Performance of low-chill stonefruit from different germplasms in highlands of sub-tropical Asia.

Unaroj Boonprakob[1], Suthin Promchot[1], Somdej Thaisamak[2] and Nattavie Mabangkrut[2]

[1] Department of Horticulture, Kasetsart University, Kamphaeng Saen Campus, Nakhon Pathom 73140, Thailand
[2] Royal Project Foundation, 65 Suthep Road, Chiang Mai 50200, Thailand

Abstract

A relatively earliest onset of summer in highlands in sub-tropical Asia countries give it a marketing advantage for production of low-chill stonefruits in these mild winter areas. Several low-chill peaches and nectarines available to public from different germplasms were tested in order to select for any suitable ones. Two sites in highlands of northern Thailand representing two different chilling zones were planted with these budded trees since 1997. Daily minimum and maximum temperature in winter were recorded in order to relate them to trees' performance, particularly on dormancy breaking. Our results found that clones from US, particularly from Texas, showed the lowest chilling requirement as a group. Their fruit qualities such as shape and firmness were more suitable for mild winter area. Harvesting time ranged from late March to early May. Four clones were in a process of being jointly released with Texas A&M University for public use. Brazilian clones had more vigorous growth and some showed resistance to shot-hole and rust. Minimum requirement in winter temperature for growing low-chill stonefruit was recommended as average daily minimum and maximum not exceeding 12 C and 20 C, respectively, for a period of 60 days.

Introduction

Highlands in the sub-tropical climates of northern Thailand, Lao, Vietnam Burma and southern China are moderately suitable for producing some low-chill stonefruits. Although their winters are mild, their year-round climatic conditions are different to other mild winter areas. Winters are relatively short, sometimes less than 2 months, with high daytime temperatures (up to 25 C). Therefore, only a low-chill cultivar could be grown without breaking chemicals. Existing chilling models, particularly those based on mean temperatures of the coldest months, were not realistic. Summers are long and result in droughts due to insufficient irrigation/reservoir capacities. Fruit qualities, particularly size, are greatly reduced. The rainy season is usually long with heavy monsoonal rains (1700-2400 mm annually), resulting in excessive vegetative growth and widespread diseases. Micro-climatic conditions exist, making it impractical to formulate generalized guidelines, such as using altitude for chilling accumulation or specific recommendations for growing low-chill stonefruits.

Marketing opportunities, both domestic and export, however, override these obstacles. Harvesting times for these areas could begin in late February and last up to May (prior to the onset of the monsoon season, and the seasonal competition with US fruit imports). To achieve this goal, an ideal cultivar must be a very low-chill (less than 150 CU) and early-mid season ripening (70-90 days of FDP). High quality fruit and long post-harvest storage qualities for export markets would be needed. Disease resistance to shot-hole and rust would make trees healthy through a long and wet growing season without much pesticide application. In addition, suitable production areas should possess a short winter but sufficient chilling accumulation, in order to shift up to a new growing season sooner.

Several low-chill stonefruit cultivars have been released from the US, particularly Florida and lately Texas; however, due to protection of new releases, only few relatively obsolete cultivars were available to the public. A few low-chill stonefruit cultivars were made public by Brazilian researchers (Pelotas and Campinas). These low-chill stonefruits have never been trialed extensively in highlands of sub-tropical climates in Asia. The present article is a summary of various trials of available low-chill stonefruits, particularly peaches from different germplasms in highlands of sub-tropical climates in Thailand. In addition, winter temperatures affecting performances of fruit trees, should be evaluated in order to set a guideline for minimum requirements to grow low-chill stonefruits successfully in such climatic conditions.

Materials and Methods

Available cultivars (not restricted by plant variety protection) and selections classified as low-chill requirement were introduced for local testing. These consisted of 31 clones of peach and nectarine from the Texas A&M University Stonefruit Breeding Program (TAMU), 17 clones of peach and nectarine from the University of Florida Stonefruit Breeding Program (UF), three peaches from joint releases of TAMU-UF, 18 clones of peach and nectarine from the Brazilian Program (BZ) and three peaches from the Taiwan Agricultural Research Institute (TARI).

These clones were either budded or grafted on native peach as a seedling rootstock. Two to four trees of each clone were then planted in experimental plots at two locations: Royal

Angkhang Agricultural Station (AK) (N19^o 54.51', E99^o 2.58' altitude 1200m) and Chiang Mai Royal Agricultural Research Center at Khunwang (KW) (N18^o E98^o altitude 1100m). The sites were intentionally selected because they represented two different chilling zones where AK was a higher chilling and KW was relatively low chilling region. During winter, AK had average minimum and maximum temperatures of 5.4 and 21.1°C, respectively, while those at KW were 12.2 and 17.9°C, respectively. Temperatures during fruit growth at AK were between 7.1 and 26.2°C, while those at KW were between 18.3°C and 22.6°C. Average annual precipitation rates at AK and KW were 2000mm and 1700mm, respectively. Trees were planted at 4x4m spacings and trained as open-center systems. Trees were planted in 1998-99, except TARI clones which only became available in 2003.

