WALNUT IMPROVEMENT PROGRAM 2010

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ABSTRACT

The goal of the Walnut Improvement Program is to provide new walnut cultivars for the California walnut industry while developing new knowledge about the genetics of the crop and maintaining a breeding population. We also work with collaborators to develop and propagate new rootstocks. This year we have 41 scion selections and over 5,300 seedlings under evaluation in the breeding program. The primary goal is to develop cultivars with early harvest dates and good kernel color. The new variety 'Ivanhoe', formerly selection 95-11-14, was released this year and several advanced selections with Payne-time to mid-season harvest dates are promising. More than 1200 backcross seedlings are under evaluation for 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. Rootstock breeding to begin development of nematode resistant rootstocks was initiated and methods of screening for pest and disease resistance using tissue cultured material, particularly for nematodes, were developed. 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 improved 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, crown gall and *Armillaria*. This includes rootstock breeding and genetic enhancement and is done in conjunction with the clonal rootstocks improvement project.

- New technologies that increase the efficiency of breeding and the range 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 2010 we returned to making controlled crosses instead of utilizing open-pollinated seed. This approach results in a lower number of seedlings produced annually and increases the resources needed 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 2007-2010 seasons place priority on crossing the best high quality selections with the earliest harvesting selections as shown in the tables below.

Seed from crosses is collected in the fall before nut drop and air dried before storing chilled until the end of harvest season. To ensure the highest possible germination, nuts are chipped open at the blossom end using a “Texas Nut Cracker” which opens a hole in the shell without damaging the embryo. Nuts are then immersed in cold, slowly running, water for 2 days before planting in flats of vermiculite in the greenhouse. As nuts begin to germinate they are planted in large tree tubes in containing UC Mix for growth in the greenhouse. The resulting seedlings are chilled for 2 months in a cold room to give them their first year of dormancy. In the spring the dormant seedlings are planted in a nursery bed for a year. For many years Burchell Nursery has generously grown these seedlings and then dug the trees for orchard planting at UC Davis.

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 an 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.

Seedling trees from 2007-2009 crosses grown for planting and evaluation at Davis.

	90-031-12	91-077-6	91-077-40	91-090-41	91-096-3	92-080-11	93-028-20	94-019-29	94-019-45	94-019-85	94-020-5	95-007-13	Ivanhoe	95-011-16	95-011-22	95-018-23	95-026-16	95-026-17	95-026-22	Forde
90-031-12 **Precocity, color**		28			2	37				12	38	63				24				
91-077-6 **Early, yield**							45	66	43								120	36		
91-077-40 **Yield, precocity**							22								40					5
91-090-41 **Color, kernel%, halves**							29	35	54	2		103	80	3	15				5	
91-096-3 **blight resistance, color**							67	19	43	28		52	40	8	3		8		11	93
92-080-11 **Early, yield**							72	37	37						20		10		18	43
93-028-20 **color, shell, blight res.**										38	13	48	5	36	17	58	72			
94-019-29 **Yield, harvest date**											16		5							
94-019-45 **Yield, short season**										33	10		57							
94-019-85 **Early, Hartley shape**												129			33		190	16		
94-020-5 **Early, blight res., color**															22				19	
95-007-13 **Early, vigor, size, shell**													40	42	57		12		66	115
Ivanhoe **Very early, color, yield**															3		30			14
95-011-16 **Mid season, quality**																				
95-011-22 **Yield, color**																20				
95-018-23 **Short season, early**																			3	
95-026-16 **Very early, blight res**																				
95-026-17 **Short season, color**																				
95-026-22 **Nut size, color**																				
Forde **Yield, color, fill**																				

Seed collected from 2010 crosses for germination and nursery planting in 2011.

	93-028-20	95-007-13	Ivanhoe	95-018-23	95-026-16	98-002-129	00-005-30	00-005-44	00-005-173	00-005-174	00-006-227	00-011-107	01-007-2	03-001-665	03-001-977	03-001-2357	03-001-2434
93-028-20 **color, shell, blight res.**			147					107									
95-007-13 **Early, vigor, size, shell**			86		27	166	25		90								
Ivanhoe **Very early, color, yield**				39	62	12	17	24	42	112	110	10	45	22	59	43	26
95-011-16 **Mid season, quality**						23										9	
00-005-44 **Early, yield**																68	

Promising individuals are repropagated into selection blocks (Chico, Kearney and Davis) and grower trials where evaluations continue. The off-campus selection blocks are managed by Bill Olson (Chico) and the Kearney Ag Station 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.

In addition to evaluating seedling of conventional crosses designed to produce new varieties for growers, we also continue to evaluate a large set of over 300 trees from a Chandler x Idaho cross designed to give significant segregation for traits of interest in evaluating varieties. The purpose of evaluating this set of tree is to be able to correlate the accumulated, phenology, yield, bearing habit, nut, and kernel trait data with unique DNA coding regions that can be used to develop markers. Once developed, the markers could then be used to speed selection by identifying seedlings likely to express desirable mature-tree traits while the seedlings are still very young. Accurate characterization of this large population is essential for potentially developing useful markers.

Backcross breeding for scion varieties resistant to cherry leafroll virus.

The backcross breeding project is designed to introduce genetic resistance to blackline disease from 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).

The fidelity of the marker used for selection has been improved by Sudhi Mysore but marker selection still 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 scion selections was attempted for a second year in cooperation with Janet Caprile and Sudhi Mysore (see Caprile report in this volume). CLRV-resistant selections 92-016-1, 94-022-24, 97-027-55, and a Howard control, grown in a Contra Costa County field trial near Oakley, CA were pollinated with Chico pollen obtained in 2009 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. Pollen was stored frozen for one year prior to use.

Another possible approach to preventing black line disease would be to use a gene silencing strategy, somewhat similar to method we have used to develop crown gall resistant rootstock, but in this case employing a virus-inhibiting interstock (see proposal by Sudhi Mysore). Acceptance this approach would be greatly improved by use of a male-sterile genotype to avoid any pollen production. In order to pursue this work, we would need somatic embryo cultures of a genotype that also exhibits a tolerant (English type) response to the presence of cherry leaf roll virus. Tolerant backcross selections, those that will not go forward in the resistant scion development program, meet both these requirements. Nuts were collected from one of these in the UC Davis patch testing block, selection 93-048-6, before the nuts reached maturity. Nuts were surface-sterilized and zygotic embryo cotyledons were introduced into tissue culture for growth on somatic embryo induction medium to initiate the appropriate somatic embryo cultures.

Rootstock improvement

Rootstock breeding is aimed at producing selections with genetic resistance to *Phytophthora*, nematodes, crown gall, Armillaria, and/or 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 several of these traits of interest are reported separately in this volume: nematodes - Mike McKenry; Phytophthora – Greg Browne; crown gall – Dan Kluepfel.

Rootstock crosses

In 2010, in cooperation with Mike McKenry, we initiated as set of crosses designed to produce hybrid rootstocks expressing resistance to lesion nematode. These crosses used pollen collected from Seedling #21, a lesion nematode-resistant open-pollinated seedling of USDA-ARS *Juglans cathayensis* accession DJUG 11.3. The DJUG 11.3 tree is located at Wolfskill in Block B, Row2, Tree 12, and is therefore referred to at times in these reports as “B2-12”. Crosses using pollen of #21 were made onto bagged flowers of two female parents. One of these, Serr, was chosen for its vigor and possible resistance to root-knot nematode, which may also indicate lesion nematode resistance. Use of an English parent was dictated by concerns about possible graft incompatibility of *Juglans cathayensis*. The second parent, Rawlins, was chosen as a *J. hindsii* genotype known to produce Paradox and based on experience using it as a parent in the past to produce paradox seedlings.

In June, when seeds were partially mature and again in the fall when seeds were mature but hulls were still intact, seeds were surface-sterilize and cut or cracked open in a laminar flow hood. Zygotic embryos were removed from the nuts and cultured on tissue culture media. Epicotyls or axilllary shoots emerging from embryos that germinated were excised and multiplied as microshoot cultures for clonal plant production.

Additional crosses using Serr as a pollen parent on two female parents, *J. cathayensis* accession DJUG 11.2 and *J. microcarpa* accession DJUG 29.11, were made this spring at the USDA-ARS Clonal Germplasm Repository Wolfskill facility by Dianne Velasco and Malli Aradhya. This fall we used a similar procedure to that outlined above to introduce zygotic embryos of the mature seed resulting from these crosses into culture for micropropagation, rooting, and plant production to develop clonal plants for use in crown gall, Phytophthora, and nematode testing.

Nematode resistance screening using in vitro rooted shoot cultures

For many years we have maintained an in vitro lesion nematode population under sterile conditions for testing new genes for nematode resistance. Since we were in the process of rooting in vitro microshoots of seedling #21 to produce plants for field testing, we decided to develop and test an in vitro method for rapid screening of new seedling genotypes for nematode resistance.

The nematode screening methods described here and the results presented were developed and completed by Yingyue Li, a visiting scholar in our lab this year. The lesion nematodes employed in this work were from a population originally isolated from soil collected in a Northern California walnut orchard. These have been maintained as axenic cultures on in vitro grown walnut roots in the Walnut Improvement Lab for 20 years.

Plants for testing were developed from etiolated shoots of *J. cathayensis* seedling #21 and comparison genotypes VX211, Vlach, RX1, Px1, and Chandler by rooting them in vitro in capped glass tubes, one shoot per tube. Walnut genotypes used for in vitro nematode testing and the number of replicate shoots are indicated in the table below.

Number of shoots per genotype used for in vitro nematode resistance testing

Genotype	Trial 1	Trial 2
Chandler	4	6
Vlach	5	5
#21	6	6
VX211	4	6
RX1	5	5
Px1	-	5

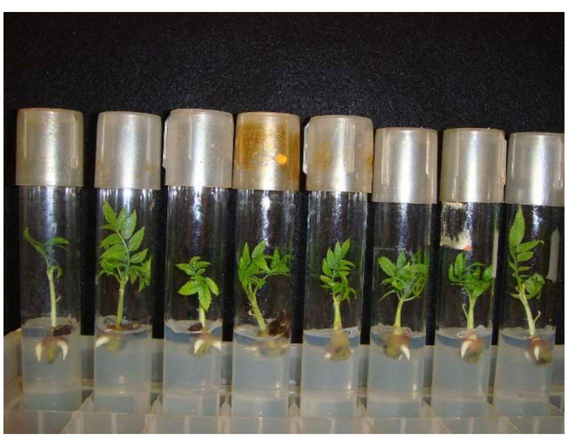
Nematodes were collected from in vitro cultures under sterile conditions using 20ml syringes and their capped shipping containers. A piece of Kimwipe was rolled to make a tube. This was folded in half and then opened to form a tube with 2 layers of Kimwipe at bottom. The Kimwipe tube was put in the syringe, and the syringe was placed in the capped container. These assemblies were then autoclaved for 20 minutes.

