Managing Fire Blight by Choosing Decreased Host Susceptibility Levels and Rootstock Traits

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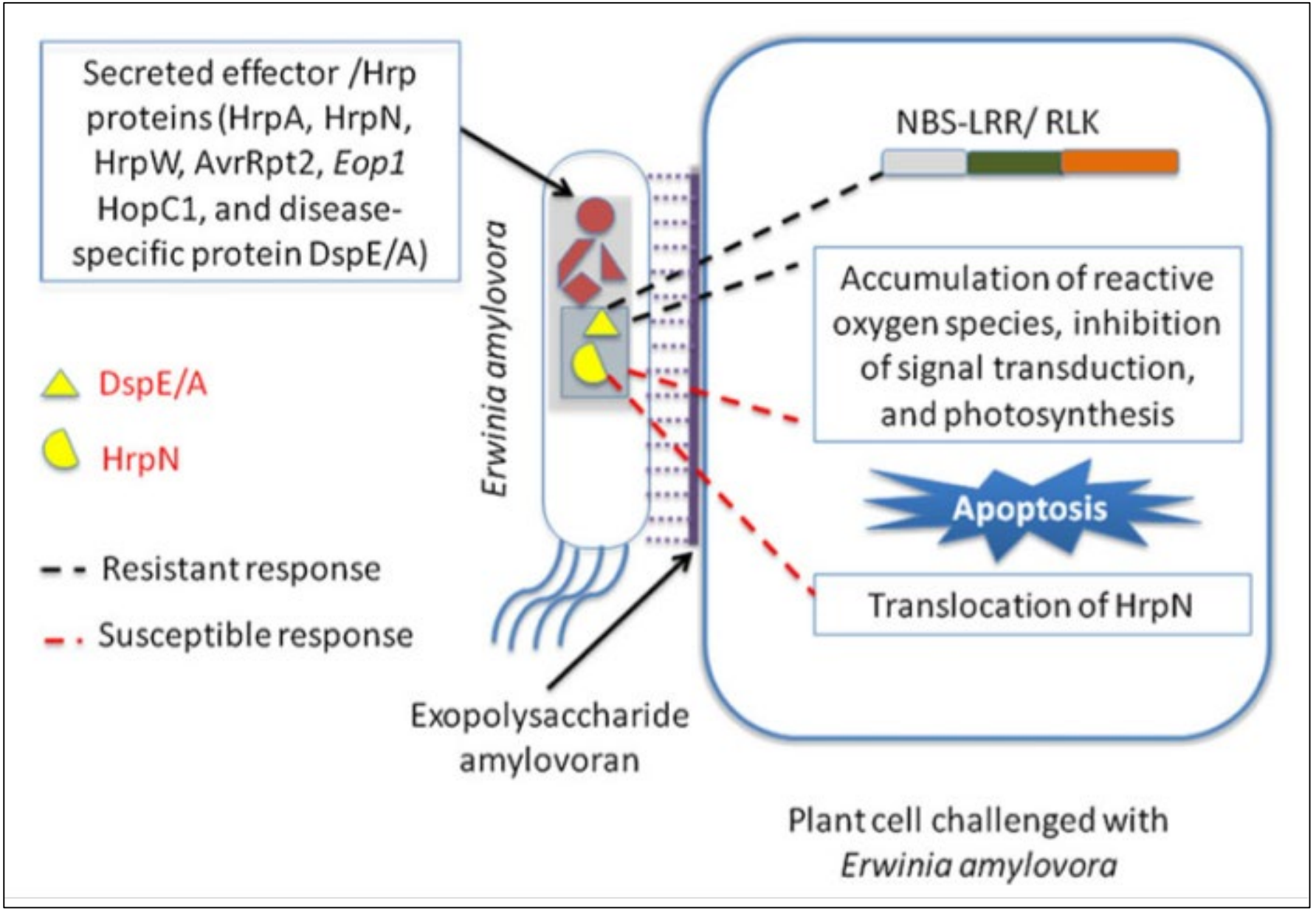
Fire blight bacterial infection of apple cells



