

## **Evaluation of Pistachio Breeding Selections Annual Full Report 2016-17**

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## **SUMMARY**

Evaluation of pistachio advanced female and male scion selections continued in two scientifically-designed trials established in 2007 (called the Buttonwillow trial) and in 2010 (called the Jasmine Trial). These trials are located in “high chill” and “low-chill” sites respectively, and, in total, contain a wide assortment of U.C. cultivars, advanced U.C. selections; and non-U.C. cultivars and varieties such as ‘Kaleghouchi’, ‘Red Aleppo’, ‘Sirora’, ‘Joley’ and ‘Pete 1’. The trees in the Buttonwillow trial are grafted on UCB-1 seedling trees and in the Jasmine Trial on UCB-1 clonal rootstocks. Evaluations in the trials were made, as appropriate for the age of the trees, with a focus on bloom timing, harvest timing, yield and nut quality. Four additional replicated scion trials, one at the U.C. Westside Research and Extension Center near Five Points, CA and three others, on the property of private growers on the west and east sides of the San Joaquin Valley and near Inyokern, were established in 2014, 2015 and 2016 and evaluation will continue in these.

Yield and nut quality were evaluated in the trial near Buttonwillow (west of Bakersfield) for this the fifth harvest season (10<sup>th</sup> leaf). One of the female selections in this trial, formerly known by its selection name of ‘S-43’, has been released to the industry under the name ‘Gumdrop’. ‘Gumdrop’ has demonstrated potentially useful very early harvest with acceptable nut quality characteristics. Two additional male cultivars were also released with ‘Gumdrop’. ‘Tejon’, formerly identified by its selection

name 'N-48', was released as one of the primary pollinizers for 'Gumdrop'. It may be advisable to plant a second pollinizer in 'Gumdrop' orchards to assist with pollination in years of low-chill. Although not a proprietary U.C. cultivars, the male 'Zarand' in low-chill years, appeared to flower earlier than 'Tejon' and more closely matched the early bloom period of 'Gumdrop'. 'Gumdrop' currently, is ready for harvest before the commercial nut processing plants are ready to accept nuts. 'Gumdrop' should only be planted by grower operations having access to a plant that is capable of processing the nuts of this cultivar when they are ready for harvest. Nuts do not 'store' well on the tree for this variety.

Another male pollinizer, formerly identified by the name 'B19-69' in earlier selection trials, was released as an adjunct pollinizer for 'Kerman' under the name 'Famoso'. 'Famoso' has proven in previous randomized and replicated trials to have a similar bloom time to 'Kerman' (see 'B19-69' in previously published reports to the pistachio industry at <http://www.acpistachios.org/Industry/research/>). Testing of 'Famoso', pollen for germination and durability was done in 2014 and 2015, along with a number of other potential 'Kerman' pollinizers, and has performed well. In one of our evaluation trials, 'Famoso', 'Peters' and 'Kerman' were treated with winter oil. The bloom period of 'Famoso' matched that of 'Kerman' more closely than did that of 'Peters', which suggests its chill requirement is more similar to 'Kerman' than is 'Peters'. 'Famoso' is also precocious, flowers profusely and was placed in additional experimental trials in 2014 and 2015, along with other potential 'Peters' replacements. These other potential 'Peters' replacements were selected, during low-chill years, for early flowering from time of grafting, high flower production, and evenness of bloom.

In 2016, the first experimental harvests were conducted in the Jasmine trial east of Delano CA near Highway 65. This trial was in 7<sup>th</sup> leaf in 2016.

As part of this project, a seedling trial (i.e. potential scions growing on their own roots) continued to be evaluated west of Wasco, California. The first of these trees were planted April 4, 2012. The parent material includes 1.) progeny from U.C. breeding selections that appear well-adapted to the San Joaquin Valley with a range of bloom/harvest maturity dates and nut quality characteristics; 2) other varieties currently being grown in California including 'Kaleghouchi' and 'Aria'; and 3) later flowering male and female selections that may produce offspring better adapted to elevations in California where early frosts and late frosts have been a problem and 4) second-generation interspecies hybrids that may have a reduced chill requirement. As these seedlings bloom and produce nuts, those with commercial potential will be placed in scientifically designed trials at various locations in California. Some of these selections will be planted in a new trial selecting for low-chill tolerance, planned for 2017.

