Resistance against insects in potato

Lotte Caarls

Plant Breeding, Wageningen Plant Research

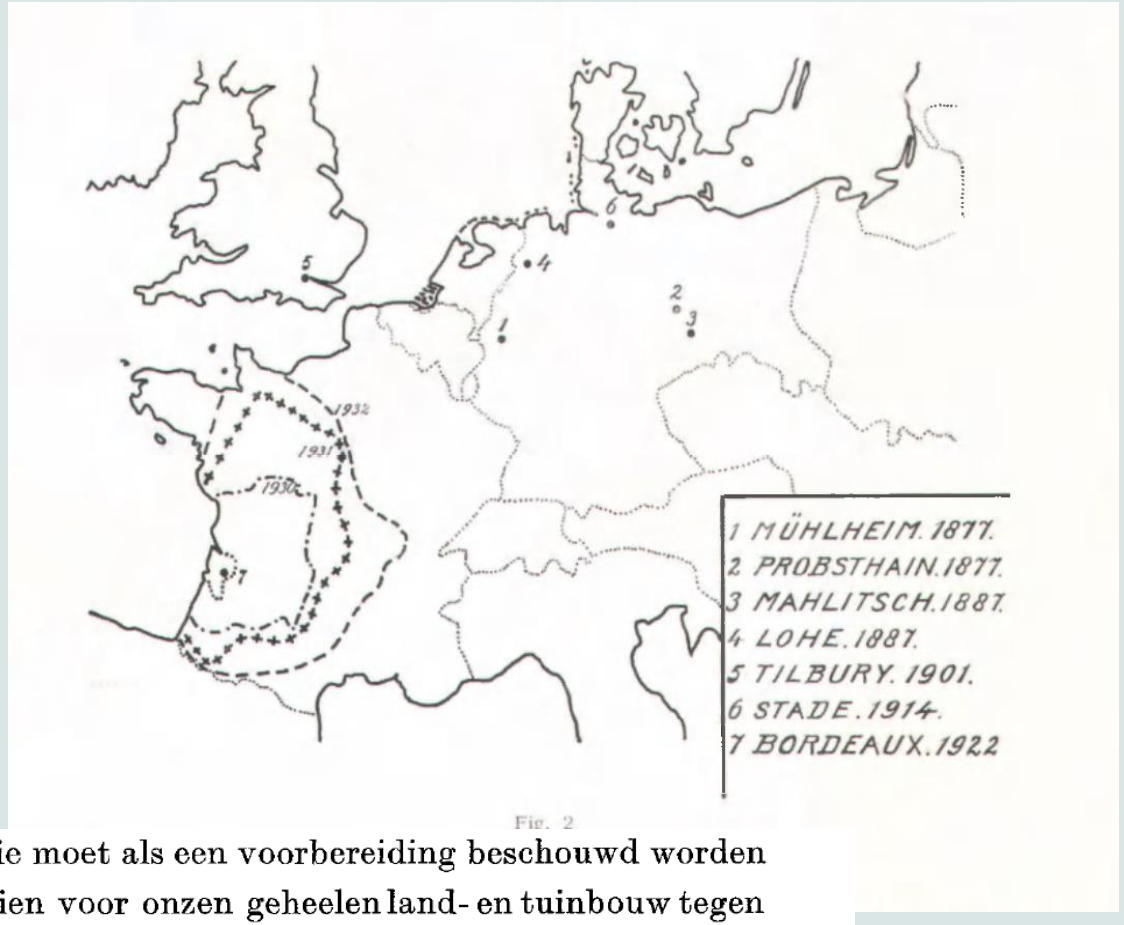

Fig. 2

Deze publicatie moet als een voorbereiding beschouwd worden tot den strijd, dien voor onzen geheelen land- en tuinbouw tegen het in meer dan één opzicht zoo gevaarlijke insect gevoerd zal worden. Met de organisatie van dezen strijd zal weldra een aanvang gemaakt moeten worden.

De Inspecteur, Hoofd van den Plantenziektenkundigen Dienst,

Wageningen, December 1932. N. VAN POETEREN.

Insect problems in potato

- Colorado potato beetle feeding causes yield reduction
- Aphids and whiteflies are vectors of viruses

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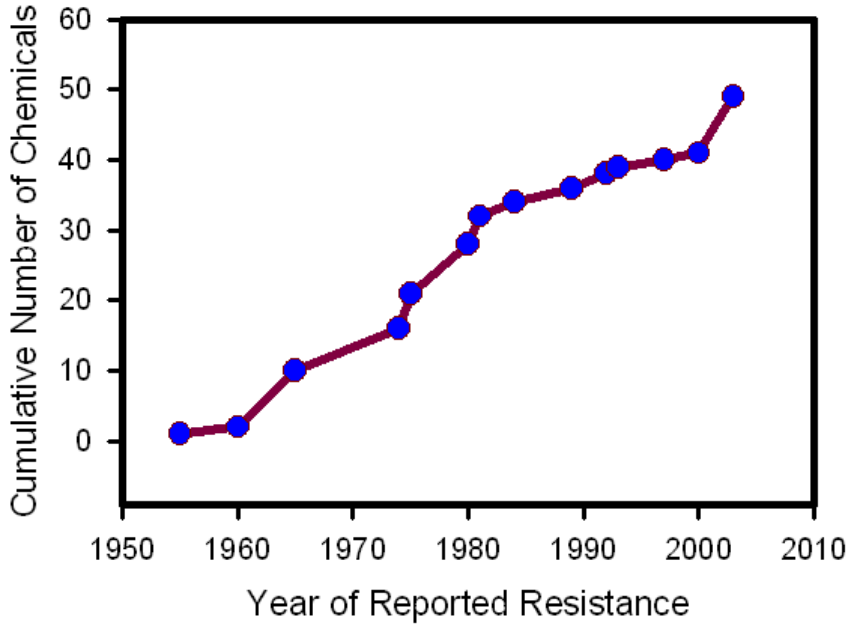
- Control with pesticides
- Alternative: host plant resistance



Resistance of CPB to chemicals (source: APRD)

Wild relatives of potato are a good source of resistance

- Some wild species have been reported to be insect resistant
- Two main resistance mechanisms known:
  - Glycoalkaloids
  - Glandular trichomes

Resistance mechanism: Glycoalkaloids

- All Solanum species contain glycoalkaloids
- Many have insecticidal and antimicrobial activity

