Confirming the breakdown of apple scab resistance in the key source for scab resistance breeding in North America

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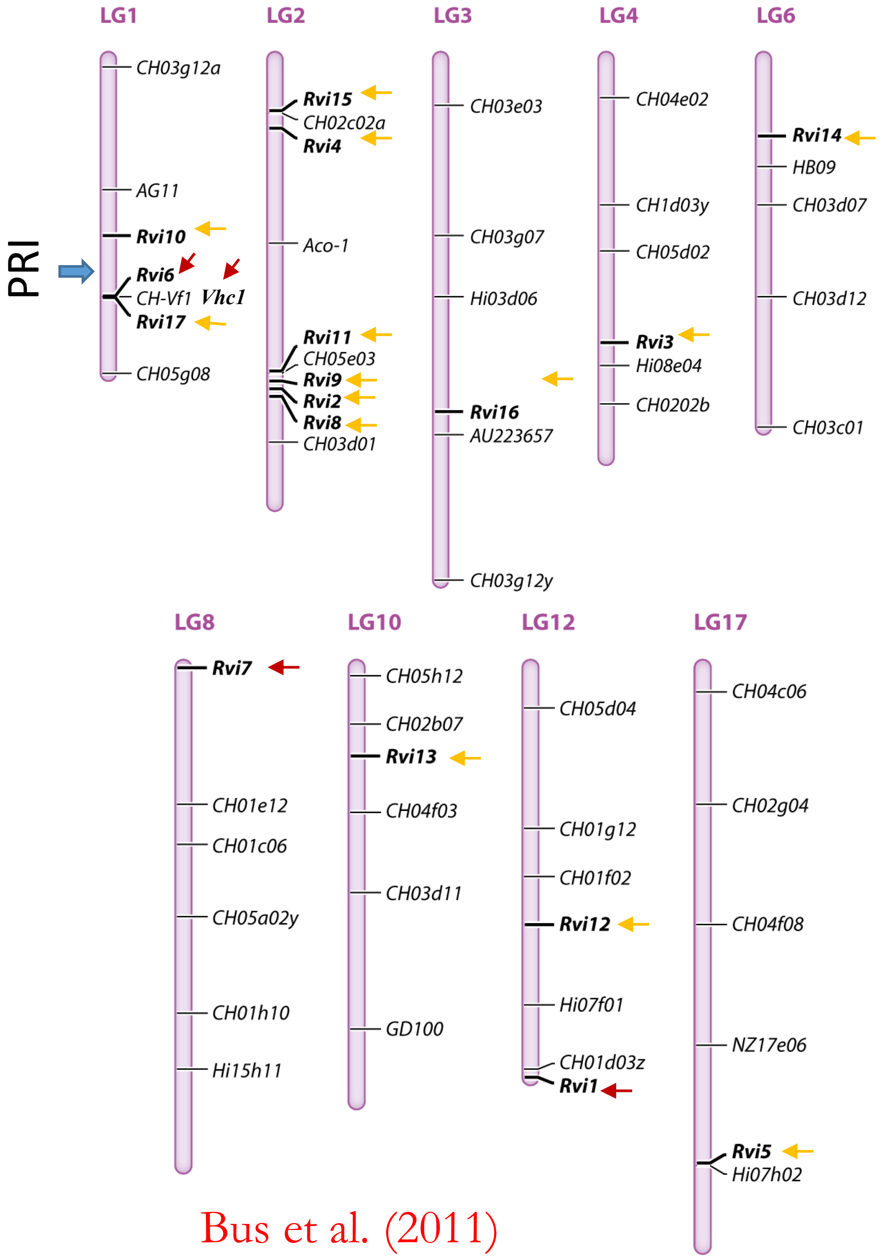
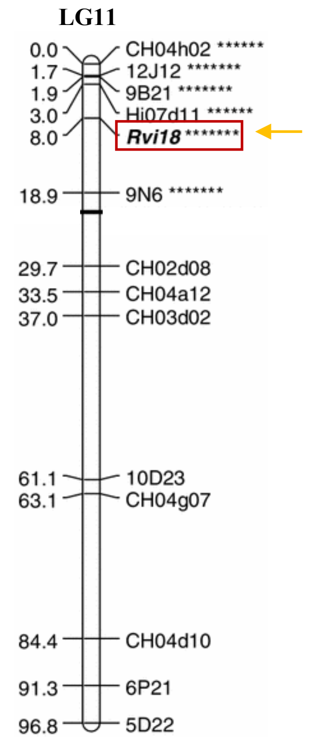
Apple scab caused by *Venturia inaequalis*

- Very old disease of apples; fungal evolution is associated with domestication of apples
- Scab fungus has rapid ecological divergence because it reproduces both asexually and sexually
- Commercial varieties are susceptible e.g., McIntosh, Red Delicious, Rome Beauty
- Impact on quality, yield, and plant productivity results in significant cost to apple production