In a laminar flow hood, in-vitro grown two month old walnut roots containing lesion nematodes were cut into 1 cm pieces and three pieces were placed in each of four sterile tube assemblies. The containers were then filled to the 5ml line on the syringe with sterile water, capped and sealed with Parafilm and kept at room temperature in the dark for approximately 3three days.

The syringes with Kimwipe tubes and roots were then removed in a laminar flow hood. The liquid in each container tube was poured in to a capped sterile plastic 20 ml centrifuge tube. The number of nematodes in each container was determined by counting four 0.25ml sub-samples under a microscope and the volume needed to obtain 50 or 100 nematodes was calculated.

The liquid with suspended nematodes was then applied in a laminar flow hood to each rooted shoot in a capped glass culture tube by use of a 1ml sterile pipe tip and all the rooted shoots were incubated with the nematodes at room temperature in the dark for approximately 2 months. The entire experiment was conducted twice at different times. In the first trial 50 nematodes were applied per shoot at the beginning. In the second trial 100 nematodes were placed in each tube.

After two months of co-cultivation, the total nematode population in each tube was collected using standard funnel filtering equipment. An iron sieve with a piece of Kimwipe folded in half on top of a glass funnel, and a rubber tube with a clamp on the bottom of the funnel was set up to collect the nematodes from each culture tube. Each rooted shoot, along with its culture medium, was removed from the culture tube. The roots were cut into small pieces and both roots and medium were put on top of the water-filled funnel apparatus to let the nematodes move into the water. Each culture tube was rinsed with water multiple times and the rinse water was added in to the funnel together with the roots and medium to make sure all the nematodes were added. Enough water was added to each funnel to make sure the roots and medium were in constant contact with the water while the filter equipment was kept at room temperature in the dark for approximately 3 days. An aliquot of 15ml of liquid was collected from each filter daily into a capped plastic 20 ml centrifuge tube and water was added back to replacement level. The liquid collected from each funnel over 3 days was combined, centrifuged, and adjusted to a volume of 10ml. The number of nematodes present in each tube was calculated from counted subsamples.




Rooted shoots and assembly for sterile extraction of nematode from in vitro cultures

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, developing use of in vitro material for rapid pest and disease resistance screening, improved 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 (see Clonal Propagation Report) and for a field trial planted on campus. Rootstocks in the field trial are in the process of being grafted to Chandler and are continuing to be observed for growth, horticultural performance, and any incidence of naturally occurring crown gall. In addition, material from this planting is available for use in examining trans-graft movement of macromolecules.

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

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

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 field 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. The in vitro germplasm is maintained in the lab. It includes diverse scion and rootstock genotypes which are maintained for experimental use and to supply material to both research and commercial labs on request.

RESULTS AND DISCUSSION

Cultivar breeding

The new variety ‘Ivanhoe’, formerly known as selection 95-011-14, was released to nurseries and growers this year. It was named ‘Ivanhoe’ after a small town in Tulare County near an initial grower trial. Ivanhoe is a very early harvesting variety with good kernel color. Performance data continues to indicate a harvest timing equivalent to ‘Payne’ and ‘Serr’ with good production of extra light kernels. The early leafing and flowering dates suggest it will be best suited to the southern part of the Central Valley. The female flowers of Ivanhoe open before its pollen shed. ‘Serr’ or ‘Payne’ should be good pollen sources for this variety. Ivanhoe trees are not expected to be large in stature and this variety may be best tried initially on paradox to ensure vigor. See additional information in the ‘Description of Selections’ section of this report. The pedigree for Ivanhoe is illustrated in Figure 1.

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 previous 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 of this report. The conventional scion breeding portion of the improvement program currently includes over 5300 seedlings under evaluation in our orchard and 41 selections as follows:

Year	Crosses (n)	Original Seedlings (n)	Selections (n)	Under Evaluation (n)
1990	15	591	1	1
1991	18	493	2	2
1992	15	243	-	-
1993	14	116	1	1
1994	15	587	3	3
1995	15	758	5	5
1996	7	333	-	-
1997	13	611	3	3
1998	5	1759	1	7
1999	1	993	-	0
2000	12	2503	6	13
2001	16	210	4	16
2002	5	1200	1	3
2003	11	4608	13	198
2004	7 hs**	6000	1	128
2005	9 hs	3332	-	1345
2006	22	954	-	894
2007	27	1045	-	904
2008	33	929	-	929
2009	32	1187	-	1187
2010	32	1397 seed		
Total	146	29849	41	5387

**hs denotes half sib families

<u>Backcross breeding for resistance to cherry leafroll virus.</u>

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.
Last year we substantially increased the number of seedlings in this part of the program by establishing an additional 1200 backcross seedlings in a new evaluation block on very close spacing. Sudhi Mysore, USDA-ARS, contributed valuable assistance in evaluating the material by screening these fourth generation backcross (BC4) seedlings for virus resistance or susceptibility using his newly redesigned SCAR marker. This SCAR marker, with improved reliability, was used to identify the likely tolerant (not virus resistant) seedlings. Many trees were tested before planting, reducing the space needed for the block. In addition, he tested all the newly planted trees so that virus susceptible individuals could be removed quickly, reducing maintenance costs for the block, allowing extra room for the resistant individuals, and allowing us to concentrate on horticultural evaluation of only the trees of further interest. In addition he screened a smaller set of already mature BC 4 trees. Several of these that tested resistant by DNA marker were then used for crossing this spring to produce the first BC5 seed. These will also be patch tested to confirm the DNA results. We continued nut and yield evaluations this year on the 122 backcross seedlings remaining in previously established blocks.

To date 14 of 81 backcross selections that we began patch testing in 2001-2002 without prior DNA marker testing have proven to be virus-resistant, 6 remain questionable and under further 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. We also attempted this year, in co-operation with Caprile and Mysore, to repeat an orchard trial designed to examine effects of virus infected pollen on nut set of virus-resistant varieties (see Caprile report in this volume). The trial included both blackline-resistant selections and Howard as a control but the stored pollen we used was apparently not viable. We will attempt this again next year with fresh pollen.

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, and PDS selections for crown gall, nematode, and *Phytophthora* resistance.

Rootstock crosses and introduction of seed to culture.

Crosses of Serr x *J. cathayensis* seedling #21 and Rawlins x Serr exhibited rather poor nut set and low survival to maturity. A total of 150 female flowers were bagged and pollinated on Serr and 50 on Rawlins. Some flowers were lost early to either PFA, or non-pollination drop. Substantial additional losses occurred due to blight. By June only two Rawlins nuts remained and more than half of the developing Serr nuts showed obvious signs of blight. Twelve of these were cultured in late June to see if they could be saved and half were introduced cleanly. Several immature nuts not showing blight at that time were also successfully introduced. The few remaining Serr nuts were cultured successfully at maturity in mid-September. The Rawlins nuts present in June were lost before they reached maturity.

Introduction of new rootstock crosses into culture by extraction of zygotic embryos rather than from nodal cuttings was tried on an experimental basis this year and was quite successful. This method saved approximately one year of time in establishing new seedling material in culture and avoided a considerable effort that would otherwise be expended in disinfesting nodal explants. Within two months 24 of 43 attempted *Juglans cathayensis* x Serr seed, 38 of 78 J. microcarpa seed, and 7 of 22 Serr x #21 seed were established cleanly in culture and micropropagated to the extent that they were ready for DNA testing to confirm parentage and ready to begin rooting for replicated pest and disease testing. Additional seed that were slower to develop are also in culture. This method of introducing seedling material to culture has the additional advantage that somatic embryo cultures of the new material can potentially be established simultaneously. This would allow later gene insertions into new genotypes that prove promising. Somatic embryos are most easily developed if immature seed is cultured but already this year at least one somatic embryo culture from a mature *J. cathayensis* x Serr cross has been initiated.

Introductions to culture by nodal cuttings

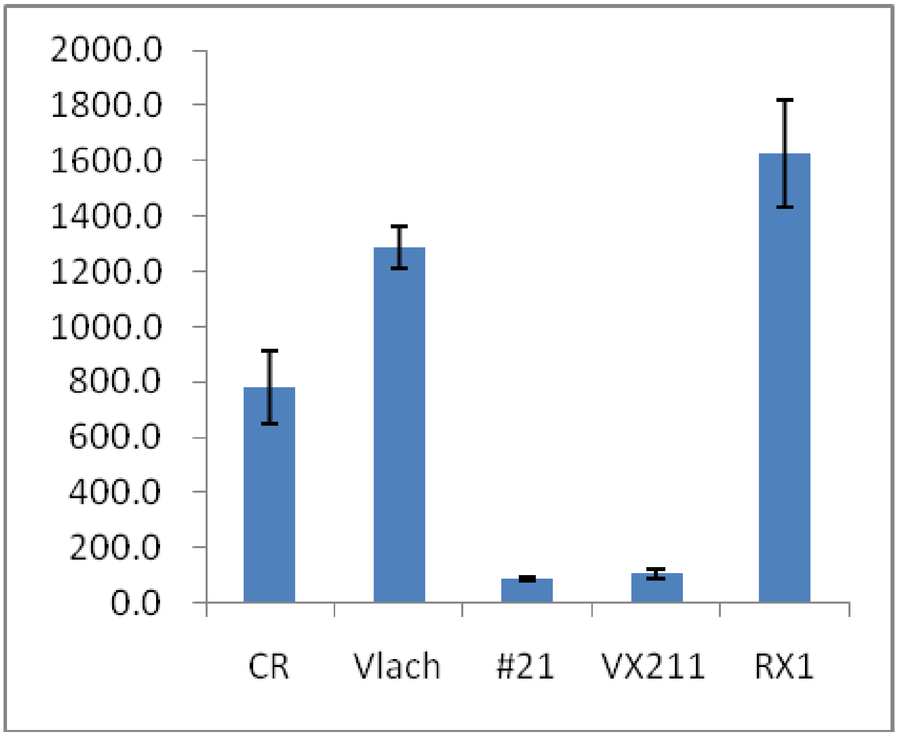
Several new genotypes were introduced into tissue culture this year from nodal cuttings for microshoot production and rooting as part of the rootstock improvement efforts. One of these was *Juglans cathayensis* accession DJUG 11.3 (a.k.a. 'B2-12'), which is of interest as a parent of the nematode resistant selection identified by Mike McKenry, seedling #21. A second introduction, at the request of Mike McKenry, was PI159568, a parent of Serr and Tulare, and a possible source of root knot nematode resistance in English walnut. In addition, we decided to re-introduce Chandler into culture this year. Although walnut microshoots cultures have appeared to be quite stable for many years, occasional variants have been observed and the current Chandler culture in use was initiated 25 years ago. It seemed prudent to develop a fresh culture, given the use of in vitro Chandler cultures for own-rooted plant production and potential use as scion budding material for in vitro produced clonal rootstocks. Microshoot cultures of both rootstock genotypes and English cultivars were provided again this year to several commercial laboratories on request.