As part of the breeding program, seeds originating from breeding crosses made in 2011 are now being trialed as experimental rootstock trees. These trees are now present in six (6) trials located throughout Kern County, including a site near Rosamond, California. All of these trials are now budded to 'Kerman', 'Golden Hills' or 'Lost Hills', the earliest in 2012. Additional rootstock trials are planned. The objectives of the rootstock evaluation will be to identify breeding lines or individual trees that may confer greater cold and salt tolerance, comparable Verticillium wilt and Phytophthora crown rot resistance to that possessed by existing commercial rootstocks, and which will form a smoother, more uniform graft union with new cultivars such as 'Golden Hills', 'Lost

Hills’ and ‘Kaleghouchi’, than do existing rootstocks.

## **FULL REPORT**

### **PROBLEM AND ITS SIGNIFICANCE TO THE INDUSTRY**

The California pistachio industry has a few cultivars and rootstocks that are well-suited to producing pistachios in the San Joaquin Valley. However, a perfect cultivar or rootstock for all conditions does not exist. A given cultivar or rootstock, usually, is superior in some traits and inferior in others. A mature industry should have a large number of cultivars and rootstocks that growers can choose from to maximize the opportunity for the best possible production in a given location. Desirable traits that growers have mentioned that would be useful in new cultivars include the following:

1. earlier or later harvest to extend the harvest season.
2. later flowering that would miss late frost events common at higher elevations in California
3. less alternate bearing
4. lesser chill requirement
5. a kernel with greater internal green coloring for use in pastries etc.
6. more intense flavor
7. higher yielding

Desirable characteristics in new rootstocks would include the following:

1. easier passage into winter dormancy not requiring irrigation shutoff or tree defoliation.
2. greater cold tolerance.
3. greater salt tolerance.
4. equal Verticillium wilt and root rot resistance to existing commercial rootstocks
5. slower exit from dormancy in the spring delaying flowering in high elevation plantings.
6. faster initial growth to encourage earlier initial nut production.
7. smoother and more uniform graft union with new cultivars.

### **METHODS AND MATERIALS**

#### **Existing advanced-selection evaluation trials with trees on rootstocks**

At the present time, this project includes evaluation of two bearing advanced selection trials, established in 2007 in the Buttonwillow area (called the Buttonwillow Trial) and 2010 near the intersection of Highway 65 and Garces Highway in Kern County (called the Jasmine Trial). Five additional trials, one at the U.C. Westside Research and Extension Center near Five Points, CA and four others, on the property of private growers on the west and east sides of the San Joaquin Valley, were established in 2014, 2015 and 2016 and evaluation will continue in these as well.

The Buttonwillow trial site is the oldest and the current center of attention. Relative to

the southern San Joaquin Valley, the Buttonwillow site would be characterized as a ‘high winter chill’ area and the Jasmine site as ‘low chill’. Pistachio, of course, requires considerable winter chilling for uniform flowers and nut set. The Buttonwillow trial is composed of the following plant material: six second-generation U.C. advanced selections; two selections obtained from the U.S.D.A. pistachio germplasm repository located in Davis California; and Golden Hills and Kerman as controls. The Jasmine trial contains the following selections and cultivars:

- several of the most promising second-generation U.C. advanced selections that exist in the Buttonwillow trial;
- several first-generation U.C. advanced selections from the 1990 seedling trials including the first from one of the original seedling trials located at the U.C. Kearney Agricultural Center;
- a number of existing selections, cultivars or varieties such as ‘Red Aleppo’, ‘Pete 1’, and ‘Joley’ that have been grown commercially or observationally in relatively small numbers across the state in the past but rarely, if ever, in replicated trials in the San Joaquin Valley;
- a bud sport from ‘Kerman’ with earlier bloom and harvest dates and appears to be precocious.
- existing cultivars such as ‘Kerman’, ‘Kalehghouchi’, ‘Lost Hills’ and ‘Golden Hills’.

Each of these advanced-selection trials are randomized and replicated scientifically-designed trials. The trees in the Buttonwillow trial are on UCB-1 seedling trees and some have exhibited problems with uniformity with some selections. The trees at the Jasmine trial are grafted onto UCB-1 clonal rootstocks and appear uniform. Evaluations in these trials were made, as appropriate for the age of the trees, with a focus on bloom timing, harvest timing, yield and nut quality.

