Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Condiment Mustard Breeding: Update

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Canada

Outline of the Presentation

- Mustard Adaptation Test
- Candidate oriental mustard hybrid O3856 for registration
- Development of Group II IMI-tolerant brown and oriental mustard hybrid varieties
- Creating Group II IMI-tolerant yellow mustard germplasm
- Development of clubroot resistant brown and oriental mustard, and yellow mustard
- Acknowledgement

Mustard Adaptation Test

Entries:

Brown mustard: Centennial Brown (check), AAC Brown 18, AAC Brown Elite and candidate hybrid B4253

Oriental mustard: Cutlass (check) and candidate hybrid O3841

Yellow mustard: Andante (check), AAC Yellow 80, candidate composite lines Y4015 and Y4016

Trial sites:

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

Manitoba: Melita

Alberta: Coaldale; Tabler

Mustard Adaptation Test

- **Number of Tests**

	No of tests	CV less than 16%
Brown mustard	**17**	**10**
Oriental mustard	**16**	**7**
Yellow mustard	**15**	**10**

Agronomic performance of AAC Brown 18, AAC Brown Elite and B4253

Entry	Yield			Seed size	Seed Color	Green Seed	Height	Lodging	Maturity
	Kg/ha	Bu/ac	% Check	g/1000seed	WI E313	%	cm	1 to 5	days
Centennial Brown (Check)	1703	30.3	100	2.72	-7.7	0.04	136	2.65	81
AAC Brown 18	1992‡	35.5	117	2.71	-7.1	0.03	138	2.4	81
AAC Brown Elite	1693	30.2	99	2.66	-7.4	0.10	163‡	1.95‡	83‡
B4253	1887‡	33.6	111	2.80‡	-6.9	0.03	144‡	2.3	81
LSD	72.8			0.06	0.73	0.08	4.31	0.36	0.53
# station yrs	10			10	10	10	10	5	10

Quality traits of AAC Brown 18, AAC Brown Elite and B4253

Entry	Fixed Oil	Protein	Allyl GSL	Chlorophyll
	% whole seed		µmole/g seed	mg/kg seed
Centennial Brown (Check)	36.0	29.5	111	1.88
AAC Brown 18	37.7‡	27.1‡	109	1.47
AAC Brown Elite	37.6‡	29.1	121‡	2.36
B4253	36.5	28.1‡	111	1.52
LSD	0.46	0.51	2.93	0.63
# station yrs	10	10	10	10

Agronomic performance of AAC Brown 18 in the Mustard Adaptation Test in 2017 - 2024

Entry	Yield			Seed Weight	Seed Color	Green Seed	Height	Lodging	Maturity
	Kg/ha	Bu/ac	% Check	g/1000seed	WI E313	%	cm	1 to 5	days
Centennial Brown (Check)	**1760**	**31.4**	**100**	**2.98**	**-5.5**	**0.10**	**123**	**1.54**	**84**
AAC Brown 18	**2079‡**	**37.0**	**118**	**2.93‡**	**-6.1‡**	**0.11**	**125‡**	**1.54**	**84**
LSD	38.5			0.02	0.30	0.02	1.60	0.08	0.32
# station yrs	58			58	58	56	51	41	47

Quality traits of AAC Brown 18 in the Mustard Adaptation Test in 2017 - 2024

Entry	Fixed Oil	Protein	Allyl GSL	Chlorophyll
	% whole seed		µmole/g seed	Mg/kg seed
Centennial Brown (Check)	**35.7**	**30.4**	**115**	**2.69**
AAC Brown 18	**37.4‡**	**28.9‡**	**111‡**	**2.55**
LSD	0.16	0.18	1.50	0.2
# station yrs	58	58	58	58

Agronomic performance of AAC Brown Elite in the Mustard Adaptation Test in 2021 - 2024

Entry	Yield			Seed Weight	Seed Color	Green Seed	Height	Lodging	Maturity
	Kg/ha	Bu/ac	% Check	g/1000seed	WI E313	%	cm	1 to 5	days
Centennial Brown (Check)	**1647**	**29.3**	**100**	**2.89**	**-6.4**	**0.14**	**122**	**1.49**	**82**
AAC Brown Elite	**1791‡**	**31.9**	**109**	**2.87**	**-6.5**	**0.37‡**	**148‡**	**1.36†**	**85 ‡**
LSD	57.15			0.04	0.53	0.10	2.68	0.12	0.37
# station yrs	27			27	27	27	27	20	22

