Breeding for clubroot resistance at the University of Alberta

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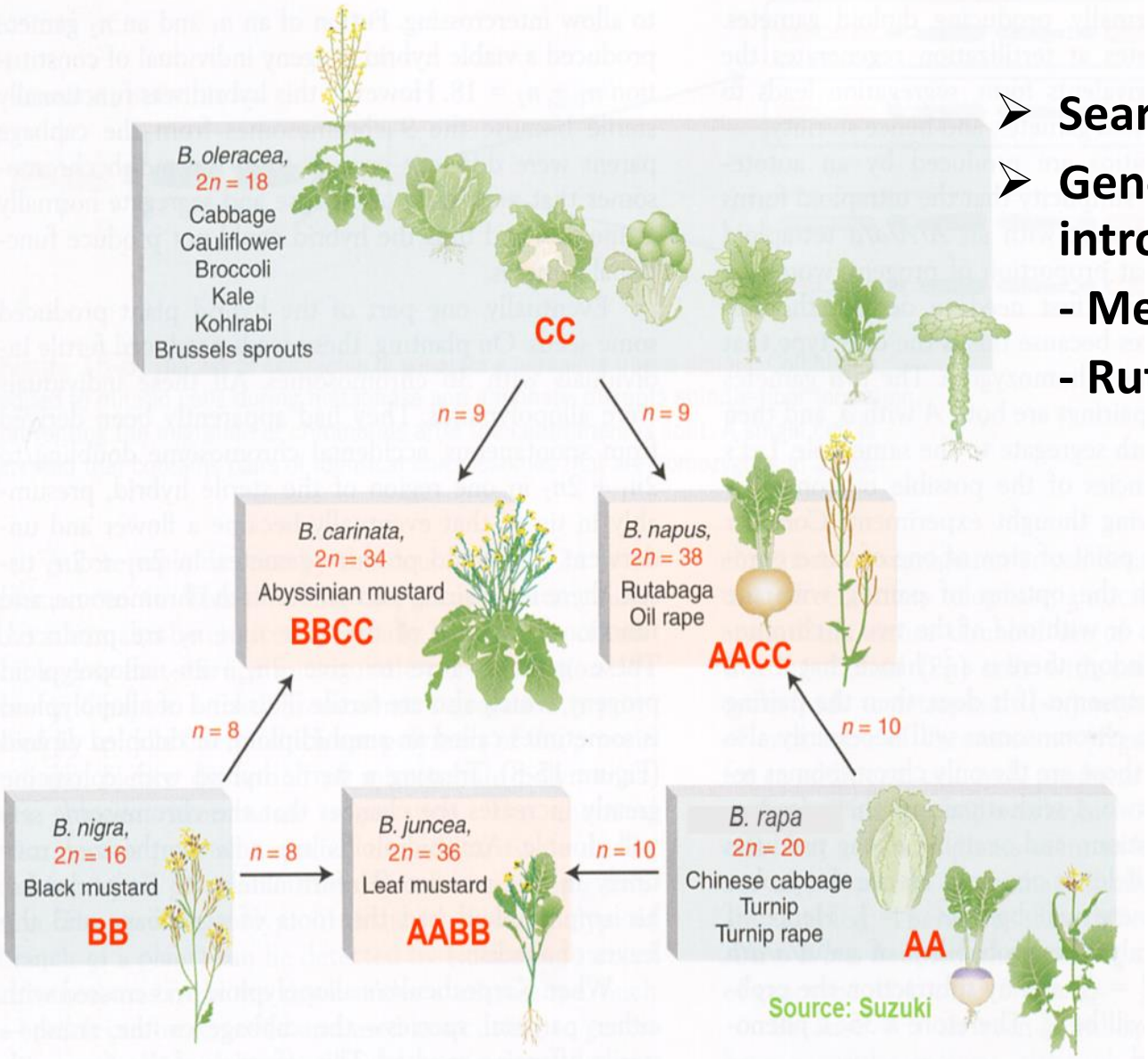
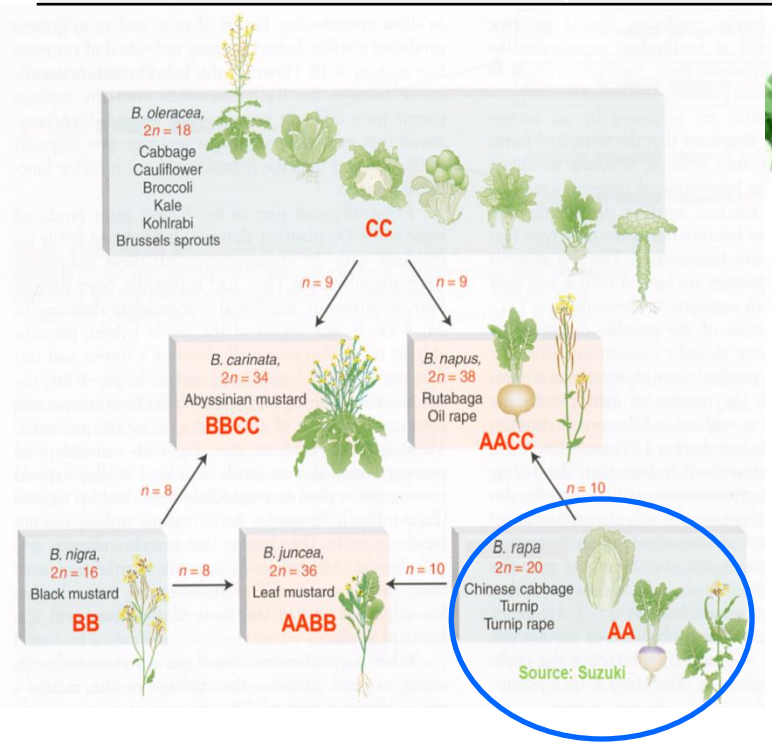
Overview



- **Search for resistance**
- **Genetic basis and introgression of resistance**
  - **Mendel resistance**
  - **Rutabaga resistance**

Search for resistance: B. rapa (AA, 2n = 20)

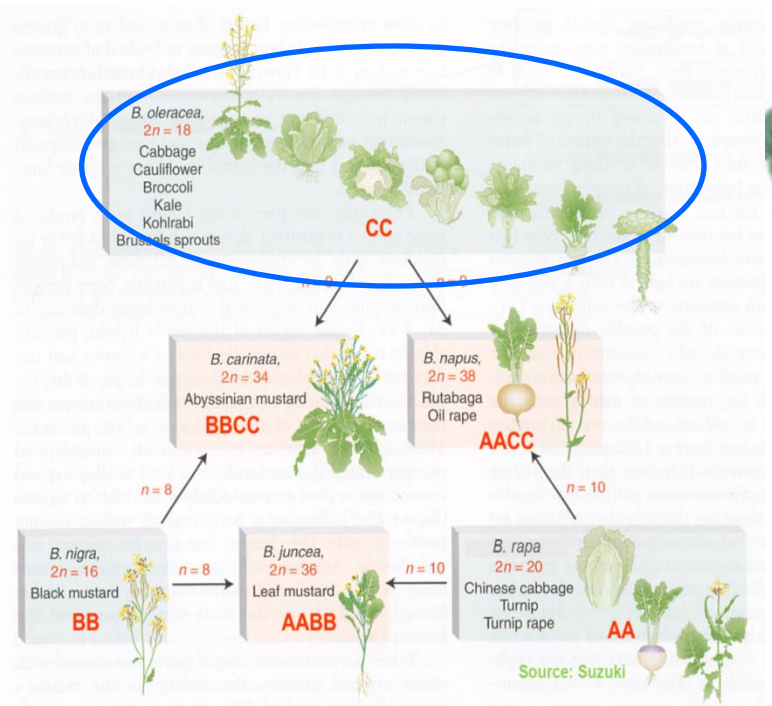
Species	No. accession	No. of accession with resistance				
		Path 2	Path 3	Path 5	Path 6	Path 8
B. rapa var. *rapifera*	**5**	5	**5**	5	5	5
B. rapa var. *chinensis*	**8**	1	**1**	2	1	1
B. rapa var. *pekinensis*	**5**	0	**0**	0	0	0
B. rapa var. *oleifera*	**18**	6	**9**	9	12	12
B. rapa var. *oleifera*	**9**	0	**0**	0	3	3
Total	**45**	**12**	**15**	**16**	**21**	**21**