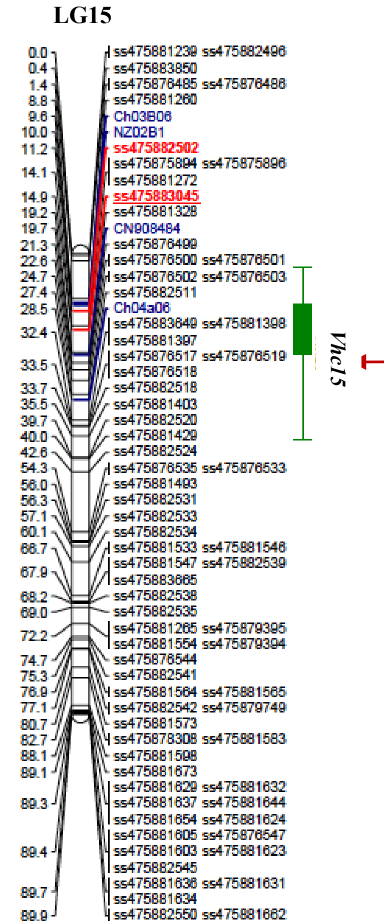
Host genetic resistance against apple scab



Bus et al. (2011)



Soriano et al. 2014



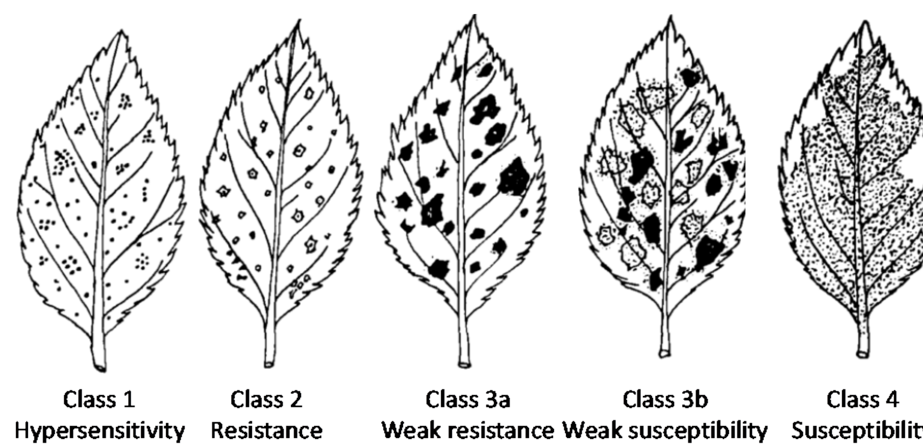
Clark et al. (2014)

Characterization of apple scab infection in apple core collection to identify novel sources of resistance

- 180 accessions from approximately 28 *Malus* species
- No fungicide spray
- Partial set of host differentials

		R-gene(s) (known)	
Hosts	Genotypes	Historical names	New names
h0	'Gala'	none known	
h1	'Golden Delicious'	*Vg*	*Rvi1*
h2	TSR34T15	*Vh2*	*Rvi2*
h3[2]	Q71 ('Geneva' x 'Braeburn')	*Vh3.1*	*Rvi3*
h4	TSR33T239	*Vh4*	*Rvi4*
h5	9-AR2T196	*Vm*	*Rvi5*
h6	'Priscilla'	*Vf*	*Rvi6*
h7	F1 of *M. floribunda* 821[1]	*Vfh*	*Rvi7*
h8[2]	B45 (Pacific Beauty x M. sieversii GMAL4302-X8)	*Vh8*	*Rvi8*
h9[2]	J34 ('Gala' x 'Dolgo')	*Vdg*	*Rvi9*
h10	A 723-6 ('Worcester' x PI172623)	*Va*	*Rvi10*
h11	*M. baccata jackii*	*Vbj*	*Rvi11*
h12	*Hansen's baccata #2*	*Vb*	*Rvi12*
h13	'Durello di Forlì'	*Vd*	*Rvi13*
h14	'Dülmener Rosen'	*Vdr1*	*Rvi14*
h15	GMAL 2473	*Vr2*	*Rvi15*

