

# Marker-Assisted Selection in Tropical Fruits

Alan Chambers  
Advanced Plant Breeding Guest Lecture  
2018-10-18

# Outline

Introduction

Big Decisions

Looks Like Progress

Discussion Activity

Marker-assisted Selection...Tropical Fruit Style

Conclusions

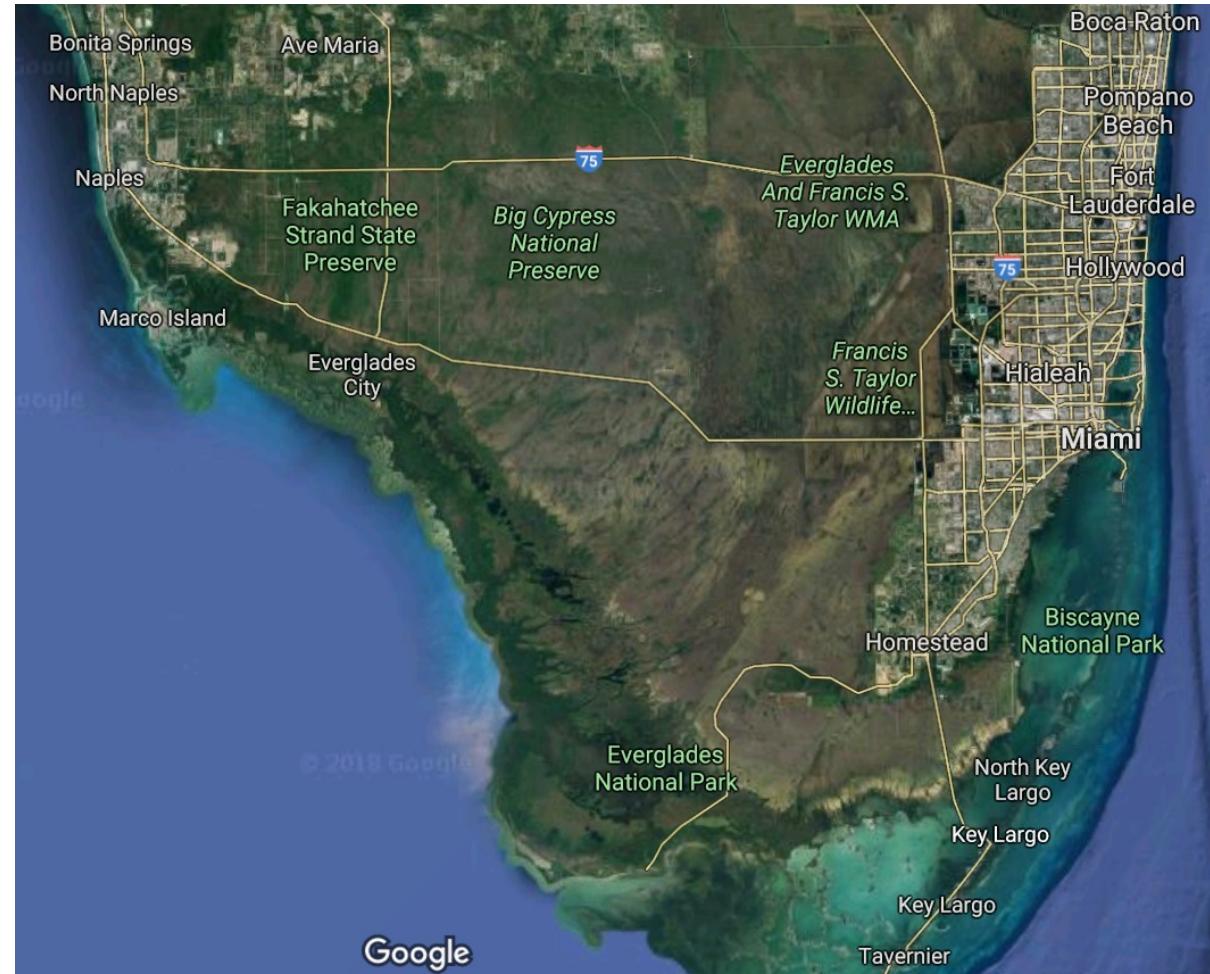
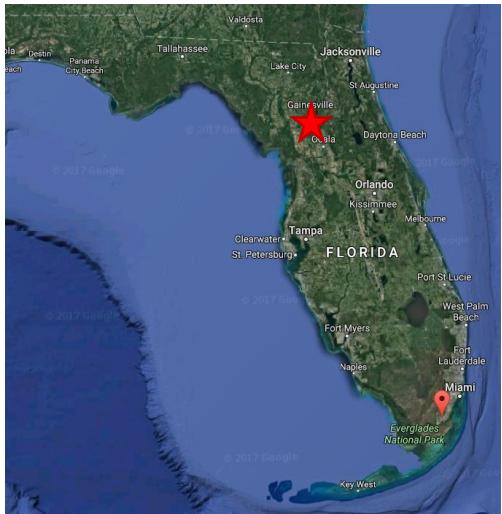
# Introduction

# UF Tropical REC

Established in 1929, 160 acres, 17 faculty

Pathology, entomology, soils, hydrology,  
tropical/subtropical fruits/vegetables,  
ornamentals, natural resources

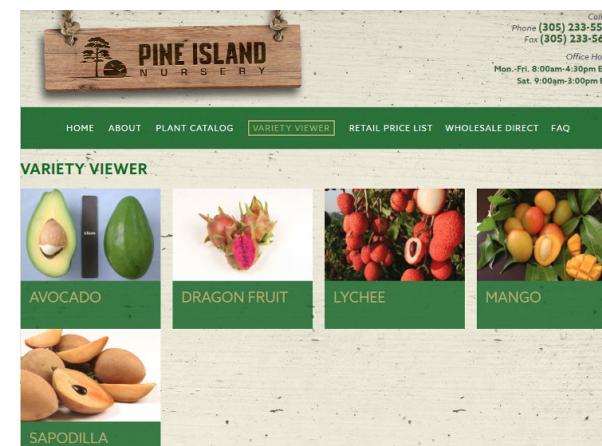
Supporting ~\$1B local agricultural economy



# Substrate



# Meet Your Clientele



# My Program

Test and develop tropical fruit crops with...***pest resistance, stress tolerance, fruit quality***...that results in ***cultivars for commercial production***