Data based on Hasan et al. (2012) Can J Plant Sci 92:501-515

Search for resistance: B. oleracea (CC, 2n = 18)

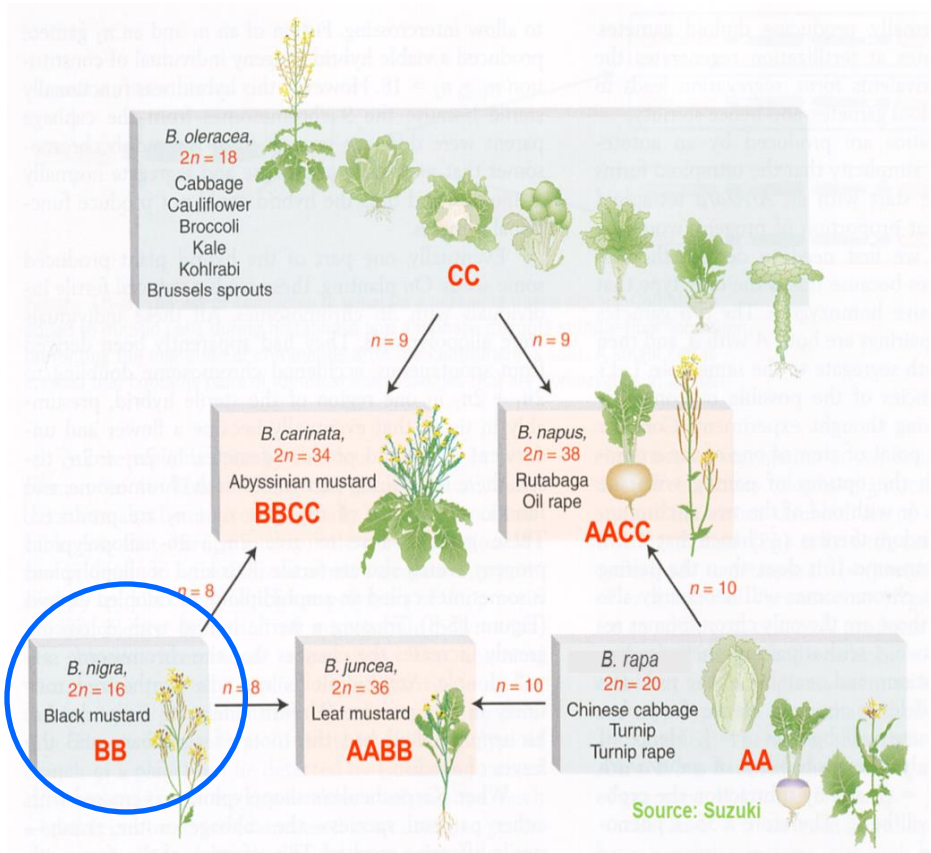
Species	No. accession	No. of accession with resistance				
		Path 2	Path 3	Path 5	Path 6	Path 8
B. oleracea var. *capitata*	**16**	1	**3**	2	1	2
B. oleracea var. *botrytis*	**14**	0	**0**	0	0	0
B. oleracea var. *italica*	**13**	0	**0**	0	0	1
B. oleracea var. *gemmifera*	**3**	0	**2**	1	0	0
B. oleracea var. *alboglabra*	**2**	0	**0**	0	0	0
B. oleracea var. *villosa*	**1**	0	**0**	1	0	0
Total	**49**	**1**	**5**	**4**	**1**	**3**



Data based on Hasan et al. (2012) Can J Plant Sci 92:501-515

Search for resistance: B. nigra (BB, 2n = 16)

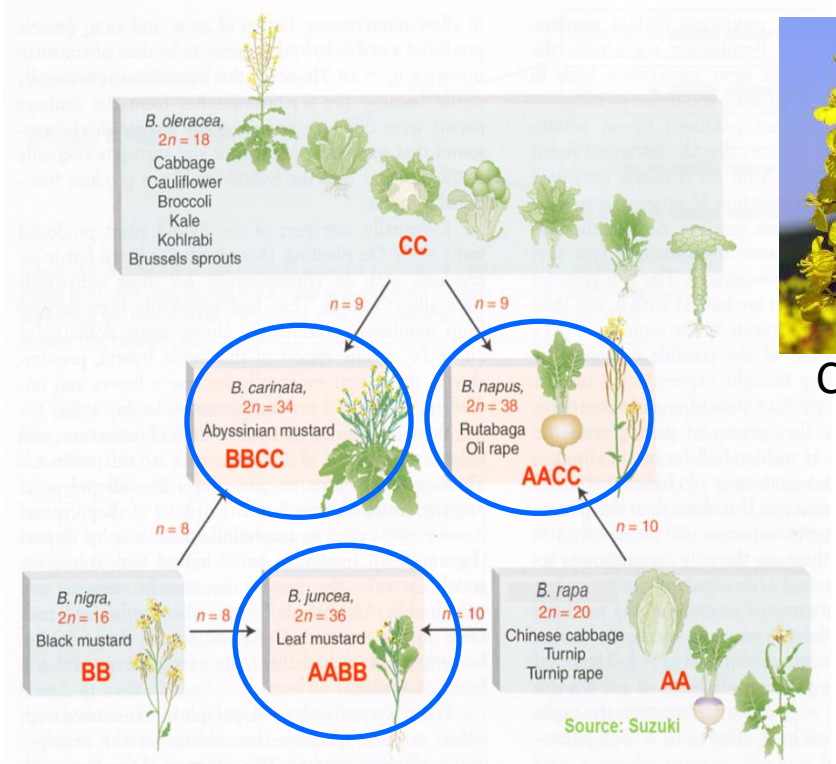
Species	No. accession	No. of accession with resistance				
		Path 2	Path 3	Path 5	Path 6	Path 8
B. nigra	**77**	67	**70**	**67**	68	75

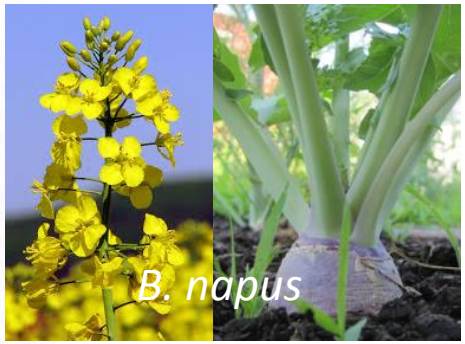


Data based on Hasan et al. (2012) Can J Plant Sci 92:501-515

Search for resistance: Amphidiploid species

Species	No. accession	No. of accession with resistance				
		Path 2	Path 3	Path 5	Path 6	Path 8
B. napus (AACC, 2n = 38)	**36**	29	**0**	1	27	32
B. napus ssp. *napobrassica*	**5**	5	**3**	4	5	5
B. juncea (AABB, 2n = 36)	**48**	0	**0**	0	0	0
B. carinata (BBCC, 2n = 34)	**24**	0	**0**	0	0	0
Total	**163**	**34**	**3**	**5**	**32**	**37**





Canola Rutabaga

B. juncea

B. carinata

Data based on Hasan et al. (2012) Can J Plant Sci 92:501-515

Search for resistance: Summary

- **A total of 275 accessions of six Brassica species evaluated.**
- **Resistance to pathotype 3 frequent in:**

