USDA National Clonal Germplasm Repository for Citrus and Dates, (NCGRCD), Riverside, CA

Annual Report to the W-6 Technical Advisory Committee
CY 2016

Mission

The mission of the National Clonal Germplasm Repository for Citrus and Dates is to collect, maintain, evaluate, preserve, and distribute germplasm of citrus, dates, related Aurantioideae genera, and date palms and other *Phoenix* species. The achievement of this goal involves: 1) acquisition of the widest possible genetic diversity within citrus and dates to reduce genetic vulnerability in the future, 2) testing and treatment of accessions for pathogenic organisms, 3) maintenance of accessions in a protected, pest-free environment, 4) genetic, horticultural, and physiological characterization and evaluation of accessions, 5) establishment of an informational record for each accession covering acquisition, inventory, evaluation, and gene descriptor data, 6) distribution of germplasm to qualified researchers throughout the world, and 7) research into improved methods of collection, evaluation, propagation, preservation, and distribution.

Permanent/Term Federal Staff

MaryLou Polek, Research Leader/Plant Pathologist (Category 1)
Robert Krueger, Curator/Horticulturist (Category 4)
Manjunath Keremane, Plant Pathologist (Category 3)
Vicki Newman, Biological Science Technician
Brittany Moreland, Biological Science Technician
Esteban Rodriguez, Biological Science Technician (Lab) (Term Position)
Patricia Moore, Secretary
Lee Gross, Agricultural Science Research Technician

University grant funded laboratory technician

Amanda Rawstern (MAC Funding)

Student workers

Jamie Alaniz
Jonathan Cassell
Benedict Mamaril
Lawrence Pointer

Germplasm Holdings

NCGRCD germplasm accessions and inventory as of 2016-12-31 are shown in Tables 1, 2, 3, and 4. Overall there was little change in either accessions or inventory in CY 2016.

Germplasm Backup

Citrus germplasm maintained in Riverside exists as both protected plants and field plantings. The University of California- Riverside (UCR) Citrus Variety Collection (CVC) maintains all Rutaceous genotypes in a traditional field planting. About one third of the genotypes exist in the protected, pathogen-tested collection (USDA APHIS-certified screenhouse). In 2008, due to the presence of the Asian citrus psyllid (ACP) in Southern California, the entire CVC was propagated and is maintained as potted plants in greenhouses. Thus, all genotypes without regard to pathogen status are backed up as a protected propagation.

Beginning in 2012, efforts were made to further secure citrus genetic resources by establishing them in cryopreservation at the USDA-ARS National Laboratory for Genetic Resource Preservation (NLGRP) in Fort Collins, Colorado. Initial efforts were funded by the California Citrus Research Board (CRB) and were aimed at developing and optimizing protocols to preserve the valuable commercial cultivars maintained by the UC Citrus Clonal Protection Program (CCPP). More recently, National Programs and the Pacific West and High Plains Area Offices allocated additional resources in CY 2016 to expand efforts to include all sanitized genotypes maintained by NCGRCD. In CY 2016, 219 accessions (approximately 38,325 buds) were collected from the protected, pathogen-tested collection and sent to NLGRP for processing and preservation. In addition, Repository technicians were trained in cryo-technology and an additional 7 accessions (approximately 1,225 buds) were processed in Riverside and will be sent to Fort Collins once viability tests are completed. This has brought the total number of accessions from the screenhouse in cryopreservation to 401, with approximately 78 remaining.

With the bulk of the sanitized accessions secured under cryopreservation, future citrus cryopreservation efforts will be prioritized as follows: the remaining accessions from the protected screenhouse, sanitized commercial varieties from the CCPP, pre-tested (using multiplex assay developed by CCPP) accessions from the secure backup CVC, and sanitized accessions imported from the Florida certification program (through USDA MAC funding).

The NCGRCD will expand its collaboration with the NLGRP and include a private entity, Phoenix Agrotech to develop and optimize a cryopreservation protocol for date palms. This crop presents some considerable hurdles in that it is a monocot and mature plants are 80 to 100 feet in height. To solve this dilemma, the NCGRCD will provide germplasm to Phoenix Agrotech who will use their expertise to put accessions into tissue culture. Germplasm in the form of tissue culture will be sent to the NLGRP for processing and storage. A Materials Transfer Research Agreement (MTRA) was executed in September 2016 to legally allow for this 3-way exchange.

Germplasm Acquisitions

NCGRCD acquired 25 new accessions in 2016, six being clean source citrus accessions received from the CCPP and 19 being date palms. All citrus accessions established, however 4 of the date palms did not (Table 5).

Germplasm Sanitation & Quarantine

In 2015, NCGRCD completed sanitation of 15 accessions that were released from State and Federal quarantine in May, 2016 (Table 6).

During the period 2013 – 2014, NCGRCD revised its quarantine/sanitation processing procedure as per USDA-APHIS. This agency revised their standards for the interstate movement of citrus germplasm and they now require either shoot-tip grafting or thermotherapy in order to release accessions from quarantine. In the past, biological indexing was performed after therapy and post-therapy testing was conducted on a limited basis. This has now

been updated so all required lab tests are performed before the release indexing. This should reduce the number of positives discovered during indexing, and thus increase the overall efficiency of the process since the biological indexing is the most time and resource intensive step.

Using this protocol, in CY 2016, 19 inventory items were screened with lab tests and 17 that tested negative in all lab tests were selected for the 2016 release index. These are shown in Table 7. Request for release is pending completion of a small number of additional laboratory tests. It is anticipated that release will be requested in late summer of 2017.

Also in CY 2016, an additional 47 inventory items were screened with lab tests and 17 that tested negative in all assays were selected for the 2017 release index. These are shown in Table 8. The indexing portion of the sanitation process is currently in progress and should be completed by September 2017. After the follow up laboratory tests are completed, quarantine release will be requested. Projected date is January, 2018. Note: I2017008 revealed that 'Little Sweetie' is *still* contaminated with tatterleaf and so will not be eligible for release.

NCGRCD currently holds an additional 114 accessions in quarantine, not including the release candidates (Table 9). This includes self-quarantine, which means sanitation of existing germplasm accessions that are not importations. Nucleic acids have been extracted and lab tests have been conducted to determine which approach is necessary to clean up each accession The NCGRCD seeks commentary regarding prioritization of these accessions for sanitation.

Therapy procedures at NCGRCD include shoot-tip grafting (STG) and thermotherapy. A total of 40 accessions were subjected to therapeutic procedures: 29 as STG and 11 as thermotherapy, but not all were successful. STG of 223 total attempts yielded 11 plantlets from 7 accessions, whereas thermotherapy of 120 total attempts yielded trees from all 11 accessions. Thus, 18 accessions have at least one tree representing a potentially clean plant (Table 10). In CY 2017, these plants will be screened in the lab and of those testing clean, some or all will be selected for biological indexing. Final lab testing will occur in 2017 and the request for quarantine release will be submitted in late 2017 or early 2018. It should be noted that due to the National Programs request for an "all hands on deck", cryopreservation efforts were given high priority in the fall of 2016. Therefore the number of therapy attempts was lower in CY 2016 than in past years due to the temporary redirection of Technician duties from therapy to cryoprocessing.

Laboratory testing of Germplasm accessions

The laboratory is well equipped to conduct all required diagnostic tests including ELISA, conventional PCR, real time PCR, immunoblotting, culturing of *Spiroplasma citri*, and sequential PAGE. In the last few years, most of the assays have been adapted for high throughput extractions and testing. The lab is equipped with a beadbeater, lyophilizer, Robotic DNA extraction system (MagMax), and two real time PCR machines that facilitate DNA extractions and real time PCR assays in a 96 well format. A new energy efficient ultra-freezer (Stirling) was acquired in CY 2016. While many RNA extractions are still being conducted manually in single tubes, technicians are being trained in the Vidalakis/CCPP lab for multiplexing and using RNA extraction kits to increase efficiency.

The repository lab is certified as Biological Safety level II laboratory. Permits are current to maintain pathogen positive germplasm *in planta* in the greenhouse. In the last five years, more than 35 pathogen genome targets have been cloned and sequenced that are used as positive controls in diagnostic assays.

Certain lab tests are conducted at various stages of accession, therapy and maintenance. In CY 2016 these included:

1. As required by State Quarantine, all "pathogen tested" plants in the protected screenhouse were tested for the presence of CTV. All accessions were negative for CTV.