Nematode resistance screening using in vitro rooted shoot cultures

Initial attempts to screen for nematode resistance using in vitro rooted shoots failed due to introduction of contamination during the process of preparing the nematodes. Methods were adjusted and a clean co-culturing process was then established using the procedures outlined in the methods section of this report.

Two complete replicated trials compared the principal genotype of interest, suspected nematode resistant seedling selection #21, to several controls and the putatively nematode tolerant rootstock variety VX211. Results of these trials are shown in the graphs below. Bars indicate the numbers of lesion nematodes recovered per rooted plantlet after two months of co-culture in vitro in the dark. Trials were initiated with 50 (Trial 1) or 100 (Trial 2) lesion nematodes per plantlet.

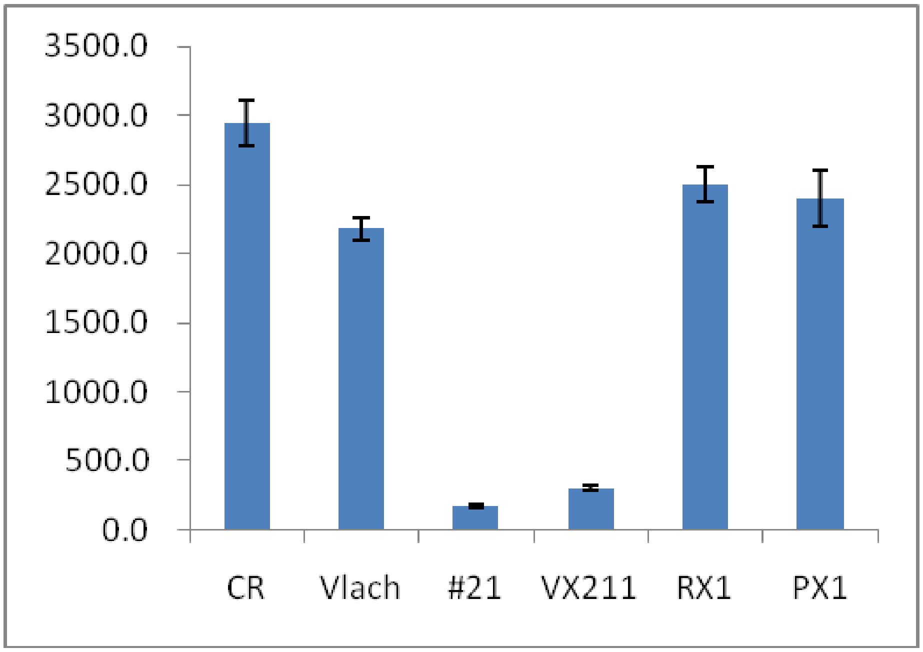
Trial 1. Number of nematodes per plantlet recovered after two months from cultures initiated with 50 nematodes per plant



Genotype	Mean No.	SD	SE
CR	782.0	188.8	133.5
Vlach	1290.0	152.3	76.2
#21	86.2	14.7	6.6
VX211	106.5	29.2	16.8
RX1	1627.8	335.2	193.6

P value	CR	Vlach	#21	VX211
CR				
Vlach	0.005649			
#21	2.66E-05	1.15E-08		
VX211	0.000767	1.33E-06	0.177554	
RX1	0.011709	0.081722	2.75E-06	0.001426

Trial 2. Number of nematodes per plantlet recovered after two months from cultures initiated with 100 nematodes per plant



Genotype	Mean No.	SD	SE
CR	2944.3	234.3	165.6
Vlach	2181.7	114.5	81.0
#21	171.5	28.1	12.6
VX211	302.0	44.4	22.2
RX1	2499.5	215.6	124.5
PX1	2397.3	285.0	201.6

P value	CR	Vlach	#21	VX211	RX1
CR					
Vlach	0.007148972				
#21	9.89076E-09	9.15147E-10			
VX211	2.21465E-07	4.20382E-08	0.000217488		
RX1	0.047737495	0.070990186	3.88465E-09	8.45857E-08	
PX1	0.062116637	0.290816429	1.69798E-07	2.62551E-06	0.609596

Gene insertion

Additional plants of 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.

A small sub-set of these genotypes, grown in large pots and grafted with Chandler scions, were used for a second year by Allen Bennett's graduate student Victor Haroldsen to test for any trans-graft union movement of DNA, RNA, or other macromolecules and to test for any alteration of horticultural traits of scion material on these rootstocks. To date, genes for GUS, NPTII, iaaM and IPT and the NPTII selectable marker protein have been detectable in rootstocks material but not in scion material. In addition, small rooted plantlets of the better lines expressing crown gall resistance and several larger resistant plants grafted to Chandler were supplied to the Dandekar lab for preliminary work on macromolecule expression in graft union tissues.

A one-acre field trial of rootstock lines containing the RNAi construct for crown gall resistance and the appropriate controls continues to be maintained under APHIS field permit and has been partially budded or grafted to Chandler scions. Growth measurements are being taken and trees will continue to be observed for both horticultural performance and any natural occurrence of crown gall. These trees are also trained so that they produce leaves on the rootstock portion as well as the scions so that suitable plant tissue is available for use in DNA, RNA and protein analysis.

Several additional plants of genotypes exhibiting altered expression of shikimate dehydrogenase (SDH), an enzyme that regulates the production of gallic acid, were produced and existing plants continue to be maintained in large pots in the greenhouse so they can be used to complete a study of the role of gallic acid in *A. flavus* resistance and used in examining the role of tannins in nut quality and insect, nematode and disease resistance.

Walnut polyphenol oxidase (PPO) is thought to play a role in disease resistance and kernel color traits. Transgenic walnut trees silenced for expression of PPO and expressing PPO specific activities < 1% of wild type and control plants were maintained in large pots and used this year in blight and stress resistance assays by Matt Escobar. Planned additional work using these plants will be directed at examining the role of PPO in kernel color formation. Chandler trees expressing the cry1A(c) BT gene, and which have shown good efficacy against codling moth in previous USDA tests, are no longer in the field but continue to be maintained in pots for future use if desired.

Genomics

We are continuing to evaluate individuals of an established population of Chandler x Idaho seedlings that we generated over the last six years. The parents of this cross 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.). A total of 350 seedlings have been established. In addition, 92 of the genotypes have been regrafted to rootstock on wider spacing to improve the evaluation process and to provide some replication. Trees from this cross will continue to be evaluated for horticultural traits as they mature over the next several years and nuts will continue to be evaluated through the crackout process. DNA from these trees will eventually be used to map traits in the walnut genome and to develop markers for more efficient selection in breeding (see Dandekar et al. report on Genomics). The field data collected on this population will be critical to a successful completion of the walnut genomics project.

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. We continue to supply *in vitro* rooted microshoots to Kendra Baumgartner for use in developing new screening methods for *Armillaria* resistance and to Greg Browne for preliminary work in developing and in vitro screening procedure for *Phytophthora*. 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 and Ferris labs.

The field germplasm collection was used again this year by a variety of research projects including Nick Mills for insect work, Bob Beede for Ethephon sensitivity evaluations, and Mike McKenry for post-planting nematode treatments. In addition, we supplied graftwood of germplasm from these blocks to fill a variety of research and nursery requests.

Description of Selections 2010. (*indicates most promising, indent indicates probable discard)

Sexton (90-031-10) (Chandler x 85-008) (selected 2000): This offspring of a Chandler x Chinese cross was selected for its very precocious yield and low amount of blight. It has large light kernels that average 8.4 g. Kernel color has been good most years, averaging 80% light and 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. Little blight was seen at Davis this year during a wet spring. Trees tend to form neck buds and narrowly forked branches, requiring more pruning than average to set conventional 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. This variety also accumulates a significant number residual dead fruiting spurs following heavy fruiting. Its pollen shed overlaps the female bloom very well and it tends to exhibit 2nd flowering like Chico, resulting in some small and late harvesting nuts. Released 2004. (Trials: Conant, Scheuring, Crane, CSU-Chico, Modesto JC, Taylor, Headrick)

Gillet (95-022-26) (76-80 x Chico) (selected 2002): This protogynous variety continues to exhibit excellent yield, large 7.9 g kernels, and harvests mid-season, about two weeks earlier than Chandler. Giller is a large and vigorous tree that was selected in part for its low blight scores and it exhibited little blight again this year at Davis in a wet spring. The canopy is more open and allows better light penetration than Tulare. Nuts average 51% kernel and yield halves easily. Kernels color has been generally lighter than Tulare at comparable locations, averaging 88% light or extra light. Kernels have had little shrivel and few veins or blanks. Seals, which remain a concern, particularly in young trees, were adequate this year. This variety is suitable for cracking but not for in-shell use. Released 2004. (Trials: Conant, Scheuring, Crane, Modesto JC, Taylor, Headrick)

Forde (95-026-37) (Lara x Chico) (selected 2001): This selection has consistently produced kernels with very good color and shown excellent yield and kernel fill, but it continues to harvest very close to Chandler time, or this year often even later. It has large, plump 8.3 g kernels, a protogynous bearing habit, and nuts that 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. Yields this year were generally not as strong as the past several years. Nuts often loosen in the hulls before the hull split and some hulls, particularly this year, do not open widely, so that nuts may not dry in the field as well and may tend to stay in the canopy until shaken rather than fall on their own. Released 2004. (Trials: Conant, Scheuring, Modesto JC, Crane, Stolp, Taylor, Headrick)