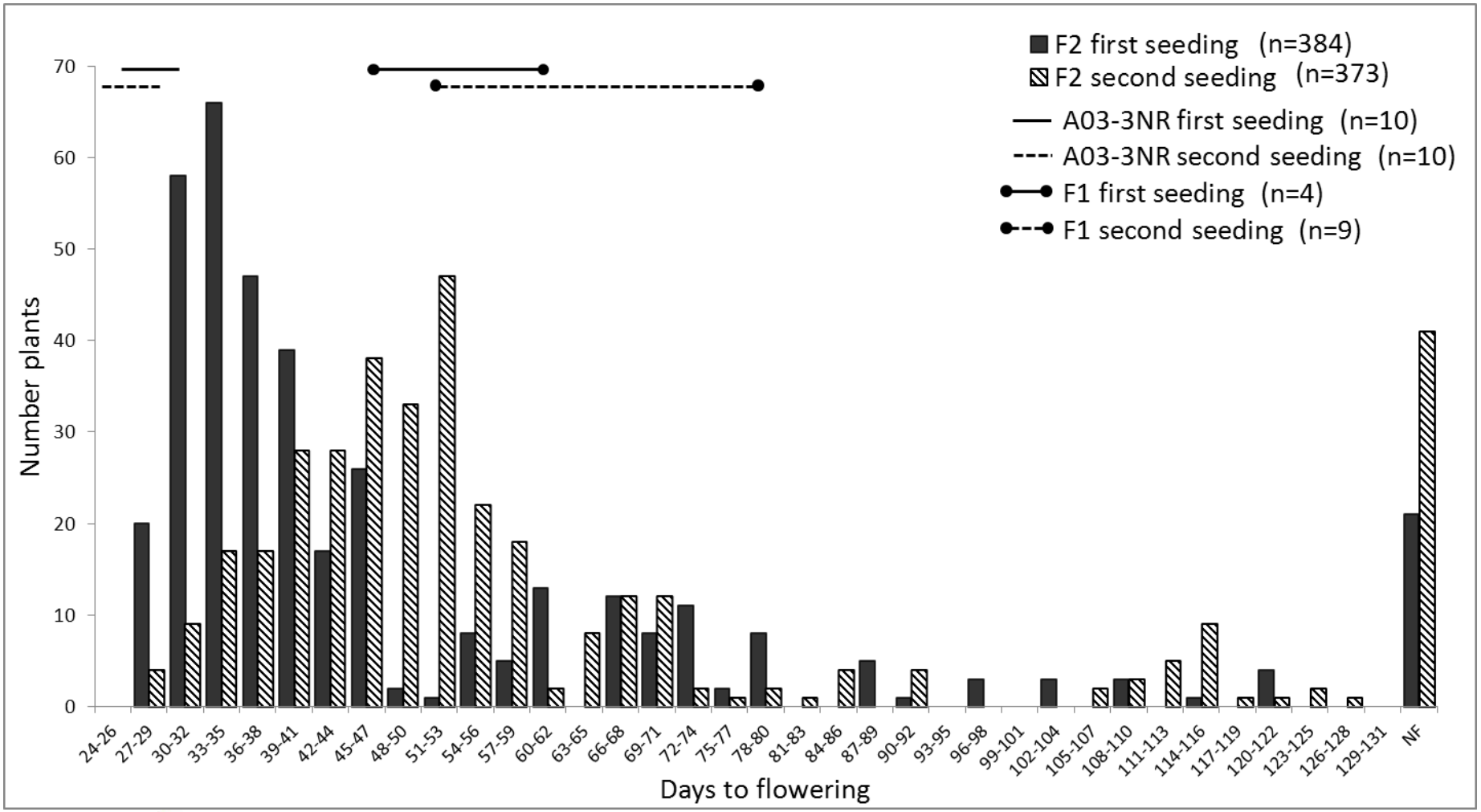
  - Diploid species: Turnips (*B. rapa* var. *rapifera*) and *B. nigra*.

  - Amphidiploid species: Rutabaga (*B. napus* var. *napobrassica*).
- **No resistance found in *B. juncea* and *B. carinata*.**

Mendel resistance: Genetics & Breeding

Winter × Spring: Breeding spring canola

Days to flower in F_2 populations of Winter × Spring canola crosses in greenhouse at two different dates with three weeks interval



Rahman & Kebede (2012) J Oilseed Brassica 3:1-17
Kebede et al. (2010) Crop Sci 50:1236-1243

Mendel resistance

Segregation for resistance to *P. brassicae* pathotype 3 in F_3 families of Mendel × spring canola *B. napus* crosses

Cross	Number plants		X^2 test		
	Res.	Sus.	Ratio	X^2	*p*
Mendel x A04-71NA	124	49	3:1	1.02	0.31
Mendel x A04-75NA	56	14	3:1	0.93	0.33

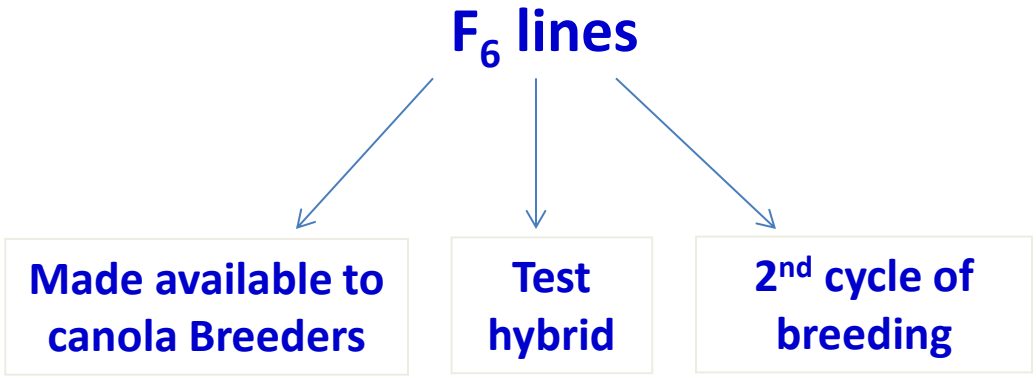
Data based on Rahman et al. 2011: Can J Plant Sci 91:447-458

Mendel resistance: Germplasm development

Field evaluation of F_5 families

	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 (Check)	3.0	**3.00**	44-45	**44.5**	50.8-53.2	**52.5**	6.8-7.0	**6.90**

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



Mendel resistance: Germplasm development

Index of disease: Resistant F_6 lines & test 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

Index: 100 = most susceptible; 0 = no disease

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

Mendel resistance – 2nd cycle breeding

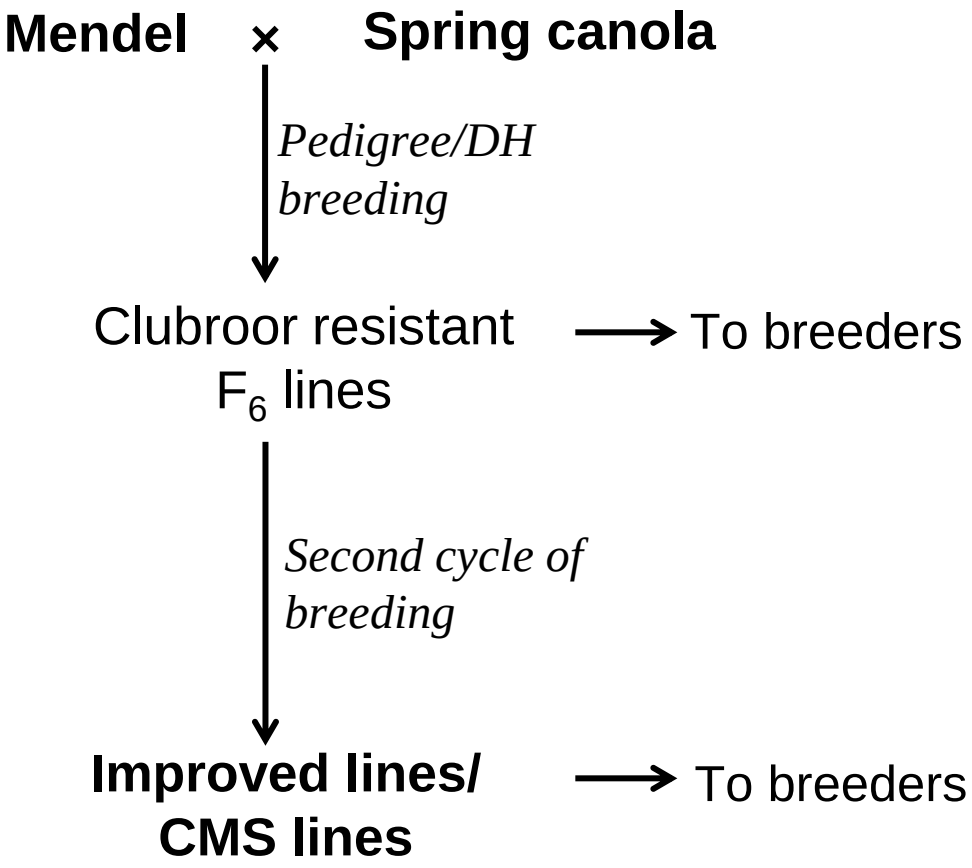
2011 Field trial data of clubroot resistant F_6 breeding lines