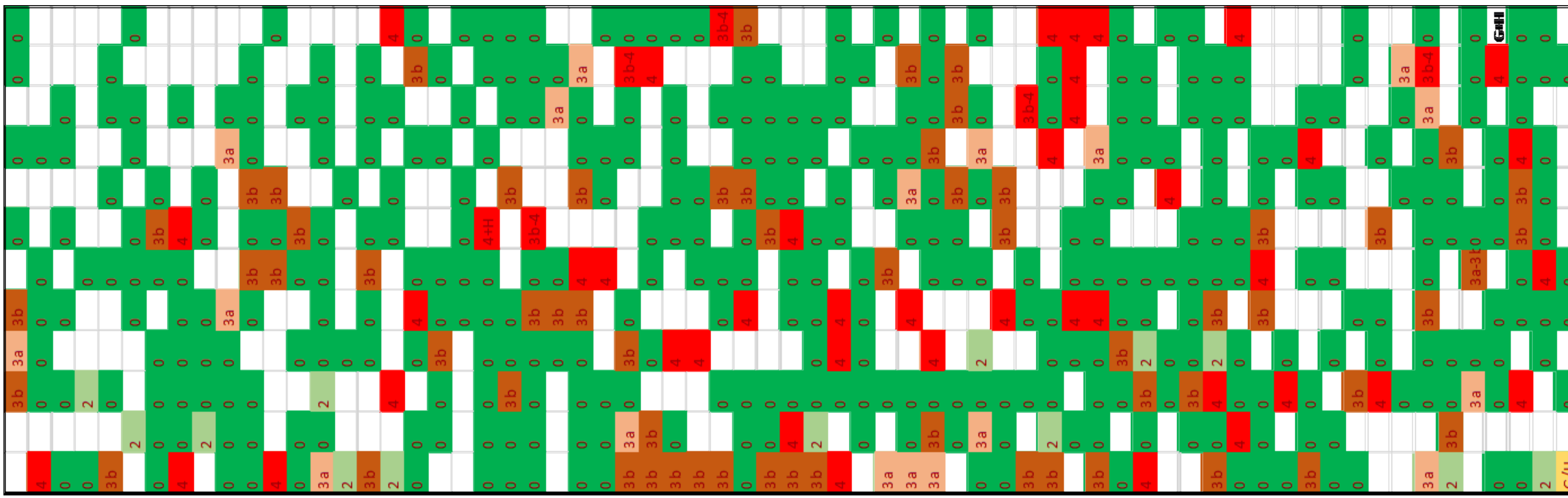
Vinquest.ch



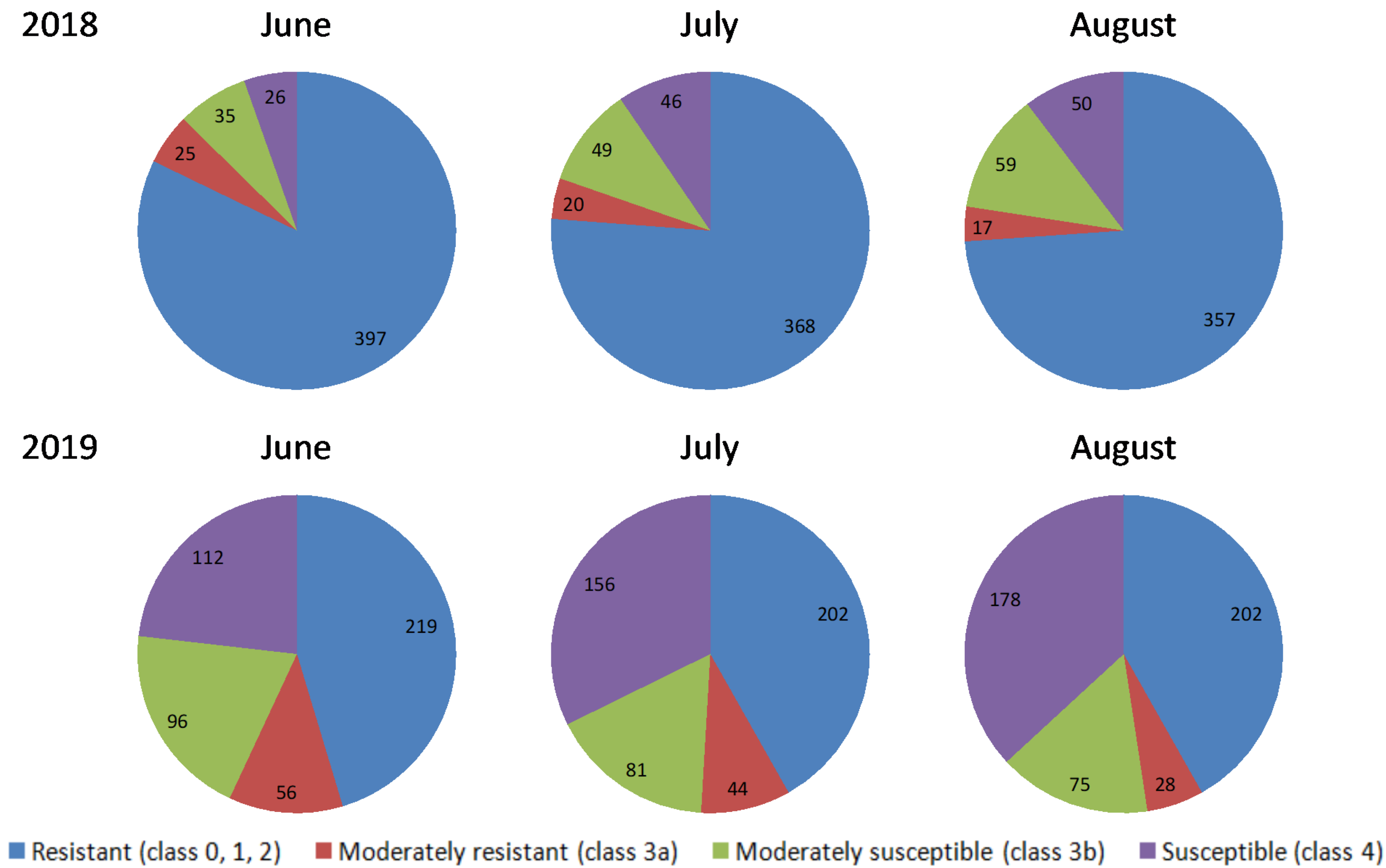
Chevalier et al. 1991

Characterization of apple scab infection in apple core collection to identify novel sources of resistance

August 7, 2018



Characterization of apple scab infection in apple core collection to identify novel sources of resistance



New North American isolates of *Venturia inaequalis* can overcome apple scab resistance from *M. floribunda* 821

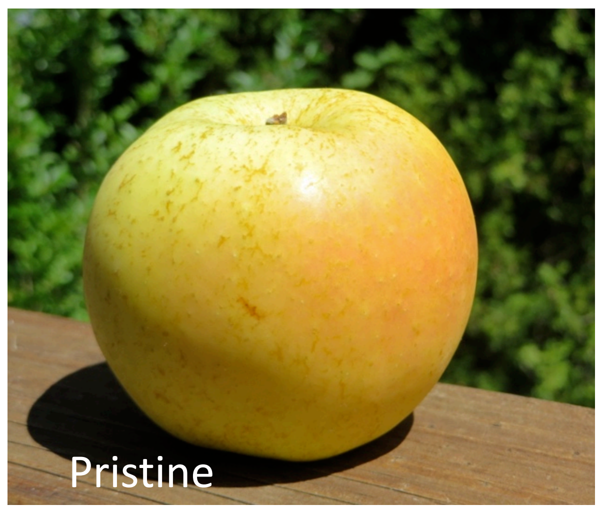
(Papp et al. 2019).

