台灣農業研究 (J. Taiwan Agric. Res.) 63(1):43–56 (2014)
DOI: 10.6156/JTAR/2014.06301.04

荔枝新品種「台農 7 號 (早大荔)」之育成

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摘要

張哲瑋、顏昌瑞、王婉伶、劉茂南、張仁育。2014。荔枝新品種「台農 7 號 (早大荔)」之育成。台灣農業研究 63(1):43–56。

新品種荔枝「台農 7 號 (早大荔)」係農業試驗所嘉義分所自 1982 年以「沙坑」為母本之實生後裔選育而得，於 2010 年取得品種權。本品種兼具早熟、大果特性，故以此命名。「台農 7 號 (早大荔)」於台灣南部地區可於 5 月上旬至下旬採收，較早熟商業品種「玉荷包」早約 10 d，較中熟商業品種「沙坑」或「黑葉」早約 17–21 d。本品種生產栽培成本低於「玉荷包」，而單穗著果量與豐產品種「沙坑」及「黑葉」相當，品種系比較試驗及區域試驗結果亦顯示本品種著果良好且無明顯隔年結果；「台農 7 號 (早大荔)」果實平均單果重約 25–35 g，果色澤紅、果形呈橢圓或心形、清甜多汁，具備市場價值，期能部分取代我國現有荔枝生產，提早荔枝產期，紓解台灣長期以來的荔枝產銷問題。

關鍵詞：台灣、荔枝育種、玉荷包、黑葉、沙坑。

前言

荔枝 (*Litchi chinensis* Sonn.) 為台灣近 10 年栽培面積第 4 大果樹作物，佔台灣果樹栽培面積 5.7%，僅次於柑橘類、檳榔及香蕉，近 5 年平均年產值近新台幣 31 億元，顯示其在台灣果樹產業的重要性。目前台灣荔枝栽培品種仍以「黑葉」為主，約佔總栽培面積 70% (Lee *et al*. 2010; Chang *et al*. 2012)，產期集中加上「黑葉」荔枝不耐貯存 (Yeh *et al*. 2013)，時有產銷失衡減損農友收益情形，在中部地區尤甚。南部地區荔枝果實成熟期較早，部分果農種植市場價格較高的早熟品種「玉荷包」荔枝，可分散市場供給、紓緩滯銷問題。然而，近年來「玉荷包」栽植面積已增加至近3,000 ha (Hsu 2008)，栽培技術較為繁瑣、每公斤生產成本約新台幣 33–50 元 (Chang *et al*. 2012)，高於其他商業品種。而且台灣過去 10 年「玉荷包」年市場均價兩度跌破新台幣 50 元 (2007 年「玉荷包」年市場均價為新台幣 47.2 元、2009 年為新台幣 47.4 元)，顯示「玉荷包」已面臨產銷不穩定的局面。如何調整產業結構，健全產業經營與發展，已然是台灣荔枝產業一大考驗。

開發加工、貯藏技術可以延長果實供貨時程、擴大市場，然而寄望果品得以提早上市以調整生產結構，迄今仍仰賴荔枝育種選拔。行政院農業委員會農業試驗所自 2005 年起分別選育出「台農 1 號 (翠玉)」(Chang *et al*. 2005)、「台農 2 號 (旺荔)」(Teng & Liu 2007)、「台農 6 號 (豔荔)」(Teng & Chen 2011) 等品質優良的早熟品種荔枝，各該品種獨具特色，備受期盼能部分取代「玉荷包」及「黑葉」在台灣荔枝產業所佔區位，以增進產業價值。兼具果色鮮紅、果實碩大、豐產而穩定等品種特色，

投稿日期：2013 年 9 月 27 日；接受日期：2013 年 12 月 11 日。
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乃是荔枝育種者追求的目標之一 (Sarin *et al*. 2009)，而且在荔枝產業轉型與佈局之初面對多元市場需求，亦較易有出線機會。本研究以選育早熟大果、穩產豐產、易於栽培管理品種且具市場獨特性爲育種目標，選育出「台農 7 號 (早大荔)」荔枝，本文說明自選拔至各階段試驗評估之育成歷程，而該品種由於果實大、產期早於「玉荷包」具市場優勢，遂得其名。

材料與方法

育種方法與程序

本品種選育溯自 1982 年，係先以多交方式 (poly cross) 取得種子，母本爲農業試驗所嘉義農業試驗分所荔枝遺傳資源庫中的「沙坑」，園區尚植有「玉荷包」與「黑葉」荔枝。種子於當年培育爲實生苗後定植於嘉義分所試驗果園，歷經實生苗選拔、品種系比較試驗、區域試驗及植物性狀檢定等程序，於 2010 年 12 月獲得農業委員會果樹品種審議委員會審核通過、取得品種權。

實生苗培育與選拔

1983 年將前年度培育之實生苗以 2.5 m × 0.5 m 行株距密植於嘉義分所試驗果園，並依一般荔枝栽培及病蟲害防治方式管理園區。實生苗於 1987 年起陸續開花結果，分別於 1987 年評估 39 個品系，1988 年評估 50 品系。以單果重 20 g 以上、具有焦核、可溶性固形物在 16°Brix 以上，果實成熟期異於「黑葉」等條件列爲選拔標準，評選出品質較優良者共 12 品系，其中包含品系代號 '71-3-15' 實生苗 [即爲本品種「台農 7 號 (早大荔)」，於下以後者名之]。

