WALNUT IMPROVEMENT PROGRAM 2020

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ABSTRACT

The Walnut Improvement Program develops improved scion cultivars and new rootstocks with pathogen and abiotic stress resistance for the California walnut industry, improves our understanding of the genetics of the crop, and maintains breeding resources. Scion breeding seeks to generate new cultivars with improved disease and insect resistance, a range of harvest dates, increased yield and precocity, good kernel color stability, shelf life, and yield of kernel halves.
This year we released ‘Wolfskill’ (formerly 03-001-2357), a mid-season variety with Chandler color and better fill that harvests 10-14 days before Chandler. Wood of ‘Wolfskill’ and advanced selections was distributed to nurseries for further increase. We continued evaluation and propagation of scion selections on campus and in state-wide grower trials and continued early evaluations of seedling trees. DNA markers were developed for prediction of lateral bearing, precocity, and leafing date in new seedlings. We continue to work towards identifying the genetic basis for cherry leaf roll virus (CLRV) resistance. We examined modifications to tissue culture propagation procedures, produced additional plants of clonal rootstock candidates, and distributed these to cooperating pathologists for disease resistance testing. We also developed lab and greenhouse procedures for use in screening material for *Armillaria* resistance. Field and tissue culture germplasm collections continue to be maintained as a breeding resource, for use in marker development, for distribution to commercial labs and nurseries, and for use by other walnut research projects.

OBJECTIVES

The objectives of the Walnut Improvement Program are:

1) To provide the California walnut industry with improved cultivars and rootstocks
2) To develop and maintain germplasm with an array of useful traits for breeding
3) To develop and apply new phenotypic, genomic and molecular tools for more efficient walnut breeding

The program consists of several projects with specific goals:

- To develop and release new scion cultivars that combine precocity (high early yield) and a range of harvest dates with kernel quality, in-shell traits, and disease resistance.
- To provide solutions for blackline disease (CLRV), by moving resistance from black walnut into commercial-quality English walnut varieties, and/or by moving tolerance from English walnut into disease-resistant BC1 hybrid rootstocks
- To develop genetic solutions to rootstock disease and pest problems including *Phytophthora*, nematodes, crown gall and *Armillaria*, and to improve rooting and clonal

propagation methods. Both rootstock breeding and gene editing methods are being used to develop new genotypes that can be multiplied and grown for pathogen resistance testing.

- To exploit new technologies to increase the efficiency of the breeding process, including genomic information, new and more quantitative phenotyping methods, and gene modification methods such as CRISPR.
- To maintain, curate, and augment germplasm collections for future breeding use, as a source of foundation material for commercial labs and nurseries, for use by entomology and pathology research projects, and as a diverse resource for development of genomic tools.

SIGNIFICANT FINDINGS

- Completed procedures for release of selection 03-001-2357 as 'Wolfskill'. Wood for commercial increase has been established at interested commercial nurseries. Selections 03-001-1372, 03-001-1938, 07-002-5, and others continue to be evaluated on campus and in grower trials as additional candidates for release.
- Deployed four DNA markers for prediction of lateral bearing and leafing date in nuts from 2019 scion breeding crosses. To save time and expense, nuts from crosses with a homozygous *LB1/LB1* parent were not genotyped, since all their progeny are predicted to be lateral bearing. Of 1,015 nuts genotyped, 405 were discarded, 303 because they were predicted to be terminal bearing and 102 because they were predicted to have very late leafing dates.
- Planted 1,625 trees from 31 distinct crosses in 2019 into a new seedling block.
- Generated 1,579 new nuts from 17 distinct crosses in spring 2020.
- Genotyped 2,315 *J. microcarpa-J. regia* hybrids from six microcarpa mother trees (29.11, 31.01, 31.03, 31.05, 31.09, and 31.12), distributed them externally to SCRI cooperators for pathology testing and internally to WIP personnel for abiotic stress screening.
- Established an additional selection block on the Davis campus for evaluation of the most recently advanced selections and completed budding of the block established last year.
- Planted a new 860-seedling backcross test block and initiated CLRV resistance evaluations. Continued CLRV testing and observation for blackline formation in two older seedling blocks established in 2008 and 2009 and in a block of putatively CLRV-resistant scion varieties identified by the DNA marker and grafted for confirmation testing by virus patching in 2017. Additional virus patches were added this year to accelerate blackline development. A number of promising selections putatively identified as CLRV resistant by DNA marker were established in a grower trial in a blackline problem area. Promising selections are retained for use as mother trees in subsequent breeding and will be moved to additional grower trials.
- Evaluated a trial to verify the CLRV response of Vlach, VX211 and RX1
- Developed greenhouse procedures for use in identifying *Armillaria*-resistant rootstock candidates.
- Modified *in vitro* methods and media for rootstock propagation.

PROCEDURES

Scion cultivar breeding

Seedlings for evaluation are generated either through controlled crosses or by collecting open-pollinated (OP) nuts from selected mother trees. For controlled crosses, female flowers are bagged prior to bloom, pollen is collected, stored for up to one year if necessary, and is applied to selected female flowers when receptive. The 2020 crossing design placed priority on introducing blight and husk fly resistance while retaining early harvest dates, kernel quality, nut traits and yield. Seed is collected in the fall before nut drop, air dried before storing, and chilled until the end of harvest season. To ensure the highest possible germination rate, nuts are chipped open at the blossom end without damaging the embryo and immersed in cold, slowly running, water for 2 days before planting in the greenhouse. Soon after germination, seedlings are tagged with unique barcode, and a small (< 1 cm) disc of leaf tissue is harvested for DNA extraction. Genotyping is then performed to determine which seedlings to discard prior to planting into seedling blocks at UC Davis.

Seedlings are planted on relatively close spacing: 6' within row and 20' between rows, or approximately 360 trees/acre, with families randomized across blocks. Trees exhibiting terminal bearing, low early yield, or other obvious defects are culled at age 2-4. Only the remaining precocious and laterally fruitful individuals have been fully evaluated for phenology (leafing, flowering and harvest dates), precocity, lateral bearing, yield, blight incidence, and nut quality traits. The 2020 seedling block is the second one to have been pre-selected with marker-assisted selection (MAS), and we expect that the proportion of seedlings subjected to early culling in the field will gradually decrease, as our markers become more effective at weeding out these individuals before planting.

The most promising seedlings are propagated onto rootstocks in selection blocks on 20' x 20' spacing. Early selection blocks used seedling rootstocks and four replicate scions of each seedling selection grafted to two adjacent rootstocks per row in each of two adjacent rows. Our recent selection blocks use clonal rootstocks (both commercial and experimental SCRI clones) and two replicates of each seedling selection (a single tree in each of two adjacent rows). The number of selections is increasing but not doubling, since we are also including more commercial cultivars (eg: Chandler, Howard, Tulare, Ivanhoe, Solano) as "checks" within our selection blocks to allow for more direct comparison with our selections. This year we again harvested larger nut samples from selection blocks (60 nuts per tree from selection blocks versus 30 nuts per tree from seedling blocks) to allow more detailed phenotyping of nut and kernel quality traits, specifically shelf life and yield of kernel halves during shelling.

The best selections are moved to grower trials for continued evaluation. Grower field trials are an essential component of releasing a new cultivar. We continue to evaluate current trials, seek opportunities to expand at current locations, and attempt to identify additional growers interested in participating.

The next walnut crackout meeting is not yet scheduled but will be held remotely in February 2021 due to the ongoing pandemic.

Providing solutions to blackline disease (cherry leaf roll virus --CLRV)

Blackline disease results when a CLRV-tolerant English scion allows virus to spread through the graft union to a CLRV-hypersensitive rootstock. Two potential solutions to blackline disease include the development of CLRV-hypersensitive scions and the development of CLRV-tolerant rootstocks. For many decades the backcross breeding program has targeted the first solution by backcrossing the hypersensitivity to blackline disease found in northern California black walnut into commercially acceptable English walnut cultivars. Crosses are conducted using the same methods as in conventional cultivar breeding. Seedlings are first screened for potential resistance to the cherry leaf roll virus using a DNA marker as reported in Walnut Research Reports (1998, 2003). Retained seedlings are then culled based on screening for virus resistance as well as the same shell, kernel, yield, and horticultural traits used for conventional scion breeding.

The DNA marker, which maps to ~6.2 Mb on chromosome 14, only has a fidelity of ~90%, so the virus resistance of backcross selections and potential parents still must be confirmed directly. Genotyping and phenotyping more backcross individuals for virus tolerance will help identify a better marker and ultimately identified the gene(s) conferring hypersensitivity. The process primarily used to date is described in previous reports and involves field grafting a backcross selection onto both black and English rootstock (two each). After the grafts are established, bark from a CLRV-infected tree is patched into the English rootstock and into the backcross scions grafted onto black rootstock. If a backcross selection is resistant to the virus, it will survive on the black rootstock because the inoculum patch will be rejected, and it will die (exhibiting a black line) on the inoculated English rootstock. Confirmed resistant, thin-shelled individuals with the best commercial traits are then used as parents for the next generation of backcrosses to an English walnut parent with nut and kernel quality.

In 2018 we initiated a new CLRV resistance screening procedure that could be carried out year-round in the greenhouse. Young backcross and English seedlings in pots were approach-grafted and once the graft union was secure, the English seedling was cut from its root system and allowed to form the scion on top of the backcross seedling to be tested. After further healing, the established English scions were budded using virus-infected source material. Leaf samples from both the English scion and the backcross plant were tested for the presence of virus and genotyped and plants were to be observed for blackline development. Our experience, however, was that this process was less efficient than expected and blackline development was not evident on these small plants within the first year. Therefore, all greenhouse plants, grafted and ungrafted were field-planted this spring to continue grafting, virus application, DNA marker and virus testing, and observation for blackline development.

Rootstock breeding

Juglans microcarpa mother trees, including DJUG31.01 and DJUG31.09 (the mothers of the SCRI project) and DJUG29.11 (the mother of RX1) and several others, were previously grafted into one of our English seedling blocks. Each spring we remove their catkins to promote generation of *J. microcarpa* x *J. regia* hybrid nuts. Of 1,511 seedlings generated in 2018 and genotyped in spring 2019, only 869 (58%) were determined to be hybrids, suggesting that we need to be more diligent about removing tiny *J. microcarpa* catkins. These seedlings were distributed to SCRI pathologists for *Phytophthora* (Browne) and crown gall (Kluepfel) screening.

RESULTS AND DISCUSSION

Cultivar breeding

The conventional scion breeding portion of the improvement program currently includes over 6000 seedlings under evaluation in our orchard and 67 selections under evaluation at Davis and in state-wide selection blocks and grower trials (Table 1). Crosses made this year and the number of nuts resulting from each are shown in Table 2. Seedlings planted in 2020 from 2019 crosses are shown in Tables 3-4. Average phenology, yield, and nut trait data for standard varieties, recent releases, and the advanced selections under evaluation are provided in Tables 5-7. Descriptions and comparative data for recent releases and advanced selections, several potential pollinizers for Chandler, and two red-kernel selections can be found in Appendix 1. We continue to collect data and observations on performance of industry standards, previously released varieties, and advanced selections in grower trials. Appendix 2 contains an updated comprehensive list of grower trials and nursery blocks that include new scion selections and recent releases, their locations by county, the year each was established, and the growers involved. This year's Diamond evaluation data are included in Tables 14-15.

With the release of Ivanhoe (2010), Solano (2013), Durham (2016), and Wolfskill (early 2021) we now have four new varieties that address early variety quality issues and fill a range of harvest dates prior to Chandler (Table 8). Wolfskill (formerly 03-001-2357) is a Chandler x Solano cross with a mid-season harvest date and consistently light to extra-light kernel color. Several additional advanced selections are showing promise as new varieties and will continue to be evaluated and moved to additional grower trials.

Marker-assisted selection has been used for the last two years in the breeding program. In spring 2019, two markers for lateral bearing were used, and 34% of genotyped seedlings were discarded. In spring 2020, three markers for lateral bearing and one marker for leafing date were used, and 41% of genotyped seedlings were discarded. We continue to develop new markers to increase our efficiency. In spring 2020 we screened the 2019 seedling block for precocity (presence/absence of nuts) one year after planting. Overall, 142/825 (17%) of one-year-old seedlings had nuts, with most (125) of these resulting from open pollination and 47 resulting from open-pollination of 'Wolfskill'. Using molecular data to assign a most likely pollen parent to each of these, we observed that most precocious seedlings came from three fathers: 03-001-3382 (17/30 seedlings precocious), 03-001-985 (11/23 seedlings precocious), and 03-001-977 (6/12 seedlings precocious). All three of these pollen parents are within two trees of the Wolfskill mother trees in Selection Block D, and all three are "Chandler x Phase II" crosses, meaning that they resulted from a polycross of bulked (mostly Chinese) pollen onto Chandler. Using molecular data once again to assign a likely pollen parent to each of these three Phase II trees gave the same answer for each: 91-041-14, an Aksu tree not recorded as one of the Phase II parents, suggesting that the true father of these trees has not yet been genotyped.

GWAS using precocity data from the 2019 seedling block found several significant hits in the vicinity of the lateral bearing *(LB1)* locus on chromosome 11. Marker-assisted selection had previously been performed to ensure that every planted seedling contained 1-2 copies of the Payne lateral-bearing allele *(LB1a)*. However, we are aware of a second lateral-bearing allele *(LB1b)* present in some Chinese material, which we did not test for when planting the 2019 seedling block.

LB1 has long been known to affect precocity as well as lateral bearing, and we surmise that the precocious individuals we observed carry a *LB1a/LB1b* genotype at *LB1*. However, it is worth noting that homozygotes for the Payne *LB1* allele *(LB1a/LB1a)* did not show a higher prevalence of precocity than the 2019 seedling population as a whole. Our previous finding that *LB1a/LB1a* homozygotes are much more precocious than *LB1a/lb1a* heterozygotes (2018 WIP Walnut Research Report, Fig. 4) used data from 2-3 year old trees in a selfed Chandler population. Therefore, our tentative conclusion is that the Chinese lateral bearing allele *(LB1b)* allele confers precocity at an earlier age than the Payne lateral-bearing allele *(LB1a)*. A marker for *LB1b* is being developed for use in winter 2020-2021 to select more precocious 'Wolfskill' progeny. Precocity is of interest not only because it provides earlier returns to growers, but also because it is associated with higher yields in mature trees. The fortuitous incorporation of this extreme precocity into the breeding program resulted from the inclusion of open-pollinated seedlings in our new seedling blocks.

Backcross breeding for resistance to cherry leaf roll virus.

We currently retain 102 individuals under evaluation from an original population of over 800 4th generation (BC4) crosses (Table 11). All of these trees have been evaluated using the SCAR marker indicating hypersensitivity or tolerance to CLRV. Of these trees, 72 tested likely resistant to CLRV. The most horticulturally promising of these were planted in a test plot on both English and black rootstocks in 2017 for confirmation of SCAR marker results by patching virus into the English rootstocks. Both scions and test material are tested periodically for virus titer, additional virus patches were applied this year to increase virus load, and trees continue to be observed for development of blackline (Table 12). In addition, most of the full set of 102 mature BC4 trees growing on their own roots are now bark-grafted with English graftwood to develop solidly grafted English branches (Table 13). We began budding virus to these branches this year but most will be ready for virus application next year. Both English and test material will be evaluated for virus titer, branch graft-unions will be observed for development of blackline, and results obtained from both hypersensitive and tolerant trees will be used to improve marker accuracy and aid eventual identification of the responsible gene.

The best of these BC4 trees were used as parents to produce a set of BC5 seedlings, now mature and under field evaluation for horticultural traits. We expect to graft English branches onto these this year and test for virus resistance as we are currently doing with BC4 trees.

An additional set of primarily BC5 plants that was germinated and initially grown in the greenhouse (see 2019 Walnut Research Report) was planted this spring in the field for continued grafting, virus application, DNA marker testing, and observation for blackline development (Table 13). Ungrafted seedlings of sufficient size were patched with English buds to develop English scions for virus application in 2021. Previously greenhouse-grafted plants to which virus was not already applied were chip budded this year using virus-infected budwood. Plants with virus applied in the greenhouse in 2019 were tested multiple times this year for virus titer and observed for blackline development. Virus testing also involved initial trials and comparison of a new RT-LAMP procedure to the standard qPCR method. Scion development and virus application is expected to be completed for most plants in 2021. All trees will be tested for the presence of the SCAR marker and genotyped using GBS, tested for virus titer in scions, tested repeatedly for any virus transmission to rootstocks, and observed for blackline symptoms and horticultural traits.

Virus-resistant individuals with suitable horticultural traits will be moved to grower trials, released, and/or retained further use as parents. GBS data will be used to develop a marker with higher accuracy than the current SCAR marker.

Though it is usually assumed that all black walnuts (section Rhysocaryon) and their hybrids are hypersensitive to CLRV, almost all the observed cases of blackline have involved rootstocks of *Juglans hindsii* or its Paradox hybrid *(J. hindsii x J. regia)*. We therefore initiated a field experiment in 2019 to test the CLRV response of all three clonal walnut rootstocks (Vlach, Vx211, and RX1) grafted with Chandler, chiefly to verify that RX1, and by extension *J. microcarpa*, are hypersensitive. We applied additional virus to this trial this year and will continue to observe it for development of black line or any transmission of virus to rootstocks.

