Genetic Resources for Pest Management

Dwayne Hegedus
Agriculture & Agri-Food Canada
Saskatoon Research Centre

Field(s) of Dreams

Ple ns

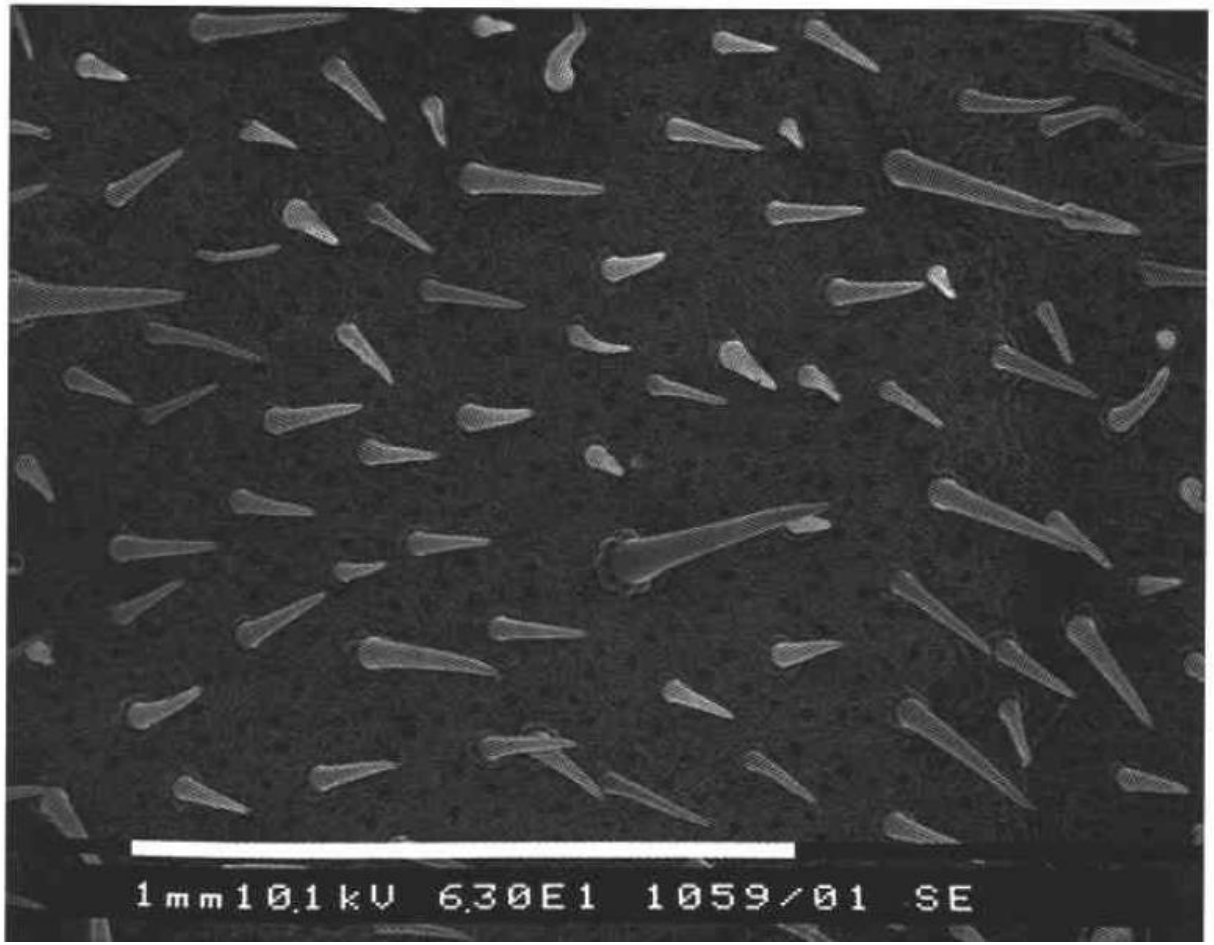
Flea Beetles

Crucifer Flea Beetle

Striped Flea Beetle

Flea Beetles vs Hairs/Trichomes

B. villosa



Palaniswamy P and Bodnaryk R. 1994. **A wild Brassica from Sicily provides trichome-based resistance against flea beetles, *Phyllotreta cruciferae* (Goeze) (Coleoptera: Chrysomelidae).** The Canadian Entomologist 126:1119-1130.