品種系比較試驗

具有優良性狀的「台農 7 號 (早大荔)」實生苗與對照品種「黑葉」於 1987 年進行品種系比較試驗，二者經高壓法無性繁殖後擇定 5 株，以 4 m × 3 m 行株距栽植於嘉義分所試驗果園，並按一般荔枝栽培方法管理園區。同年並取相鄰之分所荔枝品種園「沙坑」之高壓苗 5 株，株齡爲 9 年、行株距 4 m × 3 m，作爲參考對照品種。2000–2004 年度各荔枝著果期間調查果實性狀，依 Chang *et al*. (2010) 所敘方法調查包括果實單果重、果皮重、果肉重、種子重、焦核率、可溶性固形物含量、可滴定酸及結果數等項目。

區域試驗

「台農 7 號(早大荔)」與對照商業品種「玉荷包」於台南市楠西區、屏東縣高樹鄉、高雄市杉林區 3 處篤實農戶荔枝園進行區域試驗。台南試區於 1999 年以高壓苗作爲試驗材料、行株距 4 m × 4 m，兩品種系逢機取 5 株，自 2003 年開始調查果實性狀。屏東試區自 1999 年以 10 年生「黑葉」高壓苗爲砧木，採嫁接株作爲試驗材料進行試驗，供試品種系皆爲 5 株，2003 年起調查果實性狀。高雄試區於 2005 年採以 5 年生「玉荷包」爲砧木之「台農 7 號 (早大荔)」嫁接株及未嫁接者作爲試驗材料進行試驗，各供試品種系同爲 5 株，2008 年起調查果實性狀。區域試驗中，果實性狀調查方式與品種系比較試驗相同。

植物性狀檢定

根據「植物品種及種苗法」(第六版，2010)，申請植物品種權時須填寫植物品種性狀檢定報告書，以證明申請品種與對照品種具有可區別性。「台農 7 號 (早大荔)」整體植物性狀與其母本「沙坑」最爲接近。2008–2010 年間於嘉義農業試驗分所以「沙坑」作爲對照品種檢定「台農 7 號 (早大荔)」，植物性狀檢定項目參照臺灣現有作物栽培品種名錄 (Chao 1999) 及農業委員會農糧署公告之荔枝品種性狀檢定表 (test guideline) 爲之。

資料分析

本研究採完全逢機設計，試驗資料經由 Microsoft Excel 2007 套裝軟體 (Microsoft Corporation, Washington, USA) 或 SAS 9.0 套裝軟體套裝軟體 (SAS Institute Inc., North Carolina, USA) 進行變方分析 (one way ANOVA)，以及最小顯著差異性測驗 (Fisher's least significant difference; LSD)、*t* 檢定 (Student's *t*-test) 比較。

結果

實生苗初選

1987–1988 年兩度評估實生苗，'71-3-15' 即「台農 7 號 (早大荔)」，穩定表現早熟大果的特性 (表 1)：包含平均單果重約 27 g，種子重約 4.5 g，平均果肉率在 64.4–67.6% 間，可溶性固形物約 16.1°Brix 等，合乎選拔標準。

品種系比較試驗

2000–2004 年連續 5 年在嘉義分所品種系比較試驗結果 (表 2)，除 2002 年適逢乾旱年，根據中央氣象局台灣南區氣象中心 (http://south.cwb.gov.tw/index1.php) 資料，當年 2–4 月份嘉義地區總雨量不及 5 mm，3 個供試品種系各項調查數值均明顯較其他年度低外，其餘 4 年間「台農 7 號 (早大荔)」平均果重介於 25–32 g，果皮重介於 4–6 g，果肉重介於 18–25 g，種子重介於 2.3–3.7 g (表 2)。「台農 7 號 (早大荔)」平均果重及果肉重於各年度內均顯著重於「黑葉」及「沙坑」，果皮及種子重量亦有高於「黑葉」及「沙坑」態勢。「台農 7 號 (早大荔)」果肉率介於 72–78% 間，與「黑葉」及「沙坑」相近；然而「台農 7 號 (早大荔)」與「沙坑」偶見焦核種子，前者焦核率介於 13–50% 間，後者介於 6–31% 間，焦核率並不穩定，「黑葉」則無焦核情形。在可溶性固形物含量方面，「台農 7 號 (早大荔)」與「黑葉」差異不大，約爲 16–18°Brix 間，「沙坑」相對較低約爲 15–16°Brix。「台農 7 號 (早大荔)」果皮顏色爲淺紅至紅色，色澤較「黑葉」及「沙坑」鮮明。就著果情形而言，「台農 7 號 (早大荔)」於採收時平均每穗著生 8–13 顆果實，略高於「黑葉」之 6–11 顆及「沙坑」之 6–7 顆。「台農 7 號 (早大荔)」採收期約在 5 月 20 日至 5 月 29 日左右，較 6 月中旬採收之「黑葉」早約 17–24 d、較「沙坑」早約 17–21 d。

由於試區缺乏完善灌溉設備，2002 年乾旱影響 3 品種系荔枝果實生育，其中「黑葉」受乾旱影響最爲明顯，平均果重約只有其他年份的 70%，而「台農 7 號 (早大荔)」及「沙坑」在該年果重則約爲其他年份 85%。3 品種系荔枝果重下降係反映自果肉重降低，在「台農 7 號 (早大荔)」及「黑葉」亦可觀察到果肉率下降。

