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Types of Hazelnut, *Corylus* species (see page 57)

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*Cover Picture (varieties of hazelnut) from Chastnoe Plodovodstvo (Specialist Fruit
Production) by V. A. Kolesnikov (Moscow, Kolos. 1973)*
1. Kudryavchik; 2. Badem; 3: Furfulak

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EDIBLE FRUITS OF MYRICA SPECIES -

Red Bayberry in Japan, China and Asia

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Introduction

The genus *Myrica*, of the family Myricaceae, contains about 50 species distributed almost world-wide. Only Australia and the Mediterranean area lack representatives; northern Europe, Canada, and Siberia contain species which edge up towards the Arctic Circle [14].

The different species have names such as Bayberry, Waxberry, Wax Myrtle, Candleberry, and Bog Myrtle or Gale. Their principal products are edible fruits, and waxes or products derived from wax, such as soaps or candles.

Other uses include medicines and pharmaceuticals; dyes and fish poisons (eg *Myrica esculenta* of the Indo-Malaysia region); insecticides; and fuel wood (eg *M. javanica* of Java). The Bog Myrtle (*M. gale*), widespread over northern America, Europe, and Asia, has also found use in flavouring and improving foaming of beer [14].

However, in most parts of the world these uses have been at the native-population or early settler level. Only in China and adjacent parts of Asia has commercialization proceeded to the point where products are canned, dried, and exported in bar-coded containers (Fig. 1), the modern indication of commercial acceptance.

The label shown in Fig. 1 was from a box of dried Red Bayberry. Cans of Bayberry fruits can sometimes be bought from Asian stores in Australia, often labelled 'Chinese Arbutus'. Although these fruits have a strong resemblance to *Arbutus unedo*, Irish Strawberry tree fruit, they are totally unrelated. They are easy to distinguish, as Red Bayberries have a single large pip, whereas Irish Strawberries have many tiny seeds.



Fig. 1. Label from box of dried Red Bayberry

Red Bayberries in China

In recent years, there has been rapid development in red bayberry production. The cultural area and production of red bayberry has risen continuously, and red bayberry is an important fruit in southern China. The fruit is an attractive colour, with much juice, high nutritive values, a sweet or tart taste, and good flavour. The fruit can be eaten fresh or with sugar, preserved in alcohol (as for medicinal use), or may be processed to canned fruit, juice, jam, dried fruit and fruit wine etc.

The fresh fruit contains sugar 12-18%, fruit acid 1-3%, and is rich in vitamins. An essence can be extracted from the leaves, the root and branch contain tannin. The seed contains 40% oil.

Canned red bayberry is well-known both inside and outside China. The red bayberry is exported to Europe and other countries from China.

Because the trees grow easily in cold and drought-prone areas, red bayberry could be grown worldwide. The Actinomyces symbiosis on the roots of red bayberry means that they can not only grow well at high altitudes but also grow rapidly. The branches and leaves are luxuriant and evergreen. It is a good plant for water and soil conservation. Because the tree is graceful, it has environment value.

History and distribution of red bayberry

Chinese people have eaten the fruit since before the Han Dynasty (206-220 A.D.). Pollen of *Myrica* was found in the area of Yuyao City, Zhejiang province, when the plant remains were unearthed at Ho-mu-du, proving that red bayberry grew at the place 7000 years ago [1]. Lu Jia wrote about red bayberry in the book "Nan yue ji xing", which means its history of cultivation extends over more than 2000 years [2].

Jia Sixie wrote about the shape and taste of red bayberry, and also about the method of storage of red bayberry, in the book "Qi Min Yao Shu" (Bei Wei Dynasty, 386-534 A.D.). This book is the earliest agricultural book in the world [3].

Wang Xiangji wrote a book called "Qun Fang Pu", which is a book about the production of many kinds of crops (Ming Dynasty, in 1621 A.D.). He wrote that red bayberry grew south of the Yangzi river. The best ones were produced in Huiji. There were many types in Wuzhong: (1) Daye red bayberry: the earliest maturing one with a good taste; (2) Bianshan: produced in Zhaoxi, but if grown on Guangfu mountain, the quality will be better; (3) Qingdi, Baidi, Dasongzi and Xiaosongzi. The taste of any others is not better than above mentioned types [2].

The red bayberry grows well in the subtropical zone, as in the provinces with warm and moist climates. The red bayberry trees are mainly distributed in southern China. The plantation limit of north latitude is around between 20-30, which latitude corresponds to the plantation areas of citrus, loquat, tea and bamboo.

The relevant provinces of China are Zhejiang, Jiangsu, Fujian, Guangdong, Taiwan, Anhui, Jiangxi, Hunan, Guangxi, Yunnan, Guizhou and Sichuan [4]. Red bayberry is also found in Eastern Asia, as in Korea, Japan and the Philippines, and in Africa and Europe [10, 11, 12].

Species of red bayberry

Red bayberry belongs to the genus *Myrica* Linn. of the family Myricaceae. There are 50 species in *Myrica*. There are 4 species [5] and 9 varieties in China [4]. The species are:

(1) Yangmei (*Myrica rubra* (Lour.) Sieb. et Zucc.)

