A Brief Overview of Citrus Breeding in Florida

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From Ancient Times

• Citrus origins in Asia
  – Natural species and hybrids
  – >3000 years of cultivation in China and India
• First wave migration to Persia 6th century BCE, then to the Mediterranean 4th century BCE (citron)
• Second wave migration to N Africa, Sicily, Italy and Spain, 8th century CE (Sour orange and lemon)
• Sweet orange from S China to Europe, 15th-16th century
• Mandarins to England, 1805
Citrus to the Americas

- European settlers brought:
  - Sour orange to St. Augustine
  - Sweet orange to Brazil and elsewhere
  - Mandarins
  - Pummelo from SE Asia to the Caribbean
  - This latter introduction gave rise to grapefruit
From where did new varieties come?

- ALL citrus previously came from seedlings or chance bud sport mutations
- Mendel developed the science of genetics
- Swingle began a few years BEFORE the rediscovery of Mendel’s work
- Swingle and Webber, USDA, began breeding at a time when most sweet oranges in the US came from a handful of trees (1st crosses in 1893)
- 2nd crosses: *Citrus x Poncirus* for cold hardiness
- Tangelo breeding started in 1897 and proceeded to 1911: led to Minneola and Orlando
Next generations

- Robinson followed Swingle, then a host of others leading through Carpenter and Reece, Hearn, Wutscher, Bowman, McCollum, and Stover
- USDA breeders have contributed substantially to the development and advancement of Florida citrus
- And UF-CREC? Some dabbling with rootstocks, clonal selection, and other breeding efforts
- ...until 1984-85: Grosser and Gmitter hired to work with Castle, a new team with new technology
Thirty+ years ago

- Mutation breeding of most scion types
- Rootstock and mandarin breeding by sexual hybridization of seedy parents
- Little or no genetic information of key traits
- Tissue culture techniques newly available for use
- First reports of genetic transformation in plants
- Molecular markers were leaf isozymes or RFLPs
- “We have too many varieties already!”
Today

• Methods to produce seedless mandarins
• Research reveals genetic control of key traits
• Tissue culture techniques widely adapted
• Targeted genetic modifications undertaken
• Genetic transformation of citrus is commonplace
• The impact of the “Genomic Revolution” is at hand
Factors Impacting the Development and Commercialization of New Citrus Cultivars

• Availability of new tools to facilitate breeding

• Rapid evolution of consumer demands for products and their characteristics

• Globalization of production, marketing, and cultivar management vs. localized market niche opportunities

• Global proliferation of insect pests and devastating diseases, such as Huanglongbing

• Societal expectations for “safe” foods and citrusulture
Citrus Genetic Improvement Needs

• New sweet oranges to improve fresh and OJ quality

• New seedless and easy to peel mandarins

• New consumer friendly grapefruit types: No GJE

• New product forms, to renew consumer excitement and retain interest in fresh citrus

• Rootstocks that overcome stresses and improve quantity and quality of citrus products

• Disease resistance, or extinction!
Sweet Orange Improvement

• Selection of Mutations
  • Naturally occurring
  • Somaclonal variation

• Hybridization
  • Genome sequencing and fruit metabolites redefine “orange”
  • Unique orange hybrid: HLB tolerant?
  • Mandarange: Interploid hybrids
Variant Selection

- Midsweet 11-1-24 (irradiation)
- Valquarius
- Valenfresh
- OLL Series: #8, and others
- Budwood selection: DPI Budwood program, Hughes nucellars, etc.
Grapefruit Improvement

• Naturally occurring mutations

• Cybridization

• Sexual hybridization; e.g. UF 914 and others
Seedless Mandarin Improvement

- Mutation selection
- Diploid hybridization
- Interploid hybridization
- Parental development
• Selection from the wild, foraging, and domestication

• Global movement of the most desirable types, expanded planting but a reduction of genetic variation

• Mutant selection first from seed, then from sports, made practical following the use of rootstocks

• First efforts at targeted genetic improvement by hybridization

• Currently, an explosion in breeding programs and new cultivars, globally!
• 1980s: a new generation of scientists came to tackle the ancient challenge of citrus genetic improvement

• 1980-now: Advances in genetics, genomics, and information technologies have taken the dreams of our earlier years and brought them closer to reality

• A multitude of tools are available and still rapidly evolving, to address the many current needs of the industry and to provide new opportunities for the future

• Rootstocks and scions, both vigorously pursued

• What works? How do we know? On what basis have growers made their decisions in the past? And now?