區域試驗

高樹試區試驗：屏東高樹試區「台農 7 號 (早大荔)」平均單果重介於 28–36 g 間、果皮重介於 3.5–6.0 g 間，種子重約 3–4 g，果肉率約 70–75%，焦核率介於 11–23% 之間，可溶性固形物含量約 16–17°Brix。「台農 7 號 (早大荔)」單果重、果肉重、種子重顯著較「玉荷包」高，果肉率、焦核率及可溶性固形物則反之 (表 3)。此外，「台農 7 號 (早大荔)」平均每穗可收穫 8–13 顆果實，約爲「玉荷包」2 倍，而其採收日期爲 5 月 9 日至 5 月 19 日，亦較「玉荷包」早 5–17 d。

楠西試區試驗：在台南楠西試區「台農 7 號 (早大荔)」性狀表現穩定，平均單果重約 28 g、果皮重約爲 4–5 g、果肉重約爲 21–22 g、種子重約爲 3 g，果肉率約爲 74%，焦核率約 10%，可溶性固形物含量約 16°Brix。「台農 7 號 (早大荔)」單果重及種子重顯著較「玉荷包」重，果肉率、焦核率及可溶性固形物含量則較「玉荷包」低 (表 4)。「台農 7 號 (早大荔)」平均每穗可收穫 8–10 顆果實，約爲「玉荷包」2 倍，而其採收日期爲 5 月 14 日至 5 月 31 日，亦較「玉荷包」早 7–13 d。

表 1. 1987 年至 1988 年「台農 7 號 (早大荔)」荔枝實生苗果實品質性狀與採收日期。

Table 1. Fruit characteristics and harvest dates of litchi seedlings 'Tainung No.7 (Early Big)' in 1987 and 1988[z].

Year	FW[y] (g)	AW (g)	SeW (g)	AP (%)	TSS (°Brix)	HD (mo. d)
1987	26.7	17.2	4.7	64.4	16.0	May 20
1988	28.7	19.4	4.3	67.6	16.1	May 24

[z] The materials for the trail were 5 year-old seedlings in 1987; data were mean of 20 fruit.
[y] Abbreviations, FW: fruit weight; AW: aril weight; SeW: seed weight; AP: aril percentage; TSS: total soluble solids content; HD: harvest date.

表 2. 嘉義農業試驗分所試區「台農 7 號 (早大荔)」荔枝及 2 比較品種果實性狀及採收期比較。

Table 2. Comparisons of fruit characteristics and harvest dates of litchi 'Tainung No.7 (Early Big)' and 2 companion cultivars tested at Chiayi Agricultural Experiment Branch of Taiwan Agricultural Research Institute[z].

Year	Cultivar	FW[y] (g)	PW (g)	AW (g)	SeW (g)	AP (%)	SS (%)	TSS (°Brix)	TA (%)	PC	Fruit no. cluster^{-1}	HD (mo. d)
2000	Tainung No. 7 (Early Big)	31.1 a[x]	5.2 a	22.7 a	3.2 a	73.3 a	23 a	18.1 a	0.23 a	red	9.0 a	May 26
	Hak Ip	23.7 b	3.5 b	17.7 b	2.5 a	74.6 a	0 b	16.0 b	0.05 b	dark red	6.0 b	June 17
	Sah Keng	23.4 b	3.9 b	17.3 b	2.3 a	73.5 a	14 ab	14.9 c	0.04 b	dark red	7.0 ab	June 12
2001	Tainung No. 7 (Early Big)	32.3 a	6.0 a	24.0 a	2.3 a	74.3 a	50 a	16.7 a	0.24 a	red	8.2 a	May 20
	Hak Ip	21.2 b	3.1 c	16.0 b	2.2 a	75.0 a	0 b	16.2 ab	0.09 b	dark red	5.3 a	June 12
	Sah Keng	23.7 b	4.0 b	17.2 b	2.4 a	72.9 a	0 b	15.0 b	0.13 ab	dark red	6.0 a	June 9
2002	Tainung No. 7 (Early Big)	25.6 a	4.1 a	18.4 a	3.1 a	72.0 b	13 a	18.7 a	0.08 b	red	13.4 a	May 24
	Hak Ip	16.7 c	2.4 b	11.9 c	1.8 b	73.9 b	0 b	18.0 a	0.19 a	dark red	9.3 ab	June 10
	Sah Keng	20.7 b	3.4 ab	15.9 ab	1.5 b	76.7 a	28 a	15.2 b	0.10 b	dark red	7.2 b	June 10
2003	Tainung No. 7 (Early Big)	31.7 a	4.1 a	24.5 a	3.1 a	77.6 a	15 ab	17.2 a	0.12 a	red	11.4 a	May 29
	Hak Ip	21.7 b	3.5 a	15.9 b	2.3 b	73.1 b	0 b	18.2 a	0.14 a	dark red	11.0 a	June 20
	Sah Keng	24.4 b	4.5 a	18.3 b	1.5 c	75.1 ab	31 a	18.3 a	0.12 a	dark red	6.8 b	June 17
2004	Tainung No. 7 (Early Big)	28.9 a	5.1 a	21.3 a	3.7 a	73.2 b	27 a	17.2 a	0.15 a	red	9.0 a	May 28
	Hak Ip	23.2 b	3.3 b	17.6 b	2.3 ab	75.8 ab	0 b	17.1 ab	0.10 a	dark red	6.6 a	June 21
	Sah Keng	23.2 b	3.7 b	17.5 b	1.8 b	76.4 a	6 ab	16.1 b	0.13 a	dark red	7.2 a	June 18

[z] The materials for the trail were 7-year-old air layers in 2000.

