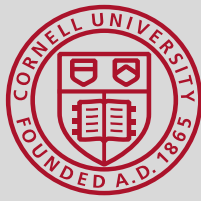


Managing Fire Blight by Choosing Decreased Host Susceptibility Levels and Rootstock Traits

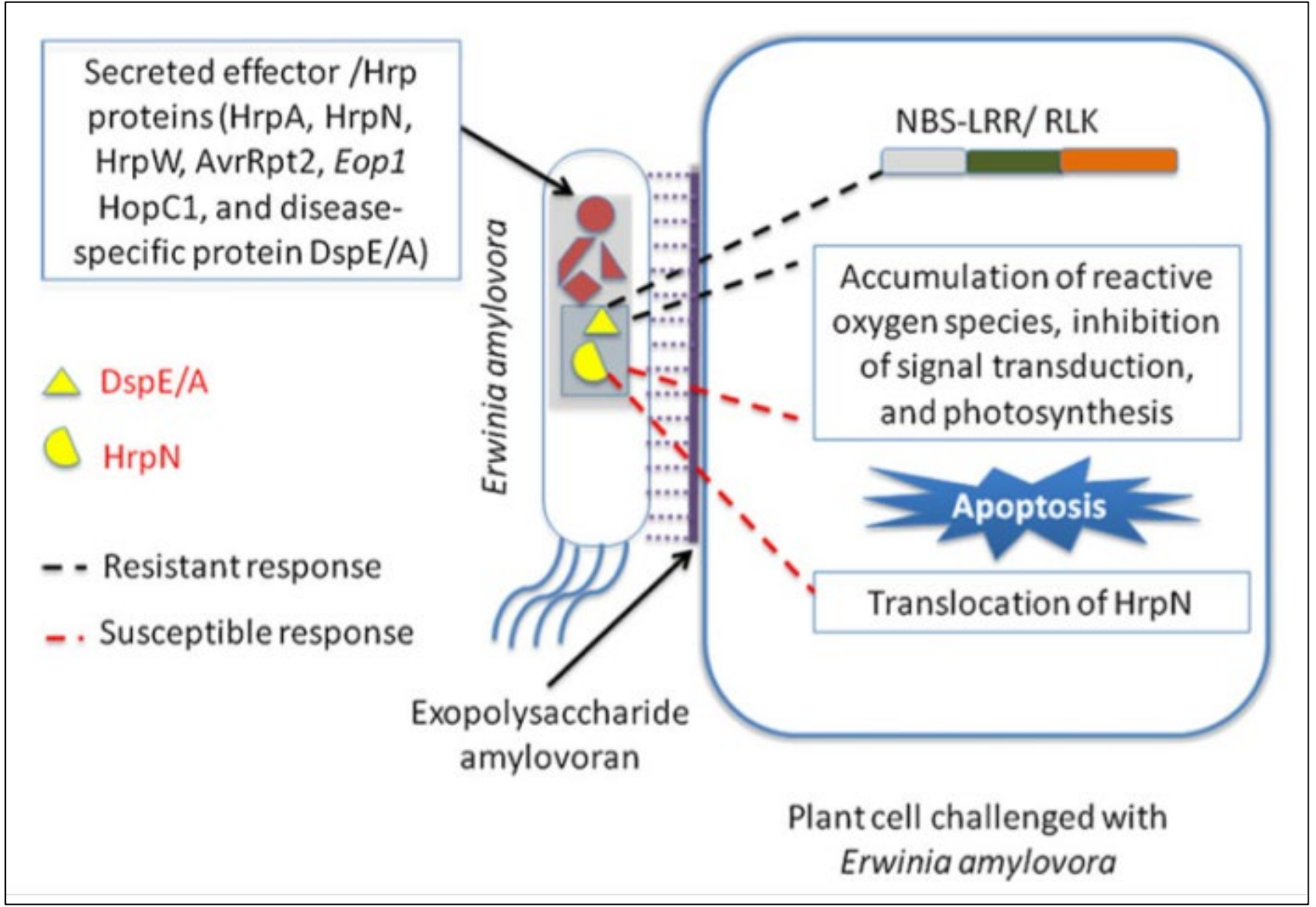


January 15, 2020

Awais Khan

Plant Pathology and Plant-microbe Biology, SIPS,
Cornell University, Geneva, NY

Fire blight bacterial infection of apple cells