Of special concern is the fact that very few of our recent virus patches in the field or greenhouse have resulted in blackline symptoms. We have confirmed the passage of virus through grafts on juvenile plants presumed to be tolerant, but individuals that have not accumulated virus and are presumed to be hypersensitive have not yet developed blackline, at least not clearly in most cases. In the field, many English rootstocks known to be tolerant are not accumulating high virus titers after several rounds of patch-budding with virus-infected bark patches. Our source of CLRV inoculum has not changed for many years: every year we prune back these CLRV-infected English trees to remove their catkins and prevent them from spreading the virus. This year we established new source trees using systemically-infected tolerant backcross trees, both in order to provide a larger virus supply from hybrid trees with greater vigor than English, and to avoid the need for continual catkin removal by using male-sterile backcrosses. Next year we intend to establish new sources of CLRV inoculum from trees obviously declining due to blackline, and to maintain these sources in tolerant, male-sterile backcross seedlings.

Rootstock improvement

This year we increased lab cultures of 41 SCRI genotypes scheduled for pathology screening in potential field trials. We also increased cultures and initiated greenhouse rooting of four genotypes requested by Andreas Westphal for a nematode field trial in 2021 and sent approximately 600 greenhouse-grown plants of 14 different genotypes plus controls for a nematode field trial started this year. At the request of a commercial nursery, we successfully initiated 'Grizzly' rootstock into culture and provided them in vitro shoots for commercial production and we supplied 120 Magentas of microshoots of clonal rootstock genotypes to several commercial nurseries. We also produced clonal rootstocks of test material and controls for use by Wes Hackett in developing *Armillaria* resistance screening procedures in a greenhouse growth chamber.

Over the last 18 months we germinated somatic embryos and initiated micro shoot cultures of 32 transgenic genotypes from Paulo Zaini (Dandekar lab). These genotypes are designed to convey resistance to Phytophthora (see report by Zaini, Dandekar et al. in this volume). Approximately 24 shoots of each line were sent for in vitro testing and additional shoots of the two most promising lines and controls were rooted and established in the greenhouse for additional testing ex vitro. Shoots of 12 lines continue to be maintained in the lab and somatic embryo lines are being kept for potential future use in staking additional traits.

We continued to test media modifications for several difficult to grow *Juglans major* genotypes of particular interest for their nematode resistance and several additional plants of these were successfully rooted and grown in the greenhouse. Elimination of the ammonium nitrogen component of the induction medium appeared to have little or no effect in an initial trial. We also initiated experiments to evaluate the effects on rooting success of including paclobutrazol or increasing in vitro media aeration during the initiation process. These trials are still in progress. We also began testing use of an aeroponic chamber to improve rooting and to produce clean roots for Phytophthora testing and gene expression work.

Wes Hackett and Steven Lee continued to develop procedures for greenhouse screening of rootstock candidates for *Armillaria* resistance. Procedures were developed to culture *Armillaria* on walnut tissue in the lab and work is in progress to develop reliable inoculation procedures for greenhouse use with young potted plants. We produced 132 clonal rootstocks of test material and controls for this purpose. This work was supported in part by IAB funding.

J. microcarpa x *J. regia* open pollinated nuts harvested in 2019 were planted in the greenhouse in three batches for pathology screening. Plants were sorted according to leaf and bud morphology. Pure *J. microcarpa* seedlings were discarded and the hybrids were sent for screening. Table 9 shows the quantities from each mother tree in the first batch that were sent for pathology screening. An additional 130 seedlings from the third batch were planted in an old seedling block on campus on close spacing for replant screening (Table 10) and we kept approximately 150 seedlings in our lath house for a salinity test and a root hydraulic conductance experiment in the spring.

<u>Germplasm resources and maintenance</u>

We continue to manage collections of both field and *in vitro* germplasm for use by the Walnut Improvement Program, cooperating researchers, and commercial labs and nurseries. We supply microshoots and somatic embryos to commercial laboratories and research cooperators on request to support a variety of projects. We maintain a collection of nearly 2,000 genotypes in tissue culture for rootstock and other projects. Among these are licensed commercial rootstock releases, CLRV tolerant selections, and SCRI selections for crown gall, nematode, and *Phytophthora* resistance. We also maintain an *in vitro* nematode population for use in nematode resistance research. We continue to maintain several populations in our orchard for genetic study, including a Chandler x Idaho population that was used to create a genetic map and a wingnut seedling population that segregates for crown gall resistance. Again this year we supplied graftwood to fill a variety of research and nursery requests.

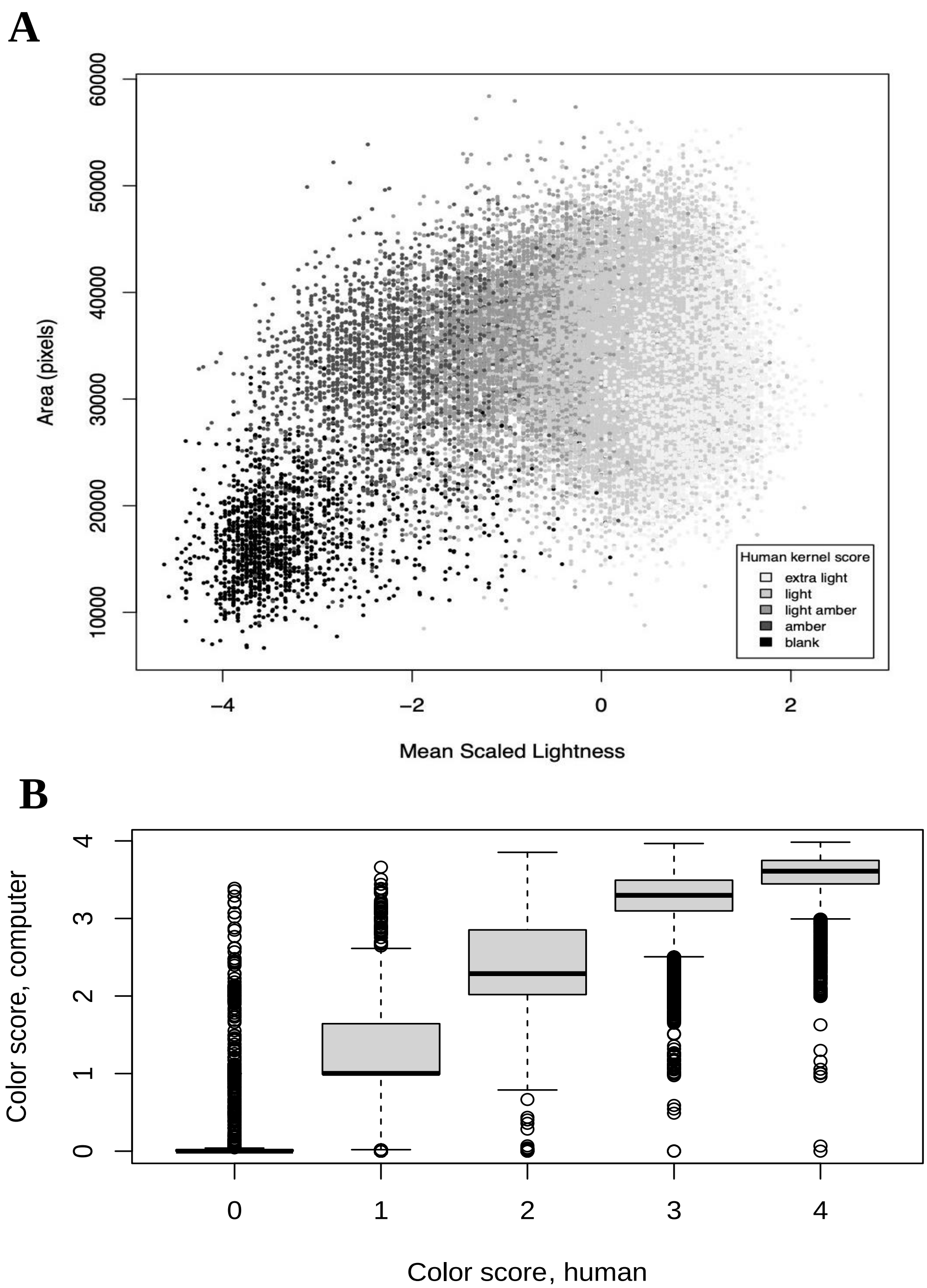
<u>New tools for genetic improvement</u>

Last year we purchased a walnut sheller and developed a protocol to measure the yield of kernel halves from different varieties in the breeding program. In winter 2020-2021 we are running ~500 samples through the sheller and evaluating their yield of kernel halves at least 95% intact, as well as their yield of halves at least 75% intact. 202 of these samples had been processed as of late December 2020, and two advanced selections currently stand out as having outstanding yield of halves: 07-002-5, which had an average yield of 43% halves at least 95% intact (and 76% halves at least 75% intact) across samples from three different blocks; and 04-003-143, which had an average yield of 44% halves at least 95% intact (and 74% halves at least 75% intact) across samples from two different blocks.

This year we began preliminary screening for variation in shelf life in the breeding program, using one Rancimat instrument purchased with Pat J. Brown's startup funds and a second Rancimat instrument purchased by the almond breeding program. These two instruments are housed together in a shared lab space. Each Rancimat instrument measures the development of rancidity in up to 8 ground walnut samples at a time by blowing hot air over the samples and measuring their "induction time", the time required to change water pH in each sample's headspace. Of the 188 samples run so far, the most promising candidate for extended shelf life is PI159568, for which the single sample analyzed to date had an induction time 50% higher than the mean for all samples. Several lines with PI159568 in their pedigree, including Durham and 06-005-31, also had high induction times.

In collaboration with Dr. Mason Earles (UC Davis Dept. of Viticulture and Enology) and his student Sean McDowell, a computer vision system for scoring kernel color was developed and used to generate quantitative color scores for 52,325 kernels (Figure 1). Several aspects of this system are under active development: first, the machine learning procedure sometimes fails to recognize broken kernels, and requires further training; second, the preliminary analysis shown in Figure 1 identified many discrepancies that have all so far proven to be cases of human error in kernel scoring or data management. Once these errors are fixed, new quantitative color scores can be calculated that are expected to yield better results for downstream analyses, such as GWAS. Computer vision will not immediately replace human vision for scoring kernel color in the breeding program: for comparative purposes, we will continue to evaluate seedlings, cultivars, and advanced selections using human as well as computer vision. However, we will use computer vision for all new experiments involving potentially subtle effects on pellicle color from pre-harvest stress, prolonged drying, and prolonged storage. This new treasure trove of quantitative color data is currently being used to search for markers associated with kernel color and kernel color stability.

Figure 1. A comparison of human and computer vision for 52,325 kernels from the breeding program. **A.** Computer vision measurements of lightness and area compared to human classification of kernels. **B.** Quantitative color scores generated by computer vision compared to ordinal human classification (0 = blank; 1 = amber; 2 = light amber; 3 = light; 4 = extra-light). Boxplot outliers represent discrepancies that have all so far proven to be human errors.



Appendix 1. Descriptions of varieties and advanced selections.

* indicates most promising,

# indicates potential pollinizers for Chandler with inverse bloom habit

Ivanhoe (95-011-14) (67-013 x Chico) (selected 2001): Released 2010. Ivanhoe is a protogynous variety (females bloom first) released for its very early harvest timing and extra light color. It harvests about a week before Payne and Serr with very strong yields and an abundance of nuts set in 3s and 4s. Harvest in the southern valley can occur in late August. It has smooth light colored shells and produces mostly Chandler-like extra light kernels averaging 7.6 g. The shells are relatively thin and this variety is probably not suitable for in-shell use. The seals are adequate but should be watched. Nuts yield 56% kernel with very easy removal of halves. Ivanhoe also leafs and blooms early in the spring, similar in time to Payne and Serr, and has similar exposure to blight. Trees should be planted on Paradox rootstock and closer spacing than other varieties due to Ivanhoe's relatively small stature and trees should be managed well to maintain tree health and nut size.

Solano (95-011-16) (67-013 x Chico) (selected 2003): Released 2013.Solano is a protandrous (males first) early to mid-season harvesting in-shell sibling of Ivanhoe with harvest timing similar to Vina, about a week after Payne. Solano has good yield and color and better tree structure than Vina. The large, light colored kernels average 8.4 g. Nuts have very solid oval shells with sufficient strength and seal for in-shell use, contain 51% kernel, and have an attractive appearance. Growers at several locations this year experienced issues with color. Leafing and flowering dates are about a week after Payne and similar to Vina. Trees appear to be upright and vigorous in growth habit.

Durham (93-028-20) (Chandler x PI159568) (selected 2001): Released 2016. Durham has Tulare or earlier timing with large, oval, very attractive nuts. It leafs a week before Chandler but harvests about two weeks earlier with good yield and has had little blight to date in trials. The smooth, light-colored, very solid shells have solid seals, 57% kernel and an attractive appearance. The large, very plump kernels average 8.9 g and kernel color is consistently excellent. Its shell qualities also make it an excellent candidate for use as a mid-season in-shell alternative to Hartley. Yield is good on mature trees but young trees appear, like Chandler, to be less precocious than Ivanhoe and Solano.

Wolfskill (03-001-2357) (Chandler x Solano) (selected 2010): Scheduled for release in early 2021, Wolfskill has consistently exhibited strong yields and produces attractive kernels with excellent color and easy removal of halves. The tree is protandrous, leafs nearly a week after Payne, but harvests 12 days before Chandler. Kernels average 8.1 g and have consistently been mostly extra light in color. Shells are well filled, have an attractive appearance, are thin but not weak, and give 57% kernel yield. Clearly it is harvesting well before Chandler. (Trials: Scheuring, Whitney Warren, Stolp, Crane, Norene, Sierra Gold, Burchell, Orestimba, Gilbert).

****07-002-5** (91-077-6 x 93-028-20) (selected 2012): This is a short season selection that leafs out approximately Chandler time and harvests with Tulare. It has 8.0 g plump kernels with excellent color and outstanding ease of removal, and nuts contain 59% kernel. Nuts have smooth, light-colored, and fairly thin shells. This selection still needs to be watched further for consistency of yield but nut and kernel traits, near absence of blight, and phenology make this a very interesting late-leafing selection. One of the best for color and nut appearance. (Trial: Scheuring, Suchan, McDavid, Crane).

****03-001-1372** (Chandler x Phase II) (selected 2010): This mid-season protandrous selection leafs only a few days before Chandler but harvests between Vina and Tulare and is under consideration for release. It has a strong yield of 7.7 g kernels and excellent kernel color. The nuts average 54% kernel with excellent removal in halves. Kernel color is Chandler-like and almost entirely light to extra light. (Trials: Scheuring, Whitney Warren, Suchan, Burchell, McDavid, Crane, Norene, Stolp, Spanfelner, Sierra Gold, Burchell, Orestimba, Gilbert).

***03-001-1938** (Chandler x Phase II) (selected 2010): Selected for its huge yields and early harvest timing similar to Vina or Solano, this protandrous selection produces 7.9 g kernels with very good kernel color. The smooth, light colored shells have good strength. Seal strength appears to be sufficient. The attractive, round, and well-filled nuts yield 57% kernel with easy removal of halves. This selection is under consideration for release but the leafing date is early, close to Payne, and it needs further observation in grower trials. (Trial: Whitney Warren, Scheuring, Crane, Burchell, Orestimba, Gilbert).

***06-005-31** (Ivanhoe x 59-124) (selected 2013): This early harvest selection leafs and harvests a week later after Payne, has had almost no blight, and is very productive. The large, attractive, well-filled long-oval nuts yield 55% kernel although they have fairly thick shells. The very large, shiny, and very plump 10.3 g kernels are mostly light or extra light in color and have good removal in halves. This is an excellent candidate and needs to be moved to additional trials. (Trial: Scheuring, Crane, Gilbert).

***07-019-4** (Ivanhoe x 95-007-13) (selected 2016): This very high yielding, short-season selection leafs two weeks after Payne and harvests 4 days after Payne. Nuts have light colored, solid but slightly rough, shells, solid seals, yield very easy halves, and contain 56% kernel. Kernels average 7.8 g and have excellent extra light color. Should go to grower trials.

***08-006-12** (90-026-17 x 91-077-6) (selected 2014): This is a late leafing, early harvesting selection with excellent yield. It leafs only a few days before Chandler and harvests a week after Payne. The tree has a male-first bloom habit and low blight incidence. The nuts have good strength and easy removal of halves, yielding 59% kernel. Kernels have excellent color, scored almost entirely light or extra light, and average 8.5 g. Needs to go to grower trials.

 # 00-006-227 (76-080 x O.P.) (Selected 2009): This early-harvest date selection with very good yield harvests approximately with Vina. The large, mostly extra light kernels average 7.8 g and appear to hold color well in the field and after harvest. The tree leafs a week after Payne and produces nuts with 58% kernel. Shells are thin but sufficiently strong, like Serr. Watch the seals. The tree is protogynous with a bloom period that is inverse of Chandler, so it could also serve as a pollinizer for Chandler. (Trials: Scheuring, Whitney Warren, Stolp, Suchan, Burchell, McDavid, Crane, Norene, Orestimba, Leonard, Tos).

 # 04-003-143 (Chandler x O.P) (selected 2011): This selection has very strong yield and excellent kernel color. The tree leafs mid-season and has a protogynous bloom habit that is inverse of, and overlaps, Chandler. The large round nuts have big plump kernels averaging 8.9 g with Chandler-like light or extra light color. Nuts have smooth, light attractive shells that yield 54% kernel with easy removal of halves. Harvest date is only a week before Chandler. This is probably the best of these Chandler pollinizers. (Trial: Scheuring, Crane, Leonard).

