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‘Tejon’ Male Pistachio: An Early Blooming Pollenizer for ‘Gumdrop’

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Pistachio (*Pistacia vera* L.) is a dioecious plant in which male cultivars that flower synchronously with the female are required for nut production. ‘Tejon’ is a new male pistachio whose pollen is shed early, overlapping the time of female receptivity of ‘Gumdrop’. It produces much pollen from many flowers, and the pollen shows good viability. ‘Tejon’, like ‘Gumdrop’, is precocious, producing flowers beginning in the fourth or fifth leaf. Early season flowering and fruiting pistachio cultivars are being developed through the University of California pistachio breeding program to provide early nut harvest and improve access to processing facilities. ‘Gumdrop’ (Kallsen and Parfitt, 2017a) is at full bloom about 6 d before ‘Golden Hills’ (Parfitt et al., 2007) female and the male pollenizer ‘Randy’ (Parfitt et al., 2010), the earliest commercial pollenizer. ‘Tejon’ was selected for flowering period overlap with ‘Gumdrop’ based on its high level of pollen production from many flowers and good pollen viability.

Origin

‘Tejon’, originally denoted as ‘N-48’, is an open pollinated seedling of ‘B4-19’. Only three males (‘Peters’, ‘Randy’, and ‘B6-6’) were present in or near the plot location. Since both ‘Peters’ and ‘B6-6’ are very late flowering, we believe that the early shedding ‘Randy’ is the male parent of ‘Tejon’. ‘Randy’ is from a cross of female ‘2-35’ and male ‘ES#3’. ‘B4-19’ is an early-flowering female from a cross of female ‘2-35’ and an unknown male. ‘B4-19’ was selected in a 1997 plot on the west side of the San Joaquin valley as part of the University of California’s breeding program (Chao et al., 1998).

Description

Tree. The ‘Tejon’ tree, grafted to ‘UCB1’ or ‘PG1’ rootstock, is similar in character to other pistachio male cultivars, 5–10 m tall, with multiple scaffold branches at 60° angles from vertical. Trunks are 10–20 cm diameter at 10 years. Bark is grey 202C to 202D with colors referenced to color samples of the Royal Horticultural Society Color Chart (Royal Horticultural Society, 1966).

Fig. 1. ‘Tejon’ leaves and shoots on the tree.

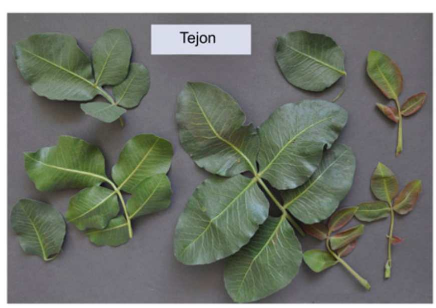

Fig. 2. ‘Tejon’ leaves collected for color evaluation.

Leaves. Leaves are deciduous simple compound imparipinnate with one or two pairs of oppositely arranged lateral leaflets. Leaflet margins are entire to slightly crenate. Leaflets vary considerably in shape, but are generally oval to ovate, 5–8 cm long, with cuspidate to rounded tips and rounded base (Fig. 1). Margins of leaf blades are entire. Leaf surfaces are glabrous, smooth, and waxy. Color ratings from three or more mature leaves were 136C for the upper surface of mature leaves, 139B for lower surfaces, 139C for the top surface of new leaves, 139D for lower surfaces, and 143D for midribs (Fig. 2).

