Clubroot Resistance in Canola: Germplasm development and molecular mapping

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Overview

- **Search for resistance**
- **Germplasm development: Introgression of resistance**
  - Mendel resistance
  - Rutabaga resistance
  - Resistance from allied species
- **Molecular mapping of resistance**
  - Mendel resistance
  - Rutabaga resistance

Search for resistance

Hasan MJ, Strelkov SE, Howard MJ, Rahman H, 2012: Can J Plant Sci (in press)

Species	No. accession	No. of accession with resistance				
		Path 2	Path 3	Path 5	Path 6	Path 8
B. rapa var. *rapifera*	**5**	5	**5**	5	5	5
B. rapa var. *chinensis*	**8**	1	**1**	2	1	1
B. rapa var. *pekinensis*	**5**	0	**0**	0	0	0
B. rapa var. *oleifera*	**18**	6	**9**	9	12	12
B. rapa var. *oleifera*	**9**	0	**0**	0	3	3
B. oleracea var. *capitata*	**16**	1	**3**	2	1	2
B. oleracea var. *botrytis*	**14**	0	**0**	0	0	0
B. oleracea var. *italica*	**13**	0	**0**	0	0	1
B. oleracea var. *gemmifera*	**3**	0	**2**	1	0	0
B. oleracea var. *alboglabra*	**2**	0	**0**	0	0	0
B. oleracea var. *villosa*	**1**	0	**0**	1	0	0
B. nigra (different ssp.)	**77**	67	**70**	**67**	68	75
B. napus	**36**	29	**3**	1	27	32
B. napus ssp. *napobrassica*	**5**	5	**3**	4	5	5
B. juncea	**48**	0	**0**	0	0	0
B. carinata	**24**	0	**0**	0	0	0
Total	**275**					

Germplasm development: Mendel resistance

Rahman et al. 2011: Can J Plant Sci 91:447-458

Two crosses → 1,872 F_2 plants (sel. for CR)
→ 18+22 = 40 F_3 families

Cross	No. F_3 fam.	No. segr. fam.	No. non-segr. fam.	χ^2 (1:2 segr.)	p
Mendel x A04-71NA	18	8	10	**1.00**	**0.3-0.5**
Mendel x A04-75NA	22	16	6	**15.52**	**<0.05**

	Total F_3 plants	% Res. plants	No. R-plants flowered	Days to flower	
				Range	Mean
Mendel x A04-71NA	296	83.4	77	**47 - 70**	**63.4**
Mendel x A04-75NA	313	95.5	37	**49 - 64**	**56.4**
Hi-Q				*46 - 48*	*47.0*

Summarized data, Rahman et al. 2011: Can J Plant Sci 91:447-458

Germplasm development: Mendel resistance

Field evaluation of F_5 families in Leduc in 2008

	Clubroot res.		Days to flower		% Oil		Saturated FA	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Mendel x A04-71NA	0.0-3.0	**0.43**	44-52	**47.1**	45.0-52.7	**48.9**	6.6-8.0	**7.26**
Mendel x A04-75NA	0.0-3.0	**0.40**	43-51	**46.0**	45.9-55.8	**51.7**	6.2-7.4	**6.85**
46A65	*3.0*	***3.00***	*44-45*	***44.5***	*50.8-53.2*	***52.5***	*6.8-7.0*	***6.90***

Index of disease: Resistant F_6 lines & hybrids – few examples

	Path 3	Path 5	Path 6
591.165 OP	0.0	0.0	**0.0**
591.165 Hybrid	0.0	0.0	**7.4**
591.186 OP	**0.0**	**0.0**	**0.0**
591.186 Hybrid	**0.0**	**0.0**	**0.0**
591.225 OP	**27.8**	0.0	**0.0**
591.225 Hybrid	**22.2**	0.0	**9.3**
591.232 OP	0.0	**0.0**	0.0
591.232 Hybrid	0.0	**2.8**	0.0

