

## **Oriental Pear Breeding for High Fruit Quality and Adaptation to Subtropical Lowland in Taiwan<sup>1</sup>**

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**Abstract:** The breeding objective of pear is to develop varieties with high fruit quality but low chilling requirement for table use. Hybridizations of 9 combinations started in 1976 were made from a native, very low-chilling required variety 'Hungshan' and 7 introduced varieties with high-chilling requirement but high fruit quality. Hybrid progenies were planted with a highly dense spacing of 1M×4M at TARI's experimental orchard which is about 100M above sea level. Five hybrid progenies with early maturing, high fruit quality and low-chilling requirement in characters were selected out of more than 1,500 hybrid seedlings after 1 to 5 years juvenile period by the culture of single trunk training and heavy fertilization. Top-working of these selected progenies onto bearing 'Hungshan' trees was followed at various lowlands for preliminary evaluation. Data showed that the genetical deviation of fruit color and size appeared in random, however, fruit quality and date of sprouting and flowering appeared in the middle range of parents. Fruit maturing, on the contrary, earlier than both of parents. The sugar content of selected individuals is superior to their parents. A further evaluation is being carried out for fruit quality, yield and adaptation to various environments in different areas.

### **Introduction**

Taiwan with Tropic of Cancer passing through and surrounded by sea is tropical and subtropical in climate resulted a warm winter which is a detrimental factor for growing deciduous fruits with high quality. Most of the high quality pear cultivars are Japanese and European origin and were planted only in limited mountain areas with elevation of 1,500—2,300M above sea level. Although the current techniques to produce high quality fruits in lowland by grafting mountain developed flower-bud onto bearing 'Hungshan' trees are very successful, there are still some disadvantages such as

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laborsome annual regrafting, high cost for collection of flower budwoods, high frequency of disease and pest control as well as high level of fertilization<sup>(1,4)</sup>. The limited sources and low quality of flower budwoods are also another problems.

For the viewpoints of plant physiology and commercial cultivation, the flower bud grafting practice is supposed only to be an alternative pear production. Therefore, the pear breeding with objectives to develop varieties with high fruit quality but low chilling requirement for cultivation in lowland was initiated at TARI in 1976.

### Materials and Methods

Two groups of pear varieties, low chilling required with poor fruit quality and high chilling required with high fruit quality, were used as crossing parents in the breeding program. Low-chilling required cultivar 'Hungshan' (*Pyrus pyrifolia*) is native and cultivated widely in the lowland of Taiwan. High chilling required cultivars of *Pyrus pyrifolia*: 'Shinseki', 'Nijisseiki', 'Chojuro', 'Kosui', and 'Kikukou' as well as cultivars of *Pyrus communis*: 'Bartlett' and 'La France' were used as another group of parents. Reciprocal crosses listed in the note of Table 1 were made between these two groups of parents since 1976 both in lowland and highland orchards. All the combinations of hybrid seeds were collected separately when they were fully matured. Stratification of the seeds was operated with moist vermiculite at 5°C. Germinated seeds with 1cm radicle were transplanted into small polyethylene bags containing vermiculite medium only. Complete nutrient liquid fertilizer applied at an interval of week during 6 months to one year period in the nursery. Seedlings about 1 to 2M high were transplanted into selection field with a spacing of 1M×4M at TARI orchard. Regular orchard management of pear was routinely practiced. Number of hybrid seedling flowered in each combination were recorded through the first five year period. Fruits harvested from individual seedling were measured and recorded separately with characters of weight, length and diameter. Brix of flesh was measured with hand refractometer. Texture and flavor of flesh were tasted by 3-person panel. Only fruits with good shape and size, sweet, juicy, crispy and good in flavor were selected for further evaluation. Scionwoods of selected progenies were taken from the upper part of canopy and grafted onto bearing trees of 'Hungshan' for further district evaluation on fruit quality, yield and adaptability in lowland orchards.

### Results and Discussion

#### Juvenile period

It is very difficult to evaluate the juvenile period of pear at present because of the polygenic controlling in inheritance<sup>(11)</sup>. Some segregates started to flower as early as 2.5 years after seeding, the flowering percentages of hybrid seedlings in the first five year was listed in Table 1. Data indicated that the varietal hybrids of *Pyrus pyrifolia* had shorter Juvenile period than that of interspecific hybrids between *P. pyrifolia* and *P. communis*. The reason to cause short juvenile period in *pyrifolia* hybrids was not clear. It might be due to the easier formation of spur in *P. pyrifolia* than

that of *P. communis*. The high density spacing supplemented with single trunk training and heavy fertilization used in the experiment also shortened the juvenile period drastically. This method was taken widely in shortening juvenility in deciduous fruits<sup>(6)</sup>.

