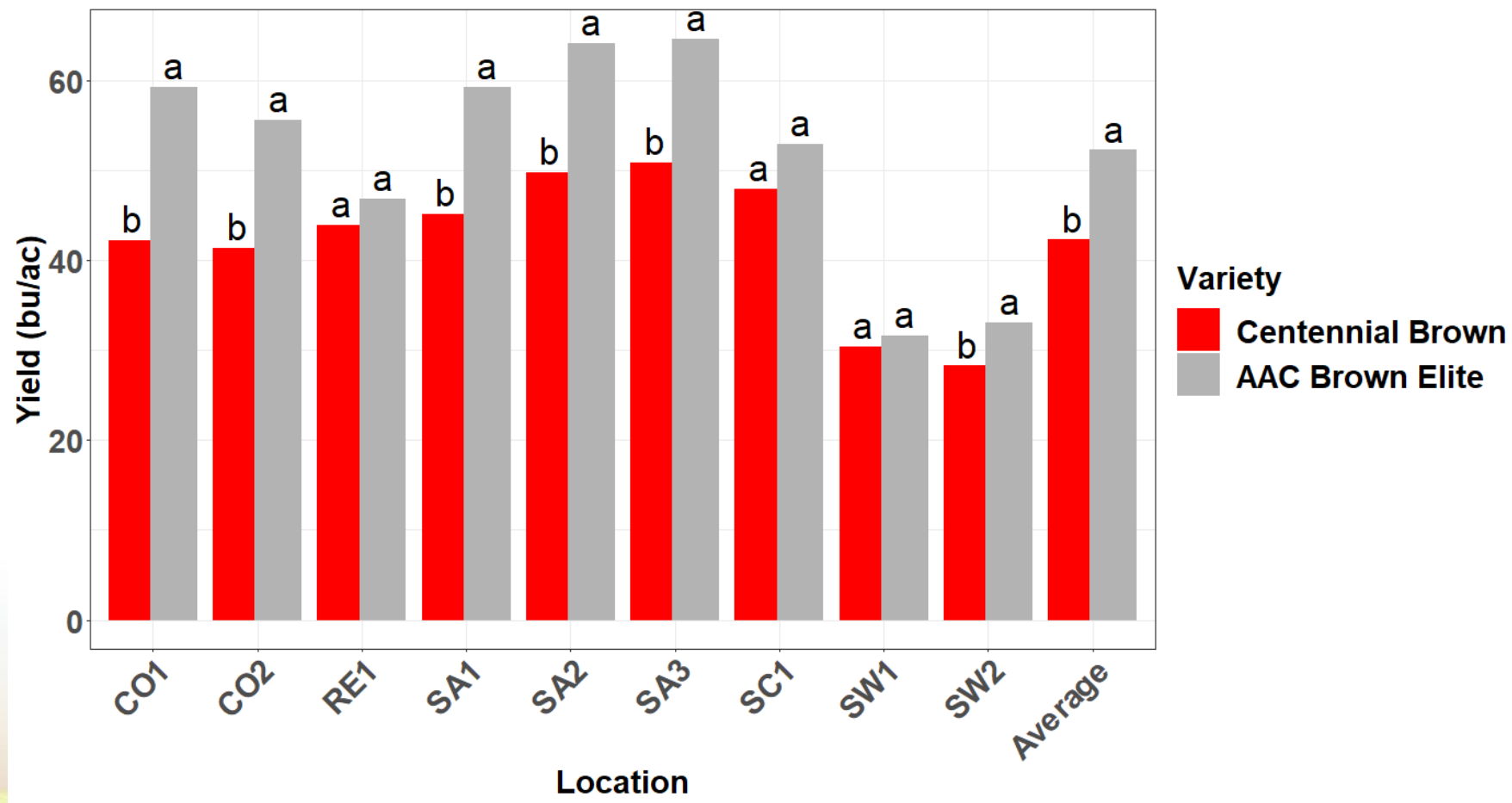
Mustard Adaptation Test

Number of Tests:

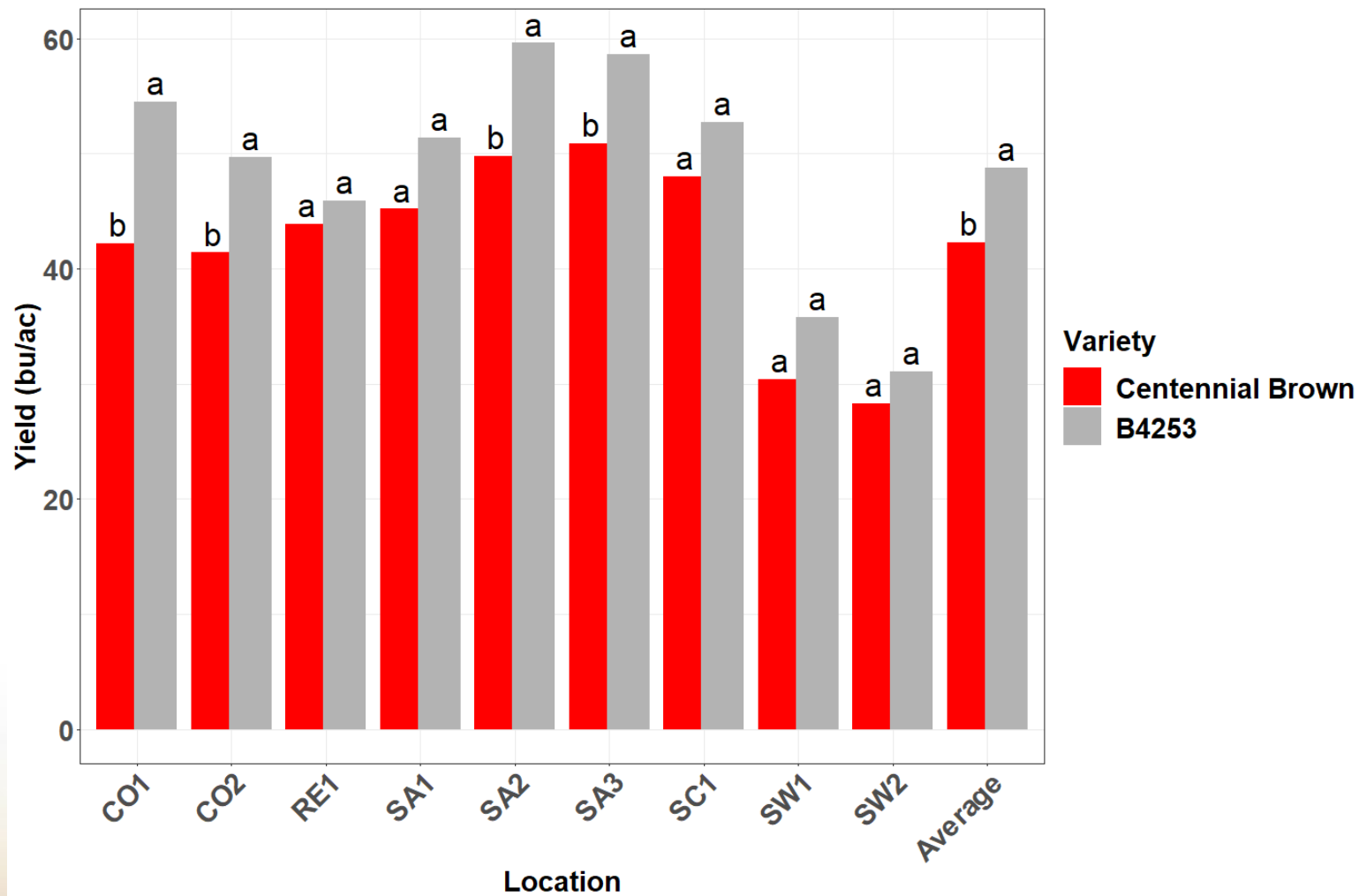
	No of tests	CV less than 16%
Brown mustard	13	9
Oriental mustard	15	11
Yellow mustard	14	7



