# WALNUT IMPROVEMENT PROGRAM 2009

Chuck Leslie, Gale McGranahan, Wes Hackett, Nicolas Manterola, Abhaya Dandekar, Matt Escobar, Alan Bennett, Victor Haroldsen, Tom Burchell, Bob Beede, Bill Olson, Kathy Kelley Anderson, Joe Grant, Janet Caprile, and Bill Coates, Rick Buchner, Janine Hasey, Mysore Sudarshana

## ABSTRACT

The goal of the Walnut Improvement Program is to provide new walnut cultivars for the California walnut industry while developing new knowledge and maintaining a breeding population. We also work with collaborators to develop and propagate new rootstocks. This year we have 34 selections and over 8,000 seedlings under evaluation in the breeding program. The primary goal is to develop cultivars with early harvest dates and good kernel color. A patent application was filed this year for selection 95-11-14, to be named 'Ivanhoe' and released in 2010, and several advanced selections with Payne-time to mid-season harvest dates are promising. An additional 1500 backcross seedlings were planted this year for evaluation of both horticultural traits and resistance to cherry leaf roll virus. Planting of additional controlled crosses between Chandler and Idaho further increased the population under evaluation for mapping the walnut genome and developing markers for use in future breeding. Both field and tissue culture germplasm collections continue to be maintained and shared for use in collaborative research projects.

## OBJECTIVES

The objectives of the Walnut Improvement Program are:

- To provide the California walnut industry with genetically superior walnut cultivars and rootstocks
- to develop knowledge that will increase the efficiency of walnut breeding
- to develop and maintain an array of traits available for breeding in the future

The program consists of several projects with specific objectives:

- The classical cultivar breeding project uses traditional methods to develop and release new cultivars that combine precocity (high early yield) and early harvest date with kernel quality, in-shell traits, and disease resistance.
- The backcross breeding project is designed to introduce resistance to blackline disease from the Northern California black walnut into a commercially acceptable English walnut cultivar.
- Rootstock improvement objectives include development of selections with genetic resistance to *Phytophthora*, nematodes, and crown gall. This is done in conjunction with the clonal rootstocks improvement project.
- New technologies that increase the efficiency of breeding and the scope of genetic material available for walnut improvement continue to be evaluated and adapted to walnut breeding as opportunities arise.
- Germplasm collections are maintained and augmented when possible for future breeding use and are available for other researchers.

## PROCEDURES

### Breeding program.

The procedures for the breeding program have changed as the advanced selections from earlier crosses have matured and become available for use as parents. In 2004 and 2005 we collected nuts from selected parents at the Kearney Agricultural Center to produce half-sib families. In 2006 through 2009 we returned to making controlled crosses instead of utilizing open-pollinated (OP) seed. This approach results in a lower number of seedlings produced annually and increases the needed resources for the crossing effort but better optimizes the annual land costs and reduces the resources needed for seedling evaluation. The crossing designs used during the 2007-2009 seasons place priority on crossing the best high quality selections with the earliest harvesting selections as shown below:

**Seedlings grown from crosses 2007-2008 and nuts harvested from crosses (2009).**

**Early Harvesting**

| | **91-77-6** | **91-77-40** | **91-90-41** | **91-96-3** | **92-80-11** | **94-19-85** | **94-20-5** | **95-007-13** | **95-11-14** | ***95-18-23*** |
|---|---|---|---|---|---|---|---|---|---|---|
| **High Quality** | | | | | | | | | | |
| **90-31-12** | 28 | | | 2 | 37 | 12 | 38 | 63 | | 24 |
| **93-28-20** | 45 | 22 | 29 | 67 | 72 | 18 (32) | 13 | 48 | 3(3) | 9 (70) |
| **94-19-29** | 17 (64) | | 35 | 19 | 20 (25) | | 16 | | 5 | |
| **94-19-45** | 43 | | 54 | 43 | 37 | 33 | 10 | | 57 | |
| **95-11-22** | 40 | | (18) | 3 | (63) | 33 | 22 | 57 | (4) | (26) |
| **95-26-16** | (166) | | | 8 | 10 | (231) | | 12 | (36) | |
| **95-26-17** | 36 | | | | | 16 | | | | |
| **95-26-22** | | | 5 | 11 | 18 | | 19 | 66 | | 3 |
| **95-26-37** | | 5 | | 93 | 43 | | | 115 | 14 | |

| | **91-96-3** | **91-90-41** | **93-28-20** | **94-19-85** | **95-7-13** | **95-11-14** | **95-11-16** |
|---|---|---|---|---|---|---|---|
| **91-96-3**<br>**Cisco x Chandler**<br>**Mid, blight resistant** | | | | (32) | (65) | (45) | (10) |
| **91-90-41**<br>**87-9- x Chandler**<br>**Mid, color** | | | | (2) | (131) | (128) | (3) |
| **93-28-20**<br>**Chandler x PI 159568**<br>**Mid, color, shell** | | | | xxx | Done | xxx | (47) |
| **94-19-85**<br>**Vina x 67-13**<br>**Early, shape** | | | | | xxx | | |
| **95-7-13**<br>**77-12 x Serr**<br>**Early, size, shell** | | | | | | (52) | (50) |

Seedlings from these crosses are close planted in the orchard and any that appear to be terminal bearing or have signs of inbreeding (dwarfs, extra-lates etc.) are culled at about age 3. If no nuts have been produced by age 5 (under good growing conditions) they are also cut down. Full evaluations are undertaken only on precocious and laterally fruitful individuals. This is similar to the methods we used for the supplemental pollination families (see previous reports). Surviving seedlings are evaluated for phenology (leafing, flowering and harvest dates), precocity, lateral fruitfulness, estimated yield, blight incidence, and crack-out characteristics (shell shape, texture, thickness and strength, kernel weight, percent kernel, and kernel color, fill, plumpness and ease of

removal in halves).
Data is evaluated at the annual crackout evaluation meeting that includes growers, processors, nurserymen, and farm advisors. Participants inspect kernel boxes and data sheets to identify possible selections. Data available includes current year field and crack-out data, performance data from past years, Diamond evaluations and computer-assisted selection. Team evaluations are followed by a general group discussion of each team's recommendations.

Promising individuals are repropagated into selection blocks (Chico, Kearney and Davis) and grower trials where evaluations continue. The off-campus selection blocks are under the control of Bill Olson (Chico) and the Kearney field staff. Grower field trials are an essential component of releasing a new cultivar. We have increased the number of field trials in the last few years.

Pistillate flower abscission (PFA) continues to be a concern in the selection process for the breeding program. We generally determine the potential for a PFA problem in seedlings and selections by comparing the flower abundance rating taken at bloom time with the yield rating taken after nut set. A high abundance rating and a low yield estimate may suggest a potential PFA problem. During the last two years a study was conducted to begin developing methods for more definitive estimation of PFA during seedling selection and to assess the range of PFA in a diverse set of genotypes. At peak fertility 50 double flowers of each genotype were tagged for observation under natural pollination and a matching set of 50 were tagged and artificially pollinated. In 2008 pollen was applied using a very small paint brush dipped in pollen and tapped over the flowers. That technique resulted in too much pollen and excessive, unrepresentative drop. For example, Chandler had 92% PFA in artificially pollinated flowers and 11% PFA in naturally pollinated flowers. In 2009 pollen was applied by dipping a glass rod in pollen and tapping it over the flowers. In both year 5 additional flowers were collected approximately 2 days after pollination from each treatment and stored in 70% ethanol for later pollen counts. The percent set for each treatment was recorded two to three weeks after pollination.

**Backcross breeding for hypersensitivity to cherry leafroll virus.**

The backcross breeding project is designed to introduce resistance to blackline disease from the Northern California black walnut into a commercially acceptable English walnut cultivar. Crosses are conducted using the same methods as in conventional cultivar breeding but the selection process is different. The first backcross cull is based on shell thickness and percent kernel; those exhibiting the black walnut shell characteristics are discarded. Those that are promising are tested by PCR for hypersensitivity to the cherry leafroll virus as reported in Walnut Research Reports (1998) and modified recently (see WRR 2003).

Marker selection has been improved but has a 10% chance of error. As potential parents and selections advance in the program, there is a need for more stringent testing for hypersensitivity. The screening method used is as described in previous papers: a selection is grafted on both black and English rootstock (two each); after the graft is established, bark from our CLRV-source trees is patched into the English rootstock or into the selection depending on the rootstock species. If the selection is hypersensitive it will survive on the black rootstock because the inoculum patch was rejected, and die (exhibiting a black line) on the inoculated English rootstock. Confirmed hypersensitive, thin-shelled individuals with the best commercial traits are then used as parents for the next generation of backcrosses to an English walnut parent.

A preliminary study to determine whether CLRV (blackline)-infested pollen affects nut set in blackline resistant selections was undertaken in cooperation with Janet Caprile and Sudhi Mysore. CLRV-resistant selections 92-016-1, 97-027-55, and a Howard control, grown in a Contra Costa County field trial near Oakley CA (Tennant orchard), were selected for the test. Four replications of two trees each were available. Approximately 20 double flowers per selection per rep were bagged before they opened. At peak fertility (April 18 and 19) bagged flowers were pollinated with Chico pollen obtained from CLRV-infected trees located in the UC Davis Plant Pathology fields or clean Chico pollen obtained from the Pomology germplasm collection. Sudhi Mysore confirmed the presence of the virus using ELISA. Standard pollen storage and pollination procedures were followed. On May 5 bags were removed and nut set was recorded.

**Rootstock improvement**

Rootstock breeding is aimed at producing selections with genetic resistance to *Phytophthora*, nematodes, crown gall, and environmental stress while retaining or enhancing the vigor of hybrid rootstock. The limiting factor in developing improved rootstocks had been the absence of a commercially viable clonal propagation method but this has been overcome for many rootstock selections (see Clonal Propagation report). The procedures and results of screening for traits of interest are reported separately: nematodes - Mike McKenry; Phytophthora – Greg Browne; crown gall – Dan Kluepfel and Janine Hasey.

**New technology for genetic improvement of walnut**

This part of the Walnut Improvement Program includes tissue culture, PCR, and isozyme analysis in support of genetic improvement as well as gene transfer and field-testing of transgenic plants. Current laboratory work includes micropropagation, use of DNA marker selection in backcrossing, improvements in storage of long-term cultures, efficiency of introducing material to culture, and improvements in somatic embryogenesis.

In 2005 vector pDE00.0201, developed by Matt Escobar in the Dandekar lab and designed to silence the gall forming ipt and iaaM genes of wild-type *Agrobacterium*, was used in our lab to insert crown gall resistance into somatic embryos of three paradox genotypes (J1, J21 and RR4). Transformants were selected and germinated to generate microshoot lines. Plants of forty independent transformed lines plus controls were generated from rooted microshoots for use in greenhouse testing and for a field trial planted on campus. Rootstock in the field trial will be grafted to Chandler and observed for growth, horticultural performance, and incidence of naturally occurring crown gall.

Transgenics with the following genes continue to be observed and evaluated in large pots:

- Bt - insect resistance (inoculation with codling moth)
- FAD - altered oil composition to avoid rancidity.
- PPO - altered phenolic composition to improve rooting and kernel traits.
- SDH - regulates gallic acid production for aflatoxin control.

NOTE: Transgenics are only grown on campus under USDA guidelines and catkins and nuts are removed. They are grown for proof of concept experiments and are not available for the public.

## Germplasm resources

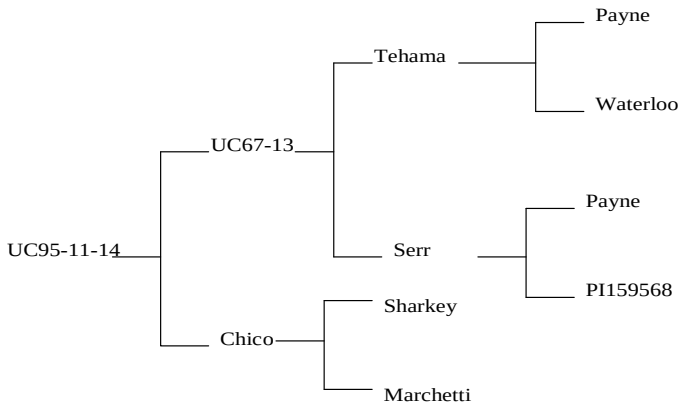
Germplasm collections are maintained and augmented when possible for future breeding use and are available for other researchers. Current collections at Wolfskill and Davis include a diversity of California cultivars, leading cultivars and selections from around the world, material with unusual traits, and germplasm of interest for rootstock development. Our collection differs in emphasis, content, distribution policy, and cultural practices from that of the USDA Germplasm Repository.