Hairy Canola

- Developed by Margaret Gruber & Julie Soroka (AAFC retired)

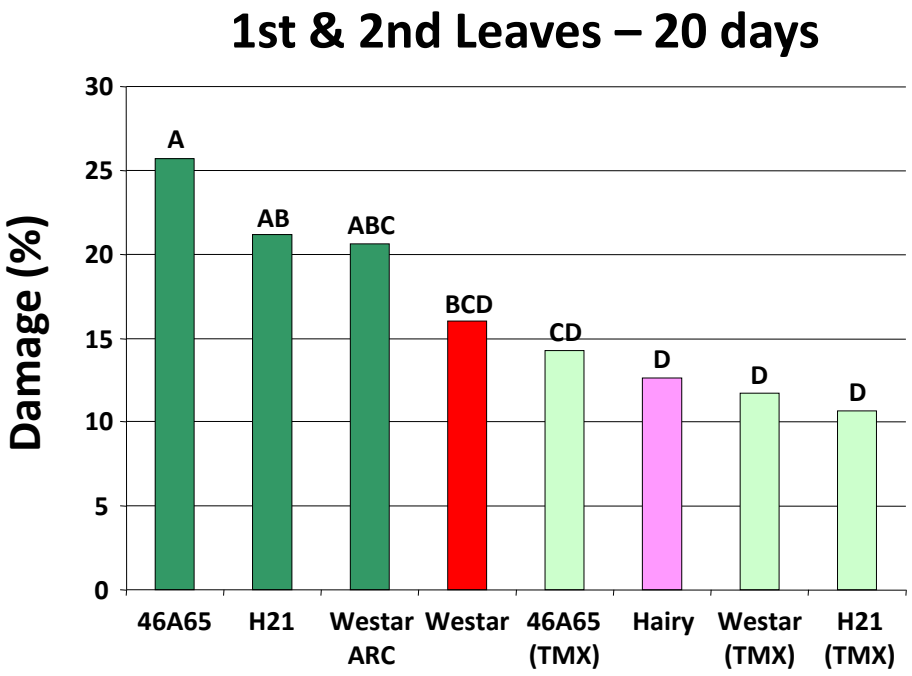
Contemporary Canola

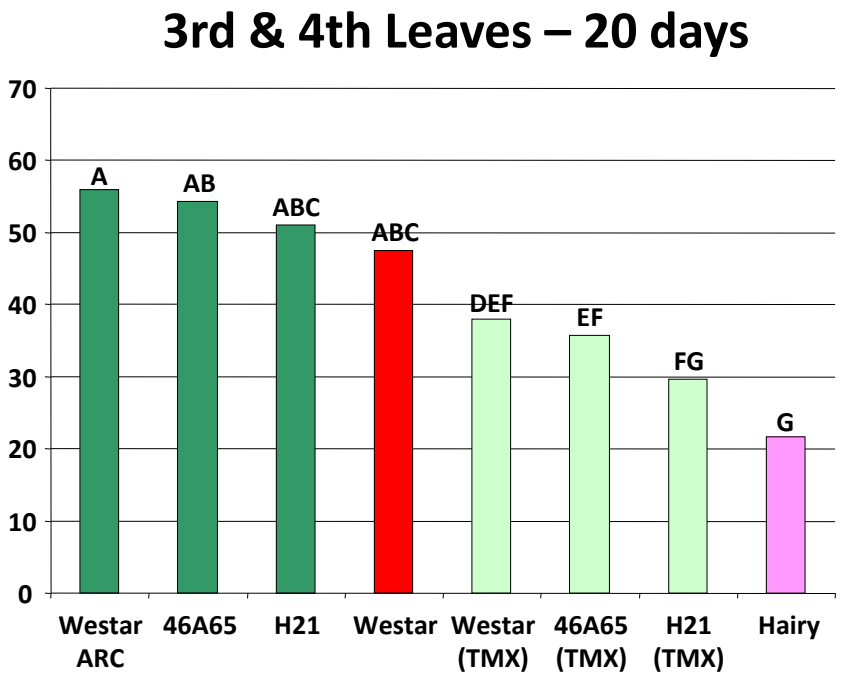