**Table 1.** Flowering Percentage of pear hybrid seedling from first flower through five years.

Cross Combinations	SH	CH	HN	HC	HS	HK	LH	HL	HB
% of Flowering	89.1	83.0	79.4	85.4	72.6	61.3	44.4	23.0	27.4

Note : SH : Shinseiki × Hungshan  
 CH : Chojuro × Hungshan  
 HN : Hungshan × Nijisseiki  
 HC : Hungshan × Chojuro  
 HS : Hungshan × Shinseiki  
 HK : Hungshan × Kosui  
 LH : La France × Hungshan  
 HL : Hungshan × La France  
 HB : Hungshan × Bartlett

### Fruit Quality

Breeding on high fruit quality is the most important goal in our pear breeding program. Fruits with white or light yellow in color, juicy or crispy, and non-browning flesh coupled with sweet and strong flavor are supposed high quality criteria in preliminary selection. Five hybrid progenies, SH—033, SH—078, SH—085, HC—089, and HC—015, were selected from 1,500 hybrid seedlings to meet the above mentioned criteria. The fruit characters of selected hybrid individuals in terms of skin color, shape, sugar content, flesh texture and flavor were measured and listed in Table 2. Sugar content of the selected individuals was significantly higher than their parents.

**Table 2.** Fruit characters of pear in the breeding parents and selections in 1986

Clutivars and selections	Fruit skin color	Fruit shape <sup>z</sup> Index (L/D)	Average <sup>x</sup> °Brix	Flesh Texture	Flavor
Nijisseiki	Yellow	0.93(0.90—0.97) <sup>yu</sup>	12.2 <sup>dwu</sup>	Tender, Juicy	Moderate
Shinseiki (1) <sup>v</sup>	Yellow	0.92(0.85—0.97)	11.4 <sup>e</sup>	Tender, Juicy	Mild
Shinseiki (2)	Yellow	0.93(0.90—1.00)	10.9 <sup>ef</sup>	Tender, Juicy	Mild
Kikukou	Yellow	0.91(0.85—0.99)	10.4 <sup>fg</sup>	Tender, Juicy	Mild
Sinku/Hungshan (1)	Brown	0.91(0.81—1.04)	10.9 <sup>ef</sup>	Crispy, Juicy	Mild
Sinku/Hungshan (2)	Brown	0.86(0.82—0.88)	9.6 <sup>gh</sup>	Crispy, Juicy	Very Mild
Sinku/Hungshan (3)	Brown	0.82(0.77—0.88)	9.0 <sup>hl</sup>	Crispy, Juicy	Very Mild
Hungshan (1)	Brown	0.94(0.90—1.04)	1.0 <sup>ef</sup>	Coarse	Moderate, Slightly Sour
Hungshan (2)	Brown	0.94(0.89—1.05)	10.4 <sup>fg</sup>	Coarse	Moderate, Slightly Sour
SH—033	Brown	0.97(0.86—1.02)	12.8 <sup>cd</sup>	Crispy, Juicy	Strong, Slightly Sour

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Cultivars and selections	Fruit skin color	Fruit shape <sup>z</sup> index (L/D)	Average <sup>x</sup> °Brix	Flesh Texture	Flavor
SH-085	Yellow	0.94(0.82—1.02)	13.9 <sup>a</sup> <sup>b</sup>	Tender, Juicy	Strong
SH-078	Brown	0.87(0.82—0.92)	14.2 <sup>a</sup>	Crispy, Juicy	Moderate
HC-089	Yellow	0.98(0.91—1.04)	14.2 <sup>a</sup>	Crispy, Juicy	Moderate
HC-015	Yellow	0.89(0.82—1.03)	13.3 <sup>b</sup> <sup>c</sup>	Tender, juicy	Mild

Notes : z : L/D=fruit length/fruit diameter,  
y : Mean value (maximum—minimum)  
x : Difference is analysed with Duncan's new multiple range test.  
w : Means with the same letter are not significantly different.  
v : 1, 2, 3 inside parentheses indicates orchard number.  
u : Mean value contains 10 fruits.

