

# Tainung No. 7 HongLing: A Low-chill Peach Cultivar for Early Fresh Market

Chun-Che Huang and Ien-Chie Wen

Crop Genetic Resources and Biotechnology Division, Taiwan Agricultural Research Institute, No. 189, Zhongzheng Road, Wufeng District, Taichung City 413008, Taiwan

Syuan-You Lin

Department of Horticulture, National Chung Hsing University, No. 145, Xingda Road, South District, Taichung City 402202, Taiwan

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Peach (*Prunus persica* L. Batsch) is an important stone fruit mainly grown in temperate countries, including China, Spain, Italy, Turkey, and the United States (Food and Agriculture Organization of the United Nations 2021). Fruit trees originating in the temperate zone undergo a cyclical growth pattern, initiating growth in spring and early summer, decelerating during midsummer and fall, entering dormancy in winter, and then resuming growth as spring returns. Bud dormancy is mainly released through adequate exposure to low temperatures during the winter (Cooke et al. 2012). The specific amount of chilling required to break bud dormancy is termed chilling requirement, and it varies by plant species and cultivars (Richardson et al. 1975).

Nestled at the convergence of the subtropical and tropical climate zones in the Northern Hemisphere, Taiwan's climate is defined as the Tropic of Cancer. The island's subtropical monsoon climate, noted for its humid summers and mild winters, often leads to the unsatisfied chilling requirement of high-chill peach cultivars favored in commercial production. Therefore, peach production in Taiwan traditionally relied on the cooler highland areas, accounting for ~2000 to 2400 ha during the past decade (Agriculture and Food Agency 2022). To reduce the environmental footprint on these highland areas and shift peach production to more accessible lower altitudes, a significant emphasis has been placed on breeding low-chill peach cultivars.

The Taiwan Agricultural Research Institute (TARI), which is located in central Taiwan (lat. 24.03°N, long. 120.70°E, elevation 89 m), is the sole research institute in Taiwan with a breeding program dedicated to low-chill peach cultivars. Mild winter temperatures provide a conducive environment for germplasm

collection and selection of low-chill peach cultivars. Meteorological data depicted the warm climatic conditions (Table 1) as follows: across the 2020–23 seasons, the mean temperature of the coldest month (January) in TARI ranged from 15.7 to 17.9 °C. In terms of the accumulated chilling hours at temperatures below 7.2 °C, there were 31 h recorded during the winter of the 2020–21 season, only 8 h during the 2021–22 season, and a spike to 69 h during the 2022–23 season. This variable winter chill accumulation across seasons illustrates the institute's strategic positioning in a location optimal for low-chill peach cultivar research.

The TARI peach breeding program has aimed to develop peach cultivars with low chilling requirements, preferably under 200 chilling units (CU), as estimated using the Taiwan low-chill model (Ou and Chen 2000). This indigenous winter chill model was established to minimize the inaccuracy encountered when using the well-known chill models developed from temperate regions, ensuring a more accurate quantification of chill accumulation pertinent to the local context (Table 1). Moreover, the focus is on peaches that are adapted to humid climates, thrive in lowland subtropical conditions, and produce attractive, juicy, and sweet fruits with minimal acidity. TARI has released multiple peach cultivars with very low chilling requirements since 2003. For example, the 'SpringHoney' peach requires 180 CU (Ou and Wen 2003), and the 'Xiami' peach requires 125 CU (Ou and Song 2006).

One of the recent additions to this line of research is the 'Tainung No. 7 HongLing' peach, which was selected for its low chilling requirement to achieve early flowering and harvesting, large fruit size, and attractive fruit appearance. The field trial has demonstrated that 'Tainung No. 7 HongLing' peach is suitable for regions with mild winters, such as the lowland areas of central Taiwan.