Yield of AAC Brown Elite and Centennial Brown (check)



Yield of B4253 and Centennial Brown (check)

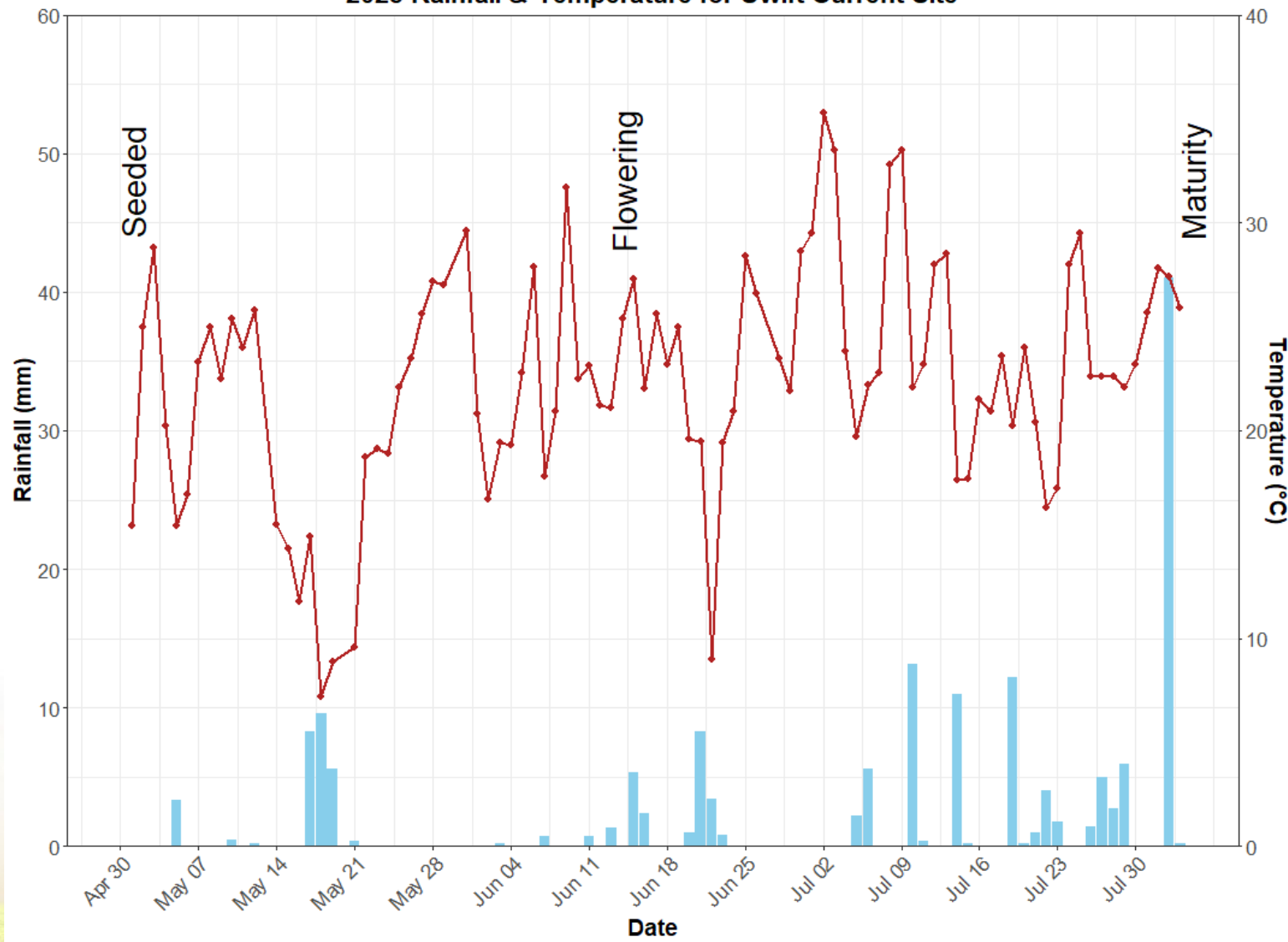


Yield of AAC Brown Elite and B4253

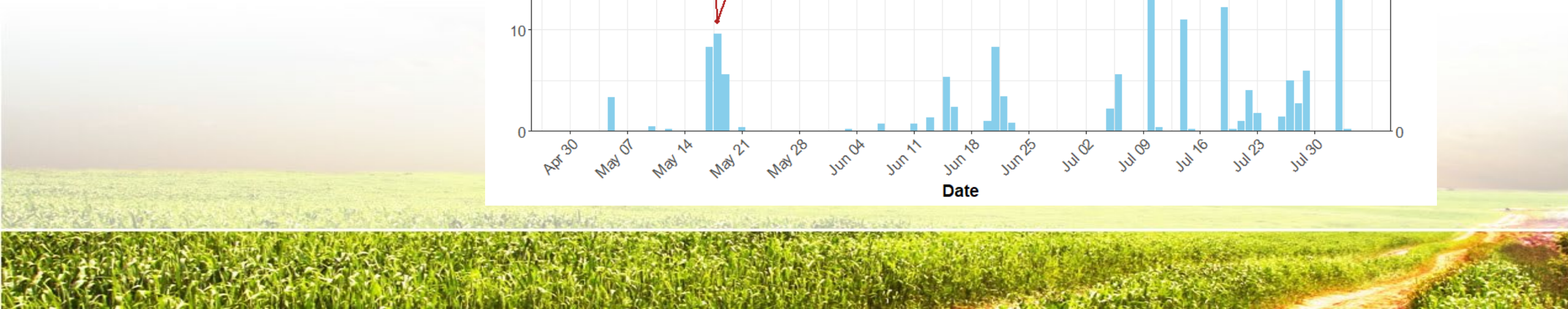
	Centennial Brown (Bu/ac)	AAC Brown Elite		B4253	
		(Bu/ac)	% of check	(Bu/ac)	% of check
AAFC-Saskatoon date 1	45.2	59.3*	131	51.4	114
AAFC-Saskatoon date 2	49.8	64.2*	129	59.6*	120
AAFC-Saskatoon date 3	50.9	64.7**a	127	58.6*	115
AAFC-Scott Farm date 1	48.0	53.0	110	52.7	110
AAFC-Swift Current date 1	30.4	31.6	104	35.8	118
AAFC-Swift Current date 2	28.3	33.1*	117	31.1	110
Redvers date 1	43.9	46.9	107	45.9	105
Coaldale date 1	43.2	59.3*	137	54.5*	126
Coaldale date 2	41.4	55.6*	134	49.7*	120
Average	42.3	52.3**a	124	48.8**b	15%