Ivanhoe (95-011-14) (67-013 x Chico) (selected 2001): This protogynous selection was released in 2010 as very 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 7.5 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 known to be susceptible to blight. Blight was apparent during the wet spring this year. Some summer heat damage to the foliage and summer nut drop has been observed in the past and should be watched. Trees should likely be planted on paradox due expected relatively small stature and trees should be managed well to maintain nut size. Released 2010. (Trials: Scheuring, Conant, Moore, Bonturi, Spanfelner, Stuke, Headrick, Carriere, Stolp)

90-027-21 (Tulare x Sinensis #5) (selected 1998): We continue to watch this selection primarily for its resistance to boron. It has had consistently good to excellent yields and nuts could be used as an early in-shell. It is an upright, vigorous tree that leafs out and harvests close to Payne. The shells are strong, well sealed, and shaped like Vina, but nuts yield only 48% kernel and kernels average 6.8 g. Kernel color has been mostly light but not excellent, 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. Possible discard. (Trials: Conant, Deardorff, Scheuring)

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 has been excellent at Davis most years but not at other locations. Color was good this year at Chico as well. 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 7.7 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, Deardorff)

***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 almost no blight. The smooth, attractive, very solid shells have good seals and 55% kernel. The very plump, Sunland-shaped kernels average 8.4 g and kernel color is excellent. (Trials: Conant, Sierra Gold, Spanfelner)

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 and was poor at most locations this year. 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. This selection has been used as a parent for shape, kernel yield, and early harvest date. Leaves can be slow to abscise and some petioles are commonly retained on the trees until spring. Watch the yield and color consistency further but this will probably not be released. (Trials: Bonturi, Conant, Scheuring, Stolp)

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. (Trials: Conant, Headrick)

95-007-13 (77-012 x Serr) (selected 2001): This Serr seedling harvests at Payne time, with excellent yield, good tree vigor, and little blight. The nuts have a solid, attractive shell, and kernels have generally good but not extra light color and can be a bit veiny. Color can be good but has been inconsistent. The well-filled nuts yield 55% kernel with easy halves. Kernels average 8.5 g. Shells are thin but still solid, like Serr, with a smoother and more attractive appearance. This could be a very good early-harvest cracking variety if the kernel color is adequate. 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 8.0 g. Nuts have very solid oval shells that give 55% kernel and have an attractive appearance. Kernels show a small amount of tip shrivel. Trees appear upright and vigorous. Consider this one for release. (Trials: Scheuring, Spanfelner, Stolp, 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 6.9 g. Keep for late leafing, short season selection. Sensitive to boron. (Trials: Scheuring, 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 53% kernel and have solid shells and seals. Kernels have averaged 7.2 g with light to extra light color. This has the strength to be an early in-shell selection but continue to watch for nut size, ease of halves, and consistency of yield in the selection blocks and grower trials. (Trials: Scheuring, Stolp, Spanfelner)

97-003-319 (Tulare x Mixed Chinese – Phase II): (selected 2009): This tree produces very large plump kernels with excellent color and harvests about a week after Payne. The tree is protandrous and leafs about a week after Payne. Nuts average 54% kernel and kernel weights average 8.4 g. Shells are solid but can be a bit dark and yield should be watched further.

98-002-129 (77-012 x O.P.) (selected 2009): This selection has large, very plump kernels that average 9.5 g with good color and harvest approximately with 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 most years. The very large, plump, 9.2 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, Conant)

00-005-149 (59-124 x O.P.) (selected 2007): This protogynous selection harvests with Payne but leafs out about a week later and has had almost no blight. Yields have been consistently huge. The round, smooth-textured nuts have solid shells and average 55% kernel. The 8.6g kernels are plump but color has been generally tan 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 52% kernel and the kernel color is consistently outstanding but kernel weights have averaged only 7.2g and yield needs to be watched further.

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 8.1 g. The tree leafs about Payne time and produces nuts with 59% kernel. The shells are thin but sufficiently strong and seals are good. The tree is protogynous and can also serve as a pollenizer for Chandler. (Trial: Scheuring, Conant)

00-011-107 (Howard x O.P.) (selected 2008): This short season protogynous selection harvests within a week of Payne with excellent yield but leafs approximately with Chandler. Kernels average 7.8g, have excellent color, and are easily removed in halves. Nuts have light-colored, solid shells and yield 52% kernel.

01-007-2 (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 8.8 g kernels with good color. This is a short season protandrous selections with a harvest date consistently several days earlier than Payne, leafing a little later than Payne. Yields are good and the large smooth-shelled nuts give 60% kernel and easy halves. Watch the seals. (Trial: Scheuring)

01-016-11 (91-019-45 x 91-090-41) (selected 2009): Harvesting about a week after Payne with large 8.5 g kernels of uniform light to extra light color, this tree bears large smooth nuts with good shell strength and easy kernel removal. The tree is protandrous, leafs a week after Payne, 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, large kernels, and excellent kernel color, this selection harvests a week after Payne and bears very large attractive nuts with solid shells and seals. Blight scores have been low. The 9.0 g kernels are almost entirely light to extra light in color and nuts give 57% kernel with easy extraction of halves.

03-001-977 (Chandler x Phase II) (selected 2009): This short-season selection leafs with Chandler but harvests about two weeks earlier 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. This selection has had no blight, even with late rain this year. The nuts have an excellent shell appearance with good strength and seals. Kernels average 7.9 g and nuts give 60% kernel. (Trials: Stolp, Conant)

03-001-1372 (Chandler x Phase II) (selected 2010): This mid-season protandrous selection leafs with Chandler but harvests a week earlier with good yield and almost no blight. The nuts give 56% kernel with easy removal of halves. Kernel color is Chandler-like and almost entirely light to extra light.

03-001-1457 (Chandler x Phase II) (selected 2010): This large vigorous tree exhibits excellent yield about a week later than Payne with protandrous bloom habit and leafing also a week later than Payne. Little blight has been observed. The nuts have excellent shell appearance and strength while yielding 59% kernel The 8.2 g kernels have excellent color.

03-001-1938 (Chandler x Phase II) (selected 2010): Selected for its very high yields and mid-season harvest timing similar to Tulare, this protandrous selection produces 7.9 g kernels with very good kernel color. The smooth and light colored shells are thin but hard, with sufficient strength. The attractive round nuts yield 58% kernel with easy removal of halves

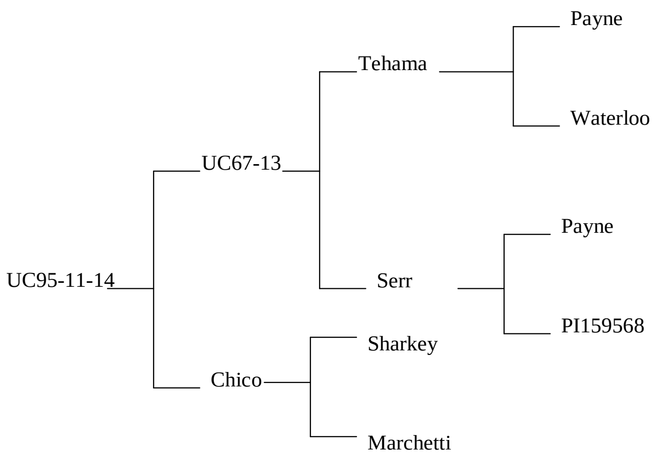
03-001-2357 (Chandler x Phase II) (selected 2010): This selection has consistently produced attractive kernels with excellent color and easy removal in halves. The tree is protandrous and produces strong mid-season yields. Leafing is about a week later than Payne with harvest in late September. The kernels average 8.7 g and have consistently been mostly extra light in color. Shells are well filled, have an attractive appearance with good strength, and give 60% kernel yield.

03-001-2424 (Chandler x Phase II) (selected 2010): This protandrous tree is characterized by excellent kernel color and strong mid season yield. The plump 8.6 g kernels have been entirely light or extra light and the well-filled nuts produce 58% kernel. The tree leafs only a few days later than Payne and showed moderate blight this year.

03-001-2556 (Chandler x Phase II) (selected 2010): A mid-season harvester with excellent kernel color, this protandrous selection leafs a week later than Payne and a week earlier then Chandler. Blight scores have been low and yields very good. The nuts have smooth, light colored, attractive shells which are thin but have good strength and seals. The mostly extra light kernels average 8.3 g and are very easily extracted nuts averaging 58% kernel.

03-001-2556 (Chandler x O.P) (selected 2010): This selection has very strong yields and excellent kernel color. The tree leafs mid-season, has shown little blight, and has a protogynous bloom habit with pollen shed that overlaps Chandler. The large round nuts have large plump kernels averaging 8.8 g with all Chandler-like light or extra light color. Nuts have smooth, light attractive shells and yield 56% kernel.

Figure 1. Pedigree of Ivanhoe (UC95-011-14)



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

2009: 95-027-23, 95-030-10, 03-019-9, 03-019-10

Contra Costa –Caprile

Tennant

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

San Joaquin - Grant

Planned for 2011

Selections budded/grafted in nursery – 2009/10

Field Trials of Standard Selections

Tehama - Buchner

Spanfelner

91-077-6, 91-090-41, 91-094-18, 91-096-3, 93-028-20, 94-020-35, Ivanhoe, 95-011-16, 95-026-16, 98-001-442, 00-006-227, 01-001-107, 01-007-2, 01-016-11, 03-001-507, 03-001-942, 03-001-977, 03-001-1938, 03-001-2357, 03-001-2822, 03-001-3382, 03-001-3682, 03-005-4, 04-003-417, 04-004-26, 04-004-58