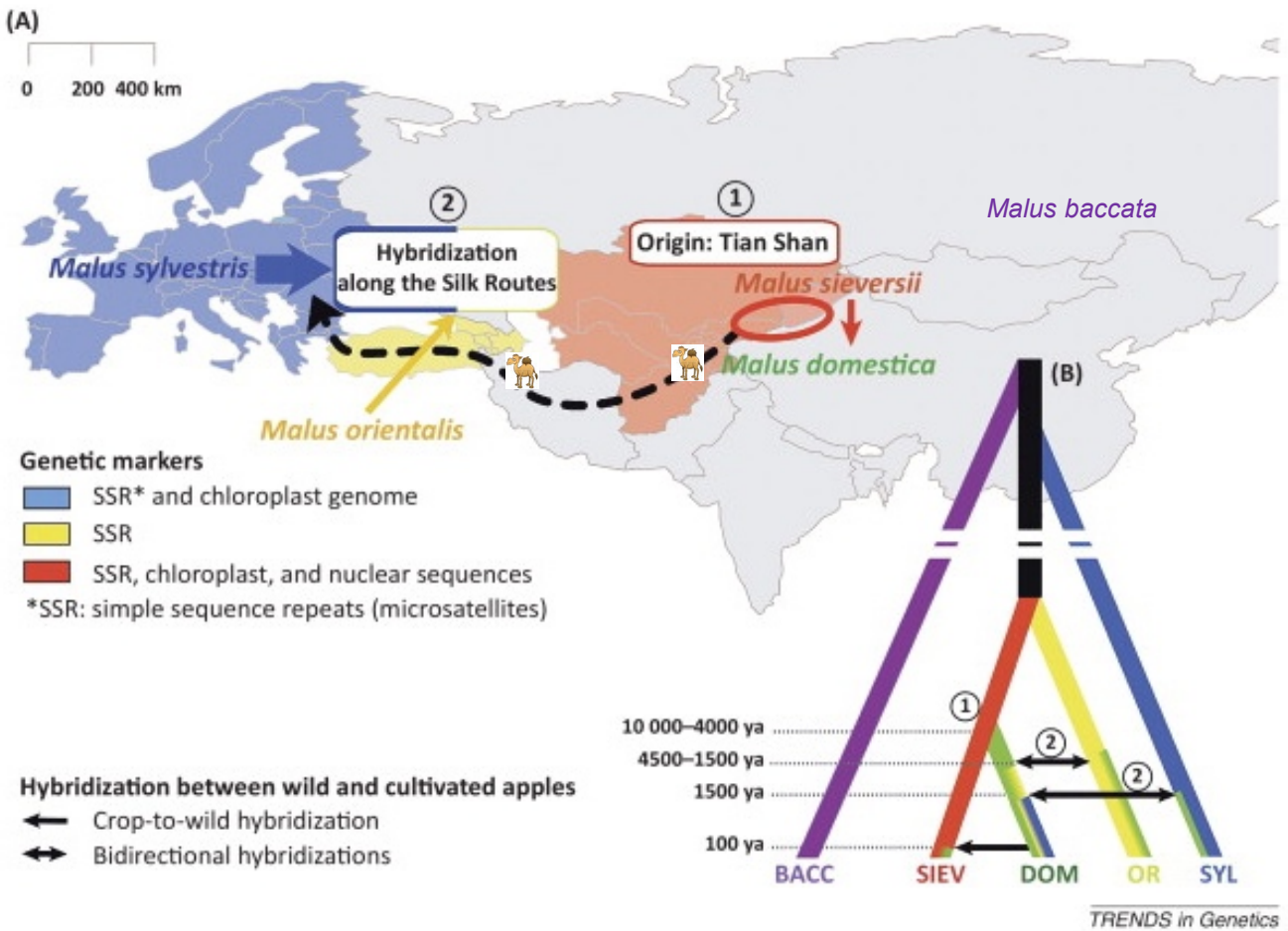


Host resistance and fire blight management in apple orchards

- ✓ 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



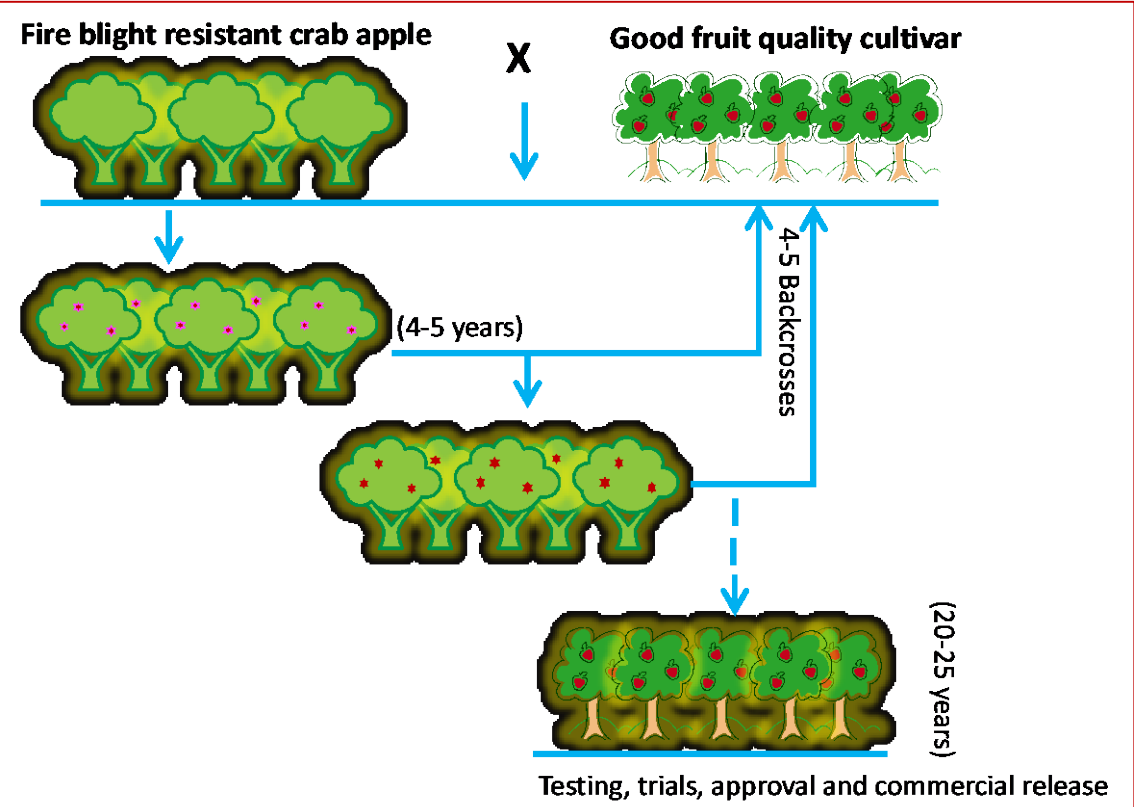
Malus sylvestris
Diameter: 1-3 cm



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

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