The Buttonwillow trial is a replicated, randomized complete block design. There are three replicates of each variety in the trial with six trees in each replicate. The male pollinators are ‘Peters’ and ‘Randy’ and, an early blooming ‘N-48’ (grafted in 2012). Flowering data at the Buttonwillow trials has been collected since 2012 (except in 2013 due to an injury sustained by the principal observer) using the scoring system found in Table 1. Harvest readiness was determined when the nut hull began slipping on a majority of the nuts on the trees of each selection. In 2012, the trees were harvested with poles and nuts collected on tarps, and in 2013 through 2016 using a mechanical pistachio shaker and catcher. Leaf litter and other trash were separated from nuts. The harvested nuts (i.e. raw green nut yield) were weighed and a 20 lb. sample was removed and sent to cooperating nut processors for post-harvest processing and quality evaluation (grade out). From this data, dry weight yield, edible yield (also known as grower paid yield), percent edible in shell split nuts, percent insect damage, percent dark stained, percent loose shells and kernels, average nut weight and other nut quality characteristics were calculated, statistically analyzed, summarized and compared against data from ‘Kerman’ and ‘Golden Hills’ as standard treatments in the trial. Other cultural, disease, pest-related, and other concerns were also noted. In 2016, as was the case in 2015, based on previous evaluations, only ‘Golden Hills’, ‘Kerman’ and ‘S-43’ were harvested in this trial. ‘S-43’ was released to the industry by U.C. in late July of 2016, and named ‘Gumdrop’.

Several of the other selections in this trial have attractive characteristics, perhaps suitable for further breeding efforts, but overall, do not appear to be commercially viable.

## RESULTS

### **Sixth through 10<sup>th</sup> leaf bloom and harvest data for the Buttonwillow advanced selection trial.**

Bloom data of selected varieties in the trial are presented in Table 2. Golden Hills is a proprietary U.C. cultivar while ‘Kerman’, the industry standard, is not. While not appearing in the data tables this year due to poor yield performance, the trial also contains a number of other selections, including two from the U.C. collection and Pistachio repository at Davis (PI 223849 and Damghan). ‘PI 223849’ and ‘Damghan’ both appear to require a long chill period and these trees did not leaf-out until relatively late in the year in 2014 and 2015. ‘S-43’, now released to the industry under the trade name ‘Gumdrop’. To better pollinize ‘Gumdrop’ ‘N-48’, which had demonstrated earlier bloom than ‘Randy’ in more ‘normal’ chill years in another experimental location, was selected as a possible better pollinizer for ‘Gumdrop’ than ‘Randy’. ‘N-48’ was grafted in 2012 onto some of the ‘Randy’ trees in this trial, as a better potential pollinizer for ‘Gumdrop’. Based on the performance of ‘N-48’ in this trial and in laboratory pollen germination tests, it was released by U.C. to the pistachio industry in July of 2016, under the trade name ‘Tejon’. As noted above ‘Tejon’ was selected as the pollinizer for ‘Gumdrop’ after the trial was established and during a period of relatively sufficient chill. Note in Table 2, in 2014 and, especially in 2015, both years in which chill appeared to be inadequate, that ‘Tejon’, our chosen pollinizer for ‘Gumdrop’, did not demonstrate as good a bloom synchrony with ‘Gumdrop’ as would be desired. ‘Gumdrop’, bloomed very early and did not overlap ‘Randy’ well during bloom in 2012. Likewise, ‘Randy’, selected as a pollinizer for ‘Golden Hills’, was behind its female cultivar, and ‘Peters’ the pollinizer for ‘Kerman’, was behind its female cultivar. ‘Tejon’ bloom overlapped that of ‘Gumdrop’ much better in the more ‘normal’ chill year of 2016 (see Table 2). These observations suggests that in years of deficient chill, an earlier blooming male selection should be present in the orchard in addition to the pollinizer selected for years of adequate chill. For example, in low-chill years, ‘Randy’ would be the ‘early’ blooming male for ‘Kerman’ orchards and ‘Tejon’ the early male for ‘Golden Hills’ and ‘Lost Hills’ orchards. In a similar way, an earlier blooming male than ‘Tejon’ would be available for ‘Gumdrop’ in low-chill years. ‘Zarand’ appears to be an adequate choice as the very early blooming male in ‘Gumdrop’ orchards in addition to the male ‘Tejon’. ‘Zarand’, unlike ‘Gumdrop’ and ‘Tejon’ is not a patented U.C. cultivar, and should be commercially available from some commercial nurseries as additional budwood is produced.

Note that ‘Gumdrop’, on average, was at full bloom 10 days before ‘Kerman’ (see Table 2), on average during 2012, 2014-2016. In 2015, despite the low chill, ‘Gumdrop’ bloomed early and evenly. ‘Gumdrop’ appeared to have been less affected by low chill than the other cultivars in the trial based on evenness of bloom between the south and north sides of the tree. ‘Tejon’, its pollinizer, was far enough behind ‘Gumdrop’ in 2015, that the yield of ‘Gumdrop’ may have been adversely affected by lack of pollen. This

underscores the need for a very early blooming male for the selection for very low-chill years. Additionally, because 'Tejon' was grafted into the orchard late and only on existing 'Randy' trees, there is not much 'Tejon' wood in the orchard, further limiting pollen availability for this early-blooming female. In 2016, the male pollinizers for each variety bloomed much more synchronously with their female counterparts (Table 2).