2. A total of 90 plants belonging to 27 accessions were tested for multiple pathogens as a pre-test. From those accessions testing negative, a selection is made for material to go into the annual bio-index.
3. Final laboratory tests were completed on 13 of the 17 accessions in the 2015-2016 biological index. Those accessions testing negative are submitted to CDFA and APHIS for release from quarantine status.

Testing of plants to which therapeutic techniques have been applied: Tissue from both the source plants and those having undergone either STG or thermotherapy were used for both DNA and RNA extractions, and were tested for multiple targets by various techniques including ELISA, qPCR,, and/or reverse transcription qPCR. The results are shown in Table 13. A total of 90 plants belonging to 27 accessions, 11 of which were STG and 16 had been subjected to thermotherapy, were tested for multiple pathogens. Final laboratory tests were completed on 13 of 16 accessions that had undergone therapy

The biological indexing for 2015-2016 is almost complete; it was comprised of 17 accessions that had gone through the therapy and multiple pathogen-testing processes. Final laboratory tests were completed on 13 of the 17 accessions; 2 still need a culture test for *Spiroplasma citri*, and the citron index and sPAGE need to be repeated for another (Table 7).

Biological indexing 2016-2017 is in progress. 17 accessions were selected from those that had completed the therapy and multiple pathogen-testing processes. One accession, 'Little Sweetie', will need to have repeat therapy as it is still exhibiting viroid symptoms in the biological index.

Distributions

In CY 2016, the NCGRCD distributed 535 order items (82% domestic) to 130 requestors (78% domestic) (Table 11). These were mainly distributed amongst the various NPGS requestor categories as shown in Table 11. There has been a trend over the past several years towards an increased proportion of domestic requests. This can be attributed largely to sending larger amounts of citrus germplasm to Florida ARS personnel to support increased HLB research. In addition, more rootstock and indicator seeds are being supplied to US researchers as seed cannot be sourced in Florida due to APHIS restrictions. Researchers in Florida are particularly in need of seeds of 'Duncan' grapefruit, which is no longer available from California commercial sources. International distributions also include a fairly large proportion of rootstock and (especially) indicator seeds. Because NCGRCD budwood meets a high phytosanitary standard, distributions are often made to international certification or nursery groups. Domestic commercial entities accounted for 11% of the requests and 1% of the items distributed. Domestic private individual category orders accounted for 15% of the total requests and 2% of the order items sent. This category is basically hobbyists. NCGRCD has historically tried to accommodate these types of requests to ensure pathogen-tested material gets into the landscape. Distributions to domestic commercial and private entities are often due to NCGRCD's participation in the National Clean Citrus Network (NCCN). Requests for clean germplasm from states other than California and Florida are often referred to NCGRCD for this purpose.

In addition to the above, it is important to note that 303 total citrus items were sent in 22 shipments to NLPGRP for long-term conservation; these fall into the NPGS "backup" category rather than the "distribution" category.

In CY 2016, date palms accounted for 19% of the requests and 25% of the order items distributed (Table 12), continuing the upward rise in date palm distributions in the last several years. This trend is attributed to the international recognition of the date palm collection as a valuable resource for date palm genomics studies (see Publication listing below). A large number of the distributions were made to Michael Purugganan, New York University, for genomic work. These distributions required harvesting fruit and leaves of over 30 accessions at a specific developmental stage, which necessitated the curator being in CVARS (Thermal) almost continuously in the month of August. In addition, a number of distributions were made to a commercial tissue culture laboratory, Phoenix Agrotech (PA). As one of NCGRCD's collaborators, the repository provides germplasm from accessions

that have little or no vegetative propagative material (offshoots) to PA. In turn, PA produces tissue cultured propagations that will be sent to the NLGRP for long-term cryo-conservation (see section on backup above).

Collection Rationalization

NCGRCD and UC-CVC personnel cooperate in the rationalization of the citrus and date palm collections to identify and eliminate the redundancies and to attempt to fill the gaps. The goal is to more efficiently manage and utilize these valuable resources. In making decisions, we take into account markers, morphological observations, passport data, and other documentation. Elimination of redundancies is of utmost importance now due to the increased threat of pests and diseases to the field collection. Having to maintain the repository accessions under a protected screen structure strains financial resources and therefore, there is an immediate need to prioritize accessions for backup via cryopreservation. Cryopreservation is an efficient and economical means to conserve the genetic diversity of germplasm and specific genotypes for the long-term.

Propagations

In CY 2016 there were 244 total propagations made from 192 accessions as follows:

27	date palm, new accessions
17	new accessions for the protected screenhouse
8	new accessions for the CVC
20	CVARS replacements
19	backup CVC replacements
62	screenhouse replacements
26	released trees from the CVC and screenhouse
6	Citrus relative replacements
2	new pathogen accessions
1	pathogen replacement,
26	other

Databases

After a lengthy period in development, the GRIN-Global (GG) system went live in November, 2015, replacing GRIN Classic, which is offline to the public and is not being updated. The Curator has received training in the GRIN-Global system and is now using it. However, this new system presents many challenges due to its unfamiliarity, weightiness, and lack of specific features as compared to GRIN Classic.

NCGRCD maintains a local database in MS Access in addition to using the GRIN system. Both databases are up to date as far as accessions. Inventory is current and up to date in the local database however, it is currently not maintained in the GRIN database. The local database contains information including;

1. management data used in day-to-day operations,
2. quarantine and pathogen testing data,
3. documentation of propagations, and
4. therapy records.

It is not clear at this time whether or not these observations can be maintained effectively in GRIN, or if it even has a place there. Although inventory will probably be loaded into GRIN Global in the medium term, the local database will have to be maintained as well.

Currently, the Curator is the only person with training in the GRIN system, but the Technicians (V. Newman & B. Moreland) assist in maintaining the local database. If the NCGRCD had to rely solely on GRIN-Global, it would likely necessitate additional training for them while taking time away from their other job responsibilities. The level of human resources devoted to database management is inadequate at NCGRCD.

Facilities

The NCGRCD maintains Federal facilities on land located on the University of California, Riverside campus and leased from the University of California (UC). The lease expired in 2011 and is expected to be renewed shortly. The University of California intends to greatly increase the lease rate from USD 1 per year to USD 10,000 with an annual increase of 3% for inflation. This will have a significant negative impact on the operational budget.

Federal facilities include approximately 16,000 sq. ft. of APHIS-certified screenhouse (used for maintenance of the protected, pathogen-tested collection); 6,050 sq. ft. of greenhouse space (used for propagations, maintenance of pathogen controls, and pathogen testing); 1,372 sq. ft. of headhouse space (work and storage); 850 sq. ft. of lab space; 88 sq. ft. of office/storage space; and 480 sq. ft. office trailer (houses the PCR equipment). In addition, approximately 7,500 sq. ft. of greenhouse space is rented from the University. The UC greenhouses are used to maintain plants that are protected backups of trees in the CVC that are not backed up in the protected collection, and for accessions held under APHIS/CDFA quarantine. In CY 2016, two aging UCR greenhouses used to maintain quarantine accessions held under permit were abandoned and the trees moved into a newer UCR greenhouse that has been upgraded using funds from the National Clean Plant Network (NCPN). These funds were awarded to Georgios Vidalakis specifically for this purpose. This structure meets USDA-APHIS *structural* standards. A second UCR greenhouse is currently being upgraded and occupation is expected in the summer of 2017. This greenhouse will be used to house a portion of the un-sanitized trees also maintained in the field planting. The NCPN funds awarded to Georgios Vidalakis, UC-CCPP have been essential to meet the repository's needs since Federal funds cannot be used for the improvement of State facilities and current Federal facilities are in adequate in size.

A mission critical need withstanding is the expansion of the protected screenhouse; there is only space for approximately 12 additional accessions in the current structure. It is absolutely imperative that this structure be expanded in the next few years as new accessions are cleaned, tested and released. A pad is available for up to a 60-foot (7,200 sq ft) addition to the existing structure. There are 2 obstacles preventing this construction from going forward; first, without a signed lease agreement with the university, the land footprint cannot be changed, and second, insufficient funds. Compartmentalization in 2012 provides for a backup should a breach to one compartment occur as 1 tree of each accession is maintained in each chamber. While this strategy is vital, it does restrict the number of accessions protected.

Several improvements were made to NCGRCD facilities in CY 2016. Most importantly, a conventional HVAC system was installed in the headhouse eliminating the swamp coolers and heater that provided only minimal climate control. This has greatly improved the work environment in regards to both temperature and noise. The office trailer was renovated with improved roofing, flooring, and fresh interior paint. It is hoped that in CY 2017, a double wide trailer can be purchased and installed, providing increased and improved working area for separation of lab activities and additional office space. The existing single wide trailer will then become additional work (process samples from the field) and storage space.