# RESULTS AND DISCUSSION

## Cultivar breeding

A patent was filed this year for selection 95-011-14, a very early harvesting selection with good color that will be released for nursery licensing in early 2010. This new variety will be named 'Ivanhoe' after a small town in Tulare County near the largest initial grower trial. Performance data to date indicate a harvest timing equivalent to 'Payne' and 'Serr' with good production of extra light kernels. The early leafing and flowering dates suggest it may be best suited to the southern part of the valley. The female flowers open before pollen shed. 'Serr' or 'Payne' should be good pollen sources. This tree is not expected to be large in stature and may be best tried initially on paradox to ensure vigor. See additional information in the 'Description of Selections' section of this report.

FIG. 1. Pedigree of Ivanhoe (UC95-11-14)




We also continue to observe and collect data on performance of the three walnut varieties patented in 2006: 'Sexton', 'Gillet' and 'Forde'. These have been characterized by high early yields, harvest dates before 'Chandler', low blight scores and large light-colored kernels. They are described in more detail in a separate Walnut Research Report (2004) and brief descriptions are included in the Descriptions of Selections at the end of this report.

For a list of current field trials of breeding program scion selections, their locations by county, years they were established, the growers involved, and the selections included, see Appendix 1.

Data on the advanced selections under evaluation are provided in Tables1-4 and a description of each can be found in the Descriptions of Selections section. The conventional scion breeding portion of the improvement program currently includes over 6500 seedlings under evaluation in our orchard and 34 selections as follows:

| Year | Crosses (n) | Original Seedlings (n) | Selections (n) | Under Evaluation (n) |
|---|---|---|---|---|
| 1990 | 15 | 591 | 2 | 2 |
| 1991 | 18 | 493 | 3 | 3 |
| 1992 | 15 | 243 | 1 | 1 |
| 1993 | 14 | 116 | 2 | 2 |
| 1994 | 15 | 587 | 5 | 5 |
| 1995 | 15 | 758 | 6 | 6 |
| 1996 | 7 | 333 | 1 | 1 |
| 1997 | 13 | 611 | 3 | 5 |
| 1998 | 5 | 1759 | 1 | 7 |
| 1999 | 1 | 993 | 0 | 0 |
| 2000 | 12 | 2503 | 6 | 21 |
| 2001 | 16 | 210 | 2 | 10 |
| 2002 | 5 | 1200 | - | 96 |
| 2003 | 11 | 4608 | 2 | 707 |
| 2004 | 7 hs** | 6000 | - | 838 |
| 2005 | 9 hs | 3332 | - | 3116 |
| 2006 | 22 | 954 | - | 894 |
| 2007 | 27 | 1045 | - | 904 |
| 2008 | 33 | 929 | - | 929 |
| 2009 | 32 | 1772 seed | | |
| **Total** | 82 | 27265 | 34 | 6681 |

**hs denotes half sib families

The potential for pistillate flower abscission remains a concern in selecting new varieties. Results of a trial designed to evaluate the PFA susceptibility of both newly released varieties and a set of genotypes chosen for genetic diversity are shown in Table 5. PFA was evaluated using both natural pollination and artificially applied pollen. The method used to apply pollen to flowers in a 2008 test resulted in excessive amounts of pollen, distorting results and causing flower desiccation. Counts of pollen grains on stigmas following 2009 artificial pollinations showed the number of pollen grains applied was highly variable. A more consistent method of applying known doses is still needed. On naturally pollinated flowers PFA counts were higher in 2009 than in 2008. In both years PFA was highest in Serr (2008 PFA 32%; 2009 PFA 70%) and lowest in Gillet (2008 PFA 8%; 2009 PFA 5%). Tagged flower PFA counts should probably be continued in the future on selections close to release.

**Backcross breeding for resistance to cherry leafroll virus.**

Backcross breeding to develop English walnut cultivars with resistance to the cherry leafroll virus is proceeding. We continue to test backcross seedlings for both nut quality and virus resistance and currently have approximately 1600 seedlings under active evaluation. This year we substantially increased the number of seedlings under evaluation in this part of the program by planting an additional 1500 backcross seedlings in new evaluation block on very close spacing.

Sudhi Mysore, USDA-ARS, assisted evaluations for the backcross program this year by redesigning our previously used DNA SCAR marker and initiating DNA sampling of new seedlings. SCAR marker reliability was improved identifying and exploiting a specific single nucleotide polymorphism in the marker region differing between English and black walnut. The newly designed marker was then used to initiate the DNA sampling and testing that will be required to screen and identify the tolerant (not virus resistant) seedlings among the large number of new trees so these be removed quickly, reducing maintenance costs for the block and allowing space for horticultural evaluation of the remaining resistant individuals. We also continued nut and yield evaluations for the 122 backcross seedlings remaining in previously established blocks.

In 2001 we started the current backcross selection testing block for final confirmation of hypersensitivity by bark patch testing. Additional selections were added in 2002-2005 to a total of 81 selections. Patches were checked the last four years for blackline formation. To date 14 have tested hypersensitive, 6 remain questionable and under evaluation, and the remainder were tolerant. Only one selection that tested hypersensitive by DNA evaluation has tested tolerant in the patch testing.

Field trials of hypersensitive selections with small but commercially acceptable kernels have been established in San Benito County by Bill Coates and in a Contra Costa County by Janet Caprile (see Appendix 1 and separate reports). In addition, Joe Grant collected budwood of eleven of the best virus resistant selections for fall-budding in a nursery. These will be used to initiate an additional orchard trial in San Joaquin County this year.

Results of an orchard trial that included both blackline-resistant selections and Howard showed that immature nut drop was almost identical in pollinations comparing CLRV-infested pollen vs. clean pollen. Resistant selection 92-16-1 had the most drop (38% from infested pollen; 37% from clean pollen) followed by 97-27-55 (11% from infested pollen; 15% from clean pollen), followed by 'Howard' (5% from infested pollen; 2% from clean pollen). These results, although preliminary, indicate that CLRV-infested pollen does not interfere with early nut set in blackline resistant selections. Due to resource limitations we were not able to assay the shoots for the presence of the virus to determine whether the virus spreads to the resistant shoots. An accurate later count of nut set was not possible because the grower pruned the trees but this should be determined in the future.

**Rootstock improvement**

A number of potential rootstock selections have been identified in the past and are maintained and micropropagated in the laboratory for confirmation testing and field trials (See Clonal Propagation report). This material includes tolerant backcross selections (vigorous, CLRV tolerant), several *Phytophthora* survivors from growers' orchards, PDS selections for crown gall, nematode, and Phytophthora resistance.

Two new genotypes were introduced into tissue culture this year for microshoot production and rooting. The first of these, *Juglans cathayensis* seedling #21, was identified by Mike McKenry as having resistance to the nematode *Pratylenchus vulnus*. *J. cathayensis* stems are extremely hairy and sticky and have proven very difficult to clean for culture initiation. We were finally able to obtain two clean explants by using etiolated material. We also introduced the *J. regia* cultivar 'Forde' in response to a commercial nursery request. The *J. microcarpa* paradox RX032, identified by Mike McKenry for its nematode resistance traits, was successfully introduced into culture last year. We have now begun to root this genotype for further testing. WIP5, a tolerant backcross that we had not previously been able to culture was also introduced successfully last year and cultures have been now been successfully multiplied but this genotype remains difficult to grow in culture and still does not elongate well. Microshoot cultures of both rootstock genotypes and English cultivars were provided again this year to commercial laboratories on request.

**Gene insertion**

Additional plants of the 40 independent lines expressing a construct for crown gall silencing in three separate background genotypes (J1, J21, and RR4) and control plants were produced this year and grown in the greenhouse for further testing. Results of the crown gall resistance tests are reported separately in this volume under the Clonal Propagation Project and by Dan Kluepfel.

A small sub-set of these genotypes, grown in large pots and grafted with Chandler scions, were used by Allen Bennett's student Victor Haroldsen at PIPRA to test for any movement of DNA, RNA, or other macromolecules across the graft union from the rootstock to the scion and to test that the horticultural traits of the scion material on these rootstocks are not altered. To date, genes for GUS, NPTII, iaaM and IPT were detectable in leaves of the rootstock material but none of these genes have been detected in the scion leaves or in endosperm of nuts harvested from the scions. In addition, Western blots show NPTII expression in the rootstock material, but not in the scion.

A one-acre field trial of these rootstock lines and appropriate controls was established under APHIS field permit last year and partially budded to Chandler scions this fall. Growth measurements are in progress and trees will be observed for both horticultural performance and any natural occurrence of crown gall.

Genotypes exhibiting altered expression of shikimate dehydrogenase (SDH), an enzyme that regulates the production of gallic acid which plays a role in aflatoxin resistance were maintained in large pots in the greenhouse so they can be used to study gallic acid production in nuts and its role in insect and disease resistance.

Transgenic walnut trees with an inserted construct silencing the expression of the polyphenol oxidase (PPO) gene are being maintained in large pots in order to provide leaves and nuts for use in assays by Matt Escobar. Walnut PPO is thought to play a role in disease resistance and kernel color traits. PPO activity assays run recently by Escobar showed 8 of the 12 transgenic walnut lines examined had PPO specific activities < 1% of wild type. Enzyme specificity for 14 phenolic substrates was also determined. Planned additional work using these plants will be directed at examining the role of PPO in walnut leaf phenolic metabolism, in pathogen defense, and in kernel color formation. Current work utilizing leaves of silenced and control plants is directed at the role of PPO in blight resistance. If the potted PPO plants can produce nuts, differences in kernel color will be evaluated.

Chandler trees expressing the cry1A(c) BT gene have shown good efficacy against codling moth in previous USDA tests. They were grafted onto potted rootstock so they could be maintained for future use, if desired. These insect resistant genotypes are no longer maintained in the field.

**Genomics**

We are continuing to evaluate individuals of a population of Chandler x Idaho seedlings that we have been generating over the last six years. Data collected on this population, including leafing, flowering, and harvest dates, yield, disease, and insect resistance traits, and nut and kernel characteristics, will be critical to the success of the walnut genomics project.

The parents were chosen to develop a very large seedling population that segregates for as many important traits as possible (kernel color, phenology, lateral bearing, shell appearance, protogyny/protandry, insect resistance, blight response, etc.). To date 350 seedlings have been established and an additional 88 are ready for planting this spring. In addition, 92 of the genotypes have been regrafted to rootstock on wider spacing to improve the evaluation process and provide some replication. Trees from this cross will continue to be evaluated for horticultural traits as they mature over the next several years. DNA from these trees will eventually be used to map each of the traits in the walnut genome and to develop markers for more efficient selection in breeding (see Dandekar et al. report on Genomics).

**Germplasm resources and maintenance**

We continue to maintain a large collection of in vitro germplasm for use by the Walnut Improvement Program, other cooperating researchers, and commercial labs and nurseries. Hartley and Chandler microshoots were supplied again throughout the year to the Kluepfel lab for use in *Brenaria* and other canker research projects and we supplied *in vitro* rooted microshoots to Kendra Baumgartner for use in developing new screening methods for *Armillaria* resistance. Microshoots of modified gallic acid genotypes were propagated for the Dandekar lab to use in assays needed to complete analyses for the aflatoxin project and we continue to maintain a long-term *in vitro* nematode population for use in nematode resistance research by the Dandekar lab and others.

The field germplasm collection was used again this year by a variety of research projects including Nick Mills for insect work, Eike Luedeling for climate work, Beth Mitcham's student for food safety work, Bob Beede for Ethephon sensitivity evaluations, and Mike McKenry for nematode treatments. In addition, we supplied graftwood of germplasm to fill a variety of research and nursery requests.

In cooperation with David Ellis and Maria Jenderek at the USDA-ARS cryopreservation facility at Ft. Collins, Colorado, we continued our previous work in which Chandler somatic embryos were successfully stored in liquid nitrogen. This year somatic embryos of RR4, a vigorous paradox genotype developed from a Rawlins seed, were used to evaluate our ability store paradox selections. After cryopreservation at Ft. Collins we grew and germinated several replicate sets in our lab to determine that cryopreservation had not altered the ability of the embryos to grow in culture. Chandler somatic embryos are now stored in the USDA's long-term cryo-storage facility at Ft. Collins as a backup to our laboratory supply and to provide long-term storage without exposure to possible genetic changes that can occur during long-term culture and will be available from the USDA to other researcher on request.

