

‘Tainung No. 11 SingTao’: A Low-chill Peach with High Soluble Solids, Low Acidity, and Reliable Mid-May Harvest

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

Keywords. *Prunus persica* (L.) Batsch, seasonal maturity diversification, single-node cuttings, sub-acid peach, subtropical adaptation

The Taiwan Agricultural Research Institute (TARI) operates the country’s only breeding program dedicated to low-chill peaches (*Prunus persica* L. Batsch) that is situated in one of the warmest germplasm repositories worldwide (Wen and Sherman 2002). This subtropical setting provides a rigorous test environment in which selections must perform reliably under mild winters and humid lowland conditions. Since the early 2000s, the program has targeted cultivars that require fewer than 200 chilling units (CU) and are adapted to low elevations using the Taiwan chill model to quantify local winter accumulation (Ou and Chen 2000). Over the past two decades, the program has progressively released cultivars such as SpringHoney, Xiami, Tainung No. 7 HongLing, and Tainung No. 9 HongJin (Huang et al. 2024a,b; Ou and Song 2006; Ou and Wen 2003). These releases collectively broadened harvest windows, diversified fruit quality profiles, and established a

foundation of site-specific climatology and phenology under variable chill seasons.

We emphasize seasonal maturity diversification as a strategy to manage risk from early summer rains. The breeding objective is to position cultivars in predictable and safer harvest windows so that first harvest consistently precedes peak rainfall periods and typhoon seasons, thus reducing losses from cracking and rots. Previous releases that used this strategy are ‘Tainung No. 7 HongLing’, which extended the season through earlier ripening, and ‘Tainung No. 9 HongJin’, which introduced variation in flesh type, with both reducing weather-related risk and broadening market opportunities. The release of ‘Tainung No. 11 SingTao’ continues this seasonal maturity diversification strategy by providing a later maturity option.

‘Tainung No. 11 SingTao’ matures in mid-May under central Taiwan conditions and has a chilling requirement of approximately 90 h at temperatures below 14°C. Program descriptors classify it as a yellow skin, yellow flesh, nonmelting, clingstone peach with extremely short pubescence, low titratable acidity (TA) (~0.39%), and soluble solids concentration (SSC) of approximately 15.4°Brix. Flowering typically begins in early February, thus positioning ‘Tainung No. 11 SingTao’ in a mid-May harvest window to minimize early summer rainfall-related risk in lowland orchards.

Origin and Development

Tainung No. 11 SingTao is a fresh-market peach cultivar developed by Dr. Ien-Chie Wen at TARI (Fig. 1). It originated from the open pollination of the elite line ‘P93–32 W’ maintained in the TARI peach clonal repository. The parentage of ‘P93–32 W’ traces to a cross between the breeding line ‘P5–9’ and ‘UFGold’. The breeding line ‘P5–9’ itself was derived from a cross between the Brazilian low-chill cultivars TuTu and FlordaGold, released by the University of Florida. Together, the genetic contributions from ‘TuTu’ and ‘FlordaGold’, along with selections developed

in Taiwan, provided reliable sources of low-chill alleles, which underlie the adaptability of ‘Tainung No. 11 SingTao’ to warm subtropical climates.

The original seedling of ‘Tainung No. 11 SingTao’ was designated ‘P99–50YC’ and was first evaluated in 2010 to determine horticultural traits. Following a decade of consistent performance, the cultivar was officially released to growers in 2020. Since then, ‘Tainung No. 11 SingTao’ has been included in annual performance evaluations at TARI.

This report summarizes data of ‘Tainung No. 11 SingTao’ collected between 2023 and 2025 and the results of its comparisons with ‘Tainung No. 4 Ruby’ (Wen and Chang 2014), ‘Tainung No. 7 HongLing’ (Huang et al. 2024a), and ‘TropicBeauty’ (Rouse and Sherman 1989). Trees of ‘Tainung No. 7 HongLing’ were grafted and established in 2017, whereas those of ‘Tainung No. 11 SingTao’, ‘Tainung No. 4 Ruby’, and ‘TropicBeauty’ were grafted in 2020. All cultivars were grafted onto *Prunus persica* ‘Kutao’ rootstock trained to an open-center system and planted in three-tree observational plots. Trees were spaced 4 m within rows and 5 m between rows at the Low-Altitude Clonal Germplasm Repository at TARI in Wufeng, Taichung, Taiwan (lat. 24.03°N, long. 120.70°E; 89 m elevation).