[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**
Check (A07-26NR & 95-93)	**Mean**	**55.7**	**100.0**	**51.5**	**21.8**	**6.79**
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**
Check (A05-17NI & 45P70)	**Mean**	**54.1**	**100.0**	**46.9**	**25.9**	**6.64**

All RoundUp and Clearfield lines are canola quality

Mendel resistance – Summary



- **One major gene control resistance**

Roasted rutabaga

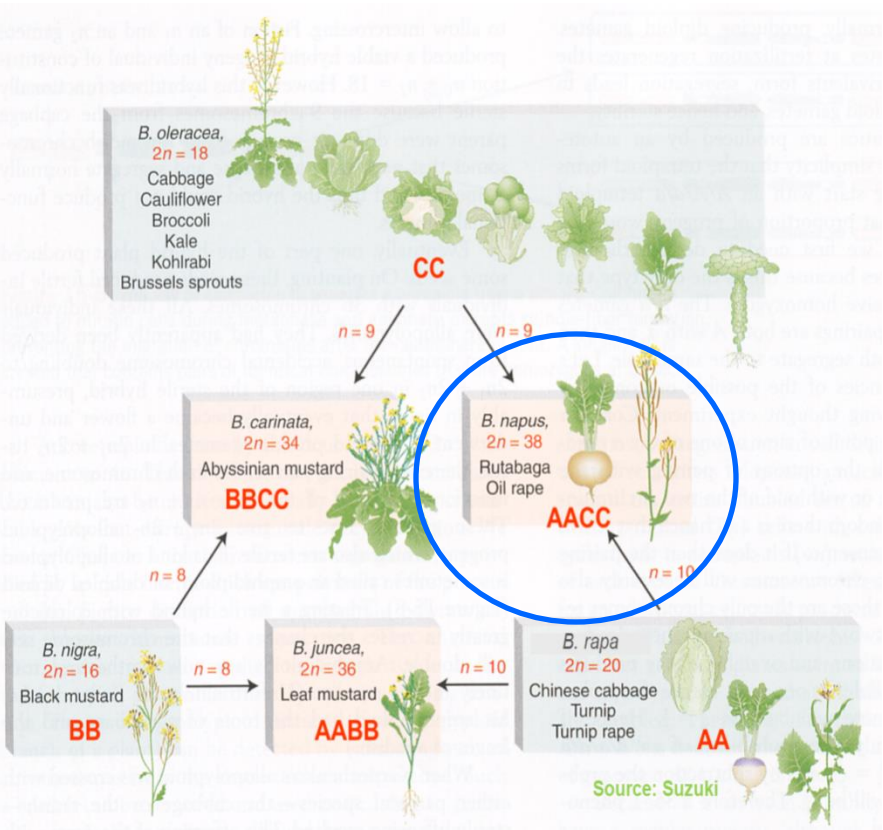
Rotmos with sausage

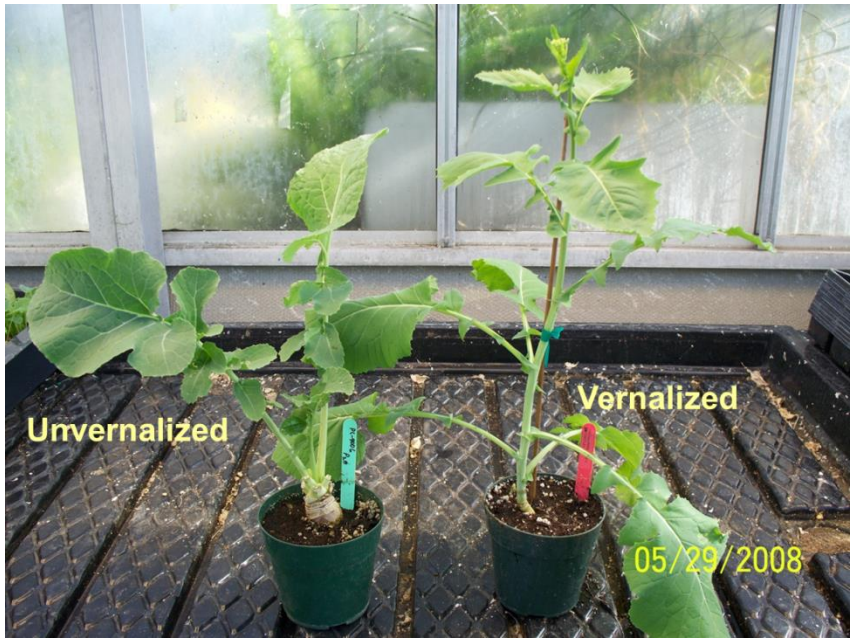
Rutabaga resistance:

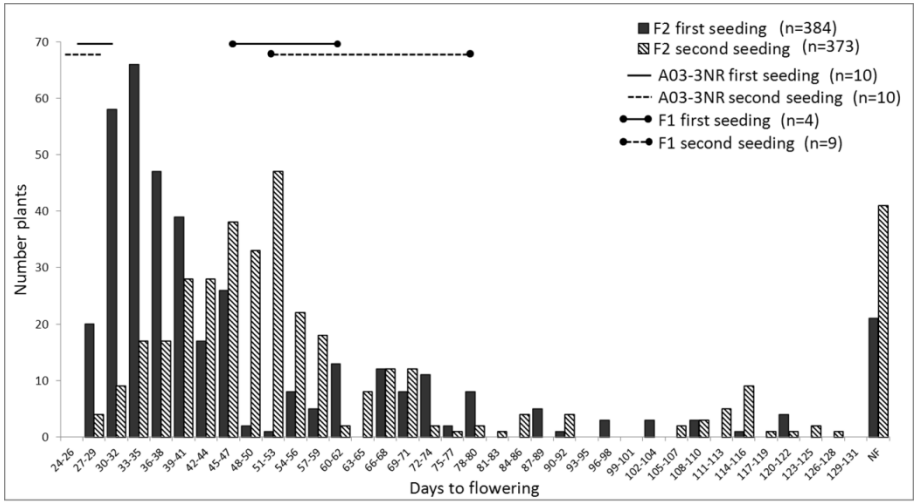
Genetics & Breeding

A traditional Irish Halloween rutabaga lantern

Rutabaga resistance







Rutabaga resistance

Rutabaga x Spring canola

↓

F_1

↙ ↘

Doubled haploid (DH)