Hairy *Brassica napus*

Hairy Canola Disrupts Feeding

Flea Beetles Avoid Hairy Canola

Field Assays

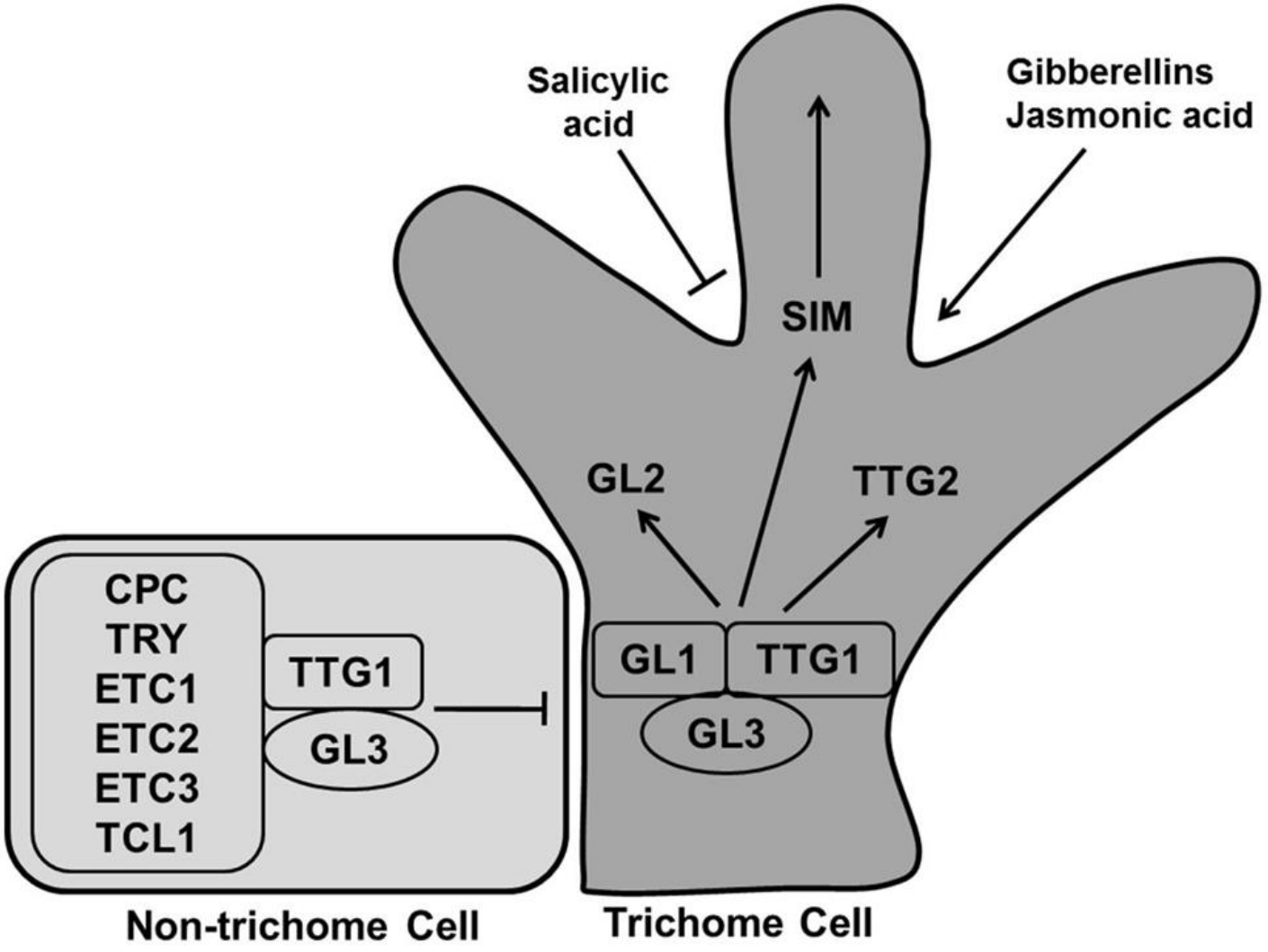




TMX = thiamethoxam (Helix)