Personnel

Dr. John Preece, permanent Research Leader for the USDA ARS Davis and Parlier repositories, served as Acting Research Leader for the NCGRCD since the retirement of Richard Lee in November, 2014. A permanent Research Leader was recruited in the Fall of 2015, and on March 21, 2016, Dr. MaryLou Polek assumed the position of permanent Research Leader/Research Plant Pathologist. Although new to the USDA ARS, Polek is not

new to citrus. She served as Plant Pathologist/Diagnostician for the California Department of Food and Agriculture and was the Program Manager for the Central California Tristeza Eradication Agency (CCTEA). Here she was responsible for the analysis of over 500,000 commercial citrus tree samples for *Citrus tristeza virus* by ELISA annually. Most recently Polek was the Vice President of Science and Technology for the California Citrus Research Board. Her main duties were the oversight of a $6 million industry-funded research portfolio and as the Chief Science Editor for the *Citrograph* magazine. She had been a member of this Citrus Germplasm Committee for over a decade and continues to serve on several advisory committees for NIFA-funded projects and the CCTEA. She was Chair of the Science & Technology Committee of the California Huanglongbing (HLB) task force, first co-Chair of the Citrus Health and Response Program's Science and Technology Committee, and was a member of the National Academy of Science Review Panel for the Strategic Planning for the Florida Citrus Industry: Addressing Citrus Greening Disease. She spent 2016 completing training and becoming familiar with the Policies & Procedures of the federal system.

Esteban Rodriguez, who has worked at NCGRCD for a number of years starting as an undergraduate intern, was recruited as a temporary ARS Biological Technician to assist with laboratory activities. A technician position (UC Riverside Laboratory Assistant) funded by a USDA Multi-Agency Coordinated Response grant (G. Vidalakis, PI) was also recruited in early 2016 to provide additional greenhouse and field support. This position is currently held by Amanda Rawstern and funding will expire in 2 to 3 years. Four Student Assistants were employed through the Research Support Agreement with UCR.

Support

NCGRCD is located at the Riverside Location of the USDA-ARS Pacific West Area (PWA). Federal administrative support is primarily provided by the Riverside Location and PWA staffs. The Location staff (N Knap) is primarily responsible for facilities maintenance (repairs and maintenance) in addition to administrative support.

NCGRCD maintains three agreements with UC Riverside: a Research Support Agreement (RSA) and three Non-Assistance Cooperative Agreements (NACA). The RSA with the Agricultural Operations Department (P Mauk, PI) provides infrastructure support (utilities, communications, a portion of the facilities maintenance, cultural care for field plantings, etc). The NACA's are with T Kahn (Botany and Plant Science), M Roose (Botany and Plant Science), and G Vidalakis (Plant Pathology). Cooperation with Kahn is aimed at characterizing horticultural traits, documenting, and maintaining the field genebank (Citrus Variety Collection), whereas cooperation with Roose is aimed at genetic characterization of citrus accessions. This latter is currently the only means of dealing with genetic questions as NCGRCD staff lacks a geneticist position. Cooperation with Vidalakis is aimed at long-term conservation of genetic resources as well as phytosanitary issues.

Health, Safety, Environmental Management

Biological Science Technician, Brittany Moreland is the Collateral Duty Safety Officer (CDSO) for the Riverside Location (including the US Salinity Laboratory) and participates on USDA and UC safety committees as appropriate. NCGRCD also takes part in various USDA and UC safety activities and initiatives such as mock fire and earthquake drills, hands-on fire extinguisher training, and review of shut-off valves. The lab is certified as Biological Safety level II laboratory by UCR. The chemical inventory was reviewed and old and unused chemicals were properly disposed of through the University Environmental Health and Safety Department.

In CY 2016, several safety-related purchases and upgrades were made. INFACO Power Assisted pruners were purchased as an ergonomic aid for the extensive spring pruning activities. The fire and security alarm systems were upgraded. An energy-efficient -80° freezer was installed in the lab.

Research Activities

Field trial on HLB resistance: Under the direction of the former Research Leader, **a** field trial comprised of about 100 accessions (over 800 plants) was planted in Fort Pierce in 2009. The objective is to evaluate the germplasm over time (approximately 6 years) for resistance and tolerance to *Candidatus* Liberibacter asiaticus (CLas). Samples from all surviving plants were collected, DNA extracted and tested for CLas. An additional field trial with about 100 accessions of trifoliates is being maintained in Fort Pierce (Collaboration with Ed Stover). Samples were collected and tested for CLas.

HLB resistance: An USDA NIFA SREP grant was awarded in late 2016 titled: Selection, molecular and genetic analysis of HLB tolerant/resistant variant citrus plants. Naturally occurring mutant citrus plants or bud sports of commercially grown cultivars will be identified. The nature of the genetic variation will be determined by genome sequencing. Using CRSPR cass9 technology, HLB tolerant/resistant cultivars with desirable fruit traits will be delivered to the industry. NCGRCD involvement includes the establishment of field evaluation plots, development of public outreach and extension materials, the organization of grower education and the annual progress report meetings.

Early Detection Technologies: The Citrus Research Board has funded several research groups to develop early detection technologies (EDTs) to detect CLas in mature citrus trees prior to symptom development. The repository continues to participate in the evaluation of EDTs by conducting qPCR, ddPCR and LAMP assays. The NCGRCD Category 3 Support Scientist is a member of the EDT Task Force. In addition, diagnostic assistance was provided to the Contained Research Facility at UC Davis to analyze research samples for CLas.

Puffy Skin in Date Palms: Production of soft cultivars of dates (fruit consistency) suffers from a problem involving skin separation, called "puffy skin" by the growers. This is a fruit quality defect in which excessive portions of the skin of the date pull away from the flesh, causing a blistered or puffed appearance. This decreases the market value of the date. This problem appears to be influenced by temperature and humidity during the khalal period of date fruit maturation. A cooperative project with Tom Perring, Entomology, UC Riverside, and Sonia Rios, UC Area Subtropical Farm Advisor, is investigating bunch and irrigation management as tools to mitigate this problem. Research conducted in 2016 suggested that specific types of fruit thinning can contribute towards alleviating of the problem. The plan for CY 2017 is to further refine bunch management techniques in addition to regulated deficit irrigation. The irrigation program will also provide an estimate of actual water use by date palms under current growing conditions.

Grants CY 2016

Several grants were applied for and received in CY 2016 that benefitted NCGRCD activities:

National Clean Plant Network, FY 2015: PI G Vidalakis, ARS PI J Preece, R Krueger. Of approximately USD 1.1 M, NCGRCD received USD $95 K used for facilities renovations (see Facilities section above), student salaries (greenhouse care), and a liquid handling system for the laboratory.

National Clean Plant Network, FY 2016: PI G Vidalakis, ARS PI M Polek, R Krueger. Of approximately USD 1.3 M, NCGRCD received USD $80 K used for facilities renovations (see Facilities section above), and student salaries (greenhouse care).

Multi-Agency Coordinated Response, FY 2016: G Vidalakis, PI, ARS PI M Polek, R Krueger. NCGRCD will receive approximately USD $70 K for 2 years to fund a position supporting greenhouse operations (see Personnel section above).

Citrus Research Board, FY 2016: K Godfrey, R Yokomi S Hajieri, ARS PI M Polek. NCGRCD will receive $1000 to investigate the effects of single, double, and triple infections of citrus with CLas, CTV, and *S. citri*. In addition, the effects these pathogens have on psyllid phenology will be examined.

Citrus Research Board, FY 2016: ARS PI M Polek. NCGRCD will receive $8K to assay plant and psyllid samples for the presence of CLas in experiments evaluating EDTs.

USDA NIFA SREP 2016 to 2022: Selection, molecular and genetic analysis of HLB tolerant/resistant variant citrus plants. F Luo, F Gmitter, Y Duan, M Polek, Z Deng, L Cano. NCGRCD will receive approximately $90 K/year for public/extension outreach and the organization of the annual progress report meetings.

California Date Commission, FY 2016: S Rios (PI), R Krueger (ARS PI), T Perring (UCR, Project Leader). USD $90 K to study skin separation in 'Medjool' dates. USD 0 net to NCGRCD, consulting role only.

Ramadugu, Keremane, Roose, Jenkins, Alabi and Smith: 2/2015 to 2/2020: "Characterization of Liberibacter populations and development of field detection of HLB" $1,770,000. USDA NIFA SCRI.