Flowers. Inflorescences are similar to those of males ‘Randy’ and ‘Peters’ (Fig. 3), described in Parfitt et al. (2010). Male inflorescences are born laterally on branches, and only rarely as terminal buds on 1-year-old wood. The flower buds form a branched compound panicle inflorescence. Panicles are 2–5 cm long when fully expanded and shedding pollen. Flowers develop from base to tip of the panicle over a period of several weeks. ‘Tejon’ inflorescences are very similar to ‘Peters’ in appearance and greener than those of the late-flowering ‘Famoso’ male (Kallsen and Parfitt, 2017b) with scores of 136B to 139B, especially on the outer surface. Individual flowers are 1–2 mm long. Tips and outsides of individual male flowers are pinkish red (48C to 49D) changing to yellow (154B to 154D) near the base of the panicles before opening of individual flowers. Flowers do not have

Fig. 3. ‘Tejon’ inflorescences, showing typical arrangement of flowers at anthesis.

Table 1. Full bloom flowering dates for male and female cultivars at a test plot near Buttonwillow, CA in the southern San Joaquin valley of California.[z]

	2014	2015	2016	2017	2018
Cultivar					
Tejon (male)	29 Mar.	31 Mar.	20 Mar.	30 Mar.	5 Apr.
Gumdrop (female)	25 Mar.	22 Mar.	21 Mar.	28 Mar.	7 Apr.
Randy (male)	5 Apr.	9 Apr.	24 Mar.	5 Apr.	10 Apr.
Golden Hills (female)	30 Mar.	1 Apr.	25 Mar.	5 Apr.	10 Apr.
Peters (male)	11 Apr.	13 Apr.	31 Mar.	11 Apr.	23 Apr.
Kerman (female)	5 Apr.	9 Apr.	31 Mar.	9 Apr.	13 Apr.

[z]Bloom within trees was more variable than normal in 2014 and 2015 due to low winter chill. Cultivars were scored for bloom progress: 0 = prebloom, no flowers receptive or shedding pollen; 2 = more than 5 flowers/tree open; 3 = midbloom, many flowers/tree open; 4 = full bloom, all flowers open; 5 = late bloom, few flowers receptive or shedding pollen; and 6 = end of bloom.

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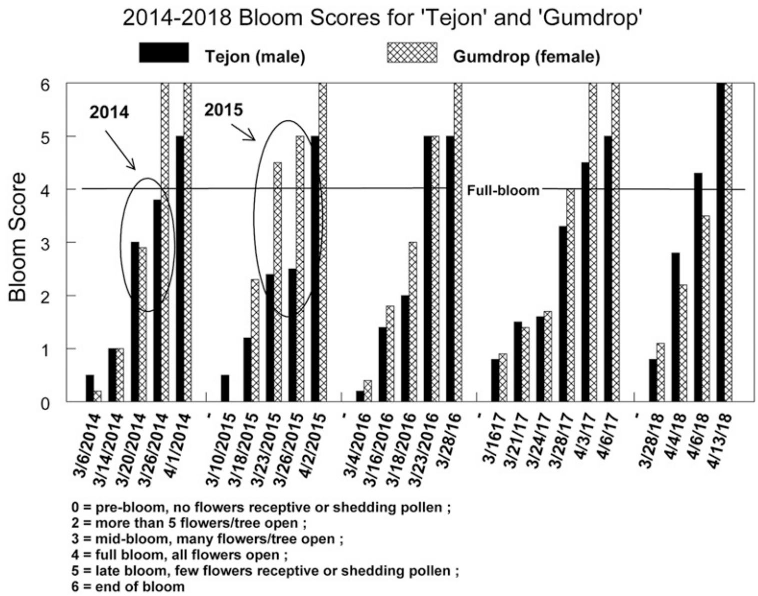

Fig. 4. 2014–18 bloom scores for 'Tejon' and 'Gumdrop', showing bloom overlap for low chill years 2014–15. Cultivars were scored for bloom progress: 0 = prebloom, no flowers receptive or shedding pollen; 2 = more than 5 flowers/tree open; 3 = midbloom, many flowers/tree open; 4 = full bloom, all flowers open; 5 = late bloom, few flowers receptive or shedding pollen; and 6 = end of bloom.

Fig. 5. 'Tejon' in a cultivar trial on the east side of the San Joaquin valley, showing abundant inflorescence production.

petals and have 5–6 stamens each with 4 lobes. Pollen is shed from the terminal ends of the stamens.