Soroka J, Holowachuk JM, Gruber MY and Grenkow LF. 2011. **Feeding by Flea Beetles (Coleoptera: Chrysomelidae; *Phyllotreta* spp.) is Decreased on Canola (*Brassica napus*) Seedlings with Increased Trichome Density.** Journal of Economic Entomology, 104:125-136. DOI: 10.1603/EC10151. URL: http://www.bioone.org/doi/full/10.1603/EC10151.

How was this achieved?



Replaced GL3 Protein

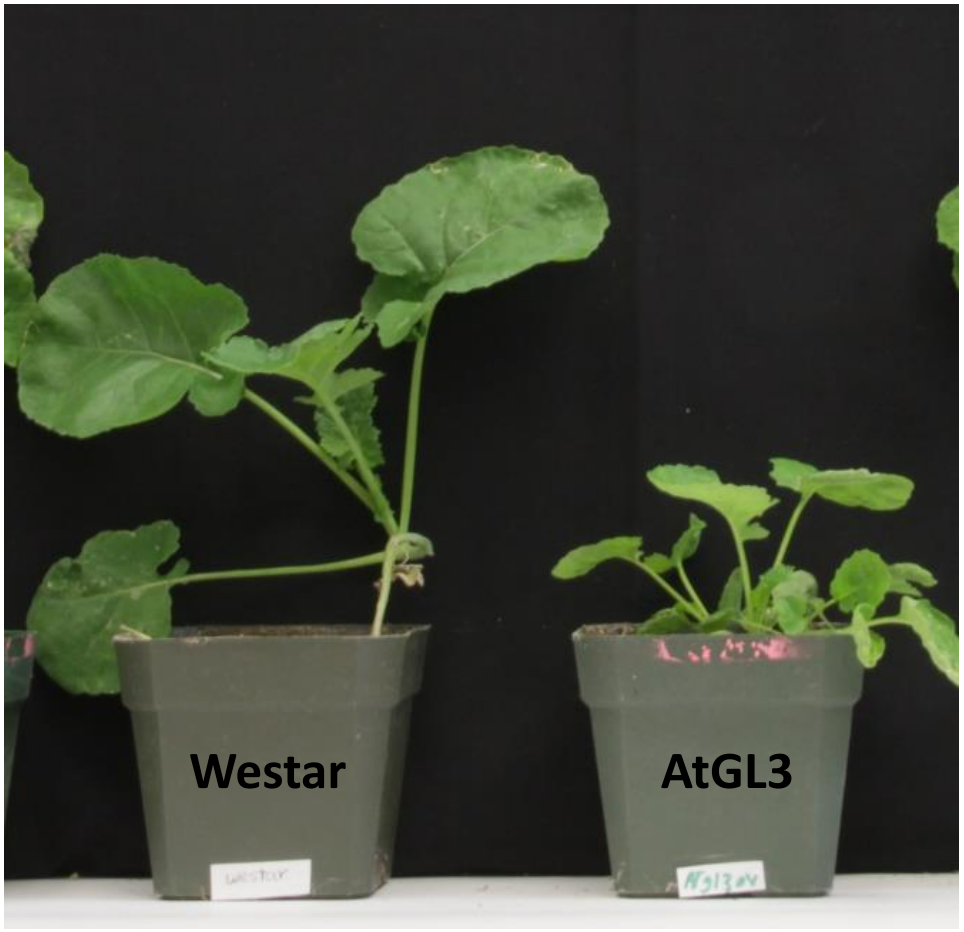
AtGL3

Arabidopsis thaliana

***B. napus* cv. Westar**

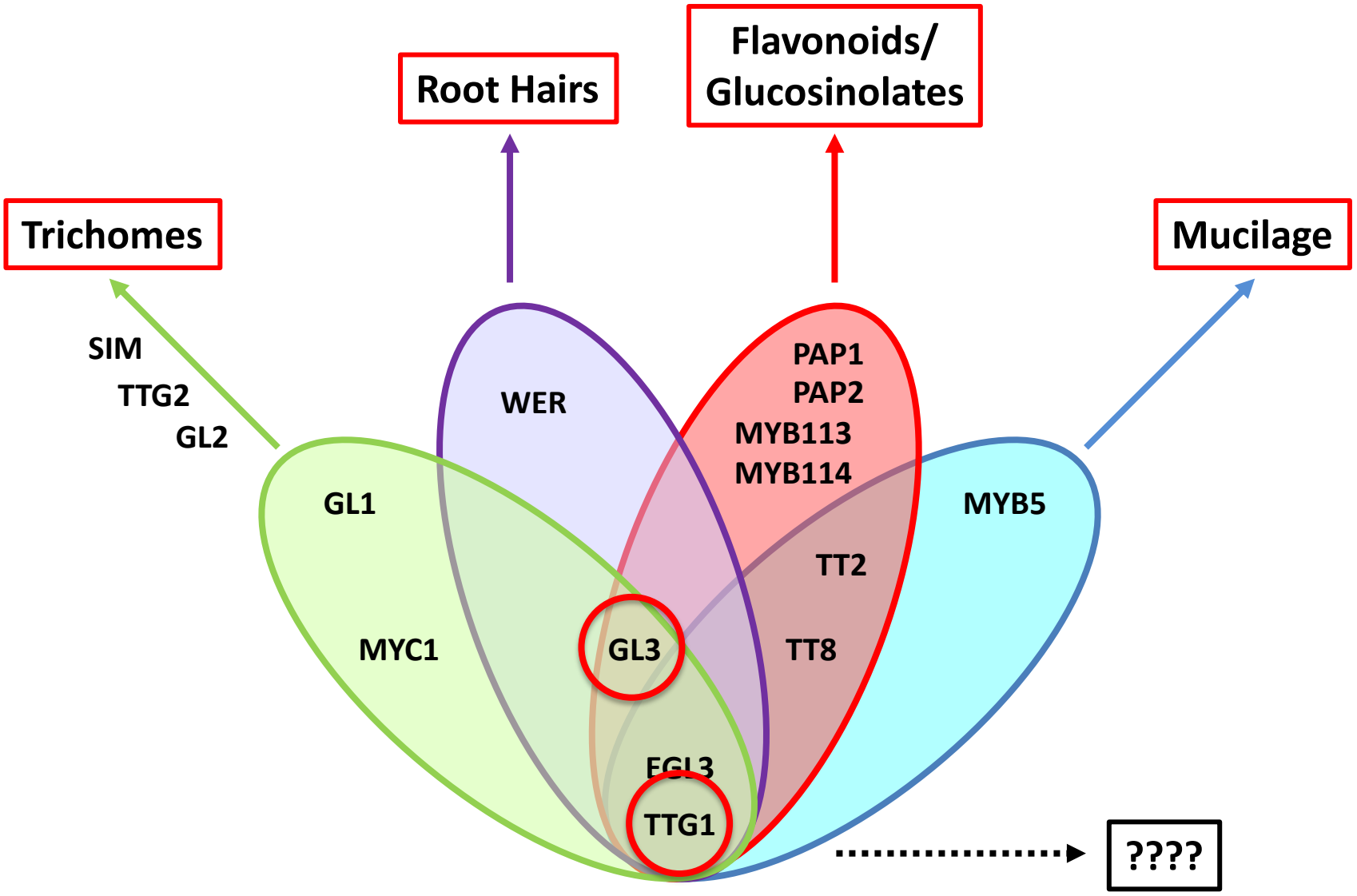
What Happened?

