UNIVERSITY OF CALIFORNIA ANR
COOPERATIVE EXTENSION

Pistachio Cultivars in California

Craig Kallsen, UCCE Farm Advisor, Kern County

Dr. Dan Parfitt, Pistachio Breeder, UC Davis Plant Science Dept.

Joseph Maranto, UC ANR CE Farm Advisor, Kern County emeritus

Dr. Brent Holtz, UC ANR County Director and Farm Advisor, San Joaquin County

Craig Kallsen, office phone 661-868-6221; cekallsen@ucanr.edu

Special thanks to all of our grower cooperators, pistachio nut processors and to the California Pistachio Research Board, who and which, have made this research possible.

Partial List of Female and Male Pistachio Cultivars Grown in California with approximate acreage in 2016.

Cultivar	Sex	Approx. Acreage
Kerman	Female	255,000
Golden Hills	Female	50,000
Lost Hills	Female	<4000
Kalehghouchi	Female	<2000
Pete 1	Female	?
Red Aleppo	Female	<1000
Joley	Female	<1000
Aria	Female	<1000
Peters	Male*	255,000
Randy	Male	53,000
Pete 1 male (Chico)	Male	?

* Male trees compose approximately 4 to 11 % of the trees on an acre of orchard

RECENT TRENDS

From 2009-2016, approximately 35% of the newly planted acreage in California were planted to Golden Hills.

In 2015, approximately 85% of the new acreage that year was planted to Golden Hills.

Information in this presentation has been amalgamated from a number of small randomized and replicated U.C. trials conducted within larger blocks of Kerman pistachio, largely in Kern County and one trial in Madera County.

The five varieties compared here, have not all been in all trials. Kerman, as the industry standard, has been in all the trials acting as a control, or basis of comparison. The other four varieties being compared, Golden Hills, Lost Hills, Kalehghouchi, and Gumdrop, have been in many, some or only one of the trials. Thus, evaluations are based on limited information.

The comparisons among these 5 varieties are the best “estimate” of the presenter based on the 18 years, or so, of evaluating pistachio cultivars.

Your results may vary.

Existing varieties that do not appear in this presentation, is solely the result of the presenter not having sufficient information for comparison. We have a trial, just coming into bearing (in 2016) that includes a wider assortment of existing cultivars.

Comparisons among cultivars would apply to trees of equal age, growing in the same location and at the same tree spacing.

Younger trees tend to be harvested later than mature trees of the same cultivar (as much as two weeks).

A given cultivar in one area of the Central Valley compared to the same cultivar of the same age in another area of the Central Valley can differ in harvest readiness by as much as a month.

The objective of this presentation is not to determine which is the best pistachio variety for California.

The objective of this presentation is to present comparative information on the relative strengths and weaknesses of 5 cultivars currently grown in the SJV (and to introduce the new U.C. female cultivar Gumdrop).

This information should assist growers in determining which, if any of these five, might be most suitable for their individual farming and marketing conditions.

There is no such thing as a perfect variety.

Gumdrop - April 1, 2016, Buttonwillow area. Gumdrop was released to the industry in July, 2016. Currently, there is no commercial acreage.

BLOOM SYNCHRONY (for areas with high fall and winter heat unit accumulation)
Below is a list of female cultivars with the names and relative apportionment of suggested pollinizers (applicable to those that believe San Joaquin Valley winters are going to get warmer and drier in the future).

Female cultivars with suggested (by Kallsen) percentages of male pollinizers

Female	Early male	Primary male	Adjunct male
Gumdrop	Zarand (50%)	Tejon (50%)	
Golden Hills	Tejon (25%)	Randy (75%)	
Lost Hills	Tejon (25%)	Randy (75%)	
Kalehghouchi	Tejon (25%)	Randy (75%)	
Kerman	Randy (25%)	Famoso (50%)	Peters (25%)

If you believe the 2014 and 2015 low winter-chill, high winter-heat and drought years were a rare, random weather anomaly go 100% with the listed primary male except for Kerman if you want to stick with Peters.

Cultivar Performance Comparisons

Historical Production Record in California (1 is the longest)	
Kerman (1960s)	**1**
Golden Hills (2002)	**3**
Gumdrop (2012 – test plot only)	**4**
Kalehghouchi (mid-1980s)	**2**
Lost Hills (2002)	**3**

Commercially, the California industry has been growing Kerman almost exclusively since the 1960s, Kalehghouchi since the 1980s?, Golden Hills and Lost Hills since 2005, and Gumdrop was just released in 2016. We know what Kerman will do over 60 years, not so for the others.

Order of full bloom in Spring
(1 is earliest, 3 is latest)

Kerman	3
Golden Hills	2
Gumdrop	1
Kalehghouchi	2
Lost Hills	2


April 1, 2016 Gumdrop on left, Golden Hills on right


Gumdrop after bloom

Average full bloom dates for Gumdrop, Tejon, Golden Hills, Randy, Kerman and Peters at the Buttonwillow Trial 2012-2016.			
Cultivar	Sex	Ave. full- bloom date	Ave. full bloom date – days from Kerman
Gumdrop	Female	Mar. 27	-10
Tejon	Male	Mar. 28	-9
Golden Hills	Female	Apr. 1	-5
Randy	Male	Apr. 4	-2
Kerman	Female	Apr. 6	------
Peters	Male	Apr. 10	+4

Because Gumdrop blooms very early, that may demonstrate that it has a lesser ‘winter rest’ requirement. Its performance in the ‘warm winter’/‘low chill’ years of 2014 and 2015 suggests that it is less affected by ‘warm winters/low chill’ than is ‘Kerman’ or ‘Golden Hills’, but it was still affected.