80% research, 20% extension

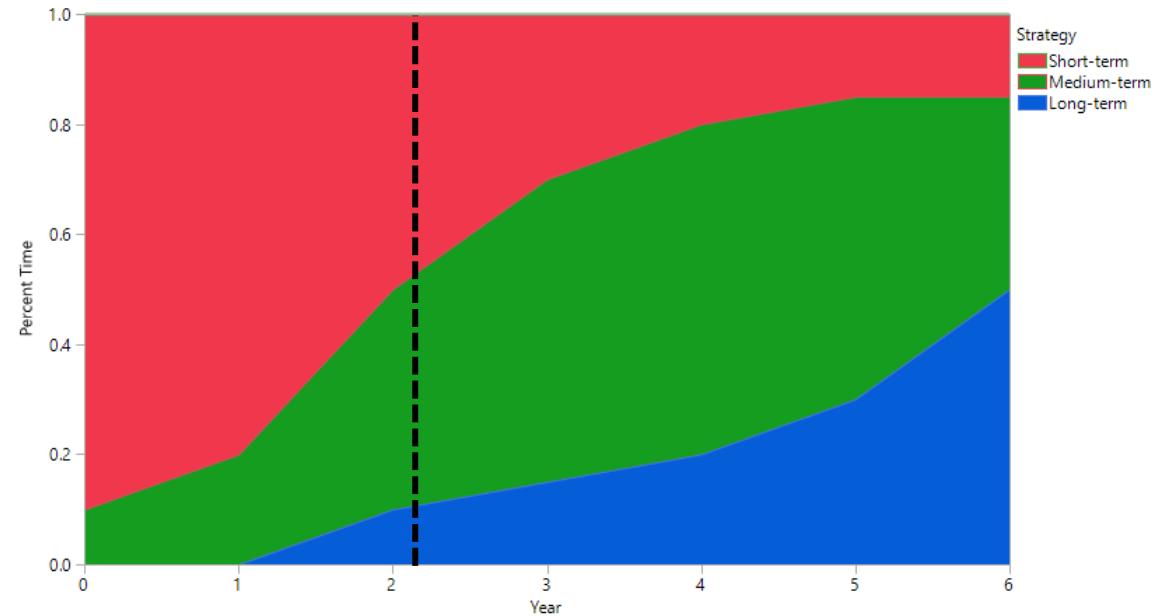
## Milestones

Lab completed December 2017

2 PhD students, 1 MS

1 OPS staff

Part-time biologist



## Grants

UF: Early Career, Equipment 2017, Interns 2017/2018, Dean's 2018 Equipment, PBWG

External: SCRI, FSGA, USAid, MF Farm, Brooks' Tropicals

# Brunelleschi's Dome



# Big Decisions

“How do I even start the building?”

# Options in South Florida



A. Chambers, UF

# Tropical Fruit Species at TREC

Common name	Species
Avocado	<i>Persea americana</i>
Ackee	<i>Blighia sapida</i>
Banana and plantain	<i>Musa</i> sp
Black sapote	<i>Diospyros ebe</i>
Canistel	<i>Pouteria campechiana</i>
Coconut	<i>Cocos nucifera</i>
Custard apple	<i>Annona</i> sp
Green sapote	<i>Calocarpum viride</i>
Guava	<i>Psidium guajava</i>
Jackfruit	<i>Artocarpus heterophyllus</i>
Longan	<i>Dimocarpus longan</i>
Loquat	<i>Eriobotrya japonica</i>
Lychee	<i>Litchi chinensis</i>
Macadamia	<i>Macadamia</i> spp.
Mamey sapote	<i>Pouteria sapota</i>
Mango	<i>Mangifera</i> sp
Miracle fruit	<i>Synsepalum dulcificum</i>
Papaya	<i>Carica papaya</i>
Passion fruit	<i>Passiflora</i> spp.
Sapodilla	<i>Manilkara zapota</i>
Soursop	<i>Annona</i> sp
Spanish lime	<i>Melicoccus bijugatus</i>
Star apple	<i>Chrysophyllum cainito</i>
Star fruit	<i>Averrhoa carambola</i>
Strawberry	<i>Fragaria x ananassa</i>
Sugar apple	<i>Annona</i> sp
Tamarind	<i>Tamarindus indica</i>
Velvet apple	<i>Diospiros discolor</i>
Wampi	<i>Clausena lansium</i>
Wax jambu	<i>Syzygium samarangense</i>
White sapote	<i>Casimiroa edulis</i>



# Long-Term Prospects

Common name	Species	Accessions
Mango	<i>Mangifera</i> sp	143
Banana and plantain	<i>Musa</i> sp	90
Avocado	<i>Persea americana</i>	78
Papaya	<i>Carica papaya</i>	30
Star fruit	<i>Averrhoa carambola</i>	22
Sapodilla	<i>Manilkara zapota</i>	21
Guava	<i>Psidium guajava</i>	20
Mamey sapote	<i>Pouteria sapota</i>	19
Loquat	<i>Eriobotrya japonica</i>	18
Passion fruit	<i>Passiflora</i> spp.	16
Strawberry	<i>Fragaria x ananassa</i>	15
Longan	<i>Dimocarpus longan</i>	13
Jackfruit	<i>Artocarpus heterophyllus</i>	12
Miracle fruit	<i>Synsepalum dulcificum</i>	10
Wax jambu	<i>Syzygium samarangense</i>	7
Lychee	<i>Litchi chinensis</i>	6
Star apple	<i>Chrysophyllum cainito</i>	6
Custard apple	<i>Annona</i> spp.	5
Soursop	<i>Annona muricata</i>	5
Sugar apple	<i>Annona glabra</i>	5
Canistel	<i>Pouteria campechiana</i>	4
Spanish lime	<i>Morinda citrifolia</i>	4
White sapote	<i>Morinda citrifolia</i>	4
Coconut	<i>Cocos nucifera</i>	2
Macadamia	<i>Macadamia</i> spp.	2
Black sapote	<i>Diospyros digyna</i>	1
Green sapote	<i>Calocarpum viride</i>	1
Tamarind	<i>Tamarindus indica</i>	1
Velvet apple	<i>Diospyros velutina</i>	1
Wampi	<i>Clausena lanigera</i>	1



# Long-Term Prospects

Common name	Species	Accessions	So.FL Production	Industry Support
Avocado	<i>Persea americana</i>	78	+++	+++
Mango	<i>Mangifera</i> sp	143	+++	+++
Passion fruit	<i>Passiflora</i> spp.	16	+++	+++
Papaya	<i>Carica papaya</i>	30	++	++
Star fruit	<i>Averrhoa carambola</i>	22	+++	++
Banana and plantain	<i>Musa</i> sp	90	++	++
Miracle fruit	<i>Synsepalum dulcificum</i>	10	++	++
Strawberry	<i>Fragaria x ananassa</i>	15	++	+++
Longan	<i>Dimocarpus longan</i>	13	++	+
Guava	<i>Psidium guajava</i>	20	++	+
Jackfruit	<i>Artocarpus heterophyllus</i>	12	+	+
Licot	<i>Eriobotrya japonica</i>	18	+	+
Manzey sapote	<i>Pouteria sapota</i>	19	+	+
Sapodilla	<i>Manilkara zapota</i>	21	+	+

A large red 'X' mark is positioned on the left side of the table, spanning from approximately row 10 to row 20 of the slide's height.