03-001-1457 (Chandler x Phase II) (selected 2010): This large vigorous tree has good yield, harvests mid-season, and has a protandrous bloom habit. Leafing is almost a week later than Payne. The nuts have excellent shell appearance, yield 58% kernel, and shells are thin but have sufficient strength. The 7.8 g kernels have good color and are very easily removed in halves. Although this selection has very strong yield, the shells can be a bit too thin, the leafing is earlier than 03-001-1372and color is not as consistently good as that selection, which will probably be the better choice.(Trial: Whitney Warren, Scheuring, Stolp, Crane, Orestimba).

03-001-2434 (Chandler x Phase II) (selected 2010): This protandrous tree has very good kernel color and mid-season yield about ten days before Chandler. The plump 8.6 g kernels have been entirely light or extra light. The well-filled nuts have hard shells and produce 56% kernel. The tree leafs early, approximately with Payne. This selection leafs earlier than 03-001-2357 and also harvests a few days earlier, kernel color is light but not as light as that selection. This selection consistently shows some June drop, nuts are often a bit too well filled for easy removal, and nuts more readily drop on the ground after hull split than03-001-2357 which tends to hold them in the canopy. We will continue to watch this selection but 03-001-2357 is the better choice. (Trial: Scheuring, Whitney Warren, Stolp).

03-001-2440 (Chandler x Phase II) (selected 2010): This selection is notable for its consistently outstanding extra light kernel color and is usually among the best selections evaluated for color. It is also one of the latest leafing of this set, leafing about 9 days after Payne and 12 days before Chandler. The nuts yield 55% kernel, kernels are very plump and easily removed, kernel weight averages 8.4 g, and it harvests mid-season in the Vina-Tulare period. Concerns with this selection are blight incidence in several years, yield has never quite been up to expectations, and shells were very thick this year. This should at least continue to be used as an outstanding color parent. (Trial: Whitney Warren, Burchell, Orestimba, Gilbert).

05-001-94 (Ivanhoe x O.P.) (selected 2014): This selection has kernels with excellent color, consistently extra light, and 8.2 g average weight. The tree harvests a week after Payne. Nuts have good removal of halves and 54% kernel. It has a females-first bloom habit and leafs just after Payne. Blight has been low and yield and color have been excellent. Watch this selection further in the grafted block and it should be moved to grower trials.

06-017-14 (Forde x 59-124) (selected 2014): This is a large vigorous tree with outstanding yield that leafs and harvests a week later than Payne and Ivanhoe and has not exhibited blight. It has a male-first bloom habit. The large plump kernels average 8.2 and have very good color. Nuts have solid seals, good strength, and yield 60% kernel.

07-021-6 (95-007-13 x Durham) (selected 2014): This is a very high yielding selection with a Tulare time harvest date about 12 days before Chandler. The kernels have consistently excellent color with all light or extra light scoring and average 7.8 g. Trees leaf a week after Payne. Previous year's hulls tend to stay on the tree during the dormant season. Nuts yield 59% kernel and have thin shells but with good strength. Consider this one as an excellent color and yield replacement for Tulare. Needs to go to grower trials.

07-029-1 (94-019-29 x 91-077-6) (selected 2012): An early harvesting selection with great yield and 7.4 g nuts yielding 56% kernel weight and kernels with fairly good color. The early harvest date is within a few days of Payne but the leafing is a week later. The tree has a male-first bloom habit and has had outstanding yield. Put in grower trials.

07-029-15 (94-019-29 x 91-077-6) (selected 2014): This short-season selection is a relatively small tree that has consistently shown outstanding yield. It leafs a week after Payne, has a male-first bloom habit, and harvests with Payne. In spite of its heavy yields, this tree continues to exhibit excellent nut and kernel size. Kernel weight averages 9.1 g and nuts yield 56% kernel with mostly light and extra light color and very easy extraction in halves. However, it appears to be susceptible to blight and has a tendency to have blanks. It should be watched further.

08-002-4 (91-090-41 x 90-031-12) (selected 2014): This is a mid-season harvesting selection that leafs ten days after Payne with excellent yield. The outstanding kernel color has been entirely light and extra light. Nuts average 61% kernel and contain kernels averaging 8.2 g with very easy removal of halves. Shells are rather thin but strength and seals are good. Move it to grower trials.

08-008-28 (94-019-45 x 91-077-6) (selected 2014): Leafing 10 days after Payne and harvesting more than two weeks before Chandler, this vigorous protogynous short-season selection has very good yield and canopy appearance. The 8.2 g kernels have excellent color. Nuts have good shell and seal strength, are a bit rough and yield 56% kernel. Continue watching.

08-014-3 (95-018-3 x 990-031-12) (selected 2014): This short-season selection leafs with Chandler and harvests within 5 days of Payne. This is a vigorous tree with excellent yield, nut size and nut appearance. The 8.2 g kernels have been entirely light to extra light in color. Shells have good strength and seal, yielding 59% kernel with easy removal. A promising selection that needs to go to additional trials (Trial: Crane).

08-030-11 (95-026-16 x 95-007-13) (selected 2014): This is a protandrous selection that leafs about a week after Payne but harvests with Payne. The large kernels averaging 9.1 g and 56% kernel are generally over 70% extra light in color. Hull russetting and above average shell roughness are both potential pitfalls for this selection that will need to be watched further.

09-002-22 (91-077-6 x 94-019-29) (selected 2015): Light, smooth shells give this selection an aesthetically pleasing appearance. This protandrous selection leafs out and harvests two weeks after Payne, with 8.0 g kernels and 54% kernel yield. This tree has a consistently good yield and kernels are mostly extra light in color.

09-007-22 (91-096-3 x Ivanhoe) (selected 2014): This early-harvesting Ivanhoe offspring leafs ten days after Payne, has a female-first bloom habit, good yield, and harvests within a week of Payne. The nuts are well-filled, yielding 58% kernel. This selection has outstanding kernel color, all consistently scoring in the extra-light category, but nut size has been consistently decreasing. Watch this one but nut size now appears to be an issue.

09-014-13 (95-007-13 x Ivanhoe) (selected 2014): This protandrous early-harvest selection leafs and harvests a few days after Payne with excellent yield. The nuts are light and smooth with excellent appearance and the 7.1 g kernels have excellent shiny color with most scoring as extra light. Nuts have good seal and shell strength, with 56% kernel yield.

10-024-22 (03-001-97 x Ivanhoe) (selected 2017): Notable for its huge, light colored kernels, this selection is protogynous. Leaf out date is 2 weeks after Payne and about a week before Chandler. It is an inverse Chandler pollinizer. The kernel color is generally extra light, kernels weigh 8.6 g with 60% kernel yield.

Red kernel selections

95-014-3 (J. purpurea (RA1088) x Chandler) (selected 2002): A red selection with a uniform dark red color tone and potentially easier extraction of halves than Robert Livermore. Kernels average 7.5 g and nuts yield 56% kernel. (Trial: CSU Chico, Warren, Bertagna, Sierra Gold, Silva, Conant). Harvest date averages a few days after R. Livermore.

04-007-20 (90-027-21 x Robert Livermore) (selected 2016). This red selection has 7.8 g kernels and nuts averaging 54% kernel weight. Nuts are well filled but kernels removal is good. Evaluate further for uniformity of color. Shell is thinner than R. Livermore. Yield and harvest date are expected to be better than Robert Livermore. (Trial: Sierra GoldAppendix 2. List of Current Field Trials of Scion Selections

Appendix 2. List of Current Field Trials of Scion Selections

<u>Field Trials of CLRV-Resistant Selections</u>

San Benito -

<u>Bonturi</u>

2003: 87-041-2, 87-262-4, 92-016-1, 93-045-1

2007: 94-022-24, 94-026-20, 95-027-19

2010: 95-027-23, 95-030-10, 03-019-9, 03-019-10

2011: 06-032-18

2013: 95-030-10, 06-003-1, 06-032-6, 06-032-13, 07-047-4, 07-047-39, 07-051-6, 07-052-2, 07-056-29, 07-058-7, 07-063-20

<u>Corotto</u>

2005: 93-045-1, 94-022-24, 95-027-11, 95-027-23, 95-029-4

2006: 92-016-11, 93-045-1, 95-027-19, 95-027-38, 95-029-4, 96-017-12, 96-027-8, 97-027-24, 97-027-55, 98-017-44

<u>Walsh</u>

2019: 95-030-10, 06-032-13, 07-036-39, 07-036-164, 07-044-4, 07-045-36, 07-047-4, 07-047-6, 07-051-49, 07-059-27, 07-063-20, 09-030-2

2020: 07-044-4, 07-051-52, 07-059-28, 07-063-20

Contra Costa – Aram

<u>Tennant</u>

92-016-1, 94-022-24, 97-027-55

San Joaquin - Nouri

<u>Barton</u>

2011: 92-016-1, 93-045-1, 94-026-20, 95-027-19

<u>Field Trials and Nursery Blocks of Standard Selections</u>

Tehama - Milliron

<u>Spanfelner-Anderson</u>

2008: Solano

2016: 03-001-1372

<u>H. Crain</u>

Blight resistant variety trial

Butte –Milliron

Chico State Farm

Chico State Selection Block

Chico State Farm Trial

2004: Sexton, 91-090-41, 95-026-22

Forde block, Solano Block

Stolp

2003: 94-020-5, 94-020-35, Forde

2007: Ivanhoe, 95-026-16

2008: Solano, 00-006-54, 00-006-179, 00-011-88, 01-004-2, 01-016-11, 02-005-870, 03-001-1098, 03-001-1747

2010: Solano, 98-002-129, 00-006-227, 01-007-1, 02-005-671, 02-005-999, 03-001-1457, 03-001-1649, Wolfskill, 03-001-2434, 03-001-2824, 03-001-2825, 03-001-3382, 03-001-3395, 03-001-3441, 03-001-4097, 03-005-4, 04-001-390, 04-003-403, 04-007-48

2011: Durham

2016: 03-001-1372

2017: 03-001-1372

2013: Durham, 03-001-1457

Bertagna - red kernels

2006: 91-084-6, 90-024-3, 95-014-3

B. Crain

2013: Durham

Moffitt

2014: Durham

Lake – Elkins

Suchan

2007: 95-018-23, 96-014-12, 00-002-27, 00-006-48

2010: 00-006-48, 00-006-227, 03-001-977, 03-001-1098, 03-001-1372, 03-001-3441

2011: 00-006-54, 04-003-107, 04-004-58, 04-006-92

2013: 07-002-5

Glenn – Milliron

Carriere

2007: Ivanhoe

2013: Solano, Durham, 95-007-13

2020: 03-001-1372, Wolfskill

Colusa - Hasey

Nickels Trial - pruning

2008: Gillet, Forde, Tulare, Chandler

Sutter-Yuba - Hasey

Whitney Warren Ranch

2001-2010: 91-077-40, 91-090-41, 92-070-12, 93-026-6, Durham, 94-016-33, 94-019-85, 94-020-35, 94-028-20, 95-007-13, Ivanhoe, Solano, Gillet, Forde, 98-001-415, 98-001-520, 98-002-129, 00-004-44, 00-005-15, 00-005-30, 00-005-44, 00-005-144, 00-005-153, 00-006-227, 00-011-107, 01-007-2, 01-016-33, 02-005-870, 03-001-507, 03-001-665, 03-001-943, 03-001-977, 03-001-1372, 03-001-1457, 03-001-1938, Wolfskill, 03-001-2434, 03-001-2440, 03-001-2822, 03-001-3383, 03-001-3395, 03-001-3446, 03-001-3701, 03-001-4097, 04-001-56

Gilbert

2008: Sexton, Gillet, Forde

2016: Wolfskill, 03-001-1372, 03-001-1938, 03-001-2440, 06-005-31

2017: Durham

Sierra Gold

2011: Durham, 95-007-13, Solano, 95-026-16, 00-006-227, 00-011-107, 03-001-977, 03-001-1372, 03-001-2556

2016: Wolfskill, 03-001-1372, 95-014-3, 04-007-20

2017: Durham

2020: Wolfskill, 03-001-1372, 03-001-1938, 06,005-31, 07-002-5, 09-007-31, 09-002-22

Norene

2001: 91-096-3, 93-026-6, 94-017-69, 94-019-29, 95-017-47

2014: Solano, Durham, Wolfskill

2015: 03-001-1372

2019: Wolfskill

Silva

95-014-3

Leonard

2016: 00-006-227, 03-001-977, 04-003-143

Fickewirth

2016: Durham

Conant

2019: Red selections 95-014-3, 04-007-20

Yolo - Jarvis-Shean

Scheuring

2002, 2004, 2008: 90-027-21, Gillet, Forde, Sexton, Ivanhoe, Solano, Durham, 95-007-13, 91-096-3, 04-003-143, 03-001-977, 00-006-227, Wolfskill, 03-001-2434, 03-001-1372

2011: 00-006-54, 03-001-507, 03-001-977, 03-001-1457, 03-001-1938, 03-001-2556, 03-001-3382, 03-001-3446, 03-001-3682, 04-004-58

2012: Durham, 03-001-475, 03-001-665, 03-001-958, 03-001-985, 03-001-3701, 04-001-390, 04-003-293, 04-008-28, 05-002-233, 07-002-5, 07-005-17, 07-019-16, 07-022-30

2013: 03-001-1457, 05-002-393, 05-005-295, 05-034-11, 06-004-2, 06-005-31, 06-012-21, 06-013-20, 06-025-21, 06-026-19, 06-027-16

Martinez

2013: Solano, Durham

UCD Selection Blocks

San Joaquin - Nouri

Taylor

2005: Sexton. Gillet, Forde, 95-026-22

Calaveras - Wunderlich

McDavid

2010: 00-006-227, 00-006-48, 03-001-977, 03-001-1098, 03-001-1372, 03-001-3441

2013: 07-002-5

Stanislaus - Arnold

MJC

2004: Sexton, Gillet, Forde, Tulare

Deardorff

2006: 91-077-6, 94-020-28, Ivanhoe, 97-003-208, 97-003-311, 97-003-319

2007: 91-090-41, 91-077-6, Durham, 94-019-85, 94-020-5, 94-020-35, Ivanhoe, 95-026-16

Orestimba Nursery

2013: Durham, 03-001-1457

2016: 00-006-227, Wolfskill, 03-001-1372, 03-001-1938, 03-001-2440

2020: 07-031-4, 09-001-39, 09-007-31, 11,030-7

Burchell Nursery

2010: 00-005-30, 03-001-977

2011: 95-007-13, 95-026-16, 00-006-227, 00-011-107, 03-001-1372, 03-001-2556

2016: 00-006-227, Wolfskill, 03-001-1372, 03-001-1938, 03-001-2440

2017: Durham

Dave Wilson Nursery

2013: Durham, 03-001-1457

2017: 03-001-2357

Merced – Gordon

Crane

2002: Sexton, 90-023-11, 90-023-37, 91-094-18, 91-096-3, Tulare

2003: 92-070-12

2004: Sexton, Forde, 95-022-26

2010: 03-001-977

2012: Solano, Durham, 03-001-1372, 00-006-227, 03-001-977, 04-003-143

2014: Wolfskill, 03-001-1457, 03-001-1938, 05-002-233, 06-013-20, 06-005-18, 06-005-31, 06-005-36, 06-025, 21, 07-002-5, 08-011-26, 08-014-3

Fresno - Culumber

KAC

2009: KAC Blight resistant variety block: Payne, Serr, PI159568, Gillet, Ivanhoe, Solano, 91-096-3, 95-026-11

Kings - Amaral

Headrick

2009: 91-077-6, 94-020-28, 94-020-35, Ivanhoe, Forde, Gillet

Tos

2014: 00-006-227

Tulare –Fichtner

Moore

2004: Ivanhoe

2012: Solano

2013: Durham, 03-001-1457

2016: R. Livermore

2020: Wolfskill, 06-005-31, 07-002-5

Table 1. Number of individual crosses completed, seedlings planted, number of selections retained, and trees remaining under evaluation by year of cross.

Year	Crosses (n)	Original seedlings (n)	Selections (n)	Under Evaluation (n)
1990	15	591	-	-
1991	18	493	1	1
1992	15	243	-	-
1993	14	116	-	-
1994	15	587	-	-
1995	15	758	1	3
1996	7	333	-	-
1997	13	611	-	-
1998	5	1759	-	-
1999	1	993	-	-
2000	12	2503	-	1
2001	16	210	-	-
2002	5	1200	-	1
2003	11	4608	1	5
2004	7	6000	-	2
2005	9	3332	2	6
2006	22	954	1	9
2007	27	1045	5	8
2008	33	929	5	9
2009	32	1187	13	34
2010	32	1081	11	30
2011	37	761	5	12
2012	60	758	5	64
2013	83	1550	17	265
2014	58	899	-	588
2015	25	2191	-	1459
2017	11	668	-	668
2018	22	1227	-	1227
2019	30	1625	-	1625
2020	17	1579*	-	
Totals	667	40002	67	5818

*Number of nuts from this year's crosses shown in table 2.

Table 2. Seed generated from 2020 crosses.

Cross #	Female Parent	Male Parent	Number of nuts
1	76-080	Earliest	121
2	76-080	85-043-1	101
3	91-031-8	05-001-94	63
4	91-090-41	Earliest	97
5	95-007-13	05-001-94	210
6	03-001-1938	Earliest	250
7	Wolfskill	05-001-94	70
8	Wolfskill	91-031-8	120
9	05-001-94	Cheinovo sd.	186
10	05-001-94	09-002-22	133
11	07-002-5	05-001-94	64
12	07-002-5	03-001-1938	29
13	09-002-22	05-001-94	5
14	09-002-22	03-001-1938	11
15	10-020-17	09-002-22	32
16	10-020-17	06-005-31	23
17	10-024-41	09-002-22	64
Total			1579

Table 3. Seedlings planted on orchard spacing spring 2020. OP = open-pollinated.

