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A Description of Lychee Cultivars

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Abstract

The lychee was introduced to the tropical and subtropical world from southern China, and now is found situated within 15-35° latitude in most countries. The important cultivars in the major producing countries are described. These include Sum Yee Hong, Souey Tung, Bah Lup, Tai So, Fay Zee Siu, Haak Yip, Brewster, Chong Yun Hong, Kwai May Red, No Mai Chee, Heong Li, Tim Naan and Kwa Lok, Wai Chee, Seong Sue Wai and Soot Wai Zee from China. Other cultivars described are from Taiwan (Sah Keng), Australia (Bengal, Kwai May Pink, Hong Kong, Salathiel and Gee Kee), India (Shahi, Rose-Scented and China), Hawaii and Florida (Peerless, Groff and Kaimana), and Thailand (Kom, Luk Lai, Baidum and Chacapat).

The lychee (*Litchi chinensis* Sonn.) from subtropical China is now found within 15-35° latitude in most countries (3, 5). China, Taiwan, Thailand, South Africa and the Malagasy Republic continue to dominate world production, but there is substantial interest in several other countries, including Australia, Mauritius, Reunion, Israel, Spain, Bangladesh and USA.

Lychee has undergone a long period of selection in China and each district has its own cultivar. Most of the modern cultivars have been selected under Chinese conditions, although there have been some selection in other countries. This paper gives a description of the major cultivars in each country. The descriptions are based on their performance in Australia (4, 16) supplemented by data from China (1, 2, 6, 7, 8, 21). The only exceptions are Indian cultivars where data refer to their performance in India (17, 18).

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Cultivars of Chinese Origin

Sum Yee Hong

Sum Yee Hong is the earliest maturing lychee in Guangdong and finds a ready market in spite of its inferior quality compared to later cultivars. It is grown along watercourses particularly on the suburban areas of Guangzhou and Zhong Shan District and is a heavy cropper. Sum Yee Hong has been imported into Taiwan, Hawaii and Australia, but is produced in significant quantities only in Taiwan. In China, it is also known under the synonym Yook Ho Pow. This has caused some confusion because in Taiwan, Yook Ho Pow is the synonym for another cultivar. (Fay Zee Siu).

The tree is medium in size with an open spreading habit and with long thin fragile branches that are easily broken. The leaves are long, narrow, shiny dark green and much thicker than other cultivars. The fruit are exceptionally large (26-42 g) with bright red thick skin that is easily peeled. The flesh is very juicy, and sweet-acid in flavour. The seeds are generally large.

Souey Tung

Souey Tung is a popular early cultivar in Fujian province. It has been distributed to Hawaii and Australia, but has not become established as an important cultivar in these areas. Souey Tung tolerates a high water table and is planted along watercourses in China. It is reported that rain near harvest

causes the fruit skin to discolour, due to a black mildew disease.

The tree is relatively low with thin, long, open spreading branches that point downwards. Leaflets are large, flat, dark glossy green and pointed. The new flush of growth is bronze changing to red and green with maturity. Fruit are medium sized (20-22 g), and heart shaped with distinctive uneven shoulders. The skin is thin, dull dark red to purple and smooth. The fruit tip is obtuse or blunt. The flesh is soft, juicy, sweet and of excellent quality. Seeds are variable in size, but mostly medium giving good flesh recovery (65-75%). There are few abortive seeds (5-10%).

Bah Lup

Bah Lup is an early maturing, highly productive cultivar and of better quality than other cultivars available at the same time such as Sum Yee Hong and Souey Tung. It is grown in Dian Bai and Gao Zhan Counties of Guangdong Province and is an important early variety for export.

The tree is medium in vigour and dome-shaped. Leaflets are long, narrow, dark glossy green with a short point. Fruit are near heart shaped, medium to large in size (20-29 g) with thin soft, brilliant red to slightly purple skin. Protuberances are obtuse. The flesh is juicy and delicately sweet. Fruit usually have large oval seeds. Flesh recovery ranges from 67-77%.

Tai So

Tai So is a common cultivar in China, Thailand, South Africa, Australia and Hawaii. Yields tend to be low and irregular in all countries, with the exception of South Africa. Trees tend to flush twice after harvest rather than initiate flowers (13). Trees in warm locations also tend to produce too few female flowers to guarantee successful fruit set.