Hair Production



Severe Impact on Growth

Why?


Root Hairs
Flavonoids/
Glucosinolates
Trichomes
Mucilage
SIM
TTG2
GL2
WER
PAP1
PAP2
MYB113
MYB114
GL1
MYB5
TT2
MYC1
GL3
TT8
EGL3
TTG1
????

The Fix

- **Reduce TTG1 (RNAi interference)**

Westar **AtGL3**

AtGL3:ttg1
“Hairy Canola”

Why is this not in farmer's fields?

- **Required 2 transgenic events**
  - First event to induce hair production (*AtGL3*)
  - Second event to fix developmental issues (*TTG1*)
- **Patent on *A. thaliana GL3* (Texas A & M)**
- **Interest from major breeding companies**
  - Registration and regulatory costs for GMO
  - Internal conflict between business units*

What next?

- **Screened 1000 Brassica lines for hairiness**

  – *B. rapa* (A genome - Polish canola – 652 lines)
  – *B. nigra* (B genome – 21 lines)
  – *B. oleraceae* (C genome – vegetables – 26 lines)
  – *B. villosa* (C genome – 1 line)
  – *B. napus* (AC genome – canola – 296 lines)

  - Plant Gene Resources for Canada and others

Naturally Hairy Brassicas

“Hairy Canola”

B. napus

B. rapa

B. villosa

Brassica villosa

Nagahabushana NK, Tan Y, Taheri A, Li X, Bjorndahl TC, Nowak J, Wishart DS, Hegedus DD, and Gruber M. 2014. ***Brassica villosa*, a system for studying non-glandular trichomes and genes in the Brassicas.** Plant Mol. Biol. 85:519-539.

Accessing the “Hairy” Trait

1. **GL3 genes from hairy Brassica species**

2. **Map and introgress hairy trait into *B. napus***

Other Brassica *GL3* Genes

Moderately Hairy
B. rapa GL3

Hairy *B. rapa GL3*

B. villosa GL3

Other *GL3* Genes

Westar ***B. rapa GL3*** ***B. villosa GL3***

- **Working on a strategy to fine-tune expression of *GL3* to avoid off-phenotypes**