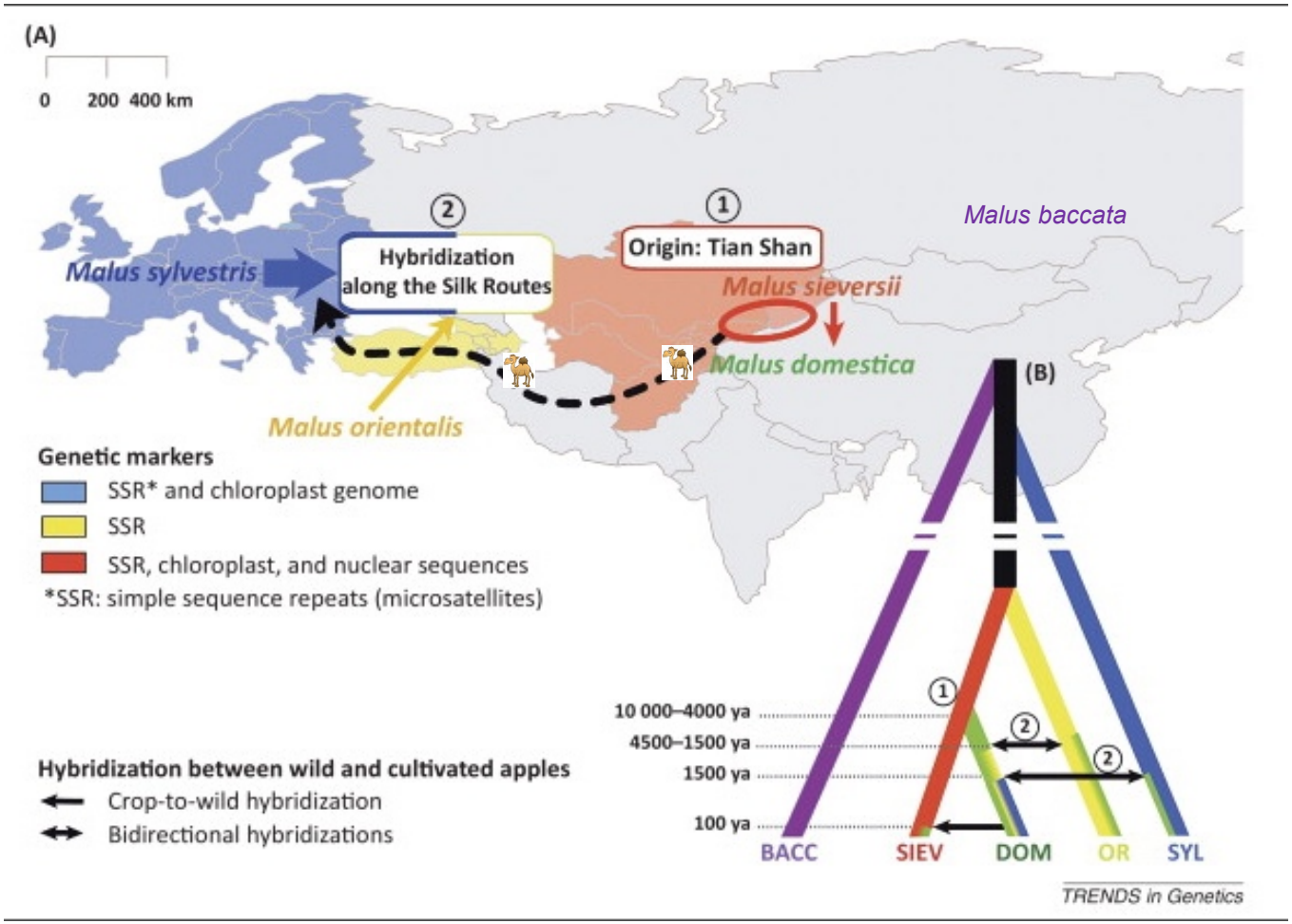
Khan et al. 2013

Host resistance and fire blight management in apple orchards

- ✓ Host resistance is considered most sustainable option for disease management due to
  - ➢ Easy to deploy/implement in the orchards
  - ➢ Low input and cost-effective
  - ➢ Environment friendly
- ✓ No choice to the growers--most of the new and old cultivars are highly susceptible
- ✓ Apple breeding to develop resistant cultivars

