

Revisiting the Early- Maturing Parson Brown Sweet Orange

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Brief History of the Parson Brown

- Identified in 1875 by J.L. Carney and named as the Carney Parson Brown (CPB).
- By the mid-1920s, the Parson Brown cultivar had become a popular early season sweet orange.
- Eventually Parson Brown fell out of favor due to
 - Seediness,
 - Peel oil content
 - Relatively lower yield versus Hamlin and
 - Poor quality fruit from blocks thought to be Parson Brown but possibly not derived from Carney Parson Brown budwood being delivered to juice plants.

Parson Brown at DPI

- During the 1950s-1960s, there were approximately 15 different clones of Parson Brown registered with the Florida Department of Agriculture Citrus Budwood Program.
- Three clones currently remain active in DPI
 - F-56-2
 - Carney Orange DPI 229-2 (CO2) and 229-3 (CO3)





PARSON BROWN



HAMLIN



CRDF PROJECT 20-014 “UNDERSTANDING THE ROLE OF SYSTEMIC ACQUIRED RESISTANCE (SAR) IN ENHANCING TOLERANCE TO HLB IN THE PARSON BROWN SWEET ORANGE”

Initiated in January 2021

OVERARCHING GOAL: To understand whether Parson Brown’s HLB tolerance is rootstock independent and identify select clones with improved horticultural qualities.

- Objective 1: Determine the effect of systemic acquired resistance (SAR) in enhanced tolerance to HLB

Hypothesis: SAR plays a positive role in the observed improved tolerance to HLB in the Parson brown trees.

- Objective 2: Monitor tree health and HLB levels

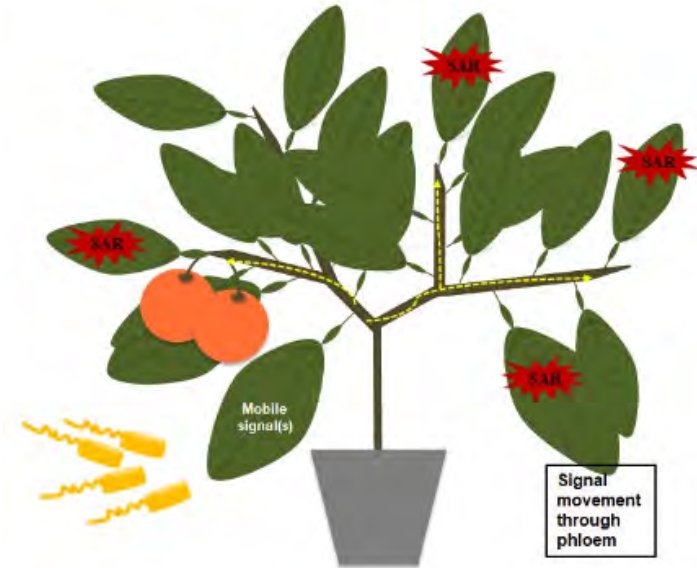
Hypothesis: Parson Brown trees will have improved tree health and lower CLas titer in the plants.

- Objective 3: Conduct juice analysis and evaluate quality parameters from selected Parson Brown trees.

Hypothesis: Select HLB tolerant trees will have acceptable juice quality

Plant Defense Mechanisms

- The plant defends itself from biotic attack, primarily by two methods.
 - Physical level defense through the production of barriers such as wax, trichomes that restrict pathogen infection.
 - Through a systemic plant defense mechanism / innate immunity mechanism.

