‘Lost Hills’: A New Pistachio Cultivar

Dan E. Parfitt¹

Department of Plant Sciences, MS2, University of California, One Shields Avenue, Davis, CA 95616

Craig E. Kallsen

University of California, Cooperative Extension, Kern County, 1031 S. Mt. Vernon Avenue, Bakersfield, CA 93307

Brent Holtz

University of California, Cooperative Extension, Madera County, 328 Madera Avenue, Madera CA, 93637

Joseph Maranto

9400 Meadow Leaf Court, Bakersfield CA 93311

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‘Lost Hills’ is a new female pistachio (*Pistacia vera* L.) cultivar released by the California Agricultural Experiment Station in 2005. The nuts mature uniformly and are harvested from 1 to 2 weeks earlier than ‘Kerman’. In-shell nut yields during the first 5 years are greater than those of ‘Kerman’, and the percentage of edible split nuts is higher. ‘Lost Hills’ flowers earlier than ‘Kerman’ and has not demonstrated symptoms of insufficient chilling in Kern County and Madera County, CA. ‘Lost Hills’ shells are more open than ‘Kerman’ shells after drying. ‘Lost Hills’ is an early-maturing cultivar, with good yield, large nut size, uniform harvest period, and little navel orangeworm infestation.

Origin

The cross that produced ‘Lost Hills’ was made in 1990, and the original seedling was planted at a research plot provided by Paramount Farming Company in 1991 near Bakersfield, CA. The *Pistacia vera* seedling parents, female ‘2-35’ × male ‘ES#6’, were created at the former Plant Introduction Garden at Chico, CA (J. Crane, J. Maranto, pers. comm.). ‘2-35’ was evaluated by Julian Crane (Crane 1977, 1988; Crane and Iwakiri, 1983). ‘Lost Hills’, evaluated under its seedling designation ‘B19-12’, first produced a crop in 1994 and was evaluated annually as a seedling from 1994 to 1999. Production characteristics were evaluated in replicated trials with eight other selections from the program and ‘Kerman’ on commercial rootstocks from 2002 through 2006. Nut yields

were compared with ‘Kerman’, the only cultivar with significant acreage (99%) in California at two locations, in Kern County and Madera County. These locations were chosen because they represent the two major growing areas for pistachio in California. The most important growing area is in Kern County and adjacent areas of southern Kings and Tulare counties. Three male pollinizers were provided at both locations: an early flowering male ‘Randy’, the standard commercial midseason pollenizer ‘Peters’, and an unnamed late flowering selection. All of the males were selected for flowering period and pollen quantity. The Kern County test used ‘PG1’ rootstock with two replicates of 10 trees each, planted and field budded in 1997. They first flowered in 2000. Performance data were obtained from 2002 through 2006. The Madera County test used budded ‘PG1’ and ‘UCB1’ rootstocks with two replicates of five trees for each rootstock, planted in 1999 from nursery-budded trees. ‘Lost Hills’ flowered and fruited in 2003. Performance data were collected from 2004 through 2006. ‘Lost Hills’ was released 20 June 2005 for distribution, and a patent was issued on 8 May 2007 (PP17701).

Description

All the color references are to the Royal Horticultural Society Color Chart (Royal Horticultural Society, 1986) and are designated as RHS. Yield data were obtained from commercial processing of nut harvests for ‘Lost Hills’ and ‘Kerman’. Nut dimensions and weights were evaluated from 50 nut samples by year, location, and rootstock (at Madera County). Nut volumes were computed as volume = $(\pi/6)$ (length)(width)(height). Comparisons were made with ‘Kerman’ pistachio, the primary cultivar in California. General Linear Models analyses of variance (ANOVAs) and balanced ANOVAs were performed as appropriate with MiniTab ver. 14.20 (Minitab, State College, PA). Analyses of variance were computed from

‘Lost Hills’ and ‘Kerman’ data, and the two locations were analyzed separately. Data from ‘PG1’ rootstock were used from Kern County whereas data from both rootstocks were used from Madera County. Split edible in-shell nut percentages were expressed as a percentage of the total dry harvested material (excluding leaves, etc.).

Tree

Tree structure. ‘Lost Hills’ has a tree structure and branching habit typical for *P. vera*. Branch angles are broad, ranging from 80° to 90° for both scaffold and lateral branches. Distribution of scaffold and lateral branches are a function of pruning and training activities, which are practiced intensively during the first 3 years of growth. The crown is generally spherical.