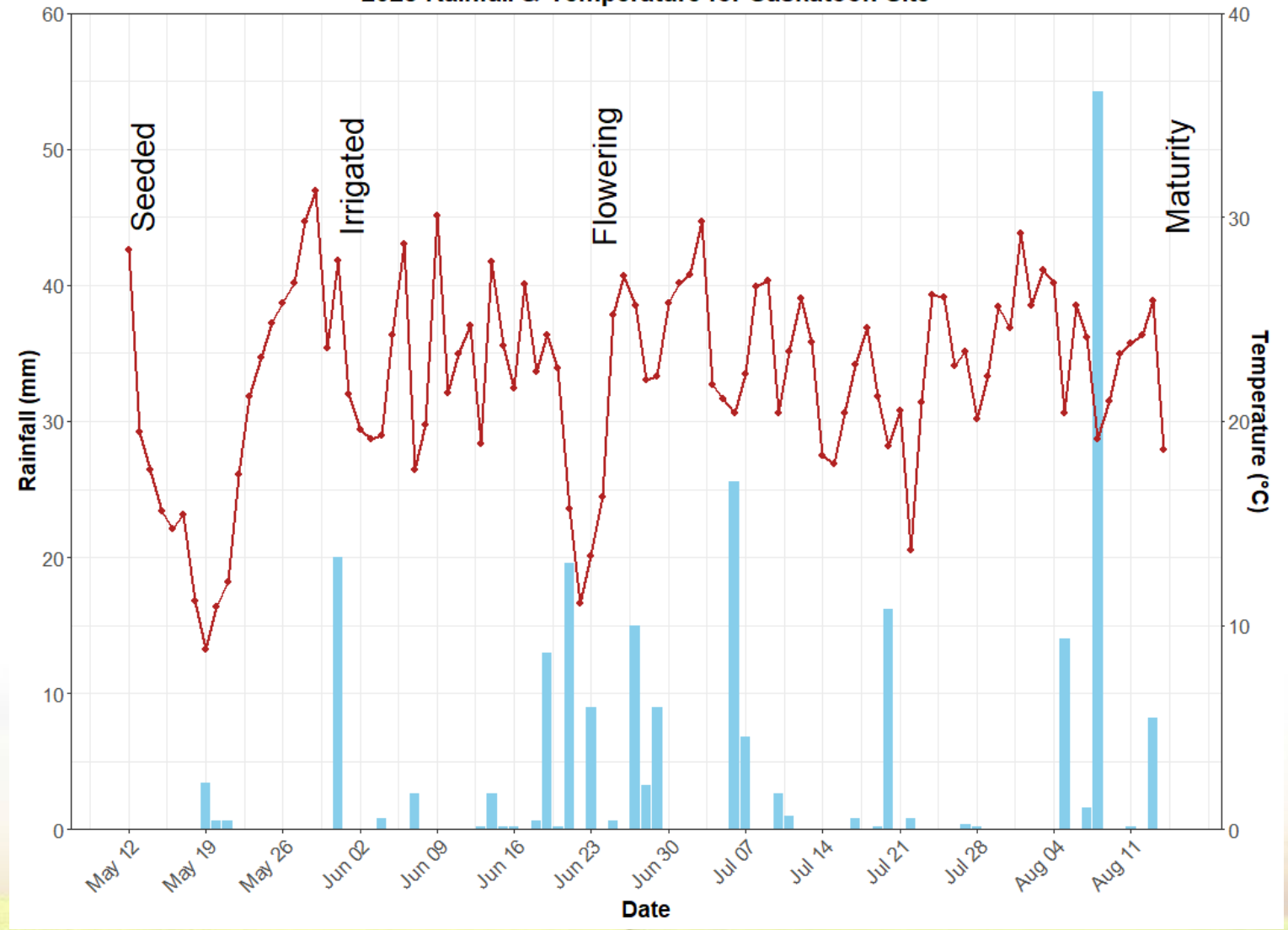
2025 Rainfall & Temperature for Swift Current Site



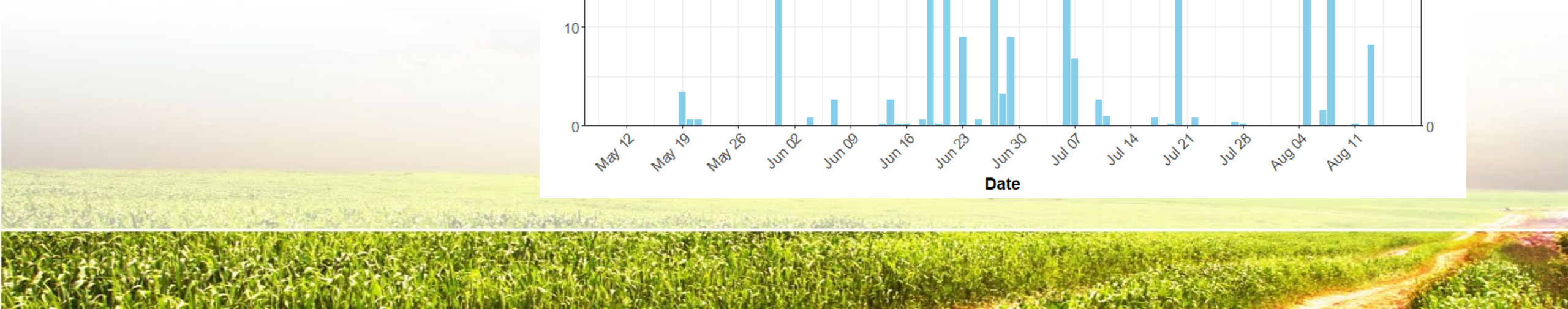
April 30: Seeded
June 13: Flowered
Rainfall (April 30-June 13):
27 mm



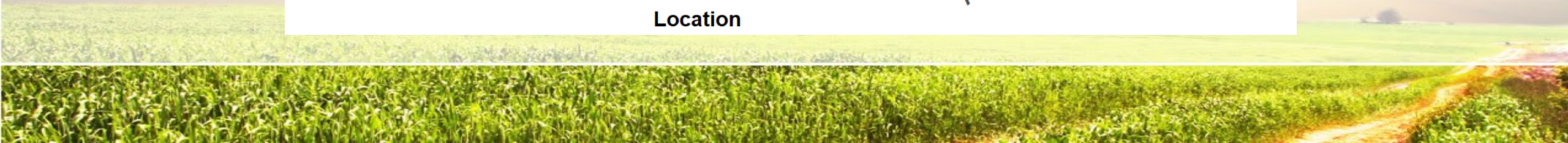
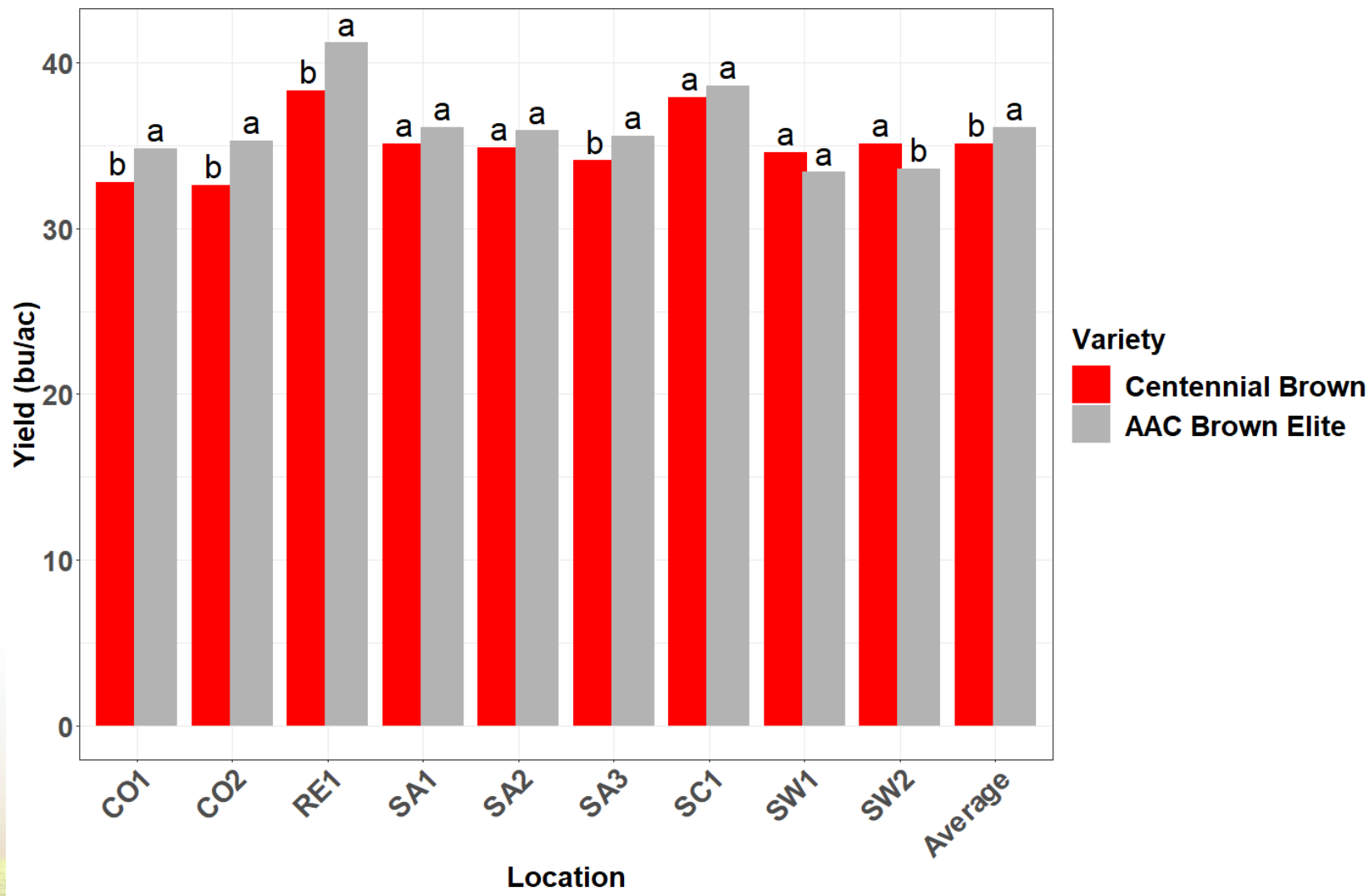
2025 Rainfall & Temperature for Saskatoon Site