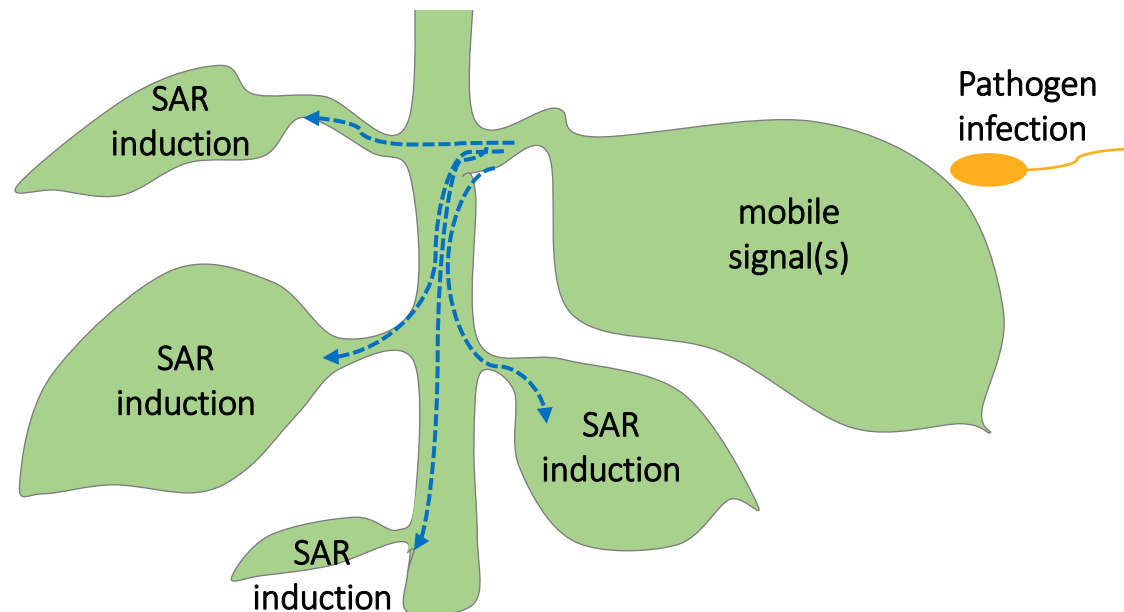


Plant Defense Mechanisms

✓ Systemic immunity

▪ Systemic acquired resistance

- SAR involves the generation of mobile signal(s) upon pathogen infection
- Translocation of those signal(s) throughout the phloem
- Protection of uninfected portions of the plants against secondary infections