[y] Abbreviations, FW: fruit weight; PW: peel weight; AW: aril weight; SeW: seed weight; AP: aril percentage; SS: shriveled seed percentage; TSS: total soluble solids content; TA: titratable acidity; PC: peel color; Fruit no. cluster^{-1}: fruit number per cluster; HD: harvest date.

[x] Means followed by the same letters at the same column within the same year were not significantly different at 5% level by LSD test.

表 3. 屏東縣高樹試區「台農 7 號 (早大荔)」及「玉荷包」荔枝果實性狀及採收期比較。

Table 3. Comparisons of fruit characteristics and harvest dates of litchi 'Tainung No. 7 (Early Big)' and 'Yu Her Pau' at GauShu trial site in Kaohsiung City[z].

Year	Cultivar	FW[y] (g)	PW (g)	AW (g)	SeW (g)	AP (%)	SS (%)	TSS (°Brix)	TA (%)	PC	Fruit no. cluster^{-1}	HD (mo. d)
2003	Tainung No. 7 (Early Big)	30.3 a[x]	4.8 a	21.0 a	4.4 a	69.6 b	11 a	16.6 b	0.12 b	red	8.0 a	May 9
	Yu Her Pau	24.4 b	4.9 a	18.0 b	1.3 b	74.6 a	62 a	18.3 a	0.19 a	red with mild green	6.6 a	May 26
2004	Tainung No. 7 (Early Big)	27.7 a	4.0 a	20.7 a	3.0 a	75.0 a	23 b	17.4 a	0.10 a	red	9.2 a	May 12
	Yu Her Pau	1.8 b	3.7 a	16.6 a	1.5 b	76.2 a	60 a	17.6 a	0.10 a	red with mild green	4.0 b	May 27
2005	Tainung No. 7 (Early Big)	32.5 a	3.5 a	24.2 a	3.5 a	74.6 b	13 b	16.1 b	0.12 b	red	13.4 a	May 19
	Yu Her Pau	22.0 b	4.1 a	16.9 a	0.9 b	76.6 a	58 a	18.3 a	0.20 a	red with mild green	5.0 b	May 26
2006	Tainung No. 7 (Early Big)	35.6 a	6.1 a	25.8 a	3.9 a	73.1 b	14 b	16.4 b	0.15 a	red	10.0 a	May 12
	Yu Her Pau	23.8 b	3.5 b	19.4 b	0.9 b	81.4 a	60 a	17.6 a	0.10 b	red with mild green	4.0 b	May 17

[z] The materials for the trial were grafted in 1999, the root stocks were 'Hak Ip' air layers.

[y] Abbreviations, FW: fruit weight; PW: peel weight; AW: aril weight; SeW: seed weight; AP: aril percentage; SS: shriveled seed percentage; TSS: total soluble solids content; TA: titratable acidity; PC: peel color; Fruit no. cluster^{-1}: fruit number per cluster; HD: harvest date.

[x] Means followed by the same letters at the same column within the same year were not significantly different at 5% level by *t*-test.

表 4. 台南市楠西試區「台農 7 號 (早大荔)」及「玉荷包」荔枝果實性狀及採收期比較。

Table 4. Comparisons of fruit characteristics and harvest dates of litchi 'Tainung No. 7 (Early Big)' and 'Yu Her Pau' at Nansi trial site in Tainan City[z].

Year	Cultivar	FW[y] (g)	PW (g)	AW (g)	SeW (g)	AP (%)	SS (%)	TSS (°Brix)	TA (%)	PC	Fruit no. cluster^{-1}	HD (mo. d)
2003	Tainung No. 7 (Early Big)	28.3 a[x]	4.7 a	21.0 a	3.3 a	74.3 b	10 b	16.4 b	0.18 a	red	10.0 a	May 25
	Yu Her Pau	23.5 b	4.2 a	18.4 a	0.9 b	78.4 a	40 a	18.0 a	0.24 a	red with mild green	5.8 b	June 6
2004	Tainung No. 7 (Early Big)	27.8 a	3.9 a	20.4 a	3.5 a	73.6 b	6 b	16.0 b	0.13 b	red	8.2 a	May 14
	Yu Her Pau	24.9 b	4.4 a	19.6 a	0.8 b	78.8 a	58 a	17.7 a	0.27 a	red with mild green	4.6 b	May 27
2005	Tainung No. 7 (Early Big)	28.3 a	4.4 a	20.7 a	3.3 a	74.3 b	9 b	16.4 b	0.18 a	red	9.8 a	May 31
	Yu Her Pau	23.3 b	4.1 a	18.3 a	0.9 b	78.4 a	45 a	18.0 a	0.24 a	red with mild green	4.2 b	June 7

[z] The materials for the trail were 4 year-old air layers in 2003.

[y] Abbreviation, FW: fruit weight; PW: peel weight; AW: aril weight; SeW: seed weight; AP: aril percentage; SS: shriveled seed percentage; TSS: total soluble solids content; TA: titratable acidity; PC: peel color; Fruit no. cluster^{-1}: fruit number per cluster; HD: harvesting date.

[x] Means followed by the same letters at the same column within the same year were not significantly different at 5% level by *t*-test.