Performance

Flowering dates. Flowering was scored annually on six or seven dates for the number of inflorescences shedding pollen and the relative number of flowers per inflorescence shedding pollen. Mean full bloom flowering dates for male and female cultivars are shown for 5 years in Table 1. 'Tejon' flowering dates were coincident with the early blooming female 'Gumdrop' (Kallsen and Parfitt, 2017a) in 2016–18. During the low chill years of 2014 and 2015 full bloom followed 'Gumdrop' by 4–9 d. However, even in those years there was sufficient flowering overlap to pollenize 'Gumdrop' (Fig. 4). 'Tejon' is the earliest commercial flowering male (mean of 6 d earlier than 'Randy' male over 5 years) that has good pollen viability and abundant pollen shed. 'Tejon' is also more precocious than other pollenizers, as is 'Gumdrop', with a few flowers in the fourth leaf and full flowering in the fifth leaf so that pollen will be available when 'Gumdrop' female first becomes productive. 'Tejon' has a large number of inflorescences (Fig. 5) and produces abundant pollen similar to other widely used commercial males.

Pollen viability and durability. Pollen viability was evaluated in 2015 and 2016 for several cultivars including 'Tejon', 'Famoso', 'Randy', and 'Peters' using hanging drop germination tests. Pollen was sprinkled onto cover slides with a drop of 18% to 20% sucrose and inverted to create a hanging drop for counting with a microscope. Four to 12 slides (mean = 8) were counted per cultivar-year. Fifty to 80 pollen grains were counted per slide. A general linear models (GLM) analysis was performed with MiniTab17.3.1 (Minitab Inc., 2016); cultivars and years were treated as fixed effects. Years were not significantly different but cultivar and cultivar by year differences were significant (Table 2). Both 'Tejon' and 'Famoso' had the best pollen germination, primarily because of performance differences in 2015 (Table 2), following the unusually warm winter of 2014–15. All cultivars had similar and high levels of pollen germination in 2016. 'Tejon' pollen viability was high (77% to 85%), similar to the other tested cultivars, and sufficient to ensure pollination of 'Gumdrop' and other early flowering female cultivars.

Pollen quantities. During Mar. 2015 and 2016, branches from several cultivars with dehiscing inflorescences were collected and brought to the laboratory for pollen collection. Three groups per cultivar of four to five 8–12 inch shoots with multiple dehiscing inflorescences per group were placed on kraft paper overnight (Fig. 6). Pollen was collected the following morning from each group, weighed, and standardized by dividing by the number of dehiscing inflorescences in the group. Data were subjected to analysis of variance (ANOVA), with years and cultivars considered fixed effects. Cultivar effects were significantly different (Table 3). Year means of 0.03 and 0.12 g/inflorescence for 2015 and 2016, respectively, were very significant. Interaction effects were not significant by ANOVA but could be separated with Tukey pairwise comparisons (Table 3). 'Tejon' pollen production was similar to the best pollen producer, 'Famoso', in 2016, and substantially better than the other cultivars in the low chill year 2015. The normal complement of 1:24 male:female tree ratio in orchards may not be sufficient if low chill years

Table 2. Pollen germination was evaluated on the day of pollen collection for both 2015–16.

	df	MS ($\times 10^{-2}$)	F	P value
Source[z]				
Year	1	1.56	2.45	0.125
Cultivar	3	4.63	7.29	0.000
Year × Cultivar	3	5.69	8.94	0.000
Error	46	0.64		
R^2	42.1%	Adj. R^2	37.4%	

Cultivar[y]	Germination mean %	95% Tukey comparisons	
Famoso	82.3	a	
Tejon	81.2	a	
Peters	71.8		b
Randy	70.0		b

Cultivar[x]	Year	Germination mean %	95% Tukey comparisons		
Famoso	2015	86.5	a		
Tejon	2015	85.1	a		
Randy	2016	80.0	a	b	
Famoso	2016	78.3	a	b	
Tejon	2016	77.3	a	b	
Peters	2016	77.0	a	b	
Peters	2015	66.7		b	c
Randy	2015	59.2			c

[z]Analysis of variance showing highly significant differences among cultivars for fresh pollen in 2015, counted immediately after flowering.
[y]Cultivar germination means with Tukey and Bonferroni pairwise comparisons at 95% confidence.
[x]Means and Tukey comparisons for year by cultivar at 95% confidence.