Produced in southern China, Zhejiang, Jiangsu, Taiwan, Fujian, Guangdong, Guangxi, Jiangxi, Hunan, Anhui, Guizhou, Yunnan, Sichuan provinces and also distributed in Korea and Japan. The fruit is a well-known fruit. There are many cultivated types. The fruit is a round drupe, of dark-red or purple-red or white colour when mature.

(2) Maoyangmei (*Myrica esculenta* Buch.-Ham.)

Produced in Yunnan, Sichuan, Guizhou, Guangdong, and Guangxi provinces. The drupe is slightly oblate, red colour when it is mature, tart or sweet.

(3) Aiyangmei (*Myrica nana* Cheval.)

Produced in central Yunnan province, west of Guizhou province. Drupe elliptical, 1.5 cm in diameter, red, very tart.

(4) Qingyangmei (*Myrica adenophora* Hance.)

Produced in Guangdong and Guangxi provinces. Drupe elliptical, 1 cm in diameter, white or red colour.

Varieties

(1) Wild red bayberry (*Myrica rubra* var. *sylvestris* Tsen). The fruit is small, red or light red, very tart, early maturity, big pit, low quality. The wild red bayberry was used as a root-stock.

(2) Red colour red bayberry (*Myrica rubra* var. *typica* Tsen). The fruit is bigger than the wild red bayberry, red and dark red or purple red, middle quality. Produced in Shangyu, Xiaoshan counties in Zhejiang province.

(3) Purple red bayberry (*Myrica rubra* var. *atropurea* Tsen). The fruit is red before ripening. Then the fruit is purple or black-purple, the quality is good, very sweet, easy to part

the pit from pulp. The famous one is “water chestnut rubra” from Yuyao, Cixi counties of Zhejiang province.

(4) Crystal red bayberry (*Myrica rubra* var. *alba* Tsen). The fruit is light green, milky white, gray-white. The yield is not high. The special flavour is very good. The fruit is the best in Shangyu county of Zhejiang province.

(5) Early maturing red bayberry (*Myrica rubra* var. *praematurus* Li). Produced in Huangyan of Zhejiang province. The fruit is small, purple-red or red colour. The quality in medium or poor. Matures early (early June).

(6) Yangping red bayberry (*Myrica rubra* var. *conservatus* Li). Produced in Yangping of Linhai county and Tanyang of Huangyan county of Zhejiang province. The fruit is orbicular, purple-red. The fruit is the best for storage. There is no change in taste after a week.

(7) Hengchun red bayberry (*Myrica adenophora* Hance var. *kusanoi* Hayata). Produced in Hengchun, Taiwan province.

(8) Sharp leaf short red bayberry (*Myrica nana* var. *integra* Chev.). Produced in Yunnan and Guizhou provinces.

(9) Big leaf short red bayberry (*Myrica nana* var. *luxurians* Chev.). Produced in Yunnan and Guizhou provinces.

Cultivated types of red bayberry

By the colour and maturity, red bayberry is divided into four groups [6,13].

(1) White types. The colour is white, yellow-white or milk-white. The quality is very good.

(2) Red types. The colour is red or dark red. The quality is very good or slight tart.

(3) Pink-red types. The colour is light-red or pink-red, sometimes it is light-red with white or light-yellow.

(4) Black types. The colour is purple-black. The quality is very good.

Classification of cultivated red bayberry

Bayberry is systematized by the shape, colour and taste, mature period of the fruit [7].

(1)The shape of the fruit: Orbicular, oblate, long-ball, ovate.

(2)The size: Large, over 12 g; middle, 8-12 g; small, below 8 g.

(3)The colour: White, red and purplish-black.

(4) The special flavour: The best one is with the taste of sweet and tart or sweet and slightly tart.

(5)The pulp column: It is on the rind. The better one is round.

(6)The pit: The small one is the best.

The four good strains in Zhejiang province [7] (1) Water chestnut red bayberry (Figure 2).



Figure 2. Waterchestnut red bayberry

Figure 3. Wandao red bayberry

Produced in Yuyao and Cixi countries. The fruit is orbicular. The diameter average of the fruit is 2.5 x 2.6 cm. The weight is 9.0 g. The top of the fruit is slightly hollow. The bottom of the fruit is flat. The pulp column is club shape. The top is round and blunt. The colour of the fruit is dark-purple-red. The pulp is delicate, very juicy, sweet and tart. The quality is excellent. The pit is small, ovate and the average weight is 0.5 g. The colour of the fruit in syrup is purple-red, this fruit won a silver medal in China.

The tree is healthy and strong. After 3-5 years trees will begin to produce fruits. A 20-40 year tree can produce 125-200 kg fruit. The best ones can produce 900 kg. They can produce fruit for 50-70 years. The oldest trees are more than 140 years old. They grow well at 10-100 m above sea level. The harvest period is 14-20 days.

(2) Wandao red bayberry (Figure 3).

Produced in Gaoxie, Zhoushan county. Wandao red bayberry is one of the good strains.