Female Parent	Male Parent											
	91-031-8	Solano	03-001-1938	03-001-2440	03-001-3395	05-001-94	07-002-5	07-029-15	09-002-22	09-025-62	10-024-41	OP
Chandler												249
R. Livermore		13							12			190
90-024-3		8							17			17
91-084-2		12							18			
92-068-2												35
00-006-227	55											74
03-001-1938						241						
03-001-2440					25							
03-001-3395				104								84
05-001-94			43									41
07-002-5										99		45
07-029-15	7											12
08-008-28							6					
09-002-22											14	
09-007-31								5				47
12-051-4								2				
Earliest												18

Table 4. Cross identification number of crosses made in spring 2018-2019 and number of seedlings of each planted in spring 2020. OP = open-pollinated.

Cross #	Female Parent	Male Parent	No. of nuts
18-005	Earliest	OP	18
18-025	R. Livermore	OP	190
19-001	05-001-94	03-001-1938	43
19-002	05-001-94	OP	41
19-003	03-001-1938	05-001-94	241
19-004	03-001-2440	03-001-3395	25
19-005	03-001-3395	03-001-2440	104
19-006	03-001-3395	OP	84
19-007	92-068-2	91-031-8	70
19-008	92-068-2	OP	35
19-009	08-008-28	07-002-5	6
19-010	08-008-28	OP	32
19-011	09-002-22	10-024-41	14
19-012	07-002-5	09-025-62	99
19-013	07-002-5	OP	45
19-014	07-029-15	91-031-8	7
19-015	07-029-15	OP	12
19-016	09-007-31	07-029-15	5
19-017	09-007-31	OP	47
19-018	12-051-4	07-029-15	2
19-019	00-006-227	91-031-8	55
19-020	00-006-227	OP	74
19-021	R. Livermore	Solano	13
19-022	R. Livermore	09-002-22	12
19-023	R. Livermore	OP	30
19-024	91-084-2	Solano	12
19-025	91-084-2	09-002-22	18
19-027	90-024-3	Solano	8
19-028	90-024-3	09-002-22	17
19-029	90-024-3	OP	17
19-030	Chandler	OP	249
Total			1625

Table 5. Cultivar and Selection Evaluations at Davis – (Average Phenology and Yield 2010-2020, ordered by harvest date)

	Grafted or	Leafing		Pollen Shedding				Pistillate Bloom			%		Harvest	
	Seedling	Date	DAP[a]	1st	Peak	Last	Abund.[b]	1st	Peak	Last	Lateral	Yield [b]	Date	DAP[c]
Cultivars														
Ivanhoe*	G	3/19	-1	4/1	4/7	4/15	7	3/19	3/25	3/31	100	7	9/7	-4
Payne	G	3/21	0	3/24	3/31	4/8	7	4/2	4/6	4/12	100	8	9/11	0
Vina	G	3/29	8	3/29	4/5	4/13	7	4/9	4/13	4/18	100	7	9/21	10
Solano	G	3/27	6	3/28	4/3	4/14	7	4/8	4/12	4/18	100	7	9/22	11
Durham	G	4/2	12	3/29	4/6	4/15	6	4/13	4/17	4/21	100	7	9/24	13
Wolfskill	G	3/27	6	3/28	4/3	4/10	7	4/10	4/13	4/17	100	8	9/26	15
Howard	G	4/7	17	4/4	4/10	4/16	6	4/17	4/21	4/26	100	7	9/30	18
Tulare	G	4/6	16	4/6	4/13	4/22	7	4/15	4/19	4/23	100	8	10/1	18
R. Livermore	G	4/7	15	4/8	4/15	4/21	6	4/18	4/22	4/27	100	7	10/3	20
Hartley	G	4/5	15	4/3	4/10	4/20	7	4/16	4/20	4/25	31	6	10/5	23
Chandler	G	4/11	20	4/8	4/15	4/24	7	4/19	4/23	4/30	100	7	10/9	25
Selections														
09-014-17	S	3/22	2	3/22	3/29	4/3	5	4/4	4/9	4/12	97	6	8/30	-13
09-014-9	G	3/18	-2	3/31	4/7	4/13	7	3/21	3/28	4/1	100	7	9/1	-10
09-014-14	S	3/20	0	3/31	4/6	4/11	7	3/23	3/27	4/2	94	6	9/4	-7
10-024-41	S	3/13	-8	3/30	4/4	4/10	6	3/18	3/23	3/27	100	7	9/8	-4
07-029-15	G	3/28	6	3/28	4/3	4/10	6	4/6	4/10	4/15	100	8	9/10	-2
10-001-9	S	3/25	4	4/5	4/10	4/17	7	3/28	4/2	4/5	100	7	9/10	-2
09-007-22	G	3/30	10	4/7	4/13	4/19	5	4/1	4/5	4/10	100	7	9/11	-1
09-014-13	G	3/25	5	3/27	3/31	4/6	4	4/6	4/10	4/15	100	7	9/11	-1
11-030-33	S	3/23	1	3/27	4/2	4/6	5	4/6	4/9	4/14	100	7	9/11	-1
11-033-2	S	4/3	13	4/4	4/9	4/14	4	4/16	4/19	4/23	100	7	9/11	-1
11-035-4	S	3/26	5	3/26	3/31	4/8	3	4/5	4/8	4/13	100	8	9/11	-1

[a] Days after Payne leafing date at Davis; [b] 1=low, 9=high; [c] Days after Payne harvest date at Davis; * indicates protogynous

Table 5. Cultivar and Selection Evaluations at Davis – (Average Phenology and Yield 2010-2020, ordered by harvest date)

	Grafted or	Leafing		Pollen Shedding				Pistillate Bloom			%		Harvest	
	Seedling	Date	DAP[a]	1st	Peak	Last	Abund.[b]	1st	Peak	Last	Lateral	Yield[b]	Date	DAP[c]
09-014-20	S	3/21	1	3/23	3/31	4/5	5	4/3	4/8	4/12	100	7	9/12	1
09-014-4	S	3/22	2	4/2	4/10	4/14	6	3/25	3/30	4/3	100	7	9/13	2
09-007-31	S	4/4	15	4/13	4/21	4/27	6	4/7	4/12	4/17	100	7	9/14	3
07-019-4	G	4/2	11	4/1	4/8	4/14	7	4/12	4/17	4/21	100	7	9/15	2
07-029-1	G	3/27	5	3/27	4/2	4/8	7	4/8	4/12	4/16	100	7	9/15	2
08-030-11	G	3/26	5	3/27	3/31	4/4	5	4/9	4/14	4/18	100	7	9/15	2
10-020-17	S	3/27	6	4/7	4/13	4/22	6	3/30	4/2	4/6	100	7	9/15	3
06-005-31	G	3/27	5	3/28	4/2	4/11	7	4/7	4/11	4/16	100	6	9/16	3
10-008-63	S	4/1	12	4/3	4/9	4/14	7	4/11	4/15	4/19	100	7	9/16	4
11-030-8	S	4/7	17	4/17	4/21	4/25	4	4/10	4/15	4/20	100	6	9/16	3
10-001-19	S	3/21	1	3/25	3/31	4/8	7	4/1	4/5	4/11	100	7	9/17	5
10-016-29	S	3/31	10	4/4	4/7	4/12	6	4/12	4/16	4/20	100	6	9/17	5
11-030-17	S	3/24	3	4/9	4/13	4/17	5	3/29	4/3	4/9	100	6	9/17	5
05-001-94	G	3/23	2	4/3	4/9	4/16	7	3/26	3/29	4/4	100	7	9/18	6
08-014-3	G	4/9	19	4/8	4/13	4/19	7	4/13	4/17	4/22	100	7	9/18	5
09-001-39	G	4/8	19	4/13	4/19	4/25	6	4/8	4/12	4/17	100	7	9/18	7
09-005-33	S	3/30	10	3/31	4/4	4/8	4	4/12	4/16	4/20	100	7	9/18	6
10-006-4	S	3/27	7	3/29	4/2	4/7	4	4/7	4/12	4/16	100	6	9/18	6
10-024-22	S	4/4	14	4/15	4/21	4/23	6	4/6	4/10	4/15	100	7	9/18	6
10-024-31	S	3/24	3	4/3	4/11	4/18	7	3/25	3/29	4/2	100	7	9/18	6
08-008-28	G	4/6	16	4/9	4/14	4/21	6	4/9	4/13	4/17	100	7	9/19	7
08-019-11	G	4/9	19	4/6	4/11	4/18	7	4/17	4/20	4/24	100	7	9/20	8
08-034-1	S	3/26	5	3/25	4/1	4/8	7	4/8	4/12	4/17	100	7	9/20	9
05-001-97	G	3/24	3	3/26	3/31	4/5	6	4/3	4/6	4/10	100	7	9/21	9
07-002-5	G	4/7	16	4/4	4/10	4/16	6	4/16	4/20	4/24	100	6	9/21	8

[a] Days after Payne leafing date at Davis; [b] 1=low, 9=high; [c] Days after Payne harvest date at Davis; * indicates protogynous

Table 5. Cultivar and Selection Evaluations at Davis – (Average Phenology and Yield 2010-2020, ordered by harvest date)

	Grafted or Seedling	Leafing Date	Leafing DAP[a]	Pollen Shedding 1st	Pollen Shedding Peak	Pollen Shedding Last	Pollen Shedding Abund.[b]	Pistillate Bloom 1st	Pistillate Bloom Peak	Pistillate Bloom Last	% Lateral	Yield[b]	Harvest Date	Harvest DAP[c]
03-001-1372	G	4/5	15	4/5	4/11	4/19	7	4/14	4/19	4/23	100	7	9/22	11
07-021-6	G	3/26	4	3/28	4/4	4/10	6	4/7	4/11	4/15	100	7	9/23	10
09-002-22	S	4/5	16	4/3	4/10	4/16	6	4/15	4/19	4/24	100	7	9/23	12
09-014-12	G	3/30	9	3/31	4/4	4/10	4	4/10	4/14	4/18	100	7	9/24	13
10-024-19	S	4/3	13	4/14	4/19	4/24	6	4/6	4/11	4/18	100	7	9/24	13

[a] Days after Payne leafing date at Davis; [b] 1=low, 9=high; [c] Days after Payne harvest date at Davis; * indicates protogynous

Table 6. Cultivar and Selection Harvest Date, Nut, and Kernel Evaluations at Davis (Average 2010-2020, ordered by year of release/cross)

			Harvest		Shell			Average Wt.				Color %			
	Date	[b]DAP	Seas Lgth	[c]Seal	[d]Strgth	Thick mm	Nut (g)	Kernel (g)	% Kernel	[e]Kernel Fill	[f]Ease of Removal	Extra Light	Light	Light Amber	Amber
Cultivars															
Payne	9/15	2	178	5	5	1.3	13.50	7.08	52.59	5	5	3	84	13	1
Hartley	10/5	23	183	5	6	1.4	14.85	6.87	46.29	4	5	19	65	16	1
Vina	9/21	9	177	5	5	1.3	13.74	7.00	50.92	5	5	4	51	42	2
Chandler	10/9	25	181	5	5	1.3	14.11	6.76	47.96	5	5	54	36	10	0
Howard	9/30	18	176	5	6	1.3	14.34	7.31	50.96	5	5	24	58	17	1
Tulare	10/1	18	178	5	5	1.2	14.71	8.13	55.21	5	5	8	80	12	0
Ivanhoe	9/7	-4	172	5	5	1.2	13.60	7.57	55.57	5	5	39	57	4	0
Solano	9/22	10	179	5	5	1.3	15.33	8.41	54.86	6	5	34	59	7	1
Durham	9/24	13	177	5	5	1.2	15.69	8.88	56.55	6	4	51	48	1	1
Wolfskill	9/26	14	183	5	5	1.2	14.10	8.06	56.94	6	5	63	36	1	0
Selections															
03-001-1372	9/22	11	171	5	5	1.3	15.41	8.31	53.77	5	4	49	50	2	0
05-001-94	9/18	6	178	5	5	1.2	14.29	8.24	57.71	5	5	56	41	3	1
05-001-97	9/21	9	181	5	5	1.2	13.55	7.72	57.03	6	5	53	42	3	3
06-005-31	9/16	3	174	5	6	1.3	18.59	10.32	55.41	6	5	25	69	3	3
07-002-5	9/21	8	167	5	5	1.1	13.66	8.03	58.74	5	4	44	50	6	0
07-019-4	9/15	2	165	5	5	1.2	13.85	7.76	55.90	5	5	53	43	4	1
07-021-6	9/23	10	181	5	5	1.1	13.33	7.84	58.71	5	5	48	46	4	3
07-029-1	9/15	2	173	5	5	1.2	13.24	7.37	55.61	5	5	39	52	6	3
07-029-15	9/10	-2	166	5	5	1.2	16.16	9.10	56.14	5	4	44	51	5	0
08-008-28	9/19	7	167	5	5	1.2	14.64	8.17	55.78	5	5	39	59	2	0

[b]=“DAP” denotes “Days after Payne harvest at Davis”
[c]=Shell seal: 3 - poor, 5 - good, 7 - very strong

[d]=Shell strength: 3 - poor, 5 - good, 7 - very strong
[e]=Kernel fill: 3 - poor, 7- well
[f]=Ease of Removal: 3 - easy, 7 – difficult

Table 6. Cultivar and Selection Harvest Date, Nut, and Kernel Evaluations at Davis (Average 2010-2020, ordered by year of release/cross)

	Harvest				Shell			Average Wt.				Color %			
	Date	[b]DAP	Seas Lgth	[c]Seal	[d]Strgth	Thick mm	Nut (g)	Kernel (g)	% Kernel	[e]Kernel Fill	[f]Ease of Removal	Extra Light	Light	Light Amber	Amber
08-014-3	9/18	5	161	5	5	1.1	13.90	8.17	58.61	5	5	38	55	7	0
08-019-11	9/20	8	164	5	4	1.0	15.37	9.46	61.53	4	4	61	37	1	1
08-030-11	9/15	2	172	5	5	1.2	16.08	9.06	56.34	5	5	68	31	1	0
08-034-1	9/20	9	179	5	5	1.2	12.82	7.81	60.84	6	5	39	54	7	0
09-001-39	9/18	7	163	5	5	1.2	15.66	8.22	52.38	4	4	64	26	8	2
09-002-22	9/23	12	170	5	5	1.3	14.65	7.95	54.26	6	5	74	23	4	0
09-005-33	9/18	6	173	5	5	1.1	13.19	7.12	53.94	4	5	60	28	10	1
09-007-22	9/11	-1	165	5	5	1.1	12.10	7.10	58.48	6	5	88	12	0	0
09-007-31	9/14	3	162	5	5	1.2	14.18	7.49	52.67	5	5	83	16	2	0
09-014-4	9/13	2	175	5	5	1.2	14.73	8.30	56.32	5	5	46	52	3	0
09-014-9	9/1	-10	167	5	5	1.2	13.23	7.20	54.29	5	5	71	22	5	3
09-014-12	9/24	13	178	5	5	1.2	13.34	7.86	58.81	5	5	62	36	1	1
09-014-13	9/11	-1	171	5	5	1.2	12.58	7.05	55.90	5	4	73	26	1	0
09-014-14	9/4	-7	167	5	5	1.3	12.76	6.72	52.67	6	5	64	28	8	1
09-014-17	8/30	-13	161	5	5	1.2	12.16	6.84	56.24	5	5	65	30	4	1
09-014-20	9/12	1	174	5	5	1.1	14.69	8.27	56.25	5	4	69	18	8	5
10-001-9	9/10	-2	168	4	5	1.3	16.67	9.35	56.09	5	5	52	47	2	0
10-001-19	9/17	5	179	4	5	1.2	12.73	7.59	59.69	5	5	31	61	7	2
10-006-4	9/18	6	173	5	5	1.2	12.86	7.25	56.39	5	5	84	14	1	0
10-008-63	9/16	4	168	5	5	1.1	13.33	7.70	57.76	4	4	76	24	0	0
10-016-29	9/17	5	170	5	5	1.3	11.24	5.98	48.12	5	4	11	73	0	16
10-020-17	9/15	3	172	5	5	1.1	17.70	10.33	58.36	5	5	28	62	6	4
10-024-19	9/24	12	173	5	5	1.0	10.80	6.69	61.89	5	4	81	16	1	1

[b]="DAP" denotes "Days after Payne harvest at Davis
[c]=Shell seal: 3 - poor, 5 - good, 7 - very strong

[d]=Shell strength: 3 - poor, 5 - good, 7 - very strong
[e]=Kernel fill: 3 - poor, 7- well
[f]=Ease of Removal: 3 - easy, 7 – difficult

Table 6. Cultivar and Selection Harvest Date, Nut, and Kernel Evaluations at Davis (Average 2010-2020, ordered by year of release/cross)

	Harvest				Shell			Average Wt.				Color %			
	Date	[b]DAP	Seas Lgth	[c]Seal	[d]Strgth	Thick mm	Nut (g)	Kernel (g)	% Kernel	[e]Kernel Fill	[f]Ease of Removal	Extra Light	Light	Light Amber	Amber
10-024-22	9/18	6	166	5	5	1.1	14.26	8.61	60.34	5	5	84	10	4	1
10-024-31	9/18	6	177	5	5	1.2	16.27	9.09	55.72	5	5	55	42	3	0
10-024-41	9/8	-4	178	5	5	1.2	15.23	8.63	56.61	5	5	46	49	4	0
11-030-8	9/16	3	159	5	5	1.2	12.55	7.19	57.06	4	5	88	5	5	2
11-030-17	9/17	5	175	5	5	1.3	13.81	7.21	52.08	5	5	61	37	0	2
11-030-33	9/11	-2	170	5	5	1.2	13.91	7.99	57.37	5	5	35	61	3	0
11-033-2	9/11	-4	157	5	5	1.2	13.48	7.51	55.69	5	5	30	60	3	7
11-035-4	9/11	-1	167	5	5	1.1	10.50	6.40	60.77	6	5	63	35	0	2

[b]="DAP" denotes "Days after Payne harvest at Davis
[c]=Shell seal: 3 - poor, 5 - good, 7 - very strong
[d]=Shell strength: 3 - poor, 5 - good, 7 - very strong
[e]=Kernel fill: 3 - poor, 7- well
[f]=Ease of Removal: 3 - easy, 7 – difficult

Table 7a. Average leafing, male and female bloom, and harvest dates of **cultivars** at UC Davis from 2010-2020 (in harvest date order).