McCollum, Volk and Preece. 2015-2017. Application of technologies to expedite cleaning of new accessions for use in Florida. $180,000. Citrus Research and Development Foundation. COMPLETE.

Publications CY 2016

Volk GM, Bonnart R, Shepherd A, Yin Z, Lee R, Polek M, Krueger R. 2016. Citrus cryopreservation: viability of diverse taxa and histological observations. Plant Cell Tiss Organ Cult DOI 10.1007/s11240-016-1112-4

Tan SH, Talibov THO, Krueger RR, Bodaghi S, Dang T, Chao YY, Greer G, Vidalakis G. 2016. First report of Citrus exocorits viroid and two citrus variants of the Hop stunt viroid on Lemon in Azerbaijan. Plant Disease 100:2341. DOI 10.1094/PDIS-05-16-0761-PDN

Volk G, Lee R, Krueger RR. 2016. The value of citrus genebanking. Citrograph (ns) 7(4):42-44.

Table 1. Accessions and inventory maintained at NCGRCD

		Accessions	Inventory
Total		**1765**	**6419**
	Citrus & related taxa	1618	5674
	Citrus spp	1228	4377
	Phoenix spp	128	724
	Citrus pathogens	102	133

Table 2. Aurantioideae accessions maintained at NCGRCD

Species	Group	Accessions
Total		**1618**
Citrus spp		1228
Citrus sinensis	Total	245
	Blood orange	22
	Navel orange	81
	Sweet orange and hybrids	105
	Valencia orange	37
Citrus aurantium and hybrids	Sour orange and hybrids	64
Citrus limon and hybrids	Lemon and hybrids	174
Citrus aurantiifolia and hybrids	Lime and hybrids	65
Citrus medica and hybrids	Citron and hybrids	108
Citrus maxima and hybrids	Pummelo and hybrids	127
Citrus paradisi and hybrids	Grapefruit and hybrids	59
Citrus madurensis and hybrids	Calamondin and hybrids	3
Citrus reticulata and hybrids	Mandarins and hybrids	240
Citrus spp and hybrids	Papedas and hybrids	31
Fortunella spp and hybrids	Kumquats and hybrids	30
Microcitrus spp	Total	30
	M australasica	10
	M australis	7
	Other *Microcitrus* spp	2
Poncirus spp and hybrids	Trifoliates and hybrids	143
	Poncirus spp	83
	Citrange	24
	Other trifoliate hybrids	36
Other Aurantioideae taxa		71
	Aegle marmelos	1
	Aeglopsis chevalieri	1
	Afraegle spp (2)	2
	Atalantia spp (4 spp)	6
	Balsamocitrus daweii	1
	Bergera koenigii	4
	Citropsis spp (4 spp)	4
	Clausena spp (4 spp)	7
	Clymenia polyandra	1
	Eremocitrus glauca and hybrid	2
	Feroniella oblata	1
	Glycosmis spp (4 spp)	5
	Limnocitrus littoralis	1
	Merrillia caloxylon	1
	Micromelum minutum	1
	Murraya paniculata	4
	Naringi crenulata	1
	Oxanthera neo-caledonica	1
	Pamburus missionis	2
	Paramygnia spp (2 spp)	2
	Pleiospermium spp (2 spp)	2
	Severinia buxifolia	10
	Severinia disticha	2
	Swinglea glutinosa	2
	Triphasia trifolia	2
	Wenzelia dolichoophylla	1
Rutaceae (not Aurantioideae)	*Esenbeckia, Ruta, Vepris, Zanthoxylum*	6

Table 3. *Phoenix* accessions maintained at NCGRCD

		Accessions
Total		**128**
P dactylifera		118
	Named Old World female cv	28
	Named New World female cv	9
	Superior male selections	5
	Backcrossed male accessions	30
	Hybrid "Breeding Lines"	17
	Baja California Sur seedlings	13
	Spanish seedlings	7
	Miscellaneous unverified	19
P acaulis	seed source	1
P canariensis OPS	seed source	1
P hanceana OPS	seed source	2
P loureiroi	seed source	1
P loureiroi var *loureiroi*	seed source	1
P paludosa OPS	seed source	1
P reclinata	1 clonal, 1 seed source	2
P roebelinii		3
P slyvestris		5

Table 4. Citrus accessions and inventory maintained at different sites

	Accessions	Inventory
Total	**1616**	**5582**
Citrus Variety Collection (Riverside – field planting)	1049	1912
Protected (pathogen tested – APHIS-certified screenhouse)	541	1081
GH (Riverside)	730	1803
Quarantine	117	177
Coachella Valley Agricultural Research Station (CVARS)	79	235
South Coast Field Station (SCFS)	51	92

Table 5. Germplasm acquisitions 2015.

CV	Group	Accession No	Source	Status
Torreblanca_2015_01	date palm	RSD 2016001	Murcia, Spain	seedlings
Torreblanca_2015_02	date palm	RSD 2016002	Murcia, Spain	seedlings
Torreblanca_2015_03	date palm	RSD 2016003	Murcia, Spain	seedlings
Torreblanca_2015_04	date palm	RSD 2016004	Murcia, Spain	seedlings
Torreblanca_2015_05	date palm	RSD 2016005	Murcia, Spain	seedlings
Torrecons_2015_01	date palm	RSD 2016006	Murcia, Spain	seedlings
Campfira_2015_01	date palm	RSD 2016007	Murcia, Spain	seedlings
La Purisima III	date palm	RSD 2016008	La Purisima, BCS, Mexico	seedlings
Comandu	date palm	RSD 2016009	Comandu, BCS, Mexico	seedlings
San Javier	date palm	RSD 2016010	San Javier, BCS, Mexico	seedlings
Adamopoulou	lemon	RCRC 4247	Greece	clean from CCPP
Mihrio	mandarin	RCRC 4248	Greece	clean from CCPP
Diller	sweet orange	RRUT 544	Arizona	clean from CCPP
Cuban	pummelo	RRUT 542	California	clean from CCPP
Cunningham	citrange	RRUT 543	California	clean from CCPP
Shiranui	mandarin	RCRC 4249	China	clean from CCPP
Sultana	date palm	RPHO 47, RPHO 48	UK	TC, did not establish
Yellow Sukkary	date palm	RPHO 49, RPHO 50	UK	TC, did not establish
Anbarah	date palm	RPHO 51, RPHO 52	UK	TC, did not establish
Ajwah	date palm	RPHO 53, RPHO 54, RPHO 55	UK	TC, did not establish
Sultana	date palm	RPHO 56, RPHO 57	UK	TC
Yellow Sukkary	date palm	RPHO 58, RPHO 59	UK	TC
Anbarah	date palm	RPHO 60, RPHO 61	UK	TC
Ajwah	date palm	RPHO 62, RPHO 63, RPHO 64	UK	TC
Oliver male	date palm	RPHO 65	UK	TC

TC = Tissue Culture

Table 6. Accession released from quarantine, 01-2016.

indexno	CULTIVAR	GROUP	Accessio No
I2015001	Amoa 8	tangor	RRUT 455
I2015002	Bergamotto Fantastico	sour orange hybrid	RRUT 387
I2015003	Bidwell's Bar	sweet orange	RRUT 140
I2015004	Collins-Hibbert	sweet orange	RRUT 36
I2015005	Daoxian wild orange	mandarin	RRUT 191
I2015007	Melanesian papeda	papeda	RRUT 192
I2015008	Ordubad	lemon	RRUT 511
I2015009	Salò	Citron	RRUT 453
I2015010	un-named lemon (?) ex-	lemon	RRUT 160
I2015011	un-named lemon (?) ex-	lemon	RRUT 161
I2015012	un-named lemon (?) ex-	lemon	RRUT 162
I2015013	un-named lemon (?) ex-	lemon	RRUT 165
I2015014	Variegated	citron	RRUT 311
I2015015	Bitters Newhall	navel orange	RCRC 4228

Table 7. Release candidates, 12-31-2016.