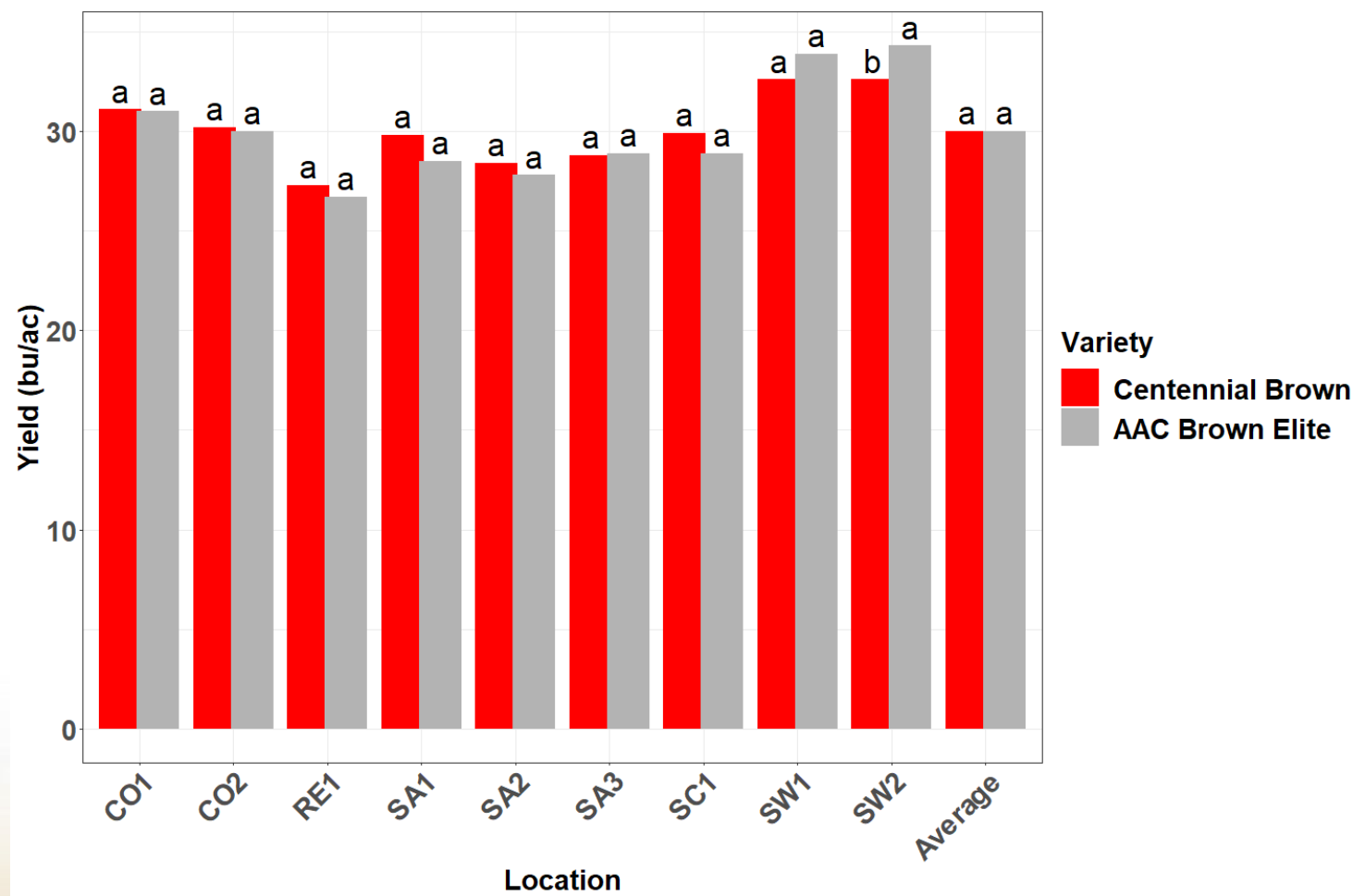
May 12: Seeded
May 20: Irrigated (20 mm)
June 23: Flowered
Rainfall (May 12-June 23):
34 mm



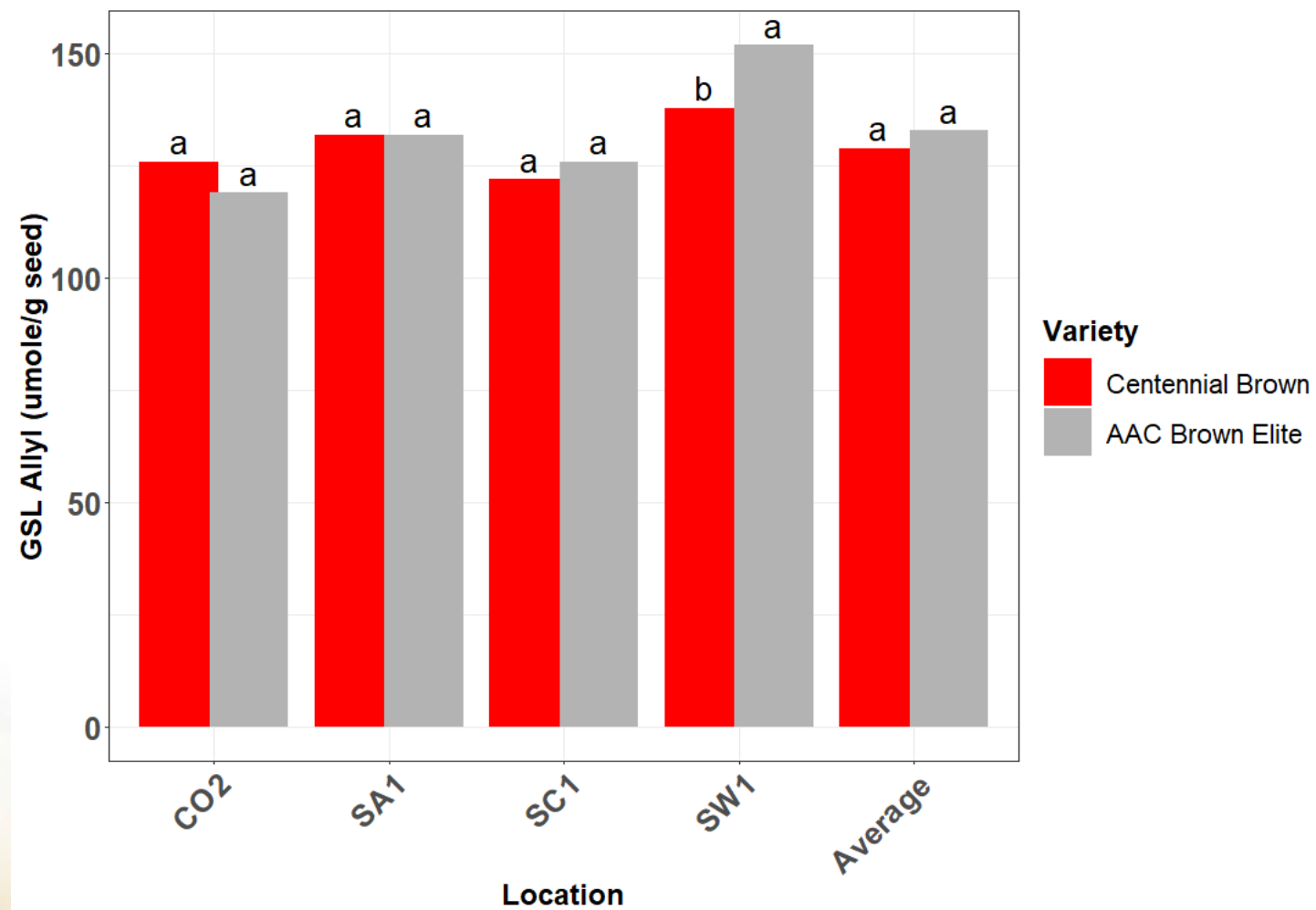
Oil content (% whole seed) of AAC Brown Elite and Centennial Brown (check)