Quality traits of AAC Brown Elite in the Mustard Adaptation Test in 2021 - 2024

Entry	Fixed Oil	Protein	Allyl GSL	Chlorophyll
	% whole seed		µmole/g seed	Mg/kg seed
Centennial Brown (Check)	**36.2**	**30.0**	**116**	**2.26**
AAC Brown Elite	**37.7‡**	**29.5‡**	**124‡**	**3.26‡**
LSD	0.24	0.26	1.91	0.45
# station yrs	27	27	27	27

Agronomic performance of candidate oriental mustard hybrid O3841

Entry	Yield			Seed size	Seed color	Green Seed	Height	Lodging	Maturity
	Kg/ha	Bu/ac	% Check	g/1000seed	WI E313	%	cm	1 to 5	days
Cutlass (Check)	1762	31.4	100	2.53	-41.1	0.02	131	1.79	79
O3841	1987‡	35.4	113	2.59	-35.2‡	0.01	144‡	1.82	79
LSD	106			0.06	0.80	0.04	4.33	0.24	0.79
# station yrs	7			7	7	7	7	7	7

Quality traits of candidate oriental mustard hybrid O3841

Entry	Fixed Oil	Protein	Allyl GSL	Chlorophyll
	% whole seed		µmole/g seed	mg/kg seed
Cutlass (Check)	**43.7**	**26.2**	**124**	**1.16**
O3841	**42.9‡**	**27.1‡**	**124**	**1.09**
LSD	0.40	0.56	2.84	0.35
# station yrs	7	7	7	7

Agronomic performance of AAC Yellow 80, candidate composite lines Y4015 and Y4016

Entry	Yield			Seed Weight	Seed Color	Green Seed	Height	Lodging	Maturity
	Kg/ha	Bu/ac	% Check	g/1000 seed	WI E313	%	cm	1 to 5	days
Andante (check)	1606	28.6	100	5.15	-42.3	0.07	123	1.64	80
AAC Yellow 80	1730‡	30.8	108	5.29‡	-45.1‡	0.04	125	1.61	80
Y4015	1700‡	30.3	106	5.03	-44.9‡		121	1.5	80
Y4016	1718‡	30.6	107	5.23	-44.2‡		123	1.89	81
LSD	51.1			0.1	0.81	0.04	2.82	0.30	0.53
# station yrs	10			10	10	10	10	7	10

Quality traits of AAC Yellow 80, candidate composite lines Y4015 and Y4016

Entry	Fixed Oil	Protein	HOBenzyl GSL	Chlorophyll
	% whole seed		µmole/g seed	Mg/kg seed
Andante (check)	**29.3**	**33.8**	**167**	**0.95**
AAC Yellow 80	**30.0‡**	**33.8**	**168**	**0.69‡**
Y4015	**29.2**	**33.4**	**155‡**	**0.58‡**
Y4016	**29.5**	**33.3**	**153‡**	**0.79**
LSD	0.30	0.36	2.33	0.12
# station yrs	10	10	10	10

Agronomic performance of AAC Yellow 80 in the Mustard Adaptation Test in 2019 to 2024

Entry	Yield			Seed Weight	Seed Color	Green Seed	Height	Lodging	Maturity
	Kg/ha	Bu/ac	% Check	g/1000seed	WI E313	%	cm	1 to 5	days
Andante (check)	**1596**	**28.4**	**100**	**5.98**	**-38.1**	**0.23**	**111**	**1.40**	**84**
AAC Yellow 80	**1731‡**	**30.8**	**108**	**5.98**	**-41.6‡**	**0.23**	**113‡**	**1.36**	**84**
LSD	25.1			0.04	0.33	0.06	1.14	0.06	0.30
# station yrs	64			63	64	52	60	42	57