Index #	CULTIVAR	GROUP	Accession Number
I2016001	Caoshixiangju (1-11-12)	mandarin	RRUT 150
I2016002	Beibeiyou (15-3)	pummelo	RRUT 153
I2016003	Mesero	lemon	PI 209862
I2016004	M'guerqueb	citron	PI 265834[1]
I2016005	Valencia SPB-1-14-19	valencia orange	RRUT 440
I2016006	Shekwasha X Koethen (C61-252)	mandarin	RRUT 168[2]
I2016007	Tomango	sweet orange	RRUT 175
I2016008	Rico #6	sweet orange	RRUT 169
I2016009	Long huang kat	mandarin	RRUT 177
I2016010	Italian pink-fleshed variegated	lemon	RRUT 452
I2016011	Bearss	lemon	RRUT 443
I2016012	un-named sweet orange (?) ex-Nepal	sweet orange	RRUT 157
I2016013	USDA 1-49-105	mandarin hybrid	RRUT 377
I2016014	USDA 1-25-1	mandarin hybrid	RRUT 375
I2016015	USDA 1-22-32	mandarin hybrid	RRUT 382
I2016016	USDA 1-42-70	mandarin hybrid	RRUT 372[1]
I2016017	USDA Navel 1-N	navel orange	RRUT 390

[1]*Spiroplasma citri* culture pending
[2]Repeat of citron index pending

Table 8. Accessions currently being indexed, 12-31-2016

Index no	CULTIVAR	GROUP	Accession Number
I2017001	USDA 5-51-2	mandarin hybrid	RRUT 448
I2017002	Iwaikan	pummelo	RRUT 173
I2017003	Etonia citrange nucellar	citrange	PI 29160
I2017004	Fumin Evergreen trifoliate (OPS)	trifoliate	RSD 1998001
I2017005	Gou Tou Xiang Yuan (B)	sour orange	RRUT 321
I2017006	Nin Kat	mandarin	PI 433265
I2017007	pummelo #2 ex-Sichuan	pummelo	RRUT 197
I2017008	Little Sweetie	sweet lemon	RRUT 113
I2017009	US Early Pride	mandarin hybrid	RRUT 389
I2017010	Old Indian	lemon	RCRC 4211
I2017011	Canaliculata di Palermo	lemon	RRUT 222
I2017012	Dona Adelina	sweet lime	RRUT 451
I2017013	Orange	lemon	RRUT 487
I2017014	Shatianyou (2-1)	pummelo	RRUT 154
I2017015	Cariappa-pummelo3	pummelo	RSD 2013003
I2017016	Toronja ex-Paso Hondo	grapefruit	RRUT 539
I2017017	USDA Navel 3-S	navel orange	RRUT 392

Table 9. Accessions held in quarantine (114 total).

CULTIVAR	GROUP	Accessionn Number	QTYPE
'lemon pummelo' ex-western Yunnan (OPS)	lemon	RRUT 107	INTL
'Limon pummelo' ex-Reili County nucellar	lemon hybrid	RRUT 84	INTL
Amoa 8	tangor	RRUT 455	INTL
Bahianinha Monte Parnazo	navel orange	RRUT 184	STATE
Bahianinha Piracicaba	navel orange	PI 133261	STATE
Bahman Persian #2 nucellar	lime - sweet lime	PI 658374	SELF
Baiju nucellar	mandarin	RRUT 76	SELF
Bearss	lemon	RRUT 443	STATE
Beibeiyou (15-3)	pummelo	RRUT 153	INTL
Bergamotto Fantastico	sour orange hybrid	RRUT 387	INTL
Bidwell's Bar	sweet orange	RRUT 140	SELF
Bitters Newhall	navel orange	RCRC 4228	SELF
Cami	mandarin hybrid	RRUT 386	INTL
Campeona	mandarin	RRUT 393	INTL
Caoju (1-18-47)	mandarin	RRUT 151	INTL
Caoshixiangju (1-11-12)	mandarin	RRUT 150	INTL
Cariappa-CM3	mandarin	RRUT 524	INTL
Cariappa-pummelo2	pummelo	RRUT 523	INTL
Cariappa-pummelo2	pummelo	RSD 2013002	INTL
Clementine X Murcott (C54-4-2)	mandarin	RRUT 167	STATE
Clementine X Orlando (F-6-9-10)	mandarin	RRUT 166	STATE
Collins-Hibbert	sweet orange	RRUT 36	SELF
Consolei (OPS)	sour orange	RSD 2000003	INTL
Corniculata (OPS)	sour orange	RRUT 119	INTL
Corsican	citron	PI 539421	SELF
Corsican	citron	PI 539422	SELF
Daoxian wild orange	mandarin	RRUT 191	INTL
Dayap	lime	RRUT 35	SELF
Diamante	citron	PI 539423	STATE
Etrog	citron	PI 539425	SELF
Foerster "mutant"' nucellar	sour orange	RRUT 89	STATE
Fuju nucellar	mandarin	RRUT 82	INTL
Fuming evergreen trifoliate	trifoliate	RRUT 178	INTL
Gainesville 71	trifoliate	RRUT 388	STATE
Gaojiantou Mitong nucellar	mandarin	RRUT 77	INTL
Garcia-Yanez	sweet lime	RRUT 449	STATE
Goutoucheng (4-1)	sour orange	RRUT 149	INTL
H-56	tangor	PI 539241	SELF
Hamlin 1-4-1	sweet orange	RRUT 442	STATE
Hawaiian	pummelo	RRUT 143	SELF
Hongju nucellar	mandarin	RRUT 74	INTL
Horned	Sour orange	RRUT 454	INTL

Huangguogan #1 nucellar	tangor	RRUT 106	INTL
Huangguogan nucellar	tangor	RRUT 83	INTL
Hudson #1 (4N)	grapefruit	RRUT 385	STATE
Hyuganatsu-mikan	pummelo	PI 280540	STATE
Italian pink-fleshed variegated	lemon	RRUT 452	INTL
Kuharske	citrange	RRUT 439	STATE
Limequat	lime hybrid	RRUT 146	SELF
Ling Mung	rangpur	RRUT 174	STATE
Little Sweetie	sweet lemon	RRUT 113	SELF
Local lime 2-8 ex-Reili County (OPS)	lime	RRUT 85	INTL
Local lime ex-Xiaochenhang nucellar	lime hybrid	RRUT 86	INTL
Long huang kat	mandarin	RRUT 177	STATE
M'guerqueb	citron	PI 265834	STATE
Man Ju (OPS)	mandarin	RRUT 104	INTL
Marmalade tree		RSD 2015001	SELF
Mediterranean nucellar	blood orange	RRUT 90	STATE
Melanesian	papeda	RRUT 192	INTL
Melanesian (New Caledonia)	papeda	RRUT 534	INTL
Mesero	lemon	PI 209862	SELF
Nan Feng Mi Ju (OPS)	mandarin	RSD 2002003	INTL
New Zealand Grapefruit	grapefruit	PI 539464	SELF
Nine Pound	lemon	RRUT 485	STATE
Ordubad	lemon	RRUT 511	INTL
Pomo d'Adamo nucellar	lemon	RRUT 138	INTL
Pon tri DPI-50-7-6	trifoliate	RRUT 441	STATE
pummelo #1 ex-Sichuan	pummelo	RRUT 196	INTL
pummelo #3 ex-Sichuan	pummelo	RRUT 198	INTL
Red ling mung	rangpur	RRUT 176	STATE
Red Mexican	grapefruit	RRUT 170	STATE
Reina	mandarin	RRUT 536	SELF
Rico #6	sweet orange	RRUT 169	STATE
Ruby 4N	blood orange	RRUT 31	STATE
Salò	Citron	RRUT 453	INTL
Sarah #2	sweet orange	RRUT 172	STATE
Seville	sour orange	PI 539169	SELF
Shamel	tangor	RRUT 148	STATE
Shekwasha X Koethen (C61-252)	mandarin	RRUT 168	STATE
Suanju nucellar	mandarin	RRUT 81	INTL
Sunki	mandarin	RRUT 444	STATE
Swingle	tangelo	RRUT 188	STATE
Temecula Sweet	mandarin	RRUT 463	STATE
Temple 4N	tangor	RRUT 32	STATE
Thimmaiah1	pummelo	RSD 2013001	INTL
Tomango	sweet orange	RRUT 175	STATE
Tonkan nucellar	tangor	RRUT 91	STATE
Tung kum	mandarin	RRUT 185	STATE