Hairy *B. napus* Accessions

Naturally Hairy B. napus

Westar

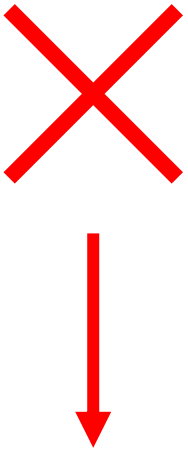
AtGL3

AtGL3:ttg1

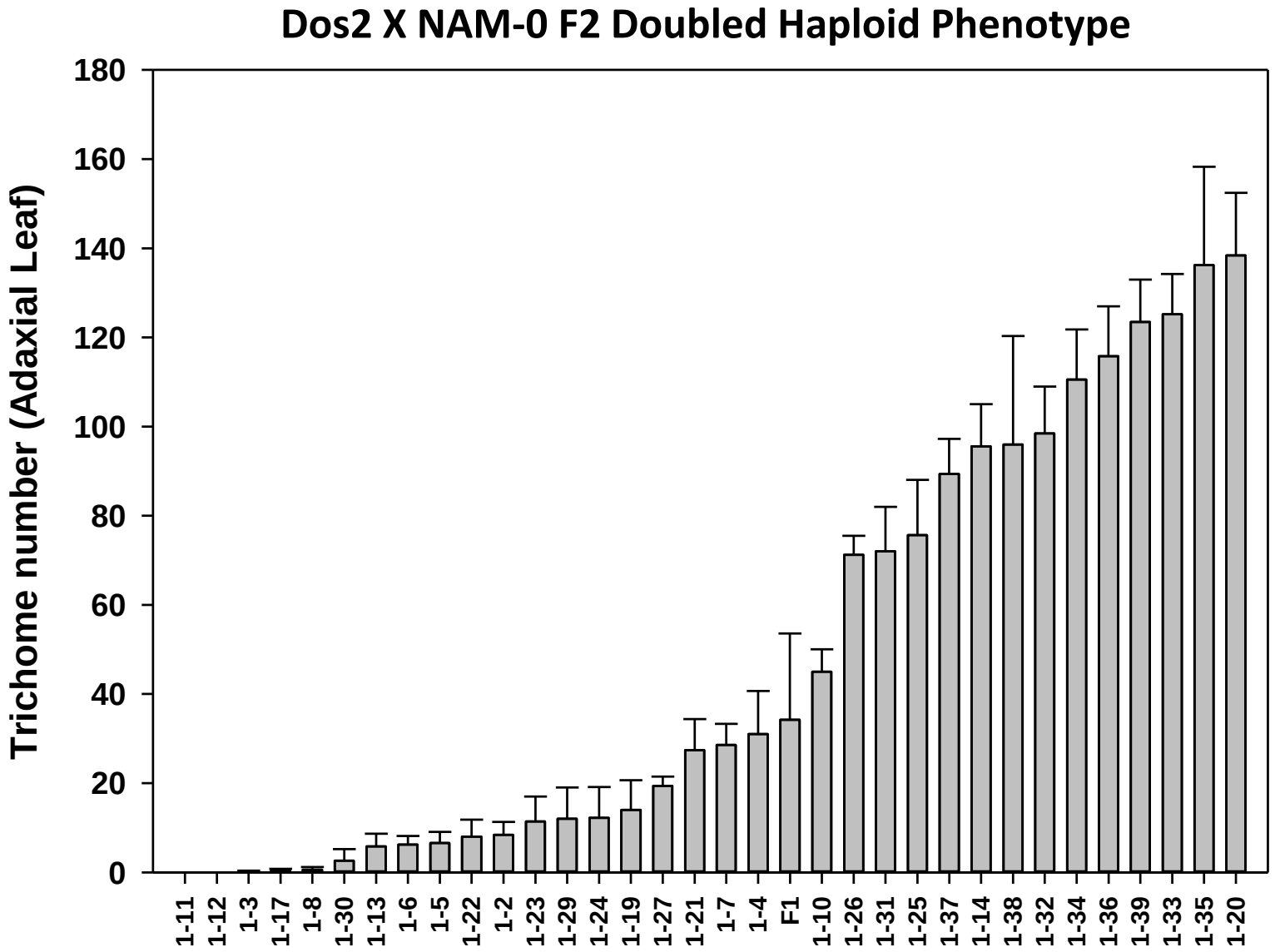
B. napus Crosses

Hairy *B. napus (*DH-Dos2)