Trees are vigorous and spreading with an open crown. The branches have weak crotch angles and are susceptible to splitting. Even large trees may suffer wind damage. Leaflets are large, glossy dark green and have an upward curl from the midrib to be almost canoe shaped. The new flush of growth is bronze changing to dull mid green to pale green with maturity. Fruit are large (22-26 g) and somewhat egg-shaped with flat shoulders and a round tip. The thin skin is bright red changing to dull red at maturity. Protuberances are hair-like/sharp pointed when the fruit is ready to harvest. Fruit is not of good quality until fully mature. Flavour is sweet acid when immature and sweet when fully ripe, becoming bland when overripe. Flesh is slightly chewy becoming moderately crisp when fully mature. Seeds are medium in size giving a fair flesh recovery (60-70%). There are usually very few chicken tongues (8-12%), although in some seasons (cool spring weather) there may be up to 50% or more chicken tongues. Fruit also tend to split in hot weather and are susceptible to browning if they suffer water stress.

Fay Zee Siu

This cultivar is ranked as one of the best lychees in China, and is in great demand for export. It has been recently imported into Australia. The colour of the fruit is described as amber, the size and shape of goose egg, and the sweetness of honey. It is grown in and around Guangzhou. Fruit mature early in the season, after Tai So. In Taiwan, Fay Zee Siu is known under another name (Yook Ho Pow).

The tree is vigorous with long sparse fragile branches. Leaflets are large, narrow and deep glossy green. Fruit are large (24-32 g), round to oval-shaped with thin light red skin. The flesh is firm, sweet, delicious and very

fragrant. Seed size is variable. Flesh recovery is 77-82%.

Haak Yip

Haak Yip is a very popular cultivar in China, Taiwan and northern Thailand, but has undergone limited distribution elsewhere. It is commonly used in canning in Taiwan. Fruit mature about a week after those of Souey Tung. Trees are medium in size, densely foliaged with long, thin, fragile branches. The characteristic feature of this cultivar is the colour of the leaflets, which are very dark glossy green. Leaflets are long, narrow pointed and slightly curled at the tip.

The heart shaped fruit are medium in size (20-22 g) and formed in large compact clusters (15-30 fruit). The purplish red skin is thin and prone to insect attack, soft, with a distinctive suture line. Shoulders are wide and even. The skin is smooth with no protuberances. The flesh, which separates easily from the seed, is sweet, crisp, slightly aromatic and of excellent quality. Seeds are medium in size and fully developed (flesh recovery of 68-76%). Fruit are suitable for export. Haak Yip can be distinguished from Souey Tung by its slightly later maturity, even shoulders of the fruit, obvious suture line, firmer flesh and more uniform and slightly larger seeds (71). Both are good marketing types.

Brewster

This variety was obtained from Fujian province by the Reverend W. M. Brewster and propagated in Florida in 1903 (9). It has also spread to Australia and Hawaii, but it is not popular. In 1948, W. Groff suggested that Brewster was, in fact, the recognized Chinese variety Chen Zi (Chen Family Purple) (9) and recent information indicates that they are the same cultivar. Lychee plantings in Florida have been almost exclusively confined to this one cultivar. Yields in Florida, Hawaii and Australia have been disappointing (11, 12, 16, 22). In Fujian province in China, trees grown along rivers yield consistently with a high percentage of chicken tongues compared to those grown in the mountains. Fruit with chicken tongue seeds shed more readily under moisture stress than full seeded fruit. Evidence from China and Florida also indicates that Brewster requires a relatively severe winter (minimum temperatures below 7.0°C) to initiate flowers (15).

Trees are small and upright, with wide, strong crotch angles and dense foliage. Brewster is one of the few cultivars with distinct lenticels (corky outgrowths) on the branches. Leaflets are large, dark green and pointed at the tips. The new flush of growth is reddish-brown. The medium to large sized fruit (20-26 g) are heart shaped and have bright pinkish red, thick, rough skin and are borne in small loose clusters. The shoulders are uneven with one raised ridge along the suture line of the shoulder. The fruit tip is round in full seeded fruit to pointed in chicken tongue fruit and have small nipple-form protuberances. The flesh is slightly fragrant, juicy and sweet when fully ripe, but very acid when immature. Seeds are small to medium in size, with a large percentage being undevelped (70-80% chicken tongue) after cool spring weather. Plump seeds are oblong with a blunt tip. Flesh recovery is about 65-75%.