Pathogen infection

Triggers accumulation of SA

SA binds to NPR1 protein reducing it from oligomer to monomer

NPR1 monomers move to the nucleus

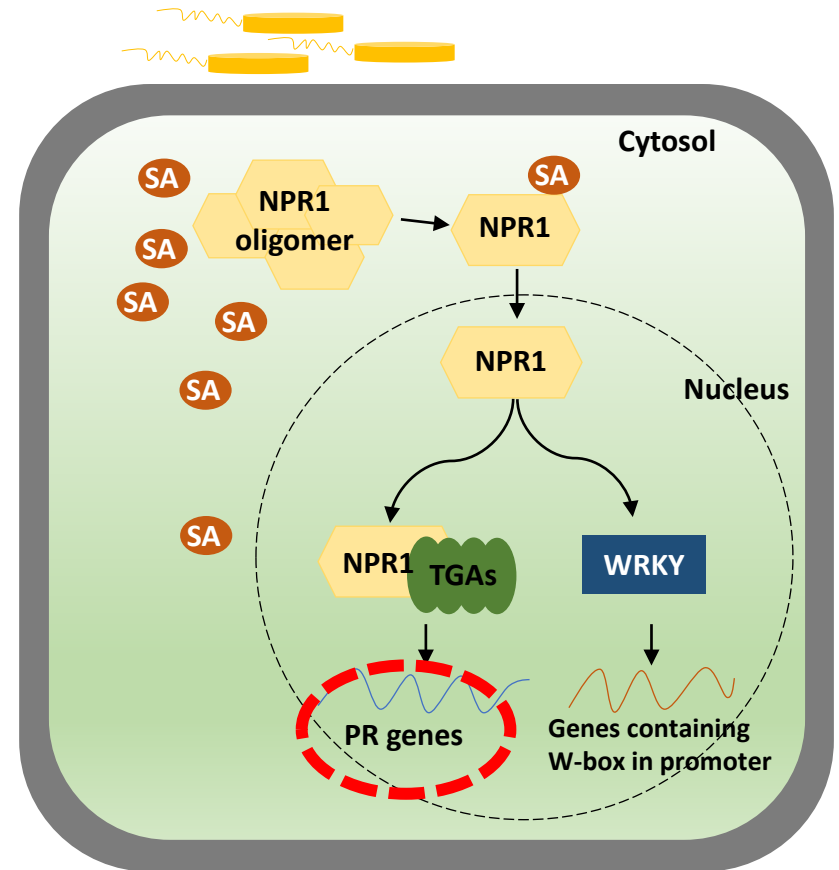
Interact with TGA transcription factors

Turn on PR and SA responsive genes

Induce expression of WRKY genes

Activates defense related genes

Activation of plant defense

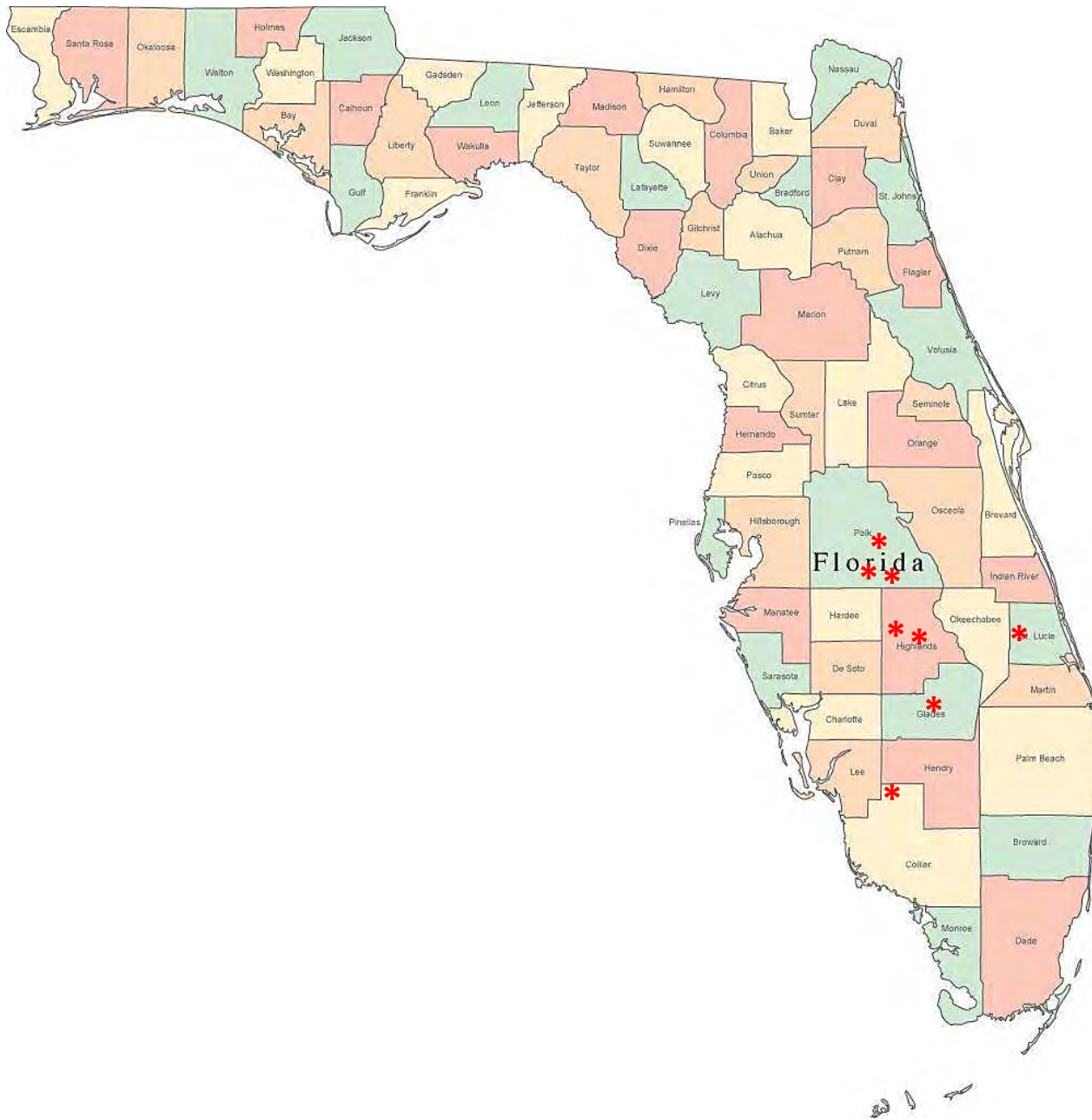


Wang et al., 2006, Mou et al., 2003

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PR1 and PR2 are efficient markers for the SAR process