Some of these F_6 and F_8 lines supplied to interested canola Breeders

Summarized data, Rahman et al. 2011: Can J Plant Sci 91:447-458

Germplasm development: Mendel resistance – 2nd cycle breeding

Clubroot resistant x Susceptible HT canola

Gene-ration	No. plants tested for HT & CR
F_2	1144
F_3	877

Evaluation F_5 families in field 2010

	No. F_5 fam.	Days to flower	% Oil	% Protein	Glucosi-nolate	% Sat FA
RoundUp	**249**	**45 - 50**	**44.4 - 53.5**	**19.7 - 25.8**	**11.2 - 19.5**	**5.8 - 7.7**
A07-26NR		*45.2*	*50.6*	*22.1*	*13.9*	*6.5*
Clearfield	**167**	**44 - 51**	**40.4 - 52.8**	**21.7 - 28.7**	**9.5 - 22.5**	**5.8 - 7.8**
A05-17NI		*44.6*	*48.3*	*25.1*	*12.8*	*6.3*

Germplasm development: Mendel resistance – 2nd cycle breeding

2011 Field trial data of clubroot resistant F_6 breeding lines

[RoundUp (n=47), 2 loc; Clearfield (n=30), 3 loc; data of top 1/3rd – 2/3rd lines]

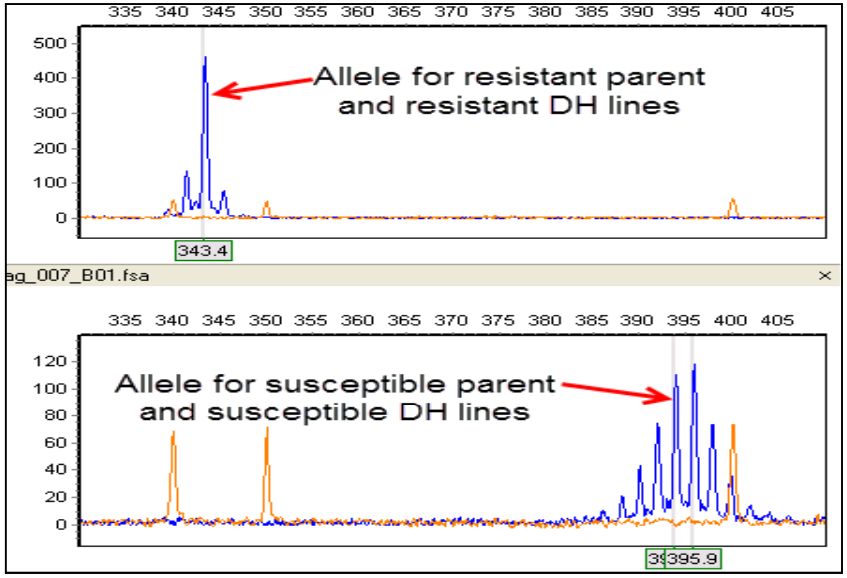
		Days to flower	Yield (%)	% Oil	% Protein	% Sat FA
RoundUp	Range	**54.5 - 56.3**	**91.2 - 105.1**	**46.7 - 50.9**	**22.3 - 26.0**	**6.16 - 7.18**
	Mean	**55.5**	**96.8**	**48.6**	**23.9**	**6.74**
A07-26NR (OP)	*Mean*	***55.5***	***104.8***	***51.5***	***21.8***	***6.79***
95-93 (hybrid)	*Mean*	***55.8***	***95.2***			
Clearfield	Range	**53.0 - 56.2**	**91.3 - 107.9**	**45.8 - 50.5**	**23.9 - 26.4**	**6.16 - 7.17**
	Mean	**54.7**	**98.2**	**47.6**	**25.4**	**6.76**
A05-17NI (OP)	*Mean*	***54.0***	***96.2***	***46.9***	***25.9***	***6.64***
45P70 (hybrid)	*Mean*	***54.2***	***103.8***			