Chong Yun Hong

This cultivar is grown widely in the Cong Hua District in Guangdong. It has a long ripening period, crisp flesh, but low yield. Fruit mature mid-season before Kwai May.

Tree is round-shaped with fragile branches. leaflets are small, oval shaped and mid-green. Fruit are medium sized (20-23 g), round-shaped with a characteristic deep red skin (from which the cultivar gets its name). The flesh is very juicy and sweet. Seeds are large (flesh recovery:65-75%).

Kwai May Red

Kwai May Red is a highly regarded cultivar in China but is not grown widely elsewhere. Fruit are of good quality. Panicles normally carry only a few fruit due to poor fruit set. Consequently, this variety is generally known as a shy bearer.

In general, trees resemble the appearance of Kwai May Pink (from Australia), but are more spreading. They have long thin branches which curve upwards towards their tips. Leaflets are small, oval shaped and shiny green. Leaflets are slightly larger than Kwai May Pink and are flatter. The new flush of growth is red. Fruit are almost identical to those of Kwai May Pink except that Kwai May Red has red rather than pink-orange skin, firmer flesh, higher percentage of chicken tongues (50-60%) and flesh recovery (70-80%), and a slightly better flavour. The fruit are distinctly aromatic and suitable for export.

No Mai Chee

No Mai Chee is one of the most highly prized lychees in China and is widely grown in the suburbs of Guangzhou, Dong Guan, Zong Cheng, Pan Yu and other districts. It appears on the market late in the season and commands a high price. For instance, the retail price of No Mai Chee in Singapore in July 1985 was A$8.70/kg compared to A$2.00/kg for Haak Yip. The fruit of No Mai Chee is one of the largest of any cultivar (21-28 g) and nearly all are chicken tongue (flesh recovery of 75-80%). The flesh is very smooth, firm and clean and has a sweet fragrant flavour. It is good for fresh fruit and drying. The tree is large and tall with dense canopy and slim branches which hang downwards. The leaves are small, soft and thin with a wavy edge that is characteristic of the cultivar.

No Mai Chee is cultivated extensively only in southern China and Taiwan (1, 2, 8). It is reported to have been introduced into Hawaii and Australia (4), but most imports have proven to be other cultivars (Kwai May Red or Haak Yip).

Heong Li

This cultivar is produced in various places in Guangdong, but the best are produced in Xin Xing County. It is one of the most famous lychee cultivars in China. The flavour of the fruit is said to be even better than that of Kwai May and its seeds are very small. Its only defect is that fruit are small (8-12 g).

The tree is upright with thin dense branches and small oval-shaped leaves. The fruit are long egg-shaped with flat shoulders and thin dark red skin. The skin segments are protruding and relatively dense. The protuberances are blunt or sharp-pointed. The flesh is crisp and delicately sweet. The seeds are small and often aborted (flesh recovery:70-80%).

Tim Naan

Tim Naan is sparsely distributed in the suburbs of Guangzhou, Zeng Cheng, Bao An and other districts. It is high yielding, drought resistant and adapts to low fertility situations. Fruit have a deliciously fragrant taste. The germination of its seed is very high and seedlings grow very quickly. Consequently, it is suitable as a rootstock.

Trees are vigorous and dome-shaped with sparse thin branches which droop down to the ground. Leaflets are small and oval shaped with short tips. Fruit are medium in size (18-22 g), near round with dark red thick fragile skin and flat shoulders. Both skin segments and protuberances are smooth. The flesh is soft, sweet, juicy and fragrant. Seeds are normally large (flesh recovery:70-80%).

Kwa Lok

Kwa Lok (Pinyin: Zeng Chen Gua Lu) is one of the most famous lychee

cultivars from China and the Chinese literature is full of interesting stories concerning the mystical qualities of the fruit. The original tree is still growing in Zeng Chen and air-layers from the tree are distributed widely but sparsely in Guangdong. It appears on the markets after Wai Chee, but fruit are not common. Single fruit were selling for HK$25 each in 1975. In ancient times, most of the fruit was reserved for officials.

The tree is dome-shaped, medium in height, with fragile open branches. The leaves are deep green, small, narrow and pointed. The fruit are medium to large in size (14-29 g), almost round with a smooth skin. The skin is dull red, sometimes with touches of green at the tip, from which the cultivar gets its name. The flesh is crisp, sweet, aromatic and of excellent quality with big seeds. Flesh recovery is 60-75%. Yields are reported to be irregular.