We are also continuing to work with Ft. Collins to develop a reliable method for cryopreservation of

shoot cultures for safe long-term storage. This year we again sent dormant shoots of Chandler and Franquette of various diameters to Ft. Collins as part of continuing work designed to develop cryopreservation methods for backing up field material of important genotypes to protect against loss from catastrophic disease or other events and in the interest of developing a long-term backup method for the USDA walnut collection at the National Clonal Germplasm Repository – Davis and our own collection. Following desiccation and liquid nitrogen treatments at Ft. Collins, stem pieces were sent to Burchell Nursery which generously provided grafters and rootstock for the post-treatment viability testing. Buds failed to survive the liquid nitrogen storage but improvements were made in survival of the preliminary desiccation treatments. Results were encouraging and we plan to continue to cooperate in this work next year.

**Description of Selections 2009. (*indicates most promising, indent indicates probable discard)**

**Sexton (90-031-10)** (Chandler x 85-008) (selected 2000): This very precocious offspring of a Chandler x Chinese cross has large light kernels that average 8.4 g. Color has been very good most years averaging 18% extra light. Nuts have smooth, round, solid shells and yield 53% kernel. The tree leafs about a week after Payne and harvests a week before Chandler. Yields continue to be excellent with little blight observed most years. Tree tends to have neck buds and narrowly forked branches. Pruning will be needed to set tree structure and to prevent possible stunting from early over-cropping. It may be suitable for hedgerows where limb structure is less critical, heavy early yield is an objective, and limited tree size is an advantage. Its pollen shed overlaps the female bloom very well and it can have some 2$^{nd}$ flowering like Chico, resulting in some small and late harvesting nuts. Released 2004. (Trials: Conant, Sierra Gold, Scheuring, Crane, Modesto JC, Taylor)

**Gillet (95-022-26)** (76-80 x Chico) (selected 2002): This protogynous selection continues to exhibit excellent yield, large 7.9 g kernels, and harvests mid-season, about two weeks earlier than Chandler. Nuts average 51% kernel and yield halves easily. Kernels color can be excellent but is showing some variability by location. Kernels generally have little shrivel and few veins or blanks. Seals appear adequate for cracking but are not suitable for in-shell use, and remain a concern, particularly in young trees. This is a large and vigorous tree that has had very little blight. Released 2004. (Trials: Conant, Scheuring, Crane, CSU-Chico, Modesto JC, Taylor)

**Forde (95-026-37)** (Lara x Chico) (selected 2001): This selection has consistently produced kernels with very good color and shown excellent yield but it harvests very close to Chandler. It has large, plump 8.5 g kernels, a protogynous bearing habit, and nuts yield 53% kernel. This is a large vigorous tree with upright growth and little blight. Its shell and seal strength, kernel fill and plumpness, percent kernel, and yield on young trees have all been better than Chandler and kernels show an absence of tip shrivel. Released 2004. (Trials: Conant, Scheuring, Modesto JC, Crane, Stolp, Taylor)

**Ivanhoe (95-011-14)** (67-013 x Chico) (selected 2001): This protogynous selection will be released this year as an early-harvest cracking variety. It harvests with, or before, Payne and Serr and is characterized by very good yield, smooth shells with excellent color and appearance, and mostly Chandler-like extra light kernels averaging 7.6 g. It likely will not have sufficient shell strength for in-shell use, the seals should be watched, and nut size is not large. Nuts yield 57% kernel with very easy removal of halves. Kernel quality and harvest date are excellent. Trees leaf and bloom early

and are susceptible to blight, have shown some summer heat damage to the foliage, and some summer nut drop in the past. Trees should likely be planted on paradox due expected small stature and should be managed well to maintain nut size. To be released in 2010 (Trials: Sierra Gold, Scheuring, Conant, Moore, Bonturi, Spanfelner, Stuke, Headrick, Carriere, Stolp)

**90-027-21** (Tulare x Sinensis #5) (selected 1998): We are interested in this selection primarily for its apparent resistance to boron. Yield has been consistently good to excellent and nuts could be used as an early in-shell. It is a protandrous, upright, vigorous tree that leafs out and harvests close to Payne. The shells are strong, well sealed, and shaped like Vina. Nuts yield only 48% kernel and kernels average 6.9 g. Kernel color has been mostly light but not excellent. Blight has been severe on unsprayed trees in wet years but little blight has been observed in sprayed blocks even though it leafs early. Nuts tend to have a white interior lining on the shell, sometimes don't fill well at the blossom end, and have packing tissue with a rather woody center. Tree is upright and branchy with a dense canopy and is likely easy to train. Kernel weight and percent are concerns but this selection continues to produce excellent yields. Possible discard. 2003 (Trials: Conant, Deardorff, Scheuring)

**90-027-23** (Tulare x Sinensis #5) (selected 1998): This short-season sibling of the previous selection leafs out close to Chandler but harvests about two weeks earlier. It exhibits good shell strength and kernel color. Kernels average 7.5 g and nuts average 52% kernel. Nuts are Vina shaped and have a striped appearance. This is a vigorous, thrifty tree that consistently harvests about a week after Payne with good yield. (Trials: Conant, Deardorff, Carriere)

**91-077-6** (Howard x 85-008) (selected 2000): This high-yield, early cracking selection is a protandrous tree that harvests close to Payne time but leafs about a week later. Yield has frequently been huge on this very precocious tree. The large 8.8 g kernels have shown good color with easy removal of halves. The large, round, smooth-shelled nuts average 56% kernel but shell strength and seal are often insufficient and it shows problems with incomplete shells that continue even after trees are fully mature, and it has frequently exhibited problems with sunburn or black nuts. Definitely not for in-shell use and shows boron sensitivity. (Trials: Conant, Sierra Gold, Scheuring, Bonturi, Deardorff)

**91-077-40** (Howard x 85-008) (selected 2001): This is a rather small tree characterized by precocity, outstanding yield, protogynous bearing habit, and large kernels averaging 8.1 g. Color continues to show a pattern of excellence at Davis but not at other locations. Nuts are well sealed with 51% kernel and strong shells. Harvest averages a week before Chandler and yields have been consistently huge but there can be some second bloom and variable nut size. The large yields can stall growth. This selection may be of interest under power lines or in hedgerows. (Trials: Conant)

***91-090-41** (87-009 x Chandler) (selected 1999): This mid-season selection is notable for its light color, particularly relative to other selections in locations with generally poor color. It has an attractive shell appearance and growth appears to be upright. The nuts have thin shells and average 58% kernel. Seals and strength are not adequate for in-shell use. Yields have consistently been very strong, and color of the 7.8 g kernels has been mostly light to extra-light with easy recovery of halves. Harvest is about two weeks before Chandler and blight has been consistently low. Grower comments, our evaluation data, and Diamond data, suggest consideration for release but shells and seals are rather weak in many cases and remain a concern. (Trials: Conant, Sierra Gold, Deardorff)

**92-070-12** (Soleze x Chandler) (selected 1999): Attributes of this selection include excellent kernel color, easy removal of halves, excellent shell appearance, 7.1 g kernels, and 54% kernel yield. This selection harvests about ten days earlier than Chandler and the blight incidence has been low. Shells are very smooth textured and light colored but the seals and shell strength are rather weak and kernels consistently exhibit Chandler-like tip shrivel. Great nut appearance and very high value scores from Diamond crackout in multiple years and locations. Nut size is larger and more consistent than Chandler with a greater percent kernel, fewer small nuts, and an earlier harvest date. Possible discard 2003. (Trials: Conant, Deardorff, Crane)

**93-026-6** (Chandler x Sinensis #5) (selected 2001): Good yield with harvest averaging about a week after Payne or two weeks before Chandler. This protogynous selection has large Hartley-shaped nuts with solid shells and seals that yield 50 % kernel. The large 8.7 g kernels have had mostly light to extra light color. Stem end holes should be watched but have been mostly acceptable. Although rather Hartley-shaped and large, the shells can be irregular and are probably not be consistent enough in appearance for in-shell use. Veins and tip shrivel are consistent defects. (Trials: Driver, Deseret, Stuke, Crain, Conant, Noreen, Sierra Gold, Scheuring)

***93-028-20** (Chandler x PI 159568) (selected 2001): This selection should be considered for use as a mid-season in-shell competitor with Hartley. It has Tulare timing with large, oval, very attractive nuts. It leafs a few days before Chandler but harvests about two weeks earlier with good yield and has had little blight. The smooth, attractive, very solid shells have good seals and 55% kernel. The very plump, Sunland-shaped kernels average 8.6 g and kernel color is excellent. (Trials: Conant, Sierra Gold, Spanfelner)

**94-019-29** (Vina x 67-013) (selected 2001): This tree was selected for its great yield, early harvest about 2 weeks before Chandler, and shell traits suitable for in-shell use. Kernel color has been excellent but shells are often dark in color. This upright and vigorous tree is blight susceptible when not sprayed but has been blight free in selection blocks. Nuts average 53% kernel. The 8.0 g kernels are easily removed in halves. (Trials: Noreen)

**94-019-45** (Vina x 67-013) (selected 2001): A large, vigorous, branchy, and heavy cropping selection with moderate blight susceptibility and 8.1 g kernels. Leafing date is similar to Chandler but it harvests early to mid-season with nut traits suitable for in-shell use. Nuts yield 53% kernel. Color is good but has had shrivel some years and harvest date may be spread out. (Trials: Conant)

**94-019-85** (Vina x 67-013) (selected 2001): This selection is notable for its very early harvest date similar to Payne, and a Hartley-shaped nut. Kernel color has been generally good but not consistent. The shell is quite thin and a bit rough but has relatively good strength, resembling Serr in this regard. Yield has been good, nuts contain 59% kernel with easy halves, and kernels average 8.4 g. Use as a parent for shape and early harvest date. Watch the yield and color consistency further. (Trials: Bonturi)

**94-020-28** (Vina x PI159568) (selected 2005): This protandrous potential in-shell selection has Payne-time harvest date with excellent yield and very solid shells and seals. The nuts contain 54% kernel and have a smooth, attractive shell that yields easy halves. The very plump kernels average 8.2 g but consistency of color needs to be watched further. Trees in selection blocks are still young.

**94-020-35** (Vina x PI159568) (selected 2001): This early in-shell selection harvests within a few days of Payne with moderate blight and good yield. Shells are very solid and have excellent strength for in-shell use but are pointed and have a rough inner surface, which along with excellent fill, can often impede halves. Kernels average 8.2 g with generally light color. Nuts are long and oval like Sunland and the thick shell accounts for nuts averaging only 49% kernel. Tree appears to have a spreading weepy or willowy growth habit. (Trials: Stolp, Moore, Conant, Sierra Gold)

***95-007-13** (77-012 x Serr) (selected 2001): This Serr seedling harvests at Payne time, with excellent yield and good tree vigor. The nuts have a solid, attractive shell, and kernels have generally good color, but can be a bit veiny. The well-filled nuts yield 54% kernel with easy halves. Kernels average 8.3 g. Shells are thin but still solid, like Serr, with a smoother and more attractive appearance. This could be an early-harvest cracking variety if the kernel color is adequate. Color can be good but has been inconsistent. Continue to evaluate it in selection blocks and grower trials. (Trials: Stuke, Conant, Scheuring)

***95-011-16** (67-013 x Chico) (selected 2003): This protandrous early in-shell selection and sibling of Ivanhoe harvests about a week after Payne and ahead of Vina with good yield. It has large, light colored kernels that average 8.1 g. Nuts have very solid oval shells that give 55% kernel and have an attractive appearance. It shows some tip shrivel. Consider this one for release. (Trials: Scheuring, Spanfelner, Stolp, Conant)

**95-011-22** (67-013 x Chico) (selected 2001): A high yielding selection with mostly light to extra light kernels and fairly early harvest date. Nuts have 54% kernel with shell and seal strength suitable for in-shell use. Kernels average 7.1 g but nut size has been inconsistent by location. Continue to watch. (Trials: Conant)

**95-018-23** (Tulare x Chandler) (selected 2003): Excellent yield of mostly extra light kernels and harvests less than a week after Payne. This is a short season selection that leafs after Chandler and has low blight. Shells are thin and have insufficient strength for in-shell use. Nuts yield 51% kernel and easy halves but fill is poor and kernels average only 7.0 g. Keep for late leafing, short season selection. Sensitive to boron. (Trials: Scheuring, Carriere, Suchan)

***95-026-16** (Lara x Chico) (selected 2003): This protogynous selection harvests with Payne or

earlier and has good kernel color with little blight. Nuts yield 52% kernel and have solid shells and seals. Kernels have averaged only 7.2 g and have light, but mostly not extra light, color. This could be an early in-shell selection. Continue to watch for nut size and consistency of yield in the selection blocks and grower trials. (Trials: Scheuring, Stolp, Spanfelner)

**95-026-22** (Lara x Chico) (selected 2001): This protandrous tree harvests mid-season with a very strong shell and seal and good nut size. Kernels average 8.7 g and nuts yield 48% kernel. Kernels have generally been large and light. Blight incidence has remained very low. The rough textured shells are very solid and can have inner roughness as well. If nuts are too well filled, kernels can be difficult to remove in halves. This tree continues to have good nut size and yield. Likely discard. (Trials: Conant, Scheuring, Sierra Gold, Carriere, Taylor)

**96-013-13** (Howard x Chico) (selected 2003): This protogynous tree was selected for its excellent yield, light kernel color, good shell appearance, and mid-season harvest. It had better yield than Tulare trees around it as a seedling, an equivalent harvest date, and better color. Kernel color can be excellent but has been inconsistent. The light colored, smooth, attractive shells are solid and adequate for in-shell use. Nuts give 54% kernel but kernels average only 6.9 g and are averaging only 7.6 g on grafted trees in a selection block.