Domestication history of the cultivated apple

45-50 Malus species-----*Malus sieversii*—Gene flow



Malus baccata
Diameter: 1 cm

Malus sieversii
Diameter: up to 8 cm

Malus orientalis
Diameter: 2-4 cm

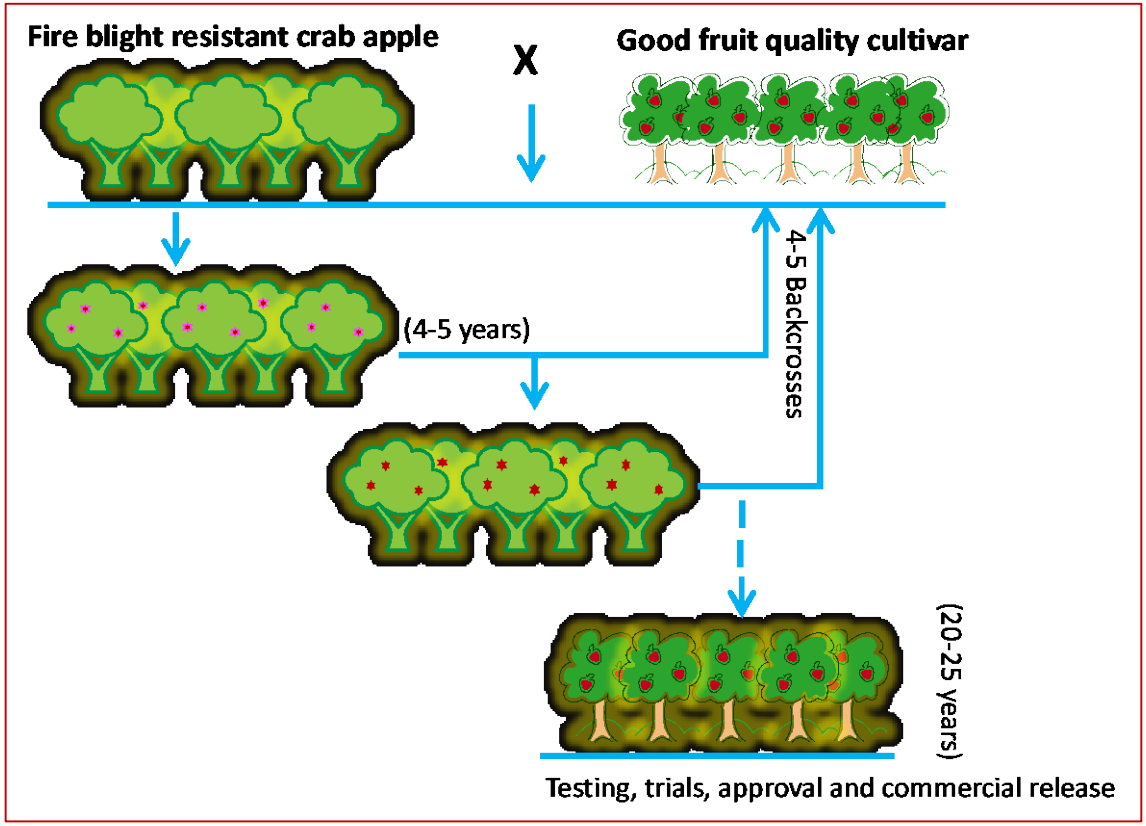
Malus sylvestris
Diameter: 1-3 cm

Duan et al. 2017

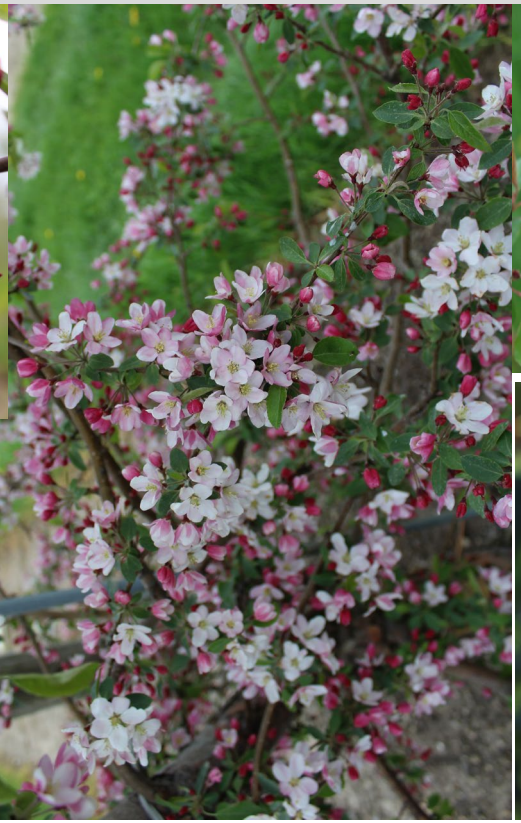
Known sources of major/moderate resistance to fire blight to breed resistant cultivars

Source	Resistance level
Malus Robusta 5	80%
Malus Fusca	66%
Malus Arnoldiana, Evereste, Malus floribunda 821	*35-55%*
Fiesta, Enterprise	34-46%

- Fruit quality is the main driver for success of an apple cultivar
- Due to long juvenility of apples, it can take 20-25 years to breed resistance from wild crab apples