## Origin

Tainung No. 7 HongLing resulted from a cross made in 2006 by Dr. Ien-Chie Wen at TARI using P87-1 and the United States cultivar UFOne (Fig. 1). P87-1 is a breeding line selected from a cross using P5-9 ×

'TropicBeauty'. P5-9 was a seedling selection of the offspring from 'TuTu' × 'FloridaGold'. The selection of 'UFOne', 'TropicBeauty', and 'FloridaGold' as parental lines was attributable to their low chilling requirements, which are essential for subtropical climates, whereas 'TuTu' was chosen for its low acidity characteristic, which is preferable for fresh consumption.

Initially labeled as P97-09, the original seedling of 'Tainung No. 7 HongLing' was first characterized and selected for its desirable traits in 2008. Recognizing its potential, TARI officially released it to the growers in 2018. Since then, Tainung No. 7 HongLing has undergone consistent annual evaluations at TARI to ensure that its performance and quality fulfilled the high standards set for commercial peach cultivars.

## Description and Performance

The information presented summarizes the description and performance annually evaluated from 2020 to 2023 regarding 'Tainung No. 7 HongLing' grafted on the bitter peach rootstock. Trees were spaced at 4 m within a row and 5 m between rows at the Low Altitude Clonal Germplasm Repository of TARI in Wufeng, Taichung, Taiwan.

'Tainung No. 7 HongLing' are vigorous, with a semi-spreading habit. Leaf glands are reniform. Flowers have self-fertile, showy, pink petals and bright yellow and abundant pollen. 'Tainung No. 7 HongLing' typically blooms from late January to early February, and the fruit ripening phase spans from late April to early May in Wufeng, Taichung, Taiwan. The fruits are characterized by a red blush on the skin with white flesh, a combination that greatly appeals to consumers (Fig. 2). 'Tainung No. 7 HongLing' consistently exhibits melting and clingstone characteristics. Despite experimenting with delayed harvests to observe over-ripening effects, we found that the fruits transition to semi-clingstone rather than freestone, even when the endocarp is fully developed.

**Phenology.** We used UFSun, a well-known low-chill peach cultivar, to evaluate the phenological development from winter to spring. During the 2020–21 season, 'Tainung No. 7 HongLing' and 'UFSun' had the same defoliation dates on 17 Nov (Table 2). The full leaf drop for 'Tainung No. 7 HongLing' was on 5 Dec, 1 d earlier than that for 'UFSun', which was on 6 Dec. 'Tainung No. 7 HongLing' showed 50% bloom on 6 Feb, 1 d earlier than that for 'UFSun', which began on 7 Feb. Full bloom for 'Tainung No. 7 HongLing' was reached by 8 Feb, 9 d earlier than that for 'UFSun', which reached it on 17 Feb.

During the 2021–22 season, 'Tainung No. 7 HongLing' reached 50% leaf drop on 25 Nov, 18 d later than that for 'UFSun', which defoliated on 7 Nov (Table 2). The full leaf drop for 'Tainung No. 7 HongLing' occurred on 13 Dec, 1 week later than that for 'UFSun', which occurred on 6 Dec. 'Tainung No. 7 HongLing' showed 50% bloom on 10 Feb, 11 d earlier than that for 'UFSun', which started on 21 Feb. Full bloom for 'Tainung No. 7

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C.-C.H. is the corresponding author. E-mail: [huang79@tari.gov.tw](mailto:huang79@tari.gov.tw).

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Table 1. Climatic characteristics at the Low Altitude Clonal Germplasm Repository of the Taiwan Agriculture Research Institute (TARI) in Wufeng, Taichung, Taiwan.

Season	2020–21	2021–22	2022–23	Mean $\pm$ SD <sup>i</sup>
Mean temperature (°C)				
December	18.5	18.8	17.6	18.3 $\pm$ 0.6
January	15.7	17.9	17.8	17.1 $\pm$ 1.2
February	19.1	17.3	19.0	18.5 $\pm$ 1.0
Mean	17.8	18.0	18.1	18.0 $\pm$ 0.2
Accumulated hours <sup>ii</sup>				
<7.2 °C	31	8	69	36.0 $\pm$ 30.8
<12 °C	303	183	281	255.7 $\pm$ 63.9
<15 °C	602	645	632	626.3 $\pm$ 22.1
Chilling model				
Taiwan model (chilling unit, CU) <sup>iii</sup>	216.5	207.0	200.5	208.0 $\pm$ 8.1
Low chilling model (CU) <sup>iv</sup>	68.0	115.5	–63.0	40.2 $\pm$ 92.5
Dynamic model (chill portion, CP) <sup>v</sup>	6	1	3	3.3 $\pm$ 2.5

<sup>i</sup> Means and SD of the 2020–23 seasons are presented.