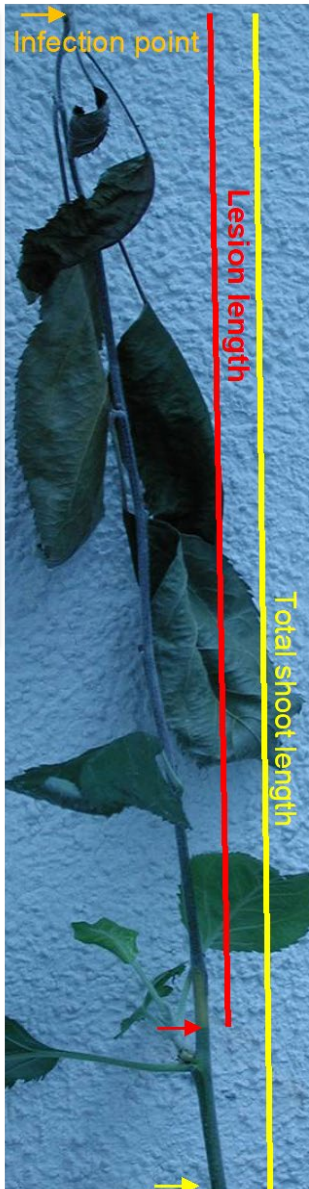
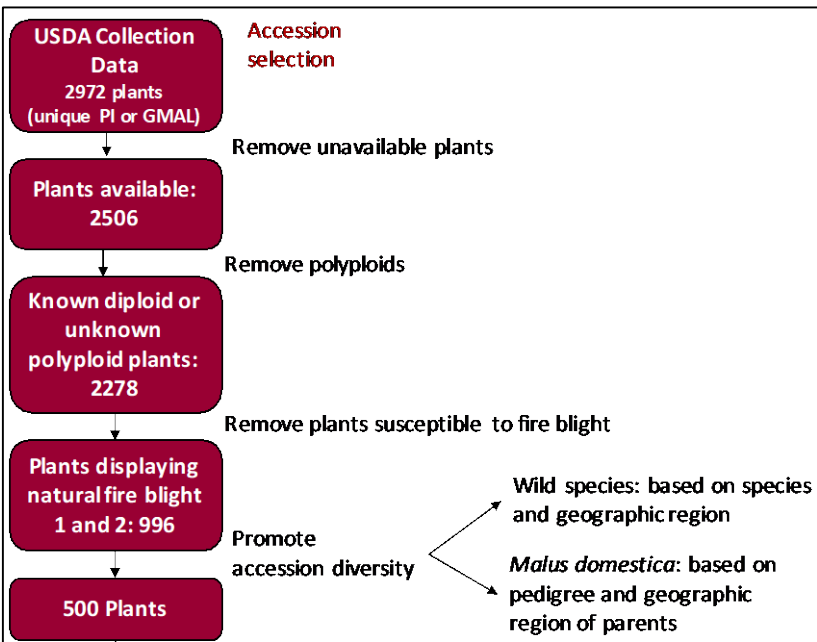
- Fruit quality is the main driver for success of an apple cultivar
- Due to long juvenility of apples, it can take 20-25 years to breed resistance from wild crab apples



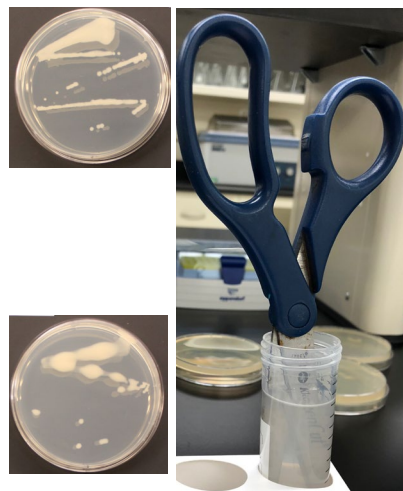
Genetic disease resistance in world's largest collection of apples