Wai Chee

Wai Chee is the most common cultivar in China and is also popular in Thailand and Australia. It is considered to be a reliable cropper and to have wide adaptability, although it does not crop heavily along the coastal strip in northern Queensland unless winters are cool. Fruit hang on the tree for up to 14 days after reaching maturity which allows some flexibility in harvesting as well as extending the production season. Trees establish slowly after planting and lack vigour.

Trees are low dome shaped with thick branches and have compact foliage and many growing points. Trees are susceptible to wind damage during cyclonic winds unless thinned out and the lower branches removed. The small leaves are oval shaped and curve upwards from the midrib and downwards along their length. New flushes of growth are red. The small (16-18 g) rounded fruit are formed in small loose clusters. Skin colour is strong red. Shoulders are flat, although often ridged on one side along the suture line. The skin is of medium smoothness (less rough than Haak Yip). The flesh is soft, very juicy and sweet. Most seeds are fully developed (flesh recovery of 63-73%). Although fruit of Wai Chee have full flavour, their large seed and soft flesh reduce their eating quality and, therefore, their price, in Asian markets compared to that of Haak Yip, Kwai May Red and No Mai Chee.

Seong Sue Wai

Seong Sue Wai originated in Fujian Province, but is now widely grown in the suburbs of Guangzhou. It is named after the official from Guangzhou who went to Fujian and brought back with him a seed from a tree of this cultivar. Environmental adaptation and disease resistance of Seong Sue Wai are good. However, market quality is reduced, because in some fruit the second ovary fails to abort, and stays attached as undeveloped fruitlet. It is the second last cultivar to be harvested, maturing just before Soot Wai Zee.

The trees are slow growing and dome-shaped with soft sparse branches. Leaflets are long oval shaped (6-11 cm long) and rich glossy green. The tip of the leaf is gradually pointed. Fruit are small (14-18 g), near round with thin fragile, dark red skin. The skin segments are large and slightly protrubing. Protuberances are obtuse and sparse. The flesh is easily separated from the seed and is sweet but only lightly fragrant. Many fruit have shrivelled seeds. Flesh recovery is 72-78%.

Soot Wai Zee

Soot Wai Zee is one of the last cultivars to be harvested and matures after Wai Chee. It is a popular cultivar and is high yielding with excellent fruit.

The tree is vigorous and dome-shaped with fragile branches. The leaflets are small (7-11 cm long), long oval or wide needle shaped with a gradual

point at their tip. Fruit are large (24-28 g) and lopsided heart shaped, with flat protuberances. The skin segments are large and slightly protruding. The skin of the fruit is light red with a yellow tinge, thin and easily peeled. The flesh is juicy and sweet. Most of the seeds are large. Flesh recovery is 65-80%.

Cultivars in Taiwan

Sah Keng

Sah Keng was developed by horticulturists in Taiwan in the 1970's and appears to be a seedling of Haak Yip (23, 24). It has been introduced into Australia, but is not grown commercially outside Taiwan. Sah Keng produces large and small seeded fruit, with a large variation amongst trees in a single orchard. Fruit are available mid-season. Yields are heavy, but irregular.

Trees are medium in vigour, dome-shaped with short fragile branches. Leaflets are 6-8 cm long, elongate and mid-green. The new flush of growth is green. Fruit are large (30-35 g), heart-shaped, with purple red skin. The skin segments are swollen and protuberances blunt. The flesh is soft and sweet. Seed size is variable, often small. Flesh recovery is 70-80%.

Cultivars of Australia

Bengal

This cultivar is a seedling of the Indian cultivar Purbi sent to Florida in 1929 (14). It was selected in Florida in 1940 and does not resemble any known Chinese cultivar. It is the second most important cultivar after Tai So in Australia, but is not exploited to a large degree anywhere else. Fruit are attractive and pleasant tasting. It has recently lost popularity, however, because fruit with a large seed have a poor flesh recovery. Fruit also suffer from uneven ripening and are more susceptible to bird and insect damage. Yield regularity has been disappointing in some districts, although it can have very high yields in an 'on year.'