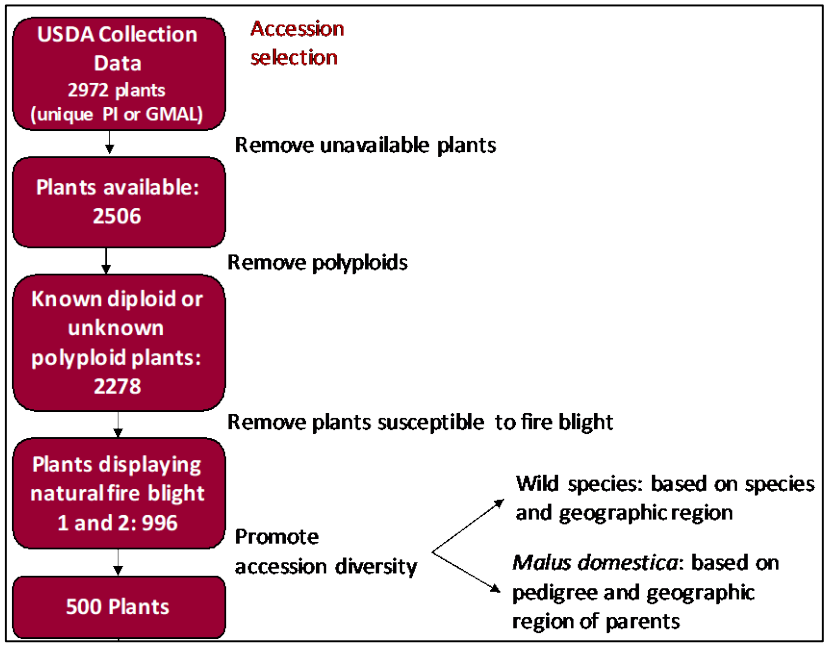
Genetic disease resistance in world's largest collection of apples



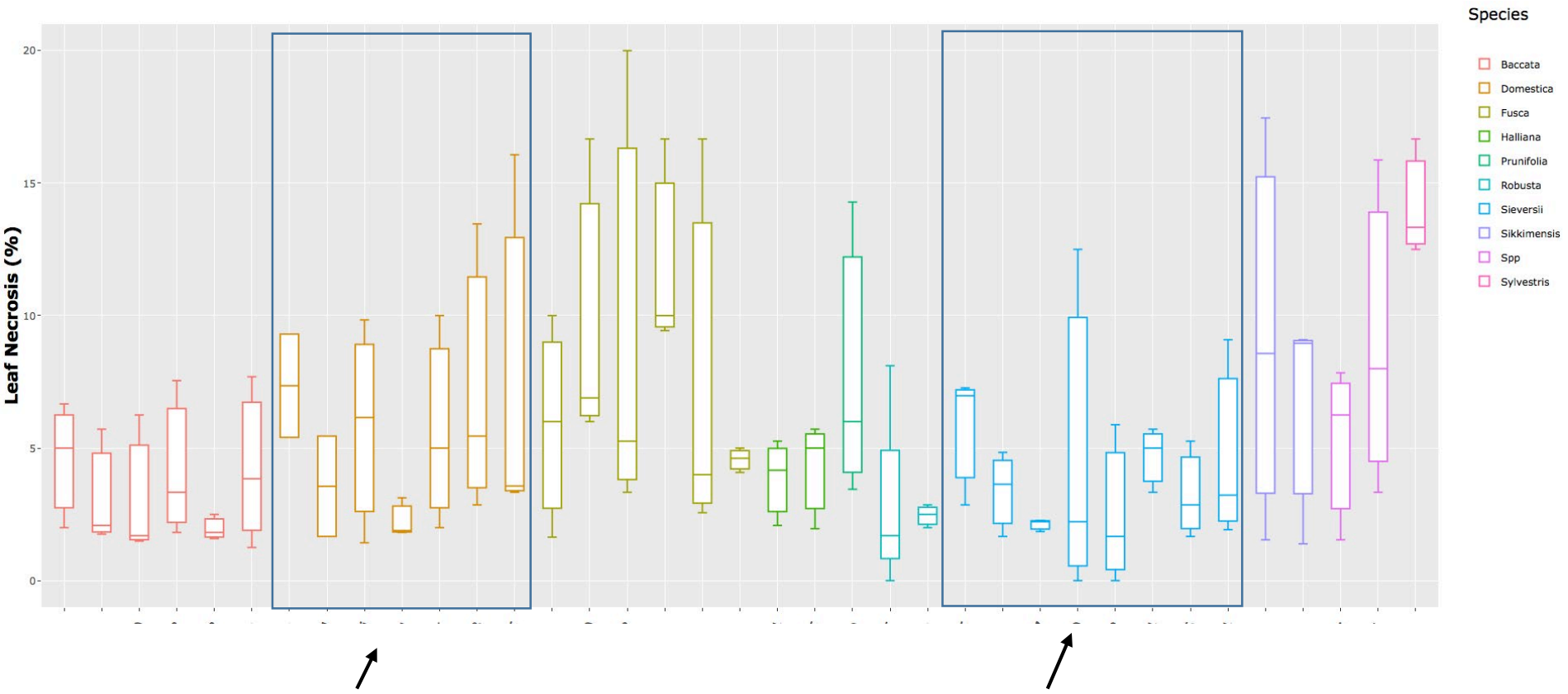


Evaluation of fire blight resistance of accessions from US national apple collection



- Grafted 5 replications: acquired bud-wood and rootstocks
- Inoculated with Ea273 *Erwinia amylovora* strain
- Measurement of fire blight lesion length

Accessions for fire blight resistance and decreased susceptibility research and breeding