# Looks Like Progress

“Scaffolding for that impossible roof.”

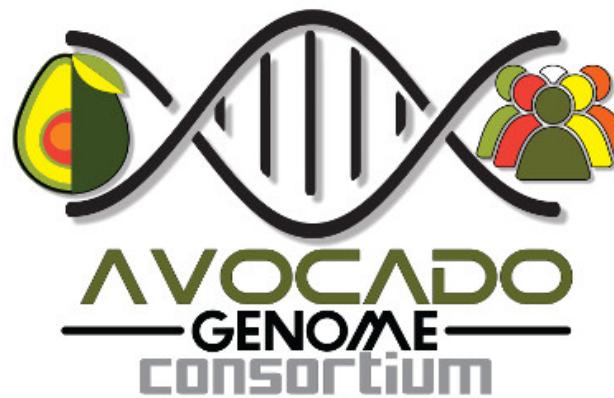
# Avocado

Title: Application of genomic tools to avocado (*Persea americana*)  
breeding: SNP discovery for genotyping and germplasm  
characterization

<sup>1</sup>Kuhn, David N\*†, <sup>2</sup>Livingstone III, Donald S†, <sup>3</sup>Richards, Jennifer H, <sup>4</sup>Manosalva, Patricia, <sup>5</sup>Van den Berg, Noelani, <sup>6</sup>Chambers, Alan H



Title: Avocado (*Persea americana*) Genome

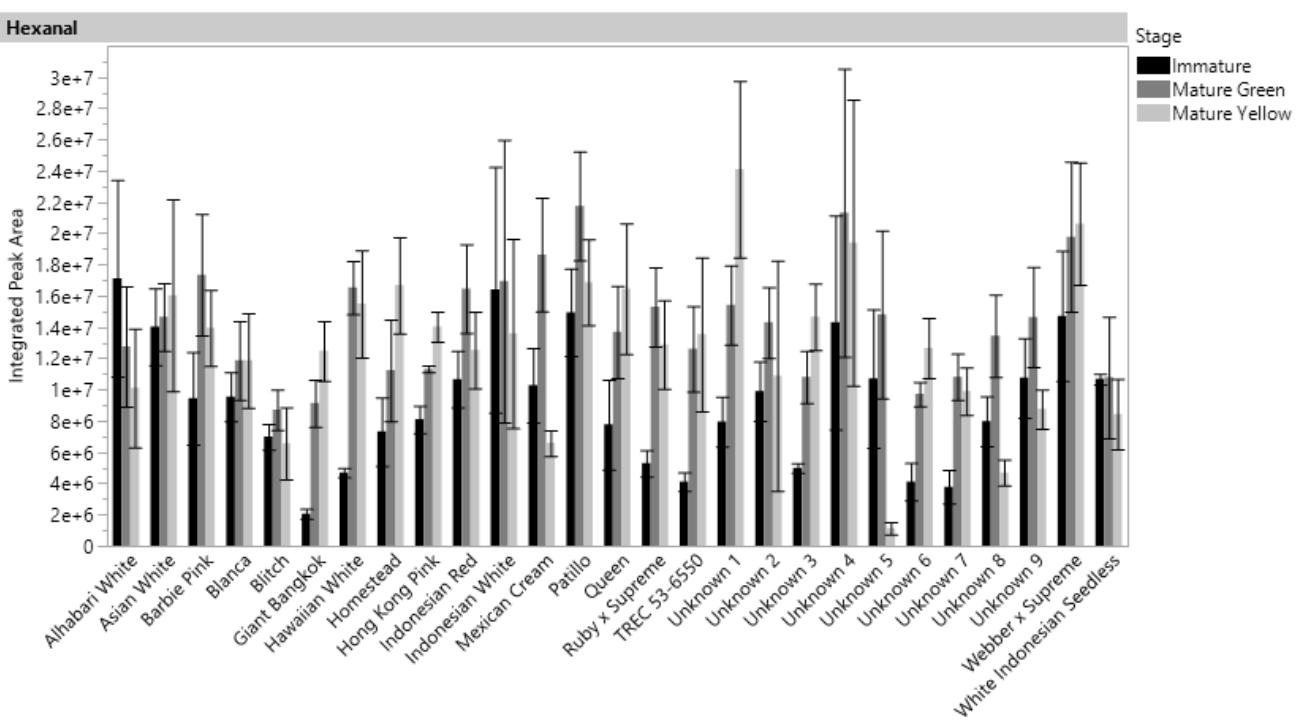
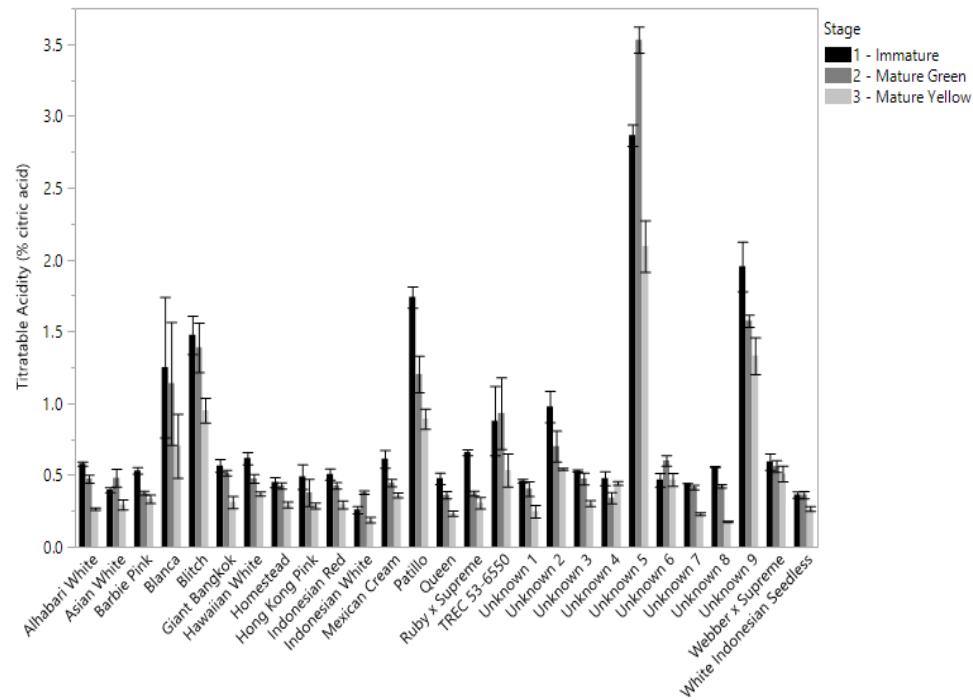