Phenological traits, including Julian days for 50% leaf drop, 50% bloom, 50% leaf budbreak, and 50% harvest, were recorded annually. The fruit development period (FDP), fruit weight, firmness, SSC, and TA were measured from a sample of 10 fruits collected at peak harvest for each cultivar annually. The FDP was defined as the number of days from 50% bloom to fruit physiological maturity. Firmness, SSC, and TA (expressed as % malic acid) were measured using a digital texturometer (KG02-15; Caesar Instrument Co. Ltd., Taipei, Taiwan), a digital refractometer (PAL-1; ATAGO Co. Ltd., Saitama, Japan), and a digital acidity meter (PAL-Easy ACID11; ATAGO Co. Ltd.), respectively.

The chilling requirement of ‘Tainung No. 11 SingTao’ was assessed during the 2024–25 season using a single-node cutting assay. Weekly samples of 45 cuttings were collected from 29 Oct 2024 to 21 Jan 2025 and incubated under forcing conditions (24°C, 16 h light/8 h dark). Chilling hours in the orchard below 7.2 and 14°C were recorded upon each collection. The 14°C threshold was applied based on the Taiwan low-chill model (Ou and Chen 2000) and a review by Erez (2024), which offered a more accurate estimation of chill accumulation in subtropical climates compared with traditional models developed for temperate regions (Huang et al. 2024a). The chilling requirement for dormancy release was defined as the point when 50% of the cuttings exhibited flower budbreak.

All phenological and fruit data were obtained from three-tree observational plots for each cultivar, with individual trees serving as the experimental units. Data were analyzed

Received for publication 29 Sep 2025. Accepted for publication 17 Oct 2025.

Published online 11 Nov 2025.

We thank Wayne B. Sherman at the University of Florida for his insights and expertise that greatly assisted the project.

The ‘Tainung No. 11 SingTao’ peach has secured the Taiwan Plant Breeder’s Rights (certificate no. A02718) issued by the Ministry of Agriculture, Taiwan. For research purposes, a restricted amount of nonindexed bud wood can be accessed upon submission of a formal request to the Crop Genetic Resources and Biotechnology Division of TARI. During the preparation of this work, the authors used ChatGPT (Open AI, San Francisco, CA, USA) to correct grammar. After using this tool/service, the authors reviewed and edited the content to ensure accuracy and clarity and take full responsibility for the content of this publication. C.H. is the corresponding author. E-mail: huang79@tari.gov.tw.

This is an open access article distributed under the CC BY-NC license (<https://creativecommons.org/licenses/by-nc/4.0/>).