Heavy and sporulating apple scab infection on *M. floribunda 821* last year.

Chlorotic and pin point type resistance symptoms can also be seen.

Majority of currently available apple scab resistant cultivars carry resistance of *M. floribunda* 821

Papp et al. 2019



PRI (Purdue, Rutgers, Illinois apple breeding program) website and Adams blogs

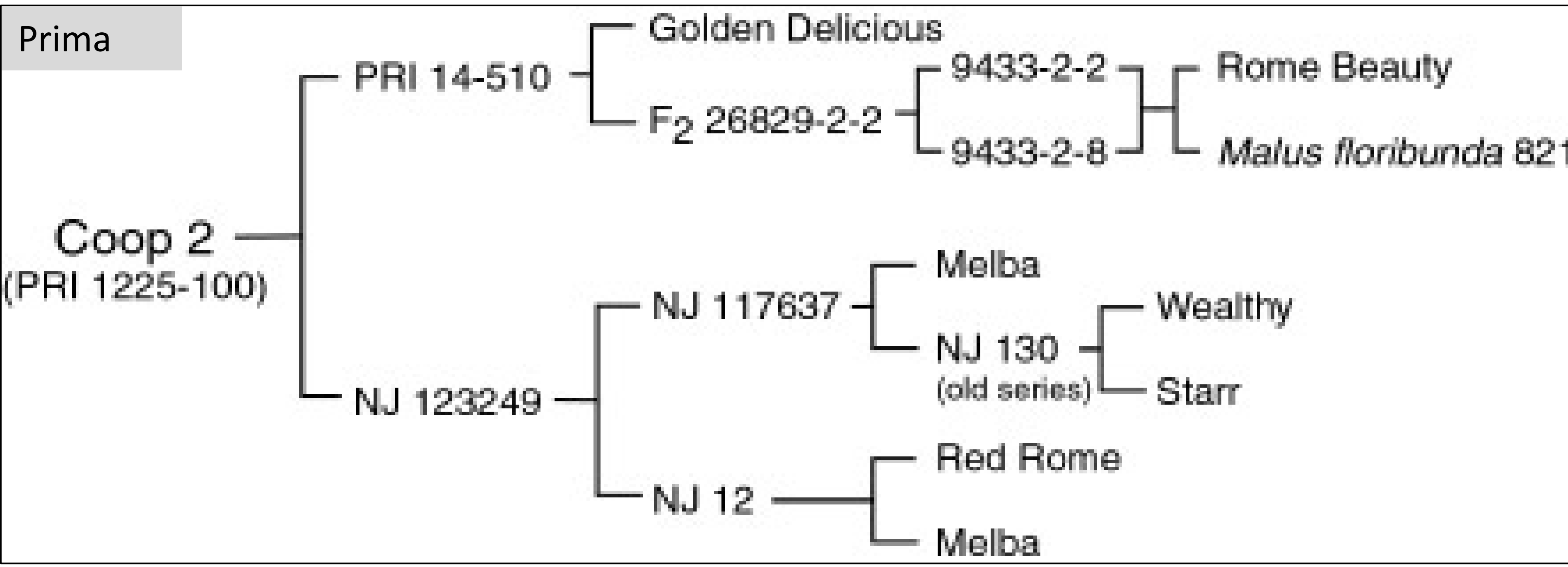
Apple scab symptoms and incidence on *Rvi6* cultivars and susceptible controls

Papp et al. 2019

PI Number	Cultivar Name	*Rvi* Genes	Symptom class (0-4)	Incidence (0-9)	Source
392303	Gala	none	4	5	-
590186	Wijcik McIntosh	none	4	8	-
588998	Marshall McIntosh	none	4	8	-
590184	Golden Delicious	*Rvi1*	4	7	-
589827	*M. floribunda* 821	*Rvi6, Rvi7*	4	4	-
588747	Florina	*Rvi1, Rvi6*	0	1	EU (French)
588838	Nova Easygro	*Rvi6*	M	2	PRI (Canadian)
589181	Prima	*Rvi1, Rvi6*	3	2	PRI
589962	Jonafree	*Rvi6*	0	1	PRI
590183	Dayton	*Rvi6*	0	1	PRI
594111	Redfree	*Rvi6*	0	1	PRI
589965	Priscilla	*Rvi6*	0	1	PRI

c) Intact crown of 'Nova Easygro'. D) Weak sporulation surrounded by chlorosis and necrosis on 'Nova Easygro'. E) Strong chlorosis on 'Prima'