Protein content (% whole seed) of AAC Brown Elite and Centennial Brown (check)



Glucosinolate content ($\mu\text{mol/g seed}$) of AAC Brown Elite and Centennial Brown (check)



Summary of the agronomic performance of AAC Brown Elite and B4253 in MAT

Entry	Yield			Seed Weight	Colour	Height	Lodging	Maturity	Sprouting
	kg/ha	bu/ac	% Check	g/1000 seed	WI Index	cm	1 to 5	days to	%
Centennial Brown (Check)	2374	42.3	100	3.21	-1.6	127	1.87	93	0.66
AAC Brown Elite	2934[‡]	52.3	124	3.22	-2.5	150[‡]	1.87	96[‡]	0.6
B4253	2740[‡]	48.8	115	3.27	-3.2[†]	136[‡]	1.67	93	0.46
LSD	115			0.06	1.11	3.47	0.34	0.59	0.18
F-stat	50.6 [‡]			34.8 [‡]	4.21 [†]	66.7 [‡]	1.18	39.7 [‡]	6.98 [‡]
# station yrs	9			9	9	9	6	9	9

[†] indicates p-value <0.05; [‡] indicates p-value <0.01



Summary of the seed quality of AAC Brown Elite and B4253 in MAT

Entry	Oil	Protein	GLS Allyl	Green Seed	Chorophyll
	% whole seed		$\mu\text{mol/g seed}$	%	mg/kg seed
Centennial Brown (Check)	35.1	30.0	129	0.15	4.56
AAC Brown Elite	36.1[‡]	30.0	133	0.15	4.28
B4253	35.8[‡]	29.7	130	0.21	4.66
LSD	0.44	0.53	8.15	0.12	0.72
F-stat	41.7 [‡]	8.8 [‡]	15.3 [‡]	1.93	6.2 [‡]
# station yrs	9	9	4	9	9

[†] indicates p-value <0.05; [‡] indicates p-value <0.01

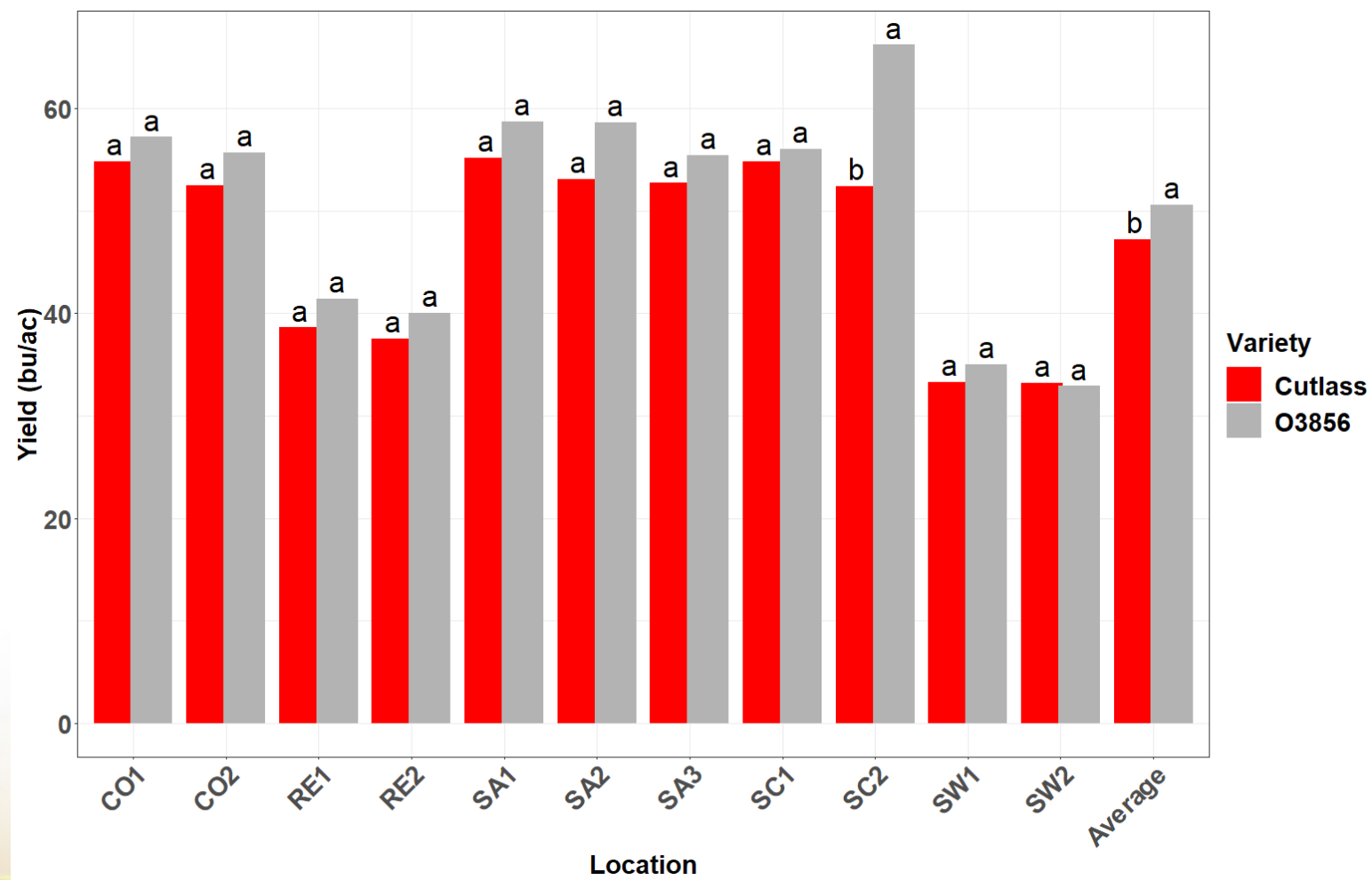


Summary of the agronomic performance of AAC Brown Elite in 2022, 2023 , 2024 , 2025