All RoundUp and Clearfield lines are canola quality

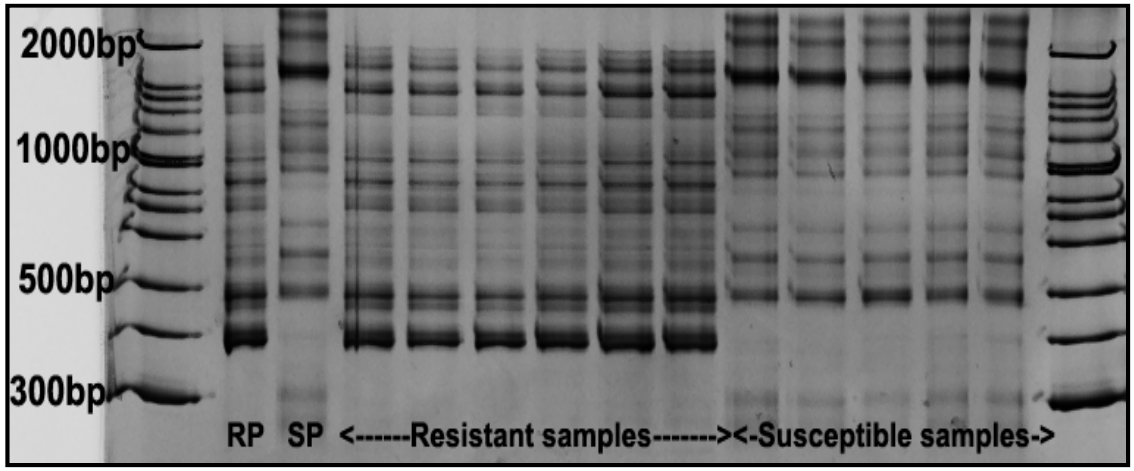
Mendel resistance: Molecular mapping

- **Resistant x Susceptible crosses**
- **Four (2 DH + 2 pedigree) mapping populations developed**
- **SSR markers used**