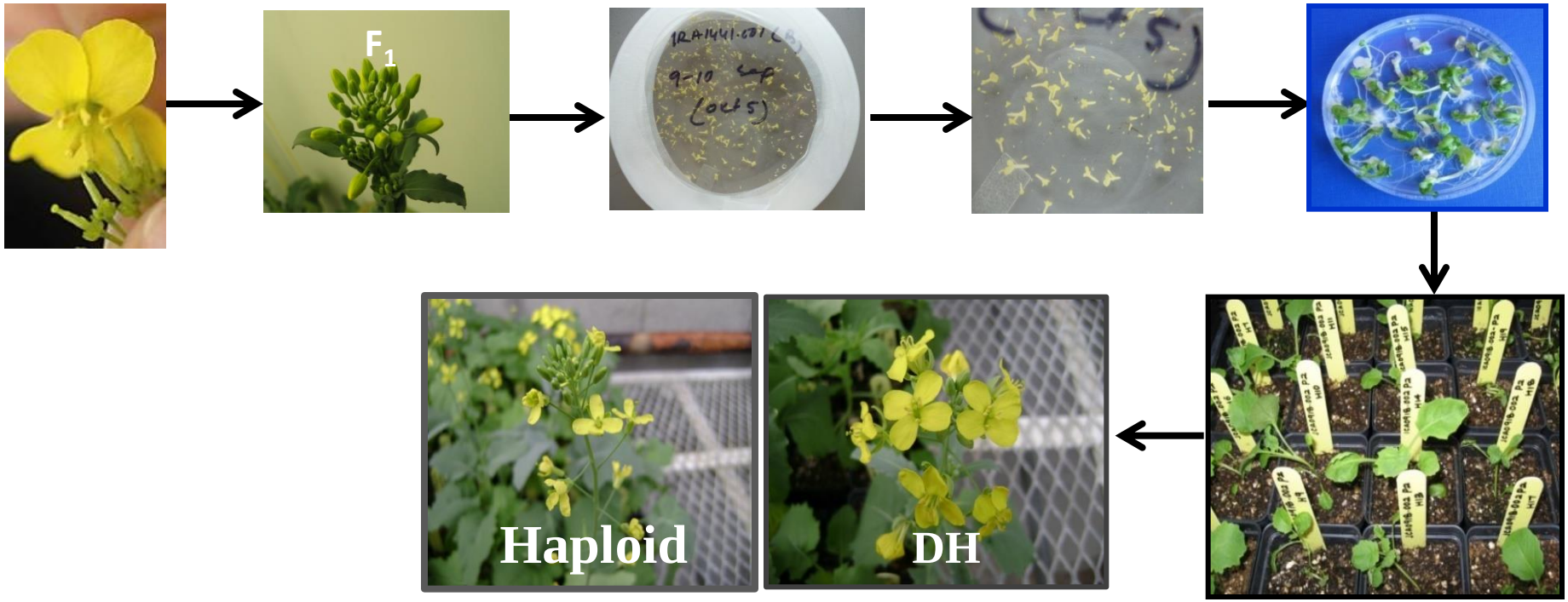
- **Genetic study**
- **Molecular mapping**

Pedigree breeding

- **Genetic study & mapping**
- **Germplasm development**

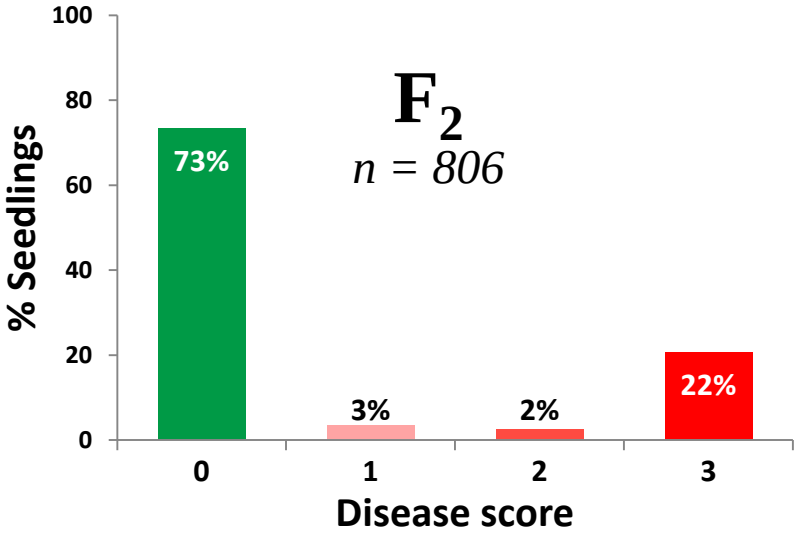
Rutabaga resistance: Doubled haploid (DH) production

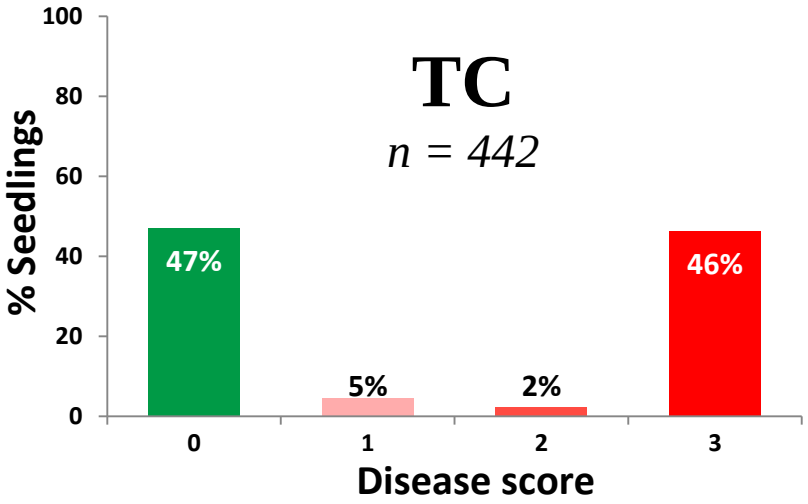
Cross	No. embryos	No. DH (%DH)
Rutabaga-BF × A07-29NI	4,328	106 (2.4)
A05-17NI × Rutabaga-PC	2,865	36 (1.3)
Total	**7,193**	**142** (2.0)