Umatilla	tangor	RRUT 445	STATE
un-named lemon (?) ex-Nepal	lemon	RRUT 160	INTL
un-named lemon (?) ex-Nepal	lemon	RRUT 161	INTL
un-named lemon (?) ex-Nepal	lemon	RRUT 162	INTL
un-named lemon (?) ex-Nepal	lemon	RRUT 165	INTL
un-named sweet orange (?) ex-Nepal	sweet orange	RRUT 157	INTL
un-named trifoliate ex-Beibei	trifoliate	RRUT 155	INTL
US-897	trifoliate hybrid	RRUT 384	STATE
US-942	citrandarin	RRUT 532	STATE
USDA 1-22-32	mandarin hybrid	RRUT 382	STATE
USDA 1-25-1	mandarin hybrid	RRUT 375	STATE
USDA 1-42-70	mandarin hybrid	RRUT 372	STATE
USDA 1-46-30	mandarin hybrid	RRUT 371	STATE
USDA 1-49-105	mandarin hybrid	RRUT 377	STATE
USDA 5-8-122	mandarin hybrid	RRUT 447	STATE
USDA 6-2-53	mandarin hybrid	RRUT 446	STATE
USDA Navel 1-N	navel orange	RRUT 390	STATE
USDA Navel 2-C	navel orange	RRUT 391	STATE
Valencia seedless	valencia orange	RRUT 394	INTL
Valencia SPB-1-14-19	valencia orange	RRUT 440	STATE
Variant citradia	trifoliate hybrid	RRUT 171	STATE
Variegated	citron	RRUT 311	INTL
Vecino	sweet lime	RRUT 450	STATE
Xiangchen (OPS)	papeda hybrid	RRUT 100	INTL
Yemen	citron	PI 539434	STATE
Yuzuquat	kumquat hybrid	RRUT 49	STATE

Table 10. Accessions receiving therapy, CY 2016.

CULTIVAR	Accession Number	Type of Therapy	Established
Hamlin 1-4-1	RRUT 442	STG	
Clementine X Murcott (C54-4-2)	RRUT 167	STG	
Sunki	RRUT 444	STG	
Goutoucheng (4-1)	RRUT 149	STG	X
Caoju (1-18-47)	RRUT 151	STG	
pummelo #3 ex-Sichuan	RRUT 198	STG	
Yuzuquat	RRUT 49	STG	
Red Mexican	RRUT 170	STG	X
Nine Pound	RRUT 485	STG	X
Dweet	PI 539240	STG	
Campeona	RRUT 335	STG	
Horned	RRUT 454	STG	
Reina	RSD 2010004	STG	
un-named trifoliate ex-Beibei	RRUT 155	STG	X
Lotus Hill sour (OPS)	RSD 2012008	STG	X
Xizhang smooth round (OPS)	RSD 2012015	STG	
Gunlong Hill wild (OPS)	RSD 2012002	STG	
Pon tri DPI-50-7-6	RRUT 441	STG	
Gainesville 71	RRU 388	STG	
Clementine X Orlando (F-6-9-10)	RRUT 166	STG	
USDA 6-2-53	RRUT 446	STG	
US- 942	RRUT 532	STG	
Cariappa-pummelo2	RRUT 523	STG	
pummelo #1 ex-Sichuan	RRUT 196	STG	
Garcia-Yanez	RRUT 449	STG	
sweet orange ex-San Isidro	RSD 2011002	STG	
Naranja-lima ex-Rancho Santa Rosa	RSD 2010011	STG	X
'lemon pummelo' ex-western Yunnan (OPS)	RRUT 107	STG	X
Shekwasha X Koethen (C61-252)	RRUT 168	STG	
Tonkan nucellar	RRUT 91	Thermo	X
Foerster ‘mutant’	RRUT 89	Thermo	X
Huangguagan #1 nucellar	RRUT 106	Thermo	X
Bahianinha Monte Parnazo	RRUT 184	Thermo	X
Bahianinha Piracicaba	PI 133261	Thermo	X
Ling Mung	RRUT 174	Thermo	X
Xiangchen (OPS)	RRUT 100	Thermo	X
‘Limon pummelo’ ex-Reili County nucellar	RRUT 84	Thermo	X
Vecino	RRUT 450	Thermo	X
Mediterranean nucellar	RRUT 90	Thermo	X

STG = Shoot Tip Grafting
Thermo = Thermotherapy

Table 11. NCGRCD number of orders distributed CY 2016.

Category	Orders	Orders (%)	Order Items	Order Items (%)
Agricultural Research Service	11	5	42	8
US Agency for International Development	0	0	0	0
U.S. federal agency (not AID or ARS)	3	2	3	0
U.S. state agencies and all universities	42	32	199	37
U.S. non-profit organizations	11	8	109	1
U.S. commercial company	14	11	33	1
U.S. individual no affiliation	20	15	51	2
CGIAR International Agr. Res. Center	0	0	0	0
Foreign genebank/genetic resources unit	1	0	0	0
Foreign non-commercial organization	22	17	92	17
Foreign commercial company	2	1	0	0
Foreign individual no affiliation	4	2	6	1
Domestic	101	78	437	82
Foreign	29	22	98	18
Total	**130**	**100**	**535**	**100**

Table 12. NCGRCD distributions by crop type, CY 2016.

	Phoenix	Citrus	Total
Orders	25	105	130
Orders (%)	19	81	100
Order Items	132	403	535
Order Items (%)	25	75	100

Table 13. Plants tested after therapy by either shoot tip grafting (STG) or thermotherapy. The quality of DNA and RNA extractions were analyzed by testing for internal control genes. CTV was tested by both ELISA and qRT-PCR. These accessions tested negative for multiple pathogen tests in the laboratory.

Number	Therapy	ACP	ACNO	#Plants	CULTIVAR
1	STG2015-42-03	RRUT	149	1	Goutoucheng (4-1)
2	STG2015-19-3	RRUT	154	1	Shatianyou (2-1)
3	TH2015-3-2	PI	280540	3	Hyuganatsu-mikan
4	TH2015-10-9	RRUT	176	7	Red ling mung
5	TH2015-6-8	RRUT	188	3	Swingle
6	TH2015-8-9	RRUT	143	5	Hawaiian
7	TH2015-1-2	PI	539169	1	Seville
8	TH2015-12-3	PI	2000003	1	Consolei (OPS)
9	TH2015-14-10	RRUT	119	9	Corniculata (OPS)
10	TH2015-5-10	PI	539241	9	H-56
11	TH2016-01-01	RRUT	91	5	Tonkan Nucellar
12	TH2015-7-1	PI	658374	9	Bahman Persian #2 nucellar
13	TH2015-13-9	RRUT	138	7	Pomo d'Adamo nucellar
14	STG2015-47-1	RRUT	371	2	USDA 1-46-30
15	STG2015-39-02	RRUT	391	1	USDA Navel 2-C
16	STG2015-63-05	RRUT	392	1	USDA Navel 3-S
17	TH2015-9-5	RRUT	394	2	Valencia seedless
18	TH2015-11-10	RRUT	385	2	Hudson #1 (4N)
19	TH2015-2-1	RRUT	439	10	Kuharske
20	STG2015-38-5	RRUT	451	1	Dona Adelina
21	TH2014-9-1	RRUT	448	1	USDA 5-51-2
22	STG2015-14-1	RRUT	447	1	USDA 5-8-122
23	TH2015-4-4	RRUT	463	2	Temecula Sweet
24	STG2015-48-1	RRUT	487	2	Orange
25	STG2016-09-01	RRUT	485	3	Nine Pound
26	STG2015-60-2	RRUT	539	1	Toronja ex-Paso Hondo
27	STG2015-24-4	RSD	2013003	1	Cariappa-pummelo3
		Total		90	

Table 14. Testing of plants of 129 accessions in quarantine and release status (last column) of 30 accessions for which all or most of the lab testing has been completed. The quality of DNA and RNA extractions were analyzed by testing for internal control genes. CTV was tested by both ELISA and QRT-PCR. Release of accessions planned for either January 2016 (14 accessions) or December 2016 (17 accessions as indicated on the last column). Results for each pathogen is shown as N (negative) or P (positive).