Cautionary Note on ‘Red Aleppo’ and relatives

In the “Jasmine Cultivar and Breeding Selection Trial located in an area with high winter heating (also moderate winter chilling) the following cultivars are being evaluated (among many others):

1. ‘Red Aleppo’
2. a patented (expired) sport of Red Aleppo called ‘Ruehle’,
3. and a variety that is purported to be ‘Sirora’ and, if so, has ‘Red Aleppo’ parentage.

This trial was planted in 2010, and as of 2017 none of these three cultivars listed above have produced any yield. Kerman, Golden Hills and Lost Hills began producing harvestable yield in 2016, now over 4000 lbs. per acre as of the 2017 harvest.

Tree Growth Characteristics

Pruning/Training Requirement (1 is least)	
Kerman	**3**
Golden Hills	**1**
Gumdrop	**4 ?**
Kalehghouchi	**5**
Lost Hills	**2**

Upright scaffold and branch growth (1 is most upright)	
Kerman	**3**
Golden Hills	**1**
Gumdrop	**4**
Kalehghouchi	**5**
Lost Hills	**2 - 3**

Upright branch growth is useful in that it reduces sagging branches in high yield years, reduces pruning requirements and allows for closer tree spacing.

Do not tip Lost Hills or Golden Hills late (i.e. after Feb. 21 to be safe).

Apical buds begin producing auxins in the spring, which prevents buds lower on the branch from pushing. Tip the apical buds <u>before</u> they come out of dormancy.

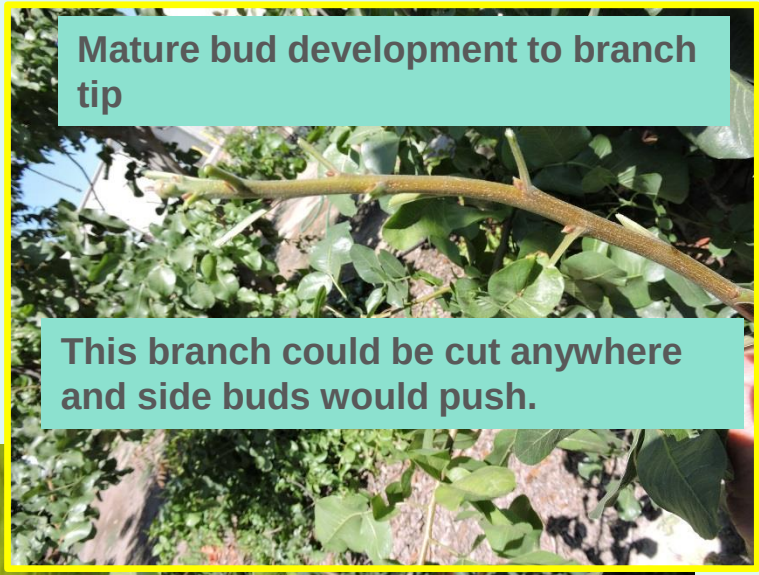
Everything happens earlier with these two varieties than Kerman – about 2 weeks or more earlier. If you tip the terminal buds after the terminal buds come out of dormancy, buds a foot or more below that point will be extremely slow to push or won't push it all.

The same thing happens in Kerman, but the buds remain dormant for an additional two weeks, giving you more time to prune the orchard in late winter.

Training Golden Hills versus Kerman (spring/summer training second year)

Cutting secondary branches too early (or too close to the terminal bud) is more likely to result in insufficient or delayed bud push below training cut. Wait until you can see the developing buds in the axils of leaves below the proposed training cut before making it.

Golden Hills, particularly, appears to demonstrate poor bud push below the training cut if cut too early. Wait until you can see some development of the axillary bud directly below the proposed cut.



With <u>Kerman</u>, much of the training cuts involve removing sagging branches, that is branches that are growing too horizontally. We train Kerman to grow more upright. As we prune Kerman, we leave branches on the outer canopy that we designate as being temporary. They will produce yield when the trees are young; to be removed later when they flatten out and grow too horizontally.

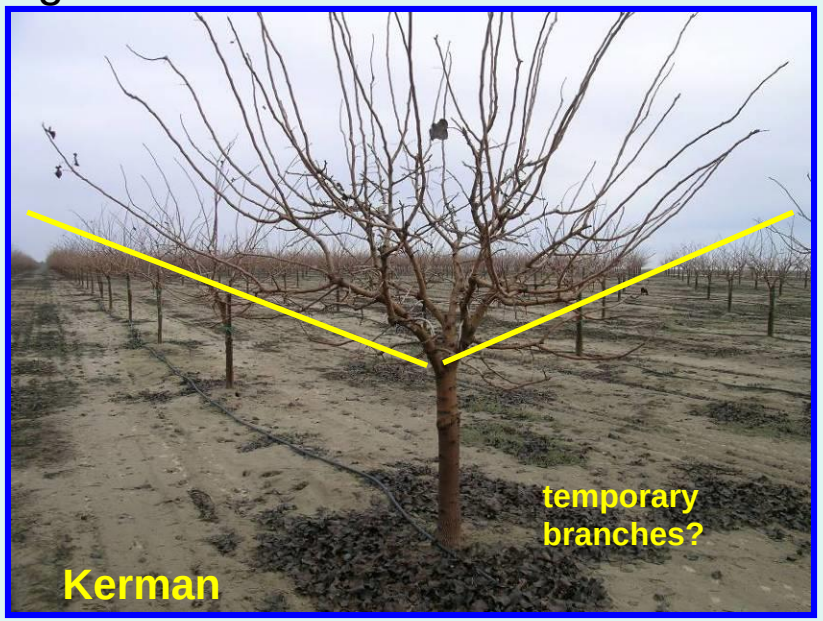
With Golden Hills, the focus appears to be on encouraging more horizontal growth, since the tree tends to grow so upright naturally. The outer branches of Golden Hills can be considered more permanent than is the case with Kerman since they resist growing horizontally.