Tree vigor. Grafted trees were about 3 m tall at 7 years with a spread equal to the height. Trunk diameters were from 13 to 18 cm at 7 years. ‘Lost Hills’ is a vigorous tree, somewhat larger than ‘Kerman’. Trunk cross-sectional areas of ‘Lost Hills’ were 15% greater than for ‘Kerman’ at Kern County ($P < 0.14$) and 21% greater than for ‘Kerman’ at Madera County ($P < 0.01$). Rootstock effects were evaluated at Madera County and were not significant.

Bark. Bark color is RHS 202D (gray) and is similar to ‘Kerman’.

Lenticels. Lenticels tend to be more horizontally elongated on ‘Lost Hills’ trunks than on ‘Kerman’, and more compound lenticel structures are seen on ‘Lost Hills’ bark. ‘Lost Hills’ lenticels are less corky in appearance than ‘Kerman’ lenticels. ‘Lost Hills’ lenticel colors are gray brown (RHS 199B-C) to gray orange (RHS 172C) versus a gray orange (RHS 172D) for ‘Kerman’ lenticels. Lenticel counts were done on either 16 or 20 cm² imaged patches from five trees at Kern County. The mean number of lenticels per square centimeter for ‘Lost Hills’ (18.6) and ‘Kerman’ (19.0) were not significantly different by ANOVA. The variance in the number of lenticels within a given area was much higher for ‘Lost Hills’ than for ‘Kerman’ (16.0 vs. 1.0).

Flower

Inflorescences. Female inflorescences of ‘Lost Hills’ are born laterally on 1-year-old wood, and rarely from terminal buds. Flowers are borne on panicle inflorescences with three to nine branches. The panicle is typically 2.5 to 4 cm long at the beginning of flowering, expanding to 8 cm after completion of pollination. The panicles are about two-thirds as wide as they are long when fully expanded. The panicle shape is roughly conical. Flowers become receptive from the base to the tip of the panicle, and receptivity spans a 3-week period, depending on weather conditions during individual seasons. Young inflorescences are pale green (RHS 145B; yellow-green group), becoming darker green (RHS 144C) as the panicles mature. Individual flowers are 0.5 to 1.0 mm long and all are female. Fifty to 200 flowers are typically

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¹To whom reprint requests should be addressed; e-mail deparfitt@ucdavis.edu

borne on each inflorescence with a high level of variability among inflorescences. Typical of *P. vera*, the majority of flowers abort before fruit maturation, leaving from 10 to 20 mature fruit/inflorescence.

Flower buds. Ten dormant flower buds, measured on each of five trees at Kern County, were significantly longer for 'Lost Hills' (8.36 mm) than for 'Kerman' (7.48 mm) by ANOVA ($P < 0.01$).

Flowering date. 'Lost Hills' typically flowered from 1 to 2 weeks before 'Kerman' (Table 1). 'Kerman' sometimes exhibited an extended and irregular bloom period, most recently in 2003, that resulted in asynchronous nut maturity, whereas 'Lost Hills' had regular synchronous bloom since first flowering.

Leaves

Leaf description. 'Lost Hills' leaves are deciduous simple compound paripinnate with one or two pairs of oppositely arranged lateral leaflets. The average number of leaflets is three or five. The apex of the leaflet blades are obtuse to cuspidate and the leaflet base is rounded. Leaflet margins are entire to slightly crenate. Leaflets are oval to ovate. The terminal leaflet appears mucronate in some situations. Leaves vary considerably in shape, in general being ovate with cuspidate to rounded tips and a rounded base. Margins of leaf blades are entire. Leaf surfaces are glabrous, smooth, and waxy. Leaves range from light green at first emergence to dark green at maturity. Upper and lower leaf surfaces do not differ significantly in color. Colors for older leaves are between RHS 136A and RHS 139A, and for young leaves are between RHS 136A and RHS 139A. Leaf veins are yellowish green (RHS 149C to RHS 149D). Leaflets are typically 4 to 6 cm wide and 5 to 8 cm long. The compound leaves are typically 10 to 15 cm long. There is considerable variation in leaf and leaflet size, depending on time of the season, position in the tree, and year.

Fruit

Fruit and nut description. 'Lost Hills' fruits are semidry drupes arranged in panicle clusters (Fig. 1). Seed mesocarps are fleshy, endocarps are boney, germination is hypogeal. Husk color gradually changes from a light green in late June to a cream white with tiny brown spots at maturity (RHS 8D to 11D). Unlike some cultivars, the husks show little pink color in parts of the tree exposed to the sun.