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, Ivanhoe, 95-026-16

2008: numerous selections

Stuke

2008: Ivanhoe

Bertagna - red kernels

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

Lake – Elkins

Suchan

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

Glenn – Krueger

Carriere

2007: Ivanhoe

Colusa - Edstrom

Nickels Trial - pruning

2008: Gillet, Forde, Tulare, Chandler

Sutter-Yuba - Hasey

Conant

Selection trials

2001-2010: 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

2001-2010: 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

2002-2010: 91-077-6, 94-019-85, Ivanhoe

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: Ivanhoe

Jeb Headrick

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

Tulare – Beede/Fichtner

Moore

2004: Ivanhoe

Swall

2004: Sexton. Forde, Gillet

Cultivars													
Payne	G	3/19	0	3/24	3/30	4/7	7	3/29	4/5	4/10	100	7	9/20
Hartley	G	4/3	15	4/4	4/16	4/28	7	4/21	4/24	4/28	0	6	10/5
S. Franquette	G	4/19	31	4/19	4/26	5/5	7	5/1	5/5	5/10	0	5	10/18
Idaho	G	3/21	2	4/7	4/14	4/21	4	3/26	3/28	3/31	0	5	9/23
Vina	G	3/26	7	3/29	4/8	4/19	7	4/11	4/15	4/22	100	7	9/26
Serr	G	3/19	0	3/24	3/28	4/14	7	4/2	4/6	4/15	30	7	9/22
Chandler	G	4/6	18	4/5	4/15	4/27	6	4/19	4/25	4/29	100	7	10/9
Howard	G	4/6	18	4/8	4/13	4/19	6	4/19	4/24	4/28	100	7	9/30
Tulare	G	3/28	9	4/3	4/15	4/24	7	4/16	4/19	4/25	100	8	10/6
R. Livermore	G	4/6	18	4/6	4/14	4/25	6	4/18	4/23	4/28	100	7	10/3
Sexton	G	3/23	4	3/26	4/1	4/13	7	4/7	4/12	4/18	100	7	10/10
Gillet	G	3/21	2	4/10	4/17	4/22	7	3/26	3/31	4/7	100	8	10/4
Forde	G	3/27	8	4/17	4/23	5/3	8	4/3	4/7	4/15	100	7	10/14
Ivanhoe	G	3/18	1	4/4	4/14	4/22	7	3/19	3/23	3/30	100	7	9/18
Selections													
59-124	G	3/17	-2	3/25	3/31	4/8	8	4/2	4/7	4/11	100	7	9/19
61-025	G	4/1	13	4/3	4/10	4/21	7	4/18	4/22	4/26	100	6	9/25
64-057	G	3/23	4	4/9	4/16	4/26	7	3/29	4/5	4/13	100	6	9/28
90-027-21	G	3/20	1	3/24	3/31	4/15	7	4/8	4/12	4/17	100	8	9/22
90-027-23	G	4/5	17	4/5	4/14	4/27	7	4/18	4/21	4/25	100	6	9/26

91-077-40	G	3/24	5	4/12	4/17	4/25	8	3/25	4/3	4/12	100	8	10/8
91-090-41	G	4/4	16	4/5	4/10	4/20	7	4/18	4/24	4/28	100	8	10/1
93-028-20	G	3/24	5	3/26	4/5	4/15	7	4/13	4/17	4/21	100	7	9/29
94-019-29	G	3/21	2	3/27	4/7	4/18	8	4/10	4/14	4/20	100	7	10/1
94-019-85	G	3/17	-2	3/19	3/26	4/9	6	3/29	4/6	4/11	100	5	9/24
94-020-35	G	3/17	-2	3/24	4/3	4/15	8	4/6	4/12	4/19	100	7	9/26
95-007-13	G	3/20	1	3/23	3/30	4/14	8	4/6	4/9	4/16	100	7	9/19
95-011-16	G	3/22	3	3/27	4/3	4/13	7	4/7	4/10	4/15	100	8	9/30
95-018-23	G	4/5	17	4/7	4/14	4/24	7	4/18	4/22	4/25	100	8	9/26
95-024-1	G	3/24	5	4/1	4/8	4/19	7	4/14	4/17	4/21	100	8	10/8
95-026-16	G	3/23	4	4/10	4/17	4/22	7	3/26	3/30	4/7	100	7	9/20
95-026-17	G	4/4	16	4/17	4/23	5/1	6	4/5	4/13	4/17	100	7	10/6
96-013-13	G	3/23	4	4/12	4/17	4/27	6	3/25	3/28	4/5		7	9/26
97-003-11	G	3/25	6	3/30	4/7	4/20	8	4/13	4/18	4/22	100	7	10/7
97-003-23	G	3/28	9	4/13	4/18	4/29	7	4/17	4/21	4/27	100	7	10/6
97-003-79	G	3/23	4	3/29	4/8	4/22	7	4/14	4/19	4/26	100	6	9/26
98-001-415	G	3/25	6	4/4	4/13	4/18	6	4/15	4/18	4/21	100	7	10/2
98-002-129	G	3/20	1	3/28	3/31	4/9	3	4/8	4/12	4/16	100	7	9/26
98-003-54	G	4/8	20	4/20	4/27	5/2	4	4/12	4/17	4/22	100	8	10/2
00-005-30	S	3/20	1	4/10	4/15	4/22	6	3/24	3/27	4/3	100	7	9/15
00-005-149	S	3/24	5	4/14	4/18	4/26	8	3/30	4/5	4/14	100	7	9/18

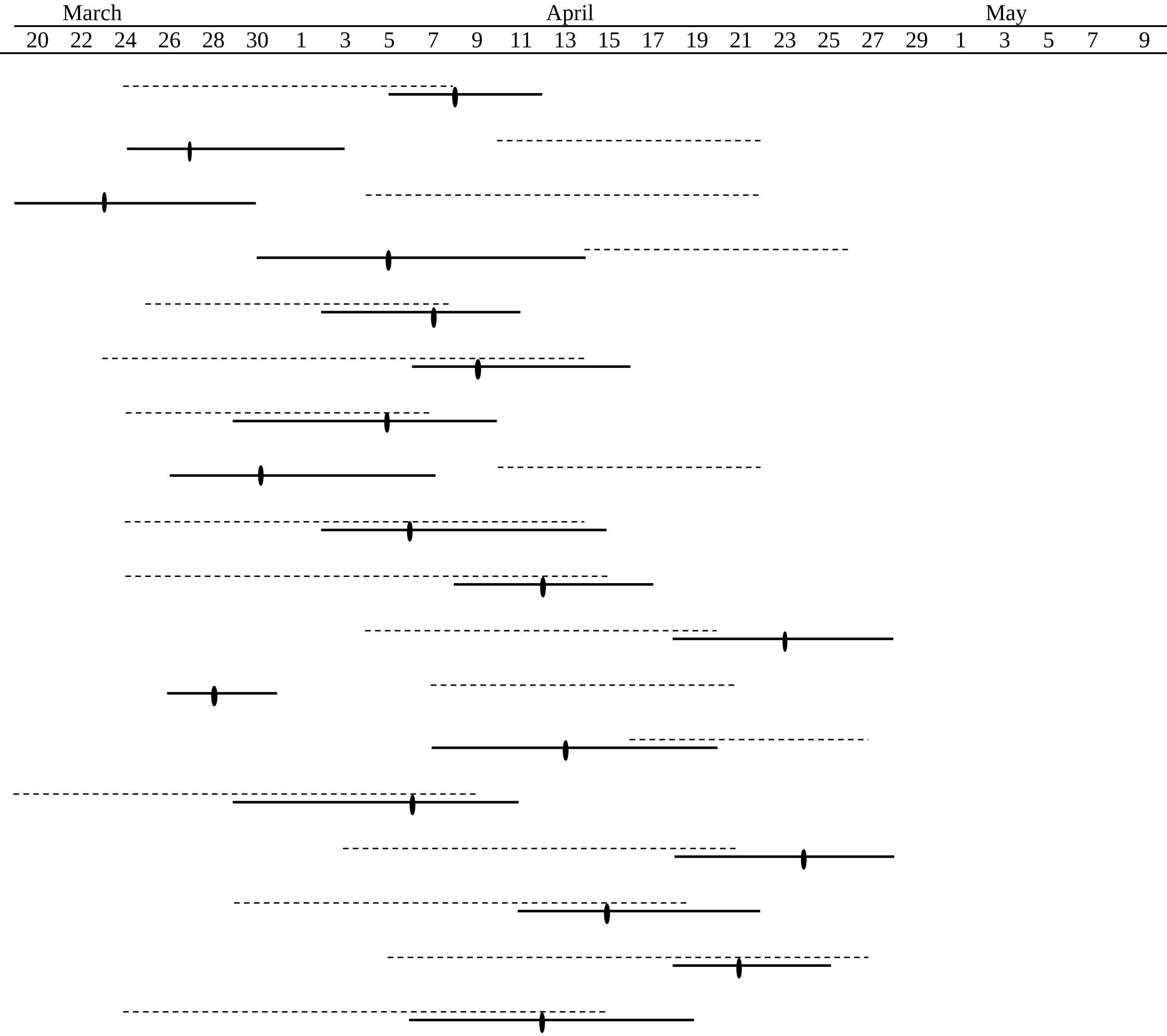
00-006-48	S	4/9	21	4/10	4/16	4/29	7	4/20	4/24	4/28	100	7	10/9
00-006-227	S	4/5	17	4/18	4/24	5/3	7	4/9	4/13	4/20	100	7	9/27
00-011-107	S	4/4	16	4/16	4/20	4/27	3	4/7	4/13	4/20	100	7	9/23
01-007-2	S	3/22	3	3/24	3/30	4/8	7	4/5	4/8	4/12	100	6	9/13
01-007-3	S	4/6	18	4/10	4/17	4/22	7	4/17	4/20	4/26	100	7	9/30
01-009-10	S	3/30	11	4/4	4/10	4/20	7	4/18	4/23	4/28	100	7	9/22
01-016-11	S	3/24	5	3/29	4/6	4/10	7	4/7	4/12	4/17	100	7	9/26
03-001-507	S	3/24	5	4/2	4/8	4/19	7	4/12	4/15	4/19	100	7	9/28
03-001-977	S	4/5	17	4/22	4/28	5/3	5	4/12	4/16	4/23	100	7	9/29
03-001-1098	S	4/2	14	4/9	4/16	4/26	7	4/20	4/23	4/27	100	7	10/5
03-001-1372	S	4/6	18	4/13	4/22	4/30	7	4/22	4/25	4/29	100	7	10/1
03-001-1457	S	3/24	5	3/30	4/3	4/10	6	4/14	4/17	4/22	100	8	9/28
03-001-1649	S	3/29	10	3/31	4/6	4/16	3	4/18	4/23	4/28	100	5	9/28
03-001-1938	S	3/21	2	3/25	4/6	4/15	7	4/15	4/19	4/24	100	8	9/29
03-001-2357	S	3/25	6	4/1	4/10	4/17	6	4/14	4/18	4/23	100	7	10/6
03-001-2434	S	3/22	3	3/27	4/3	4/10	7	4/9	4/12	4/16		7	10/7
03-001-2556	S	3/28	9	4/6	4/13	4/24	7	4/15	4/21	4/25	100	7	10/7
03-001-3395	S	4/1	13	4/18	4/24	4/30	7	4/7	4/12	4/19	100	7	10/5
04-003-143	S	3/28	9	4/19	4/24	4/30	5	4/2	4/9	4/17	100	8	10/3