杉林試區試驗：高雄杉林試區「台農 7 號 (早大荔)」平均單果重約 33 g、果皮重約爲 5 g、果肉重約爲 24 g、種子重約 4 g，果肉率約 73%，焦核率爲 10%，可溶性固形物含量約 16–17°Brix。「台農 7 號 (早大荔)」單果重、果肉重及種子重顯著較「玉荷包」重，果肉率、焦核率及可溶性固形物含量則較「玉荷包」低 (表 5)。「台農 7 號 (早大荔)」平均每穗可收穫 9–10 顆果實，較「玉荷包」平均 6–7 顆高，而其採收日期爲 5 月 26 日至 5 月 27 日，較「玉荷包」早約 10 d。

「台農 7 號 (早大荔)」與「沙坑」植物性狀之差異性

「台農 7 號 (早大荔)」與「沙坑」重要植物性狀及差異性狀如表 6 所列，共具有 21 項性狀具可區別性，其中重要差異如下：(1) 葉片：「台農 7 號 (早大荔)」小葉葉形爲長橢圓形、葉片較寬，因此小葉長/寬比值較低 (約 3.3)；「沙坑」小葉呈披針形、葉子較窄，葉長/寬比值較高 (約 4.3)。(2) 花：「台農 7 號 (早大荔)」花序長而疏，雌蕊柱頭形狀成微卷裂；「沙坑」花序短而密，雌蕊柱頭形狀爲圓卷裂。(3) 果實：「台農 7 號 (早大荔)」果實成心形或橢圓形，果棘成毛尖狀，果皮色澤紅或淺紅色；「沙坑」果形爲近圓球形，果棘乳頭狀突起，果皮顏色較暗紅。(4) 物候期：「台農 7 號 (早大荔)」小花約 2 月下旬陸續開放，果實在嘉義地區約於 5 月下旬成熟；「沙坑」小花於 3 月中旬陸續開放，果實在嘉義爲 6 月中旬成熟。

討論

「台農 7 號 (早大荔)」選育始自 1982 年獲取種子至 2010 年取得品種權，共歷經 29 年。根據品種系比較試驗、區域試驗乃至於植物性狀檢定 (表 6) 一系列調查分析顯示「台農 7 號 (早大荔)」具有如下特性：(1) 新梢呈淡綠色 (圖 1A)。(2) 小葉形狀長橢圓形，葉片長寬比值約 3.3 (圖 1B)。(3) 花序長而分枝疏 (圖 1C)，雌蕊柱頭形狀成微卷裂 (圖 1D)。(4) 果實爲心形或橢圓形 (圖 2A)，果皮色澤淡紅至紅，果棘毛尖 (圖 2B)，縫合線不明顯。(5) 平均果

表 5. 高雄市杉林試區「台農 7 號 (早大荔)」及「玉荷包」荔枝果實性狀及採收期比較。

Table 5. Comparisons of fruit characteristics and harvest dates of litchi 'Tainung No. 7 (Early Big)' and 'Yu Her Pau' at Shanlin trial site in Kaohsiung City[z].

Year	Cultivar	FW[y] (g)	PW (g)	AW (g)	SeW (g)	AP (%)	SS (%)	TSS (°Brix)	TA (%)	PC	Fruit no. cluster^{-1}	HD (mo. d)
2008	Tainung No. 7 (Early Big)	33.4 a[x]	4.7 a	24.4 a	4.3 a	73.1 b	10 b	16.7 b	0.05 a	red	10.0 a	May 26
	Yu Her Pau	25.3 b	4.8 a	19.3 b	1.1 b	76.4 a	44 a	18.5 a	0.09 a	red with mild green	7.0 b	June 6
2009	Tainung No. 7 (Early Big)	33.2 a	5.1 a	24.4 a	3.8 a	73.1 b	11 b	16.4 b	0.05 a	red	9.4 a	May 27
	Yu Her Pau	25.1 b	4.1 a	20.0 b	0.9 b	79.7 a	64 a	18.0 a	0.09 a	red with mild green	6.0 b	June 8

[z] 'Tainung No. 7 (Early Big)' was grafted in 2005, the root stocks were 8-year old 'Hak Ip' air layers. 'Yu Her Pau' were 8-year old air layers in 2005.
[y] Abbreviations, FW: fruit weight; PW: peel weight; AW: aril weight; SeW: seed weight; AP: aril percentage; SS: shriveled seed percentage; TSS: total soluble solids content; TA: titratable acidity; PC: peel color; Fruit no. cluster^{-1}: fruit number per cluster; HD: harvesting date.
[x] Means followed by the same letters at the same column within the same year were not significantly different at 5% level by *t*-test.

表 6. 「台農 7 號 (早大荔)」與「沙坑」荔枝物候期與植物性狀比較。

Table 6. Phenology and morphological characteristics of litchi 'Tainung No. 7 (Early Big)' and 'Sah Keng'[z].