**97-003-11** (Tulare x Mixed Chinese – Phase II) (selected 2004): Selected for its mid-season harvest, Chandler leafing date, and very large, very plump, light colored kernels averaging 9.6 g. The large well-filled nuts yield 57% kernel. Shells are rough and seals should be watched. Harvest date is likely only a week ahead of Chandler and yield, which was stronger as a seedling, should be watched further. Continue to evaluate.

**97-003-79** (Tulare x Mixed Chinese – Phase II) (selected 2005): This is a protandrous mid-season selection with exceptionally large 10.1 g kernels, smooth shells, and good yield. Removal of halves is easy and the shells are solid, yielding 54% kernel. Kernel color may not be adequate. Continue to watch. (Trial: Sierra Gold)

**97-003-96** (Tulare x Mixed Chinese – Phase II) (selected 2005): This selection harvests about ten days after Payne. Nuts have a solid shell and seal with 51% kernel. The kernel color has been very good and kernels average 7.8 g. Pay attention to veins and watch this on rootstock. (Trial: Sierra Gold)

**98-002-129** (77-012 x O.P.) (selected 2009): This selection has large, very plump kernels that average 9.7 g with good color and harvest within a week of Payne. Nuts of this protandrous tree are well filled, have good shell strength, and yield 57% kernel

***00-005-30** (59-124 x O.P.) (selected 2007): This large vigorous selection harvests several days earlier than Payne with good yield. Leafing is also early but little blight has been observed to date. The very large, plump, 10.0 g kernels are easily removed in halves and have generally light color. The tree has a protogynous bloom habit and nuts yield 55% kernel with easy removal. (Trial: Scheuring)

**00-005-149** (59-124 x O.P.) (selected 2007): This protogynous selection harvests with Payne but

leafs out about a week later. Yields have been consistently huge. The round, smooth-textured nuts average 55% kernel. The 8.6g kernels are plump but color has been inconsistent and perhaps too dark. Gale calls it "Gale's Caramel" because of its color. (Trial: Scheuring)

**00-006-48** (76-080 x O.P.) (selected 2008): This is a late leafing and relatively late harvesting selection with excellent kernel color. It leafs about a week after Chandler and harvests about a week earlier. Nuts yield 50% kernel and the kernel color is consistently outstanding but kernel weights have averaged only 7.2g and yield needs to be watched further. This one is for Lake County.

**00-006-227** (76-080 x O.P.) (selected 2009): This early-harvest date selection with good yield harvests within a week of Payne. The large, mostly extra light kernels average 8.2 g. The tree leafs about Payne time and produces nuts with 60% kernel. The shells are thin but sufficiently strong and seals are good. (Trial: Scheuring)

**00-007-2** (91-077-6 x 90-023-11 (selected 2009): This seedling from a controlled cross of two early harvesting, high yield parents produces large plump 9.1 g kernels with good colr. The harvest date is Payne-time or earlier with good yields. The large smooth-shelled nuts give easy halves. Watch the seals. (Trial: Scheuring)

**00-011-107** (Howard x O.P.) (selected 2008): This protogynous selection harvests within a week of Payne with excellent yield but leafs approximately with Chandler. Nuts have light colored shells and yield 51% kernel. Kernels average 7.8g, have excellent color, and are easily removed in halves.

**01-009-14** (91-094-18 x 91-007-6) (selected 2008): This very small and very precocious tree produces huge yields that harvest early. Nuts give 53% kernel but kernels average only 7.2g and both color and seals need to be watched. This selection needs to be grafted and evaluated further on rootstock. Small stature selection.

**01-016-11** (91-019-45 x 91-090-41) (selected 2009): Harvesting about a week after Payne with large 9.0 g kernels of uniform light color, this tree bears large smooth nuts with good shell strength and easy kernel removal. Yields have been very good and nuts give 53% kernel. (Trial: Stolp)

**03-001-507** (Chandler x Phase II) (selected 2009): Notable for its huge yields, this selection harvests a week after Payne and bears very attractive nuts with solid shells and seals. The large 9.0 g kernels have very good color and nuts give 58% kernel with easy extraction of halves.

**03-001-977** (Chandler x Phase II) (selected 2009): This selection leafs and harvests about a week ahead of Chandler and has consistently produced a very large crop. The protogynous bearing habit, with flower timing inverse of Chandler, can provide good pollen coverage for Chandler. The nuts have an excellent shell appearance with good strength and seals. Kernels average 8.1 g and nuts give 59% kernel. (Trials: Stolp, Conant)

Appendix 1. List of Current Field Trials of Scion Selections

## Field Trials of CLRV-Resistant Selections

### San Benito – Coates

Bonturi

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

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

### Contra Costa –Caprile

Tennant

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

### San Joaquin - Grant

Planned for 2010

Selections fall-budded in nursery - 2009

## Field Trials of Standard Selections

### Tehama - Buchner

Spanfelner

91-094-18, 91-090-41, 91-077-6, 91-096-3, 93-028-20, 94-020-35, 95-011-14, 95-011-16, 95-026-16

H. Crain – blight resistant variety trial

### Butte – Olson/Connell

Chico State Farm

Chico State Selection Block

Chico State Farm Trial 2004: Sexton, 91-090-41, 95-026-22

Stolp

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

2007: 94-019-85, 95-011-14, 95-026-16

2008: numerous selections

Stuke

2002: 95-007-13.

2008: 95-011-14

Bertagna - red kernels

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

Appendix 1. List of Current Field Trials of Scion Selections (cont.).

**Lake – Elkins**

Suchan

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

**Glenn – Krueger**

Carriere

2005: 91-096-3, 93,028-20, 95-018-23, 95-026-22

2007: 91-077-6, 94-019-85, 95-011-14

**Colusa - Edstrom**

Nickels Trial - pruning

2008: Gillet, Forde, Tulare, Chandler

**Sutter-Yuba - Hasey**

Conant

Selection trials

2001-2009: Numerous selections

Selections for reduced tree stature

2009: Howard, Forde, Sexton, 91-077-40, 95-011-14 on RX1, VX211, Vlach rootstock

Gilbert

2008: Sexton, Gillet, Forde

Sierra Gold

2001-2008: Graft wood block – numerous selections

Noreen

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

**Yolo - DeBuse**

Scheuring selection trials

2002, 2004, 2008: Numerous selections

UCD Selection Block

**San Benito – Coates**

Bonturi

2002: 91-077-6, 94-019-85, 95-011-14

Appendix 1. List of Current Field Trials of Scion Selections (cont.).

**San Joaquin - Grant**

Taylor

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

**Stanislaus – Anderson**

MJC

2004: Sexton, Gillet, Forde, Tulare

Deardorff

2006: 91-077-6, 94-020-28, 95-011-14, 97-003-208, 97-003-311, 97-003-319

2007: 91-090-41, 91-077-6, 93-028-20, 94-019-85, 94-020-5, 94-020-35, 95-011-14, 95-026-16

**Merced – Anderson/Doll**

Crane Sr.

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

2003: 92-070-12

Crane Jr.

2004: Sexton, Forde, 95-022-26

**Fresno**

KAC

KAC Selection Block

KAC Blight resistant variety block

**Kings - Beede**

Miya Farms

2009: 95-011-14

Jeb Headrick

94-020-28, 94-020-35, 95-011-14

**Tulare – Beede/Fichtner**

Moore

2004: 95-011-14

Swall

2004: Sexton. Forde, 95-022-26

**Table 1. Cultivar and Selection Evaluations at Davis – (Spring 2009)**

| | Seedling or Grafted | Leafing | | Pollen Shedding | | | | Pistillate Bloom | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Date | DAP[a] | 1st | Peak | Last | Abund.[b] | 1st | Peak | Last | % Lateral | Yield[b] |
| **Cultivars** | | | | | | | | | | | | |
| Payne | G | 3/22 | 0 | 3/25 | 4/1 | 4/12 | 7 | 4/2 | 4/6 | 4/16 | 100 | 7 |
| Hartley | G | 4/3 | 12 | 4/5 | 4/12 | 5/1 | 7 | 4/19 | 4/23 | 5/8 | 0 | 6 |
| Vina | G | 3/28 | 6 | 3/31 | 4/5 | 4/15 | 7 | 4/6 | 4/14 | 4/19 | 100 | 7 |
| Serr | G | 3/22 | 0 | 3/26 | 4/2 | 4/14 | 8 | 4/2 | 4/6 | 4/14 | 100 | 6 |
| Chandler | G | 4/2 | 11 | 4/4 | 4/12 | 4/25 | 7 | 4/19 | 4/25 | 5/10 | 100 | 6 |
| Howard | G | 4/1 | 10 | 4/3 | 4/8 | 4/22 | 7 | 4/14 | 4/20 | 5/5 | 100 | 7 |
| Tulare | G | 3/30 | 8 | 4/6 | 4/11 | 4/22 | 7 | 4/12 | 4/16 | 4/21 | 100 | 7 |
| Sexton | G | 3/26 | 4 | 3/28 | 4/2 | 4/15 | 7 | 4/4 | 4/9 | 4/16 | 100 | 7 |
| Gillet | G | 3/24 | 2 | 4/6 | 4/14 | 4/23 | 7 | 3/27 | 4/2 | 4/10 | 100 | 8 |
| Forde | G | 3/29 | 7 | 4/15 | 4/20 | 4/30 | 6 | 4/1 | 4/8 | 4/15 | 100 | 6 |
| Ivanhoe | G | 3/21 | -1 | 4/4 | 4/12 | 4/19 | 6 | 3/22 | 3/26 | 4/2 | 100 | 7 |
| **Selections** | | | | | | | | | | | | |
| 59-124 | G | 3/20 | -2 | 3/24 | 3/31 | 4/11 | 8 | 3/31 | 4/4 | 4/9 | 100 | 7 |
| 64-057 | G | 3/26 | 4 | 4/6 | 4/14 | 4/24 | 7 | 3/30 | 4/3 | 4/9 | 100 | 7 |
| 90-027-21 | G | 3/23 | 1 | 3/27 | 4/2 | 4/12 | 7 | 4/4 | 4/8 | 4/15 | 100 | 7 |
| 90-027-23 | G | 4/1 | 10 | 4/4 | 4/15 | 4/29 | 7 | 4/15 | 4/19 | 4/30 | 100 | 7 |
| 91-077-6 | G | 3/25 | 3 | 3/27 | 4/3 | 4/13 | 7 | 4/5 | 4/12 | 4/18 | 100 | 7 |
| 91-077-40 | G | 3/26 | 4 | 4/9 | 4/15 | 4/28 | 7 | 3/27 | 4/2 | 4/9 | 100 | 8 |
| 91-090-41 | G | 4/1 | 10 | 4/2 | 4/9 | 4/21 | 7 | 4/14 | 4/20 | 4/26 | 100 | 7 |
| 93-028-20 | G | 3/27 | 5 | 3/25 | 4/2 | 4/10 | 7 | 4/8 | 4/14 | 4/18 | 100 | 7 |
| 94-019-85 | G | 3/22 | 0 | 3/24 | 3/31 | 4/6 | 7 | 3/31 | 4/3 | 4/8 | 100 | 6 |