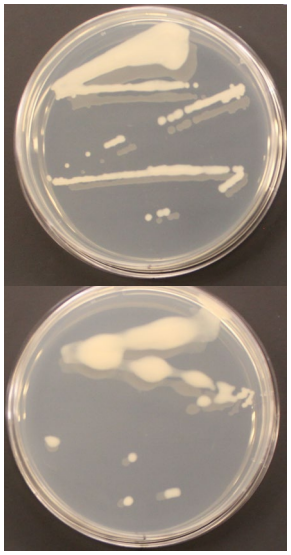
Different levels of susceptibility/resistance responses of *Malus sieversii* and *Malus x domestica* accessions

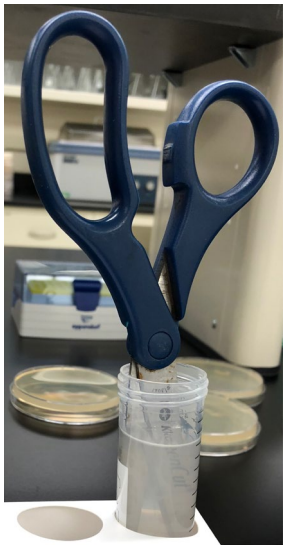
Is There a Relationship Between Root Traits and Susceptibility to Fire Blight?

Variation in root mass of a rootstock (M.7) obtained from a commercial nursery

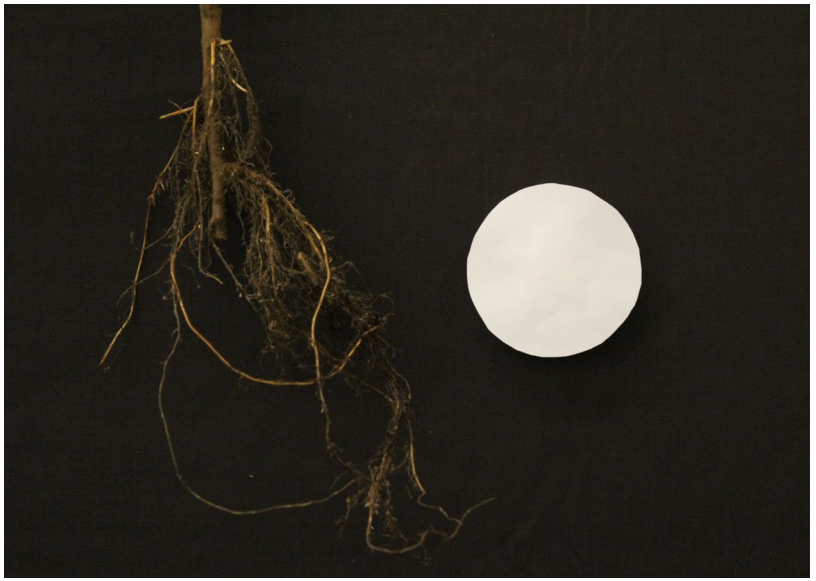
Fire blight evaluation of scion populations and rootstock trait measurement

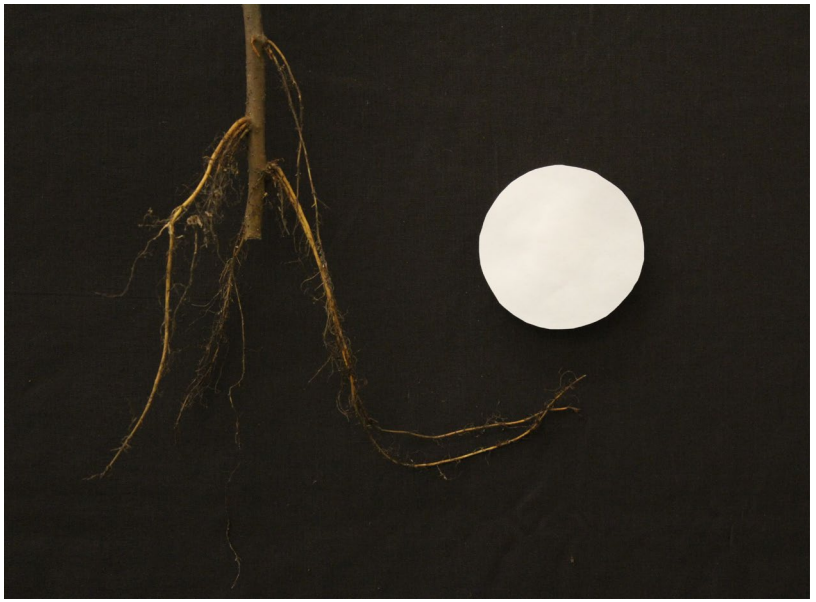
- Roots of M.7 rootstocks were altered to create four different root area classes (RACs) and imaged to quantify root-area (cm^2)
- Afterwards, these non-grafted rootstocks were grown in 5 gallon pots in the greenhouse
- Shoots were inoculated with Ea273 fire blight strain
- Fire blight evaluation as Percent Lesion Length=length of necrosis/shoot length
- At the end of experiment, fresh and dry root mass and number of primary roots