Performances of tree adaptation, particularly responses to chilling accumulation and trees' growth, fruit qualities such as shape and firmness, as well as yield were evaluated once trees set fruit. Overall resistance to shot-hole and rust was observed on all clones. Other diseases such as brown rot and leaf curl were not common in this area.

Climatic conditions, particularly daily minimum and maximum temperatures during winter, were recorded in order to be correlated to tree performances. Symptoms of poor adaptation due to insufficient chilling accumulation, included prolonged blooming and poor leafing, low fruit set, and off-shaped fruit such as big apex.

Results and Discussion

Performance of clones from TAMU. For adaptability evaluation, most TAMU clones had a chilling requirement (CR) between 150-250 chilling unit (CU) except for a couple of selections which had a CR of about 450 CU. Very low-chill clones (less than 200 CU) flowered and leafed well at AK, while trees at KW showed prolonged blooming and leafing. Tree growth in term of canopy size was low to moderate. Most clones could be adequately cultivated at a spacing of 4x5m or 4x6m for the open-center training system. None of the TAMU clones showed any resistance to either shot-hole or rust, and pesticide applications were carried out on a routine basis only. Tree yield ranged from low to moderate, with about 15-25 kg/tree, which was equivalent to about 6 to 10 metric tons per hectare. Harvesting began in late March and lasted to early May. Typical fruit qualities were yellow-melting flesh, very firm, good shape (round to flat-round), high color and acidity. Although most of the TAMU clones could be traced back to UF materials since they were especially selected for lower chilling requirement, better shape (round with small suture and apex) and good firmness, TAMU clones were superior to UF clones in these aspects. It should be noted that the available UF clones in this trial were not those recently released. Currently, four advanced selections are in the process of being jointly released with TAMU. Their fruit qualities are shown in Table 1.

Performance of clones from UF. For the adaptability evaluation, most UF clones had a CR between 150-450 CU. Surprisingly, the lowest CR among all clones tested in this study, was found with 'Flordaglo'. Flower and leaf buds were well formed. Several nectarine cultivars ('Sunblaze,' 'Suncoast,' 'Sungem,' 'Sunraycer,' and 'SunWright'), regardless of their CR, showed a high flower bud density. Clones with CR less than 200 CU produced more uniform and intense blooming and leafing at AK; while trees at KW showed little signs of insufficient chilling. Tree growth was similar with TAMU clones. Both, the UF and TAMU clone harvesting seasons were comparable. The characteristic traits of UF clones were related to fruit qualities. UF clones tended to produce softer fruits, prominent suture and apex, high fuzz and less color. Yields were low to moderate with about 10-20 kg/tree (equivalent to 4 to 8 metric tons per hectare). Poor firmness and difficult-to-pack shape contributed to the less commercial yield. None of these UF clones were recommended for planting in highlands of northern Thailand. Fruit qualities of some clones are presented in Table 1 for comparison to others.

Performance of clones jointly released by TAMU and UF. These cultivars ('TropicBeauty' 'TropicSweet' and 'TropicSnow') were originally from UF breeding programs and underwent evaluation and selection under southern Texas conditions where the weather is mild in winter and very hot in summer. Therefore, selected clones were adapted to very low-chill regions, while maintaining acceptable fruit qualities, particularly shape. Performance of these cultivars in the highlands of sub-tropical climates was comparable to TAMU clones, except for fruit firmness which is less in 'TropicSweet' and 'TropicSnow'. In addition, 'TropicSweet' showed a high susceptibility to rust. The best performer was 'TropicBeauty' which is currently introduced to replace the obsolete cultivars, and its fruit qualities are presented in Table 1.

Performance of clones from BZ. For the adaptability evaluation, none had CR lower than either TAMU or UF clones. They ranged between 250-600 CU. The lowest CR clones were 'Premier' and 'Diamante' which were estimated at about 250-300 CU. Clones with CR greater than 400 CU were later pulled out from the testing plot at KW due to severe insufficient chilling symptoms. At AK, flower and leaf buds were well formed, except in ‘Pilcha’. Tree growth was moderate to vigorous; therefore, suggested planting space was no less than 4x6m. Trees grew much faster than those of TAMU and UF clones, and leaves stayed relatively healthy. BZ clones were planted a year later than those of TAMU and UF, and some were outgrown in their third year. A few clones showed moderate resistance to shot-hole and rust. Adapted clones had moderate to high yields with about 20-40 kg/tree. However, the harvesting season was later, beginning from early May and lasting to early July. Prominent suture and apex were common for most BZ clones. The best performer was ‘Jade’, which has yellow and non-melting flesh (Table 1) with the relatively earliest ripening among BZ clones. It is presently being tested at other locations prior to any commercial attempt.