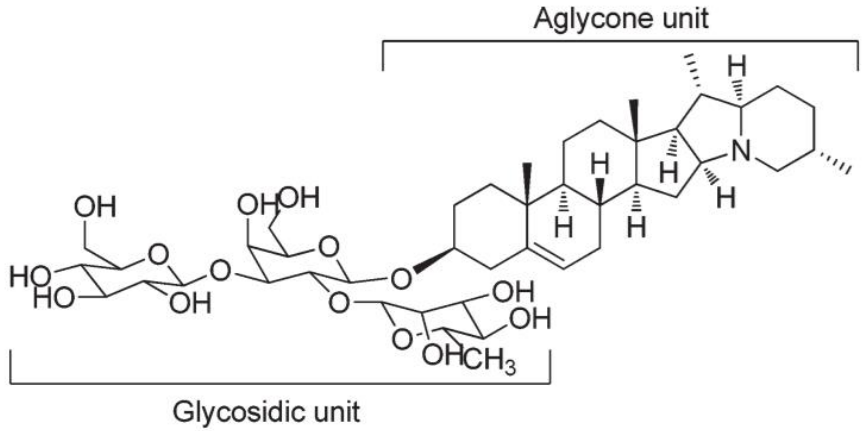


Figure 1. Structure of α-solanine **1**.

Resistance mechanism: Glycoalkaloids

- All Solanum species contain glycoalkaloids
- Many have insecticidal and antimicrobial activity
- High total levels do not confer resistance
- Resistance associated with dehydrocommersonine from S. *oplocense* and leptines from *S. chacoense*

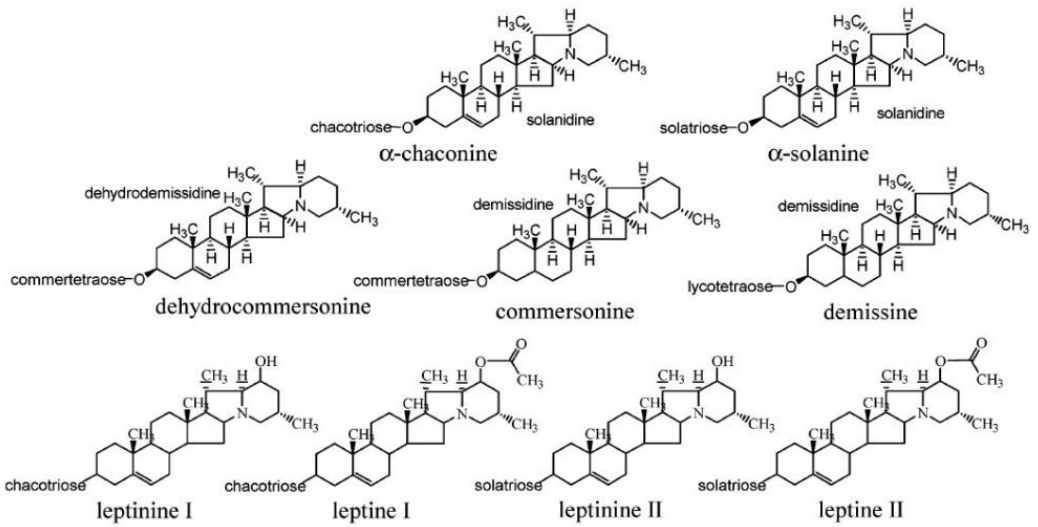
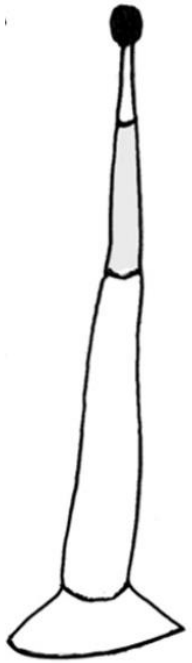


Figure 1. Glycoalkaloids in cultivated and wild potatoes (Friedman, 2006). The two common forms of GAs, solanine and chaconine, are abundant in cultivated potatoes, while the other forms of GAs are concentrated in wild potatoes.

Resistance mechanism: glandular trichomes



Type I and IV

Acyl sugars: trapping insects

Repelling pheromones

Ruptures upon contact

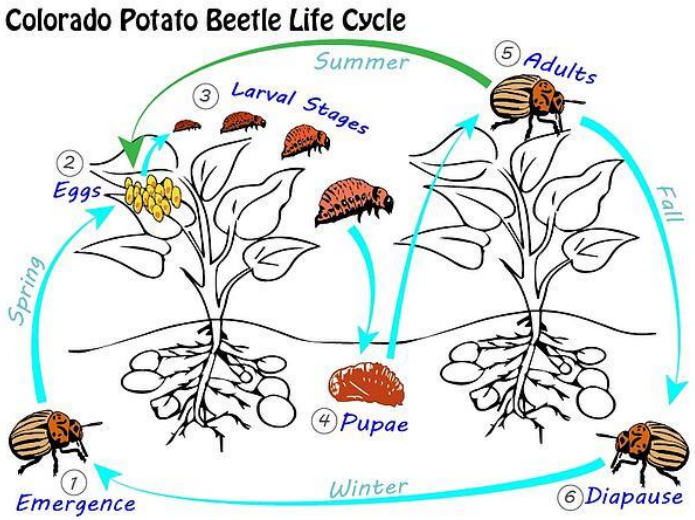
Exudate is polymerized (PPO)