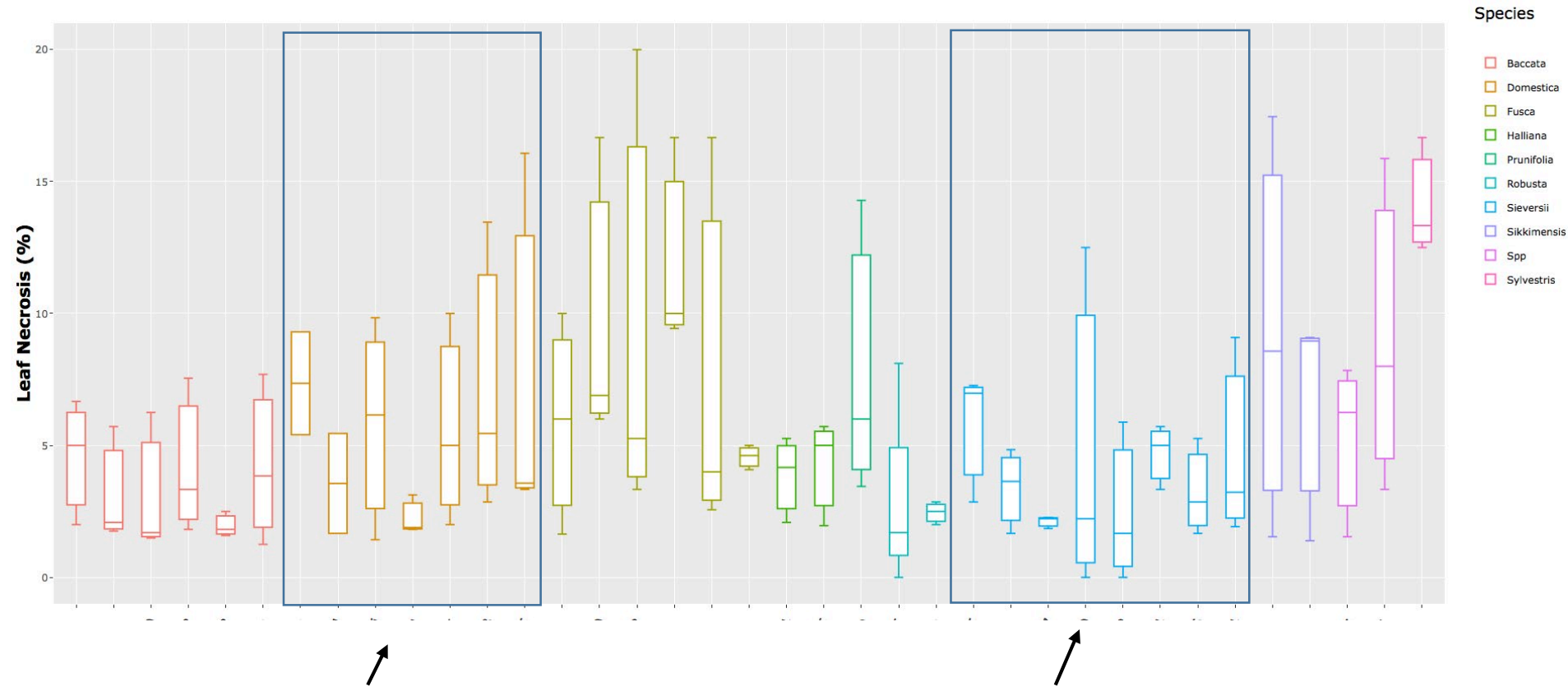
Evaluation of fire blight resistance of accessions from US national apple collection



- 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?