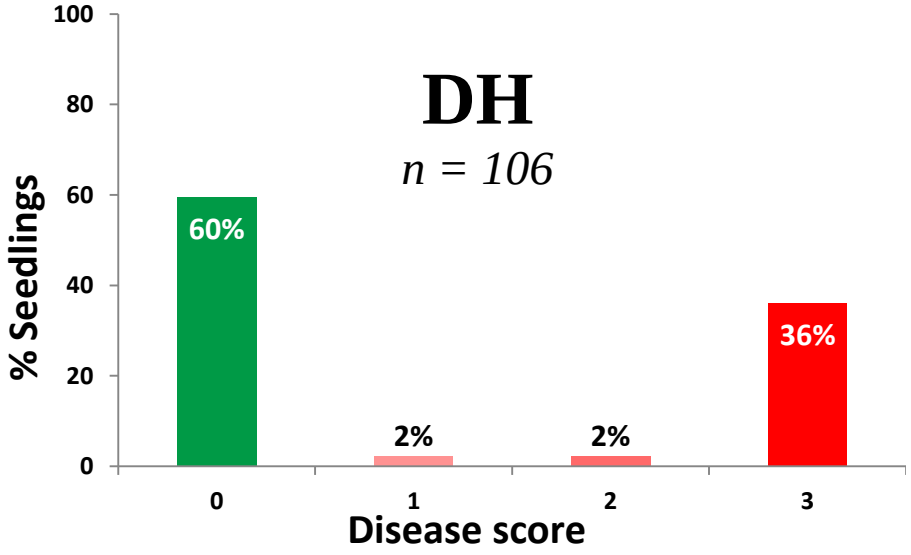


Rutabaga resistance: Genetics

Resistance to pathotype 3: Rutabaga-BF ✕ A07-29NI

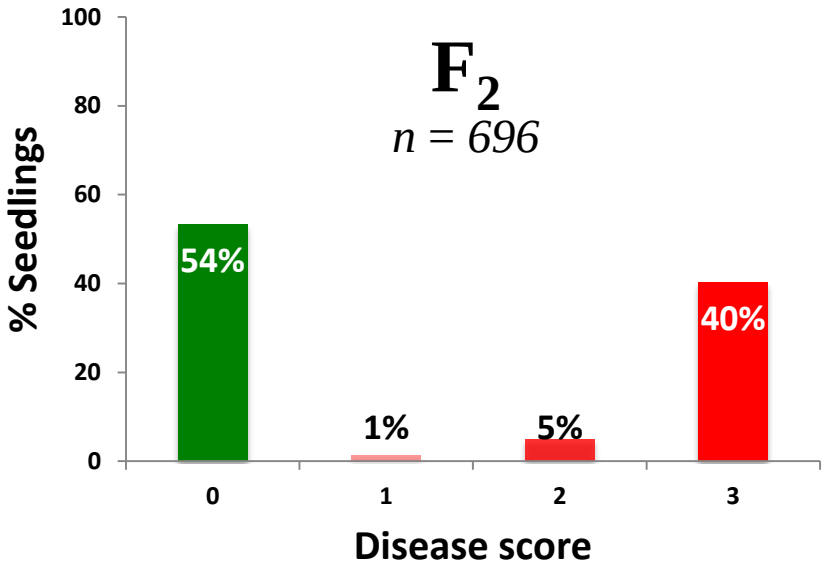


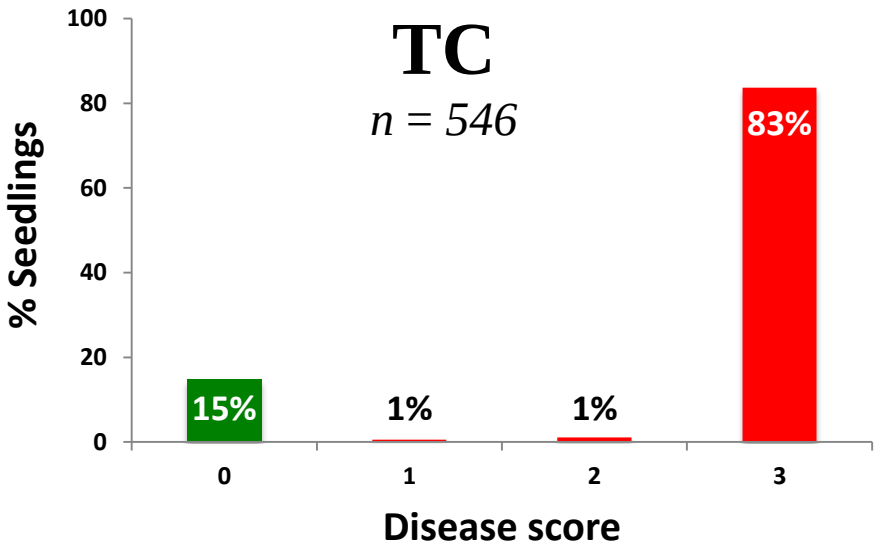


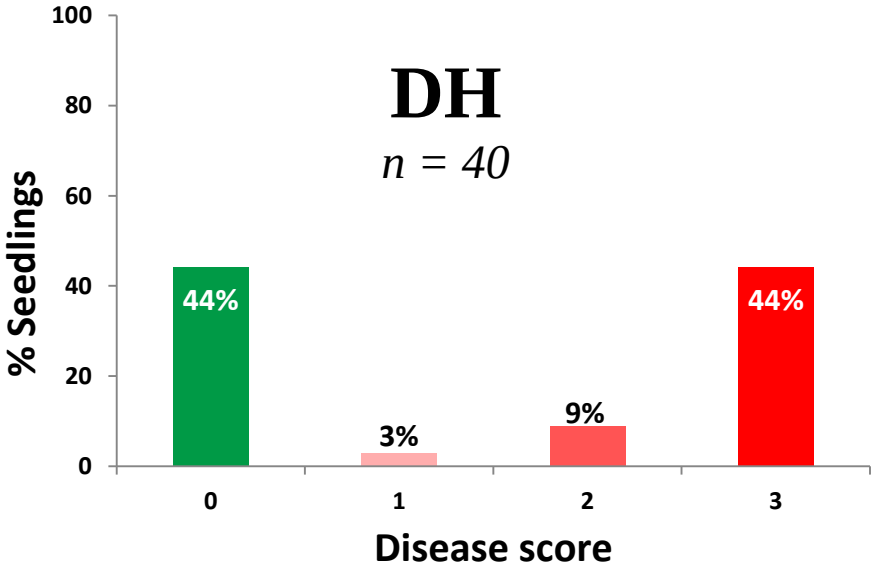


Rutabaga resistance: Genetics

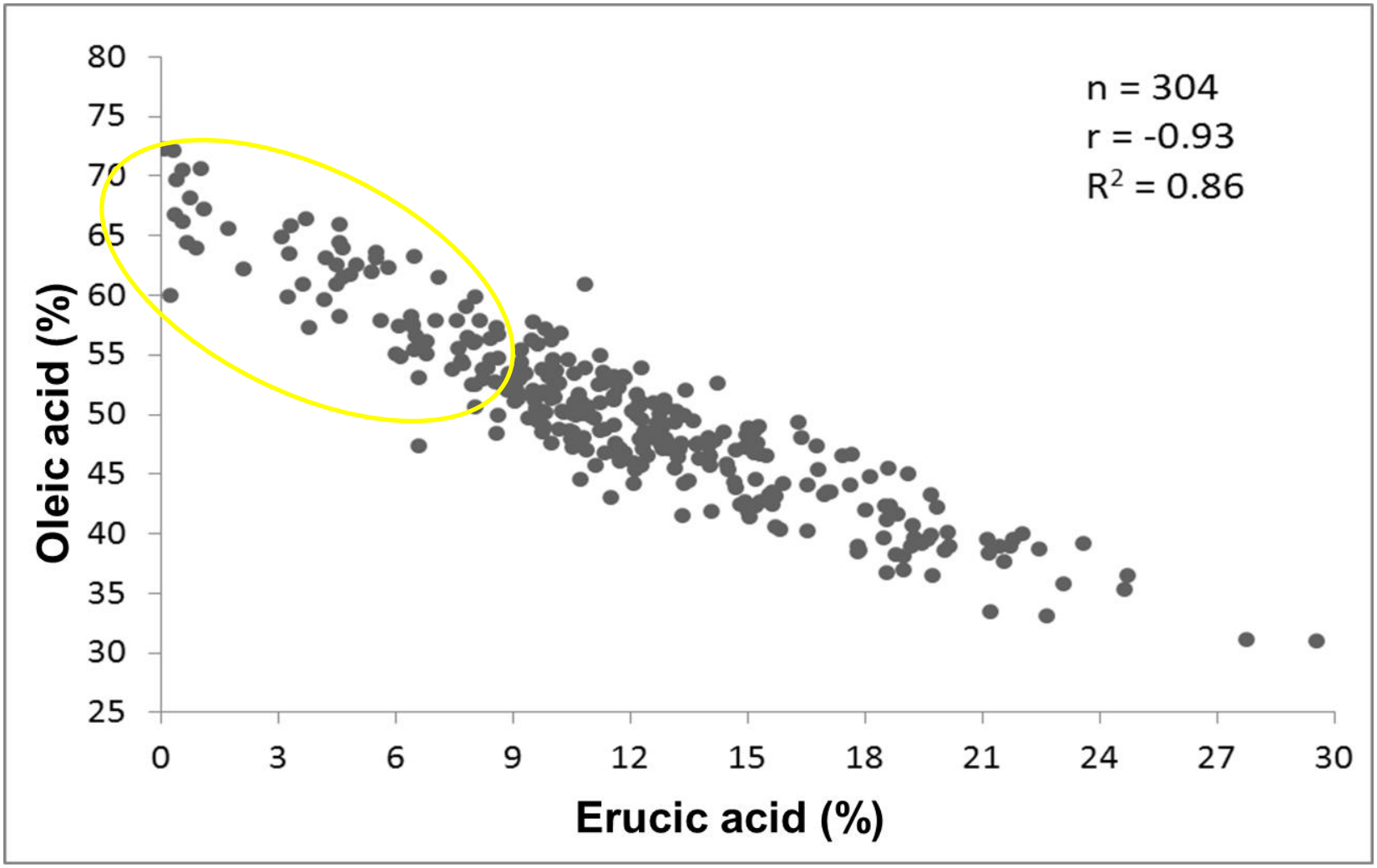
Resistance to pathotype 3: Rutabaga-PC × A05-17NI