Non-bearing trees

‘Golden Hills’ should be pruned harder than ‘Kerman’ to encourage more outward growth.

Circle tying Golden Hills branches, as is sometimes done with Kerman to encourage more upright growth, is unnecessary.

6th leaf pistachio trees before dormant pruning



6th leaf pistachio trees

How about Gumdrop?

‘Gumdrop’ is a large, fast-growing tree with large diameter branches. It appears to be going to need more training and hedging than most other cultivars.

If you are going to bud ‘Gumdrop’ expect to use large diameter budwood since small-diameter branches are rare. Large diameter rootstocks are recommended at budding.

Smooth Graft Union Scion and rootstock grow at same rate (1 is smoothest)	
Kerman	**1**
Golden Hills	**3**
Gumdrop	**4**
Kalehghouchi	**5**
Lost Hills	**2**

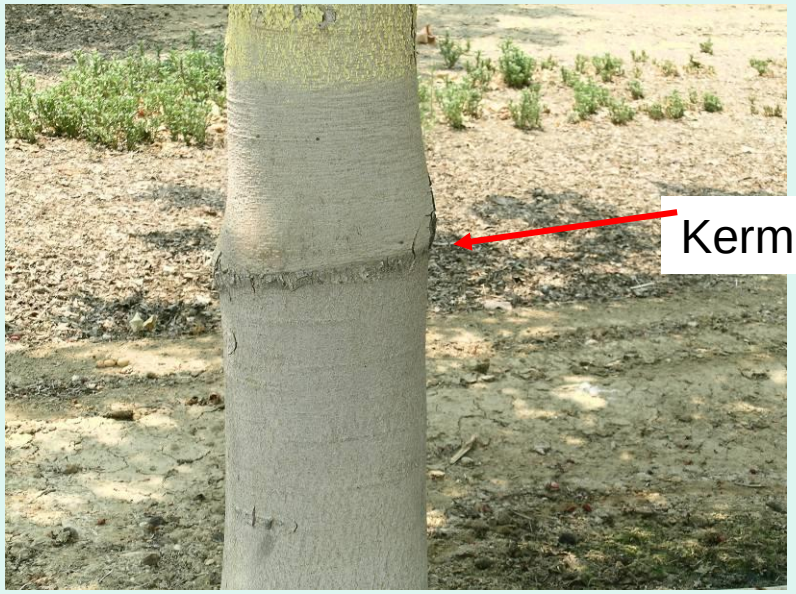
Note: This evaluation is based on rootstock that is all *P. integerrima* or hybrids between *P. atlantica* and *P. integerrima.* Graft unions of all cultivars tend to be smoother on P. atlantica x P. integerrima hybrids that on pure P. integerrima rootstocks.

Kalehghouchi on *P. integerrima*

Kerman on *P. integerrima*

The concern is that for cultivars other than Kerman, tree barking increases with uneven trunk growth, and perhaps scion/rootstock incompatibility may become a problem as the trees grow old.

Golden Hills and Lost Hills trunks increase in diameter faster than Kerman on P. integerrima and to a lesser extent on UCB1 (trees shown are 12th leaf). The trees pictured are all growing on P. integerrima.



Kerman

Gumdrop appears to grow faster than Golden Hills or Kerman on seedling UCB-1 rootstock. Note, also, that it appears to be growing faster than the rootstock.

Scion and rootstock circumference and the ratio of the scion to rootstock for tree trunks of Golden Hills, Gumdrop and Kerman on UCB-1 seedling rootstock as measured 4 inches above and below the graft union. Measured on June 6, 2016. 10th leaf trees, 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

To address the potential problem of overgrowth of the rootstock by the scion, which appears to be a characteristic of most cultivars other than Kerman, we have been doing some experimental breeding of new rootstocks that won’t do this.

We are having some success.

Lokern Trial in early January 2017. Every other tree in the row on the right is an experimental rootstock grafted to Golden Hills. The control is a UCB-1 seedling.

5th leaf Golden Hills on experimental seedling rootstock

Tree on right is 5th leaf Lost Hills on experimental seedling rootstock.

Tree on right is 6th leaf Golden Hills on UCB-1 seedling rootstock.

Order of harvest timing (based on a single shake harvest)
(1 is earliest, 4 is latest)