Quality traits of AAC Yellow 80 in the Mustard Adaptation Test in 2019 to 2024

Entry	Fixed Oil	Protein	HOBe GSL	Seed Color	Chloro-phyll	Mucilage
	% whole seed		µmole/g seed	WI E313	Mg/kg seed	cS/mlg^{-1} seed
Andante (check)	**28.5**	**35.1**	**150**	**-38.1**	**1.48**	**83.2**
AAC Yellow 80	**29.3‡**	**34.7‡**	**148‡**	**-41.6‡**	**1.43**	**81.3**
LSD	0.12	0.14	1.66	0.33	0.20	1.98
# station yrs	64	64	61	64	62	50

Outline of the Presentation

- **Candidate oriental mustard hybrid O3856 for registration**

Agronomic performance of the oriental mustard hybrid O3856 in the yield trials in 2019

Entry	Yield			Seed Size	Oil	Protein	Allyl GSL	Butyl GSL	Color	Height	Maturity
	Kg/ha	Bu/ac	% Cutlass	g/1000 seeds	% whole seed	% whole seed	µmole/g seed	µmole/g seed	WI	cm	Days
Cutlass (check)	**2996**	**53**	**100**	**2.74**	**43.3**	**29.1**	**120**	**0.49**	**-46.2**	**141**	**101**
O3856	**3522**	**63**	**118**	**3.31‡**	**44.1**	**28.8**	**130‡**	**0.48**	**-42.9‡**	**146**	**101**
LSD	364			0.12	0.63	0.53	5.63	0.08	1.64	8.90	4.00
# station years	2			2	2	2	2	2	2	2	2

†indicates that values are significantly different from one another ($p < 0.05$)
‡ indicates that values are significantly different from one another ($p < 0.01$)

Agronomic performance of the oriental mustard hybrid O3856 in the Mustard Adaptation Test in 2020

Entry	Yield			Seed size	Seed Color	Green seed	Height	Lodging	Maturity
	Kg/ha	Bu/ac	% check	g/1000 seeds	WI	%	cm	1-5	Days
Cutlass (check)	**2308**	**41.2**	**100**	**2.59**	**-41.9**	**0.33**	**126**	**2.01**	**88**
O3856	**2511‡**	**44.8**	**109**	**2.92‡**	**-42.6**	**0.2**	**128**	**1.84**	**88**
LSD	107			0.06	0.79	0.16	3.06	0.18	0.59
# station yrs	13			13	13	13	11	11	11

†indicates that values are significantly different from one another ($p < 0.05$)
‡ indicates that values are significantly different from one another ($p < 0.01$

Quality traits of the oriental mustard hybrid O3856 in the Mustard Adaptation Test in 2020

Entry	Oil	Protein	Allyl GSL	Chlorophyll
	% whole seed	% whole seed	µmole/g seed	Mg/Kg seed
Cutlass	**42.6**	**27.8**	**121**	**1.7**
O3856	**43.1†**	**27.9**	**130‡**	**1.3**
LSD	0.35	0.31	3.86	0.57
# station yrs	13	13	13	13

†indicates that values are significantly different from one another ($p < 0.05$)
‡ indicates that values are significantly different from one another ($p < 0.01$

Agronomic performance of the oriental mustard hybrid O3856 in the Mustard Adaptation Test in 2021

Entry	Yield			Seed	Seed Color	Green seed	Height	Lodging	Maturity
	Kg/ha	Bu/ac	% check	g/1000 seeds	WI	%	cm	1-5	Days
Cutlass (check)	**1473**	**26.3**	**100**	**2.63**	**-40.4**	**0.27**	**102**	**1.25**	**74**
O3856	**1641‡**	**29.3**	**111**	**2.94‡**	**-39.0**	**0.24**	**110‡**	**1.06**	**75**
LSD	66.9			0.06	1.04	0.30	4.17	0.32	0.81
# station yrs	7			7	7	7	5	4	4

†indicates that values are significantly different from one another ($p < 0.05$)
‡ indicates that values are significantly different from one another ($p < 0.01$

Quality traits of the oriental mustard hybrid O3856 in the Mustard Adaptation Test in 2021

Entry	Oil	Protein	Allyl GSL	Chlorophyll
	% whole seed	% whole seed	µmole/g seed	Mg/Kg seed
Cutlass (check)	**37.4**	**31.6**	**140**	**4.83**
O3856	**38.1‡**	**31.8**	**154‡**	**5.81**
LSD	0.34	0.24	4.52	2.78
# station yrs	7	7	7	7