Trees are vigorous and spreading. Branches are thin but reasonably resistant to wind damage. Leaflets are large, mid green and have a distinctive twist or curl along their length. The new flush of growth is reddish brown. The large fruit (23-27 g) are formed in large clusters of up to 50 or more fruit. The thick skin is very rough and attractive bright red. The fruit are egg-round to lopsided heart shaped with uneven shoulders. The fruit tip is distinctively pointed. Protuberances are sharp pointed to wedge shaped. The flesh is soft, sweet and moderately juicy. Fruit do not keep their flavour if left to hang on the tree. There are very few abortive seeds (< 5%). Under poor moisture conditions, the aril (flesh) may be undeveloped and may not cover the seed at the pointed end. This gives poor flesh recovery (50-60%). It is not considered a good marketing type.

Kwai May Pink

Kwai May Pink is thought to have originated in China possibly as a variant or seedling of Kwai May Red. The cultivar has become popular in recent years in Australia and large numbers of trees have been planted. Bearing ability is good in most districts. It has a long harvest period, possibly due to the development of acceptable sweetness and flavour well before full maturity. Fruit are harvested mid-season.

Trees are large and very erect, and have long slim branches that point upwards. Leaflets are narrow, longish oval shaped and shiny light green. They curl upwards slightly from the midrib and downwards along the length. The new flush of growth is attractive red. Fruit are medium in size (18-22 g), and round with very rough thick skin. Skin colour changes from yellow to yellow-pink to orange-pink with advancing maturity with occasional green colourings on the

shoulders. Fruit are overmature when fully coloured. Shoulders are usually flat, but one is sometimes raised along the suture line. Flesh is firm, crisp, sweet, juicy and aromatic. Fruit are sweet well before full maturity. Seeds are variable in size, mostly small, although sometimes the fruit are seedless (45-55% chicken tongue). Flesh recovery is about 67-77%. Fruit are suitable for export.

Hong Kong

Hong Kong was imported into Australia during the 1960s probably as a seedling introduction but its origin has not been firmly established. It does not resemble any of the commercial Chinese cultivars. There are large trees of Hong Kong growing in India, but only a few trees have been planted in Australia. Fruit mature mid-season. Although isolated trees have produced heavy crops, the small size of the fruit limits the commercial acceptance of Hong Kong.

Trees are small and spreading, and have long branches and dense foliage. Leaflets are small, narrow and light green in colour. They curl upwards from the midribs. A distinctive feature of this cultivar is the position of the leaflets which hang vertically from the branches. The young flushes are red changing to light green with maturity. Fruit are variable in size, normally small (10-14 g), egg-shaped with a thick deep red skin. Shoulders are smooth and the fruit tip obtuse. Fruit segments are small, swelling and regular in shape and arrangement. Protuberances are obtuse. Flesh is soft, juicy and pleasant. Most seeds are undeveloped giving excellent flesh recovery (70-80%). Despite the good flesh recovery, Hong Kong is not considered a good marketing type because of its small size.

Salathiel

Salathiel was found growing at Kamerunga, near Cairns in north Queensland, Australia and its parentage is unknown. Some have suggested it is possibly a seedling of No Mai Chee, but this needs to be confirmed by genetic analysis. It is similar to the standard No Mai Chee from China, but is not identical in all characteristics. Fruit are more pointed and smaller in size than in No Mai Chee with even shoulders and also have a higher percentage of chicken tongue and smaller and flatter leaflets. In No Mai Chee, the point of attachment of the fruit stalk is sunken or concave. This is rare in Salathiel. Yields are regular and heavy, especially in subtropical districts. Fruit are harvested late in the season, just before Wai Chee.

Salathiel trees are small and compact. Branches tend to produce elongated shoots with small leaflets. Leaflets are small, broad and curve down slightly at the tip. The tip of the leaflet is round with a short distinctive point. The colour of the new flush is red changing to green with maturity. Fruit are small (15-18 g), egg-shaped to ball-shaped in more temperate areas, and borne in small loose clusters. The skin is thick, moderately rough and with prominent markings. Skin colour changes from blotchy yellow to deep red at maturity. The fruit tip is obtuse changing to round in cooler areas. Flesh is thick, crisp, juicy and very sweet. Fruit are sweet long before they develop full colour. Some fruit are seedless and the balance chicken tongue, giving excellent flesh recovery (76-80%). Very rarely, fruit are almost all full seeded after warm spring weather or in tropical locations. Fruit are suitable for export into Asian markets.