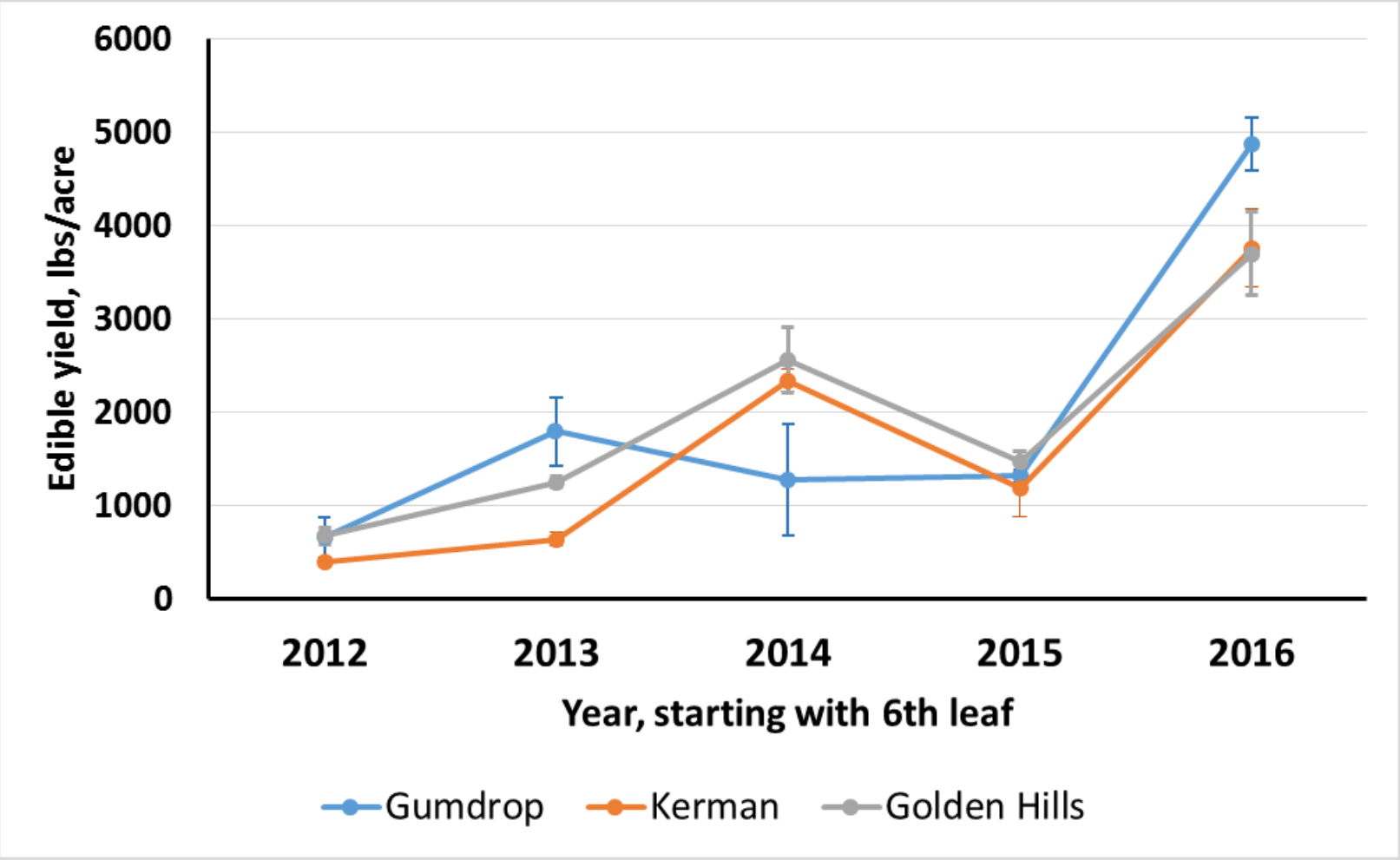
Kerman	4
Golden Hills	2
Gumdrop	1
Kalehghouchi	4
Lost Hills	2-3

The key trait that makes Gumdrop unique is its very early harvest date.

Average harvest readiness dates for Gumdrop, Golden Hills, and Kerman at the Buttonwillow Trial 2012-2016.			
Cultivar	Sex	Ave. harvest-readiness date	Ave. harvest readiness date, days from Kerman
Gumdrop	Female	Aug. 20	-20
Golden Hills	Female	Aug. 29	-11
Kerman	Female	Sept. 9	------

Because Gumdrop harvests early, it will probably miss most of the last and big Navel orangeworm (NOW) flight. However a timely and early harvest is essential for adequate nut quality with this cultivar.

Yield and Nut Quality Characteristics



Edible yield (lbs. /acre) by year for Gumdrop, Kerman and Golden Hills. Error bars represent ± 2 standard errors of the mean of the three plots harvested for each cultivar each year. Buttonwillow Trial

The cumulative edible yield of Gumdrop has been comparable to Golden Hills and Kerman the first 5 years of bearing.

Cumulative edible yield for Golden Hills, Gumdrop and Kerman, Buttonwillow Trial, 2012-1016 (6th through 10th leaf).		
Cultivar	Cumulative edible yield, lbs./acre	Significant differences*
Golden Hills	9632	a
Gumdrop	9899	a
Kerman	8293	a
Different letters in the same column denote significant differences by Fisher's protected LSD test a $P > 0.05$.		

Selected nut quality parameters for Golden Hills, Gumdrop and Kerman Cultivars from 6th through 10th leaf at the Buttonwillow Trial, Kern County. 2012-2016						
Cultivar	Inshell split nuts, %	Insect damage, %	Loose shells & kernels, %	Dark stained shells, %	Harvested blank nuts, %	Nut size, # of nuts per oz.
Golden Hills	86.9 b*	0.5 a	0.3 a	0.6 a	4.1 a	21.0 a
Gumdrop	85.1 b	0.9 ab	0.8 b	1.2 b	6.4 b	20.8 a
Kerman	69.8 a	1.4 b	0.3 a	0.3 a	10.5 c	20.7 a

* Different letters in the same column denote significant differences by Fisher's protected LSD at $P < 0.05$

The Gumdrop harvest has been delayed a week or more <u>after</u> nut maturity because the commercial nut processors were not yet open to accept pistachios for processing. This delay at this time of year undoubtedly increased insect damage and staining in this cultivar.

With Golden Hills and Gumdrop (especially), don't delay harvest until the hulls have tattered. Do not use hull tatter (i.e. split hulls) to gauge harvest with Golden Hills or Lost Hills.

The hull of Golden Hills or Gumdrop nuts do not tatter as much as Kerman when ready for harvest.