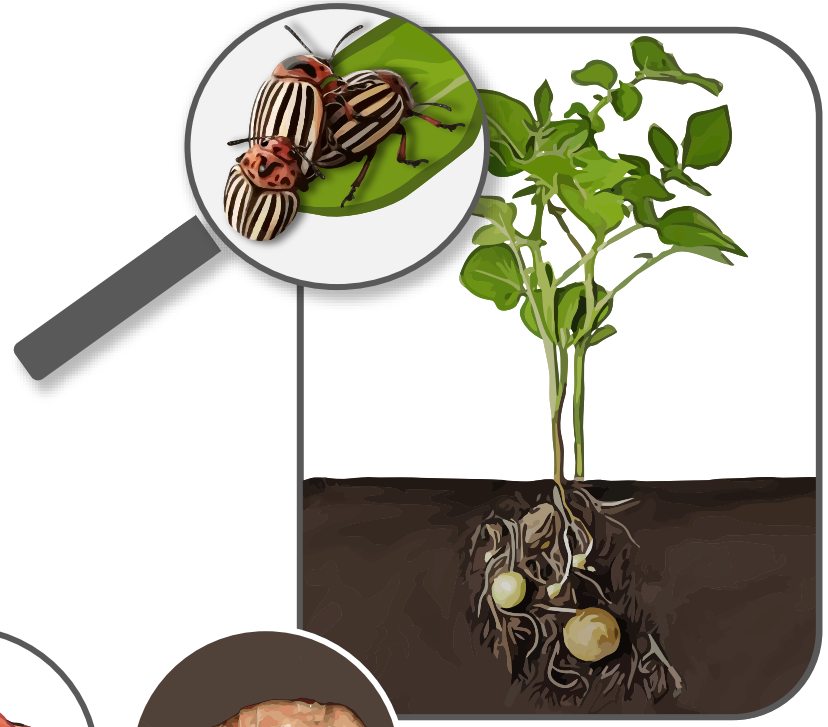
TypeVI

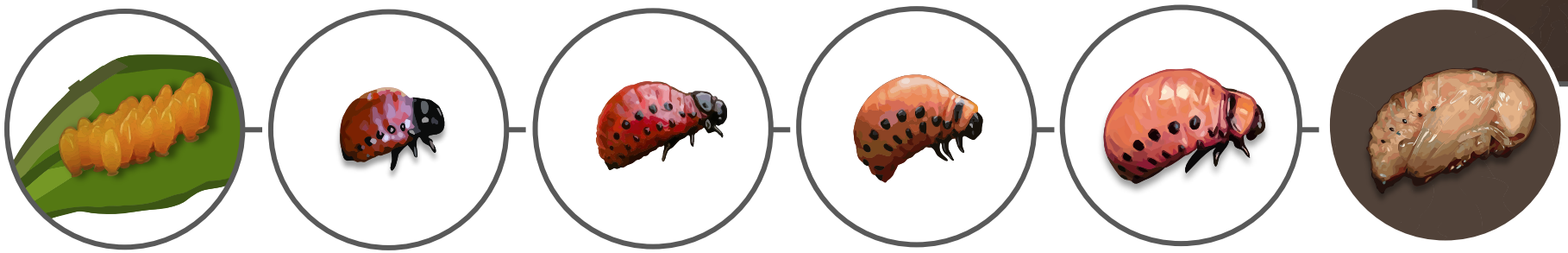
Known from:

S. berthaultii, S. tarijense, S. neocardenasii

Finding resistance against CPB



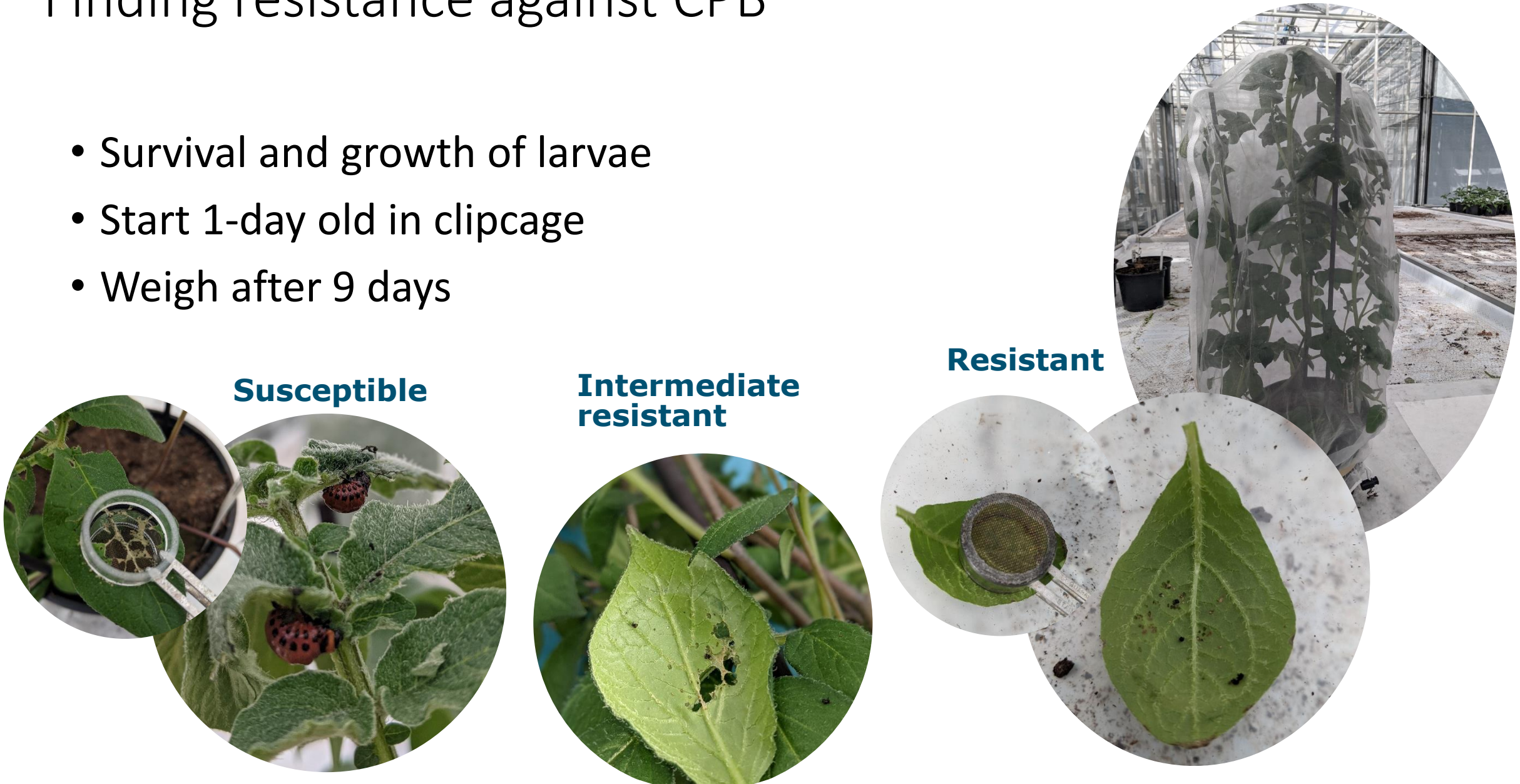




Egg cluster **Larvae** **Pupa**

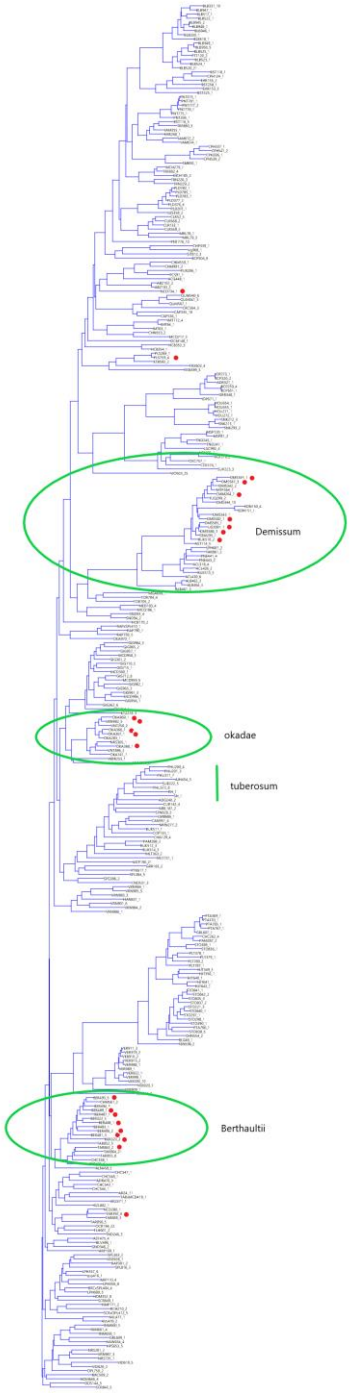
Finding resistance against CPB

- Survival and growth of larvae
- Start 1-day old in clipcage
- Weigh after 9 days



Plant Breeding collection was screened for resistance

- In vitro collection of 348 clones of Plant Breeding was screened for 3 insects
- Large number of clones resistant to CPB:
  - 96 no survival of larvae (R)
  - 85 survival but average weight <50 mg (IR)