Trees at the Buttonwillow location (i.e. low elevation lake bed with heavy soil) tend to be harvested later than in mid-elevation pistachio-growing areas with loamy soils in Kern County. Generally, relative differences in harvest dates among a group of cultivars of similar age at a given location remain relatively constant. For example, once trees reach 8 or 9 years of age, 'Golden Hills' will be harvestable 12 to 14 days ahead of 'Kerman' trees of the same age at a given location, but the actual harvest calendar date of 'Golden Hills' and 'Kerman', will vary depending on the orchard locations. The variety 'Gumdrop' was ready for harvest, on average, 11 days before 'Golden Hills' and 20 days before 'Kerman' (see Table 4). 'Gumdrop' yield and nut quality are interesting because 1) the harvest date is very early, and 2) harvest and nut quality characteristics are similar to those of 'Golden Hills' and 'Kerman' (see Tables 3 and 4). 'Gumdrop' produces a gum on the hulls which is not desirable but, which in looking at the nut quality data in Table 4, has not affected quality greatly. All pistachio selections/cultivars produce some gum on the hulls, but 'Gumdrop' produces more than either 'Golden Hills' or 'Lost Hills'. 'Gumdrop' exhibited unusual precociousness and produced the most yield in 2013 of the varieties being trialed, but currently, as of the 2016 harvest, there is not significant difference in yield among these three cultivars. The earlier maturing cultivars, such as 'Golden Hills' and especially 'Gumdrop' mature during the heat of the summer, whereas, 'Kerman', frequently, when temperatures are starting to drop. It is easier to predict when harvest readiness will occur with these earlier-maturing cultivars due to the more uniform heat conditions during nut-fill than with 'Kerman'. However, once the nuts reach maturity, the hulls dry faster and the nuts do not store as well on the tree when summer temperatures are near their maximums. For this reason, 'Gumdrop' should be harvested immediately when it reaches harvest maturity and it appears that it would be better to err on the side of too early than too late. Because 'Gumdrop' has been ready for harvest so early, harvest has had to be delayed for this variety, because processing plants, with their sample hullers and expert nut evaluators which we need to evaluate nut quality, were not yet open. These delayed harvests appeared to have impacted nut quality of 'Gumdrop' to some degree. 'Golden Hills' continued to demonstrate excellent nut quality characteristics comparable or better than the other selections in the trial. However, the very early harvest of 'Gumdrop' in combination with its very good yield and nut quality characteristics, could prove valuable in extending the harvest season, reducing peak demand for harvest resources, which occurs during the 'Kerman' harvest. As mentioned earlier, yield may have been impacted in 'Gumdrop' as a result of a deficit of early pollen for this selection at bloom. 'Golden Hills' and 'Gumdrop' have a greater inshell split nut percentage than does 'Kerman' and nut size is similar among these three cultivars (see Table 5).

Tree uniformity on the UCB-1 seedling rootstocks in this trial has been a problem, and appears to be greater with the 'Gumdrop' selection. Finding a rootstock or rootstocks with better compatibility characteristics with many of the new scion cultivars remains a worthwhile research objective. 'Gumdrop' grows more quickly than 'Golden Hills' or

‘Kerman’. ‘Gumdrop’ had a greater scion trunk circumference than either Kerman or Golden Hills and a greater tendency to outgrow the UCB-1 seedling rootstock (see Table 5).

Evaluations of ‘Gumdrop’ compared to ‘Golden Hills’ and ‘Kerman’ will continue in upcoming seasons.

### **Seventh leaf bloom and harvest data for the Jasmine advanced selection trial.**

Bloom and yield at this site have been disappointing at Jasmine and the cause is undoubtedly related to the lack of sufficient chill at this location in 2014 and 2015. This trial contains a number of pistachio cultivars and pistachio advanced selections. Selections from the UC Breeding Program that have not proven to have commercial potential in earlier, older trials, are not reported herein. Bloom data collected from 2014-2016 appear in Table 6. The earliest blooming female in the trial is what appears to be a bud sport of Kerman, called ‘Velez’ with a U.C. breeding selection ‘KB25-78’ not far behind. The males ‘Tejon’ and ‘B16-58’ in the trial appear, as of this stage of the trial, to bloom more or less synchronously with ‘Velez’ (see Table 6). ‘Kerman’, ‘Pete 1’ and ‘Golden Hills’ have been the latest to be at full bloom in this trial.