†indicates that values are significantly different from one another ($p < 0.05$)
‡ indicates that values are significantly different from one another ($p < 0.01$

Agronomic performance of the oriental mustard hybrid O3856 in the yield trials in 2019, and in the Mustard Adaptation Test in 2020 and 2021

Entry	Yield			Seed size	Seed color	Height	Lodging	Maturity
	Kg/ha	Bu/ac	% check	g/1000 seeds	WI	cm	1-5	Days
Cutlass (check)	**2116**	**37.8**	**100**	**2.62**	**-41.8**	**122**	**1.79**	**86**
O3856	**2325‡**	**41.5**	**110**	**2.96‡**	**-41.5**	**125‡**	**1.61‡**	**86**
LSD	75.8			0.04	0.70	2.25	0.16	0.58
# station yrs	22			22	22	18	15	17

Quality traits of the oriental mustard hybrid O3856 in the yield trials in 2019, and in the Mustard Adaptation Test in 2020 and 2021

Entry	Oil	Protein	Allyl GSL	Chlorophyll
	%whole seed	%whole seed	µmole/g seed	Mg/Kg seed
Cutlass (check)	**41.0**	**29.1**	**127**	**2.58**
O3856	**41.6‡**	**29.2**	**137‡**	**2.66**
LSD	0.20	0.20	2.04	0.85
# station yrs	22	22	22	20

Disease reactions for the oriental mustard hybrid O3856

		Blackleg severity		White rust severity (0–9)	
Entry	Year	(0–5)		Race 2a	
Cutlass (check)	2020	0.21		0.5	
O3856	2020	0.28		0.1	

Outline of the Presentation

- **Progress on development of Group 2 herbicide tolerant brown and oriental mustard hybrid varieties**

- **Progress on development of Group 2 herbicide tolerant brown and oriental mustard hybrid varieties**

1. **About 150 IMI-tolerant brown mustard Ogura cms R lines have been produced.**
2. **About 20 IMI-tolerant brown mustard Ogura cms A and B lines have been produced.**
3. **About 130 IMI-tolerant oriental mustard Ogura cms R lines have been produced.**
4. **About 20 IMI-tolerant oriental mustard Ogura cms A and B lines have been produced.**
5. **Group II IMI-tolerant brown mustard hybrid yield trial**

Group II IMI-tolerant brown mustard hybrid yield trial

Entries of the IMI-tolerant brown mustard yield trial:
Centennial Brown (check), and nine test hybrids: B4148, B4149, B4150, B4151, B4152, B4157, B4158, B4159 and B4160

- **4 Replicates; Randomized complete block design**
- **Three sites and 6 tests**
- **Tests 1-4 are not sprayed with Group II herbicides**

Test 1. CYT01a Saskatoon 1
Test 2. CYT01b Saskatoon 2
Test 3: CYT01 Swift Current
Test 4: CYT01 Redvers

Group II IMI-tolerant brown mustard hybrid yield trial

- Tests 5-6 were sprayed with Group II IMI herbicides

Test 5. **CYT01c** Saskatoon: Sprayed with **Ares** at the recommending 1x rate

Test 6. **CYT01d** Saskatoon: Sprayed with Group II herbicide **Odyssey** at the recommending 1x rate

Note: Centennial Brown plots of tests 5 and 6 were covered with plastic when the trials were sprayed with **Ares** and **Odyssey**.

Herbicide: Ares

Centennial Brown
14 days after spraying

1x rate

Control: not sprayed

Plants covered with plastic

14 days after

Centennial Brown

Herbicide: Ares at 1 x rate

Plants at spraying

14 days after spraying

Test hybrid: B4159

Herbicide: Odyssey at 1 x rate

Plants at spraying

14 days after spraying

Test hybrid: B4159

Yield of the IMI-tolerant brown mustard test hybrids B4151 and B4159 in the yield trials (not sprayed with herbicide)