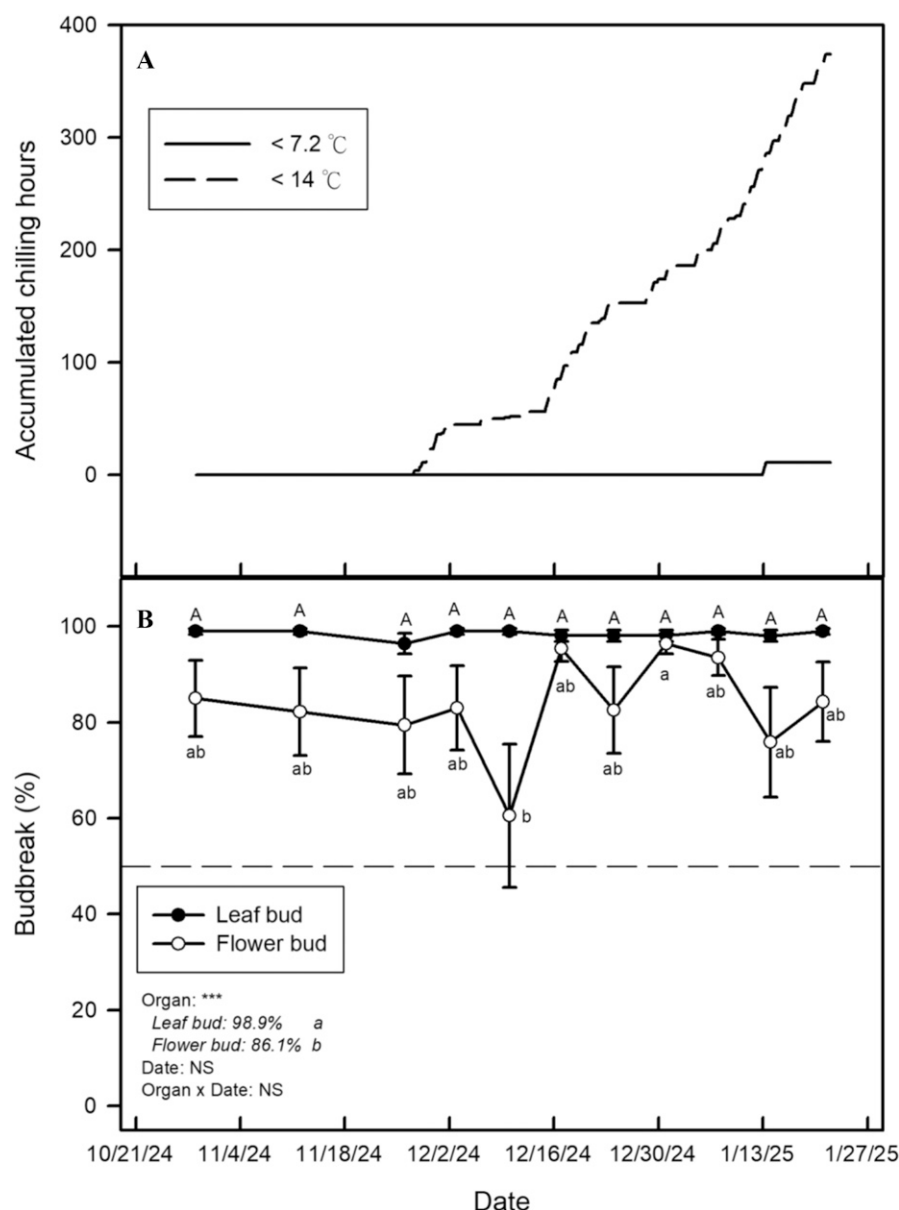


Fig. 3. Chilling requirement estimation for ‘Tainung No. 11 SingTao’ peach at the Taiwan Agricultural Research Institute (TARI) shown as (A) accumulated chilling hours and (B) budbreak percentage in single-node cuttings. Weekly samples of 45 single-node cuttings were collected from the orchard and incubated under controlled conditions (24 °C, 16-h light/8-h dark). Although >50% flower budbreak was observed at the first sampling date in late October, budbreak percentages fluctuated during November and early December, indicating incomplete dormancy release. From mid-December onward, flower budbreak stabilized above 90%, corresponding to an orchard accumulation of approximately 90 h below 14 °C (Taiwan chill model). This plateau was interpreted as the practical chilling requirement for dormancy release in subtropical condition. “Organ,” “date,” and “organ × date” denote the effects of bud type, sampling date, and their interaction, respectively. NS and *** indicate nonsignificant and significant differences at $P < 0.001$, respectively. Data are presented as the mean $\pm$ standard error of the mean ($n = 3$). Different uppercase and lowercase letters denote significant differences among sampling dates within leaf buds and flower buds, respectively, and different letters in the legend indicate treatments that are significantly different according to Tukey-Kramer’s test ($P < 0.05$).

99% across all collections from late Oct 2024 to Jan 2025 (Fig. 3B). This uniform response indicates that leaf buds required little to no additional chilling for dormancy release. In contrast, flower budbreak showed greater seasonal variation. Initial budbreak percentages were high (85% on 29 Oct 2024), declined to approximately 60% on 10 Dec 2024, and then increased sharply, exceeding 95% by 17 Dec 2024, and remained above 90% thereafter.