Cultivars																
Payne	G	9/20	0	168	5	5	1.3	10.0	4.8	48.2	6	5	0	33	67	0
Hartley	G	10/5	15	164	6	6	1.6	14.5	6.8	47.1	5	5	11	78	11	0
S. Franquette	G	10/18	28	166	7	7	1.8	12.8	5.6	43.8	5	5	10	90	0	0
Vina	G	9/26	6	164	5	5	1.3	11.6	5.7	49.0	5	5	0	20	80	0
Tehama	G	9/28	8	165	4	6	1.5	13.4	6.2	46.0	5	5	0	50	38	13
Serr	G	9/22	2	169	5	5	1.2	13.2	7.5	56.7	6	5	0	33	67	0
Chandler	G	10/9	19	167	5	5	1.4	14.3	6.9	47.9	4	4	60	40	0	0
Howard	G	9/30	10	159	5	6	1.6	13.7	6.8	49.7	5	4	0	80	20	0
Tulare	G	10/6	16	170	5	5	1.2	13.7	7.0	51.6	4	4	0	80	10	10
Sexton	G	10/10	20	181	6	6	1.7	15.7	8.2	52.2	7	6	0	100	0	0
Gillet	G	10/4	14	187	4	5	1.4	15.5	7.5	48.4	5	5	20	70	10	0
Forde	G	10/14	24	190	5	6	1.5	16.0	8.5	53.2	6	4	50	40	10	0
Ivanhoe	G	9/18	-2	179	5	4	1.3	13.6	7.4	54.5	5	4	70	30	0	0
Selections																
59-124	G	9/19	-1	165	5	6	1.8	15.8	8.3	52.4	6	5	0	100	0	0
64-057	G	9/28	8	176	4	6	1.6	18.5	9.5	51.1	5	5	25	50	25	0
90-027-21	G	9/22	2	163	4	5	1.3	13.6	6.8	50.0	5	4	0	50	50	0
90-027-23	G	9/26	6	158	5	5	1.2	13.6	7.2	53.4	5	6	50	50	0	0
91-077-40	G	10/8	18	188	6	6	1.5	14.2	7.4	52.1	6	5	20	60	20	0

91-090-41	G	10/1	11	160	5	4	1.1	11.6	7.0	60.1	6	3	30	60	10	0
93-028-20	G	9/29	9	165	5	5	1.3	13.6	7.9	58.2	6	4	40	60	0	0
94-019-85	G	9/24	4	171	5	5	1.2	13.7	8.2	59.8	6	5	0	60	40	0
94-020-35	G	9/26	6	167	5	6	1.6	15.7	7.7	49.2	7	7	0	20	80	0
95-007-13	G	9/19	-1	163	5	5	1.3	14.4	8.0	55.5	6	5	0	90	10	0
95-011-16	G	9/30	10	173	5	5	1.4	15.4	8.2	53.2	6	5	20	80	0	0
95-018-23	G	9/26	6	157	5	4	1.2	13.2	7.1	54.1	4	4	60	40	0	0
95-026-16	G	9/20	0	174	5	6	1.8	14.0	6.9	49.3	7	5	40	60	0	0
95-026-17	G	10/6	16	176	6	5	1.5	13.4	6.6	49.4	5	5	20	80	0	0
96-013-13	G	9/26	6	182	5	6	1.5	11.9	5.8	48.5	6	5	40	40	20	0
97-003-11	G	10/7	17	172	4	5	1.2	15.2	8.2	53.6	5	3	13	75	13	0
97-003-23	G	10/6	16	168	4	4	1.2	14.4	7.7	53.4	4	3	0	90	10	0
97-003-79	G	9/26	6	160	4	5	1.3	18.7	9.6	51.3	4	4	0	60	40	0
00-005-30	S	9/15	-5	172	5	6	1.5	12.7	6.7	53.0	6	5	0	60	40	0
00-005-149	G	9/22	2		5	5	1.4	15.7	8.5	53.8	5	5	0	33	67	0
00-011-107	S	9/23	3	163	5	5	1.3	11.3	5.9	52.3	5	5	30	70	0	0
01-007-2	S	9/13	-7	158	5	4	1.2	12.8	7.9	61.7	5	4	0	100	0	0
01-007-3	S	9/30	10	163	5	4	1.1	11.9	7.1	59.3	6	4	0	100	0	0
01-009-10	S	9/22	2	152	4	5	1.3	11.5	6.0	52.0	4	5	0	0	100	0
01-016-11	S	9/26	6	167	5	6	1.5	11.9	6.0	50.7	6	5	50	50	0	0
03-001-507	S	9/28	8	166	5	5	1.4	16.4	8.9	54.4	5	4	20	80	0	0

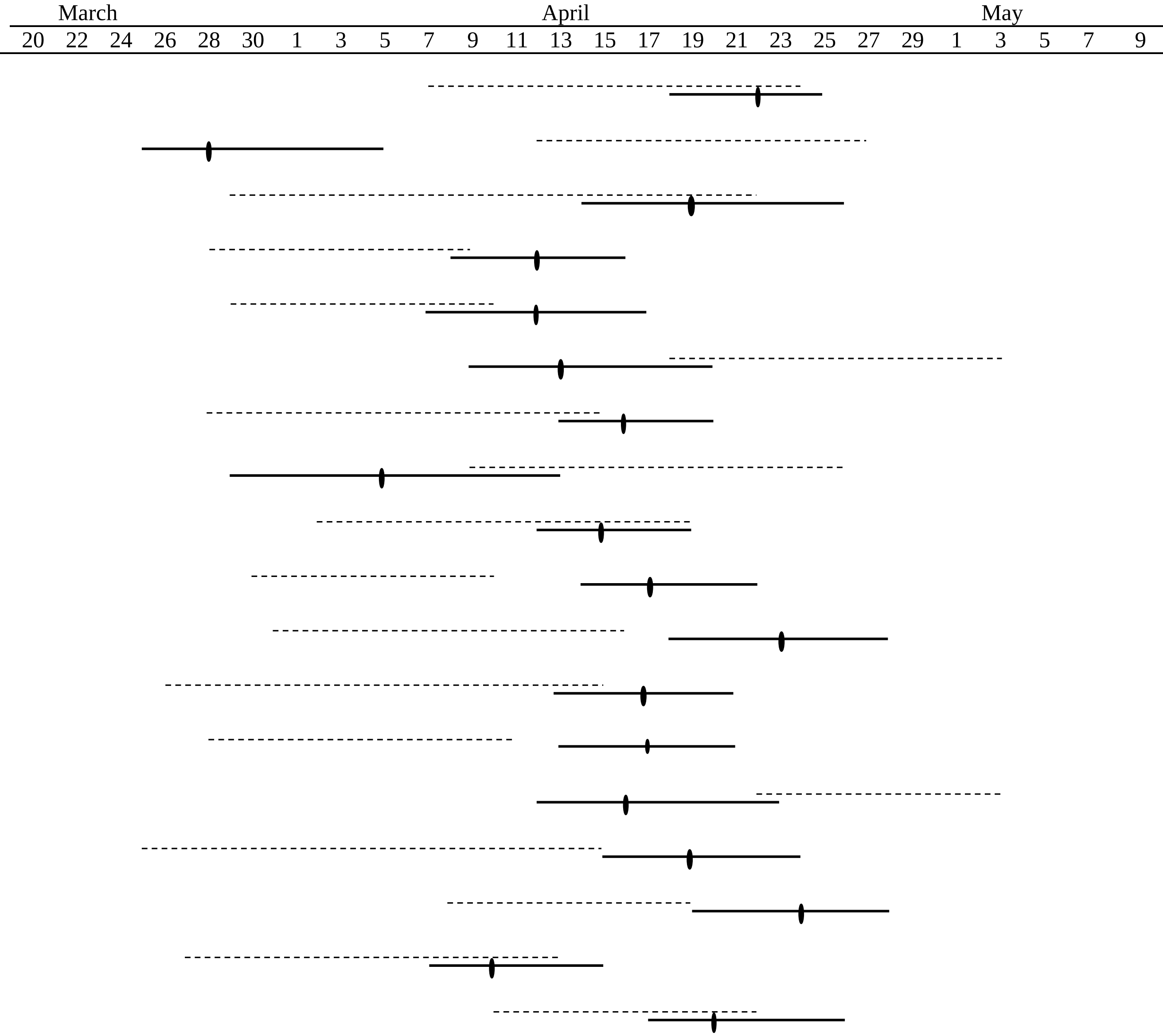
03-001-977	S	9/29	9	166	5	5	1.3	14.0	8.3	59.3	5	4	0	60	40	0
03-001-1098	S	10/5	15	165	5	5	1.3	14.3	7.4	51.7	5	5	10	70	20	0
03-001-1372	S	10/1	11	159	5	4	1.2	12.4	7.2	57.8	5	4	10	90	0	0
03-001-1457	S	9/28	8	164	5	4	1.1	12.1	7.3	60.7	5	4	0	90	10	0
03-001-1938	S	9/29	9	163	5	5	1.3	12.4	6.9	55.7	6	4	10	90	0	0
03-001-2357	S	10/6	16	171	5	5	1.3	13.6	8.1	59.6	5	5	90	10	0	0
03-001-2434	S	10/7	17	178	5	5	1.3	15.0	8.6	57.1	6	5	0	100	0	0
03-001-2556	S	10/7	17	169	4	5	1.2	13.2	7.9	59.5	6	4	100	0	0	0
03-001-3395	S	10/5	15	176	5	5	1.2	14.1	7.7	54.2	4	4	0	89	11	0
04-003-143	S	10/3	13	177	5	4	1.1	12.8	7.3	56.8	5	4	20	80	0	0

Table 3. Leafing, male and female bloom, and harvest dates at UC Davis during 2010 (in harvest date order).