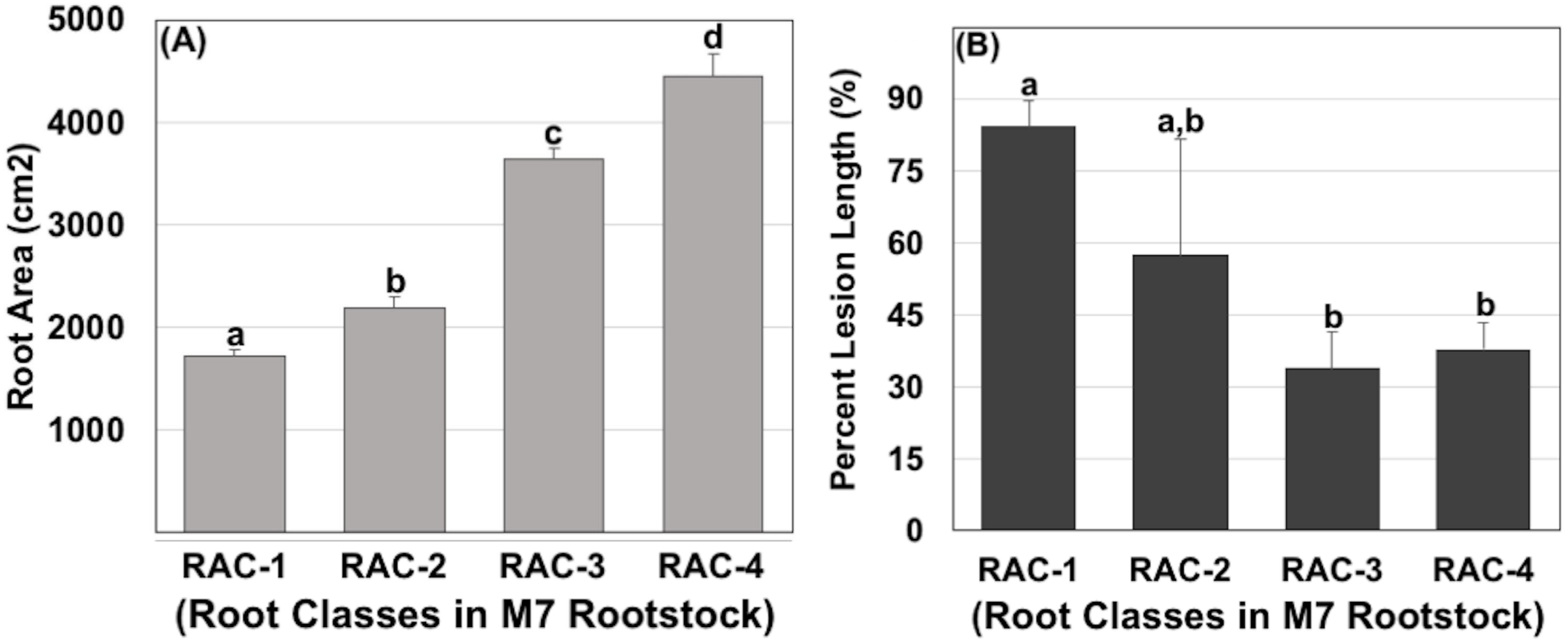


Variation in root traits of 4 different root area classes (RACs) of ‘M.7’ rootstocks