Although flower budbreak under forcing conditions exceeded 50% at the first sampling date in late October, percentages fluctuated

considerably in subsequent weeks, dropping to as low as approximately 60% by early December. This suggests that the chilling requirement was not satisfied at that stage, and that early >50% budbreak did not reliably represent dormancy release. From mid-December onward, budbreak stabilized above 90% and remained consistently high through January. At this point, orchard records indicated an accumulation of approximately 90 h below 14 °C according to the Taiwan low-chill model (Ou and Chen 2000). Therefore, we interpret the chilling requirement of ‘Tainung No. 11 SingTao’ as a practical chilling

requirement of approximately 90 h, thus reflecting the level of accumulation needed for stable and uniform flower budbreak expression under subtropical conditions.

Fruit characteristics. The FDP of ‘Tainung No.11 SingTao’ was 98 d, which was significantly longer than that of ‘Tainung No. 7 HongLing’ and ‘TropicBeauty’ (Table 2). The mean fruit weight averaged 114.4 g in ‘Tainung No. 11 SingTao’, which was comparable to that of ‘Tainung No. 4 Ruby’ and ‘TropicBeauty’, but significantly smaller than that of the larger-fruited ‘Tainung No. 7 HongLing’. Firmness measurements

Table 2. The fruit development period and fruit characteristics of ‘Tainung No. 11 SingTao’ peach compared with those of three others—‘Tainung No. 4 Ruby’, ‘Tainung No. 7 HongLing’, and ‘TropicBeauty’—from three-tree observation plots at the Low Altitude Clonal Germplasm Repository of the Taiwan Agricultural Research Institute (TARI) in Wufeng, Taichung, Taiwan, 2023–25.ⁱ

Cultivar ⁱⁱ	FDP (d) ⁱⁱⁱ	Fruit wt (g)	Firmness (kg force)	SSC (°Brix)	Acidity (%)
Tainung No. 11 SingTao	98.0 ± 4.8 ^{iv} a	114.4 ± 17.2 b	2.63 ± 0.70 a	15.4 ± 0.9 a	0.39 ± 0.01 bc
Tainung No. 4 Ruby	85.2 ± 1.3 ab	109.2 ± 33.0 b	2.40 ± 0.37 ab	14.5 ± 0.2 ab	0.50 ± 0.05 ab
Tainung No. 7 HongLing	80.3 ± 2.6 b	180.4 ± 17.3 a	0.75 ± 0.32 c	12.4 ± 0.7 bc	0.26 ± 0.05 c
TropicBeauty	84.6 ± 4.3 b	139.6 ± 14.3 ab	0.85 ± 0.20 bc	11.8 ± 0.7 c	0.65 ± 0.06 a

ⁱ Trees of ‘Tainung No. 7 HongLing’ were grafted and established in 2017, whereas those of ‘Tainung No. 11 SingTao’, ‘Tainung No. 4 Ruby’, and ‘TropicBeauty’ were grafted in 2020. All cultivars were grafted onto *Prunus persica* ‘Kutao’ rootstock.

ⁱⁱ All data were obtained from a sample of 10 fruits collected at peak harvest for each cultivar annually.

ⁱⁱⁱ Fruit development period (FDP) was measured from 50% bloom to physiological fruit maturity. Fruit firmness, soluble solids concentration (SSC), and titratable acidity (% malic acid) were assessed using a digital texturometer (KG02-15; Caesar Instrument Co. Ltd.), digital refractometer (PAL-1; ATAGO Co. Ltd.), and digital acidity meter (PAL-Easy ACID11; ATAGO Co. Ltd.), respectively.

^{iv} Data are mean ± standard deviation (n = 3). Means in a column with the same letter or no letter are not significantly different based on Tukey’s honestly significant difference test ($P < 0.05$).

reflected differences in flesh type among the cultivars. ‘Tainung No. 11 SingTao’ and ‘Tainung No. 4 Ruby’ are non-melting peaches, which maintained firmness values of 2.63 and 2.40 kg force, respectively, at harvest. In contrast, ‘Tainung No. 7 HongLing’ and ‘TropicBeauty’ are melting-flesh types, with much softer textures at 0.75 and 0.85 kg force, respectively. The SSC was highest in ‘Tainung No. 11 SingTao’ at 15.4°Brix, similar to that in ‘Tainung No. 4 Ruby’ but significantly greater than that in ‘Tainung No. 7 HongLing’ and ‘TropicBeauty’. The average TA was 0.39% malic acid in ‘Tainung No. 11 SingTao’, which did not differ significantly from that in ‘Tainung No. 4 Ruby’ or ‘Tainung No. 7 HongLing’, but it was lower than that in ‘TropicBeauty’. These results show that ‘Tainung No. 11 SingTao’ combines a longer fruit development period, small fruit size, high SSC, and non-melting flesh with moderate firmness and relatively low acidity. This combination contributes to a sweet, firm eating quality that distinguishes it from the comparator cultivars.