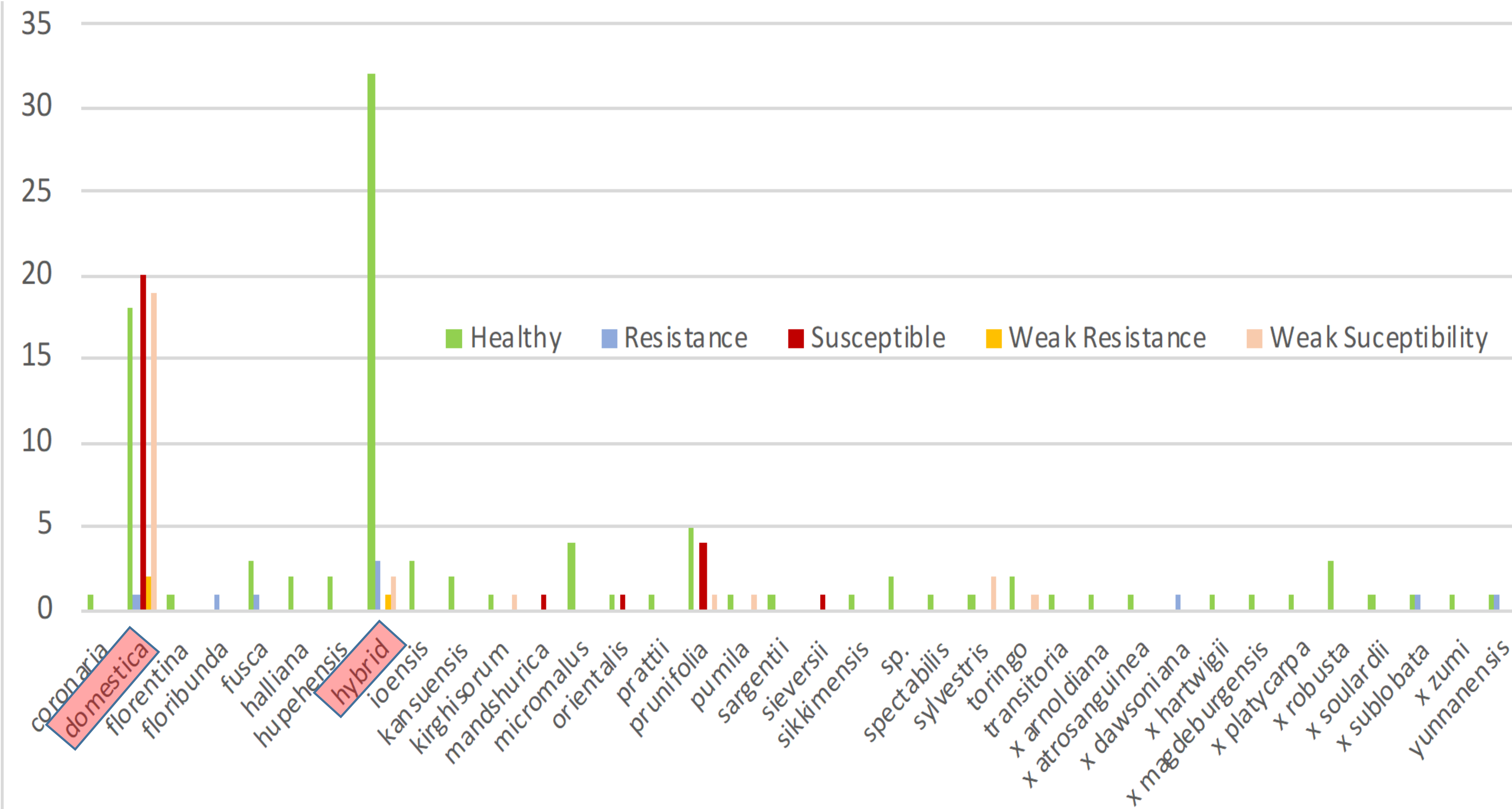
Pedigree of PRI scab resistant cultivars and potential explanation of scab breakdown in *M. floribunda* 821 but not in descendent cultivars



Papp et al. 2019

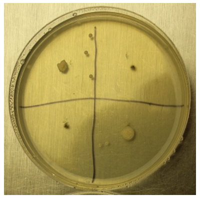
Identification of new sources of resistance to apple scab

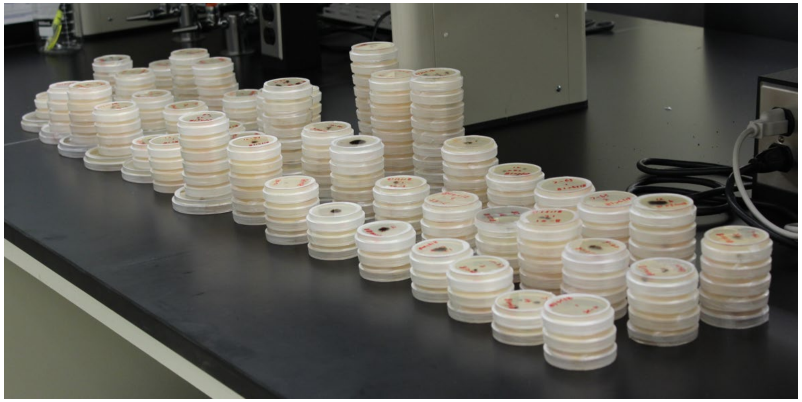
Scab susceptibility of apple core collection