In this trial, only in 2016 have there been enough nuts on the tree to warrant harvest of some cultivars and selections. Note that some varieties still did not have enough nuts for a commercial harvest in these 6-year-old trees (seventh leaf) (see Table 7). ‘Velez’ after this single year of harvest is statistically tied with Lost Hills for highest edible yield (see Table 7). Nut quality data for the cultivars and selections in this trial appear in Table 8.

### **The recently released ‘Famoso’ male pollinizer.**

A number of growers have expressed concern that the ‘Peters’ male is not as precocious as ‘Kerman’, is more variable in its response to chilling than is ‘Kerman’, and does not produce enough flowers to adequately pollinate ‘Kerman’. A potential replacement or adjunct pollinizer for the ‘Peters’ male, ‘B19-69’ has proven in previous randomized and replicated trials to have a similar bloom time to ‘Kerman’ and to produce viable and adequate quantities of pollen. It is also precocious (Peters is not), and has profuse flowering. To continue the testing of this selection it was placed in an experimental trial in 2014 along with ten (10) other advanced selection males in undulating topography near Highway 65 in Kern County. An additional trial composed of some of these males and additional males was established in 2015 approximately 20 miles west of Delano, CA. These males, other than ‘B19-69’, were selected during the low-chill winters of 2012-13 and 2013-14 and appear to be much less affected by chilling than ‘Peters’. Testing of ‘B19-69’, pollen for germination and durability was completed during bloom of 2014 and 2015. For potential early adopters, ‘B19-69’ was released to the pistachio industry in July of 2016 with the name ‘Famoso’. Several nurseries have begun the effort to produce sufficient budwood for commercial planting.

## **EFFORTS TOWARD THE FUTURE –Breeding Efforts for New Scions and rootstocks**

### **Methods and Early Progress**

#### **Evaluating New Seedling Scions (the nut producing part of the tree)**

Additional breeding crosses for new scions were made in spring of 2009 and 2011 and again in the spring of 2016. These breeding crosses were made among trees having genetic material originating from previously developed pistachio genetic material and existing plant materials. The crosses in 2009 and 2011 were made among U.C. breeding crosses that appear well-adapted to the San Joaquin Valley, other varieties currently being grown in California including ‘Kaleghouchi’ and ‘Aria’; and late-flowering male varieties which may provide female cultivars that flower later that would be useful for planting at higher altitudes where late frosts are a problem. Desirable traits that would be of value in future cultivars include the following: later bloom and harvest time than ‘Kerman’, later bloom and similar harvest time to ‘Kerman’, similar bloom timing and earlier harvest than ‘Golden Hills’ or ‘Aria’, less tendency to alternate bear as typified by ‘Lost Hills’, the large nut size and shape of ‘Kaleghouchi’ into cultivars with different harvest windows and reduced rank tree growth, less susceptibility to *Alternaria* late blight, the white nut shell of ‘Aria’ and more. The crosses, accomplished in 2011, were made with these objectives in mind. Most of the seeds originated from closed crosses between two parents, but some are from open crosses with females that have produced promising potential selections in the past. The trees (approximately 760 in total), which are being evaluated as potential scions, were planted in a grower cooperator’s orchard west of Wasco CA near Interstate 5 in April and October of 2012. These seedling trees continue to grow thanks to the efforts of our cooperating grower and funding supplied by the California Pistachio Research Board. Phosphorous acid is being applied to prevent *Phytophthora* crown rot which is a hazard for scion seedlings planted on their own roots. Some of these planted trees have flowered in 2016. Most of these earlier flowers were males although a few were female. Evaluations will continue in this trial in 2017. Many of these trees are very early bloomers.

Many of the breeding crosses made in 2016 were designed to produce experimental trees that may require less winter chilling to produce a commercial crop of pistachio nuts. Adequate chilling for pistachio in the San Joaquin Valley of California has been increasingly problematic over the past few years, and may become more of a problem in the future if some forecasters of climate change are correct. Testing of these experimental trees and other selected U.C. produced trees from previous research evaluations, along with existing cultivars and other *Pistacia* species as controls, will begin to take place in the San Joaquin Valley and in the Coachella or Imperial Valley, hopefully, in 2017.

#### **Novel Rootstock Development**

We, also, made some experimental crosses with the objectives of helping us understand how important the rootstock’s ability to enter fall dormancy along with the



scion is in frost avoidance or tolerance and toward finding a rootstock that will produce a smoother graft union with the new cultivars. These crosses were made in 2011 to create rootstock 'learning tools' and, possibly, a useful rootstock for low-elevation salty orchards. The nature of the crosses, however, may reduce Verticillium wilt or Phytophthora root-rot resistance. Representative rootstock trees from the two older breeding lines were challenged with microsclerotia and conidia produced from an isolation made by U.C. Farm Advisor Joe Nunez (UCCE Kern County) of *Verticillium dahliae* in pots in 2010 through 2014. Identification of resistant lines would be useful in selecting lines for placement in field trials and as a guide in future breeding efforts.