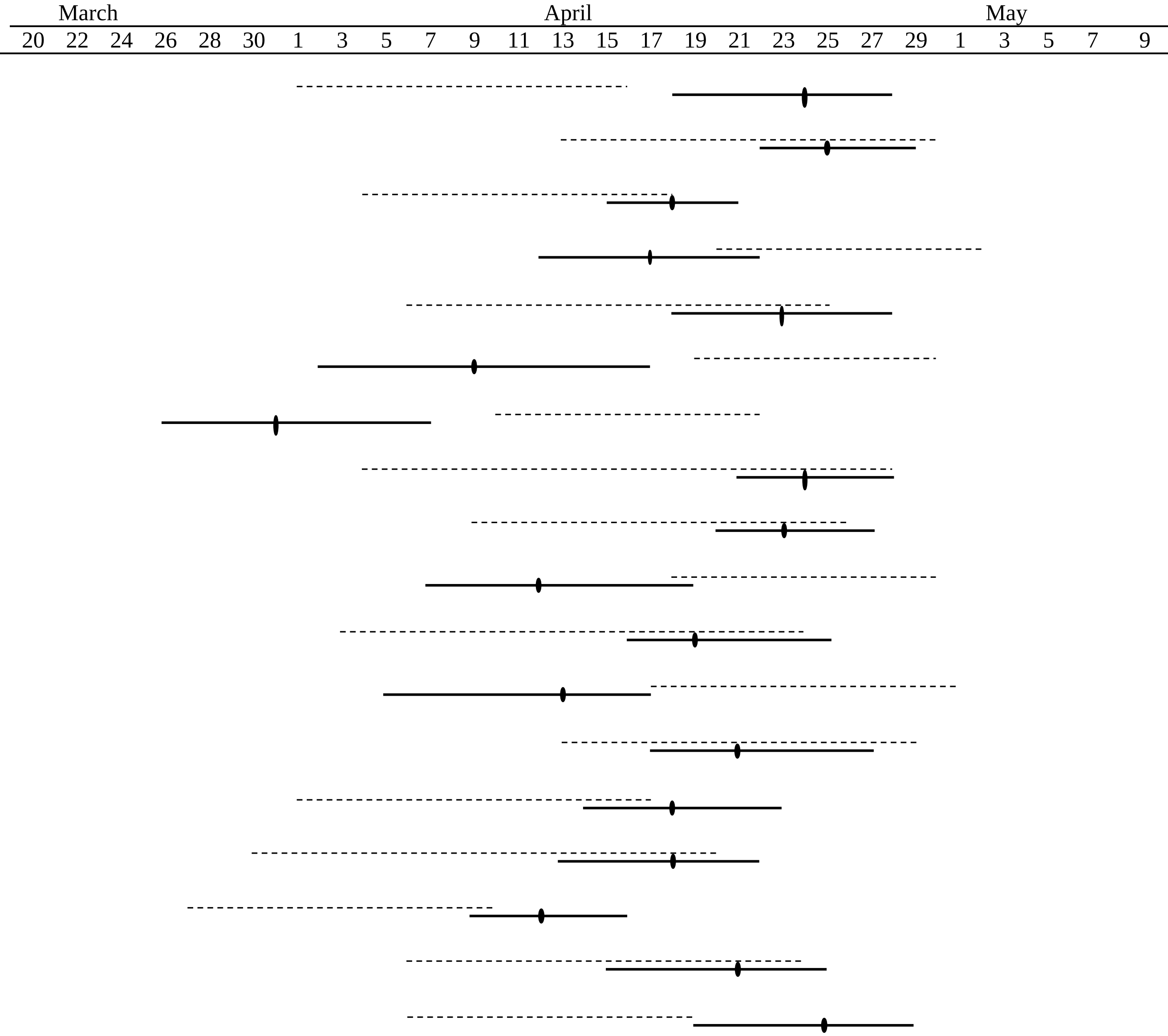
Cultivar/Selection	Leaf Date	Harvest Date
01-007-2	3/22	9/13
00-005-30	3/20	9/15
Ivanhoe	3/18	9/18
00-005-149	3/24	9/18
59-124	3/17	9/19
95-007-13	3/20	9/19
Payne	3/19	9/20
95-026-16	3/23	9/20
Serr	3/19	9/22
90-027-21	3/20	9/22
01-009-10	3/30	9/22
Idaho	3/21	9/23
00-011-107	4/4	9/23
94-019-85	3/17	9/24
Lara`	4/1	9/25
Vina	3/26	9/26
90-027-23	4/5	9/26
94-020-35	3/17	9/26

Table 3. Leafing, male and female bloom, and harvest dates at UC Davis during 2010 (in harvest date order).



Cultivar/Selection	Leaf Date	Harvest Date
95-018-23	4/5	9/26
96-013-13	3/23	9/26
97-003-79	3/23	9/26
98-002-129	3/20	9/26
01-016-11	3/24	9/26
00-006-227	4/5	9/27
Tehama	3/25	9/28
64-057	3/23	9/28
03-001-507	3/24	9/28
03-001-1457	3/24	9/28
03-001-1649	3/29	9/28
93-028-20	3/24	9/29
95-013-6	3/24	9/29
03-001-977	4/5	9/29
03-001-1938	3/21	9/29
Howard	4/6	9/30
95-011-16	3/22	9/30
01-007-3	4/6	9/30

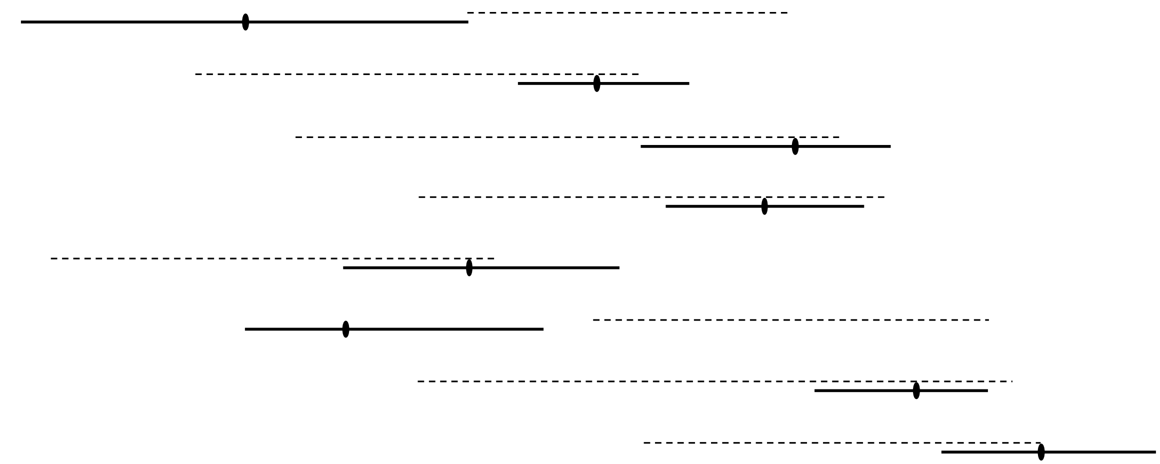
Table 3. Leafing, male and female bloom, and harvest dates at UC Davis during 2010 (in harvest date order).



Cultivar/Selection	Leaf Date	Harvest Date
91-090-41	4/4	10/1
03-001-1372	4/6	10/1
98-001-415	3/25	10/2
98-003-54	4/8	10/2
R. Livermore	4/6	10/3
04-003-143	3/28	10/3
Gillet	3/21	10/4
Hartley	4/3	10/5
03-001-1098	4/2	10/5
03-001-3395	4/1	10/5
Tulare	3/28	10/6
95-026-17	4/4	10/6
97-003-23	3/28	10/6
03-001-2357	3/25	10/6
97-003-11	3/25	10/7
03-001-2434	3/22	10/7
03-001-2556	3/28	10/7
76-080	4/2	10/8

Table 3. Leafing, male and female bloom, and harvest dates at UC Davis during 2010 (in harvest date order).

March: 20 22 24 26 28 30 | April: 1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 | May: 1 3 5 7 9



Cultivar/Selection	Leaf Date	Harvest Date
91-077-40	3/24	10/8
95-024-1	3/24	10/8
Chandler	4/6	10/9
00-006-48	4/9	10/9
Sexton	3/23	10/10
Forde	3/27	10/14
Cascade	4/7	10/15
S. Franquette	4/19	10/18

Location	Variety or Selection	Sample Wt	Nuts per sample	Avg nut wt (g)	% Large	% Med	% Baby	% Large Sound	% Stain	% Broken	% Adh Hull	% External Damage
Davis	Chandler	1002	82	12.2	91	9	0	93	0	0	0	0
Davis	Howard	1002	86	11.7	97	2	1	93	0	0	0	0
Davis	Tulare	1001	73	13.7	100	0	0	98	0	0	0	0
Davis	Sexton	1001	65	15.4	98	0	2	98	0	0	0	0
Davis	Gillet	1000	64	15.6	100	0	0	100	0	0	0	0
Davis	Forde	1002	66	15.2	100	0	0	99	0	0	0	0
Davis	Ivanhoe	1000	77	13.0	99	1	0	98	0	0	0	0
Davis	91-090-41	1001	82	12.2	100	0	0	98	0	0	0	0
Davis	91-096-3	1004	93	10.8	81	16	3	81	1	0	0	1
Davis	93-028-20	1000	80	12.5	98	3	0	97	0	0	0	0
Davis	93-028-20	1001	81	12.4	91	6	2	93	0	0	0	0
Davis	95-007-13	1002	75	13.4	97	3	0	98	0	0	0	0
Davis	95-007-5	1004	80	12.6	100	0	0	96	0	0	0	0
Davis	95-011-16	1002	70	14.3	97	3	0	96	0	0	0	0
Davis	95-026-16	1004	84	12.0	92	5	4	90	0	0	0	0
Chico	Chandler	980	101	9.7	78	19	3	81	0	0	0	0
Chico	Payne	978	100	9.8	84	14	2	82	0	0	0	0
Chico	Hartley	1004	79	12.7	99	1	0	90	0	0	0	0
Chico	Vina	968	100	9.7	75	15	10	78	0	0	0	0
Chico	Tulare	1001	85	11.8	100	0	0	97	0	0	0	0
Chico	Sexton	1003	69	14.5	100	0	0	100	0	0	0	0
Chico	Gillet	1003	71	14.1	100	0	0	98	0	0	0	0
Chico	Forde	1000	70	14.3	99	0	1	98	0	0	0	0
Chico	Ivanhoe	1001	85	11.8	100	0	0	99	0	0	0	0
Chico	91-090-41	1002	95	10.5	98	2	0	97	0	0	0	0