Geographical map of scab isolates collected

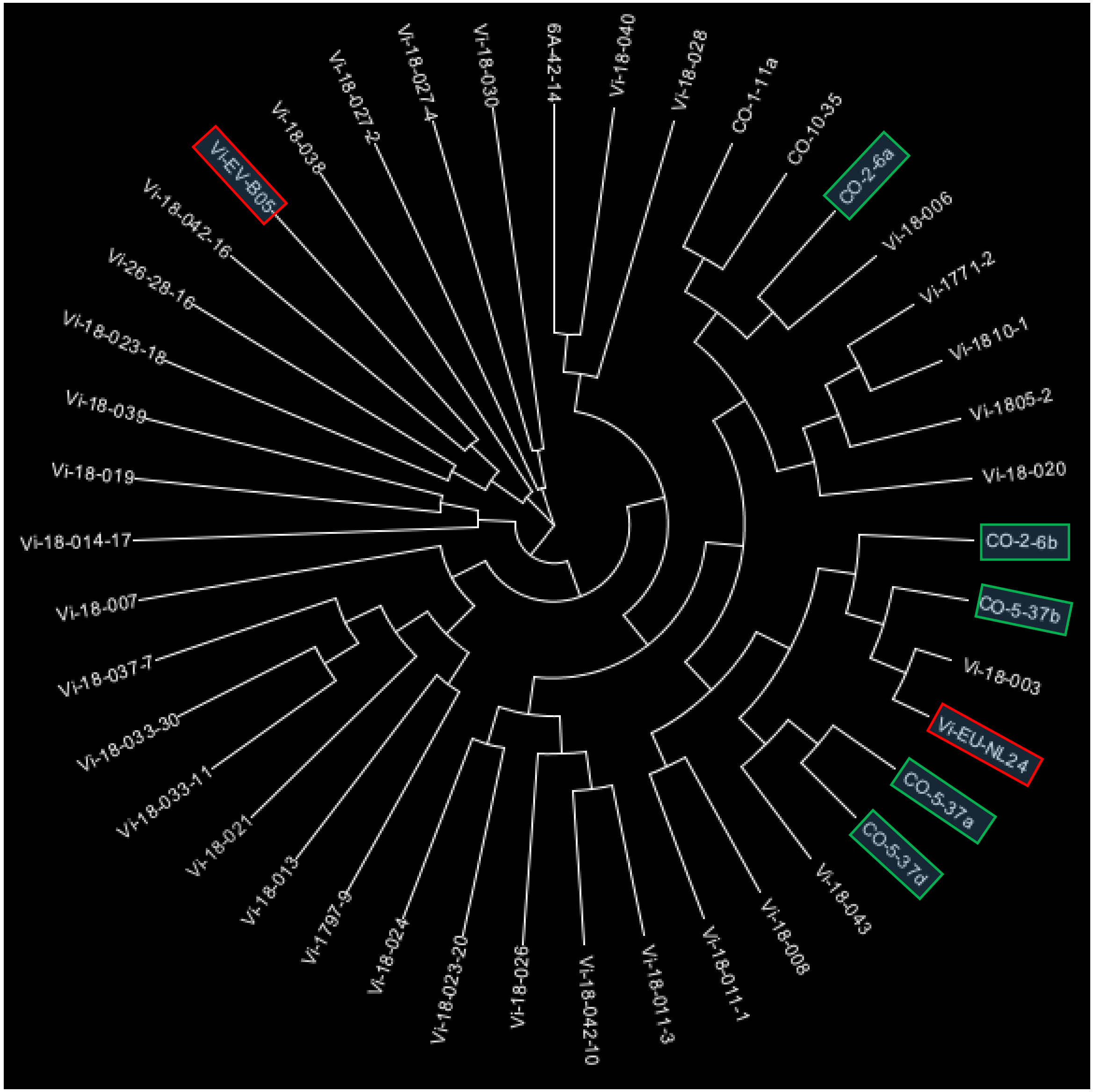
- Approx. 150 isolates from NY, Indiana, Michigan, New Hampshire, and Vermont have been collected
- 10 well-characterized isolates have been obtained from Europe



