Overcoming Limitations to Tropical Fruit Breeding in Southern Florida

GCREC IST

Alan Chambers
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Background
Professional Background

Genetics and Biotechnology, BYU, 2007
Plant Pathology, Cornell University, 2010
Horticultural Sciences, University of Florida, 2013
Assistant Principal Investigator, PepsiCo, 2016
Assistant Professor, UF, current
Established in 1929 in Homestead, FL by state legislature
160 acres, ~15 faculty (pathology, entomology, soils...)
Tropical/subtropical, vegetable, and ornamental crops
Natural resources and environment
Supporting ~$1B local agricultural economy
My Program

“Enhancing the viability and sustainability of subtropical and tropical crops via cultivar development and the use of plant genomics to [optimize] crop genes.”

80% research, 20% extension

Programs vs Projects
Overcoming Limitations
## Many Methods

Each species has individual limitations and needs

<table>
<thead>
<tr>
<th>Species</th>
<th>Major Challenges</th>
<th>Strengths</th>
<th>Improvement Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Papaya</td>
<td>Lack of diversity, PRSV</td>
<td>Transgenic PRSV-R, rapid generation time</td>
<td>Transgenic, Mutation, Traditional breeding</td>
</tr>
<tr>
<td>Banana</td>
<td>Triploid, narrow export market</td>
<td>High diversity, germplasm collections</td>
<td>Traditional breeding for diploids and ploidy optimization</td>
</tr>
<tr>
<td>Mango</td>
<td>Long juvenile period</td>
<td>High diversity, high interest</td>
<td>Transgenic/CRISPR-based breeding, release non-transgenic cultivars</td>
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<tr>
<td>Vanilla</td>
<td>Poor germplasm resources</td>
<td>High interest, high potential</td>
<td>Establishing a germplasm collection, traditional breeding</td>
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<td>Passionfruit</td>
<td>Soil-borne diseases, biological limitations</td>
<td>High diversity, rapid cycle times</td>
<td>Rootstock trials, traditional breeding</td>
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</table>
Extended Breeding Cycles

Juvenility: the time it takes for a seed to grow and flower

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<th>Crop Species</th>
<th>Natural Time to Flowering</th>
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Weigel 1995; Pena 2001; Endo 2005; Flachowsky 2007; Kotoda 2010; Kotoda 2003; Klocko 2015; Srinivasan 2012; Duan 2010; Matsuda 2009; Trakner 2010
Slow Results =

Time (Years)

1

5

10

Tenure
Rapid Cycle Breeding

**Step 1. Construct an early flowering line**
- Transform to create an early flowering line.
- Early flowering gene
- Early flowering line

**Step 2. Combine desired trait with early flowering**
- Introduce trait (Resistance) by breeding to early flowering line.
- Resulting seedlings segregate for early flowering and resistance.
- Select the early flowering resistant seedlings for next generation crosses.

**Step 3. Crosses to high quality parent**
- Cross early flowering resistant lines to high quality parental line.
- Early flowering, resistance, and high quality traits segregate in seedlings.
- Select the early flowering resistant seedlings for next crosses.

**Step 4. Backcrosses to high quality parent**
- Backcross early flowering resistant lines to high quality parental line.
- Early flowering, resistance, and high quality traits segregate in seedlings.

**Step 5. Last cross to high quality parent**
- Cross early flowering resistant lines to high quality parental line.
- Early flowering, resistance, and high quality traits segregate in seedlings.
- Select seedlings that are resistant but not early flowering. Plant in field to evaluate for quality traits.
### Overcoming Juvenility

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Vanilla
Totonac Legend - *Vanilla*

La leyenda de *Vanilla*

En tiempos del Rey Tlatoani Temmoc, Totonac, una de sus esposas dio a luz a una niña que por su singular hermosura fue la guía de la siembra de la vainilla.

Pero un príncipe llamado Odoux, ella a pesar de que se enamoró de ella, a pesar de que se enamoró de ella, a pesar de que se enamoró de ella, a pesar de que se enamoró de ella, a pesar de que se enamoró de ella.

El joven venado se prendió de ella, estaba enamorado con la muerte, la rapto, la envolvió en una tela de fuego, dulcificándola, la ensayaron, la ensayaron, la ensayaron, la ensayaron, la ensayaron.

Allí a la hierba al seca, se explotó de espés palmation, dando brosa rapidez y exuberancia.

*O doux and Grisoni, 2011, Vanilla*
Vanilla

Approximately 110 species

*V. planifolia* and *V. tahitensis*

Geographic distribution
FL Native Vanilla

http://florida.plantatlas.usf.edu
Vanilla and Vanilla

World’s most popular flavor
Important in foods and fine perfumes
  Masking bitterness in chocolate
Mesoamerican origin
Spread globally starting in 1500s
Production mostly in Madagascar (85%)
One/few genotypes for commercial production
  High risk!

Cameron, 2012, Vanilla Orchids
Cultivation

Cameron, 2012, Vanilla Orchids
Genetics and Breeding

Few named *V. planifolia* types
Most types are chance seedlings
Existing populations?
Breeding increased vanillin
   6.7% vs 2.5% (data not shown)
Older references state variety differences
   “Reference not found”
No follow up work
Research Justification

Insatiable consumption and high value
FL favorable environment, native species
Information gaps
  Foundational
    Accession-level differences in vanillin
  Feasibility for FL commercial production
Genetics
Grower interest
Vanilla Breeding

V. planifolia x V. odorata

Historical

V. x tahitensis

Gourmet, unique flavor profile

V. planifolia x V. odorata

Today

Lubinsky 2008; google image search
Proposed Research

Structured populations
  Inheritance of specific traits
    Vanillin, disease resistance, yield
Growth profiles
  Shade house, tree canopy
Ecology and natural pollinators
Economic viability

Lubinsky 2006; Cameron, 2012, Vanilla Orchids
Concepts in Brief
Banana and Plantain

Edible diploids
Novel consumer quality
Yield – winter productivity
Disease resistance
  Pararetrovirus, BSV
  *Fusarium*
Passion Fruit

Variety trialing
Fruit quality
Disease resistance (vine longevity)
Leveraging native species – genetic goldmines

*P. incarnata, lutea, multiflora, pallens, sexflora, suberosa*
Papaya

1\textsuperscript{st} generation program
Papaya ringspot virus resistance

2\textsuperscript{nd} generation program
Yield, fruit quality, longevity
Strawberry

Variety trialing

Novel types

Festival

Radiance

Winter Star

Sensation

A. Chambers, UF
Many Challenges, Many Strengths

High demand, high value crops
Great potential
  Leverage native species
  Academic rigor
Rapid progress
  Many low-input studies
  Statistically validated and published
Thank You!

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