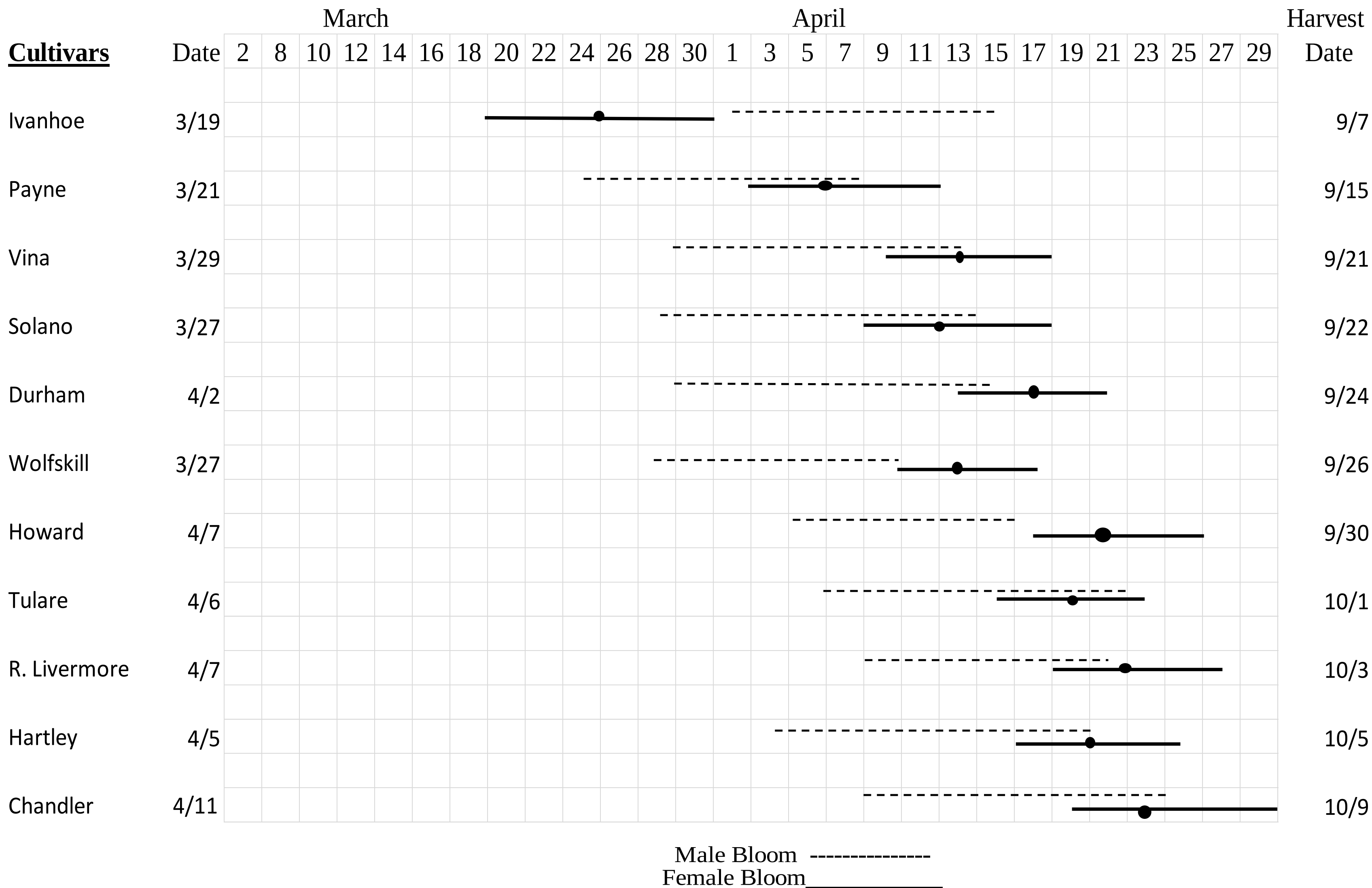
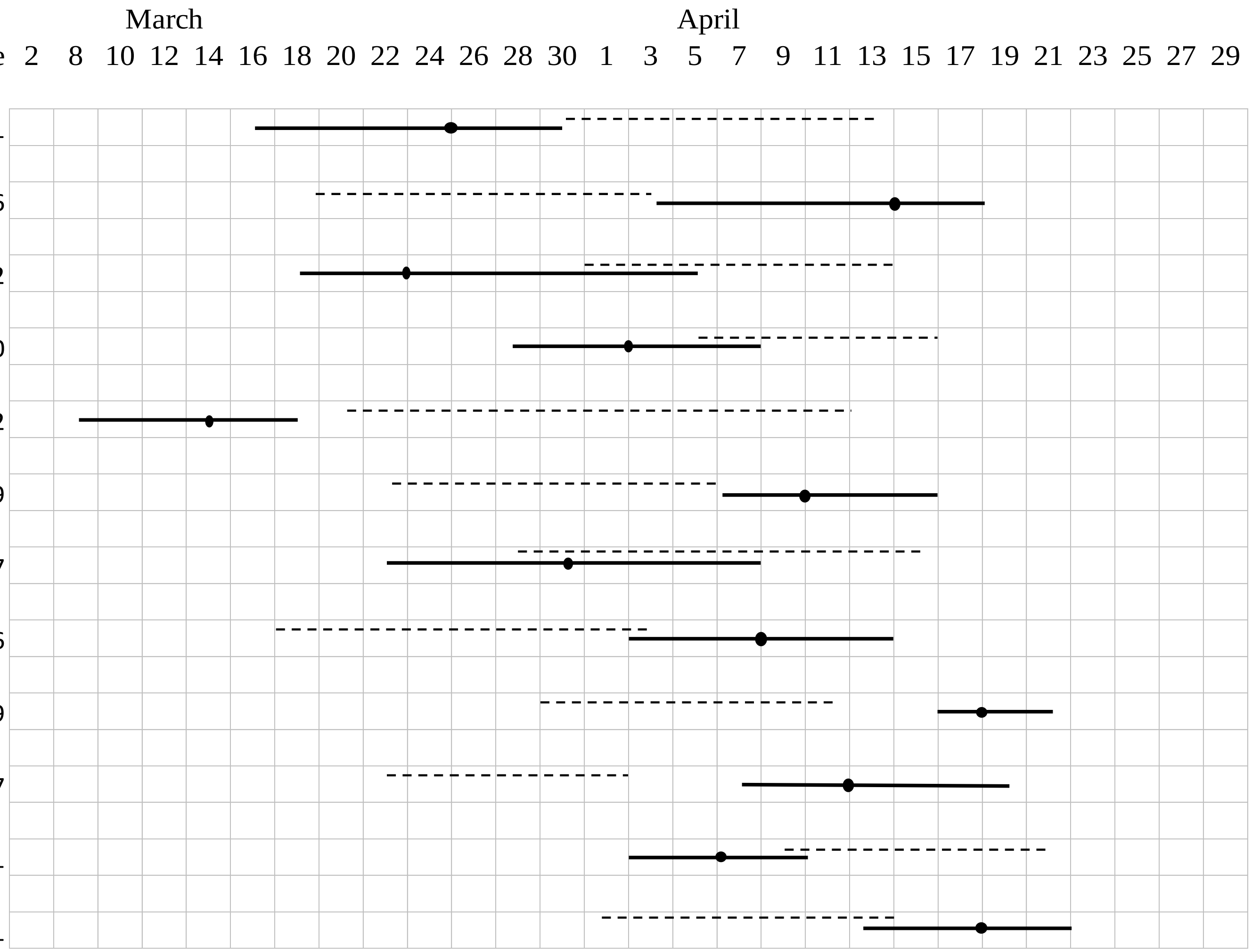


Table 7b. Leafing, male and female bloom, and harvest dates of **cultivars and selections** at UC Davis in 2020 (in harvest date order).



Selections & Cultivars	Date	Harvest Date
09-014-9	3/11	8/29
09-014-17	3/16	8/29
09-014-14	3/12	8/31
10-001-9	3/20	9/2
10-024-41	3/2	9/2
11-035-4	3/19	9/2
09-014-4	3/17	9/4
11-030-33	3/16	9/4
11-033-2	3/19	9/4
08-030-11	3/17	9/6
10-024-22	3/31	9/6
12-053-4	4/1	9/6

Male Bloom ---------------
Female Bloom____________

Table 7b. Leafing, male and female bloom, and harvest dates of **<u>cultivars and selections</u>** at UC Davis in 2020 (in harvest date order).

Selections & Cultivars	Date	Harvest Date
Ivanhoe	3/12	9/7
10-016-29	3/27	9/7
07-019-4	3/26	9/8
07-029-15	3/25	9/8
09-005-33	3/22	9/8
09-007-31	4/5	9/8
09-014-13	3/22	9/8
11-030-17	3/17	9/8
13-002-7	3/10	9/8
13-031-107	3/19	9/8
13-019-34	3/30	9/9
05-001-97	3/17	9/10

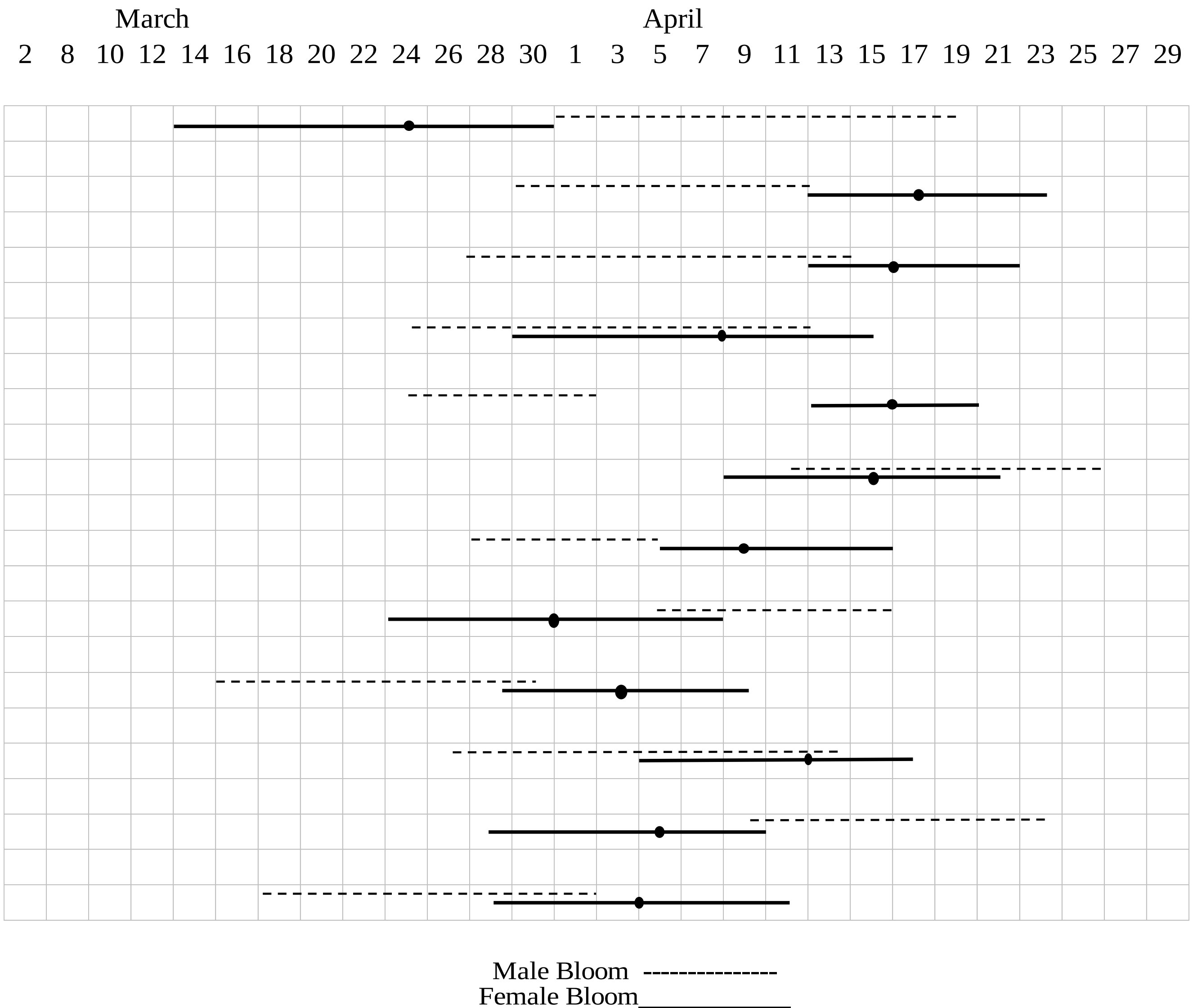


Table 7b. Leafing, male and female bloom, and harvest dates of **<u>cultivars and selections</u>** at UC Davis in 2020 (in harvest date order).