Phenology and morphological characteristics	Tainung No. 7 (Early Big)	Sah Keng
Tree		
Crown shape	Dome shaped	Dome shaped
Trunk surface color	Brown	Brown
Tree growth habit	Spreading	Spreading
Leaf		
Leaflet number	3–4	3–4
Leaflet length (cm)	14.1 ± 0.9	12.2 ± 1.2
Leaflet width (cm)	4.3 ± 0.5	2.9 ± 0.2[y]
Length/width of leaflet	3.3 ± 0.3	4.3 ± 0.5
New leaflet color	Light green	Light green
Mature leaflet surface color	Dark green	Dark green
Leaflet blade shape	Long-elliptic	Lanceolate
Leaflet apex shape	Long-acuminate	Long-acuminate
Leaflet base shape	Broad-cuneate	Cuneate
Leaflet margin	Curling inward slightly	Entire
Flower		
Length of inflorescence (cm)	30.3 ± 3.9	17.3 ± 6.8
Flower bud density	Sparse	Dense
Split number of stigma	2	2
Attitude of splitting stigma	Arc-shaped	Rolling
Color of deteriorational stigma top	Yellow green	Red brown
Fruit		
Weight of per fruit (g)	29.6 ± 4.4	24.0 ± 0.9
Uniformity	uniform	uniform
Fruit shape	elliptic or cordate	Nearly globe-shaped
Mature fruit peel color	Bright red	Dark red
Fruit shoulders	Apophysis	Apophysis
Shape of protuberance	Sligytly pointed	Nipple-protruding
Presence of suture	Unobviously	Unobviously
Peel weight (g)	4.4 ± 0.8	3.5 ± 0.5
Color of aril	Waxy white	Waxy white
Aril texture	Soft	Soft
Aril juiciness	Very juicy	Very juicy
Aril flavor	sweet	sweet
Aril fragrance	Light fragrant	Absent
Edible percentage of fruit (%)	72.0 ± 3.2	70.9 ± 7.2
Total soluble solids content (°Brix)	16.7 ± 1.0	15.5 ±1.4
Quality	Good	Fair
Seed		
Weight per seed (g)	3.5 ± 0.3	2.2 ± 0.5

表 6. 「台農 7 號 (早大荔)」與「沙坑」荔枝物候期與植物性狀比較。(續)

Table 6. Phenology and morphological characteristics of litchi 'Tainung No. 7 (Early Big)' and 'Sah Keng'[z]. (continued)

Phenology and morphological characteristics	Tainung No. 7 (Early Big)	Sah Keng
Percentage of chicken tongue seed fruits (%)	20.7	20
Seed coat color	Brown	Brown
Shape of seed	Elliptic, chicken tongue	Elliptic, chicken tongue
Phenology		
Date of inflorescence emerging	Early January	Late January
Date of male flowering	Late February	Middle March
Date of female flowering	Early March	Late March
Date of functional male flowering	Middle March	Early April
Date of late flowering	Late March	Middle April
Date of fruit maturity	Late May	Middle June
Disease reaction		
Downy blight	Susceptibility	Susceptibility
Pest reaction		
Litchi fruit borer	Susceptibility	Susceptibility
Day of storage (5℃)	21	21

[z] The materials were investigated at Chiayi Agriculture Experimental Branch, Taiwan Agricultural Research Institute. (from 2007 to 2008).
[y] The words with underline mean the characteristic of 'Tainung No. 7 (Early Big)' is different from that of 'Sah Keng'.

重介於 25–35 g 間，以 28–32 g 居多；平均種子重介於 2–4 g 間，以 3 g 左右居多；焦核率不穩定，介於 5–50% 間，以 10–20% 居多，焦核的種子形態主要爲雞嘴形，大核的種子形態主要爲橢圓形 (圖 2A)。(6) 根據 2000–2009 年於嘉義、台南、高雄、屏東等地栽植「台農 7 號 (早大荔)」結果 (表 2–6) 顯示，除 2002 年受乾旱影響之外，「台農 7 號 (早大荔)」穩定呈現單穗平均著果量約爲 8–13 顆 (圖 2C、表 2–5)，產量穩定，無明顯隔年結果情形，與豐產品種「黑葉」、「沙坑」相當，優於「玉荷包」；平均單果重約爲 27.7–35.6 g 較「黑葉」、「沙坑」、「玉荷包」佳。(7) 果實採收期約爲 5 月上旬至 5 月下旬，一般較「黑葉」及「沙坑」早約 17–21 d 左右 (圖 2A、表 2)，亦較商業早熟品種「玉荷包」早約 10 d 以上 (表 3–5)。在我國商業栽培品種中，早熟品種以「玉荷包」爲代表，而豐產品種以「黑葉」及「沙坑」爲代表 (Yen *et al*. 1984; Hsu 2008; Chang & Teng 2012)。本品種兼具早熟、高產、大果等優質特性，以高壓法繁殖或藉「黑葉」、「玉荷包」爲砧木嫁接更新品種均能表現前述遺傳優點。

作物育種係冀望藉由改變作物遺傳組成，包含導入、組合或累加與優良性狀表現有關的遺傳因子，藉以產生使個體表現理想、與特定目標相符的新品種。屬於異質結合的果樹透過雜交方式育種，將有機會透過遺傳組成改變獲得某些性狀超越親本的後裔 (Shen 1984)。Li (2008) 以特早熟荔枝「991」爲母本、早熟荔枝「三月紅」爲父本雜交子代性狀分析結果顯示，後裔果實平均重量高過雙親平均，較接近父本「三月紅」，並有 40% 株系超越雙親；後裔平均種子重大於雙親平均、而可溶性固形物含量則接近雙親平均；此外調查觀察到 66.3% 後裔果肉質地傾向母本，風味、果肉率及果實成熟期亦多近於母本，而「台農 7 號 (早大荔)」果肉豐厚、質地細緻多汁、風味清甜等 (表 2、表 6)，果實特性即似承襲母本「沙坑」性狀。Fu *et al*. (2010) 調查以晚熟品種「馬貴荔」爲母本，早熟品種「焦核三月紅」爲父本雜交所得子代，果實發育期程部分反映出數量遺傳現象，約呈平均值與雙親中值接近之常態分佈，