# Guava

**TITLE:** Assessment of fruit aroma for twenty-seven guava (*Psidium guajava*) accessions through three fruit developmental stages

Pamela Moon<sup>1</sup>, Yuqing Fu<sup>1</sup>, Jinhe Bai<sup>2</sup>, Anne Plotto<sup>2</sup>, Jonathan Crane<sup>1</sup>, Alan Chambers<sup>1\*</sup>

<sup>1</sup>Tropical Research and Education Center, University of Florida, 18905 SW 280<sup>th</sup> St, Homestead, Florida,



# Commercial Strawberry

1 TITLE: Late Season Yield and Fruit Quality of *Fragaria x ananassa* in Southern Florida

2 Maria Brym<sup>1</sup>, Yuqing Fu<sup>1</sup>, Pamela Moon<sup>1</sup>, Alan Chambers<sup>1\*</sup>

Pillet et al. BMC Plant Biology (2017) 17:147  
DOI 10.1186/s12870-017-1088-1

BMC Plant Biology

RESEARCH ARTICLE

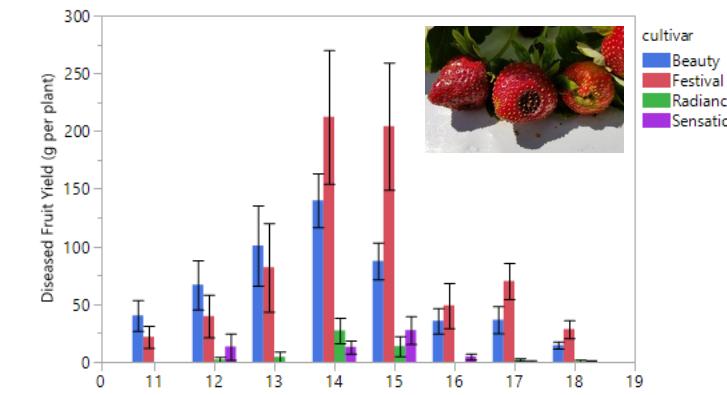
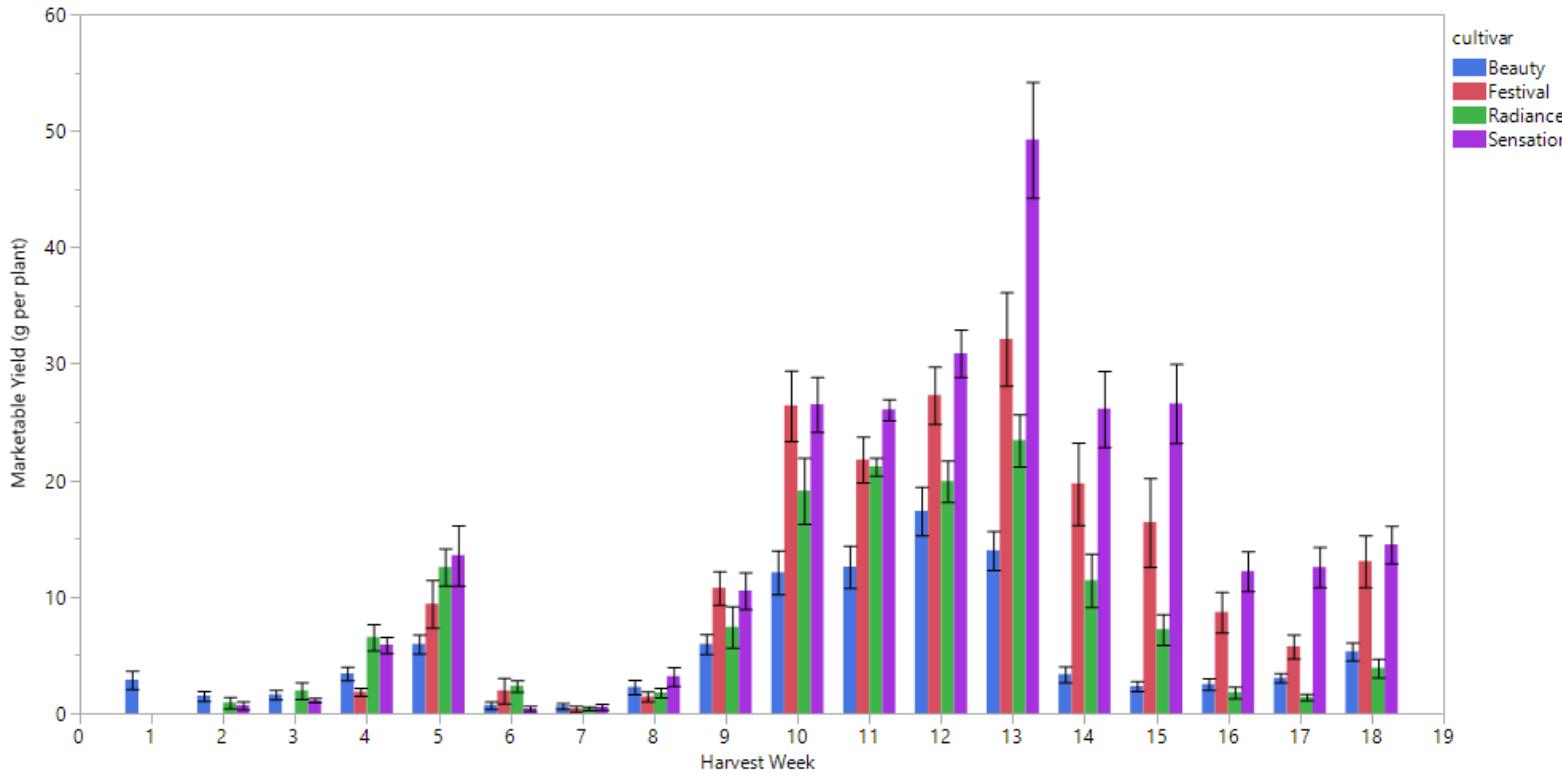
Open Access