<sup>ii</sup> Accumulated chilling hours and data computed in chilling models are hourly temperatures recorded from 1 Dec to 28 Feb in the respective seasons.

<sup>iii</sup> Ou and Chen 2000.

<sup>iv</sup> Gilreath and Buchanan 1981.

<sup>v</sup> Fishman et al. 1987a, 1987b.

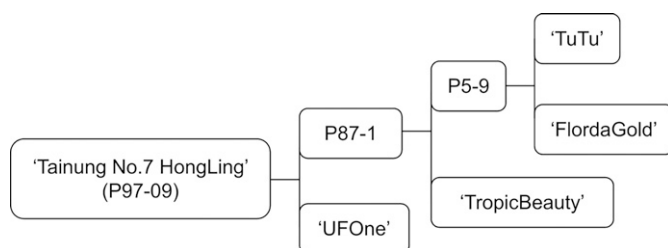


Fig. 1. Pedigree of 'Tainung No. 7 HongLing' peach.

HongLing' was reached by 14 Feb, 13 d earlier than that for 'UFSun', which occurred on 27 Feb. The 50% leaf budbreak for 'Tainung No. 7 HongLing' was on 9 Mar, the same date as that for 'UFSun'. 'Tainung No. 7 HongLing' required 77.5 CU to break dormancy. During this chilling period, it experienced 84 h of

temperatures below 12 °C and 311 h of temperatures below 15 °C.

During the 2022–23 season, 'Tainung No. 7 HongLing' reached 50% leaf drop on 14 Nov, and it reached full leaf drop on 21 Nov, the same day as that for 'UFSun' (Table 2). 'Tainung No. 7 HongLing' showed 50% bloom

on 27 Jan, 3 d earlier than that for 'UFSun'. Full bloom for 'Tainung No. 7 HongLing' was reached by 6 Feb, 1 week earlier than that for 'UFSun', which reached it on 13 Feb. The 50% leaf budbreak for 'Tainung No. 7 HongLing' occurred on 22 Feb, 2 d later than that for 'UFSun', which occurred on 20 Feb. 'Tainung No. 7 HongLing' required 76.5 CU to break dormancy. During this chilling period, it experienced 131 h of temperatures below 12 °C and 215 h of temperatures below 15 °C.

Across the three growing seasons, 'Tainung No. 7 HongLing' consistently entered the bloom phase and attained full bloom more rapidly than 'UFSun'. Although the initial defoliation occurred on comparable dates for both cultivars, the timing of the 50% leaf drop exhibited some variation between them. Notably, detailed chilling requirement data were recorded for 'Tainung No. 7 HongLing' during the latter two seasons, demonstrating its adaptability to low chill accumulation. This is in contrast to 'UFSun', which has a documented chilling requirement in the range of 100 to 150 CU (Sherman 2004), suggesting that 'Tainung No. 7 HongLing' may be a better suited for warmer climates that offer fewer chill hours.

**Fruit size, firmness, organoleptic characteristics.** In 2022, 'Tainung No. 7 HongLing' peaches ripened on 1 May, had a fruit development period (FDP) of 80 d, had a weight of 147.2 g, exhibited firmness of 1.26 kg force, had a soluble solids concentration (SSC) of 13.1 °Brix, and had acidity of 0.35% (Table 3). 'UFSun' peaches ripened slightly later on 5 May, had a shorter FDP of 73 d, were lighter (with an average weight of 108.6 g), were firmer (4.6 kg force), had a slightly lower SSC of 12.1 °Brix, and had comparable acidity of 0.33%.