Location	Variety or Selection	% Insect	% Mold	% Shrivel	% Offgrade	% Edible Yield	% Total Yield	Extra Light	Light	Light Amber	Amber	RLI	Relative Value
Davis	Chandler	0	0	0	0	50	50	76	17	8	0	58.2	1.05
Davis	Howard	5	0	3	4	47	49	53	37	7	3	56.5	0.96
Davis	Tulare	1	0	1	2	55	56	58	32	8	2	52.8	1.05
Davis	Sexton	0	0	3	0	51	51	86	9	5	0	52.2	0.97
Davis	Gillet	0	0	0	0	50	50	44	38	14	3	53.2	0.98
Davis	Forde	0	0	2	1	52	52	93	4	3	0	58.0	1.10
Davis	Ivanhoe	0	1	0	1	55	56	70	21	7	2	55.7	1.11
Davis	91-090-41	0	1	1	1	59	60	75	16	5	3	55.7	1.19
Davis	91-096-3	1	0	0	1	50	50	89	7	4	0	58.3	1.05
Davis	93-028-20	0	0	1	0	58	58	89	7	5	0	55.9	1.17
Davis	93-028-20	0	0	0	0	59	59	81	12	6	2	55.2	1.18
Davis	95-007-13	0	0	0	0	57	57	39	46	10	4	51.4	1.06
Davis	95-007-5	0	0	8	1	52	53	72	16	12	0	54.1	1.03
Davis	95-011-16	1	1	0	2	52	53	63	28	9	0	55.2	1.04
Davis	95-026-16	2	0	5	3	48	49	66	9	16	10	53.9	0.94
Chico	Chandler	0	2	1	2	51	52	68	25	7	0	56.2	1.04
Chico	Payne	0	7	5	8	49	53	43	51	6	0	51.5	0.92
Chico	Hartley	0	9	1	10	43	47	48	39	10	3	52.8	0.82
Chico	Vina	0	0	12	4	47	49	54	44	2	0	51.5	0.89
Chico	Tulare	0	0	6	2	54	55	63	30	7	0	52.2	1.02
Chico	Sexton	0	0	0	0	54	54	41	43	12	5	52.5	1.03
Chico	Gillet	0	0	4	0	48	48	74	12	10	4	54.6	0.95
Chico	Forde	0	1	0	1	47	48	44	31	19	6	52.3	0.89
Chico	Ivanhoe	0	0	2	0	58	58	89	8	3	0	56.7	1.19
Chico	91-090-41	0	1	2	1	58	59	57	37	4	2	51.6	1.10

Location	Variety or Selection	Sample Wt	Nuts per sample	Avg nut wt (g)	% Large	% Med	% Baby	% Large Sound	% Stain	% Broken	% Adh Hull	% External Damage
Chico	93-028-20	1000	76	13.2	97	3	0	97	0	0	0	0
Chico	94-019-85	1004	74	13.6	100	0	0	96	0	0	0	0
Chico	95-007-13	1004	83	12.1	98	2	0	94	0	0	0	0
Chico	95-011-16	1000	81	12.3	95	4	1	96	0	0	0	0
KAC	Chandler	1003	103	9.7	63	33	4	65	0	0	0	0
KAC	Howard	1003	90	11.1	93	7	0	93	0	0	0	0
KAC	Serr	1004	84	12.0	95	4	1	97	0	0	0	0
KAC	Tulare	1003	81	12.4	100	0	0	100	0	0	0	0
KAC	Gillet	1002	64	15.7	100	0	0	99	0	2	0	2
KAC	Forde	1004	70	14.3	100	0	0	97	0	0	0	0
KAC	Ivanhoe	1000	84	11.9	100	0	0	98	0	0	0	0
KAC	92-070-12	1004	83	12.1	99	1	0	98	0	0	0	0
KAC	93-028-20	1004	80	12.6	96	1	3	95	0	0	1	1
KAC	95-011-16	1000	68	14.7	99	1	0	99	0	0	0	0
MJC	Chandler	1004	96	10.5	79	19	2	83	1	0	0	1
MJC	Howard	1004	95	10.6	93	7	0	88	1	0	0	1
MJC	Tulare	1004	102	9.8	99	1	0	93	2	0	0	2
MJC	Sexton	1003	75	13.4	100	0	0	96	4	0	0	4
MJC	Gillet	1002	79	12.7	100	0	0	100	0	0	0	0
MJC	Forde	1000	75	13.3	100	0	0	90	7	0	0	7
Visalia	Ivanhoe	1001	85	11.8	99	1	0	93	0	0	2	2

Location	Variety or Selection	% Insect	% Mold	% Shrivel	% Offgrade	% Edible Yield	% Total Yield	Extra Light	Light	Light Amber	Amber	RLI	Relative Value
Chico	93-028-20	0	0	1	0	53	53	93	7	0	0	56.7	1.09
Chico	94-019-85	0	4	3	4	58	60	47	32	18	2	51.9	1.09
Chico	95-007-13	1	2	2	4	55	57	14	35	33	17	49.7	0.99
Chico	95-011-16	0	0	1	0	51	51	83	11	6	0	55.2	1.03
KAC	Chandler	0	0	2	1	46	46	86	11	3	0	56.5	0.95
KAC	Howard	0	0	2	1	48	49	74	18	7	0	54.8	0.96
KAC	Serr	0	0	0	0	57	57	34	35	18	12	50.2	1.04
KAC	Tulare	0	0	1	0	54	54	45	47	6	2	51.6	1.01
KAC	Gillet	0	0	0	0	47	47	38	35	21	6	37.9	0.65
KAC	Forde	0	3	0	3	51	52	40	33	18	8	53.1	0.98
KAC	Ivanhoe	0	1	1	1	55	56	62	32	5	2	54.8	1.11
KAC	92-070-12	0	0	1	0	50	50	68	22	9	0	54.1	0.98
KAC	93-028-20	0	1	4	2	52	53	37	31	30	3	52.7	1.00
KAC	95-011-16	0	0	0	0	54	54	34	43	20	3	51.8	1.01
MJC	Chandler	0	0	0	0	49	49	86	7	6	0	57.4	1.03
MJC	Howard	0	4	2	5	50	52	77	17	6	0	55.0	1.00
MJC	Tulare	0	4	1	4	53	55	69	21	8	3	54.4	1.04
MJC	Sexton	0	0	0	0	57	57	73	20	7	0	54.8	1.13
MJC	Gillet	0	0	0	0	54	54	75	17	8	0	55.9	1.09
MJC	Forde	0	8	0	8	48	52	70	16	11	2	57.1	1.00
Visalia	Ivanhoe	0	4	1	4	55	58	67	22	9	2	56.3	1.13

Location	Variety or Selection	Sample Wt	Nuts per sample	Avg nut wt (g)	% Large	% Med	% Baby	% Large Sound	% Stain	% Broken	% Adh Hull	% External Damage
Woodland B	Chandler	1003	96	10.4	98	2	0	98	0	0	0	0
Woodland A	Ivanhoe	1000	87	11.5	92	7	1	88	0	0	0	0
Woodland B	Sexton	1004	63	15.9	100	0	0	100	0	0	0	0
Woodland B	Gillet	1001	74	13.5	100	0	0	99	0	0	0	0
Woodland A	Forde	1000	61	16.4	100	0	0	100	0	0	0	0
Woodland B	Forde	1000	63	15.9	100	0	0	100	0	0	0	0
Woodland A	95-007-13	1002	71	14.1	100	0	0	100	0	0	0	0
Woodland A	95-011-16	1004	72	13.9	100	0	0	99	0	0	0	0
Woodland C	95-011-16	1004	68	14.8	100	0	0	100	0	0	0	0
Durham	Chandler	1003	91	11.0	97	3	0	93	0	0	0	0
Durham	Howard	919	100	9.2	68	16	16	75	0	0	0	0
Durham	Forde	1004	81	12.4	88	9	4	89	0	0	0	0
Durham	Ivanhoe	1003	93	10.8	91	5	3	86	0	0	1	1
Durham	94-019-85	1004	86	11.7	100	0	0	83	0	0	0	0
Sutter	Juliet	1002	85	11.8	96	4	0	98	0	0	0	0
Contra Costa	Howard	1000	85	11.8	88	9	2	89	0	0	0	0
Contra Costa	92-016-1	1003	86	11.7	84	7	9	83	1	0	0	1
Contra Costa	94-022-24	1001	90	11.1	100	0	0	91	3	0	0	3
Contra Costa	97-027-55	1001	104	9.6	56	24	20	58	1	0	0	1

Location	Variety or Selection	% Insect	% Mold	% Shrivel	% Offgrade	% Edible Yield	% Total Yield	Extra Light	Light	Light Amber	Amber	RLI	Relative Value
Woodland B	Chandler	0	0	1	0	51	51	70	24	5	0	55.2	1.02
Woodland A	Ivanhoe	0	3	3	4	50	52	77	15	7	0	54.9	0.99
Woodland B	Sexton	0	0	0	0	56	56	33	52	9	5	50.2	1.02
Woodland B	Gillet	0	0	1	0	52	52	88	9	2	0	56.7	1.07
Woodland A	Forde	0	0	0	0	53	53	69	18	10	3	52.9	1.01
Woodland B	Forde	0	0	0	0	51	51	72	20	5	2	56.1	1.04
Woodland A	95-007-13	0	0	0	0	56	56	57	27	10	6	58.2	1.19
Woodland A	95-011-16	0	0	1	0	52	52	70	16	12	3	54.8	1.03
Woodland C	95-011-16	0	0	0	0	57	57	82	10	6	2	56.3	1.17
Durham	Chandler	0	4	1	5	49	52	96	2	2	0	56.6	1.01
Durham	Howard	0	0	2	0	49	49	62	32	6	0	52.5	0.93
Durham	Forde	0	1	1	2	49	49	58	35	7	0	56.0	0.99
Durham	Ivanhoe	0	3	6	4	54	56	84	8	5	3	55.7	1.10
Durham	94-019-85	1	17	0	17	55	66	47	30	18	5	51.3	1.02
Sutter	Juliet	0	0	0	0	50	50	41	50	6	3	52.3	0.94
Contra Costa	Howard	0	2	0	2	47	49	15	27	35	23	49.1	0.85
Contra Costa	92-016-1	0	2	1	3	46	47	31	24	42	3	53.0	0.88
Contra Costa	94-022-24	2	6	2	8	50	54	62	25	10	3	54.5	0.99
Contra Costa	97-027-55	0	7	0	7	46	49	0	25	28	47	47.2	0.79