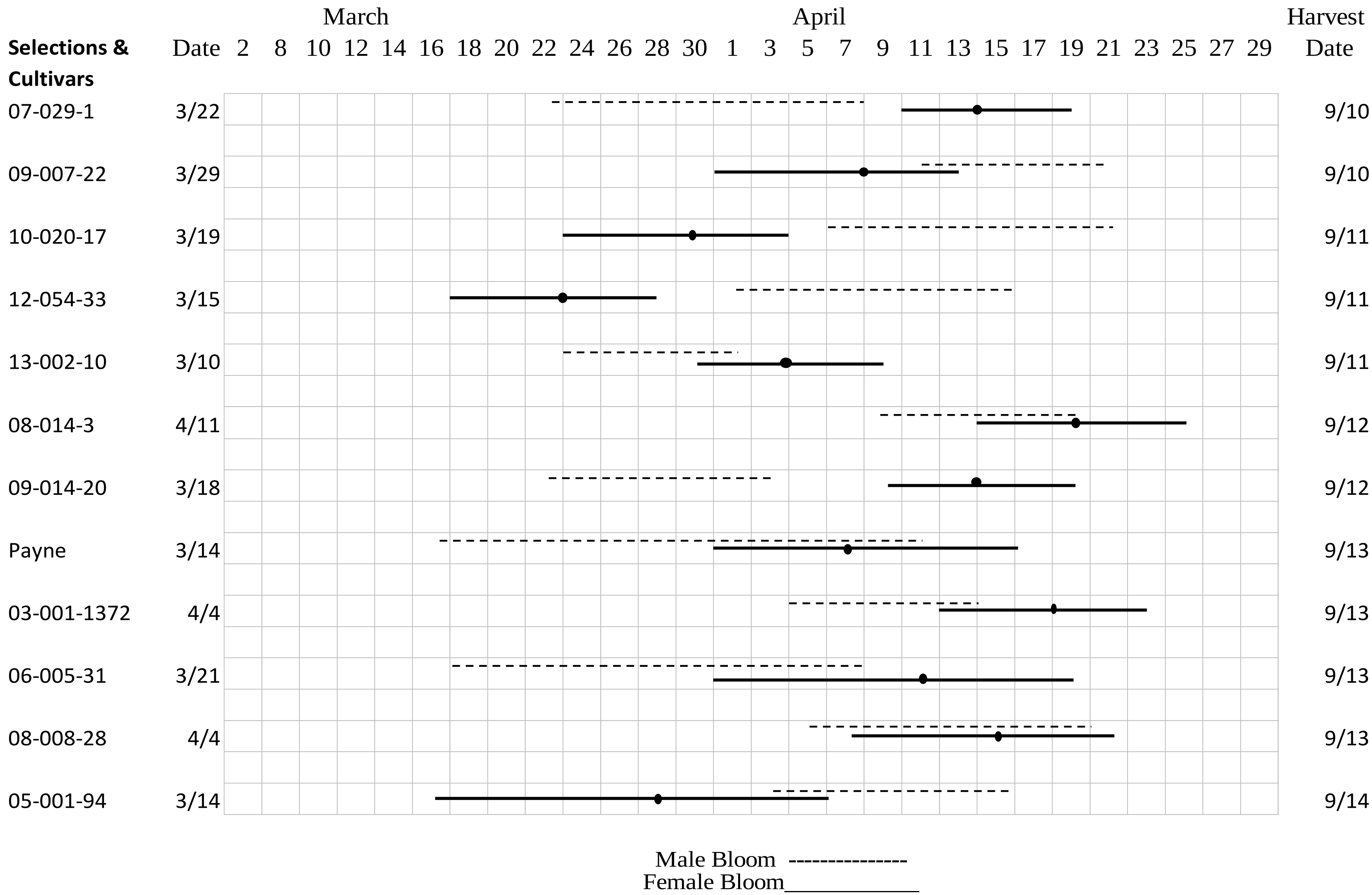
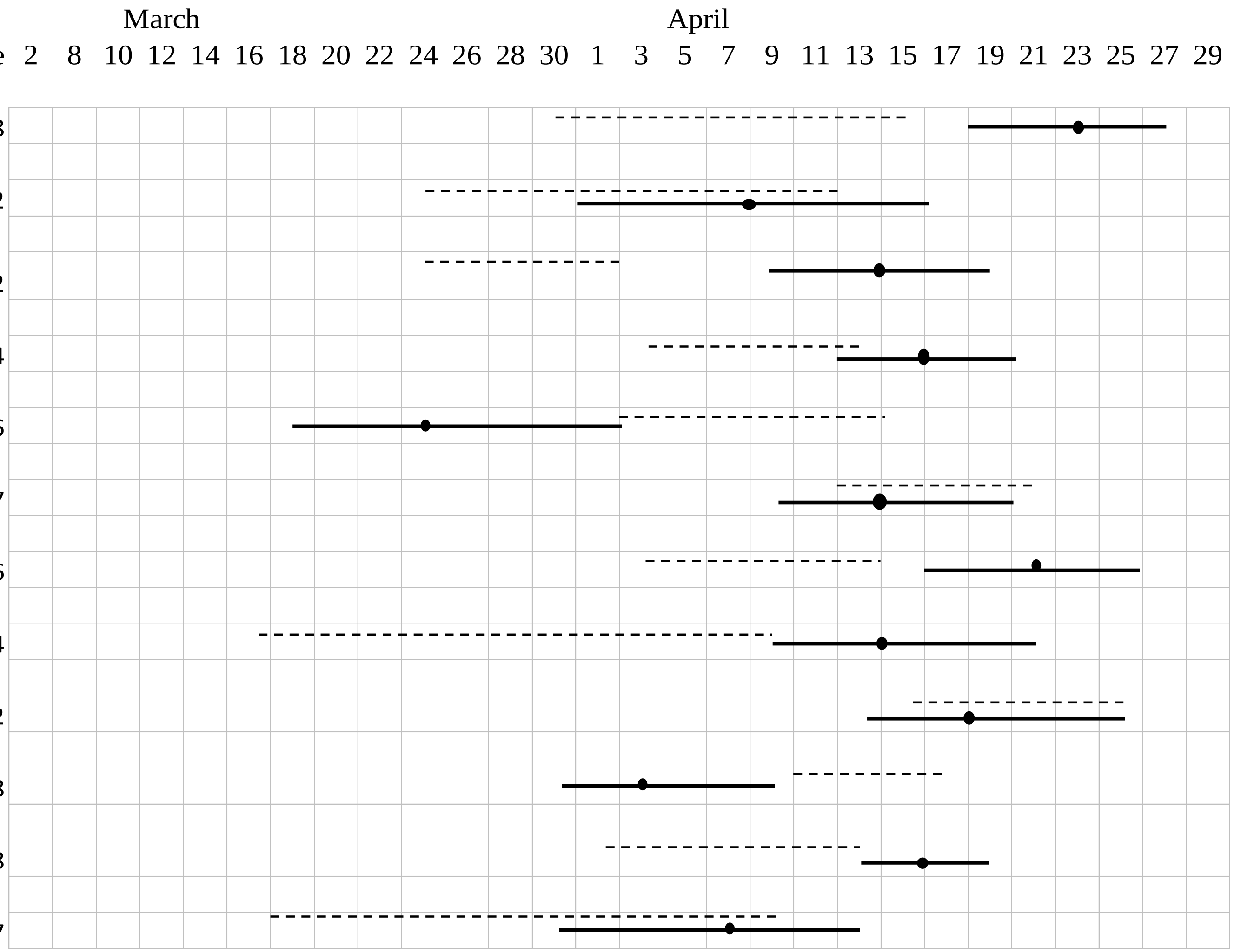


Table 7b. Leafing, male and female bloom, and harvest dates of **cultivars and selections** at UC Davis in 2020 (in harvest date order).

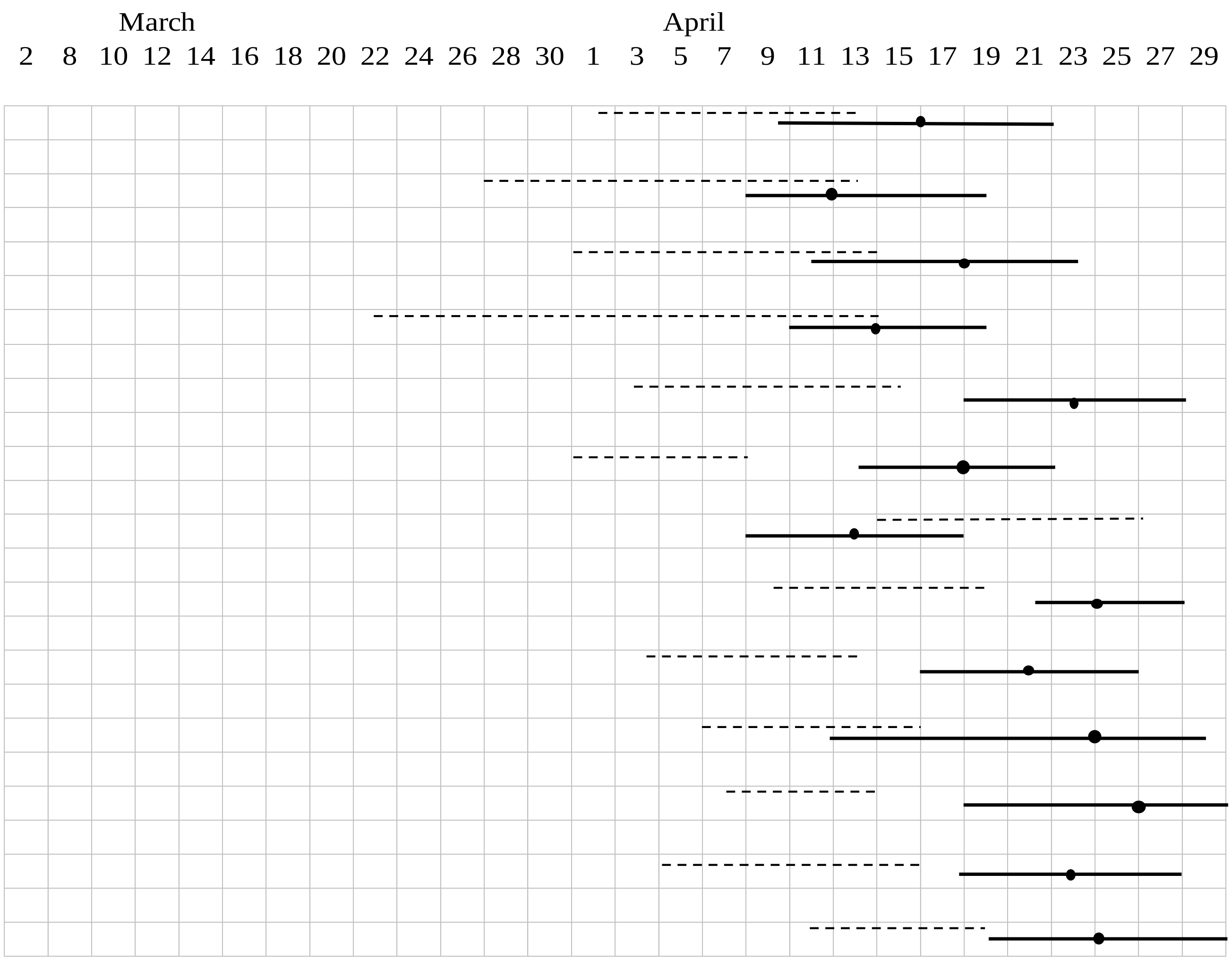
Selections & Cultivars	Date	Harvest Date
08-019-11	4/8	9/14
10-001-19	3/12	9/14
10-006-4	3/22	9/14
10-008-63	4/4	9/14
10-024-31	3/16	9/14
11-030-8	4/7	9/14
07-002-5	4/6	9/15
08-034-1	3/14	9/15
09-001-39	4/12	9/15
13-019-1	3/28	9/15
13-065-3	3/28	9/15
07-021-6	3/17	9/16



Male Bloom ---------------
Female Bloom___________

Table 7b. Leafing, male and female bloom, and harvest dates of **<u>cultivars and selections</u>** at UC Davis in 2020 (in harvest date order).

Selections & Cultivars	Date	Harvest Date
13-012-7	3/31	9/16
Solano	3/25	9/17
Vina	3/26	9/18
Wolfskill	3/25	9/18
09-002-22	4/5	9/19
09-014-12	3/30	9/20
10-024-19	4/7	9/20
Tulare	4/9	9/24
Durham	4/4	9/27
R. Livermore	4/7	9/28
Howard	4/8	9/29
Hartley	4/4	10/10
Chandler	4/11	10/11



Male Bloom ---------------
Female Bloom____________

Table 8. Average nut traits and phenology of varieties at Davis 2010-2020 in harvest date order.

Variety	Leaf Date	Harvest Date	Nut Weight	Kernel Weight	% Kernel	Ex. Light	Light
Ivanhoe	3/19	9/7	13.6	7.6	56	39	57
Payne	3/21	9/15	13.5	7.1	53	3	84
Vina	3/29	9/21	13.7	7.0	51	4	51
Solano	3/27	9/22	15.3	8.4	55	34	59
Durham	4/2	9/24	15.7	8.9	57	51	48
Wolfskill	3/27	9/26	14.1	8.1	57	63	36
Howard	4/7	9/30	14.3	7.3	51	24	58
Tulare	4/6	10/1	14.7	8.1	55	8	80
Hartley	4/5	10/5	14.8	6.9	46	19	65
Chandler	4/11	10/9	14.1	6.8	48	54	36

Table 9. First batch (of three) of J. microcarpa x J. regia hybrid seedlings grown and sent for pathology testing in 2020.

Cross #	Female Parent	Male Parent	Seedlings
31	29.11	OP	172
32	31.01-1	OP	314
33	31.01-2	OP	208
35	31.03-1	OP	117
36	31.03-2	OP	8
37	31.05	OP	21
39	31.09	OP	571
41	31.12	OP	100
Total			694

Table 10. J. microcarpa x J. regia hybrid seedlings planted in the field in fall 2020.

Cross #	Female Parent	Male Parent	Seedlings
32	31.01-1	OP	94
33	31.01-2	OP	35
39	31.09	OP	1
Total			130

Table 11. Testing status of backcross selections in the 2008SB, BC2009, and 2011SB blocks.

Block	Row	Tree	Accession	BC[1] Gen	Hort[2] Status	DNA[3] Marker	Female Parent	English[4] Grafts in 2020	Virus Buds to English	No. Virus Patched Direct to BC	No. of BC Patches Good	No. of BC Patches rejected	No. of BC Patches Unclear
2011SBb													
2012SB	6	40	10-029-1	5	D	HS	03-019-13	1		4		3	1
2011SBb	6	42	09-031-5	4	D	HS	93-045-1	2		5	2		3
2011SBb	6	44	09-031-3	4	D	HS	93-045-1	2		5	4	1	
2011SBb	6	45	09-031-2	4	W	HS	93-045-1	1	1	4		2	2
2011SBb	6	47	09-030-2	4	W	HS	93-045-1	1		4		4	
2011SBb	6	48	09-030-1	4	W	HS	93-045-1	2	2	4		3	1
2011SBb	6	49	09-029-5	4	P	HS	95-027-38	2					
2011SBb	6	50	09-029-4	4	P	HS	95-027-38	3 buds		4	4		
2011SBb	6	51	09-029-3	4	K	HS	95-027-38	1	1	3	3		
2011SBb	6	52	09-029-2	4	D	HS	95-027-38	1	1	4	3	1	
2011SBb	6	53	09-029-1	4	D	HS	95-027-38			2		1	1
2011SBb	6	54	09-028-16	4	K	HS	95-027-38	2	1	4		3	1
2011SBb	6	55	09-028-15	4	P	HS	95-027-38	2 buds		3		1	2
2011SBb	6	56	09-028-14	4	K	HS	95-027-38	1		1			1
2011SBb	6	57	09-028-13	4	K	HS	95-027-38	2		4		2	2
2011SBb	6	58	09-028-12	4	D	HS	95-027-38	1		3		2	1
2011SBb	6	61	09-028-9	4	D	T	95-027-38	1 bud		3	3		
2011SBb	6	62	09-028-8	4	D	T	95-027-38	1	1	3	1	1	1
2011SBb	6	63	09-028-7	4	P	HS	95-027-38	3		1		1	
2011SBb	6	65	09-028-5	4	P	HS	95-027-38	2					
2011SBb	6	68	09-028-2	4	D	T	95-027-38	3		2	2		

[1] No. of generations of backcrossing; [2] Horticultural status, S=selection, W= watch, P= probable discard, D= discard; R=red, G=Germplasm only; [3]HS=hypersensitive, T=tolerant; [4]No. of grafts or patch buds that took

Table 11. Testing status of backcross selections in the 2008SB, BC2009, and 2011SB blocks.

Block	Row	Tree	Accession	BC[1] Gen	Hort[2] Status	DNA[3] Marker	Female Parent	English[4] Grafts in 2020	Virus Buds to English	No. Virus Patched Direct to BC	No. of BC Patches Good	No. of BC Patches rejected	No. of BC Patches Unclear
BC2009													
BC2009	1	30	07-047-4	4	S	HS	95-027-13						
BC2009	1	32	07-047-6	4	S	HS	95-027-13	2					
BC2009	1	36	07-040-2	4	K	HS	93-045-1	1 bud					
BC2009	1	44	07-052-2	4	W	HS	95-027-20	2					
BC2009	1	62	07-048-1	4	D	HS	95-027-15	1					
BC2009	2	4	07-071-5	4	D	HS	95-034-33	1bud					
BC2009	2	24	07-067-4	4	D	HS	95-027-9	1 bud					
BC2009	2	26	07-051-2	4	K	HS	95-027-19						
BC2009	2	30	07-051-1	4	D	HS	95-027-19	1					
BC2009	2	109	07-036-39	4	W	HS	92-016-1	3					
BC2009	2	123	07-038-3	4	K	HS	93-045-1	1					
BC2009	3	2	07-051-6	4	K	HS	95-027-19	1	1				
BC2009	3	10	07-051-14	4	D	HS	95-027-19	2					
BC2009	3	31	07-051-35	4	W	HS	95-027-19	2					
BC2009	3	42	07-051-46	4	T	T	95-027-19	1					
BC2009	3	45	07-051-49	4	S	HS	95-027-19	2					
BC2009	3	48	07-051-52	4	K	HS	95-027-19	2					
BC2009	3	66	07-071-15	4	D	HS	95-034-33						
BC2009	3	76	07-071-25	4	D	HS	95-034-33						
BC2009	3	98	07-063-20	4	S	HS	95-027-34						

[1] No. of generations of backcrossing; [2] Horticultural status, S=selection, W= watch, P= probable discard, D= discard; R=red, G=Germplasm only; [3]HS=hypersensitive, T=tolerant; [4]No. of grafts or patch buds that took

Table 11. Testing status of backcross selections in the 2008SB, BC2009, and 2011SB blocks.

Block	Row	Tree	Accession	BC[1] Gen	Hort[2] Status	DNA[3] Marker	Female Parent	English[4] Grafts in 2020	Virus Buds to English	No. Virus Patched Direct to BC	No. of BC Patches Good	No. of BC Patches rejected	No. of BC Patches Unclear
BC2009	3	102	07-044-4	4	S	HS	95-027-08	4	4				
BC2009	4	5	07-051-66	4	G	HS	95-027-19	1					
BC2009	4	35	07-068-1	4	S	HS	95-029-41	3					
BC2009	4	54	07-064-41	4	W	HS	95-027-38	2					
BC2009	4	61	07-064-34	4	D	HS	95-027-38	2 buds					
BC2009	4	71	07-064-24	4	D	HS	95-027-38	4 buds					
BC2009	4	91	07-064-4	4	S	HS	95-027-38	1 bud					
BC2009	4	110	07-036-164	4	W	HS	92-016-1	1					
BC2009	4	195	07-054-3	4	D	HS	95-027-24	1 bud					
BC2009	5	23	07-073-23	4	K	HS	96-016-1	1					
BC2009	5	92	07-036-192	4	P	HS	92-016-1	1 bud					
BC2009	5	118	07-045-22	4	G	HS	95-027-09	2 buds					
BC2009	5	125	07-045-29	4	P	HS	95-027-09	2 buds					
BC2009	5	132	07-045-36	4	W	HS	95-027-09	1 bud					
BC2009	5	134	07-045-38	4	P	HS	95-027-09	1					
BC2009	5	178	07-059-15	4	D	HS	95-027-31						
BC2009	5	187	07-059-24	4	K	HS	95-027-31						
BC2009	5	190	07-059-27	4	W	HS	95-027-31	2					
BC2009	5	191	07-059-28	4	R	HS	95-027-31						
BC2009	5	197	07-046-11	4	D	HS	95-027-11	2					
BC2009	6	1	07-036-212	4	P	T	92-016-1	2 buds					
BC2009	6	8	07-037-37	4	P	HS	92-016-1						

[1] No. of generations of backcrossing; [2] Horticultural status, S=selection, W= watch, P= probable discard, D= discard; R=red, G=Germplasm only; [3]HS=hypersensitive, T=tolerant; [4]No. of grafts or patch buds that took

Table 11. Testing status of backcross selections in the 2008SB, BC2009, and 2011SB blocks.