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  - 96 no survival of larvae (R)
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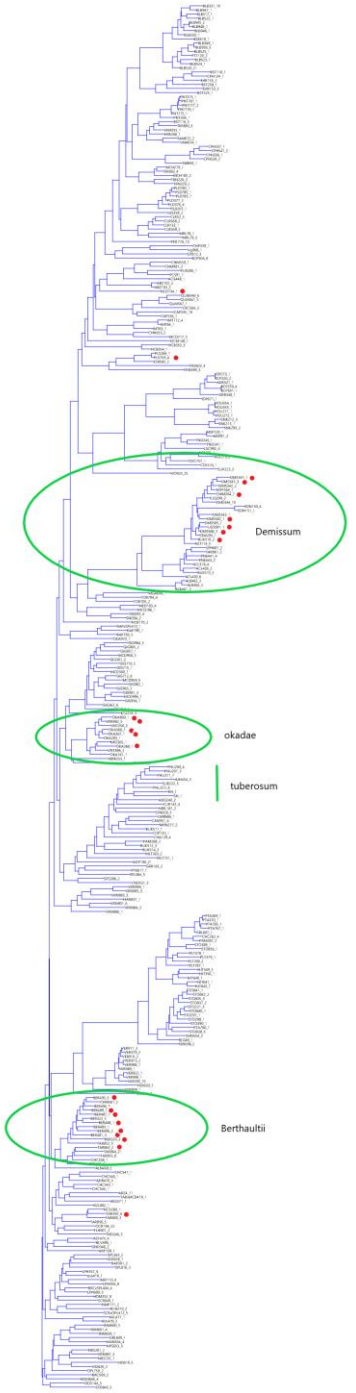
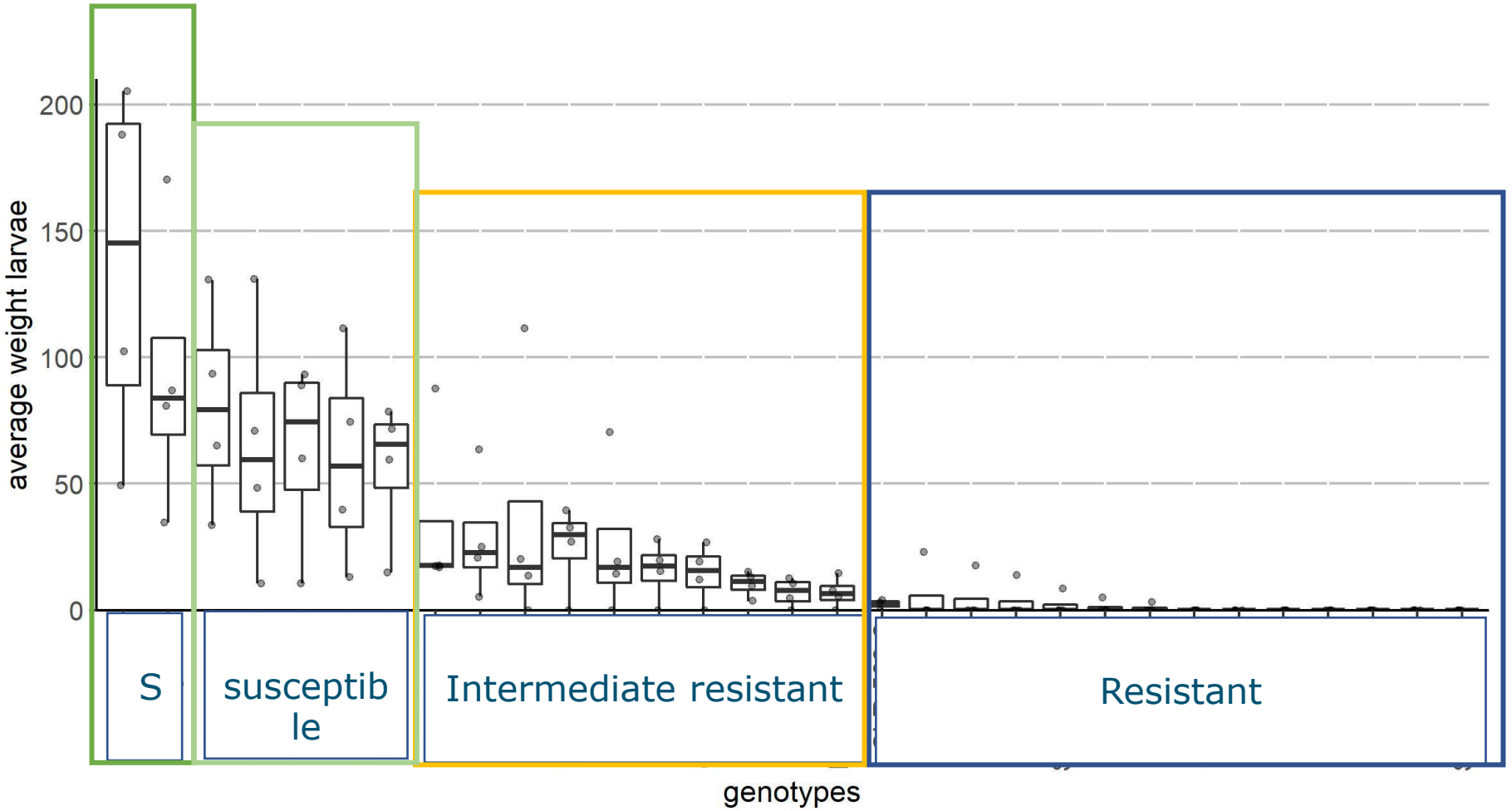
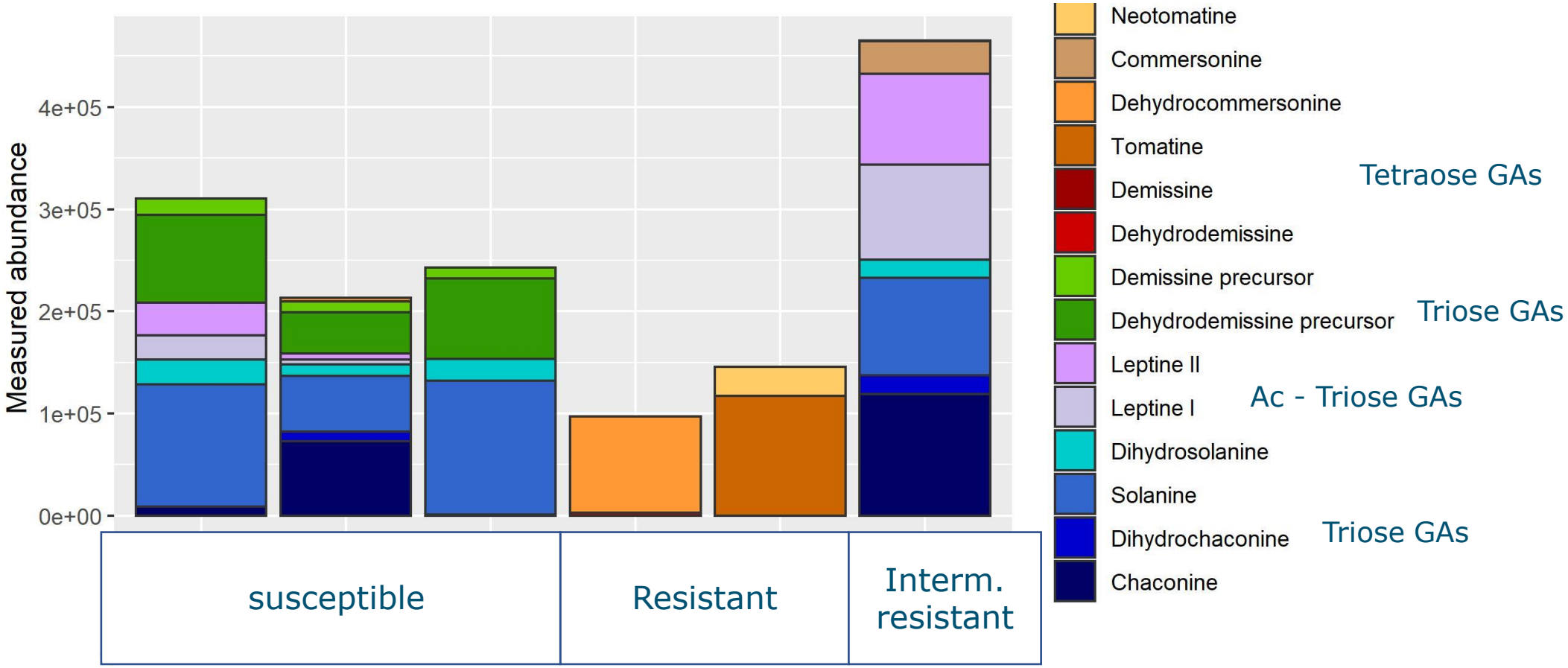
- For GPA: 56 clones 3 or more dead
- For whitefly: 76 clones 3 or more dead
- Whole plant assay: low survival on 15 clones for aphids and 5 for whitefy