[a]Days after Payne leafing date at Davis
[b]1=low, 9=high

**Table 1. Cultivar and Selection Evaluations at Davis – (Spring 2009) – (cont.)**

| | Seedling or Grafted | Leafing | | Pollen Shedding | | | | Pistillate Bloom | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Date | DAP[a] | 1st | Peak | Last | Abund.[b] | 1st | Peak | Last | % Lateral | Yield[b] |
| 94-020-35 | G | 3/20 | -2 | 3/25 | 4/1 | 4/9 | 7 | 4/2 | 4/6 | 4/11 | 100 | 7 |
| 95-007-13 | G | 3/23 | 1 | 3/25 | 4/2 | 4/10 | 7 | 4/4 | 4/9 | 4/16 | 100 | 7 |
| 95-011-16 | G | 3/27 | 5 | 3/29 | 4/4 | 4/14 | 7 | 4/7 | 4/12 | 4/19 | 100 | 7 |
| 95-018-23 | G | 4/2 | 11 | 4/5 | 4/11 | 4/21 | 7 | 4/15 | 4/20 | 4/23 | 100 | 8 |
| 95-024-1 | G | 3/27 | 5 | 4/1 | 4/7 | 4/16 | 7 | 4/13 | 4/16 | 4/21 | 100 | 8 |
| 95-026-16 | G | 3/27 | 5 | 4/7 | 4/15 | 4/23 | 7 | 3/27 | 3/31 | 4/8 | 100 | 7 |
| 95-026-17 | G | 4/1 | 10 | 4/13 | 4/18 | 4/24 | 7 | 4/5 | 4/9 | 4/15 | 100 | 7 |
| 95-026-22 | G | 3/27 | 5 | 3/29 | 4/4 | 4/16 | 7 | 4/10 | 4/15 | 4/24 | 100 | 7 |
| 96-013-13 | G | 3/25 | 3 | 4/6 | 4/13 | 4/19 | 6 | 3/27 | 3/31 | 4/4 | 100 | 7 |
| 97-003-11 | G | 3/27 | 5 | 4/1 | 4/8 | 4/17 | 7 | 4/9 | 4/13 | 4/17 | 100 | 6 |
| 97-003-23 | G | 4/2 | 11 | 4/7 | 4/14 | 4/23 | 7 | 4/17 | 4/21 | 4/26 | 100 | 7 |
| 97-003-79 | G | 3/25 | 3 | 3/28 | 4/4 | 4/15 | 7 | 4/9 | 4/14 | 4/18 | 100 | 6 |
| 98-002-129 | G | 3/25 | 3 | 3/30 | 4/3 | 4/9 | 3 | 4/9 | 4/16 | 4/22 | 100 | 7 |
| 98-003-54 | G | 4/6 | 15 | 4/18 | 4/22 | 4/30 | 3 | 4/13 | 4/18 | 4/23 | 100 | 7 |
| 00-005-30 | S | 3/23 | 1 | 4/7 | 4/14 | 4/18 | 7 | 3/26 | 3/30 | 4/5 | 100 | 6 |
| 00-005-44 | S | 3/27 | 5 | 3/31 | 4/8 | 4/20 | 6 | 4/3 | 4/10 | 4/21 | 100 | 8 |
| 00-005-149 | S | 3/27 | 5 | 4/10 | 4/17 | 4/23 | 7 | 3/31 | 4/6 | 4/15 | 100 | 7 |
| 00-005-153 | S | 3/31 | 9 | 4/3 | 4/12 | 4/24 | 7 | 4/15 | 4/22 | 4/28 | 100 | 7 |
| 00-006-48 | S | 4/10 | 19 | 4/7 | 4/15 | 4/23 | 7 | 4/18 | 4/22 | 5/1 | 100 | 6 |
| 00-006-227 | S | 3/30 | 8 | 4/16 | 4/21 | 4/30 | 8 | 4/3 | 4/9 | 4/19 | 100 | 7 |
| 00-011-107 | S | 4/1 | 10 | 4/10 | 4/16 | 4/23 | 5 | 4/3 | 4/8 | 4/16 | 100 | 7 |
| 01-007-2 | S | 3/26 | 4 | 3/27 | 4/1 | 4/7 | 6 | 4/2 | 4/6 | 4/12 | 100 | 6 |
| 01-007-3 | S | 4/3 | 12 | 4/6 | 4/12 | 4/20 | 6 | 4/16 | 4/20 | 4/24 | 100 | 7 |

[a]Days after Payne leafing date at Davis
[b]1=low, 9=high

**Table 1. Cultivar and Selection Evaluations at Davis – (Spring 2009) – (cont.)**

| | Seedling or | Leafing | | Pollen Shedding | | | | Pistillate Bloom | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grafted | Date | DAP[a] | 1st | Peak | Last | Abund.[b] | 1st | Peak | Last | % Lateral | Yield[b] |
| 01-009-10 | S | 4/4 | 13 | 4/5 | 4/11 | 4/19 | 6 | 4/19 | 4/22 | 4/29 | 100 | 5 |
| 01-009-14 | S | 4/4 | 13 | 4/7 | 4/12 | 4/22 | 7 | 4/17 | 4/21 | 4/28 | 100 | 6 |
| 01-016-11 | S | 3/26 | 4 | 3/27 | 4/4 | 4/15 | 6 | 4/5 | 4/11 | 4/16 | 100 | 7 |
| 03-001-507 | S | 3/26 | 4 | 3/28 | 4/5 | 4/17 | 8 | 4/8 | 4/12 | 4/20 | 100 | 7 |
| 03-001-958 | S | 3/24 | 2 | 3/27 | 4/4 | 4/13 | 7 | 4/7 | 4/12 | 4/16 | | 5 |
| 03-001-977 | S | 4/4 | 13 | 4/19 | 4/23 | 5/1 | 6 | 4/12 | 4/16 | 4/19 | 100 | 7 |
| 03-001-3395 | S | 4/1 | 10 | 4/15 | 4/20 | 4/26 | 4 | 4/5 | 4/10 | 4/15 | | 7 |

[a]Days after Payne leafing date at Davis
[b]1=low, 9=high

**Table 2. Cultivar and Selection Harvest Evaluations at Davis (Fall 2009)**

| | | Harvest | | | Shell | | | Average Wt. | | | | | Color % | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | [a]Seedling or Graft | 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 | G | 9/14 | 0 | 161 | 5 | 5 | 1.4 | 13.7 | 7.0 | 51.1 | 5 | 5 | 0 | 75 | 25 | 0 |
| Hartley | G | 10/4 | 20 | 164 | 6 | 7 | 2 | 18.0 | 8.2 | 45.6 | 4 | 5 | 67 | 22 | 11 | 0 |
| Vina | G | 9/22 | 8 | 161 | 5 | 5 | 1.3 | 14.9 | 7.6 | 51.2 | 5 | 5 | 0 | 90 | 10 | 0 |
| Serr | G | 9/18 | 4 | 165 | 5 | 5 | 1.2 | 16.2 | 9.5 | 58.6 | 6 | 5 | 0 | 100 | 0 | 0 |
| Chandler | G | 10/8 | 24 | 166 | 5 | 5 | 1.4 | 15.7 | 7.8 | 49.6 | 5 | 4 | 100 | 0 | 0 | 0 |
| Howard | G | 9/27 | 13 | 160 | 5 | 5 | 1.5 | 13.7 | 6.8 | 49.5 | 6 | 5 | 80 | 20 | 0 | 0 |
| Tulare | G | 10/3 | 19 | 170 | 5 | 5 | 1.2 | 16.6 | 8.8 | 53.3 | 5 | 5 | 0 | 100 | 0 | 0 |
| Sexton | G | 10/5 | 21 | 179 | 5 | 6 | 1.7 | 18.8 | 10.2 | 54.3 | 6 | 5 | 33 | 67 | 0 | 0 |
| Gillet | G | 9/26 | 12 | 177 | 3 | 5 | 1.3 | 18.3 | 9.1 | 49.8 | 4 | 5 | 0 | 90 | 10 | 0 |
| Forde | G | 10/10 | 26 | 185 | 5 | 5 | 1.4 | 18.1 | 9.8 | 54.2 | 5 | 4 | 33 | 67 | 0 | 0 |
| Ivanhoe | G | 9/10 | -4 | 168 | 5 | 5 | 1.3 | 13.2 | 7.3 | 55.0 | 5 | 5 | 0 | 80 | 20 | 0 |
| **Selections** | | | | | | | | | | | | | | | | |
| 59-124 | G | 9/15 | 1 | 164 | 5 | 7 | 1.4 | 18.0 | 9.6 | 53.6 | 7 | 5 | 0 | 100 | 0 | 0 |
| 64-057 | G | 9/28 | 14 | 178 | 4 | 4 | 1.2 | 19.8 | 10.4 | 52.6 | 4 | 4 | 60 | 40 | 0 | 0 |
| 90-027-21 | G | 9/19 | 5 | 164 | 5 | 7 | 1.7 | 16.7 | 8.2 | 49.4 | 6 | 5 | 0 | 70 | 30 | 0 |
| 90-027-23 | G | 9/23 | 9 | 157 | 5 | 6 | 1.3 | 14.6 | 7.6 | 52.3 | 6 | 5 | 10 | 90 | 0 | 0 |
| 91-077-6 | G | 9/18 | 4 | 159 | 5 | 4 | 1.3 | 17.1 | 9.6 | 55.9 | 4 | 4 | 0 | 90 | 10 | 0 |
| 91-077-40 | G | 9/27 | 13 | 178 | 6 | 5 | 1.3 | 15.8 | 8.2 | 52.0 | 6 | 4 | 0 | 78 | 22 | 0 |
| 91-090-41 | G | 10/2 | 18 | 165 | 5 | 5 | 1.2 | 13.3 | 7.0 | 52.8 | 5 | 4 | 13 | 75 | 13 | 0 |

[a] S = seedling, G= grafted
[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 2. Cultivar and Selection Harvest Evaluations at Davis (Fall 2009) – (cont.)**

| | | Harvest | | | Shell | | | Average Wt. | | | | | Color % | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | [a]Seedling or Graft | 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 |
| 93-028-20 | G | 9/25 | 11 | 164 | 5 | 5 | 1.3 | 16.4 | 9.4 | 57.1 | 5 | 4 | 20 | 80 | 0 | 0 |
| 94-019-85 | G | 9/17 | 3 | 167 | 5 | 5 | 1.2 | 15.5 | 9.3 | 60.2 | 7 | 5 | 0 | 70 | 30 | 0 |
| 94-020-35 | G | 9/23 | 9 | 170 | 6 | 7 | 1.6 | 18.8 | 10.0 | 53.1 | 7 | 6 | 0 | 90 | 0 | 10 |
| 95-007-13 | G | 9/15 | 1 | 159 | 5 | 5 | 1.2 | 18.2 | 10.7 | 58.7 | 6 | 4 | 11 | 78 | 11 | 0 |
| 95-011-16 | G | 9/26 | 12 | 167 | 5 | 5 | 1.3 | 15.4 | 8.8 | 57.4 | 7 | 5 | 20 | 80 | 0 | 0 |
| 95-026-16 | G | 9/16 | 2 | 169 | 5 | 5 | 1.4 | 14.4 | 7.8 | 54.4 | 7 | 6 | 90 | 0 | 10 | 0 |
| 95-026-22 | G | 9/22 | 8 | 160 | 6 | 7 | 1.7 | 20.6 | 10.2 | 49.5 | 7 | 6 | 0 | 100 | 0 | 0 |
| 96-013-13 | G | 9/30 | 16 | 183 | 5 | 6 | 1.5 | 14.0 | 7.6 | 53.9 | 5 | 4 | 50 | 50 | 0 | 0 |
| 97-003-11 | G | 10/3 | 19 | 173 | 4 | 5 | 1.2 | 16.7 | 9.9 | 59.6 | 5 | 5 | 0 | 100 | 0 | 0 |
| 97-003-23 | G | 10/6 | 22 | 168 | 5 | 5 | 1.3 | 14.9 | 8.0 | 53.6 | 4 | 4 | 0 | 100 | 0 | 0 |
| 97-003-79 | G | 9/25 | 11 | 164 | 5 | 5 | 1.3 | 19.9 | 10.5 | 52.5 | 5 | 5 | 0 | 100 | 0 | 0 |
| 98-002-129 | G | 9/20 | 6 | 157 | 5 | 5 | 1.3 | 20.1 | 11.3 | 56.1 | 4 | 4 | 30 | 70 | 0 | 0 |
| 98-003-54 | G | 10/3 | 19 | 168 | 5 | 7 | 2 | 20.1 | 9.4 | 46.9 | 5 | 5 | 78 | 22 | 0 | 0 |
| 00-005-30 | S | 9/9 | -5 | 163 | 6 | 7 | 1.7 | 20.1 | 10.7 | 52.9 | 6 | 4 | 40 | 50 | 0 | 10 |
| 00-005-44 | S | 9/18 | 4 | 161 | 5 | 6 | 1.4 | 16.8 | 7.8 | 46.0 | 5 | 4 | | 50 | 0 | 50 |
| 00-005-149 | S | 9/8 | -6 | 155 | 5 | 6 | 1.4 | 16.2 | 8.6 | 53.1 | 6 | 4 | 0 | 0 | 100 | 0 |
| 00-005-153 | S | 9/22 | 8 | 153 | 6 | 7 | 1.8 | 19.7 | 9.3 | 47.1 | 5 | 5 | 30 | 70 | 0 | 0 |
| 00-006-48 | S | 10/6 | 22 | 167 | 5 | 5 | 1.4 | 14.3 | 6.0 | 41.9 | 5 | 5 | 100 | 0 | 0 | 0 |
| 00-006-227 | S | 9/22 | 8 | 166 | 6 | 5 | 1.2 | 14.3 | 8.6 | 60.3 | 6 | 5 | 100 | 0 | 0 | 0 |
| 01-007-2 | S | 9/8 | -6 | 155 | 4 | 5 | 1.2 | 17.4 | 10.1 | 58.3 | 5 | 4 | 0 | 100 | 0 | 0 |
| 01-007-3 | S | 9/27 | 13 | 160 | 6 | 5 | 1.3 | 17.2 | 9.0 | 52.2 | 5 | 5 | 0 | 80 | 20 | 0 |