The name means that wandao red bayberry matures later. The crown is high and large. Wandao red bayberry is suitable for sandy loam and has high yield. The fruit is orbicular, purple-black, full of lustre, middle size. The diameter is about 2.6 cm. The average weight of the fruit is 11.0 g and the biggest fruit is more than 15.0 g. The pulp column is round and plump and the length is 1.0 cm. The top of the fruit is slightly hollow. The pit is ovate. The ripening time is in early July. The collecting period will be 12-15 days. The pulp is delicate, sweet, tart, very juicy. The pit is easily parted from the pulp. It is warmly received by the consumer. It can be eaten freshly or canned. It is a good canning fruit, which darkens when canned. One tree can produce 150-200 kg.

(3) Dongkui red bayberry (Figure 4).

A red-coloured bayberry. Produced in Huangyan county. It is well known as a big type, orbicular. The diameter is about 3.7 cm. The weight of the fruit is 20-25 g. The pulp column is thick and purple-red. The fruit contains sugar 10.5%, acid 1.35%, soluble solid 12.0%. The taste of the fruit is strong, sweet and tart. It is also canned. The tree is strong and healthy. The yield of the fruit is middle. A tree can produce about 100 kg fruits/tree and the highest yield is 175 kg. The tree has little disease. The tree can continue to produce fruits for 100 years. The ripening period is in early July. Dongkui red bayberry is one of the good strains.

(3) Dingdai red bayberry (Figure 5).

A black-red bayberry. Produced in Zhenhai county, black-purple colour. The top of the pulp column is round. The pulp is thick, delicate, very juicy, more sweet and lesser tart. The quality is excellent, small pit and ovate. The fruit is orbicular and middle size. The diameter is 2.8 cm. The weight of the fruit is about 11.0 g and the biggest fruit is over 13 g. The fruit stem is 2 cm long. It is different from the others. The yield of the fruit is middle.

Other types in China [7]

(1) Datan red bayberry (Figure 6) Produced in Chaoshan, Banshan of Hangzhou of Zhejiang province, the fruit is orbicular. The diameter of the fruit is 2.8 cm. The weight of the fruit is 14.5 g. The bottom is flat or slightly hollow. The base of the fruit is big and yellow green. The long pulp column is thick on the top. The fruit stem is very short. The colour of the fruit is purple-black, but light red near pit, very juicy, sweet, tart and strong special flavour. The pulp is delicate and soft. The quality is excellent. The ripening period is in late June to early July. Datan red bayberry can produce fruits for 100 years.

(2) Xiaotan red bayberry

Also produced in the same place as Datan red bayberry. The fruit of Xiaotan red bayberry is similar to Datan red bayberry, but is a bit smaller than it. The diameter of the fruit is about 2.6 cm. The taste is more sweet and lesser tart. The quality is middle.

(3) Drape red bayberry

Produced at the same place as Datan red bayberry. The fruit is orbicular. The diameter is about 2.7 cm. The weight of fruit is 12.0 g. The colour of fruit is purple-black and pink near the pit. The pulp is soft, very juicy and lesser sweet and strong tart with a fragrance. The quality is middle. The ripening period is in middle June.

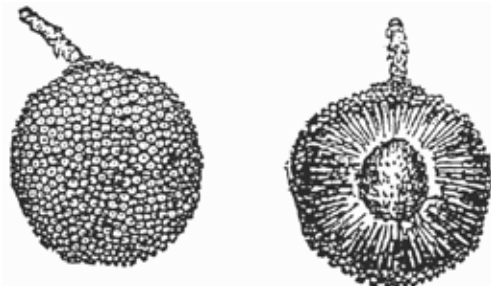


Figure 5. Dingdai red bayberry

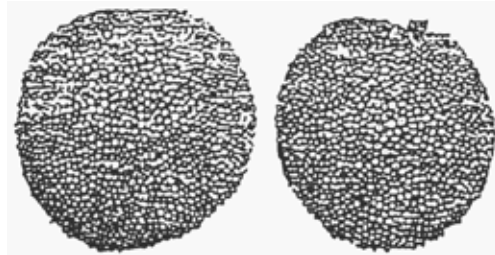


Figure 4. Donkui red bayberry

(4) Black red bayberry

Produced in Dongtingshan of Wu county in Jiangsu province. The fruit is middle large, ellipse, 13.0 g weight and purple-black. The pulp is thick and loose, very juicy and sweet and tart with a fragrance. The quality is good.

(5) Two colour red bayberry

Produced in Jianyang, Jianzhen, Gutian, Nanping and Taining counties etc. in Fujian province. The fruit is 13-15 g

weight. The fruit is part purple-black and part red. The pulp is thick and soft, very juicy, small pit. The taste is sweet. The quality is good.

(6) Shan red bayberry

Produced in Neifeng of Chaoyang county in Guangdong province. The fruit is big, purple-black, small pit, thick pulp, very juicy and sweet. The quality is excellent. The ripening period is in later May. The yield of fruit is high. The tree has good adaptability such as resistant to cold wind, rain and fog.

(7) Wusuhe red bayberry

Produced in the same place as Shan red bayberry. Wusuhe red bayberry is a fine type, selected in the last 30 years. The fruit is big, 16 g weight with purple-black, thick pulp and loose, very juicy, sweet, and small pit. The quality is excellent. The harvest period with high yield is in early and middle June. Wusuhe red bayberry has sold well in Southeast Asia.