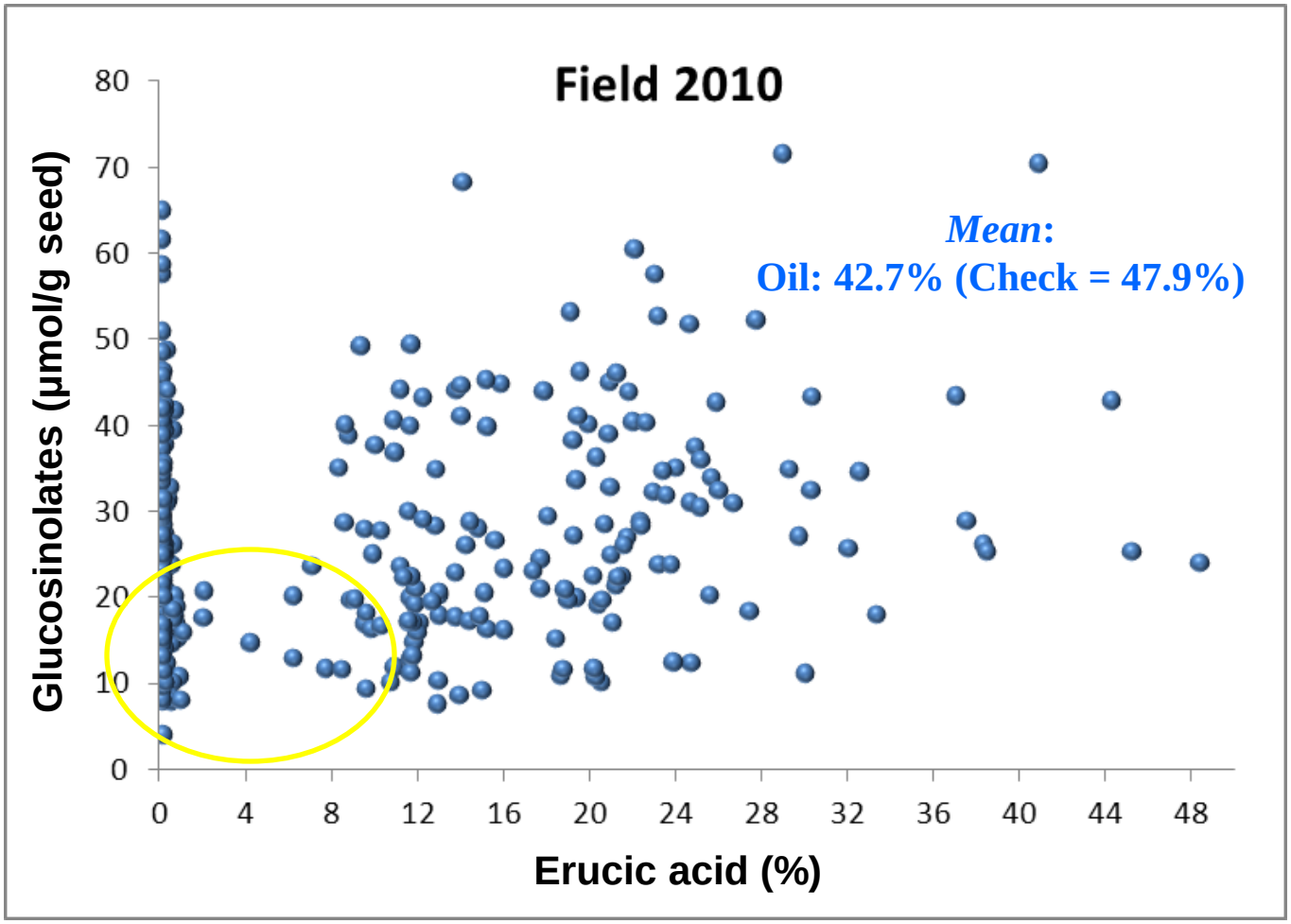
Erucic acid content in F_2 population of Rutabaga × Canola



Rutabaga resistance: Germplasm development

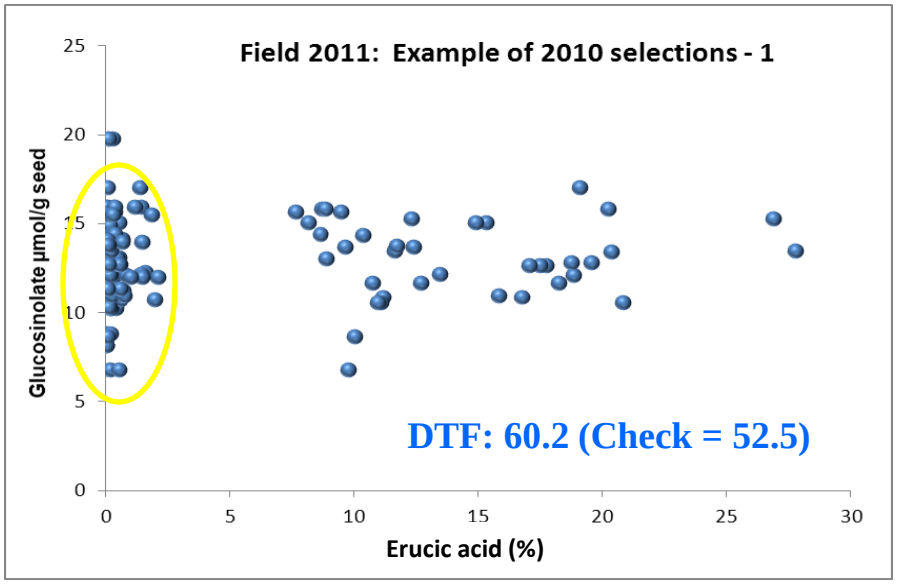
Rutabaga x Canola crosses: ***Conventional and HT populations***

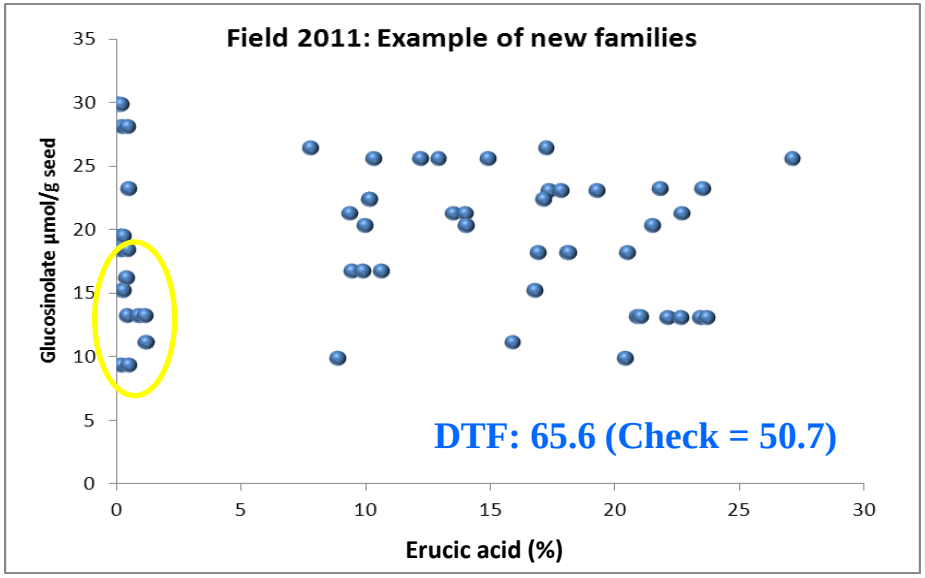
Example of F_3 families in field test (n = 209)