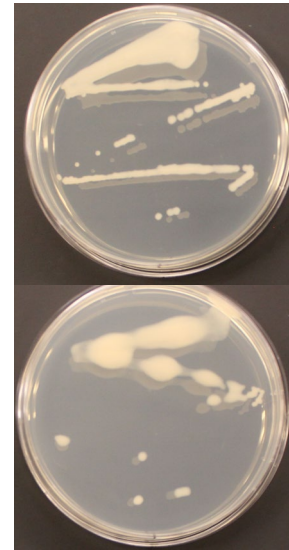


Variation in root mass of a rootstock (M.7) obtained from a commercial nursery

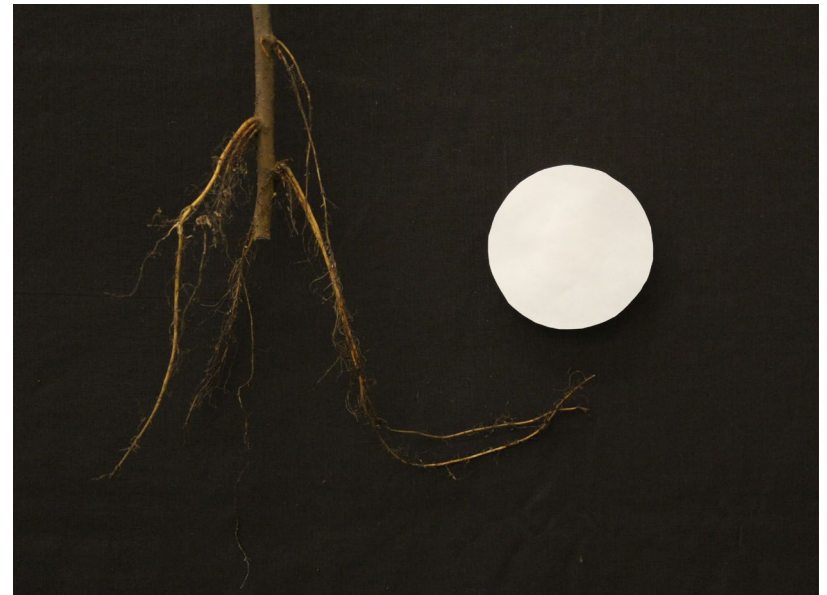
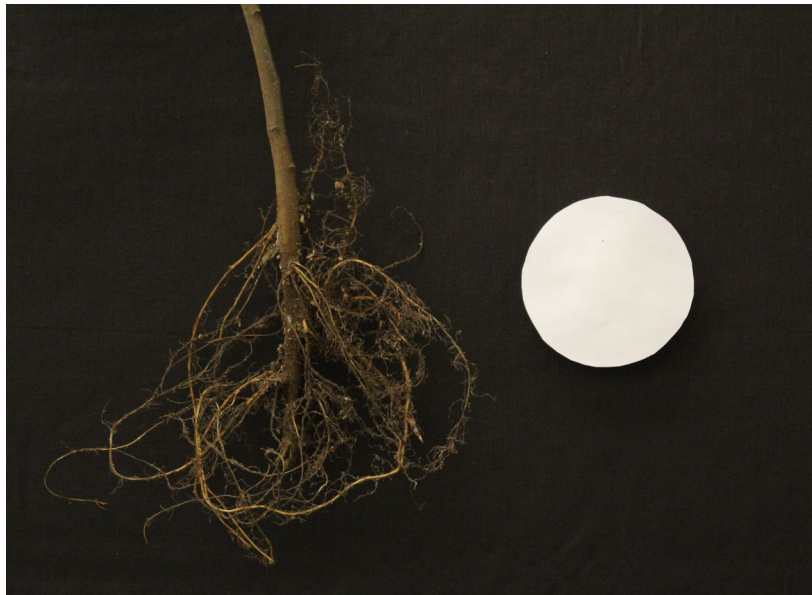
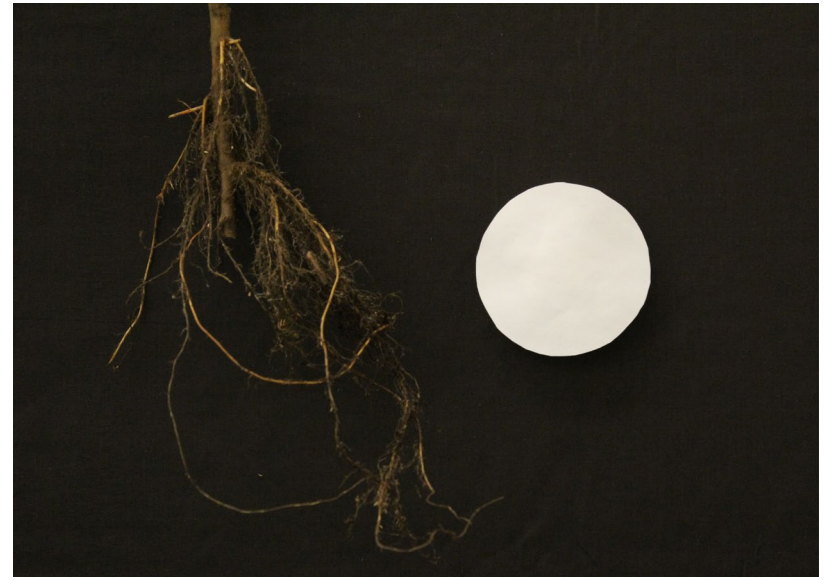
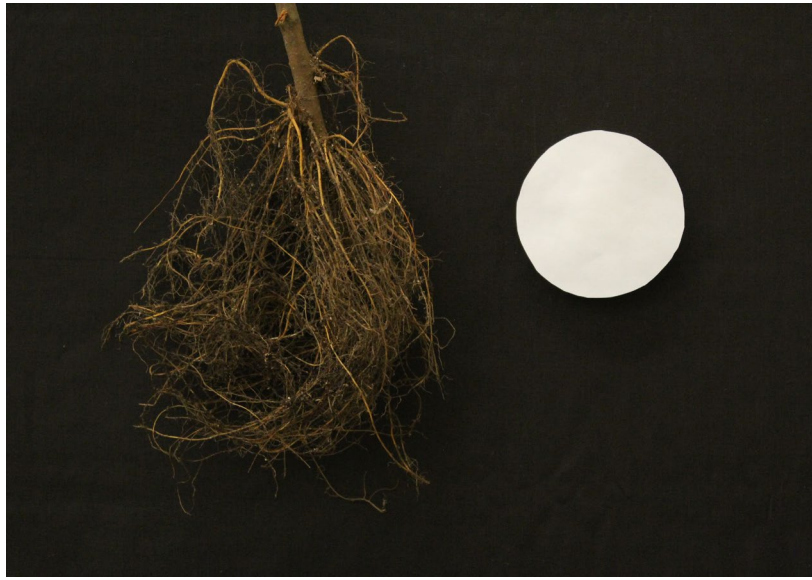