(8) Ninghai damuye red bayberry

Produced in Daili of Ninghai county of Zhejiang province. The fruit is orbicular. The diameter is about 2.65 cm. The fruit is 12 g weight with purple-red. The ripening period is in middle July. The quality is good. The yield is about 200 kg/tree.

(9) Fenghuanzhong red bayberry

Produced in Yuyao, Cixi counties of Zhejiang province. The fruit is big, about 15 g weight with purple-black or purple-red, big pit. The ripening period is in middle July. The quality is not so good.

(10) Xixian purple-red bayberry

Another name is Wumei (black red berry). Produced in Xi county in Anhui province. The fruit is middle size. The diameter of fruit is about 2.70 cm. The weight of fruit is 11.5 g. The fruit is a purple-red ellipse, very juicy and dark-red with a fragrance. The quality of fruit is good.

(11) Dayewu red bayberry

Produced in Wenling county of Zhejiang province. The tree is strong and healthy. The crown is high and large. The fruit is large. The pulp is dark-black. Dayewu red bayberry is usually canned. The tree can produce fruits for 50-60 years.

(12) Xiaoyewu red bayberry

Produced in Wenling county also. Xiaoyewu red bayberry has strong disease resistance. The fruit is smaller than Dayewu red bayberry. The fruit is dark black and sweet. The quality of fruit is better than Dayewu red bayberry. A tree of Xiaoyewu red bayberry can produce fruits for 100 years.



Figure 6. Datan red bayberry

(13) Zhongyeqing red bayberry (Figure 7)

Produced in Xiaoshan county, Zhejiang province. The tree is strong and healthy. The big fruit of 13.5 g weight with about 2.8 cm diameter is purple-red, very juicy, sweet and tart, elliptical pit. The ripening period is in late June with high quality.

(14) Dayeqing red bayberry

Produced in Hangzhou and Xiaoshan of Zhejiang province. The tree is strong and healthy. The fruit is orbicular or oblate. The diameter of fruit is about 3.0 cm. The weight of the fruit is 14.5 g. The colour of fruit is purple-red or dark-purple with light red near the pit. The pulp is soft. The outer colour of fruit is red, very juicy and sweet. The flavour is good. The fruit is high quality.



Figure 7. Zhongyeqing red bayberry

(15) Chidazhong red bayberry

Produced in Yuyao, Cixi counties. The tree is strong and healthy. The fruit is middle size and orbicular. The fruit is about 2.5 cm diameter and 8.8 g weight. The fruit is dark-red or purple-black, fine pulp, very juicy, sweet and tart. The ripening period is in early July with high yields.

(16) Guangye red bayberry

Produced in Jing country of Hunan province. The fruit is orbicular, purple-red, sweet and slight tart. The taste is high quality. The ripening period is in middle June with stable yields.

(17) Dayexidi red bayberry (Figure 8)

Produced in Wu county of Jiangsu province. The fruit is big, orbicular, 15 g weight and 2.7 cm diameter. The pulp colour is purple-red. The taste is soft, very juicy, sweet and tart. The thick pulp has small pit. The quality of the fruit is very good. The ripening period is in late June with high yields.

(18) Shenhongzhong red bayberry

Produced in Shangyu of Zhejiang province. The tree is strong and healthy. The fresh-red fruit is big and orbicular with 2.8 cm diameter and 12 g weight. The taste of the pulp is fine and soft, very juicy, sweet and light tart. The quality is good with pit. The ripening period is in late June with high yields.



Figure 8. Dayexidi red bayberry

(19) Zaodazhong red bayberry (Figure 9)

Produced in Yuyao, Cixi countries of Zhejiang province. The tree is strong and healthy. The fresh-red fruit is orbicular, big with 2.6 cm diameter and 109 weight middle juice. The taste

is sweet and light tart. The ripening period is in middle June with high yields.

(20) Qingditou big red bayberry

Produced in Huangyan county of Zhejiang province. The tree is strong and healthy. The orbicular, purple-red, red, or red-white fruit is 3.0 cm diameter and 20 g weight. The taste is sweet, tart and strong flavour. The quality is very good with big pit and ellipse. The ripening period is in early June with wind-resistant. The yield is high. The fruit is suitable for fresh eating and processing.

(21) Huangyan water red bayberry (Figure 10)

Produced in Huangyan, Linhai, Wenling counties of Zhejiang province. The well-known one is located in Huangyan. The purple-red fruit is big, orbicular with 2.85 cm diameter and 24 g weight. The quality is very good with small pit, an ellipse. The ripening period is in middle or late June. This is a very good type in southern Zhejiang province. The fruit is suitable for fresh eating and processing.