Validation resistance: weight larvae on different accessions



Resistance linked to tetraose glycoalkaloids



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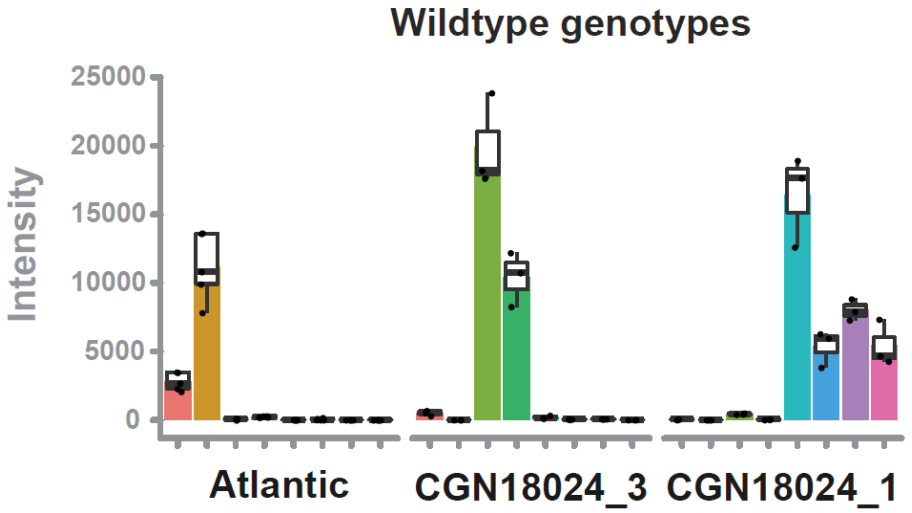
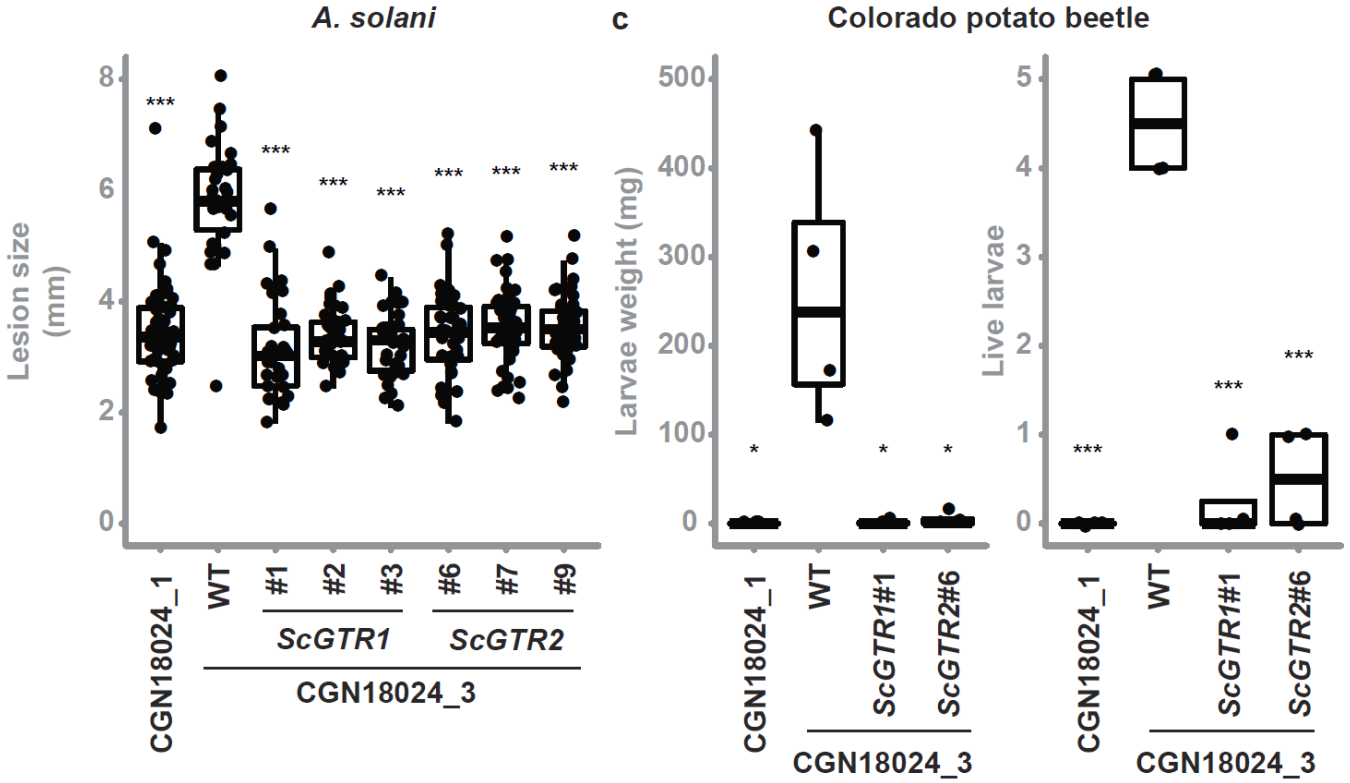
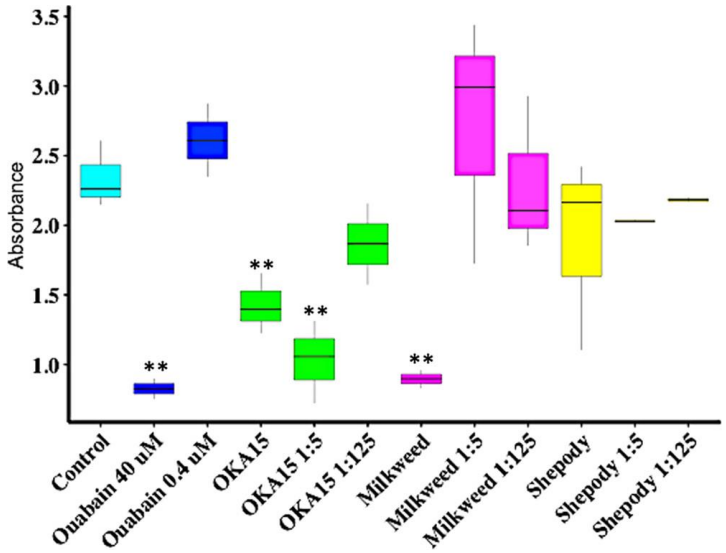