[a] S = seedling, G= grafted
[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 2. Cultivar and Selection Harvest Evaluations at Davis (Fall 2009) – (cont.)**

| | | Harvest | | | Shell | | | Average Wt. | | | | | Color % | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | [a]Seedling or Graft | 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 |
| 01-009-10 | S | 9/24 | 10 | 155 | 4 | 5 | 1.4 | 16.9 | 8.0 | 47.3 | 5 | 5 | 10 | 50 | 30 | 10 |
| 01-009-14 | S | 9/24 | 10 | 156 | 4 | 5 | 1.3 | 14.7 | 7.1 | 48.3 | 4 | 5 | 0 | 75 | 25 | 0 |
| 01-016-11 | S | 9/25 | 11 | 167 | 5 | 5 | 1.6 | 19.4 | 10.5 | 54.0 | 6 | 4 | 90 | 10 | 0 | 0 |
| 03-001-507 | S | 9/27 | 13 | 168 | 5 | 5 | 1.3 | 16.8 | 10.0 | 59.4 | 5 | 4 | 20 | 80 | 0 | 0 |
| 03-001-958 | S | 9/17 | 3 | 158 | 5 | 5 | 1.2 | 13.6 | 7.4 | 54.1 | 5 | 5 | 10 | 90 | 0 | 0 |
| 03-001-977 | S | 9/27 | 13 | 164 | 6 | 5 | 1.2 | 13.7 | 8.0 | 58.1 | 5 | 3 | 22 | 78 | 0 | 0 |

[a] S = seedling, G= grafted
[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 3. 2009 UCD Cultivar/Selection Evaluations by Diamond Walnut Growers Inc.

| Location | Cultivar | Sample Wt | # Nuts per sample | Avg nut wt (g) | % Large | % Med | % Baby | % Large Sound | % Stain | % Broken | % Adh Hull | % External Damage |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Davis | Chandler | 1001 | 65 | 15.40 | 100.0% | 0.0% | 0.0% | 98.5% | 0.0% | 0.0% | 0.0% | 0.0% |
| Davis | Howard | 1002 | 72 | 13.92 | 100.0% | 0.0% | 0.0% | 96.4% | 0.0% | 0.0% | 0.0% | 0.0% |
| Davis | Tulare | 1002 | 61 | 16.43 | 100.0% | 0.0% | 0.0% | 94.5% | 3.3% | 0.0% | 0.0% | 3.3% |
| Davis | Sexton | 1000 | 58 | 17.24 | 100.0% | 0.0% | 0.0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Davis | Forde | 1002 | 60 | 16.70 | 100.0% | 0.0% | 0.0% | 99.5% | 0.0% | 0.0% | 0.0% | 0.0% |
| Davis | Ivanhoe | 1001 | 84 | 11.92 | 100.0% | 0.0% | 0.0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Davis | 91-077-6 | 1000 | 60 | 16.67 | 100.0% | 0.0% | 0.0% | 99.3% | 0.0% | 0.0% | 0.0% | 0.0% |
| Davis | 91-090-41 | 1002 | 85 | 11.79 | 100.0% | 0.0% | 0.0% | 93.5% | 0.0% | 0.0% | 0.0% | 0.0% |
| Davis | 93-028-20 | 1001 | 62 | 16.15 | 100.0% | 0.0% | 0.0% | 97.8% | 0.0% | 0.0% | 0.0% | 0.0% |
| Davis | 95-007-13 | 1002 | 61 | 16.43 | 100.0% | 0.0% | 0.0% | 97.1% | 0.0% | 0.0% | 0.0% | 0.0% |
| Davis | 96-026-16 | 1002 | 71 | 14.11 | 100.0% | 0.0% | 0.0% | 97.9% | 0.0% | 0.0% | 0.0% | 0.0% |
| Davis | 03-001-665 | 1000 | 75 | 13.33 | 100.0% | 0.0% | 0.0% | 96.6% | 0.0% | 1.3% | 0.0% | 1.3% |
| Davis | 03-001-1098 | 1003 | 67 | 14.97 | 100.0% | 0.0% | 0.0% | 98.6% | 0.0% | 0.0% | 0.0% | 0.0% |
| Chico | Payne | 645 | 61 | 10.57 | 96.7% | 3.3% | 0.0% | 97.4% | 0.0% | 0.0% | 0.0% | 0.0% |
| Chico | Hartley | 594 | 51 | 11.65 | 100.0% | 0.0% | 0.0% | 91.9% | 0.0% | 0.0% | 0.0% | 0.0% |
| Chico | Vina | 526 | 61 | 8.62 | 68.9% | 29.5% | 1.6% | 70.2% | 0.0% | 0.0% | 0.0% | 0.0% |
| Chico | Chandler | 1001 | 91 | 11.00 | 93.4% | 6.6% | 0.0% | 94.4% | 0.0% | 0.0% | 0.0% | 0.0% |
| Chico | Sexton | 1001 | 74 | 13.53 | 100.0% | 0.0% | 0.0% | 97.3% | 0.0% | 0.0% | 0.0% | 0.0% |
| Chico | Gillet | 1001 | 63 | 15.89 | 100.0% | 0.0% | 0.0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Chico | Forde | 1002 | 70 | 14.31 | 95.7% | 2.9% | 1.4% | 96.8% | 0.0% | 0.0% | 0.0% | 0.0% |
| Chico | Ivanhoe | 695 | 62 | 11.21 | 98.4% | 1.6% | 0.0% | 95.1% | 0.0% | 0.0% | 0.0% | 0.0% |
| Chico | 91-090-41 | 582 | 62 | 9.39 | 98.4% | 0.0% | 1.6% | 85.2% | 0.0% | 0.0% | 0.0% | 0.0% |
| Chico | 93-028-20 | 1001 | 86 | 11.64 | 100.0% | 0.0% | 0.0% | 92.7% | 3.5% | 0.0% | 0.0% | 3.5% |
| Chico | 94-019-85 | 648 | 62 | 10.45 | 100.0% | 0.0% | 0.0% | 91.8% | 0.0% | 0.0% | 0.0% | 0.0% |
| Chico | 95-011-16 | 1002 | 76 | 13.18 | 100.0% | 0.0% | 0.0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Chico | 95-007-13 | 808 | 60 | 13.47 | 100.0% | 0.0% | 0.0% | 95.4% | 0.0% | 0.0% | 0.0% | 0.0% |

Table 3. 2009 UCD Cultivar/Selection Evaluations by Diamond Walnut Growers Inc.

| Location | Cultivar | % Insect | % Mold | % Shrivel | % Offgrade | % Edible Yield | % Total Yield | Extra Light | Light | Light Amber | Amber | RLI | Relative Value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Davis | Chandler | 1.5% | 0.0% | 0.0% | 1.7% | 46.5% | 47.3% | 88.4% | 8.6% | 3.0% | 0.0% | 55.2 | 0.93 |
| Davis | Howard | 1.4% | 0.0% | 4.2% | 2.0% | 48.8% | 49.8% | 69.1% | 22.3% | 8.6% | 0.0% | 56.3 | 1.00 |
| Davis | Tulare | 4.9% | 0.0% | 1.6% | 5.0% | 49.5% | 52.1% | 0.0% | 62.1% | 34.9% | 3.0% | 49.2 | 0.89 |
| Davis | Sexton | 0.0% | 0.0% | 0.0% | 0.0% | 54.6% | 54.6% | 87.2% | 8.8% | 4.0% | 0.0% | 54.5 | 1.08 |
| Davis | Forde | 0.0% | 0.0% | 1.7% | 0.2% | 54.0% | 54.1% | 23.8% | 41.2% | 28.3% | 6.7% | 51.1 | 1.00 |
| Davis | Ivanhoe | 0.0% | 0.0% | 0.0% | 0.0% | 55.1% | 55.1% | 49.8% | 44.7% | 5.4% | 0.0% | 53.9 | 1.08 |
| Davis | 91-077-6 | 0.0% | 0.0% | 1.7% | 0.2% | 53.3% | 53.4% | 72.6% | 22.3% | 5.1% | 0.0% | 53.8 | 1.04 |
| Davis | 91-090-41 | 0.0% | 0.0% | 11.8% | 4.2% | 54.3% | 56.7% | 81.1% | 9.2% | 6.4% | 3.3% | 55.3 | 1.09 |
| Davis | 93-028-20 | 0.0% | 0.0% | 4.8% | 0.5% | 56.2% | 56.5% | 73.7% | 20.8% | 5.5% | 0.0% | 55.8 | 1.14 |
| Davis | 95-007-13 | 3.3% | 0.0% | 1.6% | 3.5% | 54.8% | 56.8% | 69.9% | 19.9% | 10.2% | 0.0% | 55.5 | 1.11 |
| Davis | 96-026-16 | 1.4% | 0.0% | 1.4% | 1.5% | 51.0% | 51.8% | 18.0% | 34.6% | 31.7% | 15.7% | 52.5 | 0.97 |
| Davis | 03-001-665 | 1.3% | 0.0% | 2.7% | 1.9% | 56.6% | 57.7% | 62.2% | 33.4% | 4.4% | 0.0% | 54.9 | 1.13 |
| Davis | 03-001-1098 | 0.0% | 0.0% | 3.0% | 0.9% | 56.0% | 56.5% | 80.6% | 16.2% | 3.2% | 0.0% | 56.3 | 1.15 |
| Chico | Payne | 0.0% | 0.0% | 0.0% | 0.0% | 50.4% | 50.4% | 41.5% | 52.3% | 6.2% | 0.0% | 53.3 | 0.98 |
| Chico | Hartley | 0.0% | 3.9% | 5.9% | 6.9% | 38.4% | 41.2% | 0.0% | 70.2% | 27.2% | 2.6% | 48.7 | 0.68 |
| Chico | Vina | 0.0% | 0.0% | 4.9% | 0.9% | 42.8% | 43.2% | 0.0% | 90.2% | 9.8% | 0.0% | 49.7 | 0.77 |
| Chico | Chandler | 0.0% | 0.0% | 0.0% | 0.0% | 50.0% | 50.0% | 93.6% | 6.4% | 0.0% | 0.0% | 55.9 | 1.02 |
| Chico | Sexton | 0.0% | 1.4% | 2.7% | 1.3% | 53.0% | 53.7% | 38.8% | 40.7% | 17.9% | 2.6% | 53.2 | 1.03 |
| Chico | Gillet | 0.0% | 0.0% | 0.0% | 0.0% | 47.2% | 47.2% | 51.3% | 43.2% | 5.5% | 0.0% | 53.8 | 0.92 |
| Chico | Forde | 0.0% | 0.0% | 1.4% | 0.2% | 50.1% | 50.2% | 60.6% | 22.7% | 12.0% | 4.8% | 54.3 | 0.99 |
| Chico | Ivanhoe | 1.6% | 0.0% | 3.2% | 2.2% | 51.9% | 53.1% | 64.0% | 19.9% | 10.2% | 5.8% | 56.1 | 1.06 |
| Chico | 91-090-41 | 4.8% | 6.5% | 3.2% | 11.6% | 47.3% | 53.4% | 0.0% | 59.3% | 29.1% | 11.6% | 49.4 | 0.85 |
| Chico | 93-028-20 | 0.0% | 5.8% | 0.0% | 6.2% | 50.0% | 53.3% | 21.2% | 56.9% | 22.0% | 0.0% | 52.0 | 0.95 |
| Chico | 94-019-85 | 1.6% | 1.6% | 9.7% | 6.4% | 51.5% | 55.1% | 25.1% | 48.8% | 18.0% | 8.1% | 52.9 | 0.99 |
| Chico | 95-011-16 | 0.0% | 0.0% | 0.0% | 0.0% | 53.4% | 53.4% | 57.9% | 38.5% | 3.6% | 0.0% | 54.2 | 1.05 |
| Chico | 95-007-13 | 0.0% | 5.0% | 0.0% | 4.6% | 51.2% | 53.7% | 29.7% | 55.8% | 10.9% | 3.6% | 52.8 | 0.98 |