- Enhanced expression of PR1 and PR2 in citrus observed in response to exogenous application of SAR inducing chemicals (Dekkers et al. 2004; Francis et al. 2009 – Dr. Jim Graham Lab).
- PR1 and PR2 have antimicrobial activities against various plant pathogenic fungi, bacteria and oomycetes (Rauscher et al. 1999, Walters and Fountaine 2009)
- Upregulation of PR2 expression was correlated with reduction of canker lesions on citrus leaves (Francis et al. 2009).
- Transgenic HLB tolerant citrus upregulating NPR1 had enhanced PR1 expression (Dutt et al. 2015).



Location	County
Southern Citrus Block	Polk
Pat McKenna Block	Polk
Camp Mack Grove	Polk
Premier Citrus (Lorida)	Highlands
Marty McKenna Block	Highlands
Premier Citrus (Ft Pierce)	St. Lucie
Wheeler Farms	Glades
Alico	Collier

Understanding the performance of Parson Brown on different rootstocks

Location	Scion	Rootstock
Southern Citrus (Haines City)	PB 1-2-3	Unknown
McKenna (Lake Wales)	PB 1-2-3	Swingle
McKenna (Sebring)	Unknown	Swingle
Lykes (Camp Mack)	Both PB 1-2-3 and F-56-2	Swingle
Premier Citrus (Lorida)	Unknown	Carrizo
Premier Citrus (Ft Pierce)	Unknown	Cleo
Wheeler (Ortona)	PB 1-2-3	Carrizo
Alico (Immokalee)	Unknown	Swingle