ABI genotyping electropherogram



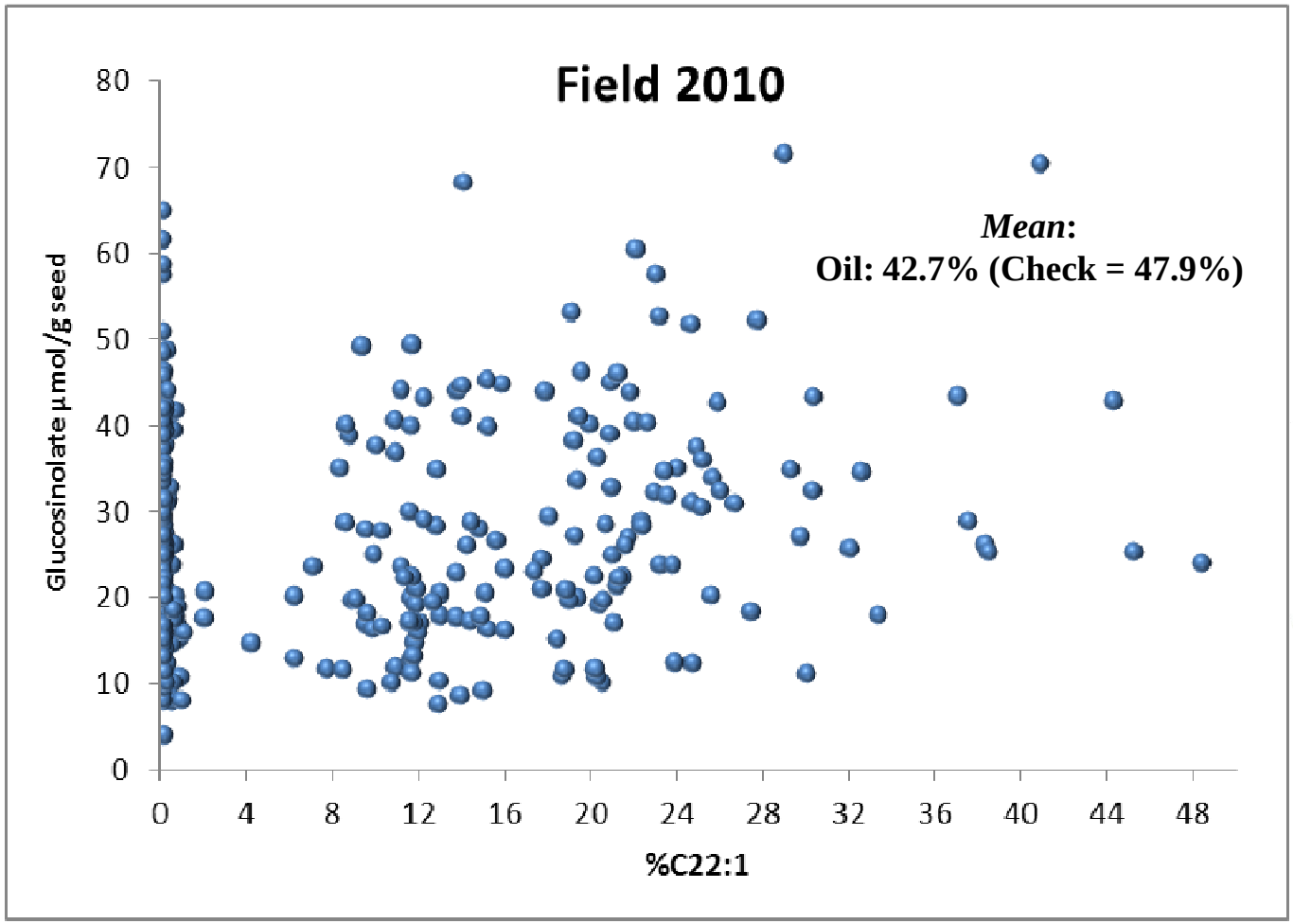
Polyacrylamide gel image



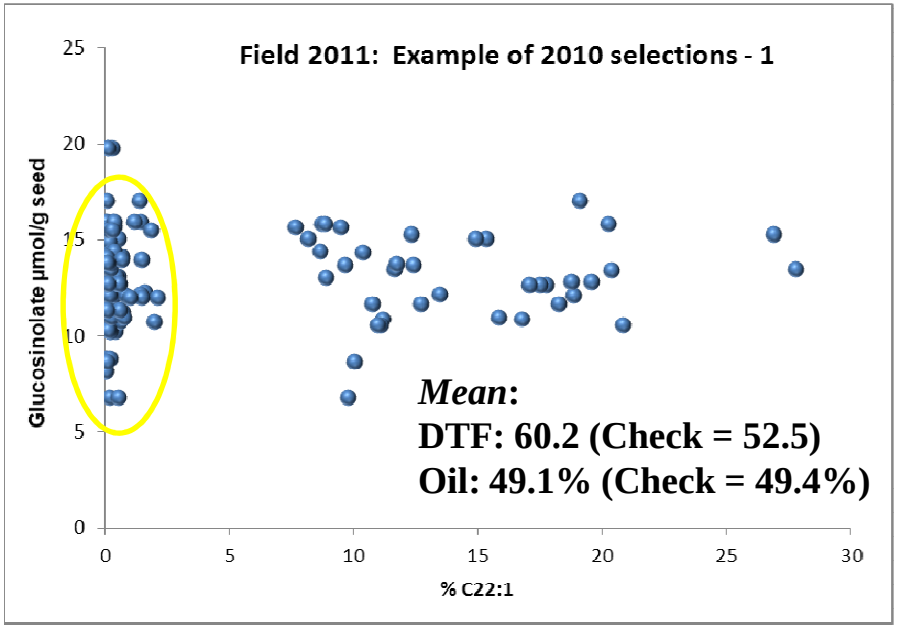
Germplasm development: Rutabaga resistance