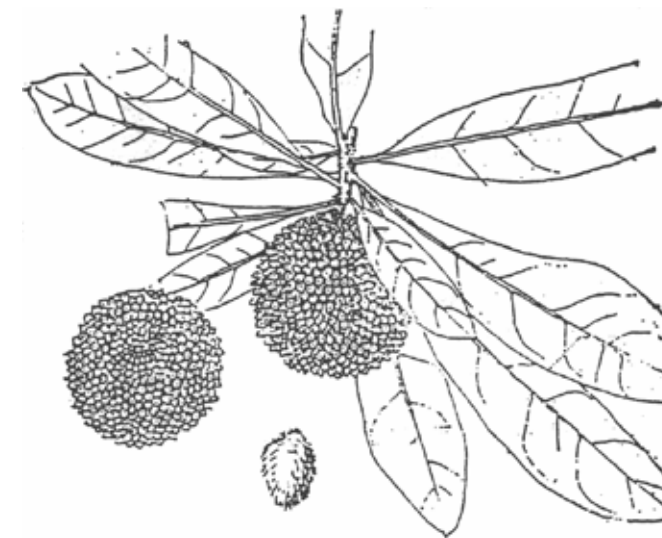


Figure 9. Zaodazhong red bayberry

(22) Zaose red bayberry

Produced in Xiaoshan of Zhejiang province. The fruit is orbicular or oblate. The purple-red fruit is 2.7 cm diameter and 11.5 g weight.

The pulp is fairly thick, fairly juicy, tart and sweet with ellipse pit. The ripening period with a high yield is in middle June. The tree grows very fast and cultivation is easy.

(23) Chise red bayberry

Produced in Xiaoshan country of Zhejiang province. The fruit is big, orbicular or oblate with 2.9 cm diameter and 15 g weight. The ripe fruit is red then changes to dark purple-red later. The taste of the fine pulp is sweet and slight tart. The quality of fruit is good with 1.9 g big pit, ellipse. The ripening period is in the end of June. The fruit is suitable for fresh eating and processing. The yield is middle.

(24) Xiyeqing red bayberry

Produced in Xiaoshan country of Zhejiang province. The purple-red or dark purple fruit is small and orbicular with 2.3 cm diameter and 7.0 g weight. The purple is fairly thick and fairly juicy. The quality is not good. The ripening period is in middle June.

(25) Lizhi red bayberry

Produced in Cixi, Yuyao and Yuhang counties of Zhejiang province. The fruit is big, long orbicular and a beautiful red with 3.0 cm diameter and 15 g weight. The fruit is similar to

litchi hence the name, litchi red bayberry. The pulp is soft, very juicy and strong taste. Lizhi red bayberry is adaptable with high yields. As the taste is tart, the fresh fruit can be eaten after some period of holding.

(26) Liushuitou red bayberry

Produced in Zhenhai county of Zhejiang province. The fruit is middle size and orbicular with 2.5 cm diameter and 9 g weight. The fruit, with ovate pit, is purple-red and pink or yellow white near the pit, very juicy, sweet and tart. The taste of the fruit is strong. The ripening period is in late June. The tree has strong wind-resistance. The fruit is suitable to store. The tree is cultured in fertile earth. The quality is very good.

(27) Dajing water red bayberry

Produced in Leqing county of Zhejiang province. The purple-red fruit with long ellipse pit is big and orbicular with 2.9 cm diameter and 14 g weight. The pulp is middle hard, very juicy, sweet and tart. The quality is good. The ripening period is in late June or early July with high yields. The tree is wind-resistant and adaptable.

(28) Wenling big red bayberry

Produced in Wenling county of Zhejiang province. The purple-red fruit with ellipse pit is strong and healthy, orbicular with 2.8 cm diameter and 12 g weight. The pulp is very juicy, sweet and tart. The ripening period is in late June with high yields. The quality is good. The fruit is suitable to store.

(29) Zaoxing red bayberry .

Produced in Huangyan county of Zhejiang province. The purple-red or red fruit is orbicular and small with 2.4 cm diameter and 6.8 g weight. The pulp is fairly juicy, tart and sweet. The quality is middle or lesser but the fruit ripens in early June.

(30) Zhoushan red bayberry

Produced in Zhoushan of Zhejiang province. The purple-red fruit is orbicular and medium size, about 2.6 cm diameter. The pulp is soft, very juicy, sweet and tart. The quality is very good.

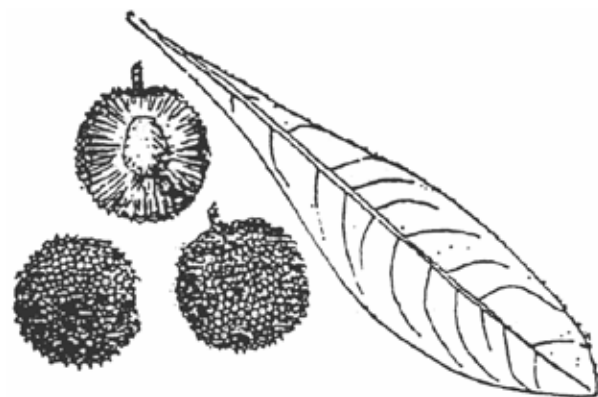


Figure 11. Muye red bayberry



Figure 10. Huangyan water red bayberry

The ripening period is in late June. The tree is adaptable and begins to produce fruits 6-7 years after grafting.