Currently, five rootstock trials, with novel germplasm, in the San Joaquin Valley, and one other near Rosamond east of the Tehachapi Mountains exist. One previous trial was terminated when the orchard that contained it was removed as a result of a defective commercial rootstock. The newest trial has a U.C. experimental scion ('Gumdrop' and its associated males) grafted onto U.C. experimental rootstocks. Observations have been made on growth characteristics such as vigor, leaf type and branching. All of the remaining five trials have been budded to 'Kerman', 'Lost Hills' or 'Golden Hills'. Some selections have been made and efforts are underway to clone those that appear to be the most promising for additional greenhouse and field testing of cold, salt, disease resistance, productivity and other rootstock-related characteristics in replicated scientific trials grafted with the newer cultivars. A growth chamber was built in 2014 for cloning by rooting some of these materials and this effort has been a new learning process in itself. Generally, at his writing, cloning by conventional plant propagation techniques has not been very successful. However, some clones have been produced using 'air-layering'. Two of the older crosses appear to produce very uniform seedlings and may produce novel commercial rootstocks without cloning in a similar fashion to how some *P. integrissima* seedlings or UCB-1 seedling are currently produced. More of these seeds were produced through crossing the parent trees in the spring of 2016 and the seeds harvested in the fall of 2016. These seedlings are scheduled for germination and planting in the spring of 2017, and, hopefully, will find homes in U.C research and extension centers or in private growers fields, under U.C. test agreement, in 2017 or early 2018.

The principal focus of the rootstock evaluation will be to identify trees that are able to maintain adequate productivity, possess greater cold and salt tolerance and which, most importantly, will form a smoother graft union when grafted with new cultivars such as 'Golden Hills', 'Lost Hills', 'Kalehghouchi' and any new cultivars coming out of the U.C. breeding program. Most of these experimental rootstocks, with UCB-1 rootstocks as controls, have been planted in low-elevation areas on the west side of the San Joaquin Valley in soils undergoing reclamation to counter highly elevated salinity. These locations should be ideal in assisting us in understanding Winter Juvenile Tree Dieback from the rootstock perspective. This dieback problem appears to be an increasing problem in the SJV as the drought continues. One of the rootstock trials, planted in the late fall of 2011, using 'Golden Hills' as the scion, may produce harvestable yield in 2017, at which point comparisons can be made with the UCB-1 seedling controls in this trial.

#### Additional Efforts

A site is under development on the U.C. Westside Research and Extension Center (REC)

where additional pistachio selection material from many of the scattered test plots of this project is being collected and further tested. At this site at the Westside REC an additional randomized and replicated scion trial has been established (in 2015) largely made up of plant materials selected from seedling trees in the precocious-seedling trial established at the research center in 2008. Selections in this trial have been grafted onto rootstocks. As well, the older precocious seedling trial is currently serving double duty. Although not part of this funded project, Dr. Richard Michelmore, a well-known plant geneticist and his staff, have been making efforts to correlate phenotypic characteristics with the genomic sequences of selected seedlings in this older trial.

## **TABLES**

Table 1. Flower emergence scores.	
Scoring number	Degree of Flowering
0	Dormant or red bud
1	Green tip
2	Early bloom, some open with pistils or pollen showing
3	Mid bloom, 50% open
4	Full bloom, 80% open
5	Late Bloom, 100% open or finished

Table 2. Full bloom timing for Kerman, Golden Hills and Gumdrop in the Buttonwillow plot for 2014, 2015, 2016 and average bloom date for the years 2012, 2014, 2015 and 2016.					
Variety	Full bloom date, 2014	Full bloom date, 2015	Full bloom date, 2016	Ave. full bloom date <sup>A</sup>	Average full bloom date, days from Kerman <sup>B</sup>
Golden Hills	3/30	4/1	3/25	4/1	-5
Gumdrop	3/25	3/22	3/21	3/27	-10
Kerman	4/5	4/9	3/31	4/6	-
Peters (male)	4/11	4/13	3/31	4/10	4
Randy (male)	4/5	4/9	3/24	4/4	-2
Tejon (male)	3/29	3/31	3/20	3/28	-9
<p><sup>A</sup> This average is for 2012, 2014, 2015 and 2016 only. Full bloom dates were not evaluated in 2013. The difference in bloom between the north and south sides of the trees was large in 2012, 2014 and 2015 as a result of insufficient winter chilling, making the determination of an average bloom date for the entire tree more difficult. Tejon was not present in the orchard in 2012. Average for Tejon is for 2014, 2015 and 2016 only.</p> <p><sup>B</sup> This is the approximate average days from Kerman that the variety was first ready for harvest from 2012-2014. A positive value indicates the bloom date was after Kerman – a negative value before Kerman.</p>					