In 2023, 'Tainung No. 7 HongLing' peaches ripened earlier, on 28 Apr, had a slightly longer FDP of 90 d, had an increased fruit weight (up to 158.8 g), maintained the same firmness (1.21 kg force), had an SSC of 13.0 °Brix, and had lower acidity (0.19%). In contrast, 'UFSun' peaches ripened on 26 Apr, had a shorter FDP of 86 d, were lighter (fruit weight of 113.6 g), were less firm (3.14 kg force), had an SSC of 12.0 °Brix, and had higher acidity (0.38%) compared with values observed during the previous year.

Overall, 'Tainung No. 7 HongLing' peaches tend to be heavier and less firm than 'UFSun', which had a nonmelting flesh type and higher SSC but varying acidity levels across the two years. Our comparison of Tainung No. 7 HongLing with UFSun was driven by their shared characteristics as low-chill, early-season peach cultivars, central to our breeding program's focus. The distinct firmness of UFSun, as a nonmelting flesh cultivar, contrasts with the melting flesh of Tainung No. 7 HongLing. In our germplasm collection, most low-chill, early-season peaches are nonmelting flesh types, thus limiting our comparative data to these specific cultivars. This context is crucial to understanding the basis for our comparative analysis of 'UFSun'.

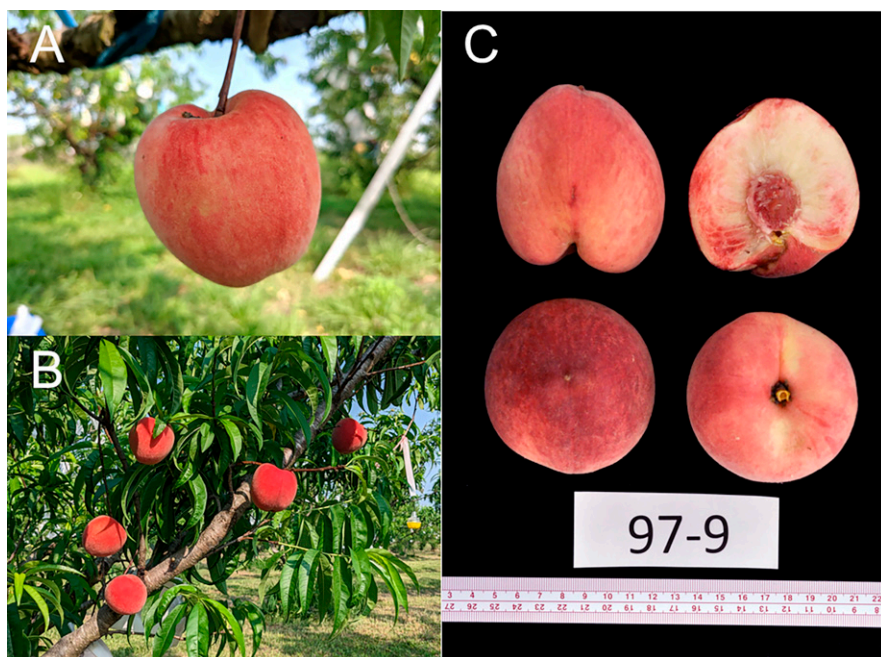


Fig. 2. Fruits of 'Tainung No. 7 HongLing' peach, initially labeled as P97-09, on the tree grown at Taiwan Agricultural Research Institute (A and B) and freshly harvested fruits (C).

Table 2. Comparison of phenology of ‘Tainung No. 7 HongLing’ and ‘UFSun’ peach grown at the Low Altitude Clonal Germplasm Repository of the Taiwan Agriculture Research Institute (TARI) in Wufeng, Taichung, Taiwan.