(31) Muye red bayberry (Figure 11)

Produced in Lanxi county of Zhejiang province. The purple-red fruit with ellipse has a 2.7 cm diameter and 12.5 g weight. The fine pulp is sweet and very juicy. The ripening period is in late June. The quality of the fruit is good. The fruit is suitable to store. The tree can begin to produce fruits in 3-4 years after grafting.

(32) Dali purple red bayberry

Produced in Fuding of Fujian province. The purple-red fruit is orbicular with 2.8 cm diameter and 13 g weight. The pulp is soft and sweet. The yield of the fruit is high. The ripening period is in middle June.

(33) Zaohong red bayberry

Produced in Lianjiang of Fujian province. The red or light-red inside fruit is orbicular with 2.3 cm diameter and 7.3 g weight. The taste is soft, tart and sweet. The quality is good with high yields but each fruit is small. The ripening period is in early June.

(34) Yuyao pink red bayberry

Produced in Yuyao city of Zhejiang province. The purple-red fruit is orbicular with 2.5 cm diameter and 10.5 g weight. The pulp is pink, thick and hard, fairly juicy and tart.

(35) Xixian red bayberry

Produced in Xi county of Anhui province. The fruit is orbicular with 2.3 cm diameter and 6.0 g weight. The taste is tart. The quality of fruit is middle. The tree is rather delicate.

(36) Shuijiaci red bayberry

Produced in Yongjia of Zhejiang province. The tree is strong and healthy. The dark-red pulp is thick, hard, sweet, tart and fairly juicy. The quality is middle or lesser with high yields. The fruit is suitable to store for later ripening.

(37) Yongjia water red bayberry

Produced in Yongjia of Zhejiang province. The tree is not so strong. The dark-purple-red fruit is orbicular, very juicy, sweet with tart. The quality is middle high with high yields. As the pulp of fruit is soft, the fruit is not good for storing.

(38) Dayegang red bayberry

Produced in Changxing of Zhejiang province, having a long cultivated history. The tree is strong, healthy and high. The dark-purple fruit is orbicular and big with 3.0 cm diameter and 14.5 g weight. The pulp is very juicy and sweet with slight fragrance. The quality is very good. The ripening period is in early July.



Figure 12. Shuijing red bayberry

(39) Shuijing red bayberry (Figure 12)

Produced in Yuyao of Zhejiang province. The tree is strong and healthy. The white or yellow-milk-white fruit is orbicular with 2.7 cm diameter and 11.5 g weight. The pulp is soft, very juicy and sweet with slight tart. The quality is very good. The ripening period is in late June to early July. Mainly the fruit is used for fresh eating.

(40) Xiaoshan white red bayberry

Produced in Xiaoshan of Zhejiang province. The tree is fairly strong. The small fruit is oblate with 2.4 cm diameter and 8.0 g weight. The pulp is milk-white, slightly soft, fairly juicy, sweet and slight tart. The ripening period is in late June to early July.

Growth environment of red bayberry [4, 8]

The best temperature for red bayberry is 15°C, but red bayberry does not grow well under 15°C. Red bayberry likes damp soil and humid air. Red bayberry grows on shady hills with a slope of 5-30 degree.

Propagation of red bayberry

The methods are seeding, grafting, layering, and cuttings.

(1) **Seeding:** Deep ploughing and seeding in September. 1.25-1.5 kg of seed is used per square metre. Covered with plastic film in middle December, red bayberry begins to emerge in middle February. The young tree of 0.6 cm diameter will be 50 cm high in November.

(2) **Grafting:** Grafting may be done in April, and the scion cut from 7-15 years old tree.

(3) **Cuttings:** Cuttings may be struck in April, using last-year or this-year wood.

(4) **Layering:** Layering may be done in late March to middle April.

Picking, storage and processing of red bayberry [6, 8]

In different places, picking will begin from April to July. It has been said that "one day the taste will change, two days the colour will change, three days the taste and colour all will change". So storage conditions are very important. Usual storage conditions are as follows.

Cold storage: (1) 0°C; (2) -18°C.

Preserved in (1) salt: red bayberry:salt:alum= 100: 14: 6. (2) sugar: red bayberry:sugar= 10:4, boil. (3) spirit: soak it with 50-60% spirit.

Processing products [7,8]

(1) Canned sugar water of red bayberry

(2) Red bayberry juice

(3) Red bayberry jam

(4) Canned red bayberry

(5) Red bayberry wine

Medicinal and other usages [7,8,9]

The red bayberry contains cellulose, mineral, vitamin B, glucose, fructose, citric acid and apple acid. Red bayberry can eliminating phlegm, relieve dyspepsia, promote the production of body fluid etc. Here are some treatment regimes:

(1) Thirst, and low fever: eat fresh fruit, 30-60 g at morning and night.

(2) Vitamin B-deficiency for example gum haemorrhage etc: eat ripe fruit 30-60 g, at morning and night.

(3) Stranguria: Pound 60-90 g fresh red bayberry fruit to pieces and add boiled water to it. Then mix well and drink the filtrate 3 times per day.

(4) Prevent heatstroke: Decoct 30 g fresh red bayberry fruit with water. Then drink it 2 times per day.