Table 3. Average harvest readiness date, hulling percent, edible yield percent and cumulative edible yield in lbs. per acre from 2012 through 2016 of 6 <sup>th</sup> through 10 <sup>th</sup> leaf pistachio cultivars in the Buttonwillow Trial. Buttonwillow, Kern County, CA.					
Variety	Ave. harvest date	Ave. harvest date, <sup>A</sup> days from Kerman	Ave. hulling weight, % <sup>B</sup>	Ave. edible weight, % <sup>C</sup>	Cumulative edible yield, lbs./acre <sup>D</sup>
Golden Hills	Aug. 29	-11	39.3 a <sup>E</sup>	35.7 a	9632 a
Gumdrop	Aug. 20	-20	36.7 b	32.2 b	9899 a
Kerman	Sept. 9	---	37.1 b	28.5 c	8293 a

<sup>A</sup> This value is the approximate average number of days from Kerman that the variety was first ready for harvest from 2012-2016. A negative sign refers to days earlier than Kerman.

<sup>B</sup> This is the percent of total green harvested material remaining immediately after initial hulling (dry weight adjusted to 5% moisture).

<sup>C</sup> This is the percent of the total green harvested material that is edible weight (i.e. yield) adjusted to 5% moisture.

<sup>D</sup> This is the cumulative edible weight (i.e. yield), in lbs. per acre, adjusted for 5% moisture and corrected for the percentage of male trees per acre in the orchard.

<sup>E</sup> Values followed by different letters in the same column denote significant differences by Fisher's protected LSD test at  $P \leq 0.05$ .

Table 4. Average nut quality characteristics from 2012 through 2016 of 6 <sup>th</sup> through 10 <sup>th</sup> leaf Golden Hills, Gumdrop and Kerman pistachio at the Buttonwillow Trial. Buttonwillow, Kern County, CA.							
Variety	Inshell split nuts, %	Insect damage, %	Loose shells and kernels, %	Dark stained shells, %	Harvested blank nuts, %	Adhering hull, %	Number of nuts per oz.
Golden Hills	86.9 b <sup>A</sup>	0.5 a	0.3 a	0.6 a	4.1 a	0.7 a	21.0 a
Gumdrop <sup>B</sup>	85.1 b	0.9 ab	0.8 b	1.2 b	6.4 b	1.5 b	20.8 a
Kerman	69.8 a	1.4 c	0.3 a	0.3 a	10.5 c	2.2 b	20.7 a
<sup>A</sup> Values followed by different lower-case letters in the same column denote significant differences by Fisher's protected LSD test at $P \leq 0.05$ . <sup>B</sup> Note that Gumdrop, due to lack of availability of commercial harvest evaluation equipment at its early harvest date, has been harvested (except in 2016) a week to two weeks later than would be desired for optimal crop quality over the past three years. The multiple harvest readiness dates among selections in trials makes timely harvests challenging and more expensive.							

Table 5. Scion and rootstock circumference and the ratio of the scion to rootstock for Golden Hills, Gumdrop and Kerman on UCB-1 seedling rootstock as measured 10 cm above and below the graft union as measured on June 6, 2016. Buttonwillow Trial – Kern County CA.			
Variety	Scion circumference, cm	Rootstock circumference, cm	Ratio of scion to rootstock
Golden Hills	49.0 a	49.3 a	1.00 a
Gumdrop	63.1 b	54.8 b	1.15 b
Kerman	48.2 a	51.8 ab	0.93 a