	Yield		Seed Weight	Fixed Oil	Protein	GLS Allyl	GLS Butyl	Seed Colour	Distinct Green	Chlorophyll	Height	Maturity
	kg/ha	% Check	g/1000seed	% whole seed		$\mu\text{mole/g seed}$	$\mu\text{mole/g seed}$	WIE313	%	mg/kg seed	cm	days
Centennial Brown (check)	1829	100	2.97	36.0	30.0	116	0.66	-5.2	0.14	2.3	123	85
AAC Brown Elite	2076*	113	2.96	37.3*	29.6*	124*	0.65	-5.5	0.31*	3.31*	149*	88*
F-Value	73.9		0.48	187	12.5	96.1	0.31	2.58	13.6	19.5	435	272
L.S.D. (5%)	56.7		0.04	0.2	0.2	1.63	0.04	0.34	0.1	0.46	2.43	0.32
# station yrs	36		36	36	36	27	27	36	36	27	34	32



Yield of O3856 and Cutlass (check)



Summary of the agronomic performance of the oriental mustard candidate variety O3856 in MAT

Entry	Yield			Seed Weight	Colour	Height	Lodging	Maturity	Sprouting
	kg/ha	bu/ac	% Check	g/1000 seed	WI Index	cm	1 to 5	days to	%
Cutlass (Check)	2650	47.2	100	2.86	-36.8	126	1.86	93	1.96
O3856	2838[‡]	50.6[‡]	107	3.25[‡]	-38.3[‡]	127	1.57	94	1.83
LSD	90.8			0.04	0.82	2.94	0.3	0.42	0.4
F-stat	8.98 [‡]			243 [‡]	29.8 [‡]	2.38	11.1 [‡]	2.13	3.8 [†]
# station yrs	11			11	11	11	7	11	11

[†] indicates p-value <0.05; [‡] indicates p-value <0.01



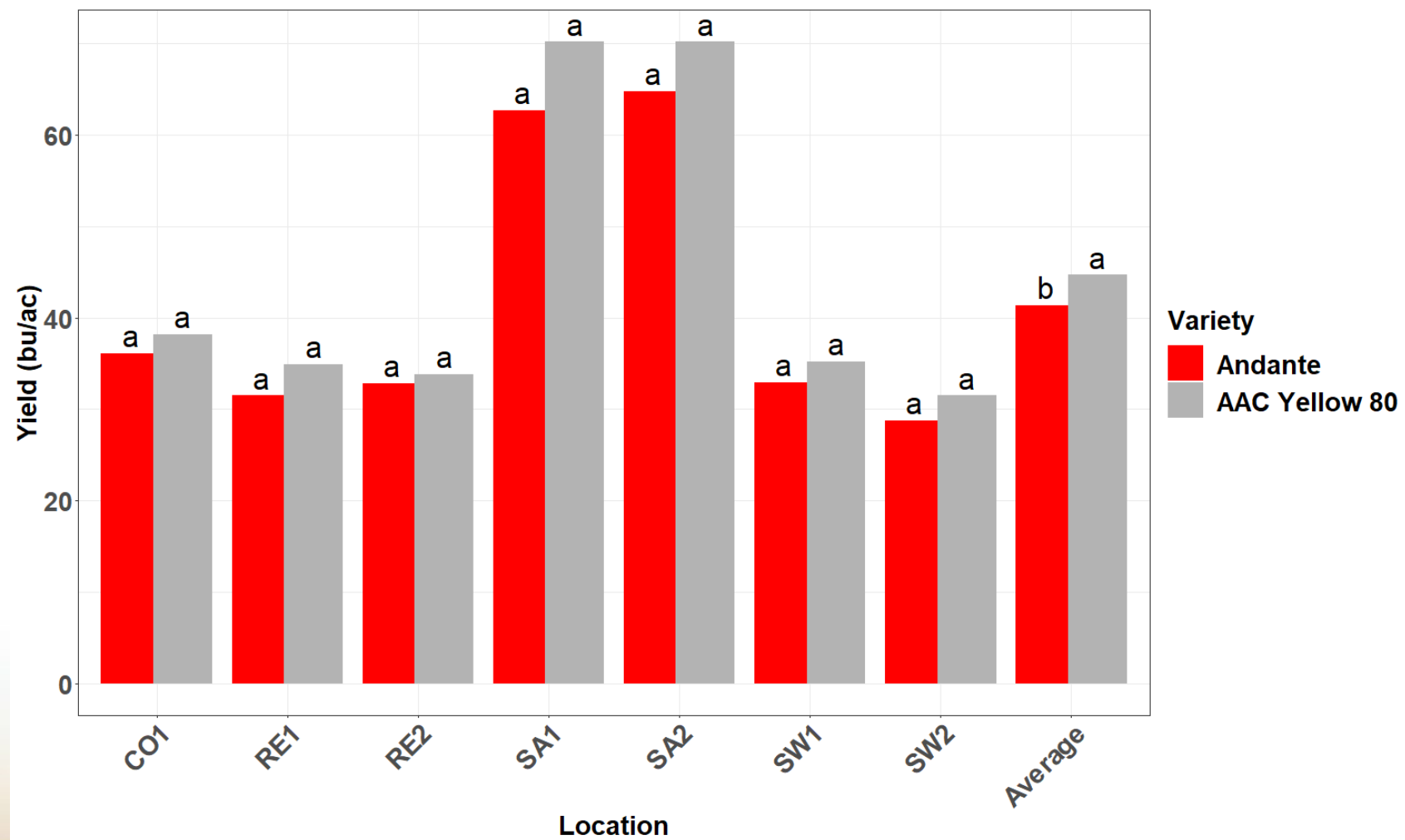
Summary of the seed quality of the oriental mustard candidate variety O3856 in MAT

Entry	Oil	Protein	GLS Allyl	Green Seed	Chlorophyll
	% whole seed		$\mu\text{mol/g seed}$	%	mg/kg seed
Cutlass (Check)	41.2	29.6		0.58	4.53
O3856	41.4	30.0‡		0.48	3.25
LSD	0.3	0.28		0.24	1.22
F-stat	5.63‡	12.8‡		3.26†	2.46
# station yrs	11	11		11	11

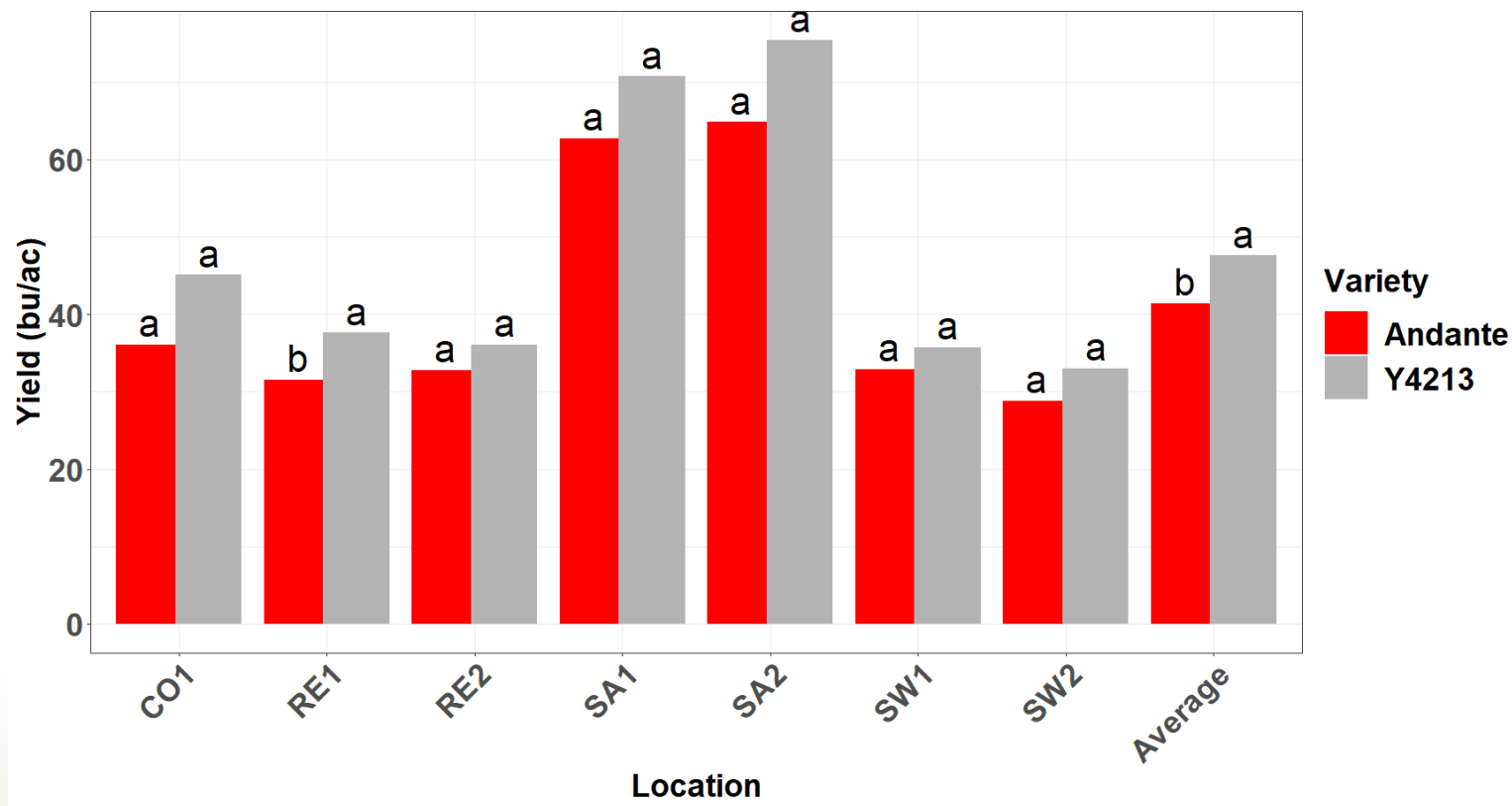
† indicates p-value <0.05; ‡ indicates p-value <0.01