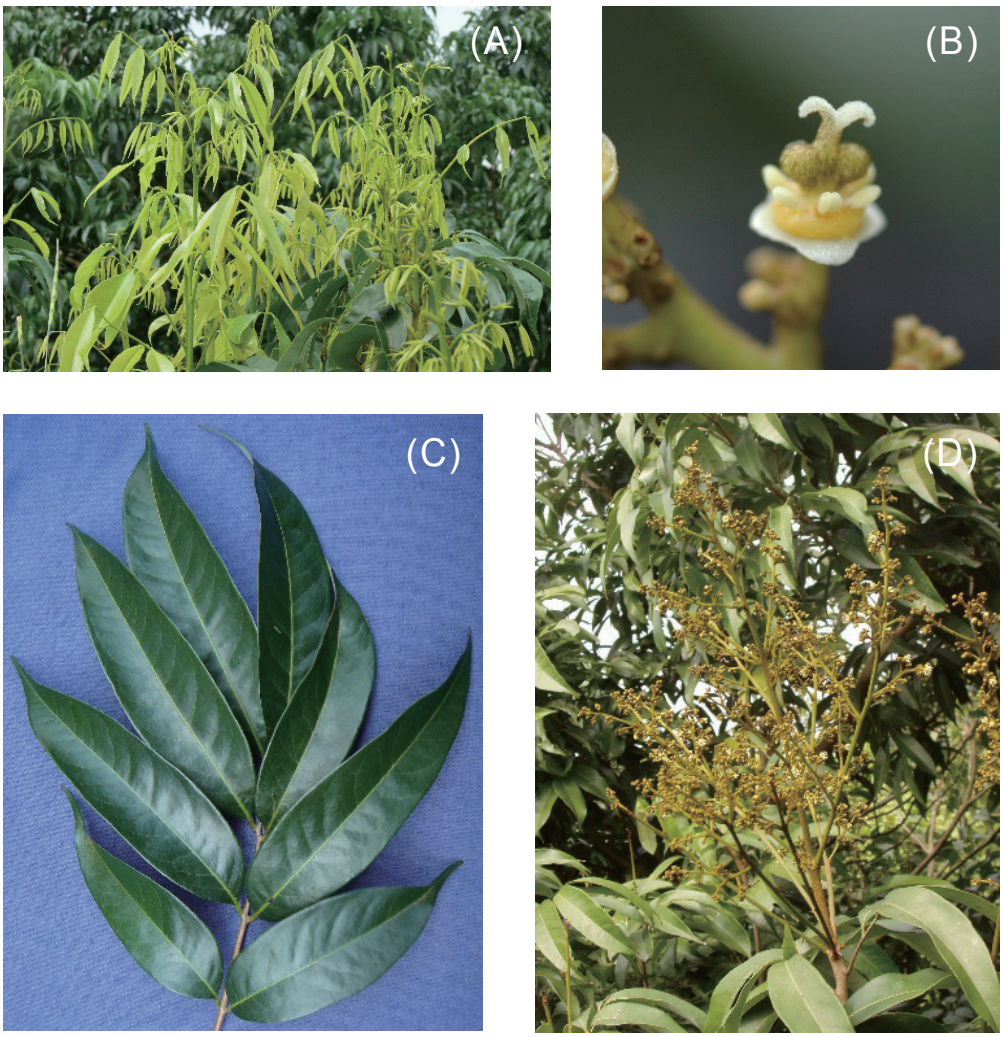

圖 1. 荔枝「台農 7 號 (早大荔)」形態外觀。(A) 新梢呈淺綠色；(B) 雌蕊柱頭微卷裂；(C) 小葉長橢圓形；(D) 長而疏之花序。

Fig. 1. The appearance of 'Tainung No.7 (Early Big)' litchi. (A) Color of young leaflets is light green; (B) The attitude of splitting stigma is arc-shaped; (C) The shape of leaflets is long-elliptic; and (D) The inflorescence is long and sparse.

且均有各有約 20% 超越雙親值之極端個體；然而各單株後裔果實成熟期落於 6 月 23 日至 7 月 21 日左右，介於「焦核三月紅」(6 月 9 日) 與「馬貴荔」(7 月 21 日) 間並較傾向母本，與 Li (2008) 描述相同，前敘結果暗示後裔族群產期具有母系遺傳影響。Chang *et al.* (2001) 分析其執行荔枝育種計畫檢視各品種荔枝子代遺傳性狀觀察到以中熟品種「沙坑」爲母本約有 8% 子代具極早熟性狀、36.8% 子代爲早熟，推測「沙坑」作爲母本具有自後裔族群更有效率地選育早生品系之潛力。雖然目前尚未清楚母本對後裔產期影響的遺傳及生理機制，但台灣已應用「沙坑」作爲選育優質早熟荔枝之用，除「台農 7 號 (早大荔)」外，Teng & Liu (2007) 育成之早熟荔枝品種「台農 2 號 (旺荔)」係以「沙坑」爲母本、「玉荷包」爲父本雜交而得。

產期過於集中及產量不穩定是世界荔枝產業的兩大問題 (Shen 1984; Yen *et al.* 1984;

圖 2. 荔枝「台農 7 號 (早大荔)」之果實特性。(A) 果實爲心形或橢圓形，焦核種子呈雞嘴形、大核種子呈橢圓形，果實成熟期較「黑葉」及「沙坑」早；(B) 果皮色澤紅；(C) 每穗結果數多。

Fig. 2. The fruit characteristics of 'Tainung No.7 (Early Big)'; (A) The fruit is elliptic or cordate in shape with normal or shriveled seeds. The harvest date is earlier than 'Hak Ip' and 'Sah Keng'; (B) Mature fruits have bright red peel; and (C) The cultivar shows good bearing ability.