Block	Row	Tree	Accession	BC[1] Gen	Hort[2] Status	DNA[3] Marker	Female Parent	English[4] Grafts in 2020	Virus Buds to English	No. Virus Patched Direct to BC	No. of BC Patches Good	No. of BC Patches rejected	No. of BC Patches Unclear
BC2009	6	20	07-036-203	4	D	HS	92-016-1	2 buds					
BC2009	6	31	07-040-8	4	D	HS	93-045-1	1 bud					
BC2009	6	104	07-046-21	4	D	HS	95-027-11	1 bud					
BC2009	6	160	07-054-30	4	D	HS	95-027-24						
BC2009	6	162	07-054-28	4	D	HS	95-027-24	3 buds					
BC2009	6	168	07-047-39	4	W	HS	95-027-13	3					
BC2009	6	178	07-071-31	4	D	HS	95-034-33	2					
BC2009	6	184	07-048-21	4	D	HS	95-027-15	1bud					
BC2009	6	196	07-058-7	4	K	HS	95-027-30	2 buds					
BC2009	7	85	07-037-165	4	D	HS	92-016-1	2 buds					
BC2009	7	124	07-080-3	4	W	HS	no tag	2					
BC2009	7	143	07-080-22	4	D	HS	no tag	1bud					
BC2009	7	180	07-080-59	4	W	HS	no tag	1					
BC2009	7	187	07-081-3	4	D	HS		1 bud					
BC2009	7	190	07-081-6	4	W	HS		1					
BC2009	7	197	07-056-29	4	K	HS	95-027-27	1 bud					
<u>2008SB</u>													
2008SB	10	5	06-032-13	4	W	HS	95-027-19	1					
2008SB	10	7	06-032-11	4	D	HS	95-027-19	1 bud					
2008SB	10	12	06-032-6	4	D	HS	95-027-19						
2008SB	10	13	06-032-5	4	G	HS	95-027-19						

[1] No. of generations of backcrossing; [2] Horticultural status, S=selection, W= watch, P= probable discard, D= discard; R=red, G=Germplasm only; [3]HS=hypersensitive, T=tolerant; [4]No. of grafts or patch buds that took

Table 11. Testing status of backcross selections in the 2008SB, BC2009, and 2011SB blocks.

Block	Row	Tree	Accession	BC[1] Gen	Hort[2] Status	DNA[3] Marker	Female Parent	English[4] Grafts in 2020	Virus Buds to English	No. Virus Patched Direct to BC	No. of BC Patches Good	No. of BC Patches rejected	No. of BC Patches Unclear
2008SB	10	14	06-032-4	4	D	HS	95-027-19						
2008SB	10	17	06-032-1	4	G	HS	95-027-19	2					
2008SB	10	18	06-003-1	4	W	HS	92-016-1	2					
2008SB	11	1	06-032-18	4	Q	HS	95-027-19	1					
2008SB	11	2	06-032-19	4	D	HS	95-027-19	2 buds					
2008SB	11	3	06-032-20	4	S	T	95-027-19	2					
2008SB	11	7	06-032-24	4	W	T	95-027-19	1					
2008SB	11	10	06-032-27	4	S	HS	95-027-19	2 buds					
2008SB	11	11	06-032-28	4	P	HS	95-027-19	2					
2008SB	11	14	06-032-31	4	D	HS	95-027-19						
2008SB	11	15	06-032-32	4	P	HS	95-027-19						

[1] No. of generations of backcrossing; [2] Horticultural status, S=selection, W= watch, P= probable discard, D= discard; G=Germplasm only
[3]HS=hypersensitive, T=tolerant; [4]No. of grafts or patch buds that took

[1] No. of generations of backcrossing; [2] Horticultural status, S=selection, W= watch, P= probable discard, D= discard; R=red, G=Germplasm only; [3]HS=hypersensitive, T=tolerant; [4]No. of grafts or patch buds that took

Table 12. Testing progress in the BC2017 Block – backcross selections grafted on English rootstocks

Block	Row	Tree	Accession	BC[1] Gen	RS	English Grafted	Virus to English	Virus Detected	DNA[2] Marker	Patch Test	Status[3]	Female Parent
BC2017	1	1	03-019-9	4	Eng	Y	Y	N	HS		S	95-027-23
BC2017	1	2	03-019-9	4	Eng	Y	Y	N	HS		S	95-027-23
BC2017	1	3	07-047-39	4	Eng	Y			HS		W	95-027-13
BC2017	1	4	07-047-39	4	Px	Y			HS		W	95-027-13
BC2017	1	5	07-051-49	4	Eng	Y	Y	N	HS		S	95-027-19
BC2017	1	6	07-051-49	4	Eng	Y	Y	N	HS		S	95-027-19
BC2017	1	7	07-059-28	4	Eng	Y	Y	N	HS		R	95-027-31
BC2017	1	8	07-059-28	4	Eng	Y	Y	N	HS		R	95-027-31
BC2017	1	9	07-063-20	4	Eng	Y	Y	N	HS		S	95-027-34
BC2017	1	10	07-063-20	4	Eng	Y	Y	N	HS		S	95-027-34
BC2017	1	11	07-064-4	4	Px	Y			HS		S	95-027-38
BC2017	1	12	07-064-4	4	Eng	Y	Y	N	HS		S	95-027-38
BC2017	1	13	07-068-1	4	Eng	Y	Y	N	HS		S	95-029-41
BC2017	1	14	07-080-3	4	Eng	Y	Y	N	HS		W	no tag
BC2017	1	15	07-080-3	4	Eng	Y	Y	N	HS		W	no tag
BC2017	1	16	95-030-10	3	Eng	Y	Y	N	HS		S	87-041-6
BC2017	1	17	95-030-10	3	Eng	Y	Y	N	HS		S	87-041-6
BC2017	1	18	03-016-1	4	Eng	Y	Y	N	T	T	D	94-025-1
BC2017	1	19	03-016-1	4	Eng	Y	Y	N	T	T	D	94-025-1
BC2017	1	20	06-032-27	4	Eng	Y	Y	N	HS		S	95-027-19

[1] No. of generations of backcrossing; [2]HS=hypersensitive, T=tolerant;
[3] Horticultural status, S=selection, W= watch, R=red

Table 12. Testing progress in the BC2017 Block – backcross selections grafted on English rootstocks

Block	Row	Tree	Accession	BC[1] Gen	RS	English Grafted	Virus to English	Virus Detected	DNA[2] Marker	Patch Test	Status[3]	Female Parent
BC2017	1	21	06-032-27	4	Eng	Y	Y	N	HS		S	95-027-19
BC2017	1	24	07-044-4	4	Eng	Y	Y	N	HS		S	95-027-08
BC2017	1	25	07-044-4	4	Eng	Y	Y	N	HS		S	95-027-08
BC2017	1	26	07-047-4	4	Eng	Y	Y	N	HS		S	95-027-13
BC2017	1	27	07-047-4	4	Eng	Y	Y	N	HS		S	95-027-13
BC2017	1	28	07-051-35	4	Eng	Y			HS		W	95-027-19
BC2017	1	29	07-051-35	4	Px	Y			HS		W	95-027-19
BC2017	1	30	07-068-1	4	Eng	Y	Y	N	HS		S	95-029-41
BC2017	1	31	07-068-1	4	Eng	Y	Y	N	HS		S	95-029-41
BC2017	1	32	07-064-4	4	Eng	Y	Y	N	HS		S	95-027-38
BC2017	1	33	07-064-4	4	Eng	Y	Y	N	HS		S	95-027-38
BC2017	1	34	07-052-2	4	Eng	Y	Y	N	HS		W	95-027-20
BC2017	1	35	07-052-2	4	Eng	Y	Y	N	HS		W	95-027-20
BC2017	1	36	07-059-28	4	Eng	Y	Y	N	HS		R	95-027-31
BC2017	1	37	07-080-59	4	Eng	Y	Y	N	HS		W	no tag
BC2017	1	38	07-080-3	4	Eng	Y	Y	N	HS		W	no tag
BC2017	1	39	07-080-3	4	Eng	Y	Y	N	HS		W	no tag
BC2017	1	40	07-059-27	4	Eng	Y	Y	N	HS		W	95-027-31
BC2017	1	41	07-059-27	4	Eng	Y	Y	N	HS		W	95-027-31
BC2017	1	42	07-047-6	4	Eng	Y	Y	N	HS		S	95-027-13

[1] No. of generations of backcrossing; [2]HS=hypersensitive, T=tolerant;
[3] Horticultural status, S=selection, W= watch, R=red

Table 13. BC2020 Block seedling count by female parent and testing status.

Female Parent	No. of Seedlings	No. with English Grafts	English Grafts with virus buds	No. Tested for Virus
87-041-2	23	20	13	13
87-262-4	4	4	2	1
91-016-1	15	14	11	7
93-045-1	2	2	1	1
94-026-20	9	7	6	3
95-027-19	10	8	4	2
03-016-1	5	5	5	3
03-019-1	18	18	15	10
05-016-2	2	1	1	1
05-018-2	3	3	3	2
06-003-1	7	2	0	0
07-036-39	2	1	1	1
07-036-212	1	1	1	0
07-037-61	6	6	6	5
07-038-2	9	9	9	5
07-040-2	11	9	9	6
07-044-4	131	63	43	14
07-045-22	1	1	0	0
07-045-36	112	72	58	5
07-047-6	10	9	7	4
07-047-39	136	85	64	10
07-051-46	37	29	22	14
07-051-66	4	2	2	2
07-061-1	7	3	3	2
07-063-20	24	20	15	9
07-064-4	4	3	1	1
07-064-41	2	2	2	1
07-068-1	16	12	7	4
07-073-23	9	7	4	2
07-080-3	5	4	3	2
09-028-5	71	66	51	20
09-028-7	23	19	16	16
09-028-8	10	9	9	3
09-028-16	56	48	41	20
09-029-2	1	1	1	1
09-029-3	5	3	3	2
09-030-2	32	21	15	5
09-031-2	8	4	3	1
09-031-3	4	4	4	2
09-031-5	15	9	7	5
BC unknown	10	8	7	5
Total	**860**	**614**	**475**	**210**

Table 14. 2020 UCD and Grower Trial Variety/Selection Kernel Evaluations by Diamond

Location	Variety or Selection	% Insect	% Mold	% Shrivel	% Offgrade	% Edible Yield	% Total Yield	Extra Light	Light	Light Amber	Amber	RLI	Relative Value
Davis[GB]	Payne	0%	0%	0%	0%	55.1%	55.1%	58%	30%	12%	0%	52.9	1.05
Davis[GB]	Vina	0%	0%	0%	0%	52.0%	52.0%	61%	32%	7%	0%	52.3	0.98
Davis[GB]	Chandler	0%	0%	0%	0%	54.1%	54.1%	65%	35%	0%	0%	57.3	1.12
Wheatland	Chandler	0%	3%	0%	2%	45.8%	46.7%	52%	31%	17%	1%	53.1	0.88
Davis[GB]	Howard	1%	0%	1%	2%	50.5%	51.3%	53%	20%	26%	0%	53.9	0.98
Davis[GB]	Tulare	0%	0%	0%	0%	54.3%	54.3%	59%	39%	2%	0%	52.6	1.03
Davis[GB]	Ivanhoe	0%	0%	0%	0%	56.5%	56.5%	84%	8%	8%	0%	56.6	1.15
Woodland	Ivanhoe	0%	0%	0%	0%	57.1%	57.1%	91%	0%	7%	2%	57.1	1.17
Sibbett	Ivanhoe	0%	9%	5%	10%	50.3%	55.8%	37%	24%	23%	16%	50.7	0.92
Davis[C]	Solano	0%	1%	1%	1%	56.0%	56.5%	28%	39%	30%	3%	56.5	1.14
Davis[D]	Solano	0%	0%	0%	0%	55.5%	55.5%	61%	32%	7%	0%	55.2	1.10
Woodland	Solano	0%	0%	0%	0%	52.2%	52.2%	49%	33%	16%	2%	54.5	1.02
Wheatland	Solano	0%	0%	3%	1%	54.1%	54.6%	8%	50%	41%	0%	52.9	1.03
Davis[D]	Durham	0%	0%	0%	0%	56.8%	56.8%	92%	3%	4%	0%	56.4	1.15
Woodland	Durham	0%	0%	0%	0%	54.4%	54.4%	93%	7%	0%	0%	54.8	1.07
Rio Oso	Durham	0%	0%	0%	0%	53.2%	53.2%	34%	40%	26%	0%	53	1.01
Wheatland	Durham	0%	0%	0%	0%	51.8%	51.8%	85%	7%	7%	0%	55.2	1.03
Davis[D]	Wolfskill	0%	0%	0%	0%	56.2%	56.2%	88%	12%	0%	0%	56.2	1.14
Woodland	Wolfskill	0%	0%	0%	0%	54.6%	54.6%	59%	34%	6%	0%	57.6	1.13
Rio Oso	Wolfskill	1%	0%	1%	1%	53.2%	53.7%	13%	14%	63%	11%	48.1	0.92
Wheatland	Wolfskill	0%	0%	0%	0%	57.2%	57.2%	12%	33%	53%	3%	51.9	1.07
Davis[NS]	91-090-41	0%	1%	5%	2%	55.2%	56.4%	41%	52%	5%	2%	52.1	1.04
Woodland	00-006-227	0%	1%	1%	1%	58.8%	59.4%	93%	7%	1%	0%	57.8	1.22

* At Davis: GB=Germplasm Block; NS=New Stuke Block; Seedlings= Davis[sd]; Selection Blocks= Davis[A, B, C, D, E, F, G]

Table 14. 2020 UCD and Grower Trial Variety/Selection Kernel Evaluations by Diamond

Location	Variety or Selection	% Insect	% Mold	% Shrivel	% Offgrade	% Edible Yield	% Total Yield	Extra Light	Light	Light Amber	Amber	RLI	Relative Value
Kt. Landing	00-006-227	0%	0%	6%	0%	57.5%	57.7%	21%	54%	22%	3%	50.4	1.04
Kt. Landing	03-001-977	0%	5%	5%	6%	49.5%	52.6%	3%	16%	40%	42%	46	0.82
Davis[D]	03-001-1372	0%	0%	0%	0%	53.8%	53.8%	77%	15%	8%	0%	55.1	1.07
Rio Oso	03-001-1372	0%	0%	1%	0%	52.6%	52.9%	16%	14%	46%	24%	47.9	0.91
Wheatland	03-001-1372	0%	0%	0%	0%	53.2%	53.2%	39%	40%	21%	0%	52.3	1.00
Davis[D]	01-001-1457	0%	0%	1%	0%	59.5%	59.7%	97%	2%	1%	0%	57.8	1.24
Davis[D]	03-001-1938	0%	0%	0%	0%	57.4%	57.4%	87%	13%	0%	0%	54	1.12
Wheatland	03-001-1938	0%	0%	0%	0%	54.8%	54.8%	44%	32%	24%	0%	52.8	1.04
Wheatland	03-001-2440	3%	0%	0%	2%	53.1%	54.4%	61%	26%	13%	0%	56.6	1.08
Kt. Landing	04-003-143	0%	0%	0%	0%	54.8%	54.8%	31%	19%	34%	17%	49.4	0.98
Davis[F]	05-001-94	0%	0%	0%	0%	59.2%	59.2%	79%	17%	4%	0%	58.1	1.24
Davis[F]	05-001-97	0%	0%	1%	0%	58.8%	58.9%	67%	13%	18%	2%	56.9	1.20
Davis[sd]	06-005-31	0%	0%	0%	0%	54.5%	54.5%	88%	5%	7%	0%	56	1.10
Wheatland	06-005-31	0%	0%	0%	0%	56.9%	56.9%	26%	44%	27%	3%	51.6	1.06
Davis[sd]	07-002-5	5%	0%	0%	6%	54.7%	57.9%	55%	17%	23%	5%	54.2	1.07
Davis[F]	07-002-5	0%	0%	0%	0%	60.0%	60.0%	41%	41%	16%	2%	55.1	1.19
Davis[sd]	07-019-4	1%	0%	0%	1%	47.8%	48.4%	27%	26%	44%	3%	50.4	0.87
Davis[sd]	07-021-6	3%	0%	8%	5%	50.2%	52.9%	59%	21%	10%	10%	54.6	0.99
Davis[sd]	07-029-1	9%	0%	2%	9%	50.4%	55.3%	74%	7%	19%	0%	54.7	0.99
Davis[sd]	07-029-15	1%	0%	0%	1%	51.8%	52.4%	82%	6%	11%	1%	54.8	1.02
Davis[F]	08-006-12	0%	0%	1%	0%	60.5%	60.6%	50%	42%	8%	0%	54.7	1.19
Davis[sd]	08-008-28	0%	0%	3%	0%	55.5%	55.7%	91%	4%	5%	0%	57.7	1.15
Davis[sd]	08-014-3	0%	0%	0%	0%	55.9%	55.9%	66%	20%	14%	0%	55.5	1.12
Davis[sd]	08-019-11	0%	0%	0%	0%	61.4%	61.4%	70%	15%	14%	0%	57.9	1.28