Performance of clones from TARI. Chilling requirement of these three clones were about 250-350 CU. Growth was moderate and showed insufficient chilling symptom such as prolong blooming at KW. Observation was inadequate to indicate any disease resistance. All three were low acid and white-melting flesh (Table 1); which is typical preference to Chinese consumers. Firmness was very poor when allowed to ripe. As a matter of fact, their fruits were very juicy and might be suitable for processing peach juice. None was recommended prior to any further testing.

Climatic conditions required for production. Based on performance of different CR clones tested at each site, AK was estimated to accumulate less than 400 CU; while KW was less than 150 CU. Due to higher temperature in winter and earlier onset of summer at KW, a clone with < 150 CU bloomed and ripened about 3-4 weeks before those planted at AK, but showed prolong blooming and ripening. Any clones with < 300 CU could be marginally produced with a breaking chemical such as Dormex®; and clones with > 300 CU were unsuitable. Very low-chill clones (< 200 CU) adapted well at AK; while, medium chill clones (> 450 CU) showed insufficient chilling symptom. To meet the goal of harvesting fruits from late February to early April, which is prior to any imports from Northern hemisphere regions entering Asia, a location with a short winter but sufficient chilling would be needed in order to allow trees to come out of dormancy earlier. According to our observations of tree performances relating to winter temperatures, we concluded that for growing 150-200 CU clones successfully, the average minimum and maximum temperatures for at least 60 days should not exceed 12°C and 20°C, respectively. Although sporadic blooming and leafing were commonly encountered in such climatic conditions, some breaking chemical could alleviate these problems. Under similar climatic conditions higher CR clones of about 250-300 CU would be marginally produced, and here too, a breaking chemical along with other techniques would be required.

Conclusion

Growing low-chill stonefruits in highlands of sub-tropical climate is a challenge but is commercially feasible. It offers an opportunity for domestic and export marketing without much competition. However, successful production depends on the availability of very low-chill cultivars (less than 150 CU) with excellent qualities and early ripening (70-90 days of FDP). They should also be resistant to shot-hole and rust. Most of the presently available germplasms are not suitable, except for a few that are only moderately fit. New cultivars with above mentioned characteristics would be needed for further expansion into production. Recommended suitable production areas should have climatic conditions that ensure average minimum and maximum winter temperatures for 60 days of 12°C and 20°C, respectively.

Table 1 Fruit qualities of selected low chill peaches in highland of sub-tropical Thailand.

Name	Source[1/]	CU[2/]	FDP[3/] (day)	Weight (g)	Fuzz	Shape	Suture	Tip	Blush (%)	Firmness (N)	TA[4/] (%)	TSS[5/] (°Brix)	Flesh type[6/]
Flordaglo	UF	< 150	90-105	70-140	medium	round	little	no - medium	75	11-19	1.0-1.2	9-12	M
Flordaprince	UF	150	90-105	80-130	high	round	little	little	80	4-17	0.6-1.0	7-12	M
Flordacrest	UF	400	100-115	90-140	medium	round oblong	medium	medium	65	9-18	0.6-0.8	9-10	M
Flordadawn	UF	> 400	90-105	90-100	high	ovate	no	large	90	10-16	0.9-1.0	9-11	M
TXW1193-1	TAMU	150	90-105	85-90	low	flat round	little	medium	80	15-22	1.1-1.2	8-11	M
TXW1490-1	TAMU	150	100-115	90-110	medium	round	little	no – little	70-80	15-16	1.1-1.3	10-13	M
TXW1C4	TAMU	150	105-120	95-130	low	flat round	no	no – little	70-80	20-23	1.2-1.4	10-15	M
TXW1491-1	TAMU	150	120-135	110-130	medium	round oblong	little	little	30-80	20-35	1.0-1.3	9-11	M
TropicBeauty	TAMU-UF	150	100-115	80-125	medium	round	medium	no - medium	70-80	9-21	1.0-1.2	7-12	M
Taiwan#4	TARI	> 250	110-125	90-115	low	round oblong	medium	little	30-70	7-27	0.2-0.6	10-13	M
Taiwan#6	TARI	> 250	110-125	75-100	medium	round oblong	little	little - medium	30-70	10-25	0.2-0.5	7-12	M
Jade	BZ	300	105-120	135-160	medium	round	medium	medium	10-50	17-21	1.0-1.5	9-11	NM
Magno	BZ	400	165-180	120-140	medium	round - oblong	little	medium	60	17-25	0.6-0.7	10-11	NM

Note: [1/] UF: University of Florida Stonefruit Breeding Program, TAMU: Texas A&M Stonefruit Breeding Program, TAMU-UF: Joint release of TAMU and UF, TARI: Taiwan Agricultural Research Institute and BZ: Brazilian Program, [2/]Chilling Unit, [3/] Fruit Development Period, [4/] Total acidity, [5/] Total soluble solid and [6/] M is melting flesh, NM is non-melting flesh