Gee Kee

This cultivar was found growing at Babinda in north Queensland. It was possibly imported from China as a seedling of Seong Sue Wai. It resembles the Chinese cultivar Seong Sue Wai, except that the trees of Gee Kee

are more compact and dense compared to Seong Sue Wai, and the fruit skin has thick pointed protuberances. There are a few trees of Gee Kee planted in most lychee orchards in Australia. It is often confused with and mistakenly planted instead of Wai Chee and Salathiel. It tends to produce small seeded or seedless fruit with an unusual flavour in cooler areas. It bears irregularly in most districts, although it is reported to crop well in a few locations. It is the last commercial cultivar to be harvested.

Trees are small, dome shaped, with many growing points and, in general, they resemble Wai Chee in appearance. Consequently, they are susceptible to wind damage in cyclonic weather. Leaflets are short, flat and broad, and recurved at the tip. They are usually larger than those of Wai Chee and unequal in size. New vegetative growth is strong red. Fruit are small (14-17 g) and rounded. Shoulders are smooth with a ridge along the surface on one side. The fruit tip is obtuse to round. Skin colour is variable, and lines between the segments are crimson red with segments paler. Segments are variable in size, shape and arrangement. The skin is thin, brittle and very rough (a reliable identification of Gee Kee). Flesh is soft, juicy, sweet aromatic and sometimes 'spicy.' Seeds are small. There is a large percentage of chicken tongues (54-64%) and flesh recovery is about 80-85%. Plump seeds have a distinctive shoulder on one side. Fruit size is in proportion to seed size. Gee Kee is not considered a good marketing type because of its small size and unusual flavour.

Indian Cultivars

Shahi

Shahi (Muzaffarpur) fruit are medium (20-24 g), oval shaped with crimson-red skin. Flesh is juicy, sweet and fragrant. Yields are heavy and regular and are produced early in the season. In Australia some imports of Muzaffarpur are Tai So.

Rose-Scented

Rose-scented is one of the most important lychee cultivars in India (15, 17, 18). The heart-shaped fruit have an attractive pink skin and have a distinct rose aroma. Average weight is 15 g. Seeds are usually small. It is a medium-yielding cultivar. Fruit are produced mid-season.

China

China is a late cultivar that ripens when most of the other cultivars have finished. Fruit are large (25 g) and orange-red in colour. The flesh is soft, juicy and very sweet. Seeds are normally small. Yields are heavy but irregular.

Cultivars in Hawaii and Florida

Peerless

Peerless is a seedling selection of Brewster developed in Florida in the late 1930s (10, 20). It is very similar to Brewster, except that the leaflets are lighter in colour and the fruit smaller with a greater percentage of chicken tongue. It was reported to be a heavy bearer in Florida, but cropping is irregular along the coastal lowlands of subtropical Australia. Planting material is scarce.

Trees are small and upright, and have wide crotch angles and dense foliage. There are distinctive lenticels (corky outgrowths) on the branches as in Brewster. Leaflets are large, flat, medium green and pointed at the tips. The new flush of growth is reddish-brown changing to light green with advancing maturity. Fruit are small (12-14 g), heart-shaped with pinkish-red skin. The shoulders are uneven and the fruit tip round. Segments are variable in size, shape and arrangement with nipple-form protuberances. The flesh is slightly fragrant, juicy and sweet. Seeds are small with a large

proportion undeveloped (80-90%) giving excellent flesh recovery (70-80%).

Groff

Groff is a seedling lychee developed from Haak Yip in 1947 by horticulturists at the Hawaii Agricultural Experiment Station (19). Although most fruit are seedless or have chicken tongue seed, the small size of the fruit and the poor performance of the tree seriously limit its potential as a commercial cultivar. Very few trees have been planted in Hawaii or in Australia, where it was imported in the mid 1970's.

Trees are upright, well branched and slow growing. Branches are strong, and have wide crotch angles and point upwards along their length. Leaflets are medium in size, shiny light green and slightly twisted along their length (less noticeable compared to Bengal). New flushes of growth are light green with a pinkish tinge. The small (8-14 g), heart-shaped fruit have a tough leathery skin. Skin colour changes from pink-red to dark red with maturity. The fruit are full and rounded at the apex and flattened but not depressed at the base. Shoulders are even. Skin segments are smooth, medium in size and regular in shape and arrangement. Protuberances are sharp pointed. The flesh is slightly chewy, acid when immature, sweet when ripe, becoming bland with over maturity. Fruit are nearly all chicken tongue giving excellent flesh recovery (75-85%).