Golden Hills Nut Cluster

Once a majority of the hulls slip harvest can begin. The nuts will be split and ready for harvest even if the hulls remain intact. Waiting, unlike with Kerman, will not improve the split percentage appreciably.

Intact hulls at harvest may reduce infestation by navel orangeworm compared to Kerman and Lost Hills.

My Concerns About Who is Planting the Newly Released (2016) U.C. Cultivar ‘Gumdrop’.

The main reason for planting Gumdrop is that it is ready for harvest extremely early. If you are not interested in an early harvest do not plant ‘Gumdrop’. Plant something like ‘Golden Hills’ which, for same aged trees in the same location, is harvestable 10 days to two weeks earlier than Kerman.

‘Gumdrop’ was released to extend the harvest season and thus reduce the need for greater investment by the industry in additional processing facilities, harvesters and transportation equipment, that would be necessary if ‘Kerman’ were planted instead.

How early is the ‘Gumdrop’ harvest?

The nuts are attached to the rachis fairly firmly, and my suggestion is that the appropriate way to harvest ‘Gumdrop’ is to do a small ‘bump shake’ the first week of August and come back for the final shake in mid-August.

Since no commercial huller/processor is likely to be open this early, only growers that will have access to a processing plant that will open this early should be planting Gumdrop.

Gumdrop has disadvantages:

Later in the season (July) some nuts produce a drop of gum on the hull (hence its name). A ‘Gumdrop’ harvest is stickier than a ‘Kerman’ harvest.

Gumdrop nuts to not hold well on the tree and it can be very hot when Gumdrop is ready for harvest. A timely ‘double shake’ harvest is recommended and the nuts from each harvest transported to the processing facility without delay.

Gumdrop has shown more growth variability on UCB-1 seedling rootstock. Growth among ‘Gumdrop’ trees has been more uniform on ‘Platinum’ clonal rootstock.

Payable early-yield from 6th through 9th leaf (1 is highest)	
Kerman	**2**
Golden Hills	**1**
Gumdrop (limited data)	**1**
Kalehghouchi	**2**
Lost Hills	**1**

Payable Yield from Mature Trees (1 is highest)	
Kerman	**1**
Golden Hills	**1**
Gumdrop	**?**
Kalehghouchi	**1**
Lost Hills	**1**

Individual Nut Size and weight (1 is largest)	
Kerman	**2**
Golden Hills	**2**
Gumdrop	**2**
Kalehghouchi	**1**
Lost Hills	**1**

Nut size will vary considerably with yield levels. High yields, generally, mean smaller nuts sizes.

Unstained and lightly stained, inshell split-nut percentage of processed yield (1 is highest)	
Kerman	**3**
Golden Hills	**1**
Gumdrop	**1**
Kalehghouchi	**2**
Lost Hills	**1**

Shell Hinge Strength (1 is highest)	
Kerman	**1**
Golden Hills	**1**
Gumdrop	**2**
Kalehghouchi	**2**
Lost Hills	**3**

Weaker shell hinge strength means more kernels are lost in hulling but the nuts that survive hulling are easier for consumers to open.

Cleanest Shell Exteriors (1 is cleanest)	
Kerman	**1**
Golden Hills	**1**
Gumdrop	**3**
Kalehghouchi	**3**
Lost Hills	**2**

The cleanest and lightest shells I have seen on cultivars that I have worked with occur on a variety called ‘Aria’.

Blank Nut Percentage (1 is lowest)	
Kerman	**3**
Golden Hills	**1**
Gumdrop	**2**
Kalehghouchi	**2**
Lost Hills	**1**

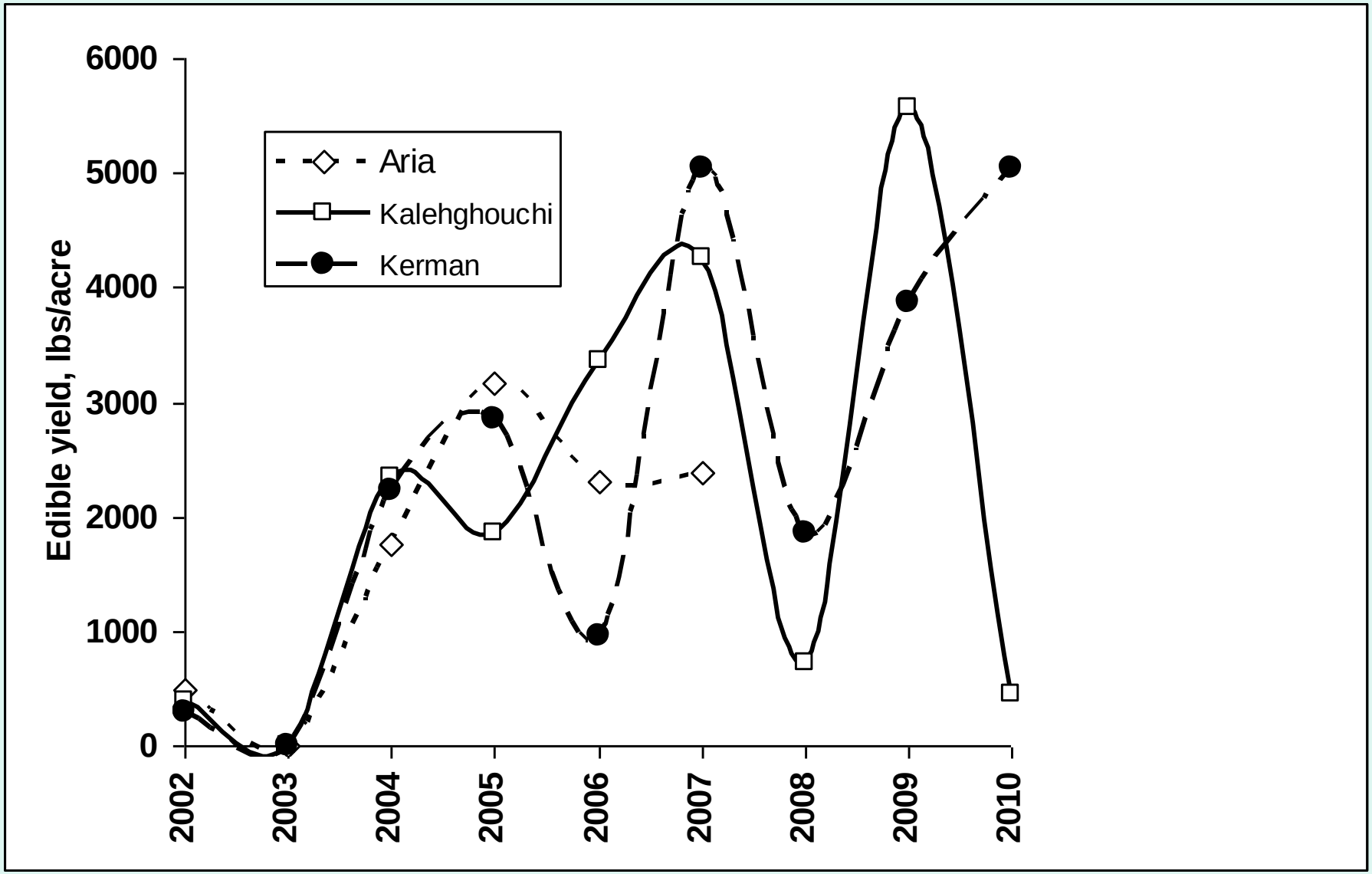
Early Split Nuts (1 is lowest)	
Kerman	2
Golden Hills	1
Gumdrop	2
Kalehghouchi	3
Lost Hills	3