(5) Dyspepsia and abdominal pain caused by acute enterogastritis, diarrhoea: Drink 30-60 g red bayberry wine 3 times per day, or eat 4-5 pieces of the soaked fruits, or eat the salted fruits which is pounded to pieces.

(6) Dizziness caused by overworked, pain of muscle and joint: Drink 30-60 g red bayberry wine 2 times per day.

(7) Gingivitis: Burn pit to charcoal and pound to pieces. Then daub it on affected part.

(8) Food poisoning: Decoct 150-200 g red bayberry with water. Drink it so the poison can be detoxified.

(9) Skin eczema, scabies: Wash with decocted bark.

(10) Hemostasis, promoting recovery: Pound the salted red bayberry, grind into a fine power, and then daub it on affected part.

(11) Red bayberry contains anti-cancer materials.

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WHAT CAN DNA TYPING OFFER MACADAMIA?

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[Editor's note: Dr Vithanage's technique described here is applicable to most tree crops. In particular it should be valuable for crops, such as the Fig and the Jujube, where there is considerable confusion on variety names, with one variety having several names, and one name used for more than one variety. This is in addition to the possibilities for crop improvement listed]

Plant improvement through modern DNA technology is a reality and we are using it in the macadamia breeding programme to

- * remove the element of chance in progeny selection;
- * accelerate plant breeding by identifying 'linked' characters; In addition, we have the capacity to use it to
- * verify nursery material is true to type;
- * trace pollen flow patterns in orchards;
- * trace parentage of superior plants;
- * identify unique populations for long term preservation.

Researchers of the different agencies will be reporting on the progress of the various aspects of the macadamia breeding project at regular intervals and my aim is to outline how molecular markers will fit in to the scheme of things and what progress we have made to date.

New technology

"DNA typing" allows us to "tag" certain unique areas or "landmarks" on the DNA, which is the genetic material found in all living cells, both in plants and animals. The size and positioning of these unique areas can be different in different cultivars. Techniques have been used to amplify these unique areas for comparison which form the basis of DNA typing. This comparison is eventually visualised on a photograph which shows a unique banding pattern for each individual tested. This is akin to the simple "bar-codes" that identify products on supermarket shelves.

Parental Selection

In plant breeding, the aim is to concentrate favourable characteristics into a few cultivars. It is common among plant breeders to attempt crosses between parental forms which are genetically distant from each other in order to bring together a diverse array of characteristics. This is done in order to exploit the natural hybrid vigour in such progeny populations. DNA markers can help us in identifying such parents based on genetic distance. Therefore, this technology gives us a quick assessment of which varieties to cross with others in the absence of good information about production and nut characteristics. Thus it is helpful in selecting best parents for crossing.

Here we report some of the preliminary results obtained by using Random Amplified Polymorphic DNA (RAPD) markers. This technique entails identifying and visualizing certain regions of the DNA.

The main steps involved are;

- * the extraction of DNA from leaves,
- * chemical identification and location of these DNA fragments,
- * the separation and visualization of these fragments of DNA,
- * scoring and computer analysis of the data.

For this exercise, several cultivars/species/genotypes were selected. They are, 246, 800, 781,819, Daddow, 344, Beaumont, Renown, A4, A16, *M. tetraphylla* and a genotype picked from the Bellthorpe area identified in this text as "Bellthorpe".

Using this technique, cultivar differences can be identified as the presence or absence of an amplification product on ethidium bromide stained agarose gels. This provides a rapid assessment of the differences in genetic composition of genotypes.

The dendrogram obtained by analysing the above data (Fig. 1) readily relates the genotypes in a hierarchical scheme.

The results analysed in a different way are summarised in the 3D figure (Fig. 2) which represents the genetic positioning of the different genotypes based on RAPD fragment data. This illustrates the best mathematical positioning of the various genotypes, indicated by numbered "balloons", on a three dimensional field. This particular method of data analysis is not specific to DNA data, but could be used to analyse the genotypes against any grouping of characters, eg. yield, nut size, sugars, oils, resistance to disease etc.

The dendrogram created with the current data separates the individual genotypes based on genetic distances. The genetic distance is indicative of the percentage of dissimilarity of the genotypes tested. For example, the most closely related cultivars, A4 and A16, showed a dissimilarity of about 10% whereas the most distant genotype 'Bellthorpe' converged with the rest at a dissimilarity level close to 60%.