Kaimana

Kaimana was developed by horticulturists at the Hawaii Agricultural Experimental Station about 10 years ago from a population of open pollinated Haak Yip seedlings. There are plantings of Kaimana in Hawaii, but most trees are not of bearing age. The tree has also been distributed to Australia, where there is strong interest. There is no published information on the cropping of Kaimana in Hawaii. B. F. Paxton (personal communication, 1989) indicated that small trees can bear heavily in the Kona area of Hawaii. Fruit were available mid-season.

Trees are medium in vigour, with a spreading shape and long strong branches. Leaves are large, elongated and mid-green. The new flush of growth is green. Fruit are large (> 25 g), heart-shaped with purple-red skin. The skin segments are swollen and the protuberances smooth when the fruit are mature. The flesh is crisp, sweet and excellent quality. Seeds are medium in size. There is no information available on the proportion of chicken tongues or flesh recovery.

Cultivars of Thailand

Kom

Kom is one of lychee cultivars developed locally in Thailand from cultivars imported from China. It is reported to crop under tropical conditions, but fruit quality is poor to average. Kom has recently been imported into Australia but has not been distributed elsewhere. Planting material is not readily available. Fruit mature about a week before Tai So. Fruit are variable in size, shape and flesh recovery depending on the season. Fruit tend to be small in southern Queensland when cool spring weather extends into early summer. Although Kom is high yielding, its poor quality in southern Queensland limits its potential. It is not considered a good marketing type because of its small fruit and poor flavour.

Trees are vigorous and erect, and have long, strong branches and dense foliage. Leaflets are narrow, pointed, medium in size and dark green. They are generally flat but curve downwards slightly towards the tip. The new flush of growth is red changing to green with maturity. Fruit are variable in size (8-20 g) and shape (long-heart to nearly round), depending on the season. Fruit tend to be small and long heart-shaped when cool spring weather

extends into early summer. The very thick skin is blotchy yellow to purplish red at maturity. Shoulders are flat or even and the fruit apex obtuse. The skin segments are smooth at maturity and variable in size, shape and arrangement. The protuberances are sharp pointed. Fruit are borne in small loose clusters. The flesh is tough to fibrous and mild in flavour becoming bland once mature. Seed and fruit size are in proportion, small fruit having chicken tongue seeds. Flesh recovery ranges from 60-80%.

Luk Lai

Luk Lai was introduced into Australia from Thailand in 1981 but does not appear to be grown in any other country. In Australia, only a few trees have been distributed to commercial orchards. Fruit mature about a week after Tai So. Fruit are small and of average quality.

Trees are medium in vigour and dome-shaped with many short upright branches and dense foliage. Leaflets are mid-green in colour, medium in size (8-10 cm long) and broad oval-shaped. The leaflets are curled slightly up from the midrib to the margins and curled down along their length towards the tip. Leaflets characteristically hang vertically from the branches. The colour of the new growth is brown-green changing to light green with advancing maturity. Fruit are small (16-18 g), nearly round to slightly egg-round in shape with flat shoulders and obtuse apex. Skin colour is yellow red changing to deep red with maturity. Skin segments are smooth and irregular in size and arrangement. The skin is relatively thick (similar to Bengal). Protuberances are very sharp pointed and strong (more than Kwai May Pink). Fruit are normally in small tight clusters with even maturity. The flesh is moderately crisp and separated easily from the seed. Flavour is subacid to sweet becoming bland once fully mature. Most fruit contain a medium to large dark brown seed (10-20% chicken tongue). Flesh recovery is about 55-65%. Fruit with chicken tongues are normally smaller than 16 g. The flavour of Luk Lai is acceptable if picked at the proper stage of maturity. However, the large seed and consequently low flesh recovery limits its potential commercial significance.

Baidum

This cultivar is the third most important cultivar after Tai So and Wai Chee in northern areas of Thailand. It was imported into Australia during the late 1960s, but there are only a few trees planted in most districts. It resembles the Chinese cultivar Haak Yip but does not match it in all characteristics. Fruit of Baidum are slightly smaller, less uniform in size, have blotchy markings on the skin, which is yellow-red rather than purple-red at maturity. Fruit are not as sweet as Haak Yip and have more chicken tongues. Fruit mature mid season. Yields are disappointing most seasons along the coastal lowlands of Australia.