Yield of AAC Yellow 80 and Andante (check) in the MAT



Yield of the candidate composite line Y4213 and Andante (check) in the MAT



Summary of the agronomic performance of AAC Yellow 80 and Y4213 in the MAT

Entry	Yield			Seed Weight	Colour	Height	Lodging	Maturity	Sprouting
	kg/ha	bu/ac	% Check	g/1000 seed	WI Index	cm	1 to 5	days to	%
Andante (Check)	2322	41.4	100	5.99	-38.3	108	1.65	93	0.44
AAC Yellow 80	2512‡	44.7	108	6.03	-40.6‡	114‡	1.05†	94†	0.42
Y4213	2670‡	47.6	115	6.26‡	-43.0‡	112†	1.20	94†	0.33
LSD	99.7			0.08	1.17	3.19	0.4	0.4	0.12
F-stat	13.8‡			14.3‡	18.4‡	4.84‡	2.72†	3.04†	2.9†
# station yrs	7			7	7	7	5	7	7

† indicates p-value <0.05; ‡ indicates p-value <0.01



Summary of the seed quality of AAC Yellow 80 and Y4213 in the 2025 MAT

Entry	Oil	Protein	GLS HOBe	Mucilage	Green Seed	Chlorophyll
	% whole seed		$\mu\text{mol/g seed}$	cS*mlg^{-1}	%	mg/kg seed
Andante (Check)	30.1	33.9		74.7	0.11	1.73
AAC Yellow 80	30.5	34.0		69.7	0.24	1.53
Y4213	31.4‡	32.8‡		85.4‡	0.19	1.03†
LSD	0.38	0.4		6.15	0.12	0.46
F-stat	13.9‡	12.4‡		8.14‡	1.95	2.79†
# station yrs	7	7		7	7	7

† indicates p-value <0.05; ‡ indicates p-value <0.01



Summary of the agronomic performance of AAC Yellow 80 in 2019, 2020, 2021, 2022, 2023, 2024 and 2025

	Yield		Seed Weight	Fixed Oil	Protein	GLS HoBe	Mucilage	Seed Colour	Distinct Green	Chlorophyll	Height	Maturity
	kg/ha	% Check	g/1000seed	% whole seed		$\mu\text{mole/g seed}$	cS*mlg-1	WI E313	%	mg/kg seed	cm	days
Andante	1686	100	6.0	28.6	35.0	150	83.3	-38.1	0.22	1.48	111	85
AAC Yellow 80	1828*	108	6.0	29.3*	34.7*	148*	81.5	-41.4*	0.23	1.43	114*	85
F-Value	132		0.02	158	20.1	6.49	3.34	434	0.31	0.23	16.9	0.70
L.S.D. (5%)	24.3		0.04	0.12	0.14	1.66	1.97	0.31	0.06	0.20	1.06	0.28
# station yrs	72		71	72	72	61	50	72	60	62	68	65



Summary of the agronomic performance of Y4213 in the yield trials in 2023 and 2024 and in the MAT in 2025

Entry	Yield			Seed Weight	Colour	Height	Lodging	Maturity	Sprouting
	kg/ha	bu/ac	% Check	g/1000 seed	WI Index	cm	1 to 5	days to	%
Andante	1952	34.8	100	5.67	-39.5	112	1.63	88	0.57
Y4213	2190[‡]	39.0	112	5.93[‡]	-44.4[‡]	115[‡]	1.39	89[‡]	0.42
LSD	71.9			0.06	0.74	2.39	0.3	0.46	0.26
F-stat	43.7 [‡]			61.6 [‡]	173 [‡]	6.31 [‡]	2.56	5.97 [‡]	1.3
# station yrs	15			15	15	13	9	14	9

[†] indicates p-value <0.05; [‡] indicates p-value <0.01



Summary of the seed quality of Y4213 in the yield trials in 2023 and 2024 and in the MAT in 2025

Entry	Oil	Protein	GSL HOBe	Mucilage	Chlorophyll	Green Seed
	% whole seed		$\mu\text{mol/g seed}$	$\text{cS} \cdot \text{mlg}^{-1}$	mg/kg seed	%
Andante	29.5	34.1	163	76.2	1.76	0.12
Y4213	30.9‡	32.8‡	158†	82.1†	1.09‡	0.16
LSD	0.32	0.44	4.84	5.6	0.72	0.08
F-stat	88.4‡	34.2‡	4.62†	4.83†	6.5‡	0.69
# station yrs	15	15	8	11	7	11

† indicates p-value <0.05; ‡ indicates p-value <0.01



Summary of disease reactions for the yellow mustard (*S. alba*) line Y4213

Entry	Year	Blackleg Severity (0-5)
Andante (Check)	2025	0.38
Y4213	2025	0.26
Westar	2025	3.69



Tet of herbicide residue in the seed samples harvested from the yield trials sprayed with herbicide Ares and Odyssey

Company for herbicide residue test: A & L Canada Laboratories Inc.

- **Method reference LC-MS/MS**
- **Detection limit: 1 ppb**



Tet of herbicide residue in the seed samples harvested from the yield trials sprayed with herbicide Ares and Odyssey

Trial I:

- Sprayed with herbicide Ares SN at recommending 1X rate
- active ingredients of Ares SN are imazamox and imazapyr

Entries	Herbicide spray	Herbicide residue test result	
		Imazamox	Imazapyr
Centennial Brown (Check)	Not sprayed	Below detection level	Below detection level
B4159	Ares SN	Below detection level	Below detection level

Tet of herbicide residue in the seed samples harvested from the yield trials sprayed with herbicide Ares and Odyssey

Trial II:

- Sprayed with herbicide Odyssey at recommending 1X rate
- Active ingredients of Odyssey are imazamox and imazethapyr

Entries	Herbicide spray	Herbicide residue test result	
		Imazamox	Imazethapyr
Centennial Brown (Check)	Not sprayed	Below detection level	Below detection level
B4159	Odyssey	Below detection level	Below detection level

Evaluating the IMI-tolerant brown and oriental mustard Ogura cms parental lines

Brown mustard:

- **71 IMI-tolerant Ogura cms A&B lines**
- **208 IMI-tolerant Ogura cms R lines**