Ghosh 2001; Chang *et al*. 2008; Hsu 2008; Wang *et al*. 2008; Yen 2008; Chang & Teng 2012)，因此選育不同產期且具穩定、豐產、優質品種一直是荔枝生產國的重點育種目標 (Shen 1984; Menzel & Simpson 1990; Chang *et al*. 2008; Li 2008; Fu *et al*. 2011)，早熟品種尤其如此 (Yen 2008)。在中國，3 月底時自泰國輸入之早熟荔枝價格高昂，至 4 月上、中旬上市荔枝果皮顏色黃綠、核大、味帶酸甜，價格仍較當年品質最優的「糯米糍」及「桂味」晚熟品種高 (Li 2008)。在澳大利亞，'Salathiel' 果品評價甚高 (Menzel & Simpson 1991; The Archive of the Rate Fruit Council of Australia 1993)，然其價格仍不及早熟品種「水東黑葉 (Souey Tung)」(Yen 2008)。相似的市場現象亦見於台灣，根據行政院農業委員會農產品交易行情站 (http://amis.afa.gov.tw/) 資料，2012 年 5 月中旬每公斤荔枝市場均價

爲新台幣 86.3 元，較 5 月下旬高出 33.9 元；2013 年 5 月中旬每公斤荔枝市場均價爲新台幣 92 元，較 5 月下旬高出 28.3 元，較 6 月上旬高出 55.1 元，顯示本地早熟品種同樣深具市場優勢。本品種在台灣南部地區可於 5 月下旬前採收，至屏東地區更可提前在 5 月上旬即可收穫 (表 2–5)，其產期較「玉荷包」早約 10 d，市場上荔枝供應量尚低，且本品種果實大、果皮鮮紅具良好賣相，品質風味近似於「沙坑」可爲本地市場接受。此外，「玉荷包」生產過程需要疏花、除梢維持著果，以致栽培技術及成本偏高，而「台農 7 號 (早大荔)」生產過程無需這些成本投入，且單穗著果量可達「玉荷包」2 倍左右 (表 3–5)。如以「台農 1 號 (翠玉)」生產模式推估，本品種每公斤產量生產成本較「玉荷包」約低新台幣 16.7 元 (Chang *et al*. 2012)，因此「台農 7 號 (早大荔)」具備生產誘因與發展價值。在品種布局策略上若能於南部推廣品種更新，汰換部分「玉荷包」生產及收益不穩定園區使農戶轉作本品種，期可紓減並穩定 5 月下旬至 6 月上旬「玉荷包」產量輸出，進而提高「玉荷包」產業價值 (Chang & Teng 2012)，分散「玉荷包」近年面臨產銷不穩定風險。

誌謝

本研究承蒙行政院農業委員會經費補助，嘉義分所楊宏仁分所長指導病害調查與防治，洪士程先生協助蟲害調查與防治，方明義先生、邱顯政先生、何昭吉先生、魏佩瑩小姐協助田間管理，葉育琪小姐協助果實品質分析、育種資料整理，李坤城先生、陳善命先生及蔡門興先生協助區域試驗，在此一併誌謝。

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Breeding of Novel Litchi Cultivar ‘Tainung No.7 (Early Big)’

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Abstract

Chang, J. W., C. R. Yen, W. L. Wang, M. N. Liu, and J. Y. Chang. 2014. Breeding of novel litchi cultivar ‘Tainung No.7 (Early Big)’. J. Taiwan Agric. Res. 63(1):43–56.

The novel litchi cultivar ‘Tainung No.7 (Early Big)’ was selected from progenies of the maternal parent ‘Sah Keng’ at Chiayi Agricultural Experiment Branch, Taiwan Agricultural Research Institute. The breeding program started in 1982 while the Plant Variety Right of this cultivar approved by the local authority in 2010. The cultivar was named for its ‘early’ harvesting season and ‘big’ fruit. In southern Taiwan, it can be harvested in early to late May, about 10 days prior to the commercial early-season cultivar ‘Yu Her Pau’ and 17 to 21 days prior to commercial mid-season cultivar ‘Hak Ip’ or ‘Sah Keng’. Its production costs are lower than that of ‘Yu Her Pau’, yet it bears similar number of fruitlets on a panicle with the high yielding cultivars ‘Sah Keng’ and ‘Hak Ip’. ‘Tainung No.7 (Early Big)’ litchi also has good fruiting ability and has no obvious alternate bearing, according to the results of varieties comparison and regional trials. The weight per fruit is about 25 to 35 g, with red peel, elliptic or cordate fruit shape, mild-sweet and juicy aril. With these special characteristics, it makes the cultivar valuable for commercial production and marketing. By taking advantages of early harvesting and the aforementioned characters, it will greatly eliminate problems of introducing this litchi variety to the market of Taiwan.

Key words: Taiwan, Litchi breeding, ‘Yu Her Pau’ litchi, ‘Hak Ip’ litchi, ‘Sah Keng’ litchi.

Received: September 27, 2013; Accepted: December 11, 2013.

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