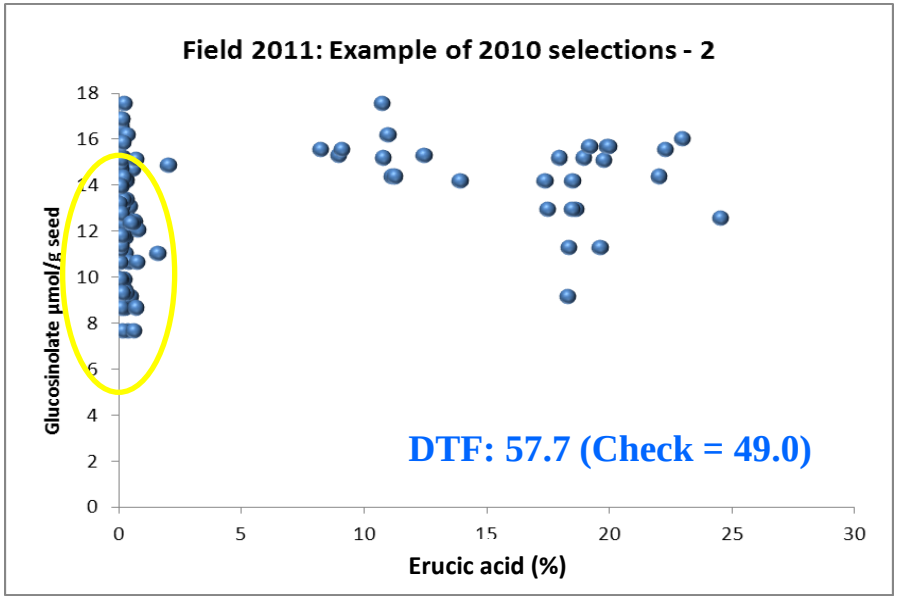


Rutabaga resistance: Germplasm development

Pedigree families (≈F_4) in Field test in 2011







Rutabaga resistance: Germplasm development

Example of advanced generation canola quality families developed from rutabaga × spring canola *B. napus* crosses through pedigree breeding

		DTF	DTM	Oil (%)	Protein (%)	GSL (µmol/g)	Sat FA (%)
F_6 (*n* = 249)	Range	48 - 58	96 - 111	42.8 - 53.0	20.7 - 29.0	10.1 - 60.9	6.0 - 7.5
	Mean	**50.6**	**103.1**	**47.6**	**24.3**	**19.9**	**6.6**
A07-26NR (*n* = 6)	Range	48 - 49	96 - 99	48.2 - 49.1	24.6 - 25.7	14.7 - 15.5	6.7 - 6.7
	Mean	**48.4**	**97.4**	**48.6**	**25.2**	**15.1**	**6.7**

DTF = Days to flower; DTM = Days to maturity; GSL = Glucosinolates; Sat FA = Saturated fatty acids

- **85% of the F_6 lines were zero-erucic**

Rutabaga resistance: Resistance to pathotype 3 in advanced generation spring B. napus canola families

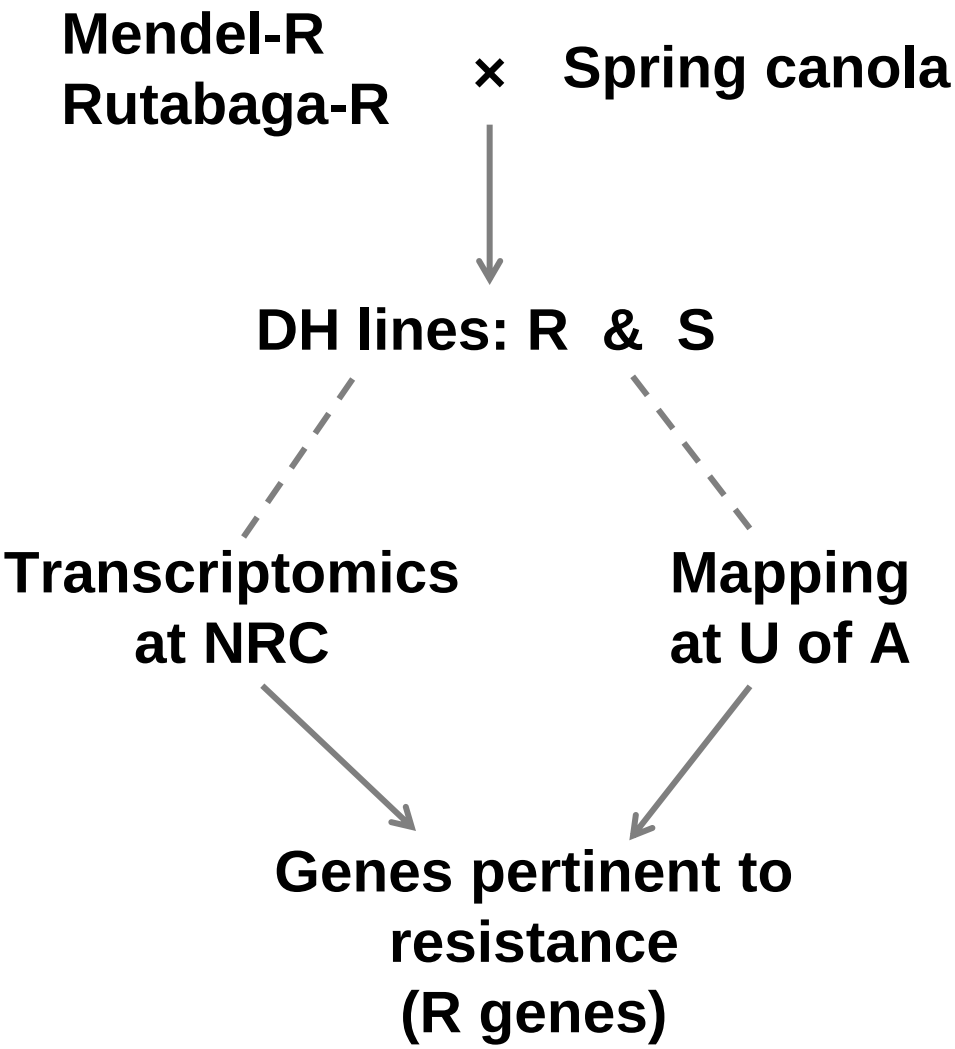
Type	Total fam.	Resistant	Susceptible	Segregating
Conv.	222	79	76	67
RR	226	61	115	50
Total	**448**	**140**	**191**	**117**

Approx. 8 seedlings per family tested

Rutabaga resistance – Summary

- **Genetic control of resistance can be simple or complex depending on genotype used.**
- **Clubroot resistant, spring type, canola quality lines developed from Rutabaga × Spring canola crosses.**
- **Second cycle breeding for the improvement of agronomic and seed quality traits in progress.**

Mendel & Rutabaga resistance: Collaborative research with NRC



Acknowledgements

ALBERTA Canola PRODUCERS COMMISSION

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CLUBROOT RISK MITIGATION

canolacouncil

Jakir Hasan, PhD student
Derek Flad, MSc student
Dr. Rudolph Freda-Agyeman, PDF
An Vo
Jose Salvador-Lopez
Zahidur Rahman
Abdus Shakir
Dr. Stephen Strelkov