CrossMark

Identification of a methyltransferase catalyzing the final step of methyl anthranilate synthesis in cultivated strawberry

Jeremy Pillet<sup>1</sup>, Alan H. Chambers<sup>1,2</sup>, Christopher Barbe<sup>1,6</sup>, Zhilong Bao<sup>1</sup>, Anne Plotto<sup>3</sup>, Jinhe Bai<sup>3</sup>, Michael Schwieterman<sup>4,6</sup>, Timothy Johnson<sup>4,6</sup>, Benjamin Harrison<sup>1</sup>, Vance M. Whitaker<sup>1,5</sup>, Thomas A. Colquhoun<sup>4,6</sup> and Kevin M. Folta<sup>1,6</sup>



# Clientele Field Day

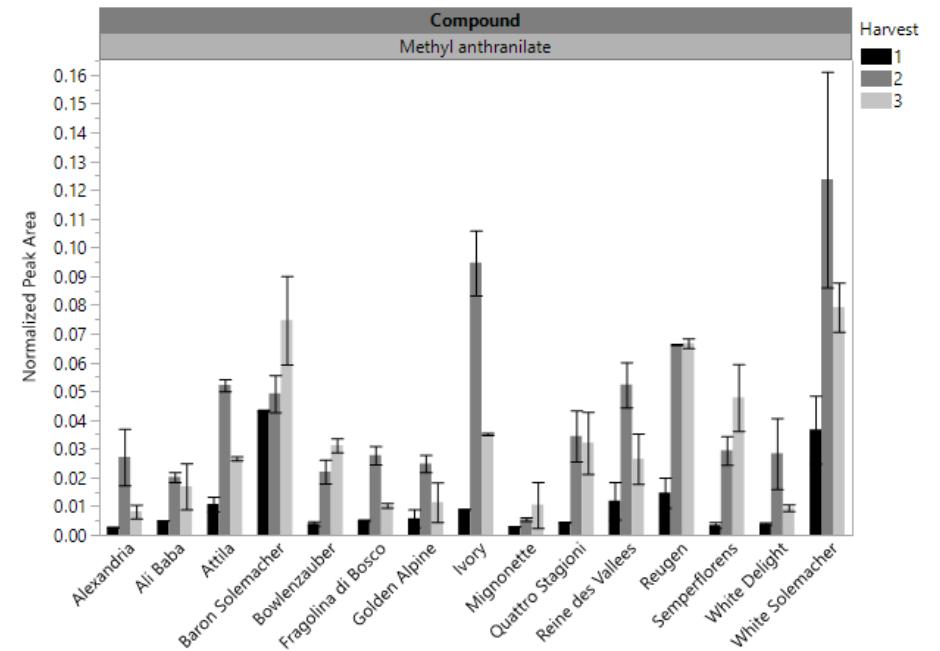
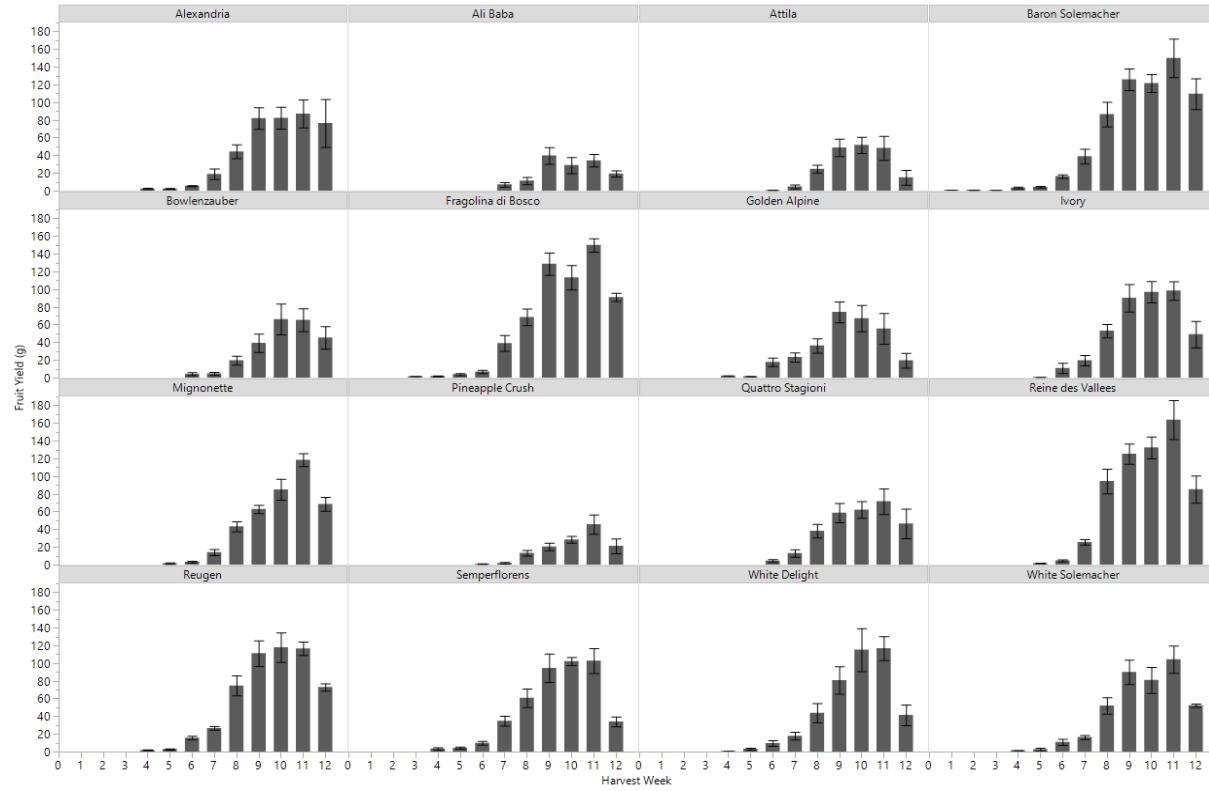