### Adaptability

The TARI selection field, located in central Taiwan with a elevation of 100M above sea level, is very warm in winter. During winter period, the average temperature seldom dropped below 13°C except that the cold front coming down occasionally from Siberia area which would drop temperature lower than 7°C for a few days. Delayed defoliation is a symptom caused by insufficient chilling hours<sup>(9,10)</sup>. However, our data showed that about 80% of hybrid progenies in the experiment sprouted and flowered normally by April each year without symptoms of delayed defoliation (Table 3). In comparing the flower season of hybrids with parents, we observed that there was 2 to 3 weeks later than 'Hungshan' and 1 to 2 weeks earlier than high chilling parents. However, sprouting date of selected progenies became more narrow to 1 to 2 weeks after topworked onto the bearing 'Hungshan' trees in orchards located at an altitude from 200 to 500M sea level (data unpublished).

**Table 3.** Flowering and fruit-maturing seasons of breeding parents and selections

Cultivars and selections	Flowering season	Fruit-maturing season	Locations of orchards (altitude)
Shinseiki	Early April	August	Li-shan(1500—2300M)
Nijisseiki	Early April	August—Early September	Li-shan(1500—2300M)
Chojuro	Early April	Late August	Li-shan(1500—2300M)
Hungshan	February—Early March	September—October	Lowland( 100— 900M)
SH-033	March	July —August	Lowland( 100— 600M)
SH-078	March	July —August	Lowland( 100— 600M)
HC-085	March	July —August	Lowland( 100— 600M)
HC-015	March	August	Lowland( 100M)

Note : SH : Shinseiki × Hungshan  
HC : Hungshan × Chojuro

### Fruit Maturity

Flowering and fruit-maturing season of both crossing parents and selected progenies were summarized in Table 3. Fruit maturing was judged by the color of seed which would turn dark brown when fruit matured. It took normally 140 to 160 days after anthesis for the fruits of 'Shinseiki' and 150 to 170 days for 'Nijisseiki' to get matured. But, it took much longer period of 7 to 8 months to reach mature stage on the fruits of 'Hungshan' in Taiwan. However, our data showed that the fruits of selected progenies matured about 2 to 3 months earlier than 'Hungshan' (low-chilling required parent) and slightly earlier than 'Shinseiki' and 'Nijisseiki' (high-chilling required parents) (Table 2). Since the early maturing is rather meaningful to avoid the losses caused by heavy rainfall and typhoon in summer harvesting season. Fruits mature early in selected hybrid is supposed due to the early mature character of high-chilling required parents and warm temperature in lowland.

### Conclusion

Pear fruit breeding with an aim of adaptation to warm climates<sup>(3,5,7,8)</sup> has been a challenge task for those researchers devoted to subtropical and tropical horticulture. Although the data collected so far are not yet enough, our data strongly support that to develop new varieties with low-chilling requirement through hybridization is eligible and encouraging. A further evaluation is being carried out for fruit quality, yield and adaptation to various environments in different areas.

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## 低海拔高品質梨之雜交育種<sup>1</sup>

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### 摘 要

爲開發適合低海拔種植之高品質東方梨品系，本所於1976年，以平地之橫山梨與自日本引進之東方梨系：幸水、長十郎、新世紀、二十世紀及西方（洋）梨：拉法蘭西及巴黎高山梨，分別在本所果園及梨山進行互交，共行九個雜組合，得雜交苗逾 1,500株，經行 4 公尺× 1 公尺之寬行密植，配合以重肥及單幹整枝，以求快速生長縮短其幼年性，經 6 個月至 1 年之育苗後植於本所果園選拔，植後 1—5 年陸續開花結果，並選出具有高糖度，香味濃，質脆多汁，石細胞少不變色及低溫需求量低之後代計有 SH—033, SH—085, SH—078, HC—089, HC—015 等五品系，爾後進行低海拔較成年樹之高接觀察，發現果色、果實形狀及果實大小之變化甚大與親本無顯著相關；果實品質，發芽期與開花期近於兩親之中間；果實成熟度因親本特性及生長期之高溫反較兩親爲早，目前正就選出之優良品系進行區域之適應性觀察。

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