Fire blight evaluation of scion populations and rootstock trait measurement

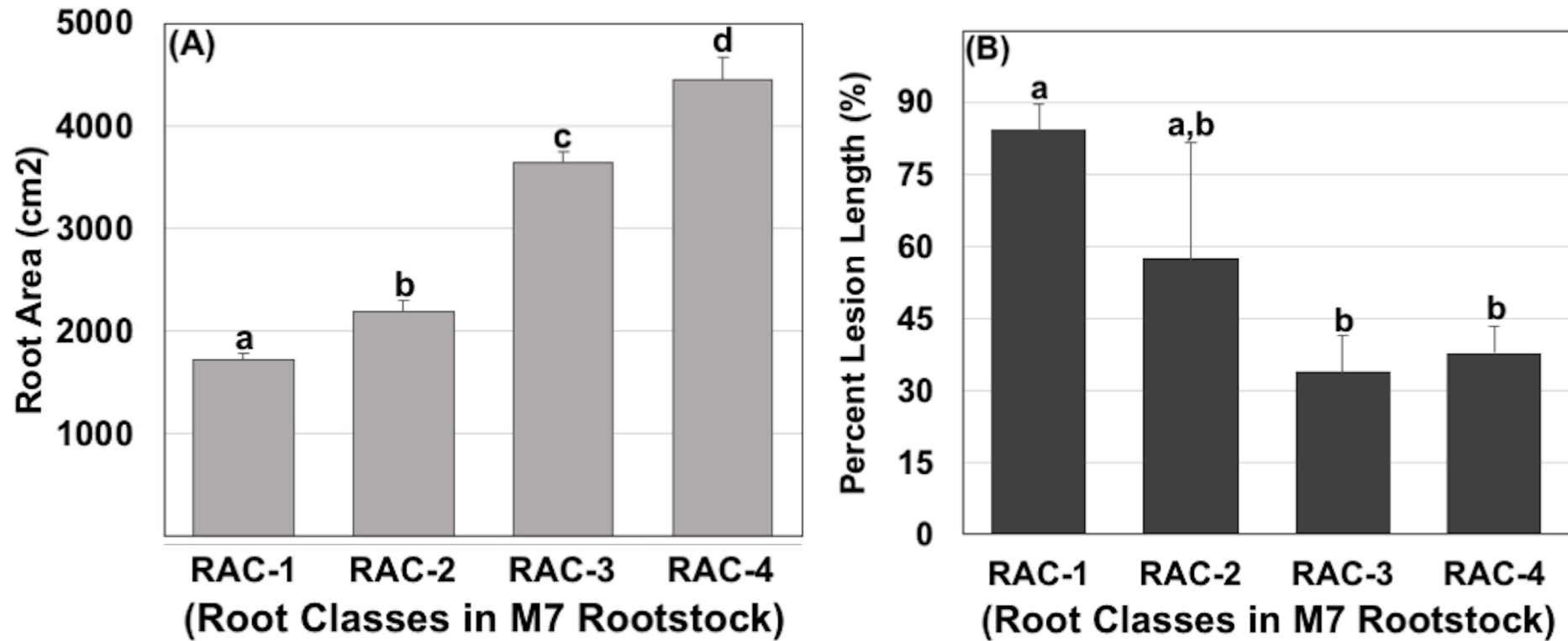
- Roots of M.7 rootstocks were altered to create four different root area classes (RACs) and imaged to quantify root-area (cm^2)
- Afterwards, these non-grafted rootstocks were grown in 5 gallon pots in the greenhouse
- Shoots were inoculated with Ea273 fire blight strain
- Fire blight evaluation as 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