Fig. 6. Pollen shed from inflorescences of 'Tejon' and 'Peters'. All shoots were collected on the same date (20 Mar. 2014).

Table 3. Pollen quantities from inflorescences (infl.) collected in 2015–16.

	df	MS ($\times 10^{-2}$)		F		*P* value
Source[z]						
Year	1	4.77		38.06		0.000
Cultivar	3	0.45		3.57		0.038
Year × Cultivar	3	0.39		3.08		0.057
Error	16	0.13				
R^2	78.3%	Adj. R^2		68.9%		
Cultivar[y]		Mean g/infl. ($\times 10^{-2}$)	95% Tukey comparisons			
Famoso		9.48	a			
Tejon		9.45	a			
Peters		5.65	a			
Randy		4.08	a			
Cultivar[x]	Year	Mean g/infl. ($\times 10^{-2}$)	95% Tukey comparisons			
Famoso	2016	17.47	a			
Tejon	2016	14.07	a	b		
Peters	2016	8.43	a	b	c	
Randy	2016	6.53		b	c	
Tejon	2015	4.83		b	c	
Peters	2015	2.86			c	
Randy	2015	1.62			c	
Famoso	2015	1.49			c	

[z]Analysis of variance showing marginally significant differences for cultivars (g/inflorescence).
[y]Cultivar means were not significantly different by Tukey comparisons.
[x]Year × Cultivar means were marginally significant by Tukey comparisons, reflecting the significant effects of the low chill 2014–15 year.

become frequent as suggested by Luedeling et al. (2009). Male:female synchrony could be more important than it is at present if pollen quantities are reduced.

Chilling. Luedeling et al. (2009) predicted that low or insufficient chilling conditions for pistachio may become normal in the near future (years 2040–60). Beede et al. (2006) reported a minimum requirement of 700 h < 7 °C for 'Kerman' and 900 h for 'Peters' bloom. With reduced chilling, coincidence of male and female bloom is more important as reduced chill can shift male and female bloom periods in different directions and limit the period of bloom overlap (Kallsen, 2017). New cultivars with lower chilling requirements will be needed for continued pistachio production in California. 'Tejon' male and 'Gumdrop' female were released to provide growers with options to address future climate change and to extend the harvest season, permitting more efficient utilization of labor, equipment and processing facilities.

Pests and diseases. 'Tejon' has not been specifically evaluated for resistance or susceptibility to pistachio diseases which are minimal in the prime growing areas of California. We expect that susceptibility to *Botryosphaeria dothidea*, *Botrytis cinerea*, or *Alternaria alternata* would be similar to other pistachio cultivars.

Application and Use

'Tejon' has very good initial pollen viability and a flowering period that is highly coincident with 'Gumdrop' receptivity during both low chill and "normal" chilling years. It is the only male cultivar with good pollen characteristics that flowers as early in the season as 'Gumdrop'. Additional details are presented in U.S. Plant Patent 28,931 (Kallsen and Parfitt, 2018).

Availability

Budwood of 'Tejon' was distributed to California nurseries and commercial budders in 2016. Trees and budwood should be available in small quantities from those sources beginning in 2018. Lists of nurseries propagating 'Tejon' are available from UC Davis Technology Transfer Services, UC Davis Innovation Access, 1850 Research Park Drive, Suite 100, Davis, CA 95618-6159, www.research.ucdavis.edu/InnovationAccess.

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