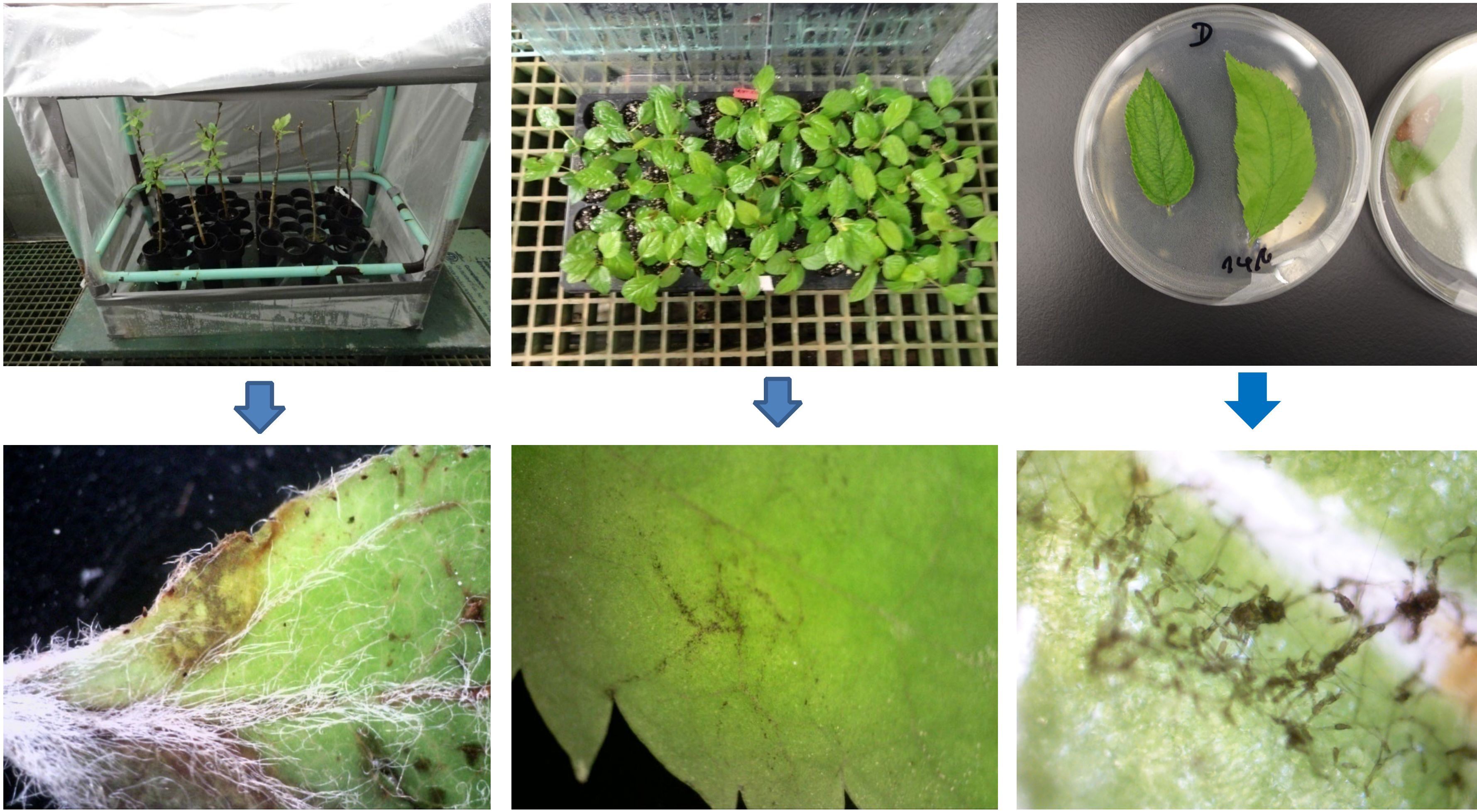


Genetic diversity of *V. inaequalis* isolates across NYS, other regions of the US and Europe

ID	Site	State	Country	Host
CO-1-11a	Geneva	NY	USA	Nova Easygro
CO-10-35	Geneva	NY	USA	MF821
CO-2-6a	Geneva	NY	USA	MF821
CO-2-6b	Geneva	NY	USA	MF821
CO-5-37a	Geneva	NY	USA	MF821
CO-5-37b	Geneva	NY	USA	MF821
CO-5-37d	Geneva	NY	USA	MF821
Vi-1771-2	Purdue	Indianna	USA	
Vi-1797-9	Purdue	Indianna	USA	
Vi-18-003	Canandaigua	NY	USA	
Vi-18-006	Geneva	NY	USA	Microcarpa
Vi-18-007	Geneva	NY	USA	Northern Spy
Vi-18-008	Geneva	NY	USA	Granny Smith
Vi-18-011-1	Geneva	NY	USA	Monroe
Vi-18-011-3	Geneva	NY	USA	Monroe
Vi-18-013	Geneva	NY	USA	Ein Shemer
Vi-18-014-17	Geneva	NY	USA	Sieversii
Vi-18-019	Geneva	NY	USA	Jonsib Crab
Vi-18-020	Geneva	NY	USA	Marshall McIntosh
Vi-18-021	Geneva	NY	USA	Crimson Beauty
Vi-18-023-18	Plattsburgh	NY	USA	
Vi-18-023-20	Plattsburgh	NY	USA	
Vi-18-024	Plattsburgh	NY	USA	McIntosh
Vi-18-026	Plattsburgh	NY	USA	McIntosh
Vi-18-027-2	Plattsburgh	NY	USA	McIntosh
Vi-18-027-4	Plattsburgh	NY	USA	McIntosh
Vi-18-030	Geneva	NY	USA	Cortland
Vi-18-033-11	Geneva	NY	USA	Microcarpa
Vi-18-033-30	Geneva	NY	USA	Microcarpa
Vi-18-037-7	Ithaca	NY	USA	
Vi-18-038	Geneva	NY	USA	Marshall McIntosh
Vi-18-039	Geneva	NY	USA	Cortland
Vi-18-042-10	Geneva	NY	USA	Inuringo
Vi-18-042-16	Geneva	NY	USA	Inuringo
Vi-18-043	Ithaca	NY	USA	Crabapple
Vi-1805-2	Purdue	Indianna	USA	
Vi-1810-1	Purdue	Indianna	USA	
Vi-26-28-16		NY	USA	
Vi-6A-42-14	Geneva	NY	USA	Golden Delicious
Vi-EU-B05			Belgium	Schone von Boskoop
Vi-EU-NL24			The Netherlands	Prima
Vi18-028	Plattsburgh	NY	USA	McIntosh
Vi18-040	Geneva	NY	USA	Marshall McIntosh



Artificial inoculation techniques to evaluate virulence of new scab isolates and fine mapping of scab loci



Artificial scab inoculation of **grafted plants, open-pollinated seedlings** and **detached leaves** of Macintosh apples. Single spore scab cultures were used to inoculate in the moist chamber under controlled temperature, light and humidity and in incubation tent.