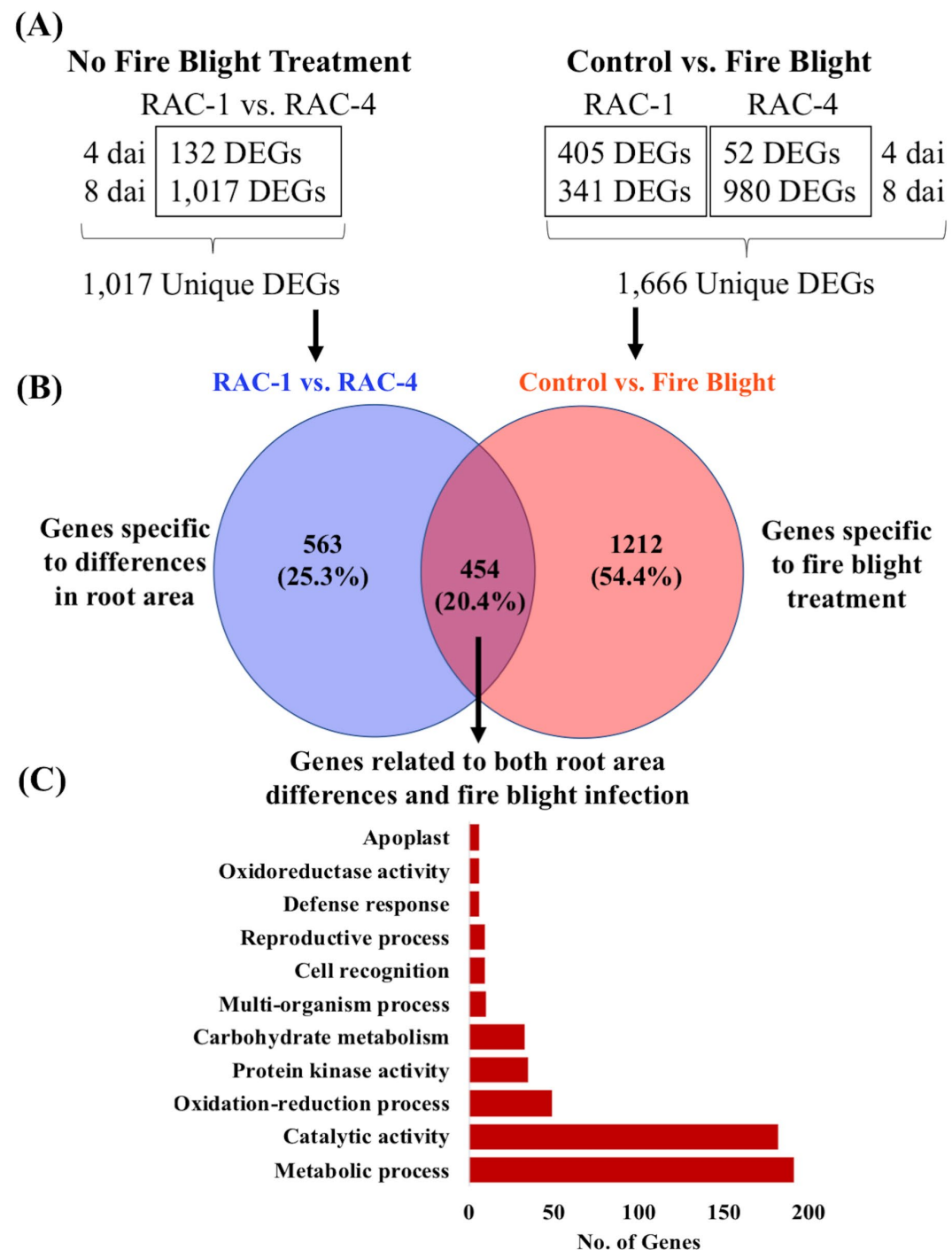
Fire blight susceptibility of four different root area classes (RACs) of 'M.7' rootstocks



Patterns of root area (cm²) 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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- Jack Fabrizio
- David Strickland

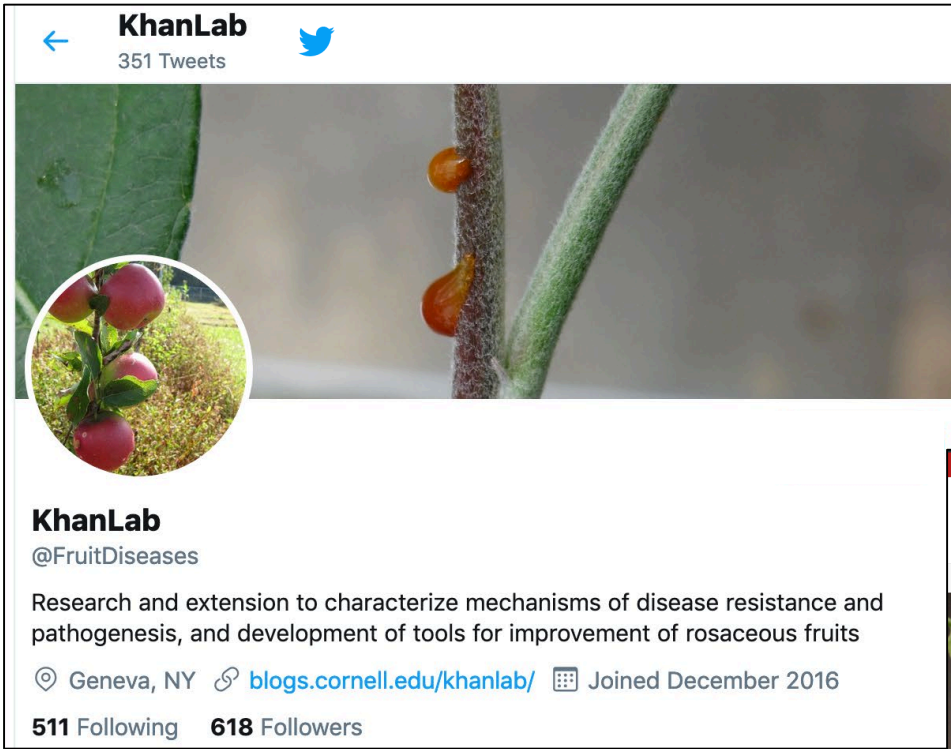
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Thank you for attention!