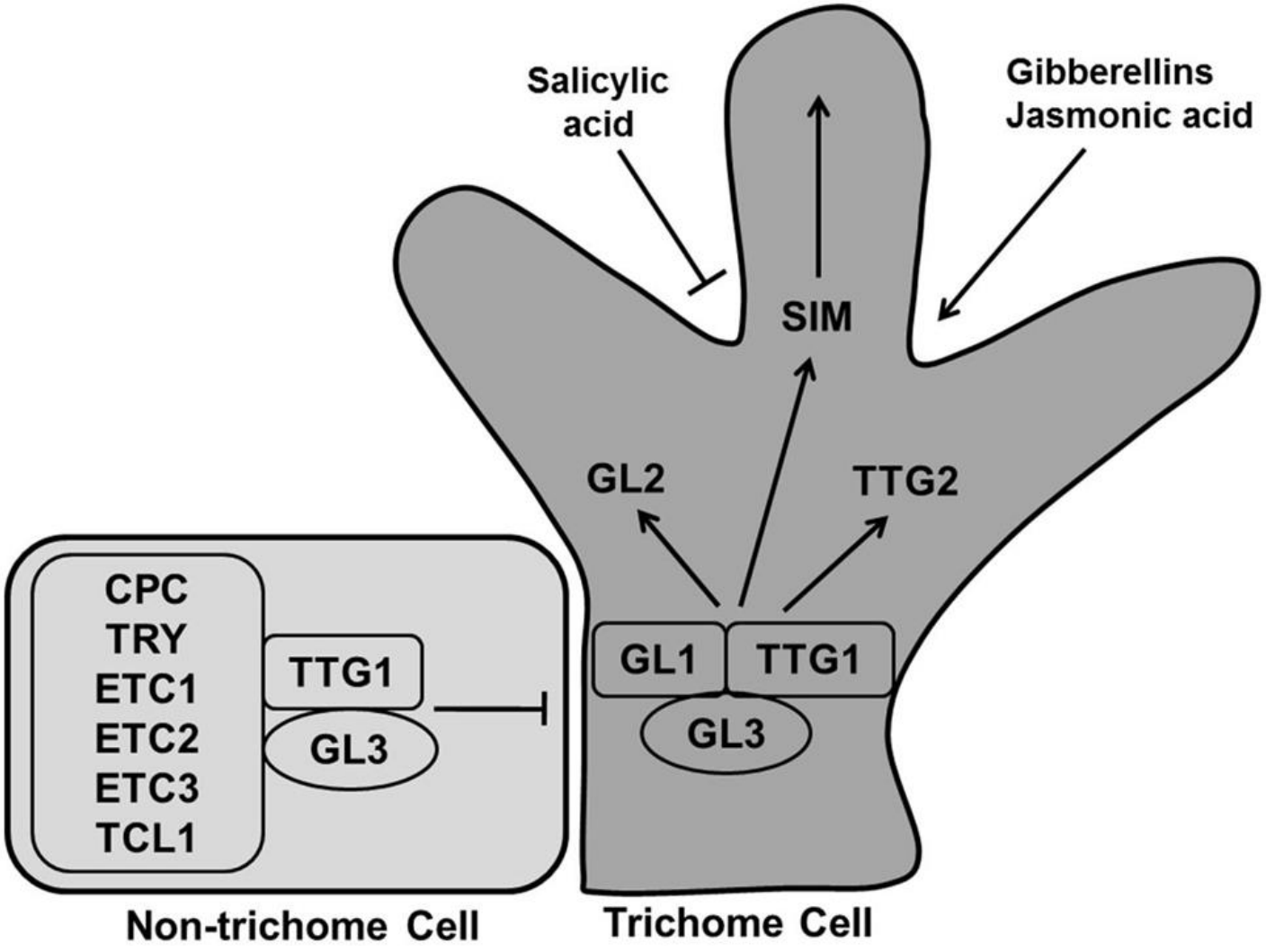
Glabrous *B. napus* (NAM-0)



B. napus Trichome Genetics



Trichome Regulation



B. villosa Interspecific Crosses

Hairy *B. rapa*
Hairy *B. napus*

B. villosa

- **Crosses between *B. rapa* (AA) and *B. villosa* (CC) to re-synthesize *B. napus* AACC**
- **Crosses between *B. napus* (AACC) and *B. villosa* (CC) to generate a triploid bridge line**

B. villosa Interspecific Crosses

Glabrous *B. oleraceae* (CC)

×

B. villosa (CC)

- **Move hairy trait into a CC genome background more amenable to crossing**
- **Develop RIL population to map genes responsible for hairiness**

B. villosa Trichome Genetics

B. villosa x *B. oleraceae* RIL F2 Phenotypes

B. villosa Trichome Genetics

B. villosa x *B. oleraceae* RIL F2 Phenotypes

Summary

- **Hairs/trichomes deter flea beetles**

- **Contemporary canola has a defective *GL3* gene**
  - **Repair with *A. thaliana*, *B. rapa* and *B. villosa* genes**
  - **Growth penalty unless *GL3* expression is fine-tuned**

- **Work to map and move hairy trait from *B. napus* and *B. villosa* into a canola-quality background**

Agriculture and Agri-Food Canada

Agriculture et Agroalimentaire Canada

Government of Saskatchewan

SaskCanola
Saskatchewan Canola Development Commission

canolacouncil of canada