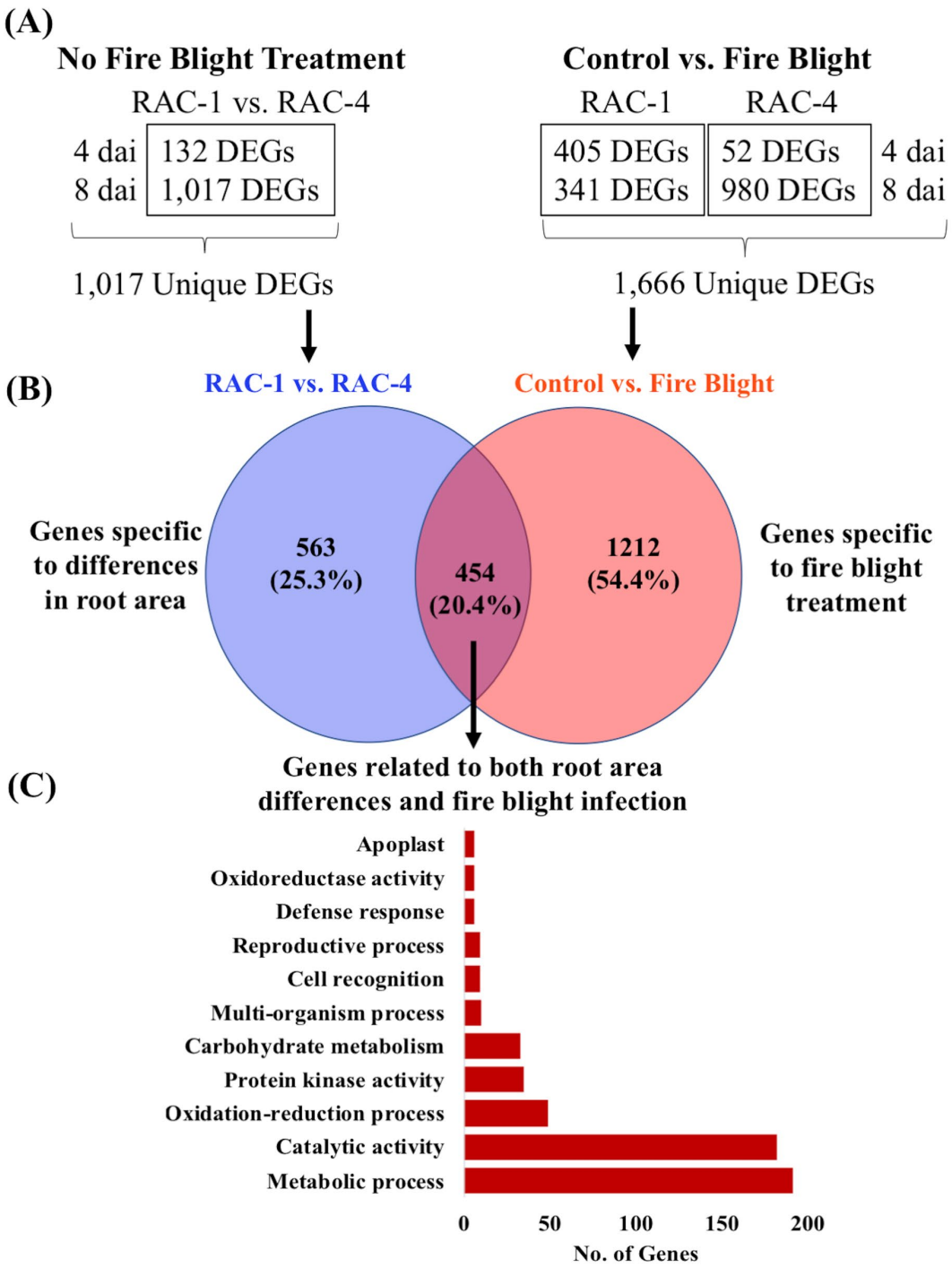
Fire blight susceptibility of four different root area classes (RACs) of 'M.7' rootstocks



Patterns of root area (cm^2) and disease severity (%) in four different root area classes (RACs) of 'M.7' rootstocks. (A) Different root area classes (RACs) observed in M.7 rootstock, and (B) Disease severity represented as percent lesion length (%) for four M.7 RACs at 8 dai.

Root area negatively correlates with fire blight susceptibility

A schematic representation of differential gene expression and pathway analysis for root-dependent fire blight infection in apple. (A) Numbers of differentially expressed genes (DEGs) obtained from analysis of control samples between RAC-1 and RAC-4, and between control and fire blight samples within RAC-1 and RAC-4. (B) Venn diagram with numbers of unique and shared DEGs from two different expression analyses. (C) Pathways showing overrepresentation from common DEGs that most likely correspond to effects of low root area and fire blight infection.



Take home message

- ✓Wild *malus* species hold great genetic diversity for fire blight resistance traits but its deployment is a major bottleneck
- ✓Resistance and decreased susceptibility from *Malus sieversii* and domesticated apples should be priority target for breeding
- ✓Root surface area has negative correlations with fire blight susceptibility of rootstocks by impacting carbohydrate metabolism and defense pathways