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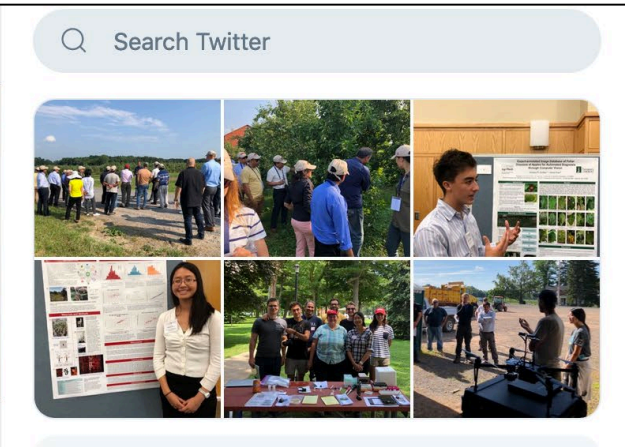


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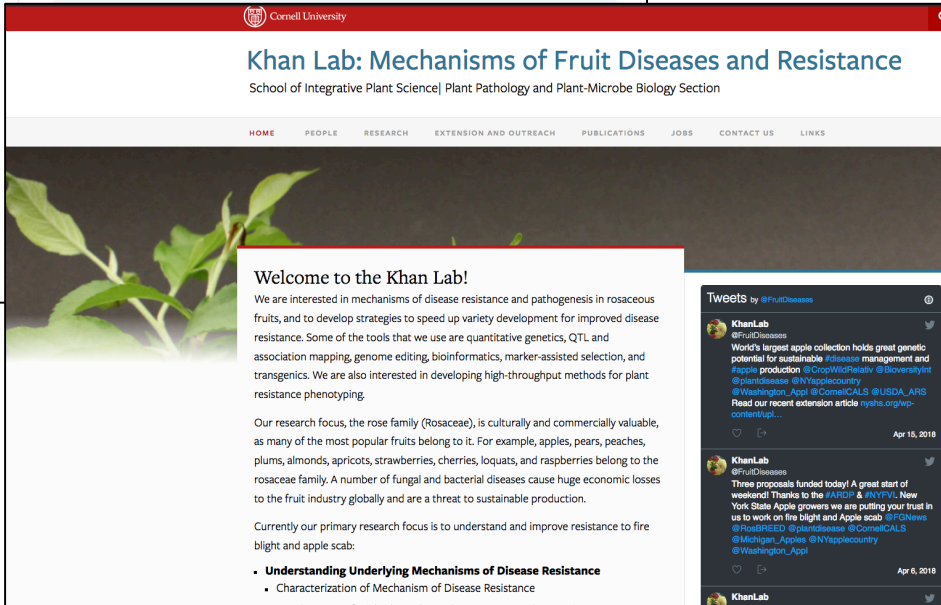

Research and extension to characterize mechanisms of disease resistance and pathogenesis, and development of tools for improvement of rosaceous fruits

Geneva, NY blogs.cornell.edu/khanlab/ Joined December 2016

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Khan Lab: Mechanisms of Fruit Diseases and Resistance

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Welcome to the Khan Lab!

We are interested in mechanisms of disease resistance and pathogenesis in rosaceous fruits, and to develop strategies to speed up variety development for improved disease resistance. Some of the tools that we use are quantitative genetics, QTL and association mapping, genome editing, bioinformatics, marker-assisted selection, and transgenics. We are also interested in developing high-throughput methods for plant resistance phenotyping.

Our research focus, the rose family (Rosaceae), is culturally and commercially valuable, as many of the most popular fruits belong to it. For example, apples, pears, peaches, plums, almonds, apricots, strawberries, cherries, loquats, and raspberries belong to the rosaceae family. A number of fungal and bacterial diseases cause huge economic losses to the fruit industry globally and are a threat to sustainable production.

Currently our primary research focus is to understand and improve resistance to fire blight and apple scab:

- **Understanding Underlying Mechanisms of Disease Resistance**
 - Characterization of Mechanism of Disease Resistance



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