	Centennial Brown (bu/ac)	B4151		B4159		CV (%)
		(bu/ac)	% of check	(bu/ac)	% of check	
Not sprayed						
Test 1. CYT01a SA	38.2	**44.2**	**116**	**43.2**	**113**	10.9
Test 2. CYT01b SA	36.9	**40.7**	**110**	**40.7**	**110**	7.2
Test 3. CYT01SW	24.8	**26.4**	**107**	**24.6**	**99**	7.4
Test 4. CYT01RE	27.1	**30.0**	**111**	**27.6**	**102**	7.1

Yield of the IMI-tolerant brown mustard test hybrids B4151 and B4159 in the yield trials sprayed with herbicide)

	Centennial Brown (bu/ac)	B4151		B4159		CV (%)
		(bu/ac)	% of check	(bu/ac)	% of check	
Test 5. CYT01cSA: **Ares** at 1x rate	35.1	**44.7**	**127**	**46.6**	**133**	9.2
Test 6: CYT01dSA: **Odyssey** at 1x rate	34.1	**40.5**	**119**	**44.1**	**129**	6.7

Note: Centennial brown plots were covered with plastic at sparying

Agronomic performance of the two IMI-tolerant test hybrids B4151 and B4159 (6 trials)

Entry	Yield			Seed Weight	Color	DTF	Height	Lodging	DTM	Sprouting
	Kg/ha	bu/ac	% Check	g/1000s	WI	Days	cm	1 to 5	Days	% seeds
Centennial Brown (check)	1798	32.0	100	2.62	-7.2	45	143	2.0	83	0.93
B4151	2050*	36.5	114	2.73*	-6.3	44	147	1.9	83	1.02
B4159	2031*	36.2	113	2.78*	-5.4*	44	149	2.3	83	0.69
LSD	96.6			0.06	0.73	0.35	4.29	0.39	0.45	0.36
# of station yrs	6			6	6	6	6	5	6	6

Quality traits of the two test hybrids B4151 and B4159 (6 trials)

Entry	Oil	Protein	Allyl GSL	Texture
	%	%	µmole/g	2-5 cm
Centennial Brown	**36.2**	**29.3**	**107**	**2.1**
B4151	**36.9**	**28.5**	**120***	**3.3**
B4159	**35.6**	**29.9**	**126***	**2.7**
LSD	0.61	0.65	3.15	
# of station yrs	6	6	6	

Texture measurement with a Bostwick.

Outline of the Presentation

- **Progress on creating Group II IMI-tolerant yellow mustard germplasm**

Development of Group 2 HT yellow mustard

Approach: Seed mutagenesis via ethyl methanesulfonate (EMS)

Results:

- Chile winter nursery spray trial in 2023: The 2 M_1 plants that survived the Solo spray have the same SNP mutation in the ALS gene as that in the previous mutant line Y4063-1.
- Two new EMS mutagenized populations using Andante and AAC Yellow 80 as seed source were created. The resulting M_1 seeds will be planted in the field in Saskatoon and sprayed with Solo at the recommending rate (325 ml/acre) in 2025 field season.

Outline of the Presentation

- **Development of clubroot resistant brown and oriental mustard, and yellow mustard**

Development of clubroot resistant brown and oriental mustard

Approaches

- Transferring the clubroot resistant gene from *B. napus* into brown and oriental mustard via interspecific crossing

- Screening *B. juncea* germplasm for clubroot resistant gene

Development of clubroot resistant brown and oriental mustard

- **Transferring the clubroot resistant gene from *B. napus* into brown and oriental mustard via interspecific crossing**

Result:

- The clubroot resistant gene **Rcr1** on chromosome A03 from clubroot resistant *B. napus* line Y549-(0)-2-1 was transferred into IMI-tolerant brown and oriental mustard Ogura cms restorer and maintainer lines

Development of clubroot resistant brown and oriental mustard

- **Screening *B. juncea* germplasm for clubroot resistant gene**

Result:

- 64 *B. juncea* accessions were screened against *P. brassicae* pathotype 3.
- All of the lines are susceptible to clubroot disease.

Development of clubroot resistant yellow mustard

Approach:

- Screening yellow mustard germplasm of different origin for clubroot resistant gene

Results:

- Progeny plants from the putative clubroot resistant plants proved to be susceptible
- Continue screening more accessions

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