Acknowledgements

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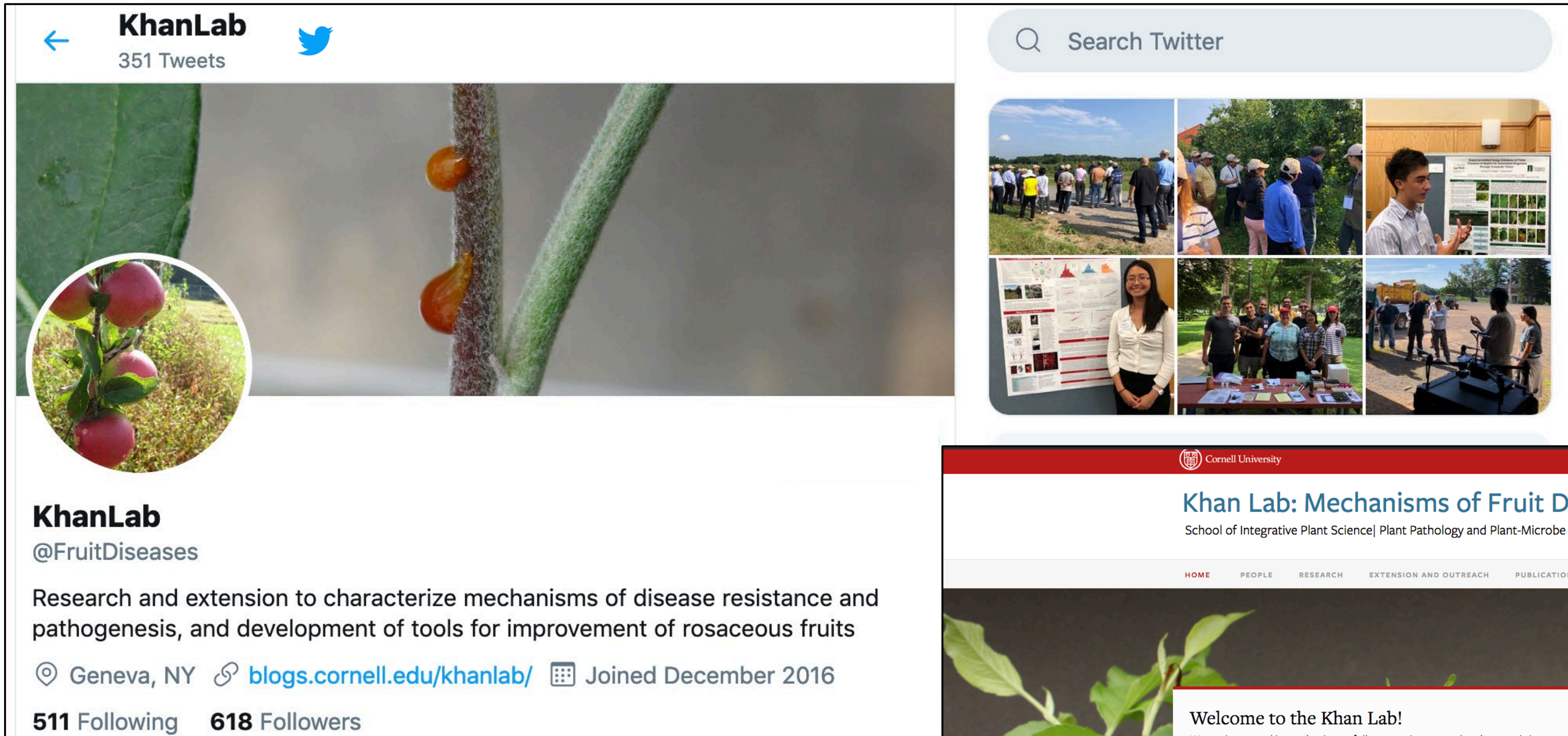
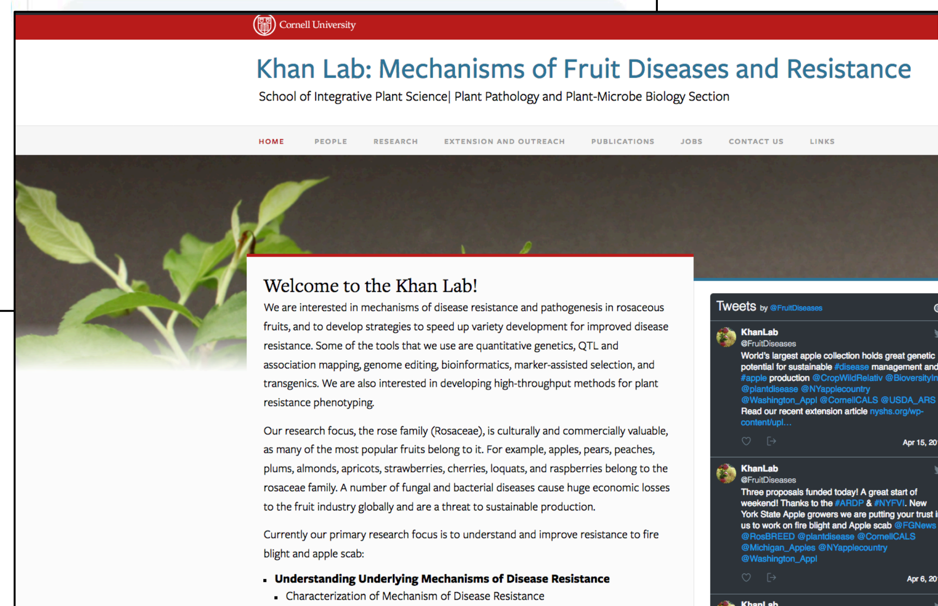
Thank you for attention!





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