One limitation of this study was that ‘Tainung No. 7 HongLing’ trees were grafted 3 years earlier than ‘Tainung No. 11 SingTao’, ‘Tainung No. 4 Ruby’, and ‘TropicBeauty’, and this difference in tree age may have influenced phenological development and fruit characteristics among cultivars. However, because all trees had reached reproductive maturity and were managed under identical cultural practices throughout the trial period, we consider the influence

of age differences on the comparative patterns of phenology and fruit quality to be limited.

Overall, ‘Tainung No. 11 SingTao’ represents a distinctive addition to the portfolio of low-chill peaches developed by TARI. Its mid-May harvest window, coinciding just before the onset of early summer rainfall and typhoon seasons, provides growers with a reliable option to mitigate weather-related risks such as fruit cracking and rot. The cultivar combines a long fruit development period, high SSC, and nearly acid-less flavor with non-melting flesh that maintains moderate firmness at harvest. These characteristics not only enhance eating quality but also reduce harvest losses by improving resistance to damage during handling.

For subtropical peach production systems, the release of ‘Tainung No. 11 SingTao’ broadens the staggered maturity schedule initiated by earlier releases such as ‘Tainung No. 7 HongLing’ and ‘Tainung No. 9 HongJin’. Together, these cultivars allow growers to distribute labor, extend supply to markets, and reduce exposure to climatic uncertainty. Additionally, the stable budbreak and bloom timing observed across year’s highlights its adaptability to lowland orchards where chilling accumulation is limited. Consequently, ‘Tainung No. 11 SingTao’ strengthens the capacity of Taiwan’s peach industry to sustain production under warm winters and provides a practical model of seasonal maturity diversification for subtropical breeding programs worldwide.

References Cited

- Erez A. 2024. Overcoming dormancy in *Prunus* species under conditions of insufficient winter chilling in Israel. *Plants* (Basel). 13(6):764. <https://doi.org/10.3390/plants13060764>.
- Huang CC, Wen IC, Lin SY. 2024a. Tainung No. 7 HongLing: A low-chill peach cultivar for early fresh market. *HortScience*. 59(3): 304–306. <https://doi.org/10.21273/HORTSCI17602-23>.
- Huang CC, Wen IC, Lin SY. 2024b. Tainung No.9 HongJin: The first yellow-fleshed, low-chill peach cultivar release from Taiwan. *HortScience*. 59(11):1661–1664. <https://doi.org/10.21273/HORTSCI18187-24>.
- Ou SK, Chen CL. 2000. Estimation of the chilling requirement and development of a low-chill model for local peach trees in Taiwan (in Chinese with English abstract). *J Chin Soc Hortic Sci*. 46:337–350.
- Ou SK, Song CW. 2006. ‘Xiami’ peach. *HortScience*. 41(5):1362–1363. <https://doi.org/10.21273/HORTSCI.41.5.1362>.
- Ou SK, Wen IC. 2003. ‘SpringHoney’ peach. *HortScience*. 38(4):633–634. <https://doi.org/10.21273/HORTSCI.38.4.633>.
- Rouse RE, Sherman WB. 1989. ‘TropicBeauty’: A low-chilling peach for subtropical climates. *HortScience*. 24(1):165–166. <https://doi.org/10.21273/HORTSCI.24.1.165>.
- Wen IC, Chang CY. 2014. Breeding of peach cultivar ‘Tainung No.4 (Ruby)’. *J Taiwan Agric Res*. 63:320–323. <https://doi.org/10.6156/JTAR/2014.06304.08>.
- Wen IC, Sherman WB. 2002. Evaluation and breeding of peaches and nectarines for subtropical Taiwan. *Acta Hortic*. 592:191–196. <https://doi.org/10.17660/ActaHortic.2002.592.27>.