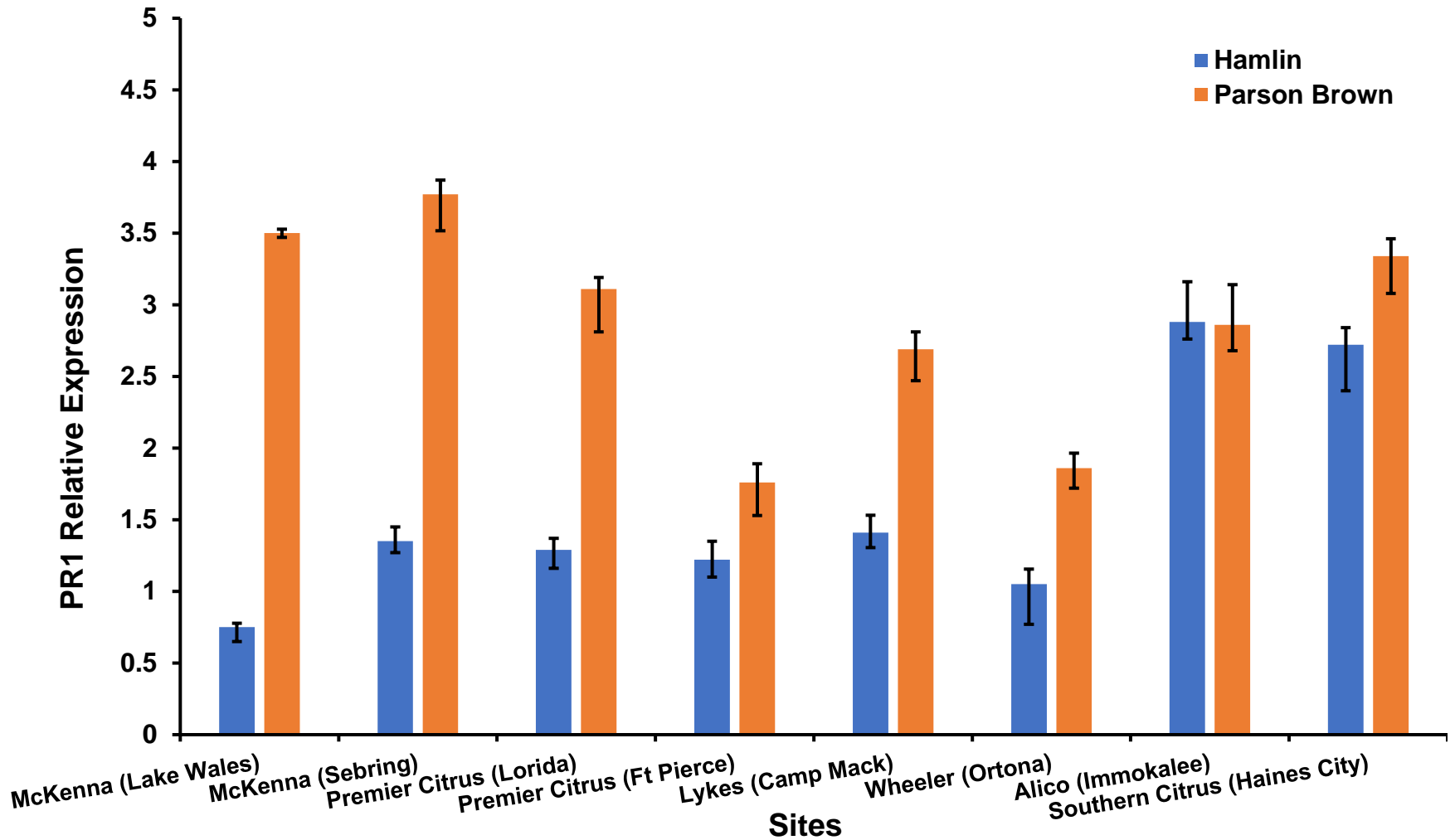
Leaf sampling



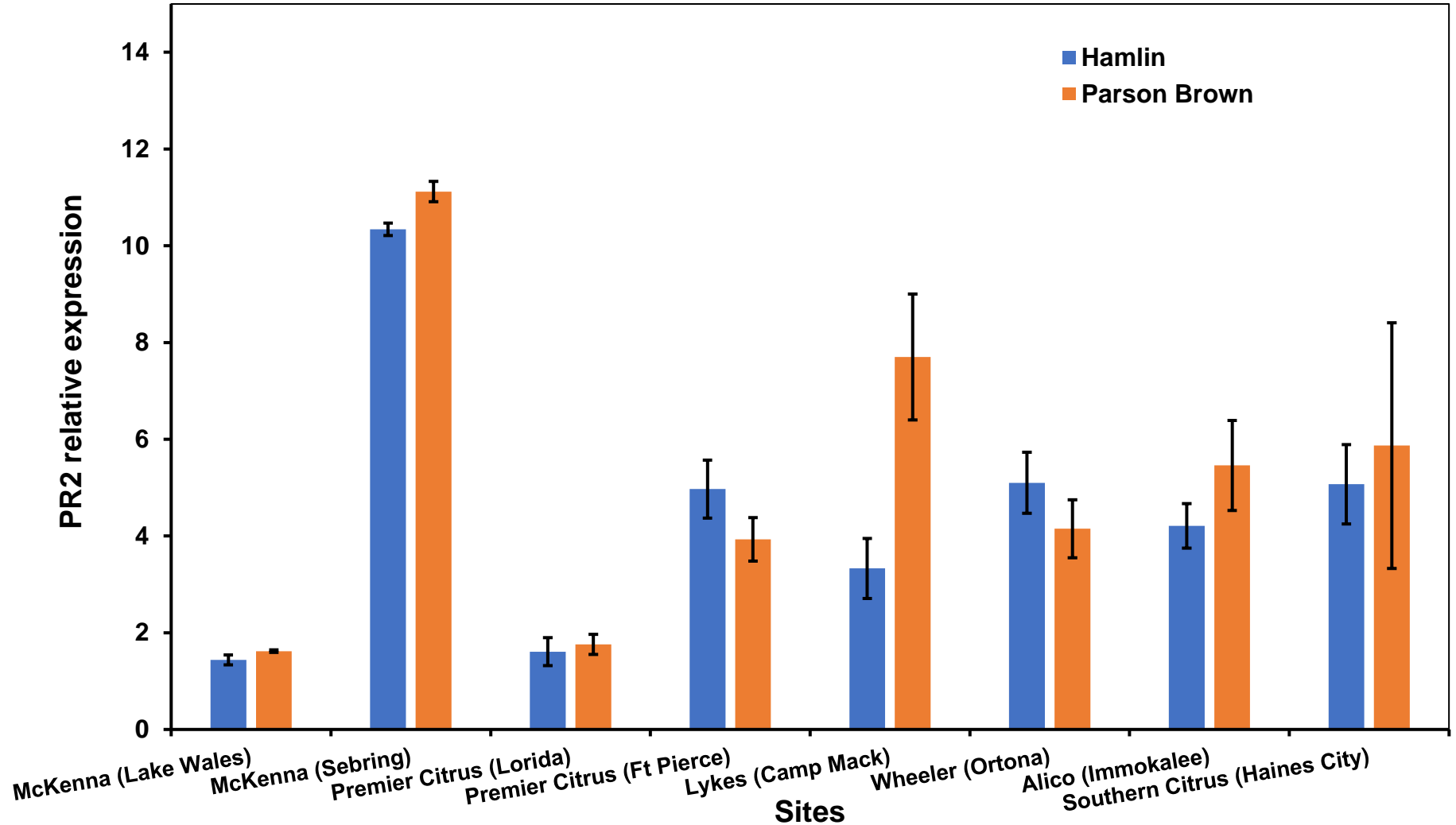
qPCR analysis of leaf samples for detection of HLB (February-March)