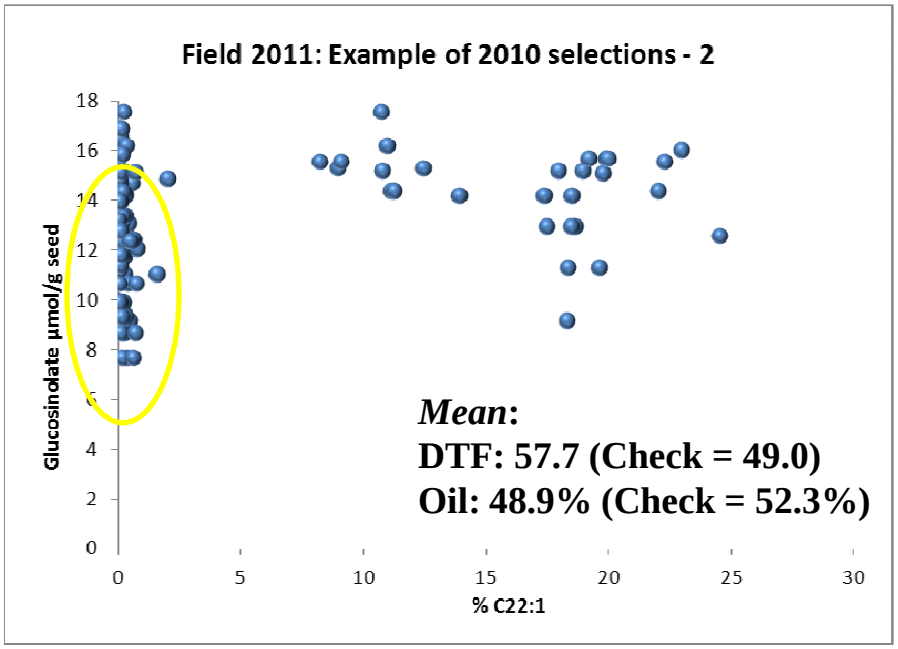
Rutabaga x Canola crosses: ***Conventional and HT populations***

No. pedigree families (≈F_3) in Field test in 2010 = 209

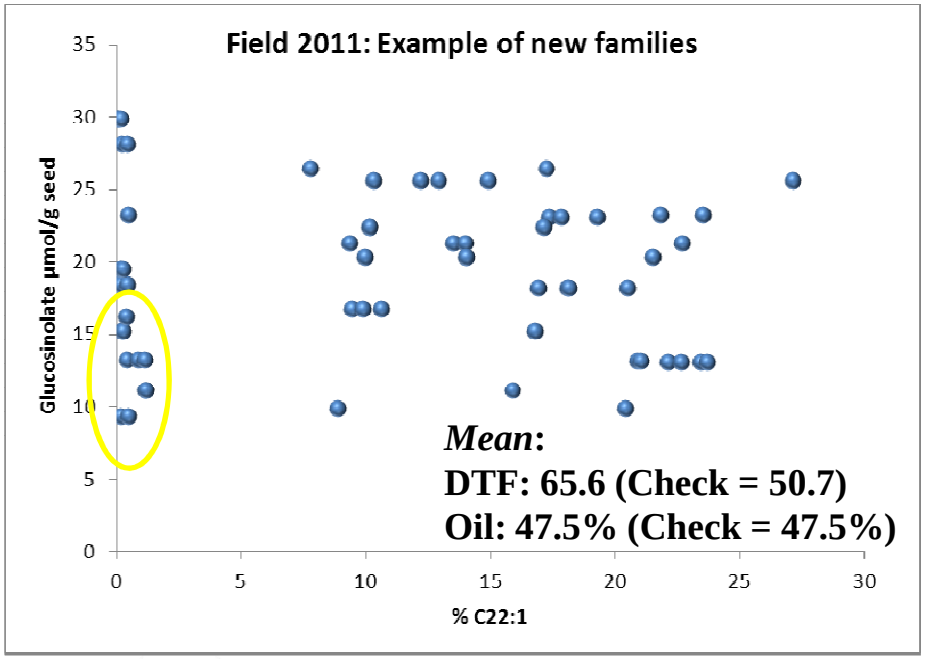


Germplasm development: Rutabaga resistance





Number pedigree families (≈F_4) in Field test in 2011:
204 families from 2010 selection +
179 new families = 383