Wolters *et al. BioRxiv 2023*

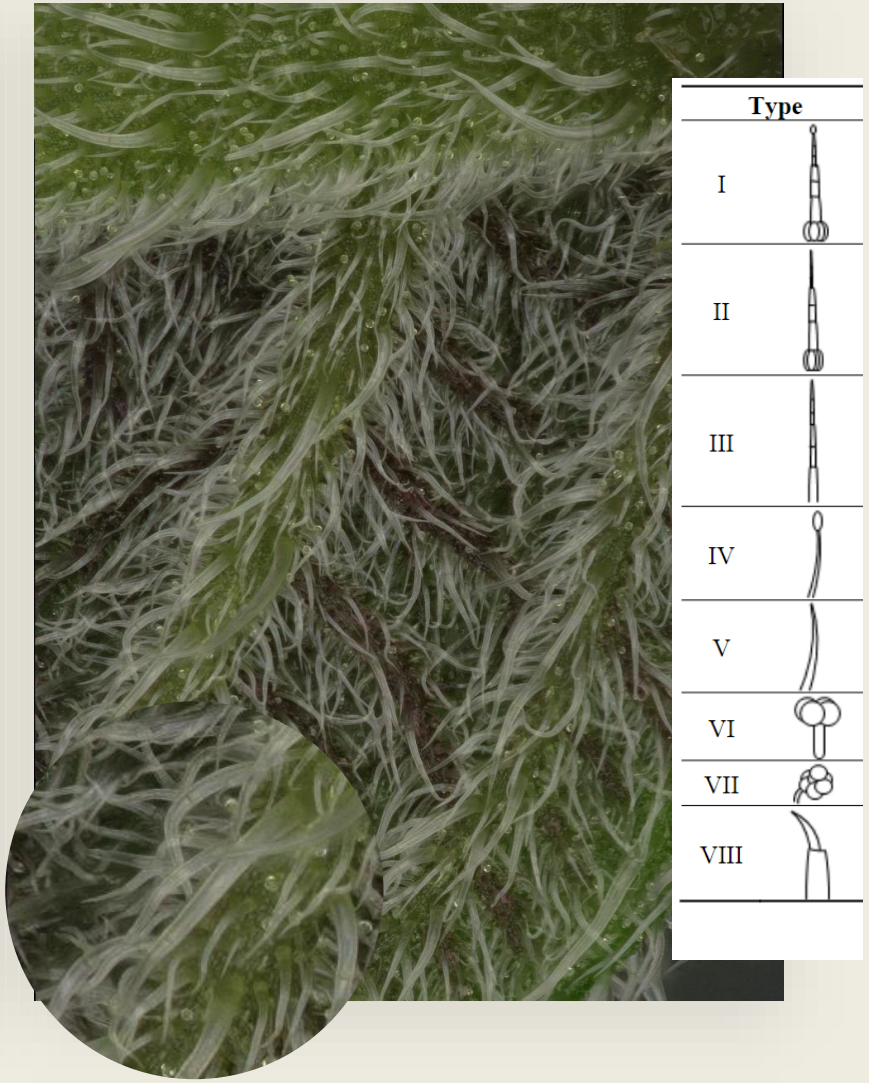
Many questions remain

- Are there other sources of resistance?
- Are there unknown resistant mechanisms or resistance genes to insects in wild potato?



McCoy 2022

Variation of type and density of trichomes in wild potato



Many questions remain

- Are there other sources of resistance?
- Are there unknown resistant mechanisms or resistance genes to insects in wild potato?
- What is exact mechanism of resistance?
- How is broad-spectrum resistance achieved?
- How to apply glycoalkaloids as resistance factor?

Proposal to study insect resistance in potato

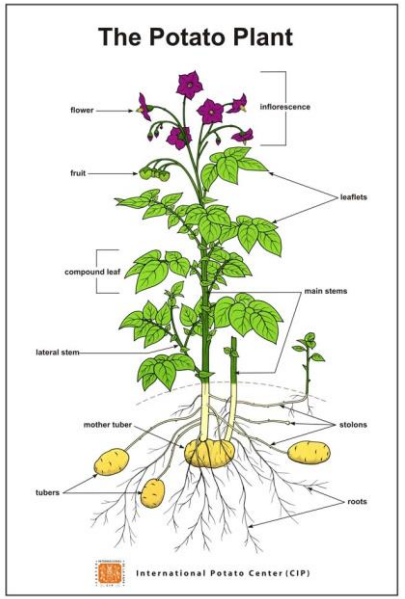
Identify resistances against insects and harness plants:

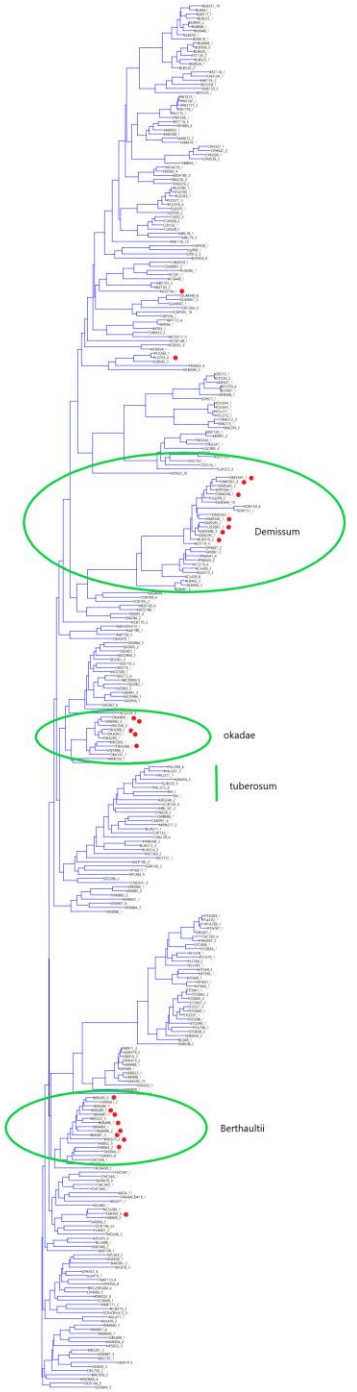
Objectives and work-packages:

1) Identify and characterize resistant sources
2) Development of populations
3) Development of molecular markers
4) Generate knowledge on resistance mechanisms

WP1: Selection and characterization of resistant accessions

- Measure glycoalkaloids in leaves and tubers
- Record trichome type and density
- Resistance assessed in bioassays





Deliverable: broad knowledge on potential resistance against insects.

-> select accessions for further population development and study

WP2: Population development and use of existing populations

- Crosses will be made with susceptible relatives and *S. tuberosum* material
- Phenotype populations to study segregation of the resistance

Deliverable: information on genetic of resistance

-> generated populations for further study

WP3: Further development and use of molecular markers

- Use populations with clear segregation to make genetic maps and develop markers

- Deliverable: identified markers to introduce and follow resistances in breeding programs

WP4: Study of resistance mechanism

- Study resistant sources and segregating population for mechanism of resistance
  - Use (in vitro) phenotyping methods