No	ACNO	IVNO	CULTIVAR	LOCATION	CTV	CPV	CCACH	CEVD	CTLV	GIII	GIV	Xylella	SC	LAS	LAF	LAM	PH	Status
1	31	2948	Ruby 4N	GH 1603-08-W	N	N	N	N	N	N	N	N	N	N	N	N	N	
2	32	2954	Temple 4N	GH 1603-10-E	N	N	N	N	N	N	N	N	N	N	N	N	N	
3	36	3891	Collins-Hibbert	GH 1603-02-W	N	N	N	N	N	N	N	N	N	N	N	N	N	Jan-16
4	36	3892	Collins-Hibbert	GH 1603-02-W	N	N	N	N	N	N	N	N	N	N	N	N	N	
5	49	4996	Yuzuquat	GH 1603-10-E	N	N	N	N	N	N	N	N	N	N	N	N	N	
6	53	9359	POS: CEVd (E 811)	GH B-03-S	N	N	N	N	N	N	N	N	N	N	N	N	N	
7	74	4048	Hongju nucellar	GH 36-01-S	N	N	N	N	N	N	N	N	N	N	N	N	N	
8	76	4053	Baiju nucellar	GH 36-07-S	N	N	N	N	N	N	N	N	N	N	N	N	N	
9	77	4054	Gaojiantou Mitong nucellar	GH 36-01-N	N	N	N	N	N	N	N	N	N	N	N	N	N	
10	81	4049	Suanju nucellar	GH 36-02-N	N	N	N	N	N	N	N	N	N	N	N	N	N	
11	82	4142	Fuju nucellar	GH 36-04-S	N	N	N	N	N	N	N	N	N	N	N	N	N	
12	83	4050	Huangguogan nucellar	GH 36-03-S	N	N	N	N	N	N	N	N	N	N	N	N	N	
13	84	4289	'Limon pummelo' ex-Reili County nucellar	GH 36-04-N	N	N	N	N	N	N	N	N	N	N	N	N	N	
14	85	4290	Local lime 2-8 ex-Reili County (OPS)	GH 36-03-S	N	N	N	N	N	N	N	N	N	N	N	N	N	
15	86	4291	Local lime ex-Xiaochenhang nucellar	GH 36-03-S	N	N	N	N	N	N	N	N	N	N	N	N	N	
16	89	4143	Foerster "mutant"' nucellar	GH 1603-04-W	N	N	N	N	N	N	N	N	N	N	N	N	N	
17	90	4144	Mediterranean nucellar	GH 1603-06-E	N	N	N	N	N	N	N	N	N	N	N	N	N	
18	91	4293	Tonkan nucellar	GH B-06	N	N	N	N	N	N	N	N	N	N	N	N	N	
19	100	4051	Xiangchen (OPS)	GH 36-02-S	N	N	N	N	N	N	N	N	N	N	N	N	N	
20	104	4146	Man Ju (OPS)	GH 36-01-S	N	N	N	N	N	N	N	N	N	N	N	N	N	
21	106	3955	Huangguogan #1 nucellar	GH 36-04-N	N	N	N	N	N	N	N	N	N	N	N	N	N	
22	107	3976	'lemon pummelo' ex-western Yunnan (OPS)	GH 36-03-S	N	N	N	N	N	N	N	N	N	N	N	N	N	
23	113	4798	Little Sweetie	GH 1603-06-E	N	N	N	N	N	N	N	N	N	N	N	N	N	
24	119	3975	Corniculata (OPS)	GH 36-06-N	N	N	N	N	N	N	N	N	N	N	N	N	N	
25	138	4799	Pomo d'Adamo nucellar	GH 36-06-N	N	N	N	N	N	N	N	N	N	N	N	N	N	
27	140	3981	Bidwell's Bar	GH 1603-02-E	N	N	N	N	N	N	N	N	N	N	N	N	N	Jan-16
26	140	3980	Bidwell's Bar	GH 1603-02-E	N	N	N	N	N	N	N	N	N	N	N	N	N	
28	143	3815	Hawaiian	GH 1603-04-E	N	N	N	N	N	N	N	N	N	N	N	N	N	
29	146	3822	Limequat	GH 1603-02-E	N	N	N	N	N	N	N	N	N	N	N	N	N	
30	148	3825	Shamel	GH 1603-08-E	N	N	N	N	N	N	N	N	N	N	N	N	N	
31	149	3549	Goutoucheng (4-1)	GH 36-04-N	P	N	N	N	N	N	N	N	N	N	N	N	N	

32	150	3550	Caoshixiangju (1-11-12)	GH 36-07-N	P	N	N	N	N	N	N	N	N	N	N	N	N	Dec-16
33	151	3551	Caoju (1-18-47)	GH 36-07-N	P	N	N	N	N	N	N	N	N	N	N	N	N	
34	153	3553	Beibeiyou (15-3)	GH 36-07-S	N	N	N	N	N	N	N	N	N	N	N	N	N	Dec-16
35	154	3554	Shatianyou (2-1)	GH 36-02-N	N	N	N	N	N	N	N	N	N	N	N	N	N	
36	155	3555	un-named trifoliate ex-Beibei	GH 36-03-N	N	N	P	N	N	N	N	N	N	N	N	N	N	
37	157	3557	un-named sweet orange (?) ex-Nepal	GH 36-05-S	N	N	N	N	N	N	N	N	N	N	N	N	N	Dec-16
38	160	9315	un-named lemon (?) ex-Nepal	GH A-13	N	N	N	N	N	N	N	N	N	N	N	N	N	Jan-16
39	161	3561	un-named lemon (?) ex-Nepal	GH 36-06-S	N	N	N	N	N	N	N	N	N	N	N	N	N	Jan-16
40	162	9314	un-named lemon (?) ex-Nepal	GH A-14	N	N	N	N	N	N	N	N	N	N	N	N	N	Jan-16
41	163	9788	un-named sweet orange (?) ex-Nepal	DISPOSED	N	N	N	N	N	N	N	N	N	N	N	N	N	
42	165	3565	un-named lemon (?) ex-Nepal	GH 36-06-N	N	N	N	N	N	N	N	N	N	N	N	N	N	Jan-16
43	166	3566	Clementine X Orlando (F-6-9-10)	GH 1603-02-W	N	N	N	N	N	N	N	N	N	N	N	N	N	
44	167	3568	Clementine X Murcott (C54-4-2)	GH 1603-02-W	N	N	P	N	N	N	N	N	N	N	N	N	N	
45	168	3570	Shekwasha X Koethen (C61-252)	GH 1603-08-E	N	N	P	N	N	N	N	N	N	N	N	N	N	Dec-16
46	169	3573	Rico #6	GH 1603-08-E	N	N	N	N	N	N	N	N	N	N	N	N	N	Dec-16
47	171	3576	Variant citradia	GH 1603-10-W	N	N	N	N	N	N	N	N	N	N	N	N	N	
48	172	3578	Sarah #2	GH 1603-08-W	N	N	N	N	N	N	N	N	N	N	N	N	N	
49	173	3582	Iwaikan	GH 1603-04-W	N	N	N	N	N	N	N	N	N	N	N	N	N	
50	174	3584	Ling Mung	GH 1603-04-W	N	N	N	N	N	N	N	N	N	N	N	N	N	
51	175	3586	Tomango	GH 1603-10-W	N	N	P	N	N	N	N	N	N	N	N	N	N	Dec-16
52	176	3587	Red ling mung	GH 1603-06-E	N	N	N	N	N	N	N	N	N	N	N	N	N	
53	177	3589	Long huang kat	GH 1603-06-W	N	N	N	N	N	N	N	N	N	N	N	N	N	Dec-16
54	178	3591	Fuming evergreen trifoliate	GH 36-05-N	P	N	N	N	N	N	N	N	N	N	N	N	N	
55	178	8828	Fuming evergreen trifoliate	GH 36-05-N	N	N	N	N	N	N	N	N	N	N	N	N	N	
56	184	3600	Bahianinha Monte Parnazo	GH 1603-02-E	N	N	N	N	N	N	N	N	N	N	N	N	N	
57	185	3602	Tung kum	GH 1603-10-W	N	N	N	N	N	N	N	N	N	N	N	N	N	
58	188	3609	Swingle	GH 1603-08-W	N	N	N	N	N	N	N	N	N	N	N	N	N	