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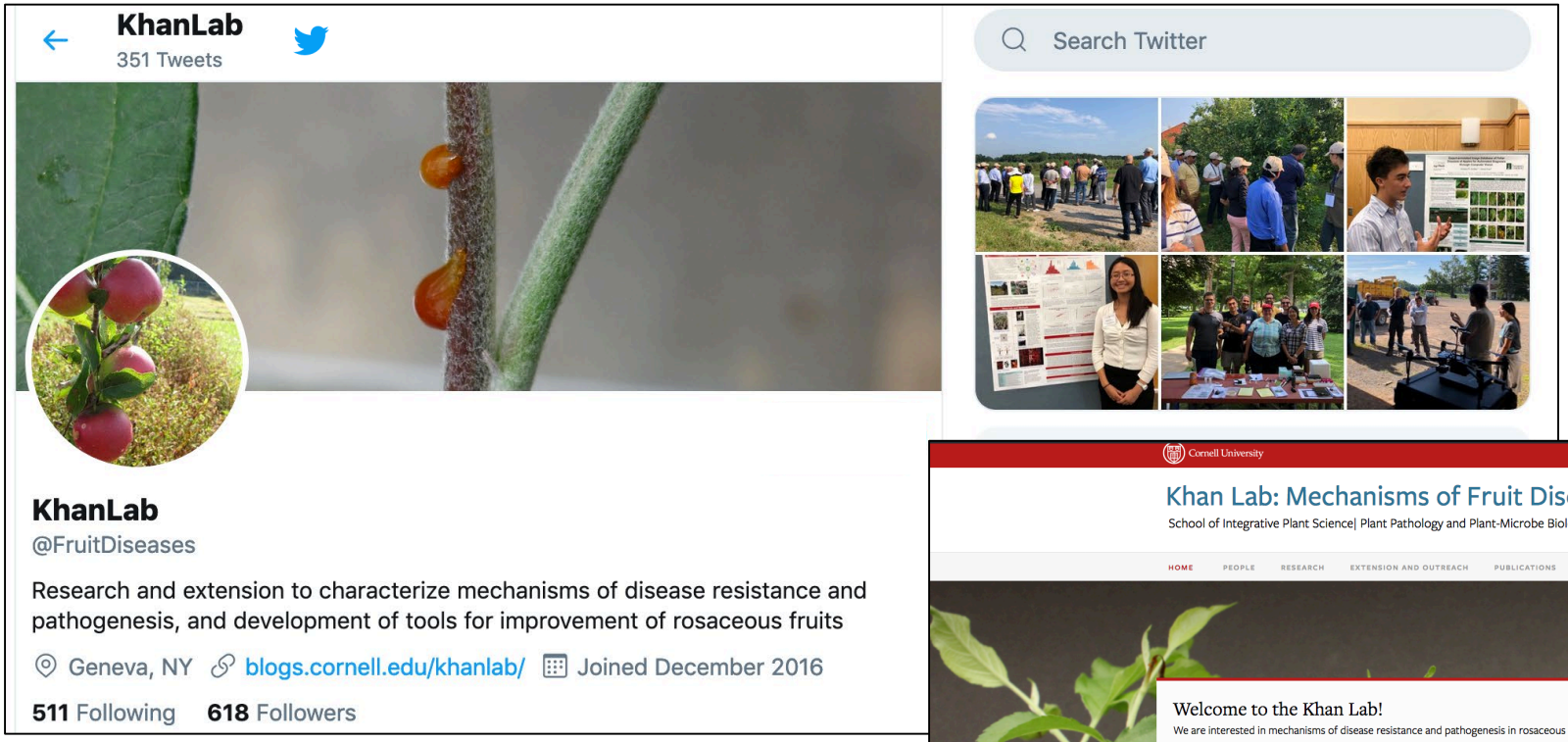
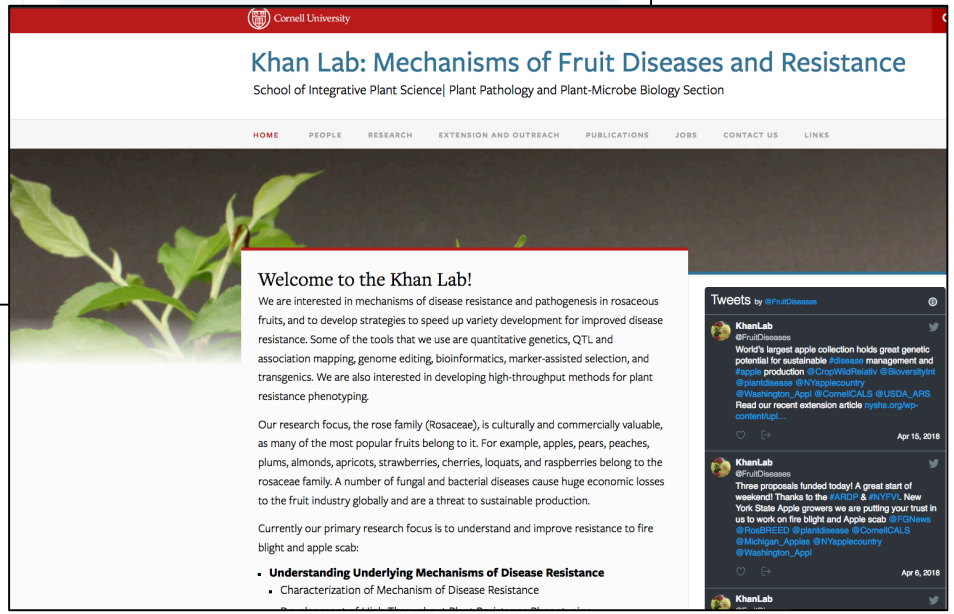
Thank you for attention!





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