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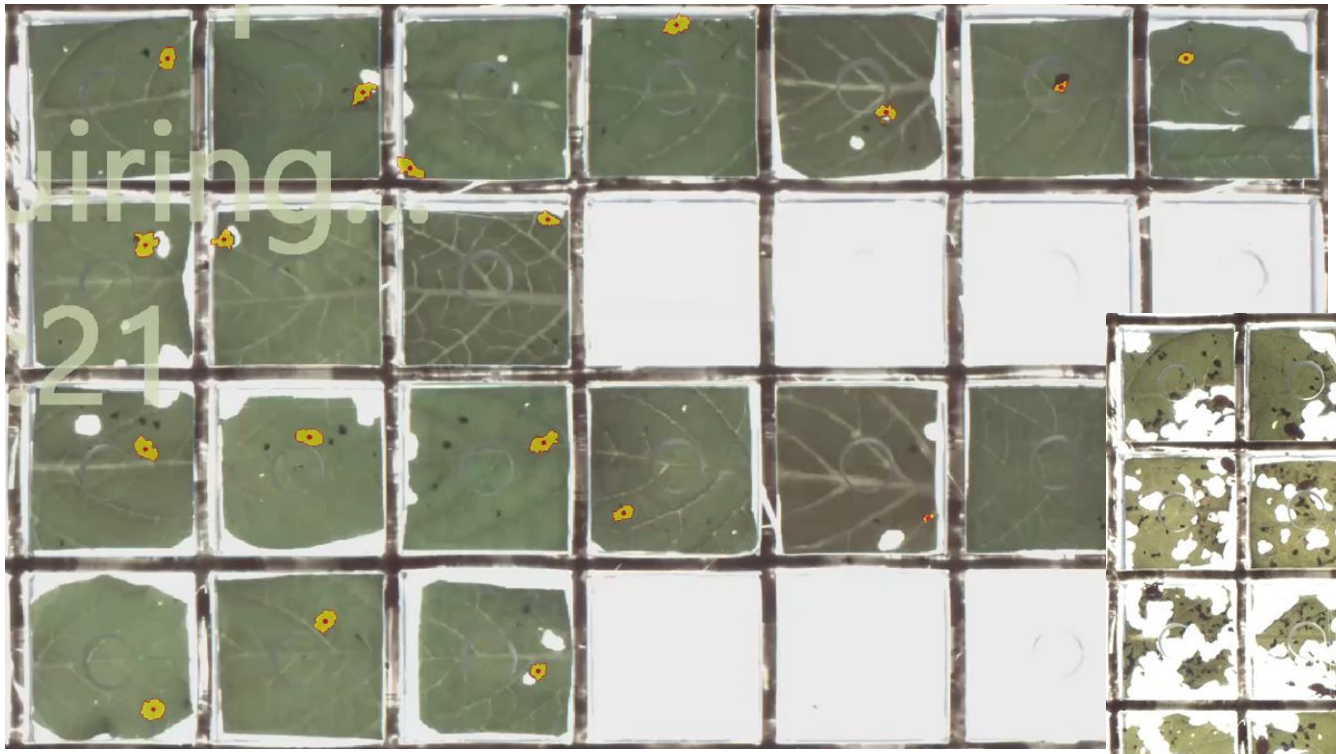
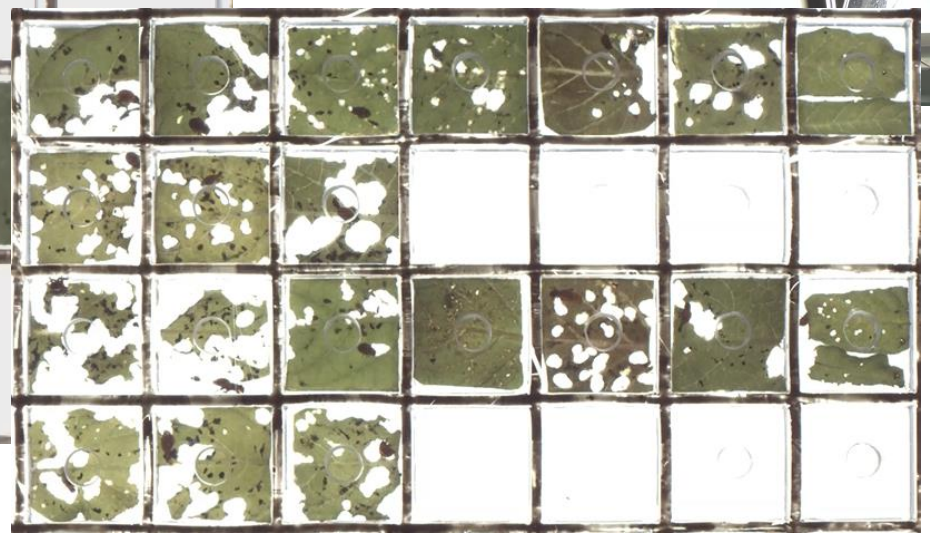
  - Video tracking for CPB behavior

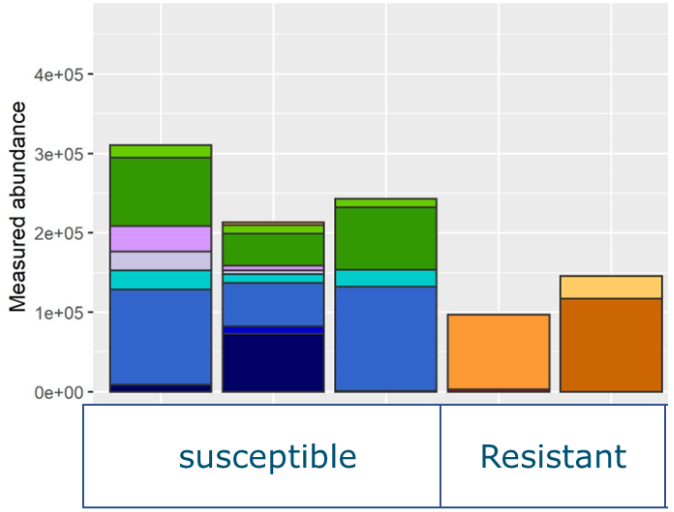
Video tracking to understand CPB behavior





WP4: Study of resistance mechanism

- Study resistant sources and segregating population for mechanism of resistance
  - Use (in vitro) phenotyping methods
  - Video tracking for CPB behavior
  - Effect specific glycoalkaloid and minimum amount required
  - Tissue specificity of resistance (tubers, leaves)
  - Study effect resistance on different populations or species
- Deliverable: knowledge on potential application of the resistances and durability of the resistance



Budget and finances

In k euro	Year 1	Year 2	Year 3	Year 4	
Personnel	140	146	157	164	609
Facilities	17	27	27	27	98
Material	30	12	10	32	84
Total					791

Identify resistances against insects and harness plants:

- Identified and characterized glycoalkaloid-based, trichome-based or novel mechanism resistances against insects
- Generated plant material with new resistances that can be further used
- Developed molecular markers that can be used to introgress resistance
- Understand the application of different resistance mechanisms