Trees are of medium size, with dense foliage on long thin branches (not as long as Haak Yip). Leaflets are large, narrow, dark green and slightly curled upwards from the mid-rib. The new flush of growth is reddish-brown in colour. Fruit are medium in size (20-22 g) and heart-shaped. The skin changes from blotchy yellow to deep red with maturity. Skin segments are irregular in size, shape and arrangement, swelling with smooth to obtuse protuberances. Flesh is juicy and sweet. Seeds are mostly plump (10-15% chicken tongue). Flesh recovery is about 65-75%.

Chacapat

This cultivar is grown in Thailand and has been recently imported into Australia. It is the latest maturing lychee cultivar in both areas. Fruit are normally very large, but acidic under most conditions. Cropping ability in

Australia is average. In some seasons, when cool spring weather extends into summer, trees may set mostly small fruit with small seeds. Chacapat is not considered a good marketing type. Chacapat is reported to have been introduced from southern China into Thailand and resembles the cultivar Zhong Shan Bah Lup (Pinyin Zhang Shan Bai La) and not to be confused with Bah Lup (Bai La). The fruit of Chacapat are slightly larger than Zhong Shan Bai La, juicier and with fewer numbers of chicken tongue fruit.

Trees of Chacapat are moderately vigorous, erect, and have long branches and dense foliage. Leaflets are small, long, narrow, pointed and dark green. They curl upwards from the midribs and downwards along their length towards the tip. The new growth is green. Fruit are normally large (28-32 g) and round to slightly heart-shaped. The skin is thin and soft, deep red in colour with yellow markings (not as prominent as Baidum or Salatheil). Shoulders are flat and the fruit tip round. Skin segments are swelling with obtuse protuberances. Flesh is moderately juicy remaining acid when fully ripe. Seeds are nearly all large. Flesh recovery is about 60-70%.

Conclusion

Lychee trees differ widely in morphological characteristics, fruit maturity and cropping. Vegetative characteristics such as tree size and shape, length and spread of branches, leaf size and shape and colour of new and mature growth are very susceptible to environmental conditions and cannot always be used to identify cultivars under different climatic, soil or cultural practices. In contrast, most cultivars can be easily distinguished by fruit characteristics such as fruit shape and size, skin colour and texture, flesh texture and flavour and seed size.

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Leaf Area and Fruiting Efficiency of Large and Small Fruited Cranberry Cultivars

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Abstract

Fruit size in cranberry is highly variable between cultivars. Small fruited cultivars produce more berries per hectare than large fruited cultivars but yield per hectare is ofter similar. The relationship between fruit size, yield and leaf area per fruiting upright was examined. Large fruited cultivars produced more fruit per leaf area on fruiting uprights than small fruited cultivars. This suggests that large fruited cultivars are more efficient at producing dry weight than small fruited cultivars. Fruit number per fruiting upright was similar regardless of fruit size but small fruited cultivars had more fruiting uprights per unit area than did large fruited cultivars. In this study, fruit size was important in determining the number of flowering uprights, which is an important yield component.

Introduction

The cranberry (*Vaccinium macrocarpon* Ait.) has been domesticated relatively recently. Many commercially grown cranberry cultivars were selected from the wild. Fruit size and shape vary widely among cranberry cultivars; size by weight ranges from 0.8 to 1.75 g per berry. Small fruited cultivars produce more berries per hectare than large fruited cultivars so that yields per hectare are similar. This suggests that two strategies i.e. fewer, larger berries or more, smaller berries may occur for fruit production in cranberry.

Growth and development of fruit crops is dependent on the amount of leaf area available to supply photosynthates to developing fruit (5, 8). In apple, a positive correlation ($r = 0.65$) was found between leaf area per spur and 17 year accumulated yield for 9 cultivars (6). Small apple fruit may be caused by insufficient leaf area during the season (4, 7).

The ability to produce high yields with minimal leaf area would be desirable for fruit crops since this indicates high photosynthetic efficiency. In cranberries, fruit are produced on vertical shoots, called uprights. Production is in beds of uprights developed from random horizontal runners. This re-

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