Oriental mustard:

- **82 IMI-tolerant Ogura cms A&B lines**
- **312 IMI-tolerant Ogura cms R lines**

Agronomic traits: growth vigour, maturity, seed size and color, height, lodging

Seed quality traits: oil, protein and glucosinolate contents, texture (brown mustard)

Disease resistance: white rust



Seed quality of the IMI-tolerant brown mustard Ogura cms restorer (R) lines

Entry	Oil	Protein	Color	Allyl GSL	Texture	White rust (2a)
	%whole seed		WI	µmole/g seed	2-5 cm	
Centennial Brown (check)	36.4	29.8	-7.6	125.1	2.3	S
B4346-18-4-34-12 R line (RfoRfo)	35.9	31.7	-6.1	129.6	11.4	R
B4352-1-7-63-1 R line (RfoRfo)	33.6	32.2	-7.8	157.1	3.8	R
B4352-25-22-44-1 R line (RfoRfo)	34.5	31.8	-6.9	128.2	3.7	R
B4352-25-22-44-2 R line (RfoRfo)	34.6	31.7	-6.8	123.5	3.3	R



Seed quality of the IMI-tolerant brown mustard Ogura cms A and B lines

Entry	Oil	Protein	Colour	Allyl GSL	Texture	White rust (2a)
	%whole seed		WI	$\mu\text{mole/g seed}$	2-5 cm	
Centennial Brown (check)	36.7	29.3	-7.0	116.5	2.4	S
B4373 B line	37.9	28.5	-9.3	111.5	2.2	S
B4373 A line (BC5)	36.3	31.0	-9.6	134.0	3.4	S
B4191 B line	38.6	28.1	-9.4	111.7	3.4	S
B4191 A line (BC5)	35.3	31.1	-8.7	136.0	3.6	S



Seed quality of the IMI-tolerant oriental mustard Ogura cms restorer (R) lines

Entry	Oil	Protein	Color	Allyl GSL	White rust (2a)
	%whole seed		WI	μmole/g seed	
Cutlass (check)	37.9	32.7	-34.9	165.7	
O4395DH35 R line (RfoRfo)	37.4	32.0	-31.3	158.8	
O4397DH153 R line (RfoRfo)	34.1	32.4	-39.3	158.6	
O4398DH65 R line (RfoRfo)	38.5	31.1	-35.9	160.2	
O4407-3 DH24 R line (RfoRfo)	36.3	34.1	-37.6	169.8	



Seed quality of the IMI-tolerant oriental mustard Ogura cms A and B lines

Entry	Oil	Protein	Colour	Allyl GSL	White rust (2a)
	%whole seed		WI	μmole/g seed	
Cutlass (check)	40.3	30.4	-35.9		
O4358-19 B line	36.2	31.9	-36.1		
O4358-19 A line (BC4)	34.0	33.8	-40.5		
O4178-4 B line	38.3	31.1	-35.5		
O4178-4 A line (BC3)	35.4	33.7	-32.5		



Preliminary IMI-tolerant brown mustard yield trials

Entries:

CYT01: Centennial Brown (check) and 6 test hybrids

CYT02: Centennial Brown (check) and 7 test hybrids

CYT03: Centennial Brown (check) and 9 test hybrids

CYT04: Centennial Brown (check) and 9 test hybrids

Locations

AAFC-Saskatoon date 1, **date 2 (lost due uneven emergence)**

AAFC-Scott: **lost due to poor establishment**

AAFC-Swift Current

Redvers

Avonia: **lost due to poor emergence**



Summary of the agronomic performance of B4523 and B4524 in the yield trial CYT04

Entry	Yield		% Check	Seed Weight	Colour	Height	Lodging	Maturity	Spouting
	kg/ha	bu/ac		g/1000 seeds	WI index	cm	1 to 5	days to	%
Centennial Brown (Check)	2210	39.4	100	3.12	-3.9	129	1.37	92	0.79
B4523	2572‡	45.8	116	3.28	-4.3	134	1.37	94‡	0.64
B4524	2449	43.6	111	3.08	-4.8	133	1.12	94‡	0.61
LSD	180			0.12	2.03	5.52	0.54	0.77	0.28
F-statistic	7.15‡			3.38†	4.65‡	7.88‡	2.76	7.97‡	0.82
# station yrs	3			3	3	3	2	3	3

† indicates p -value <0.05 ; ‡ indicates p -value <0.01



Summary of the seed quality of B4523 and B4524 in the yield trial CYT04

Entry	Oil	Protein	GLS Ally	Texture
	% whole seed	mol/g see		2-5 cm
Centennial Brown (Check)	36.3	30.4	131	3.1
B4523	37.9‡	28.8†	123	5.1
B4524	37.4†	29.7	131	4.2
LSD	0.85	1.09	11.9	
F-statistic	8.69‡	2.73†	0.76	



Preliminary HT Oriental mustard yield trials

Entries:

CYT07: Cutlass (check) and 20 test hybrids

CYT08: Cutlass (check) and 17 hybrids

Locations

AAFC-Saskatoon date 1, date 2 (lost due uneven emergence)

AAFC-Scott: lost due to poor establishment



Summary of the agronomic performance of O4473, O4481, O4482 in the yield trial CYT08

Entry	Yield			Seed Weight	Colour	Height	Lodging	Maturity	Sprouting
	kg/ha	bu/ac	% Check	g/1000 seeds	WI index	cm	1 to 5	days to	%
Cutlass (Check)	3251	57.9	100	2.97	-32.7	129	1.25	94	1.6
O4473	3761	67.0	116	3.28	-33.4	138	1.25	95	2.22
O4481	3676	65.5	113	3.53	-31.3	140†	1.75	96	1.8
O4482	3880‡	69.1	119	3.94	-33.3	148‡	1.0	96	1.3
LSD	295			0.7	2.98	7.39	0.8	1.3	0.44
F-statistic	10.1‡			2.51	3.92†	7.34‡	3	4.33‡	8.3‡
# station yrs	1			1	1	1	1	1	1

† indicates p -value < 0.05 ; ‡ indicates p -value < 0.01



Summary of the seed quality of O4473, O4481, O4482 in the yield trial CYT08

Entry	Fixed Oil	Protein	GLS Allyl
	% whole seed		$\mu\text{mol/g seed}$
Cutlass (Check)	39.6	31.1	142
O4473	38.2‡	32.0	139
O4481	40.1	30.2	147
O4482	39.4	30.8	154†
LSD	0.65	0.85	7.44
F-statistic	12.1‡	6.67‡	8.59†
# station yrs	1	1	1

† indicates $p\text{-value} < 0.05$; ‡ indicates $p\text{-value} < 0.01$



Development of new IMI-tolerant yellow mustard germplasm using ethyl methanesulfonate (EMS)

Results:

- Two new EMS mutagenized populations. **No new herbicide mutant were identified.**
- In September 2025, a new EMS-mutagenized population using AAC Yellow 80 as seed source was created.



Development of clubroot resistant (CR) brown and oriental mustard

Result:

- **Rcr1** was transferred into IMI-tolerant brown and oriental mustard Ogura cms restorer lines via interspecific crossing
- Development of double-haploid CR and IMI-tolerant brown and oriental mustard Ogura cms restorer lines is underway.



Development of clubroot resistant yellow mustard

- **Screening yellow mustard germplasm for clubroot resistance is underway**



2026 field plan

- Mustard Adaptation Test
- IMI-tolerant brown and oriental mustard Ogura cms restorer lines nursery
- Preliminary yield trials of IMI-tolerant brown and oriental mustard hybrids
- Preliminary yield trial of Group II herbicide Mustard-tolerant yellow mustard lines



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AAFC-Swift Current Research and Development Centre

AAFC-Scott Research and Development Centre



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- 2. Mustard 21 Canada Inc.**
- 3. The Western Grain Research Foundation**



Thank you!