Season	2020–21		2021–22		2022–23	
	‘Tainung No. 7 HongLing’	‘UFSun’	‘Tainung No. 7 HongLing’	‘UFSun’	‘Tainung No. 7 HongLing’	‘UFSun’
Defoliation date						
50% leaf drop	17 Nov	17 Nov	25 Nov	7 Nov	14 Nov	14 Nov
Full leaf drop	5 Dec	6 Dec	13 Dec	6 Dec	21 Nov	21 Nov
Flowering date						
50% bloom	6 Feb	7 Feb	10 Feb	21 Feb	27 Jan	30 Jan
Full bloom	8 Feb	17 Feb	14 Feb	27 Feb	6 Feb	13 Feb
Leaf budbreak date						
50% emerge	6 Feb	26 Feb	9 Mar	9 Mar	22 Feb	20 Feb
Full emerge	14 Feb	— <sup>ii</sup>	14 Mar	14 Mar	6 Mar	27 Feb
Chilling requirement <sup>i</sup>						
Accumulated hours <12 °C	—	—	84	—	131	—
Accumulated hours <15 °C	—	—	311	—	215	—
Taiwan model (CU)	—	—	77.5	—	76.5	—

<sup>i</sup> After the observation of 100% leaf drop, single-node cuttings were weekly harvested from the orchard. Then, these cuttings were incubated in a controlled-environment growth chamber set to forcing conditions of 24 °C with a 16-h photoperiod and 8-h dark cycle. The chilling requirement necessary to induce dormancy release was estimated based on the point at which 50% of the single-node cuttings exhibited floral budbreak.

<sup>ii</sup> Data not collected.

### Uses

‘Tainung No. 7 HongLing’ produces large and high-quality fruit ideal for the fresh market. Compared with distant shipping, it is more suitable for local sales because its softer texture is less likely to be a concern during shorter fruit transport. Its

low chilling requirement for flowering makes it a good candidate for commercial production in subtropical low-altitude regions. Moreover, its advanced harvest window avoids Taiwan’s peak rainy season during mid-May to June, addressing a significant challenge faced by earlier peach cultivars grown in Taiwan.

Table 3. Comparisons of fruits characteristics of ‘Tainung No. 7 HongLing’ and ‘UFSun’ peach grown at the Low Altitude Clonal Germplasm Repository of the Taiwan Agriculture Research Institute (TARI) in Wufeng, Taichung, Taiwan.

Season	2022		2023	
	‘Tainung No. 7 HongLing’	‘UFSun’	‘Tainung No. 7 HongLing’	‘UFSun’
Ripening date	1 May	5 May	28 Apr	26 Apr
FDP (d) <sup>i</sup>	80	73	90	86
Fruit wt (g/fruit)	147.3 ± 6.26 <sup>iv</sup>	108.6 ± 3.62	158.8 ± 4.75	113.6 ± 4.48
Firmness (kg force) <sup>ii</sup>	1.26 ± 0.11	4.6 ± 0.23	1.21 ± 0.20	3.14 ± 0.34
SSC (°Brix) <sup>iii</sup>	13.1 ± 0.43	12.1 ± 0.25	13.0 ± 0.39	12.0 ± 0.51
Acidity (%)	0.35 ± 0.02	0.33 ± 0.01	0.19 ± 0.02	0.38 ± 0.03

<sup>i</sup> The fruit development period (FDP) was recorded from the date when 50% of the blossoms were in bloom until the date when the fruits reached physiological maturity.

<sup>ii</sup> Fruit firmness was measured using a digital texturometer (KG02-15; Caesar Instrument Co. Ltd., New Taipei City, Taiwan).

<sup>iii</sup> To assess soluble solids concentration (SSC) and acidity, juice was extracted and homogenized from a sample of 30 fruits. The SSC was measured with a digital refractometer (PAL-1; ATAGO Co. Ltd., Tokyo, Japan), and acidity was determined using a digital acidity meter (PAL-Easy ACID11; ATAGO Co. Ltd.).

<sup>iv</sup> Means and *SD* of the fruit characteristics are presented (*n* = 10).

### Availability

The ‘Tainung No. 7 HongLing’ peach has secured the Taiwan Plant Breeder’s Rights (certificate no. A02091) issued by the Ministry of Agriculture, Taiwan. For research purposes, a restricted amount of nonindexed bud wood can be accessed by submitting a formal request to the Crop Genetic Resources and Biotechnology Division of TARI.

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