Sites	Parson Brown	Hamlin
McKenna (Lake Wales)	27.02 ± 0.35	28.37 ± 0.46
McKenna (Sebring)	25.96 ± 0.25	26.36 ± 0.21
Premier Citrus (Lorida)	28.16 ± 0.55	29.36 ± 0.40
Premier Citrus (Ft Pierce)	29.20 ± 0.67	28.37 ± 0.39
Lykes (Camp Mack)	29.01 ± 0.25	30.88 ± 0.41
Wheeler (Ortona)	26.23 ± 0.28	27.01 ± 0.43
Alico (Immokalee)	27.45 ± 0.44	27.60 ± 0.60
Southern Citrus (Haines City)	27.99 ± 0.42	27.19 ± 0.37

PR1 expression during February-March 2021



PR2 expression during February-March



Key Findings

- All Parson Brown trees irrespective of the location have much lower fruit drop compared to Hamlin.
- Blotchy mottle on leaves of Parson Brown trees were less pronounced than Hamlin, even though trees had comparable Clas titer.
- Parson Brown trees had better canopy density with much lower dieback than Hamlin.

Ongoing Work

- Collecting Parson Brown and Hamlin leaf samples at a quarterly basis from each location.
 - DNA analysis for HLB evaluation.
 - RNA analysis for gene expression.
- Starch content, chlorophyll fluorescence levels, leaf nutrient analysis will be conducted in September.
- Fruits will be evaluated through the CREC Pilot plant in November for fruit weight, % juice, lbs solids, % acid, , total brix, brix/acid ratio, and juice color.

What can we do with the knowledge gained from this study?

- The juice quality standards have changed with the advent of HLB.
 - Reintroduce the PB1-2-3 and other clones into the DPI's parent tree program.
- Establish field trials of select PB clones on different rootstocks.
- Understand the genetic makeup of select PB clones
 - Pacbio and other modern NGS sequencing techniques has significantly reduced the costs needed to sequence a genome.
- Reduce the no of seeds and the peel oil content through irradiation.
 - Several hundred buds of F-56-2 and Carney Orange DPI 229-2 have already been irradiated and budded onto US942.

Acknowledgements

- John Updike
- Gary England
- Brandon Page
- Pat and Marty McKenna
- Holly Chamberlain, Randy Weaver, David Bass, Russell Walker
- David Wheeler and Anthony Pascher
- Glen Blake
- John Gose
- Tommy Thayer, Greg Taylor.
- CRDF for funding this project.

A photograph of a large, thick tree trunk in an orchard. The tree trunk is the central focus, showing a rough, textured bark. The ground around the tree is covered with dry leaves, twigs, and several pieces of fruit, some green and some yellow. In the background, more trees and fruit are visible, along with black irrigation lines running across the ground. The overall scene is brightly lit, suggesting a sunny day.

Thank you

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