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# Diploid Strawberry

1 TITLE: Yield and Fruit Quality of Sixteen *Fragaria vesca* Accessions

2 Pamela Moon<sup>1</sup>, Yuqing Fu<sup>1</sup>, Juliette Choisel<sup>1</sup>, Jinhe Bai<sup>2</sup>, Anne Plotto<sup>2</sup>, Alan Chambers<sup>1\*</sup>



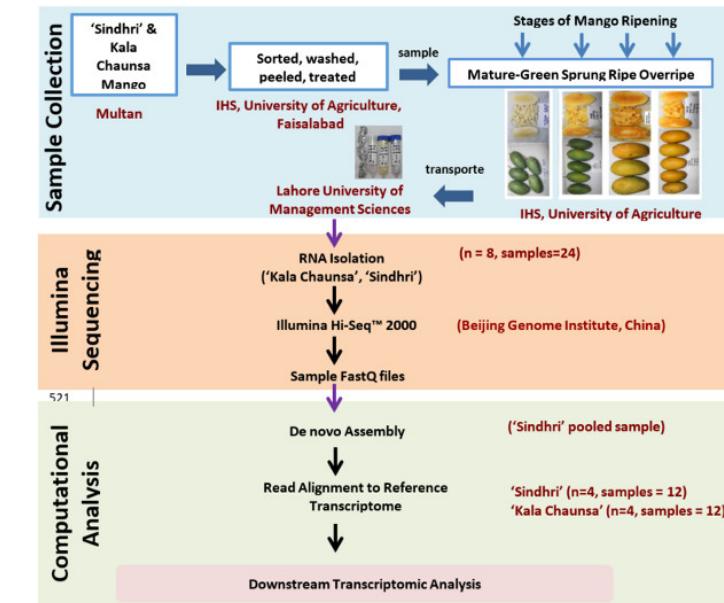
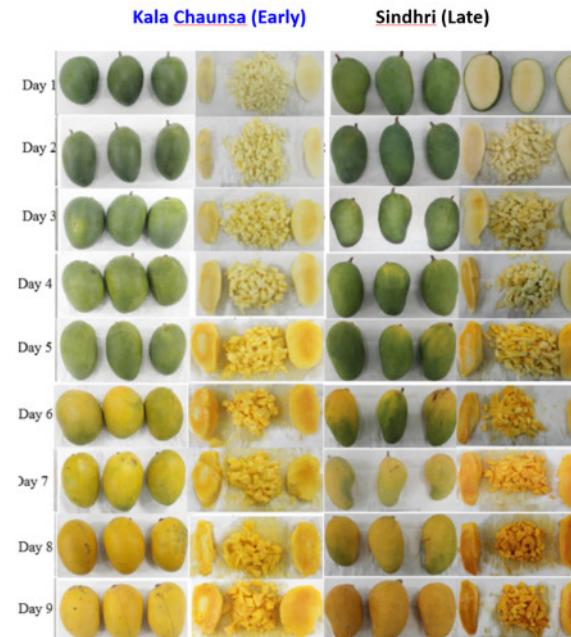
# Mango

1 TITLE: Phenotypic, biochemical and transcriptional changes  
2 correlate with temporal patterns of ripening in elite Pakistani  
3 mango cultivars

4 Akhlaq Farid<sup>1,\*</sup>, Maheen Humayun<sup>1,5,\*</sup>, Anam Siddiqui<sup>1,\*</sup>, Bilal Haider<sup>1,6</sup>, Alan H  
5 Chambers<sup>2,7</sup>, Alec Hayes<sup>2,8</sup>, Asad Ali<sup>3</sup>, Ahmad Sattar Khan<sup>3</sup>, Ishtiaq Rajwana<sup>4</sup>,  
6 Muhammad Tariq<sup>1</sup>, Aziz Mithani<sup>1,#</sup> and Ahmed Jawaad Afzal<sup>1,#</sup>

1 TITLE: Transcriptome profiles reveal distinct gene expression patterns during  
2 different stages of fruit ripening in *Mangifera indica*

3 Kahkeshan Hijazi<sup>1</sup>, Akhlaq Farid<sup>1,5</sup>, Anam Siddiqui<sup>1</sup>, Sadia Banaras<sup>1</sup>, Alan H Chambers<sup>2,6</sup>, Alec  
4 Hayes<sup>2,7</sup>, Asad Ali<sup>3</sup>, Ahmad Sattar Khan<sup>3</sup>, Ishtiaq A. Rajwana<sup>4</sup>, Muhammad Tariq<sup>1,#</sup>, Ahmed  
5 Jawaad Afzal<sup>1,#</sup> and Aziz Mithani<sup>1,#</sup>

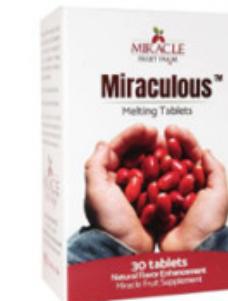


# Banana and Plantain

Nematode survey/resistance  
Fruit quality



# Miracle Fruit



Miraculous (30 Melting  
Miracle Fruit Tablets)

\$30.00

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100 Fresh Picked Fruit

\$67.50 \$147.50

[VIEW PRODUCT](#)



Pure Miracle Fruit Powder (1  
kg)

\$2,500.00

[VIEW PRODUCT](#)



**Miami Cancer Institute**

BAPTIST HEALTH SOUTH FLORIDA

The Miracle Fruit Farm's Miraculous™ tablets are now available through the pharmacy of the Miami Cancer Institute. They are the first and only dietary supplement ever approved by Baptist for sale and distribution to their patients within their entire network of hospitals.

# Passion Fruit

~100 acres, ~\$1.5-2M

'Possum Purple' major cultivar

Soil-borne pathogen complex

Native species



# Papaya

300-500 acres

Green and dessert markets

PRSV-resistance deregulated

Premium for Solo types



# Vanilla

Enthusiast collectors and four native species  
Suitable climate for commercial production  
High-value crop with agro-tourism potential



## CHEMISTRY

### The Problem with Vanilla

After vowing to go natural, food brands face a shortage of the favored flavor  
*Scientific American*

### Madagascar 2: Vanilla prices soar again

Jan. 25, 2016 - by Jeff Gelski  
Food & Business News

### Vanilla bean prices rising sharply again for local businesses

By Alli Knothe, Times Staff Writer  
Friday, January 27, 2017 5:31am

Tampa Bay Times

### Vanilla shortage leads to surge in prices

CBS THIS MORNING  
FEBRUARY 14, 2017, 8:20 AM | Vanilla bean prices have soared because of a shortage in Madagascar. The island country has more than three-quarters of the world's vanilla fields. Ben Tracy shows how this is driving up prices for many favorite treats.