Husks (exo-mesocarp) initially adhere tightly to the shell (endocarp), become detached from the shell, yet remain intact at harvest. Shells split in midseason, usually from 4 to 6 weeks before harvest, but remain enclosed in the husk. 'Lost Hills' produces a processed nut that is slightly larger than 'Kerman' and very similar to 'Kerman' in color. Nuts are oval, longer than wide with a somewhat truncate base and a slightly cuspidate to rounded tip. 'Lost Hills' has a slightly whiter shell than 'Kerman' (RHS 155B to 158D [white] for 'Lost Hills' vs. RHS 115B to 158D for 'Kerman'). 'Lost Hills' in-shell

Table 1. Flowering data for 'Lost Hills' and 'Kerman' on 'PG1' rootstock at the Kern County plot and on two rootstocks ('PG1' and 'UCB1') at the Madera County plot.

Location and cultivar	Average score per date ^a			
	25 Mar. 2004 (85)	24 Mar. 2005 (83)	21 Apr. 2006 (111)	23–29 Mar. 2007 (82–88) ^b
Kern County				
Lost Hills	3.3	4	2.5	2.5
Kerman	1.5	1.75	2.5	1
Madera County				
Lost Hills	2.3	2	2	3.6
Kerman	1.2	1	1.3	2.2

^aFlowering code: 0, dormant; 1, green inflorescence; 2, early flowering; 3, mid flowering; 4, full flowering; 5, late flowering, most flowers have set fruit.

^bData taken on 23 Mar. 2007 at Kern County and 29 Mar. 2007 at Madera County.

Julian days are in parentheses.

Fig. 1. 'Lost Hills' fruit on tree at maturity.

nuts are larger than 'Kerman' nuts (Fig. 2). The shell suture is deep, extending from the tip almost to the base and is symmetrical. Shell sutures are similar to those of 'Kerman', but the in-shell nuts have a less flattened shape than 'Kerman' and are longer than 'Kerman' nuts. After drying, 'Lost Hills' shells are more open than 'Kerman' shells and the kernels are often loose within the shells. Kernels are covered by a grey shading to purplish red (RHS 201D) pellicle, and are green (RHS 144C) where the pellicle is absent. They are greener than 'Kerman' kernels (RHS 149D).

Nut size. 'Lost Hills' nuts were significantly larger than 'Kerman' nuts (1.43 g/nut, 2.01 cm³/nut for 'Lost Hills' and 1.33 g/nut, 1.83 cm³/nut for 'Kerman') by ANOVA for nut weight and volume ($P = 0.01$ and $P = 0.006$ respectively).

Production comparisons

Rootstocks. 'Lost Hills' was grafted on both 'UCB1' and 'PG1' rootstocks. The 'UCB1' rootstocks used at the Kern County plot appeared to be off types as a result of nursery production problems (L. Ferguson, pers. comm.). Because all cultivars grafted on 'UCB1' at Kern County appeared to be affected by this problem, evaluation data were not collected from 'UCB1'-grafted trees. Performance of 'Lost Hills' and 'Kerman' on both 'PG1' and 'UCB1' were not significantly different at the Madera County plot ($P = 0.69$ for split edible in-shell yield), and rootstock effect was not considered for

subsequent analyses. No graft incompatibility has yet been reported by nurserymen on either rootstock. 'Lost Hills' should perform well on both 'PG1' and 'UCB1' rootstock.

Harvest date. 'Lost Hills' is harvested $\approx$ 2 weeks before 'Kerman' (Table 2), permitting more efficient use of equipment when grown in combination with 'Kerman' and avoiding the delayed maturity problems of 'Kerman' in years with irregular maturation and late harvest. Substantial seasonal differences in the harvest date differences, from 0 to 27 d, between these cultivars were observed.

Yield. Split edible in-shell nut yields shown in Table 3 were significantly greater for 'Lost Hills' than 'Kerman' at both locations with 3 to 5 years of yield data. Total in-shell nut yields and grower paid yields, which include other harvest products, were significantly greater ($P < 0.05$) for 'Lost Hills' (249 kg·ha⁻¹ and 230 kg·ha⁻¹ respectively) than for 'Kerman' (172 kg·ha⁻¹ and 157 kg·ha⁻¹ respectively) at Madera County, but not at Kern County (487 kg·ha⁻¹ and 463 kg·ha⁻¹ respectively for 'Lost Hills', and 429 kg·ha⁻¹ and 390 kg·ha⁻¹ respectively for 'Kerman'). Total yield = split nut yield + nonsplit nut yield + loose kernels + loose shells. Grower paid yield is a yield formula that is used as a basis for payment to growers. Grower paid yield = total yield – the shells of edible loose kernels + shells of edible closed shell nuts. These values included yields of nonsplit nuts. 'Kerman' produced more nonsplit nuts than 'Lost Hills'—an undesirable trait in the California industry. Split nuts are the primary product sold at the retail level, so growers are paid a reduced price for nonsplit nuts, which must be mechanically split, resulting in a low-quality product. Significant year effects were present for all yield measurements at both locations, and cultivar-by-year interactions were significant at Kern County but not Madera County. Rootstock effects at Madera County were not significant.