59	191	3935	Daoxian wild orange	GH 36-02-S	N	N	N	N	N	N	N	N	N	N	N	N	N	Jan-16
60	191	3933	Daoxian wild orange	GH 36-02-S	N	N	N	N	N	N	N	N	N	N	N	N	N	
61	192	3931	Melanesian papeda	GH 36-05-S	N	N	N	N	N	N	N	N	N	N	N	N	N	Jan-16
62	192	3932	Melanesian papeda	GH 36-05-S	N	N	N	N	N	N	N	N	N	N	N	N	N	
63	196	3960	pummelo #1 ex-Sichuan	GH 36-03-S	N	N	N	N	N	N	N	N	N	N	N	N	N	
64	197	3967	pummelo #2 ex-Sichuan	GH 36-01-N	N	N	N	N	N	N	N	N	N	N	N	N	N	
65	198	3970	pummelo #3 ex-Sichuan	GH 36-02-S	N	N	N	N	N	N	N	N	N	N	N	N	N	
66	222	6950	Canaliculata di Palermo	GH 36-02-N	N	N	P	N	N	N	N	N	N	N	N	N	N	
67	311	6963	Variegated	GH 36-06-S	N	N	N	N	N	N	N	N	N	N	N	N	N	Jan-16
68	311	9966	Variegated	GH A-14	N	N	N	N	N	N	N	N	N	N	N	N	N	
69	321	5183	Gou Tou Xiang Yuan (B)	GH 36-04-N	N	N	N	N	N	N	N	N	N	N	N	N	N	
70	371	7187	USDA 1-46-30	GH 1603-09-E	N	N	N	N	N	N	N	N	N	N	N	N	N	
71	372	7178	USDA 1-42-70	GH 1603-07-W	P	N	N	N	N	N	N	N	N	N	N	N	N	Dec-16
72	375	7177	USDA 1-25-1	GH 1603-09-W	N	N	N	N	N	N	N	N	N	N	N	N	N	Dec-16
73	377	7186	USDA 1-49-105	GH 1603-11-E	P	N	N	N	N	N	N	N	N	N	N	N	N	Dec-16
74	382	7175	USDA 1-22-32	GH 1603-11-E	P	N	N	N	N	N	N	N	N	N	N	N	N	Dec-16
75	385	7641	Hudson #1 (4N)	GH 1603-03-E	N	N	N	N	N	N	N	N	N	N	N	N	N	
76	387	9969	Bergamotto Fantastico	GH A-14	N	N	N	N	N	N	N	N	N	N	N	N	N	Jan-16
77	387	7144	Bergamotto Fantastico	GH 36-04-N	N	N	N	N	N	N	N	N	N	N	N	N	N	
78	388	7279	Gainesville 71	GH 1603-01-E	N	N	N	N	N	N	N	N	N	N	N	N	N	
79	389	7599	US Early Pride	GH 1603-11-E	P	N	N	N	N	N	N	N	N	N	N	N	N	
80	390	7250	USDA Navel 1-N	GH 1603-03-W	P	N	N	N	N	N	N	N	N	N	N	N	N	Dec-16
81	391	7246	USDA Navel 2-C	GH 1603-03-W	P	N	N	N	N	N	N	N	N	N	N	N	N	
82	392	7249	USDA Navel 3-S	GH 1603-05-W	P	N	N	N	N	N	N	N	N	N	N	N	N	
83	393	7607	Campeona	GH 36-01-N	P	N	N	N	N	N	N	N	N	N	N	N	N	
84	394	7611	Valencia seedless	GH 36-05-S	N	N	N	N	N	N	N	N	N	N	N	N	N	
85	439	7844	Kuharske	GH 1603-03-E	N	N	N	N	N	N	N	N	N	N	N	N	N	
86	440	7848	Valencia SPB-1-14-19	GH 1603-12-E	P	N	N	N	N	N	N	N	N	N	N	N	N	Dec-16
87	441	7812	Pon tri DPI-50-7-6	GH 1603-05-W	N	N	N	N	N	N	N	N	N	N	N	N	N	
88	442	7815	Hamlin 1-4-1	GH 1603-03-E	N	N	N	N	N	N	N	N	N	N	N	N	N	

89	443	7645	Bearss	GH 1603-01-W	N	N	N	N	N	N	N	N	N	N	N	N	N	Dec-16
90	444	7862	Sunki	GH 1603-07-E	P	N	N	N	N	N	N	N	N	N	N	N	N	
91	445	8040	Umatilla	GH 1603-12-E	N	N	N	N	N	N	N	N	N	N	N	N	N	
92	446	7821	USDA 6-2-53	GH 1603-12-W	N	N	N	N	N	N	N	N	N	N	N	N	N	
93	447	8029	USDA 5-8-122	GH 1603-11-W	N	N	N	N	N	N	N	N	N	N	N	N	N	
94	448	7897	USDA 5-51-2	GH 1603-11-W	P	N	N	N	N	N	N	N	N	N	N	N	N	
95	449	7825	Garcia-Yanez	GH 1603-01-W	N	N	P	N	N	N	N	N	N	N	N	N	N	
96	450	7853	Vecino	GH 1603-12-E	N	N	N	N	N	N	N	N	N	N	N	N	N	
97	451	7827	Dona Adelina	GH 1603-01-E	N	N	P	N	N	N	N	N	N	N	N	N	N	
98	452	7858	Italian pink-fleshed variegated	GH 36-05-N	N	N	P	N	N	N	N	N	N	N	N	N	N	Dec-16
99	453	7855	Salò	GH 36-07-N	N	N	P	N	N	N	N	N	N	N	N	N	N	Jan-16
100	453	9968	Salò	GH A-14	N	N	N	N	N	N	N	N	N	N	N	N	N	
101	454	7854	Horned	GH 36-02-N	N	N	P	N	N	P	N	N	N	N	N	N	N	
102	454	9967	Horned	GH A-14	N	N	N	N	N	N	N	N	N	N	N	N	N	
103	455	9783	Amoa 8	GH A-14	N	N	N	N	N	N	N	N	N	N	N	N	N	Jan-16
104	511	10026	Ordubad	GH A-13	N	N	N	N	N	N	N	N	N	N	N	N	N	Jan-16
105	523	10071	Cariappa-pummelo2	GH 36-06-N	N	N	N	N	N	N	N	N	N	N	N	N	N	
106	524	10012	Cariappa-CM3	DISPOSED	N	N	N	N	N	N	N	N	N	P	N	N	N	
107	532	10053	US-942	GH 1603-01-E	N	N	N	N	N	N	N	N	N	N	N	N	N	
108	133261	3605	Bahianinha Piracicaba	GH 1603-02-E	P	N	N	N	N	N	N	N	N	N	N	N	N	
109	209862	9484	Mesero	GH 1627-17-S	N	N	N	N	N	N	N	N	N	N	N	N	N	Dec-16
110	265834	3613	M'guerqueb	GH 1603-06-W	N	N	N	N	N	N	N	N	N	N	N	N	N	Dec-16
111	280540	3581	Hyuganatsu-mikan	GH 1603-08-W	N	N	N	N	N	N	N	N	N	N	N	N	N	
112	433265	7850	Nin Kat	GH 1603-05-W	N	N	N	N	N	N	N	N	N	N	N	N	N	
113	539169	3882	Seville	GH 1603-08-W	N	N	N	N	N	N	N	N	N	N	N	N	N	
114	539241	4145	H-56	GH 1603-02-E	N	N	N	N	N	N	N	N	N	N	N	N	N	
115	539421	3535	Corsican	GH 1603-04-E	P	N	N	N	N	N	N	N	N	N	N	N	N	
116	539422	3937	Corsican	GH 1603-04-E	P	N	N	N	N	N	N	N	N	N	N	N	N	
117	539423	3538	Diamante	GH 1603-04-E	P	N	N	N	N	N	N	N	N	N	N	N	N	
118	539425	3540	Etrog	GH 1603-05-E	P	N	N	N	N	N	N	N	N	N	N	N	N	
119	539434	3543	Yemen	GH 1603-10-E	P	N	N	N	N	N	N	N	N	N	N	N	N	
120	539464	4939	New Zealand Grapefruit	GH 1603-06-W	N	N	N	N	N	N	N	N	N	N	N	N	N	
121	539625	9731	Madam Vinous	SH I10-N	N	N	N	N	N	N	N	N	N	N	N	N	N	
122	600635	4025	Afraegle gabonensis	GH 1623-09-N	N	N	N	N	N	N	N	N	N	N	N	N	N	
123	658374	3403	Bahman Persian #2 nucellar	GH 36-02-S	N	N	N	N	N	N	N	N	N	N	N	N	N	
124	1998001	4918	Fumin Evergreen trifoliate (OPS)	GH 36-05-N	N	N	N	N	N	N	N	N	N	N	N	N	N	
125	2000003	3973	Consolei (OPS)	GH 36-02-N	N	N	N	N	N	N	N	N	N	N	N	N	N	
126	2013001	10031	Thimmaiah1	GH 36-01-N	N	N	N	N	N	N	N	N	N	N	N	N	N	
127	2013002	10029	Cariappa-pummelo2	DISPOSED	N	N	N	N	N	N	N	N	N	N	N	N	N	
128	2013003	10032	Cariappa-pummelo3	GH 36-05-S	N	N	N	N	N	N	N	N	N	N	N	N	N	
129	4228RCRC	7900	Bitters Newhall	GH 1603-01-W	N	N	N	N	N	N	N	N	N	N	N	N	N	Jan-16