Table 3. 2009 UCD Cultivar/Selection Evaluations by Diamond Walnut Growers Inc.

| Location | Cultivar | Sample Wt | # Nuts per sample | Avg nut wt (g) | % Large | % Med | % Baby | % Large Sound | % Stain | % Broken | % Adh Hull | % External Damage |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KAC | Payne | 1002 | 99 | 10.12 | 81.8% | 15.2% | 3.0% | 85.5% | 0.0% | 0.0% | 0.0% | 0.0% |
| KAC | Hartley | 422 | 34 | 12.41 | 100.0% | 0.0% | 0.0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| KAC | Hartley | 1002 | 80 | 12.53 | 92.5% | 7.5% | 0.0% | 93.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| KAC | Chandler | 1001 | 81 | 12.36 | 95.1% | 3.7% | 1.2% | 96.3% | 0.0% | 0.0% | 0.0% | 0.0% |
| KAC | Sexton | 1003 | 61 | 16.44 | 100.0% | 0.0% | 0.0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| KAC | Gillet | 1000 | 58 | 17.24 | 100.0% | 0.0% | 0.0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| KAC | Forde | 1002 | 61 | 16.43 | 100.0% | 0.0% | 0.0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| KAC | Ivanhoe | 1000 | 73 | 13.7 | 100% | 0% | 0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| KAC | 91-077-40 | 1003 | 60 | 16.7 | 100% | 0% | 0% | 99.3% | 0.0% | 0.0% | 0.0% | 0.0% |
| KAC | 92-070-12 | 1002 | 82 | 12.2 | 100% | 0% | 0% | 99.5% | 0.0% | 0.0% | 0.0% | 0.0% |
| KAC | 93-028-20 | 1001 | 68 | 14.7 | 100% | 0% | 0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| KAC | 94-019-85 | 1001 | 76 | 13.2 | 100% | 0% | 0% | 94.4% | 0.0% | 0.0% | 0.0% | 0.0% |
| KAC | 95-011-16 | 1004 | 76 | 13.2 | 100% | 0% | 0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| KAC | 95-007-13 | 1000 | 65 | 15.4 | 100% | 0% | 0% | 99.4% | 0.0% | 0.0% | 0.0% | 0.0% |
| KAC | 95-026-22 | 1004 | 55 | 18.3 | 100% | 0% | 0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Woodland | Chandler | 1003 | 69 | 14.5 | 100% | 0% | 0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Woodland | Howard | 1004 | 65 | 15.4 | 100% | 0% | 0% | 96.3% | 0.0% | 0.0% | 0.0% | 0.0% |
| Woodland | Sexton | 1003 | 72 | 13.9 | 100% | 0% | 0% | 96.5% | 0.0% | 0.0% | 0.0% | 0.0% |
| Woodland | Gillet | 1002 | 73 | 13.7 | 100% | 0% | 0% | 98.8% | 0.0% | 0.0% | 0.0% | 0.0% |
| Woodland | Forde | 1000 | 59 | 16.9 | 100% | 0% | 0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Woodland | 90-027-21 | 1002 | 74 | 13.5 | 99% | 1% | 0% | 99.2% | 0.0% | 0.0% | 0.0% | 0.0% |
| Woodland | 95-011-16 | 1003 | 75 | 13.4 | 100% | 0% | 0% | 98.5% | 0.0% | 0.0% | 0.0% | 0.0% |
| Durham | Howard | 1002 | 76 | 13.2 | 100% | 0% | 0% | 99.4% | 0.0% | 0.0% | 0.0% | 0.0% |
| Durham | Forde | 1000 | 75 | 13.3 | 100% | 0% | 0% | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Contra Costa | Howard | 1000 | 69 | 14.5 | 100% | 0% | 0% | 98.6% | 0.0% | 0.0% | 0.0% | 0.0% |
| Contra Costa | 92-016-1 | 1001 | 76 | 13.2 | 92% | 3% | 5% | 91.4% | 0.0% | 0.0% | 0.0% | 0.0% |
| Contra Costa | 97-027-55 | 1003 | 92 | 10.9 | 78% | 14% | 8% | 75.3% | 2.2% | 0.0% | 0.0% | 2.2% |

Table 3. 2009 UCD Cultivar/Selection Evaluations by Diamond Walnut Growers Inc.

| Location | Cultivar | % Insect | % Mold | % Shrivel | % Offgrade | % Edible Yield | % Total Yield | Extra Light | Light | Light Amber | Amber | RLI | Relative Value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KAC | Payne | 1.0% | 1.0% | 6.1% | 3.6% | 50.4% | 52.3% | 41.8% | 45.3% | 7.9% | 5.0% | 51.5 | 0.94 |
| KAC | Hartley | 0.0% | 0.0% | 0.0% | 0.0% | 46.4% | 46.4% | 75.5% | 18.4% | 6.1% | 0.0% | 55.2 | 0.93 |
| KAC | Hartley | 0.0% | 0.0% | 2.5% | 0.2% | 41.5% | 41.6% | 24.5% | 48.6% | 20.9% | 6.0% | 50.1 | 0.76 |
| KAC | Chandler | 0.0% | 1.2% | 1.2% | 1.1% | 45.8% | 46.3% | 47.8% | 41.7% | 10.5% | 0.0% | 55.6 | 0.93 |
| KAC | Sexton | 0.0% | 0.0% | 0.0% | 0.0% | 52.3% | 52.3% | 73.3% | 14.9% | 6.7% | 5.1% | 55.2 | 1.05 |
| KAC | Gillet | 0.0% | 0.0% | 0.0% | 0.0% | 46.5% | 46.5% | 0.0% | 50.3% | 40.6% | 9.0% | 44.5 | 0.75 |
| KAC | Forde | 0.0% | 0.0% | 0.0% | 0.0% | 49.7% | 49.7% | 69.1% | 19.3% | 11.6% | 0.0% | 55.7 | 1.01 |
| KAC | Ivanhoe | 0.0% | 0.0% | 0.0% | 0.0% | 54.4% | 54.4% | 60% | 24% | 11% | 5% | 55.2 | 1.09 |
| KAC | 91-077-40 | 0.0% | 0.0% | 1.7% | 0.4% | 49.2% | 49.4% | 0% | 54% | 26% | 20% | 47.9 | 0.86 |
| KAC | 92-070-12 | 0.0% | 0.0% | 1.2% | 0.2% | 51.6% | 51.7% | 34% | 31% | 31% | 4% | 53.3 | 1.00 |
| KAC | 93-028-20 | 0.0% | 0.0% | 0.0% | 0.0% | 54.1% | 54.1% | 39% | 45% | 13% | 2% | 54.1 | 1.07 |
| KAC | 94-019-85 | 5.3% | 0.0% | 2.6% | 4.4% | 51.8% | 54.2% | 37% | 38% | 22% | 4% | 53.5 | 1.01 |
| KAC | 95-011-16 | 0.0% | 0.0% | 0.0% | 0.0% | 51.6% | 51.6% | 74% | 21% | 3% | 2% | 55.6 | 1.04 |
| KAC | 95-007-13 | 0.0% | 0.0% | 1.5% | 0.2% | 54.3% | 54.4% | 0% | 57% | 31% | 12% | 49.4 | 0.98 |
| KAC | 95-026-22 | 0.0% | 0.0% | 0.0% | 0.0% | 47.0% | 47.0% | 49% | 36% | 14% | 0% | 54.5 | 0.93 |
| Woodland | Chandler | 0.0% | 0.0% | 0.0% | 0.0% | 50.5% | 50.5% | 52% | 42% | 6% | 0% | 52.7 | 0.97 |
| Woodland | Howard | 0.0% | 4.6% | 0.0% | 4.4% | 47.8% | 50.0% | 24% | 57% | 19% | 0% | 49.8 | 0.87 |
| Woodland | Sexton | 1.4% | 1.4% | 1.4% | 3.0% | 52.1% | 53.7% | 65% | 23% | 12% | 0% | 54.6 | 1.04 |
| Woodland | Gillet | 0.0% | 1.4% | 0.0% | 1.1% | 53.1% | 53.7% | 29% | 59% | 12% | 0% | 53.3 | 1.03 |
| Woodland | Forde | 0.0% | 0.0% | 0.0% | 0.0% | 53.2% | 53.2% | 0% | 64% | 33% | 3% | 50.0 | 0.97 |
| Woodland | 90-027-21 | 0.0% | 0.0% | 0.0% | 0.0% | 48.9% | 48.9% | 35% | 53% | 12% | 0% | 56.3 | 1.00 |
| Woodland | 95-011-16 | 0.0% | 0.0% | 2.7% | 0.8% | 51.9% | 52.3% | 45% | 42% | 7% | 6% | 53.0 | 1.00 |
| Durham | Howard | 0.0% | 0.0% | 1.3% | 0.2% | 52.7% | 52.8% | 20% | 45% | 35% | 0% | 51.9 | 1.00 |
| Durham | Forde | 0.0% | 8.0% | 0.0% | 7.7% | 50.0% | 54.2% | 32% | 53% | 16% | 0% | 53.9 | 0.98 |
| Contra Costa | Howard | 0.0% | 1.4% | 0.0% | 1.6% | 50.3% | 51.1% | 29% | 63% | 8% | 0% | 51.0 | 0.93 |
| Contra Costa | 92-016-1 | 1.3% | 0.0% | 3.9% | 2.1% | 47.4% | 48.4% | 19% | 62% | 18% | 0% | 52.6 | 0.91 |
| Contra Costa | 97-027-55 | 3.3% | 4.3% | 1.1% | 7.3% | 44.1% | 47.6% | 0% | 69% | 26% | 5% | 48.5 | 0.78 |

Table 4. Male and female bloom dates at UC Davis, 2009. (In order of harvest date.)