The percentages of split edible in-shell nuts for 'Lost Hills' were significantly greater ($P = 0.002$) than for 'Kerman' for ANOVA computed from combined data of trees grown on 'PG1' rootstock at Kern and Madera counties and at Kern County ($P < 0.001$, Table 3), but were not significantly different from 'Kerman' at Madera County on both rootstocks.

Fig. 2. 'Lost Hills' and 'Kerman' in-shell nuts.

Table 2. Harvest dates for 'Lost Hills' and 'Kerman' on 'PG1' rootstock from Kern County, 2002–2006 (6th–10th leaf).

Cultivar	Year				
	2002 ^z	2003 ^z	2004	2005	2006
Lost Hills	4 Sept. (247)	29 Aug. (241)	25 Aug. (238)	1 Sept. (244)	11 Sept. (254)
Kerman	4 Sept. (247)	19 Sept. (262)	21 Sept. (265)	15 Sept. (258)	20 Sept. (263)

^zOil was applied in Feb. 2002 and 2003 to promote earlier bloom in the test plot and surrounding orchard. Julian days are in parentheses.

Table 3. Split edible in-shell nut yield and percent split edible in-shell nuts at Kern County for 5 years on 'PG1' rootstock and at Madera County for 3 years.

	Kern County						Madera County			
	2002	2003	2004	2005	2006	Mean	2004	2005	2006	Mean
Split nut yield (kg·ha ⁻¹)										
Lost Hills	271	370	497	516	548	440	107	207	339	217
Kerman	249	118	500	687	235	350	112	132	168	138
LSD 0.05						77				67
						(<i>P</i> = 0.03) ^z				(<i>P</i> = 0.02) ^z
Split nuts (%)										
Lost Hills	86	92	90	92	90	90	67	92	94	79
Kerman	85	60	90	80	84	80	73	72	90	84
LSD 0.05						5				7
						(<i>P</i> < 0.001) ^z				(<i>P</i> = 0.12) ^z

^z*P* values for cultivar F from two-way analysis of variance.

Percent split edible in-shell nuts are expressed as a percentage of the total dry harvested material (excluding leaves, etc.).

Use

The entire California 'Kerman' pistachio crop ripens over a 7- to 14-d period, so that some of the crop is harvested before or after optimum harvest as a result of a lack of harvesting resources. 'Lost Hills' can be harvested earlier than 'Kerman' so that growers can optimize the use of labor and harvest equipment. Navel orangeworm (NOW) infestation (*Amyleois transitella* Walker) has been shown to be associated with high levels of *Aspergillus flavus* Link, the causal agent for aflatoxin contamination (Doster and Michailides, 1994). Navel orangeworm damage in pistachio and almond is primarily associated with third and fourth NOW generations, which develop near the end of the growing season (Beede et al., 1985; Connell et al., 1989; Holtz, 2002). The early harvest date for 'Lost Hills' may permit harvesting before large NOW

populations develop, with the potential reduction of NOW damage and associated aflatoxin contamination caused by *A. flavus* Link. Earlier harvest should also reduce yield losses from *Alternaria alternata* (Fr.) Keissler where that fungus is a problem. Inadequate chilling is associated with irregular bloom, irregular nut maturity, and a high frequency of nonsplit nuts in 'Kerman' during some years. 'Lost Hills' flowers 1 to 2 weeks earlier than 'Kerman' and may require less chilling to produce a synchronized full bloom in the spring, based on direct observation and literature correlating bloom, flowering, and leafing date (Chao et al., 2003; Kester et al., 1977). 'Lost Hills' also has a high percentage of split nuts compared with 'Kerman' and has a somewhat larger nut than 'Kerman'. 'Lost Hills' kernels are less firmly contained within the shells than 'Kerman' kernels as a result of a more open shell. This is a desirable characteristic from the

consumers' perspective, because consumers often cannot extract some of the kernels from packaged 'Kerman' nuts and usually discard them. Loose kernels are not as desirable for growers because more kernels may fall out during processing, reducing the growers' split edible in-shell yield; but, even after commercial processing, 'Lost Hills' yielded significantly more split edible in-shell nuts than 'Kerman' in the commercially processed yield trials assessed here.

Availability

Propagation wood has been distributed to California pistachio nurseries under license through the University of California at Davis Technology Transfer Center (PP17701). Licenses for nursery production of propagation wood may be obtained through the University of California at Davis Technology Transfer Center, One Shields Avenue, University of California, Davis, CA 95616 (phone: 530-757-3432).

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