Germplasm development: Rutabaga resistance

Rutabaga x Canola crosses: Conventional and HT

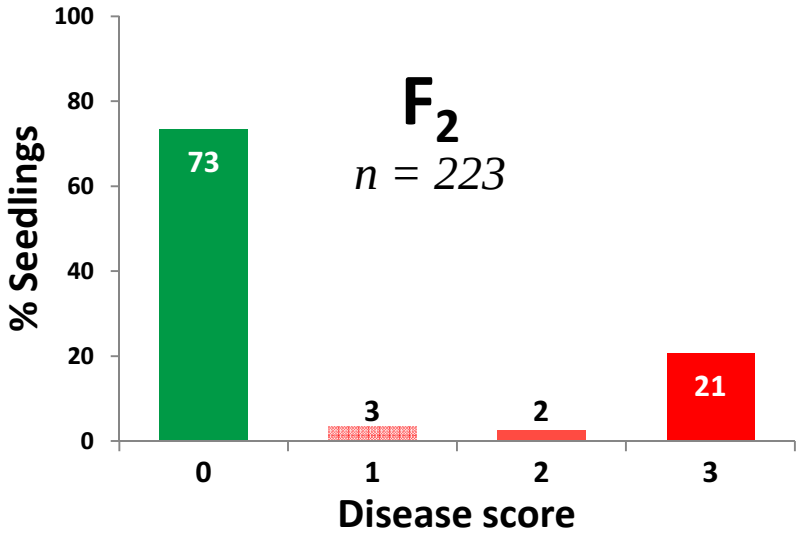
Canola line development in greenhouse

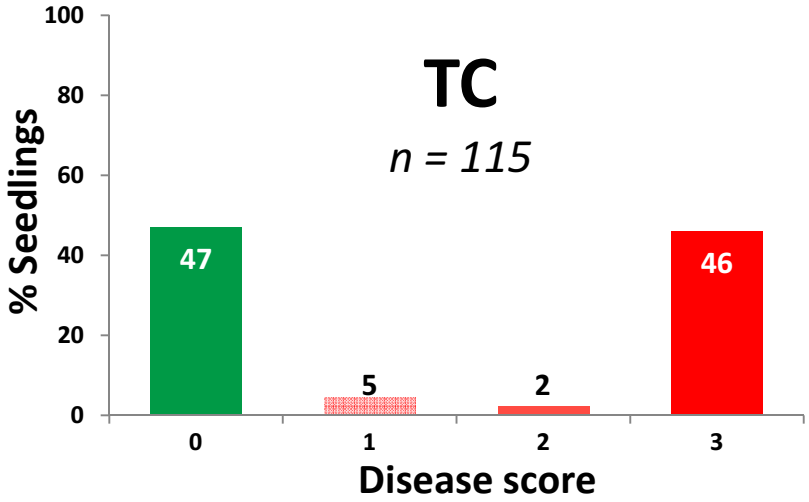
Popula-tion		No. plants	No. resistant	GLS	%C22:1	%Sat
#1[1]	Range	**3799**	**-**	**-**	**0.1 – 29.5**	**6.3 – 11.0**
	Mean				**11.8**	**7.3**
#1-progeny[2]	Range	**440**	**-**	**7.8 – 82.2**	**0.03 – 22.8**	**6.0 – 9.9**
	Mean			**11.8**	**5.4**	**7.6**
#2[3]	Range	**1242**	**478**	-	**0.04 – 14.7**	**6.7 – 9.7**
	Mean				**5.6**	**8.1**
#3[4]	Range	**1049**	**137**	-	**0.04 – 16.0**	**6.4 – 10.2**
	Mean			-	**6.6**	**8.2**
Total		**6,530**	**615**			