* At Davis: GB=Germplasm Block; NS=New Stuke Block; Seedlings= Davis[sd]; Selection Blocks= Davis[A, B, C, D, E, F, G]

Table 14. 2020 UCD and Grower Trial Variety/Selection Kernel Evaluations by Diamond

Location	Variety or Selection	% Insect	% Mold	% Shrivel	% Offgrade	% Edible Yield	% Total Yield	Extra Light	Light	Light Amber	Amber	RLI	Relative Value
Davis[sd]	08-030-11	0%	0%	0%	0%	55.2%	55.2%	86%	14%	0%	0%	57.7	1.15
Davis[sd]	08-034-1	1%	1%	0%	2%	58.4%	59.5%	79%	11%	8%	2%	56.4	1.19
Davis[sd]	09-001-39	1%	0%	0%	2%	52.1%	52.9%	52%	24%	23%	2%	52.3	0.98
Davis[sd]	09-002-22	0%	0%	0%	0%	54.7%	54.7%	59%	21%	20%	0%	55.7	1.10
Davis[sd]	09-005-33	0%	0%	0%	0%	54.8%	54.8%	65%	18%	16%	0%	57.7	1.14
Davis[sd]	09-007-22	0%	0%	4%	0%	58.5%	58.7%	74%	17%	9%	0%	58.5	1.23
Davis[sd]	09-007-31	0%	0%	0%	0%	54.0%	54.0%	93%	7%	0%	0%	60.3	1.17
Davis[sd]	09-014-4	0%	0%	0%	0%	55.9%	55.9%	94%	4%	2%	0%	57.7	1.16
Davis[sd]	09-014-12	2%	0%	0%	2%	58.1%	59.3%	92%	3%	5%	0%	55.6	1.16
Davis[G]	09-014-13	0%	0%	1%	0%	55.1%	55.2%	76%	23%	1%	0%	56.1	1.11
Davis[sd]	09-014-14	13%	0%	1%	13%	46.2%	53.2%	54%	19%	25%	3%	54.1	0.90
Davis[sd]	09-025-78	0%	0%	0%	0%	55.3%	55.3%	71%	16%	13%	0%	59.3	1.18
Davis[sd]	10-001-9	0%	0%	0%	0%	54.4%	54.4%	70%	15%	15%	0%	56.2	1.10
Davis[sd]	10-001-19	0%	0%	1%	0%	58.0%	58.1%	67%	18%	14%	1%	56.8	1.19
Davis[sd]	10-006-4	0%	0%	0%	0%	56.6%	56.6%	85%	13%	2%	0%	58.5	1.19
Davis[sd]	10-008-63	0%	0%	1%	0%	56.5%	56.6%	84%	16%	1%	0%	59.5	1.21
Davis[sd]	10-020-17	2%	2%	17%	9%	49.7%	54.7%	36%	33%	23%	7%	51.8	0.93
Davis[sd]	10-024-7	0%	0%	1%	0%	60.6%	60.7%	81%	16%	4%	0%	54.5	1.19
Davis[sd]	10-024-19	1%	0%	5%	2%	59.1%	60.2%	70%	11%	16%	3%	55.7	1.19
Davis[sd]	10-024-22	0%	0%	2%	1%	58.5%	58.8%	62%	27%	11%	0%	58.1	1.22
Davis[sd]	10-024-31	0%	1%	0%	1%	52.0%	52.6%	58%	28%	12%	2%	54.1	1.01
Davis[sd]	11-030-8	3%	0%	2%	3%	53.6%	55.6%	66%	25%	9%	0%	55.1	1.06
Davis[sd]	11-030-17	4%	1%	0%	4%	51.7%	53.8%	84%	8%	7%	1%	54.2	1.01
Davis[sd]	11-035-4	0%	0%	1%	0%	58.8%	58.9%	58%	29%	12%	2%	55.4	1.17

* At Davis: GB=Germplasm Block; NS=New Stuke Block; Seedlings= Davis[sd]; Selection Blocks= Davis[A, B, C, D, E, F, G]

Table 14. 2020 UCD and Grower Trial Variety/Selection Kernel Evaluations by Diamond

Location	Variety or Selection	% Insect	% Mold	% Shrivel	% Offgrade	% Edible Yield	% Total Yield	Extra Light	Light	Light Amber	Amber	RLI	Relative Value
Davis^{sd}	12-045-9	1%	0%	2%	2%	57.1%	58.2%	77%	22%	2%	0%	57	1.17
Davis^{sd}	12-053-4	3%	0%	1%	3%	55.7%	57.4%	64%	27%	9%	0%	56.7	1.14
Davis^{sd}	13-002-7	1%	0%	0%	1%	55.4%	55.8%	38%	25%	30%	6%	53.4	1.06
Davis^{sd}	13-002-10	0%	0%	3%	0%	57.7%	57.8%	48%	29%	21%	2%	54.7	1.14
Davis^{sd}	13-012-7	0%	0%	0%	0%	56.1%	56.1%	46%	13%	32%	9%	54.1	1.09
Davis^{sd}	13-019-1	1%	0%	0%	1%	58.5%	59.2%	55%	35%	10%	0%	56	1.18
Davis^{sd}	13-019-34	1%	0%	2%	1%	58.0%	58.5%	30%	54%	13%	3%	54.8	1.14
Davis^{sd}	13-031-63	0%	0%	0%	0%	59.0%	59.0%	81%	7%	12%	0%	57.6	1.22
Davis^{sd}	13-031-107	0%	0%	1%	0%	55.5%	55.6%	66%	24%	9%	0%	56.9	1.14
Davis^{sd}	13-032-23	0%	0%	12%	2%	54.6%	55.5%	77%	7%	14%	2%	54.4	1.07
Davis^{sd}	13-034-11	0%	0%	6%	1%	51.4%	52.0%	30%	6%	60%	3%	50	0.93
Davis^{sd}	13-054-5	0%	0%	2%	0%	61.2%	61.4%	56%	20%	21%	2%	57.7	1.27
Davis^{sd}	13-064-17	0%	0%	2%	0%	51.7%	51.9%	64%	22%	12%	1%	57.8	1.08
Davis^{sd}	13-064-18	0%	0%	6%	1%	54.1%	54.6%	71%	22%	5%	2%	57	1.11
Davis^{sd}	13-065-3	0%	3%	0%	2%	52.6%	53.9%	64%	34%	0%	2%	56	1.06
Davis^{sd}	13-069-16	4%	0%	4%	5%	50.7%	53.1%	52%	36%	10%	3%	53.6	0.98

* At Davis: GB=Germplasm Block; NS=New Stuke Block; Seedlings= Davis^{sd}; Selection Blocks= Davis$^{A, B, C, D, E, F, G}$

Table 15. 2020 UCD and Grower Trial Variety/Selection Nut Evaluations by Diamond

Location	Variety or Selection	Sample Wt	Nuts per sample	Avg nut wt (g)	% Jumbo Sound	% Large-Jumbo Sound	% Med-baby Sound	% Stain	% Broken	% Adh Hull	% External Damage
Davis[GB]	Payne	975	94	10.37	46%	78%	21%	1%	0%	0%	1%
Davis[GB]	Vina	966	79	12.23	90%	95%	5%	0%	0%	0%	0%
Davis[GB]	Chandler	1001	79	12.67	95%	100%	0%	0%	0%	0%	0%
Wheatland	Chandler	1004	71	14.14	97%	97%	0%	0%	0%	0%	0%
Davis[GB]	Howard	992	80	12.40	95%	98%	0%	0%	0%	0%	0%
Davis[GB]	Tulare	994	79	12.58	97%	100%	0%	0%	0%	0%	0%
Davis[GB]	Ivanhoe	987	92	10.73	86%	98%	2%	0%	0%	0%	0%
Woodland	Ivanhoe	984	79	12.46	95%	99%	1%	0%	0%	0%	0%
Sibbett	Ivanhoe	992	85	11.67	68%	74%	4%	0%	1%	7%	8%
Davis[C]	Solano	994	69	14.41	93%	97%	0%	0%	0%	0%	0%
Davis[D]	Solano	977	80	12.21	60%	91%	9%	0%	0%	0%	0%
Woodland	Solano	984	78	12.62	100%	100%	0%	0%	0%	0%	0%
Wheatland	Solano	986	79	12.48	73%	92%	5%	0%	0%	0%	0%
Davis[D]	Durham	995	73	13.63	95%	99%	0%	0%	0%	1%	1%
Woodland	Durham	977	77	12.69	99%	100%	0%	0%	0%	0%	0%
Rio Oso	Durham	982	71	13.83	94%	99%	1%	0%	0%	0%	0%
Wheatland	Durham	971	62	15.66	100%	100%	0%	0%	0%	0%	0%
Davis[D]	Wolfskill	975	83	11.75	63%	90%	10%	0%	0%	0%	0%
Woodland	Wolfskill	984	98	10.04	70%	88%	12%	0%	0%	0%	0%
Rio Oso	Wolfskill	935	74	12.64	88%	95%	3%	0%	0%	0%	0%
Wheatland	Wolfskill	982	78	12.59	82%	96%	4%	0%	0%	0%	0%
Davis[NS]	91-090-41	996	81	12.30	93%	94%	0%	0%	0%	0%	0%
Woodland	00-006-227	985	93	10.59	97%	98%	0%	0%	0%	0%	0%

* At Davis: GB=Germplasm Block; NS=New Stuke Block; Seedlings= Davis[sd]; Selection Blocks= Davis[A, B, C, D, E, F, G]

Table 15. 2020 UCD and Grower Trial Variety/Selection Nut Evaluations by Diamond

Location	Variety or Selection	Sample Wt	Nuts per sample	Avg nut wt (g)	% Jumbo Sound	% Large-Jumbo Sound	% Med-baby Sound	% Stain	% Broken	% Adh Hull	% External Damage
Kt. Landing	00-066-227	926	72	12.86	94%	94%	0%	0%	0%	0%	0%
Kt. Landing	03-001-977	1000	74	13.51	85%	88%	1%	0%	0%	0%	0%
Davis[D]	03-001-1372	971	80	12.14	89%	100%	0%	0%	0%	0%	0%
Rio Oso	03-001-1372	982	78	12.59	91%	97%	1%	0%	0%	0%	0%
Wheatland	03-001-1372	982	73	13.45	97%	100%	0%	0%	0%	0%	0%
Davis[D]	01-001-1457	983	94	10.46	47%	84%	15%	0%	0%	0%	0%
Davis[D]	03-001-1938	979	81	12.09	93%	100%	0%	0%	0%	0%	0%
Wheatland	03-001-1938	974	78	12.49	92%	100%	0%	0%	0%	0%	0%
Wheatland	03-001-2440	981	66	14.86	94%	95%	0%	2%	0%	0%	2%
Kt. Landing	04-003-143	970	62	15.65	100%	100%	0%	0%	0%	0%	0%
Davis[F]	05-001-94	975	82	11.89	93%	99%	1%	0%	0%	0%	0%
Davis[F]	05-001-97	973	90	10.81	53%	87%	12%	0%	0%	0%	0%
Davis[sd]	06-005-31	983	64	15.36	100%	100%	0%	0%	0%	0%	0%
Wheatland	06-005-31	983	48	20.48	100%	100%	0%	0%	0%	0%	0%
Davis[sd]	07-002-5	1002	77	13.01	82%	92%	3%	0%	0%	0%	0%
Davis[F]	07-002-5	985	84	11.73	50%	88%	12%	0%	0%	0%	0%
Davis[sd]	07-019-4	966	98	9.86	83%	94%	5%	0%	0%	0%	0%
Davis[sd]	07-021-6	982	100	9.82	78%	82%	8%	0%	0%	0%	0%
Davis[sd]	07-029-1	993	81	12.26	88%	89%	0%	0%	0%	0%	0%
Davis[sd]	07-029-15	979	95	10.31	95%	98%	1%	0%	0%	0%	0%
Davis[F]	08-006-12	975	90	10.83	77%	93%	6%	0%	0%	0%	0%
Davis[sd]	08-008-28	975	70	13.93	96%	96%	0%	1%	0%	0%	1%
Davis[sd]	08-014-3	978	78	12.54	100%	100%	0%	0%	0%	0%	0%
Davis[sd]	08-019-11	982	69	14.23	100%	100%	0%	0%	0%	0%	0%

* At Davis: GB=Germplasm Block; NS=New Stuke Block; Seedlings= Davis[sd]; Selection Blocks= Davis[A, B, C, D, E, F, G]

Table 15. 2020 UCD and Grower Trial Variety/Selection Nut Evaluations by Diamond

Location	Variety or Selection	Sample Wt	Nuts per sample	Avg nut wt (g)	% Jumbo Sound	% Large-Jumbo Sound	% Med-baby Sound	% Stain	% Broken	% Adh Hull	% External Damage
Davis[sd]	08-030-11	985	89	11.07	100%	100%	0%	0%	0%	0%	0%
Davis[sd]	08-034-1	978	86	11.37	49%	77%	21%	0%	0%	0%	0%
Davis[sd]	09-001-39	994	82	12.12	99%	99%	0%	0%	0%	0%	0%
Davis[sd]	09-002-22	995	72	13.82	97%	97%	1%	1%	0%	0%	1%
Davis[sd]	09-005-33	989	94	10.52	91%	99%	1%	0%	0%	0%	0%
Davis[sd]	09-007-22	986	90	10.96	72%	90%	6%	0%	0%	0%	0%
Davis[sd]	09-007-31	991	79	12.54	99%	100%	0%	0%	0%	0%	0%
Davis[sd]	09-014-4	989	75	13.19	99%	100%	0%	0%	0%	0%	0%
Davis[sd]	09-014-12	997	93	10.72	58%	84%	14%	0%	0%	0%	0%
Davis[G]	09-014-13	999	87	11.48	64%	85%	14%	0%	0%	0%	0%
Davis[sd]	09-014-14	984	91	10.81	54%	80%	5%	0%	0%	0%	0%
Davis[sd]	09-025-78	992	107	9.27	1%	6%	94%	0%	0%	0%	0%
Davis[sd]	10-001-9	986	76	12.97	100%	100%	0%	0%	0%	0%	0%
Davis[sd]	10-001-19	978	77	12.70	91%	97%	1%	0%	0%	0%	0%
Davis[sd]	10-006-4	982	98	10.02	65%	92%	8%	0%	0%	0%	0%
Davis[sd]	10-008-63	990	85	11.65	99%	99%	0%	0%	0%	0%	0%
Davis[sd]	10-020-17	1001	84	11.92	77%	79%	2%	0%	0%	0%	0%
Davis[sd]	10-024-7	1000	101	9.90	28%	74%	26%	0%	0%	0%	0%
Davis[sd]	10-024-19	915	103	8.88	26%	67%	31%	0%	0%	0%	0%
Davis[sd]	10-024-22	988	95	10.40	28%	69%	29%	0%	0%	0%	0%
Davis[sd]	10-024-31	984	75	13.12	87%	97%	1%	0%	0%	0%	0%
Davis[sd]	11-030-8	988	95	10.40	92%	95%	0%	0%	0%	0%	0%
Davis[sd]	11-030-17	977	79	12.37	89%	95%	0%	0%	0%	0%	0%
Davis[sd]	11-035-4	876	110	7.96	1%	8%	91%	0%	0%	0%	0%

* At Davis: GB=Germplasm Block; NS=New Stuke Block; Seedlings= Davis[sd]; Selection Blocks= Davis[A, B, C, D, E, F, G]

Table 15. 2020 UCD and Grower Trial Variety/Selection Nut Evaluations by Diamond

Location	Variety or Selection	Sample Wt	Nuts per sample	Avg nut wt (g)	% Jumbo Sound	% Large-Jumbo Sound	% Med-baby Sound	% Stain	% Broken	% Adh Hull	% External Damage
Davis[sd]	12-045-9	977	84	11.63	58%	81%	18%	0%	0%	0%	0%
Davis[sd]	12-053-4	991	70	14.16	96%	96%	0%	0%	0%	0%	0%
Davis[sd]	13-002-7	981	116	8.46	2%	4%	95%	0%	0%	0%	0%
Davis[sd]	13-002-10	977	93	10.51	31%	71%	29%	0%	0%	0%	0%
Davis[sd]	13-012-7	982	77	12.75	99%	100%	0%	0%	0%	0%	0%
Davis[sd]	13-019-1	924	97	9.53	60%	85%	14%	0%	0%	0%	0%
Davis[sd]	13-019-34	878	102	8.61	69%	87%	11%	0%	0%	0%	0%
Davis[sd]	13-031-63	991	74	13.39	92%	97%	3%	0%	0%	0%	0%
Davis[sd]	13-031-107	986	67	14.72	99%	99%	0%	0%	0%	0%	0%
Davis[sd]	13-032-23	988	74	13.35	88%	88%	1%	0%	0%	0%	0%
Davis[sd]	13-034-11	945	71	13.31	79%	87%	7%	0%	0%	0%	0%
Davis[sd]	13-054-5	990	106	9.34	25%	45%	53%	0%	0%	0%	0%
Davis[sd]	13-064-17	988	83	11.90	31%	65%	33%	0%	0%	0%	0%
Davis[sd]	13-064-18	987	89	11.09	35%	62%	37%	0%	0%	0%	0%
Davis[sd]	13-065-3	981	70	14.01	97%	97%	0%	0%	0%	0%	0%
Davis[sd]	13-069-16	987	83	11.89	81%	86%	8%	0%	0%	0%	0%

* At Davis: GB=Germplasm Block; NS=New Stuke Block; Seedlings= Davis[sd]; Selection Blocks= Davis[A, B, C, D, E, F, G]