Early split nuts are associated with increased navel worm damage

Uniformity of Nut Maturation Across the Tree (1 is most uniform)	
Kerman	**2**
Golden Hills	**1**
Gumdrop	**3**
Kalehghouchi	**3**
Lost Hills	**3**

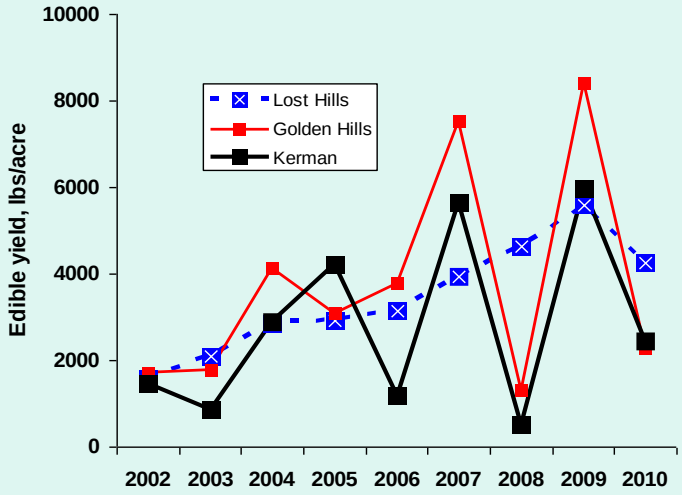
Non-uniform nut maturity across the tree means that more than one shake may be required for harvest.

Degree of Alternate Bearing to 11th leaf (1 is least)	
Kerman	**2**
Golden Hills	**2**
Gumdrop (limited data)	**3**
Kalehghouchi	**3**
Lost Hills	**1**

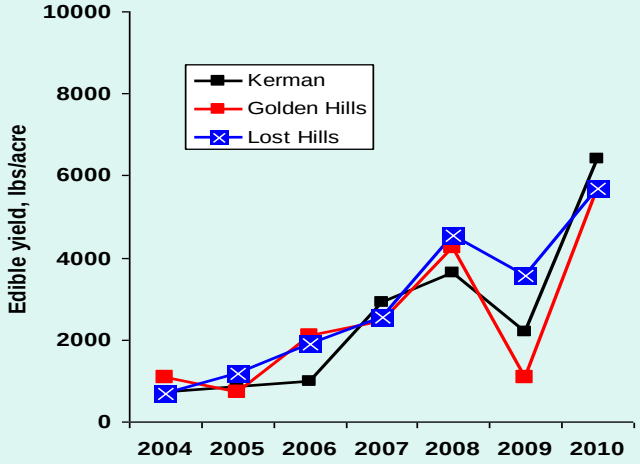


Yield results from a replicated and randomized trial in Kern County.

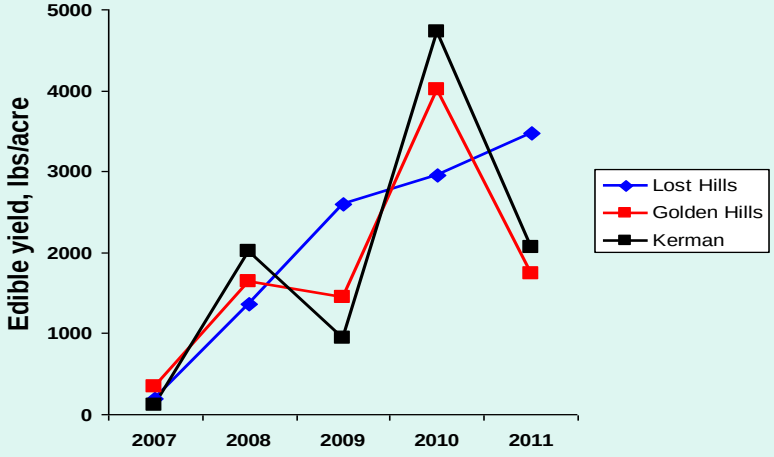
Difference in alternate bearing pattern among Kerman, Golden Hills and Lost Hills – starting with 6th leaf