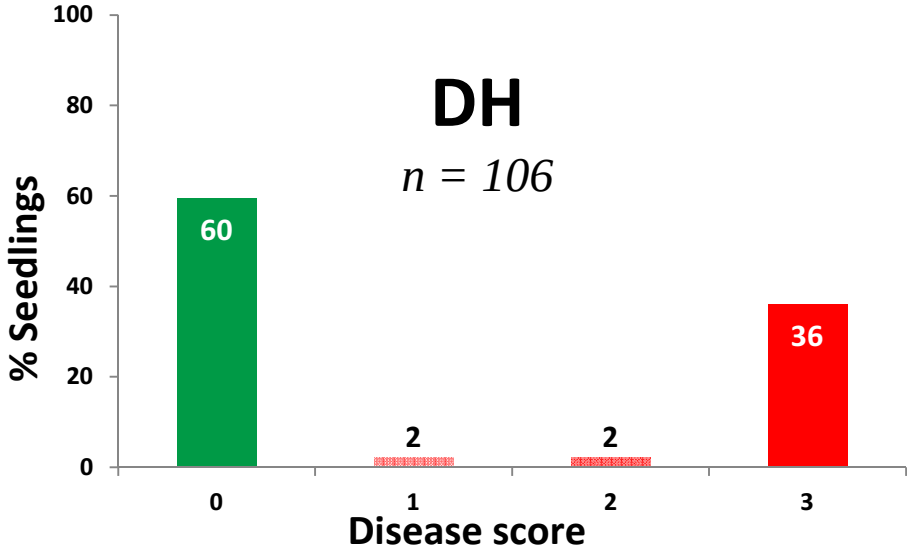
[1]n = 304 for %C22:1 & %Sat; [2]n = 106 for GLS, and 140 for %C22:1 & %Sat; [3]n = 220 for %C22:1 & %Sat; [4]n = 58 for %C22:1 & %Sat