Table 6. Full bloom timing for pistachio cultivars and selections at the Jasmine trial (Kern County) for 2014 (5 <sup>th</sup> leaf), 2015 (6 <sup>th</sup> leaf), and 2016 (7 <sup>th</sup> leaf). The Jasmine trial was planted in 2010.				
Variety	Male of female	Bloom density, rating 1 to 5 <sup>A</sup>	Full bloom date, 2016	Average full bloom date, days from Kerman <sup>B</sup>
Kerman	F	2-3	3/31	-
Pete 1	F	2-3	3/31	0
Velez	F	4	3/19	-12
Joley	F	1	3/28	-3
Kalehghouchi	F	2	3/26	-5
KA22-80	F	2	3/29	-2
Sirora	F	-	No bloom	-
Red Aleppo	F	-	No bloom	-
Ruehle	F	-	No bloom	-
KB25-78	F	3-5	3/20	-11
Golden Hills	F	2-3	3/31	0
Lost Hills	F	3-4	3/29	-2
Peters	M	1	4/5	5
Randy	M	3-4	3/22	-9
B16-30	M	3-4	3/22	-9
B16-58	M	4	3/20	-11
Pete 1 male	M	2-3	3/23	-8
Tejon <sup>C</sup>	M	3	3/20	-11
<sup>A</sup> Rated relative to flower density of the cultivar with the most flowers (1 lowest, 5 highest) <sup>B</sup> A negative sign denotes a full bloom date that many days before Kerman. <sup>C</sup> Tejon not grafted into trial until 2012.				



Table 7. Average harvest readiness date, hulling percent, edible yield percent and cumulative edible yield in lbs. per acre in 2016 (7 <sup>th</sup> leaf) from the first harvest pistachio cultivars and advanced selections of the Jasmine trial. Kern County					
Variety	Ave. harvest readiness date <sup>A</sup>	harvest date, <sup>B</sup> days from Kerman	Hulling weight, % <sup>C</sup>	Edible weight, % <sup>D</sup>	Edible yield, lbs./acre <sup>E</sup>
Kerman	Sept. 11	-	41.0 b <sup>F</sup>	29.3 ab	916 a
Pete 1	Sept. 12	1	37.4 a	27.1 a	770 a
Velez	Aug. 23	-19	39.3 ab	36.0 c	2400 c
Joley	*	*	*	*	*
Kalehghouchi	*	*	*	*	*
KA22-80	*	*	*	*	*
Sirora	*	*	*	*	*
Red Aleppo	*	*	*	*	*
Ruehle	*	*	*	*	*
KB25-78	Sept. 9	-2	38.3 a	26.5 a	1019 a
Golden Hills	Aug. 25	-17	37.6 a	32.2 bc	1264 ab
Lost Hills	Aug. 28	-14	37.7 a	34.4 c	1852 bc

<sup>A</sup> \*, denotes insufficient yield for harvest evaluations.

<sup>B</sup> This value is the approximate average days before Kerman that the variety was first ready for harvest from 2012-2016. A negative sign refers to days earlier than Kerman.

<sup>C</sup> This is the percent of total harvested green material remaining immediately after initial hulling (dry weight adjusted to 5% moisture).

<sup>D</sup> This is the percent of the total green harvested material that is edible weight (i.e. yield) adjusted to 5% moisture.

<sup>E</sup> This is the cumulative edible weight (i.e. yield), in lbs. per acre, adjusted for 5% moisture and corrected for the percentage of male trees per acre in the orchard.

<sup>F</sup> Values followed by different letters in the same column denote significant differences by Fisher's protected LSD test at  $P \leq 0.05$ .

Table 8. Average nut quality characteristics from the first harvest (7 <sup>th</sup> leaf) of pistachio cultivars and advanced selections of the Jasmine trial. Kern County								
Variety	Inshell split nuts, %	Insect damage,%	Edible closed shell, %	Loose shells and kernels, %	Dark stained shells, %	Harvested blank nuts, %	Adhering hull, %	Number of nuts per oz.
Kerman	49.6 d <sup>A</sup>	0.3 ab	42.8 d	0.0 a	0.6 a	4.7 a	0.2 a	18.7 ab
Pete 1	65.4 bc	0.6 b	10.2 ab	0.2 ab	2.9 b	18.8 c	1.0 a	17.7 a
Velez	88.5 a	0.3 ab	2.9 a	0.8 bc	0.6 a	4.5 a	1.2 a	19.7 bc
Joley	*	*		*	*	*	*	*
Kalehghouchi	*	*		*	*	*	*	*
KA22-80	*	*		*	*	*	*	*
Sirora	*	*		*	*	*	*	*
Red Aleppo	*	*		*	*	*	*	*
Ruehle	*	*		*	*	*	*	*
KB25-78	54.3 cd	0.2 ab	28.6 c	0.1 a	1.2 a	14.2 b	0.4 a	18.7 ab
Golden Hills	76.8 ab	0.1 a		0.1 a	0.4 a	4.9 a	0.2 a	20.7 c
Lost Hills	89.7 a	0.2 ab		0.9 c	0.6 a	5.0 a	0.8 a	18.7 ab
<sup>A</sup> Values followed by different lower-case letters in the same column denote significant differences by Fisher's protected LSD test at $P \leq 0.05$ .								