# Swamping



A. Chambers, UF

Photo credit: A Chambers

# Rethinking my life decisions...



# Discussion Activity

“How are you going to build the roof?”

# Breeding The Typical Tropical Fruit

Pros	Cons
High value	Lack of government funding
Consumer resonance	Relative obscurity
Open research areas	Underdeveloped genomic resources
Collaboration	Not <i>Arabidopsis</i> ...ever
Industry support	Long generation times
Fun/exciting	Major constraints from farm to fork

# Discussion

When would you implement marker-assisted selection in a tropical fruit breeding program?

How would you start MAS in a tropical breeding program?

Think about traits, funding, collaboration, germplasm, strategy

# **Marker-assisted Selection (tropical fruit style)**

**Mango**

# A Pattern of Success

1. Identify target species
2. Develop markers *de novo* at low cost (publish)
3. Genotype collections, diversity (publish)
4. Phenotype collections (publish)
5. Combine genotypic and phenotypic data (publish)
6. Implement selection in breeding program

# The King

## Breeding Strengths

High value, international appeal

Quarantine treatments = poor quality imports

Funding sources

Global collaborators

Genome seq pending (2019)

Diversity

## Breeding Limitations

Crossing efficiency

Juvenile period

Tree size

Cultivar misidentification

Polyembryonic seeds



# MAS

- ✓ 1. Identify target species
- ✓ 2. Develop markers *de novo* at low cost (publish)
- ✓ 3. Genotype collections, diversity (publish)
  - >2,000 accessions using 272 markers
- 4. Phenotype collections (publish)
- 5. Combine genotypic and phenotypic data (publish)
- 6. Implement selection in breeding program

## Hybrids vs selfed progeny

Groups	Silhouette	Inds	Contig5810	Contig1365	mango_rep_c9129	Contig6253	Mi_0481	mango_rep_c42460	Mi_0494	Contig2080	Contig1778	mango_rep_c51872
256	0.48	Mi1467_TOMMY ATKINS_FL	1	1	1	1	1	2	2	2	2	2
256	0.16	PC198::WB2-04-66::T/A 09-05	1	1	1	1	1	2	2	2	2	2
256	0.14	PC200::WB2-04-68::T/A 01-01	1	1	1	1	1	2	2	2	2	2
256	0.13	PC202::WB2-04-70::T/A 01-01	1	1	1	1	1	2	2	2	2	2
256	0.17	PC203::WB2-04-71::T/A 01-01	1	1	1	1	1	2	2	2	2	2
256	-0.06	PC207::WB2-04-75::T/A 02-03	3	3	1	3	1	2	3	2	3	2
256	-0.11	PC309::WB2-07-46::T/A 05-02	1	3	3	1	1	3	2	3	2	3
256	0.06	PC346::WB2-08-74::T/A 01-01	3	1	3	3	3	3	2	3	2	2
256	0.07	PC351::WB2-09-04::T/A 01-05	1	3	1	3	3	2	3	3	3	3

Table 1. Sequencing summary of 'Tommy Atkins' RNA.

Sample	Read pairs Q>30 <sup>1</sup>	Total contigs (transcripts) <sup>2</sup>
Flowers	38,710,821	104,094
Leaf	39,475,130	94,929
Seed	43,687,492	82,447
Seed Coat	9,433,120	33,124
Exocarp	32,910,583	83,968
Mesocarp	33,507,164	78,666
Mix <sup>3</sup>	48,539,457	100,050
<b>Total</b>	<b>246,263,767</b>	<b>577,278</b>

<sup>1</sup>Read pairs with an Illumina quality score (Q) greater than 30.

<sup>2</sup>Contigs (transcripts) are assembled reads representing expressed genes.

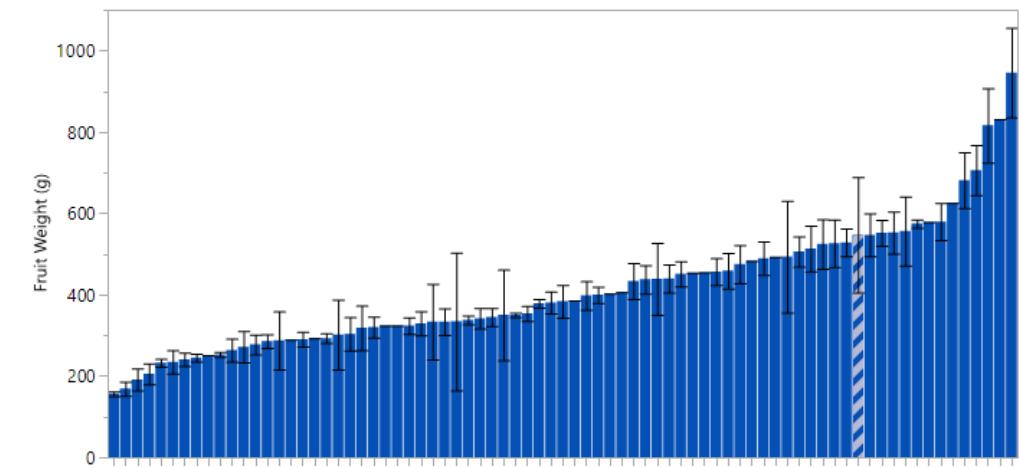
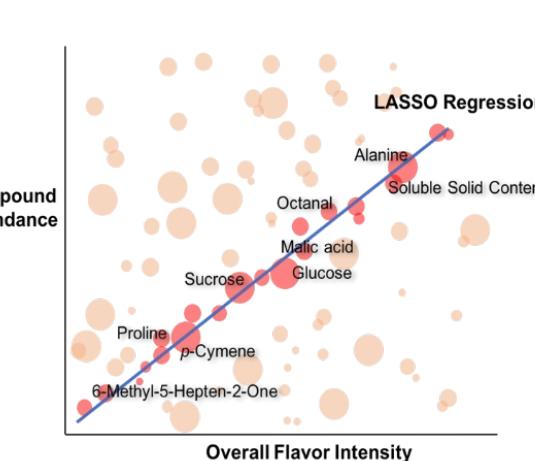
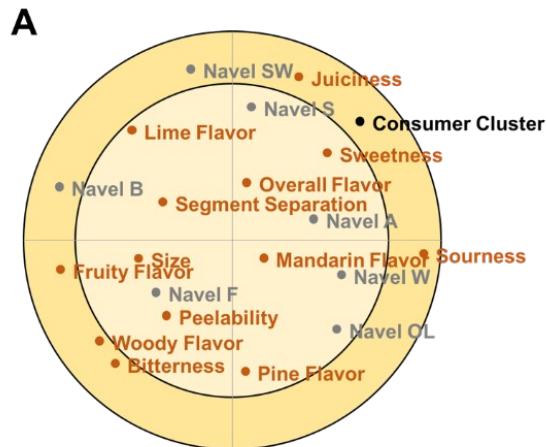
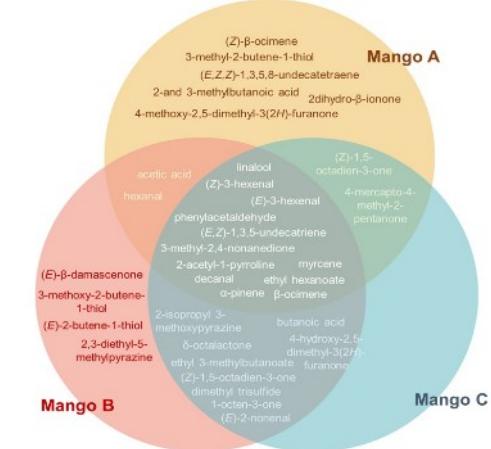
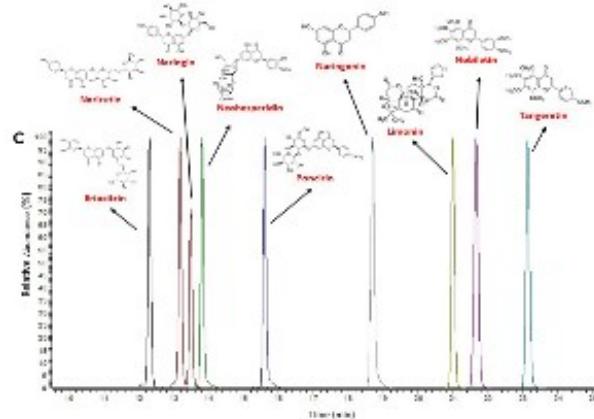
<sup>3</sup>Pooled libraries from all tissues.