Rutabaga resistance: Molecular mapping

Resistance to pathotype 3: Rutabaga x A07-29NI

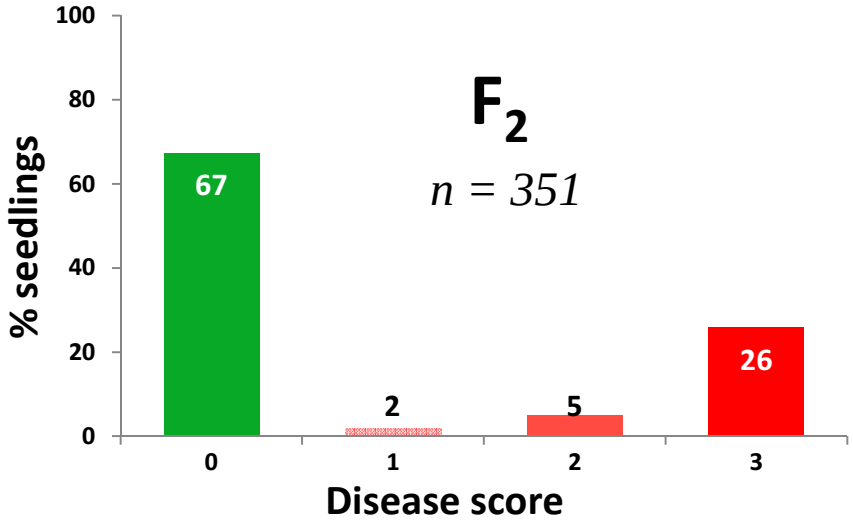


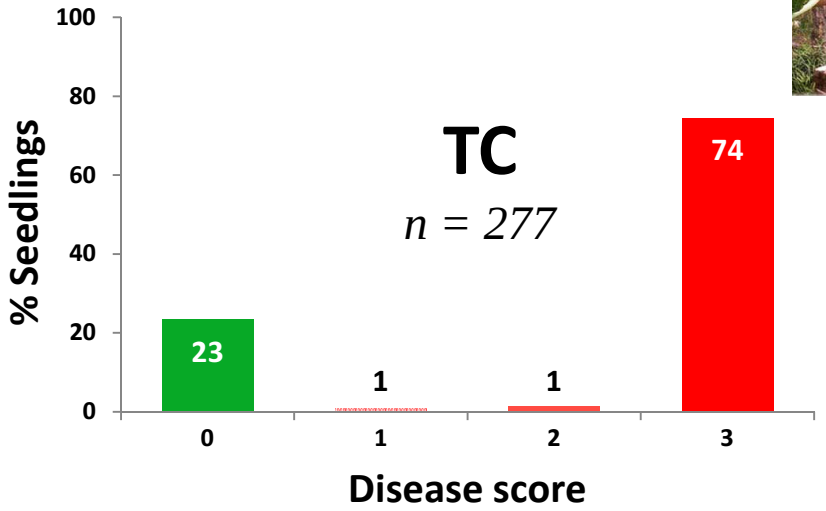


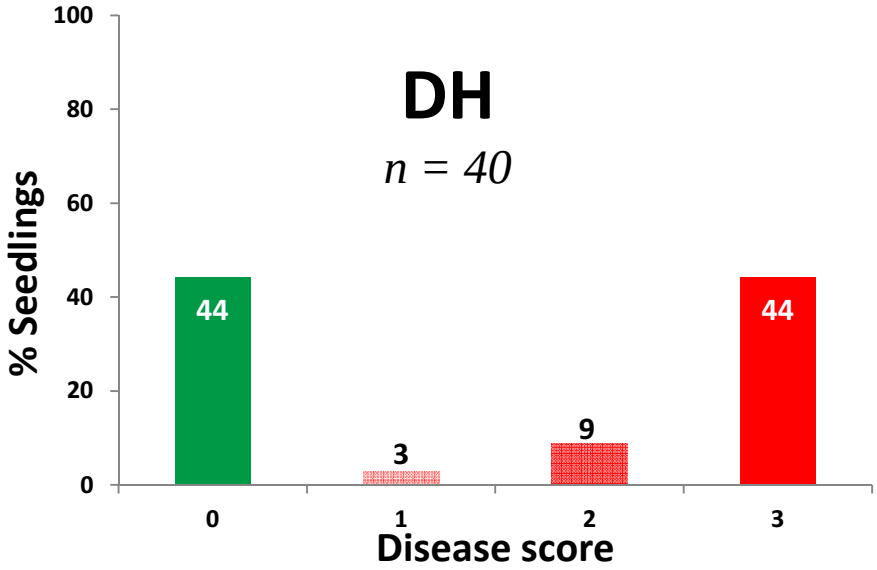


Rutabaga resistance: Molecular mapping

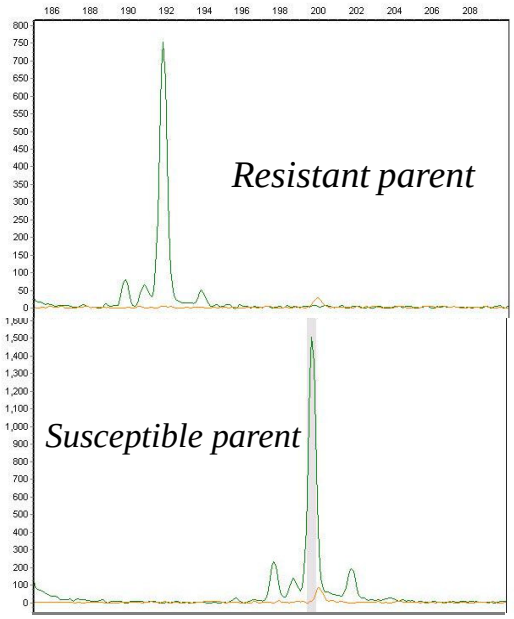
Resistance to pathotype 3: Rutabaga x A05-17NI







Rutabaga resistance: Molecular mapping



ABI genotyping electropherogram

Rutabaga x Canola mapping populations

Polymorphism of SSR markers

	Total SSR tested	% poly-morphic (> 4 bp)
Rutabaga-PL x A05-17NI	283	36.6
Rutabaga-BF x A07-29NI	271	35.1
Not amplified or < 4 bp	219	28.3
Total	**773**	

Two genomic regions identified through single marker analysis

↓

QTL mapping in progress

Acknowledgements

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canolacouncil

ALBERTA Canola PRODUCERS COMMISSION

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