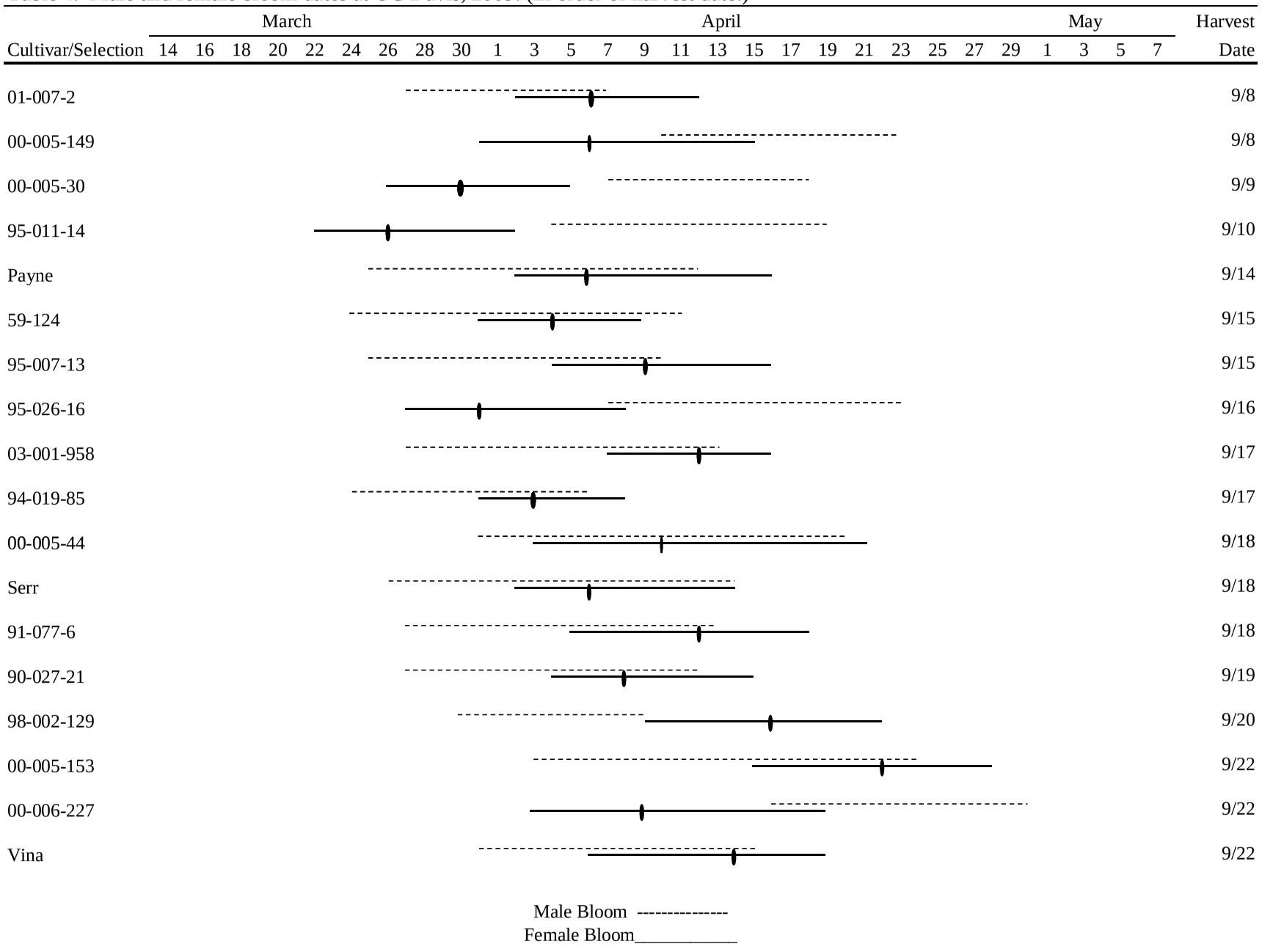


Table 4. Male and female bloom dates at UC Davis, 2009. (In order of harvest date.)

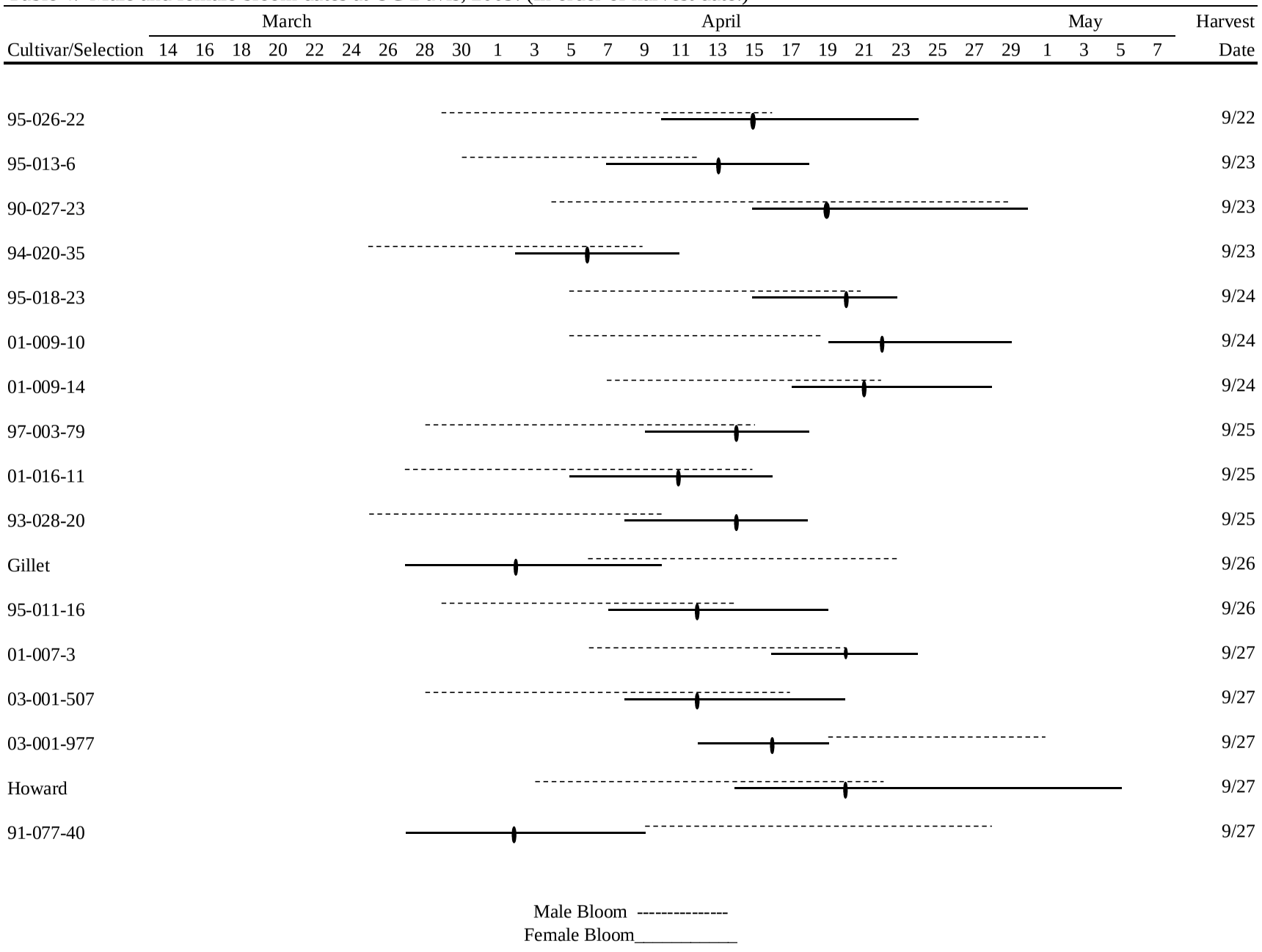


Table 4. Male and female bloom dates at UC Davis, 2009. (In order of harvest date.)

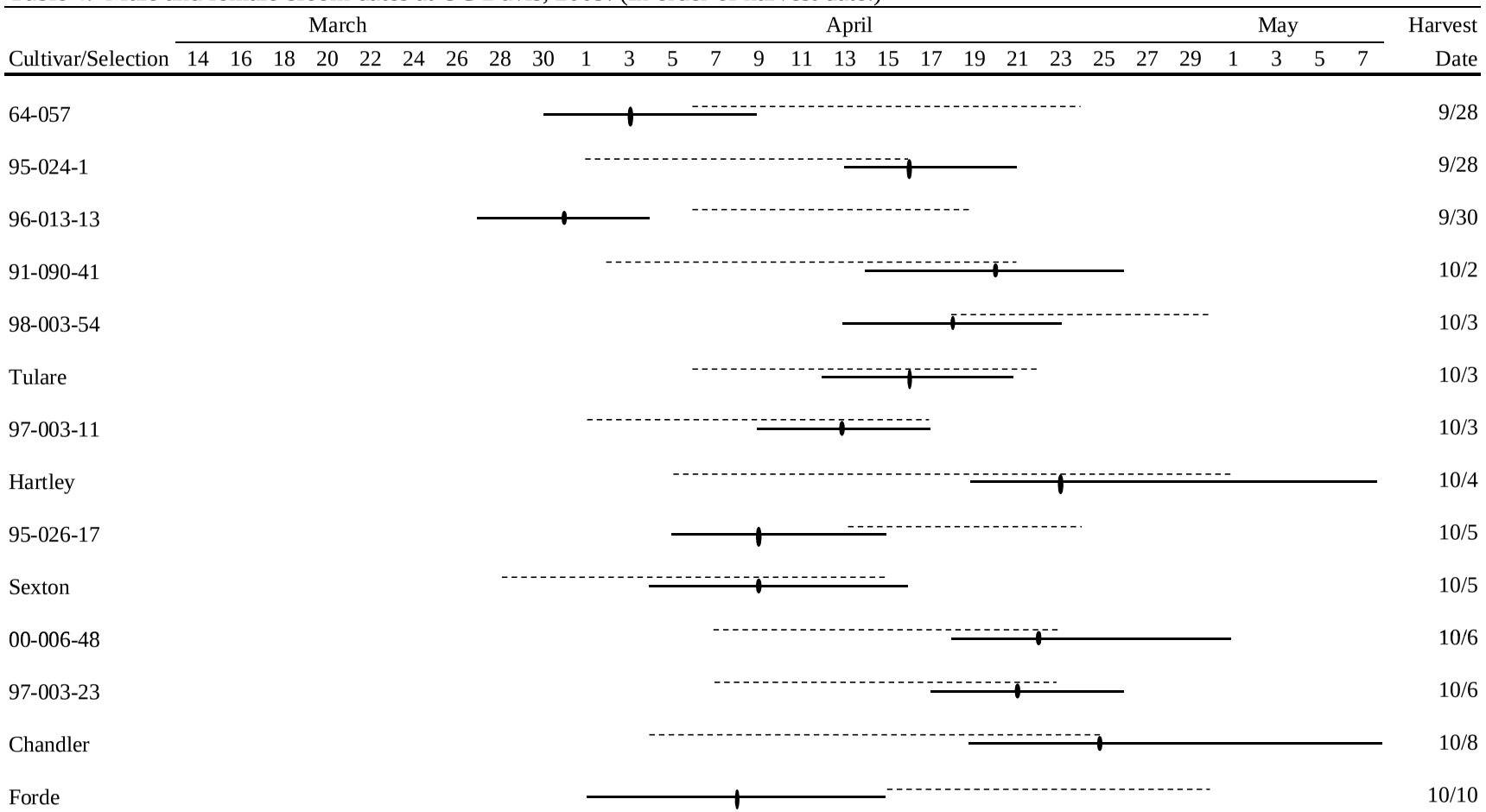


Table 5. 2009 Pistillate Flower Abscission counts following either pollen application or natural pollination controls.

| | | | Artificial Pollination | | | Natural Pollination | | |
|---|---|---|---|---|---|---|---|---|
| Variety | Pollen Date | Count Date | Total Flowers | Flowers Dropped | % Dropped | Total Flowers | Flowers Dropped | % Dropped |
| Gillet | 4/2 | 4/23 | 100 | 7 | 7 | 100 | 5 | 5 |
| Ivanhoe | 3/28 | 4/18 | 100 | 22 | 22 | 92 | 22 | 24 |
| Sinensis 5 | 3/26 | 4/16 | 100 | 24 | 24 | 100 | 45 | 45 |
| Forde | 4/7 | 4/28 | 100 | 30 | 30 | 100 | 23 | 23 |
| Sexton | 4/8 | 4/29 | 104 | 38 | 37 | 98 | 6 | 6 |
| 85-8 | 3/26 | 4/16 | 100 | 41 | 41 | 96 | 21 | 22 |
| Tulare | 4/13 | 5/4 | 100 | 46 | 46 | 100 | 24 | 24 |
| 0-20-1072 | 4/13 | 5/4 | 100 | 48 | 48 | 98 | 47 | 48 |
| Marchettti | 4/12 | 5/3 | 102 | 60 | 59 | 100 | 37 | 37 |
| Sunland | 4/12 | 5/3 | 104 | 75 | 72 | 98 | 29 | 30 |
| Eureka | 4/12 | 5/3 | 90 | 65 | 72 | 92 | 40 | 43 |
| PI 159568 | 4/10 | 5/1 | 42 | 34 | 81 | 46 | 25 | 54 |
| Payne | 4/11 | 5/2 | 100 | 81 | 81 | 104 | 27 | 26 |
| Cheinovo | 4/13 | 5/4 | 98 | 86 | 88 | 100 | 70 | 70 |
| Serr | 4/8 | 4/29 | 102 | 98 | 96 | 100 | 70 | 70 |