Table 4. Filtering of mango SNPs to identify SNPs for assay design.

Filter <sup>1</sup>	# of SNPs after filter	% of total SNPs
0	381,535	100.0
1	187,872	49.2
2	62,577	16.4
3	30,382	8.0
4	15,059	3.9
5	3,168	0.8
6	965	0.25
7	640	0.17

<sup>1</sup>See filter description in Materials and Methods.

# Phenotype Collections



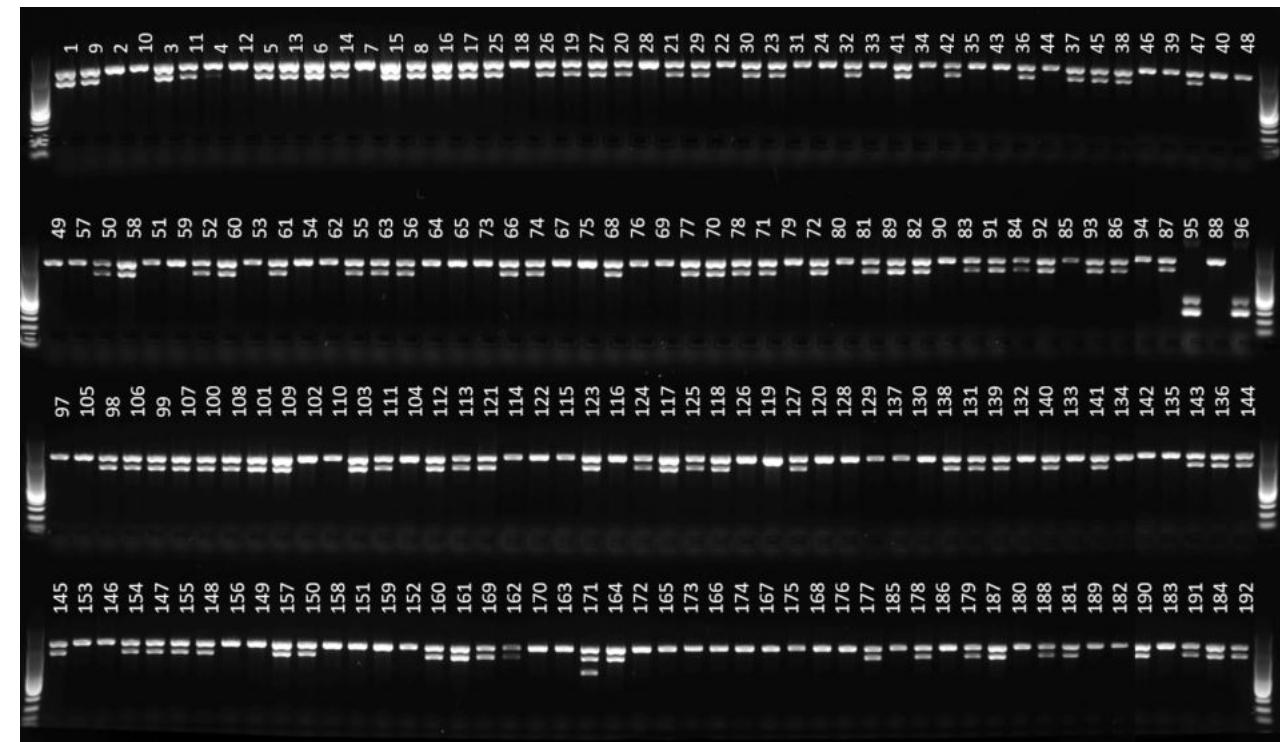
# Anticipated Results

Seedling selection for important traits

Disease resistance (fruit blemishes)

Confirm hybrid progeny

Superior quality



# Conclusions

# From Wild to Cultivars

“Cultivated *Vanilla planifolia* is very similar to the wild plants of its species and it really cannot be said to be a domesticated plant, since there has not been a selection or plant breeding.”

- Miguel Soto Arenas, 1999



# Acknowledgements

## Chambers' Lab

Maria Brym, OPS, strawberry

Sarah Brewer, PhD, papaya

Lynhe Demesyeux, MS, banana/plantain

Ginger Ross, OPS, mango

## Visiting Scientists

Juan Li

Edvan and Pollyanna Chagas



# Thanks!

ac@ufl.edu