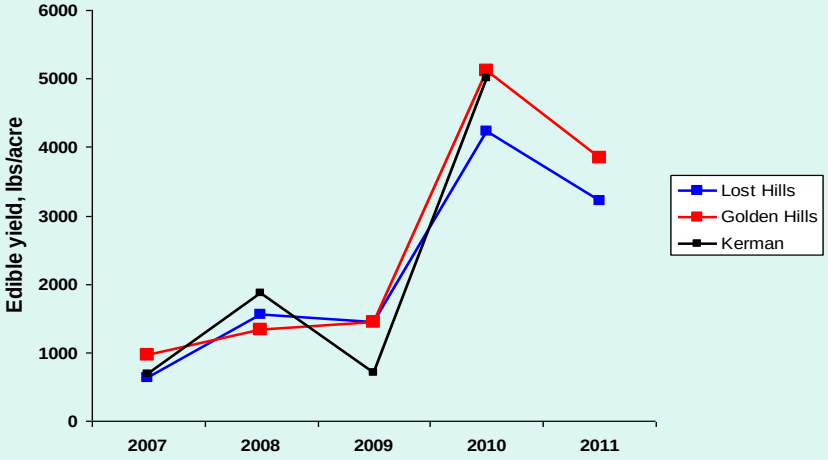
Western Kern County



Madera County



Famoso – Kern County



Tejon – Kern County

Disease, Nutrients and Winter Rest Requirement

Botryosphaeria Panicle and Shoot Blight (1 is most resistant)	
Kerman	**1**
Golden Hills	**2**
Gumdrop	**No data**
Kalehghouchi	**3**
Lost Hills	**1**

Note: This information comes from the following reports/researchers:

American Pistachio Industry Annual Reports, Crop Years 2012-2013, 2013-2014. Research by Dr. Themis Michailides, et. al.

Information in these reports comes from average disease resistance ratings. Frequently, differences were not statistically significant.

Alternaria Late Blight (1 is most resistant)	
Kerman	**1**
Golden Hills	**2**
Gumdrop	**No data**
Kalehghouchi	**2**
Lost Hills	**1**

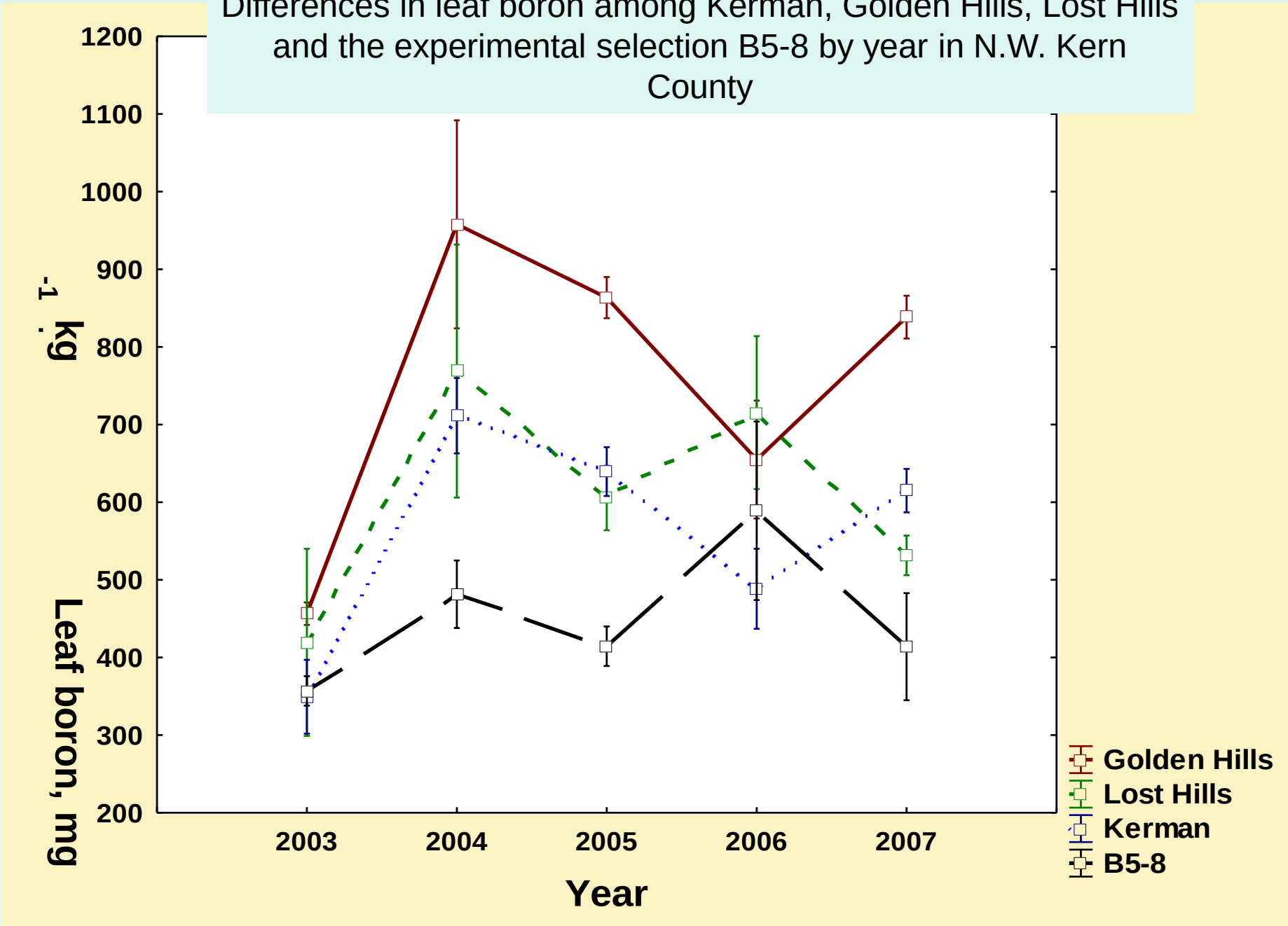
Note: This information comes from the following reports/researchers:

American Pistachio Industry Annual Reports, Crop Years 2012-2013, 2013-2014. Research by Dr. Themis Michailides, et. al.

Information in these reports comes from average disease resistance ratings. Frequently, differences were not statistically significant.

Exclusion of Boron in Leaf Tissue
(1 is less boron in leaf tissue)

Kerman	**1**
Golden Hills	**2**
Gumdrop	**no data**
Kalehghouchi	**no data**
Lost Hills	**1**


Differences in leaf boron among Kerman, Golden Hills, Lost Hills and the experimental selection B5-8 by year in N.W. Kern County
Leaf boron, mg . kg -1
1200
1100
1000
900
800
700
600
500
400
300
200
2003
2004
2005
2006
2007
Year
Golden Hills
Lost Hills
Kerman
B5-8

Boron concentrations in leaf tissue and soils at a farm in Kern County with 'high-boron' well water, 2012 – 2013.					
Location	Cultivar	Tree age, years	Leaf tissue Concentration, ppm	Soil sat. paste concentration at drip line in top 3 feet, ppm	year
1	Golden Hills, older leaf (edge burn)	4	1971	1.7	Sept 20, 2012
1	Golden Hills, younger leaf (unburned)	4	944	1.7	Sept 20, 2012
1	Golden Hills	5	926	1.9	June 26, 2013
1	Kerman	7	645	1.7	June 26, 2013
2	Golden Hills	5	834	18.1	June 26, 2013

If well water is high in boron, Kerman may be a better cultivar choice.

Leaves of Golden Hills on UCB-1 seedling rootstock on Sept. 8, 2017 – Lokern/Starrh advanced selection rootstock trial (average boron 1337 ppm).

Leaves of Golden Hills on Endeavor-1 rootstock on Sept. 8, 2017 – Lokern, Starrh advanced selection rootstock trial (average boron 597 ppm).

Insufficient ‘winter rest’ symptoms in pistachio.

Flagging of leaves on the branch.

North side of tree leafs out before south side.

Inadequate ‘Winter Rest’ Symptoms on Tree (1 is fewest)	
Kerman	**3**
Golden Hills	**2**
Gumdrop	**1**
Kalehghouchi	**4**
Lost Hills	**2**

Inadequate winter rest (low chilling and high winter heating) symptoms include the following: delayed bloom, extended bloom (differences between north and south side of trees), flagging of shoots, early nutlet drop and nut blanking/poor yield.

Regulated Deficit Irrigation (RDI*)

Remember that the work done by Dr. Goldhamer, U.C. Farm Advisor Bob Beede and others with the timing of regulated deficit irrigation in pistachio was based in large part on developmental stages of the nut.

Regulated deficit irrigation (50% of ET) was timed for Stage 2. Stage 2 normally begins about May 15 and continues to end of June with Kerman. It ends with the beginning of shell hardening and filling.

Since both Golden Hills and Lost Hills, are at full bloom about 3-6 days earlier than Kerman and are harvestable 2 weeks earlier, Stage 2 will occur earlier in the year. For Golden Hills and Lost Hills, RDI for Stage 2 should end by mid-June.

By withholding irrigation to Golden Hills and Lost Hills in the last half of June, nut-filling and shell splitting could be adversely affected.

*The objective of RDI is to save water by finding discreet time intervals during the growing season when irrigation can be reduced below full Et while maintaining yield and nut quality.

Post Harvest Irrigation

The yield and nut quality data for Golden Hills and Lost Hills were obtained in small trials <u>within</u> larger blocks of Kerman. Lost Hills and Golden Hills were irrigated based on the full irrigation requirements for Kerman.

Thus, Golden Hills and Lost Hills received generous post-harvest irrigation, since Kerman had not yet been harvested.

Attempting to institute post-harvest regulated deficit irrigation on Golden Hills and Lost Hills may produce yield and nut quality results quite different from the fully-irrigated post-harvest trees in our small experimental trials.

It is <u>not</u> difficult or expensive to become a licensed producer of U.C. budwood.

Golden Hills, Lost Hills, Gumdrop, Randy, Tejon and Famoso are proprietary varieties of the University of California.

Nursery, Budder (contractor) or Private-Grower licenses are available from the University of California to produce these cultivars. For licensing info contact the following person:

DENISE L. MEADE, Sr. Intellectual Property Analyst
Technology Transfer Services - UC Davis Innovation Access
1850 Research Park Drive, Suite 100
Davis, CA 95618
Tel: 530-754-8674
dlmeade@ucdavis.edu
www.research.ucdavis.edu/InnovationAccess

It is not precocious and requires a sustained winter rest period, but Damghan and a possibly related selection produces large, well-split, long nuts in a very open cluster. Photos from a U.C. Cultivars and Breeding Selection Trial near Buttonwillow, CA.

Damghan-like – Parfitt PI selection

Damghan cluster, 2016

Nature at work! Highway 65 wild pistachio (P. vera) forest in the making.