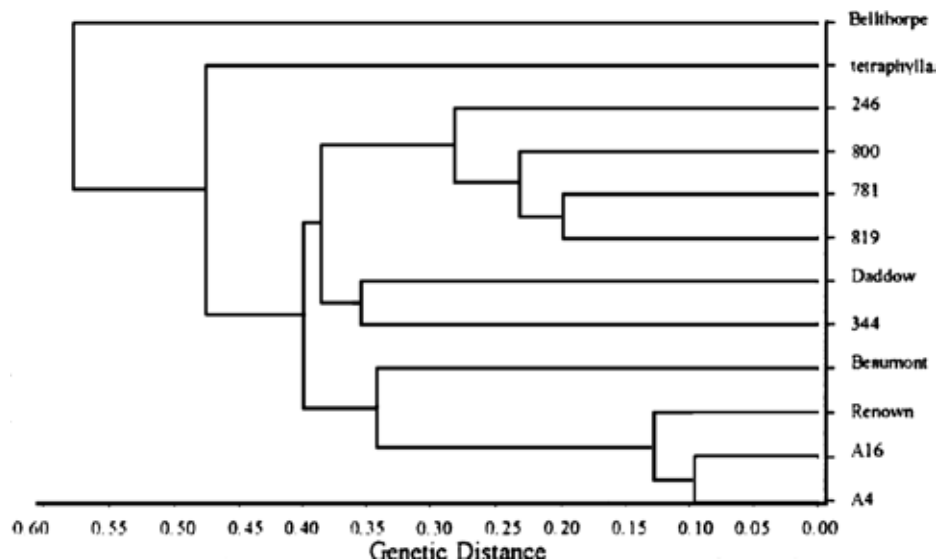


Fig. 1. Relationship of macadamia cultivars as determined from 72 RAPD DNA fragments. The cultivar separation is based on the genetic distance, which is a measure of their dissimilarity. The horizontal line represents the genetic distance of any given cultivar, and the vertical lines delimit the cultivars of equal rank, eg A4 and A16 show a dissimilarity level of close to 10% and both of them differ from Renown at a level close to 13%.

The results of the current analysis as shown in the two figures agreed with some of the pre-study concepts of the diversity of the genotypes tested. A noteworthy feature here is the fact that the unknown genotype collected from the Bellthorpe area was quite distinct from the rest, showing a dissimilarity of about 60%.

Also, the species, *M. tetraphylla* converged with the rest, the majority of which are *M. integrifolia* selections, at about the 50% dissimilarity level. The 3D analysis, however, placed the *M. tetraphylla* away from the rest. The cultivars A4 and A16, siblings of Renown, clustered together and showed a close affinity towards the mother, thus lending weight to the strength and validity of the RAPD technique. Beaumont, which is believed to have *tetraphylla* features, was placed on its own and linked with the Renown, A4 and A16 grouping.

A more distinct picture emerged with the 3D analysis where Beaumont occupied a space between the two species groups. Thus the two types of analyses are complementary and need to be used together to obtain useful information. The list of genotypes analysed is by no means comprehensive and as more data are generated, a detailed picture will emerge, which can be used to select parents based on genetic distances.

Short Cuts To Plant Improvement

From the plant breeding point of view, another feature in the DNA marker technology is the identification of "linkages" to some important characteristics. For example, if we can

identify a cultivar-specific marker to be associated with resistance to husk spot, then it will help in the pre-screening process by helping to produce populations where the resistance character has been concentrated.

Search for associations with useful characteristics will cover not only plant features such as precocity, flowering span, resistance to disease etc., but also post-harvest features such as high kernel recoveries, long shelf life, ability to withstand rancidity, better oil contents etc. Availability of progeny where both parents are known is a pre-requisite for this quest for linkages with useful characteristics.

We already have a unique population of hybrids produced not only with cultivars that are prominent in the industry, but also with some of the lesser known types including *Macadamia janseni*, a new species which may have useful characteristics. Identifying linkages to good characteristics will be extremely useful in selecting winning combinations from this collection of hybrids.

In progeny selection, testing is usually limited to elite performers only. However, if associations of various characteristics can be linked to the markers, then a single test to establish the marker of a young seedling will reveal the presence or absence of these characteristics. This feature will not only be useful in progeny selection, but also in selecting parents for crossing programmes.

There are numerous other features of macadamia that could be identified by having culti-

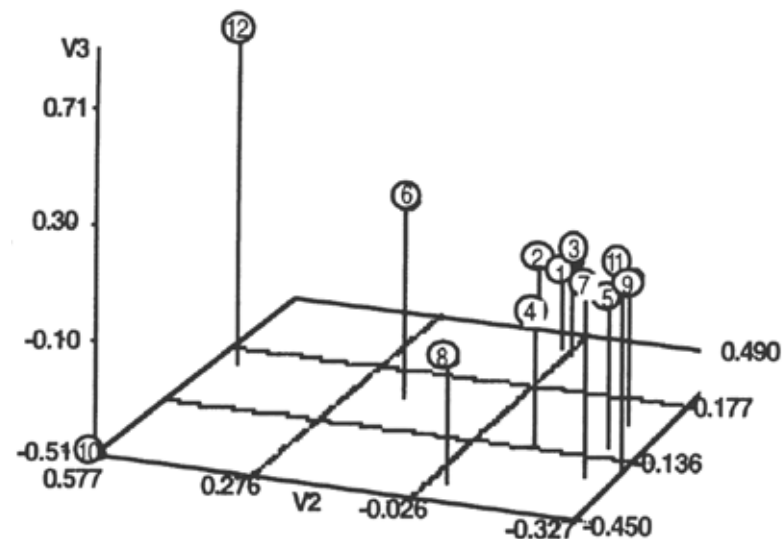


Fig. 2. The 3D figure represents the genetic positioning of the different genotypes based on RAPD fragment data. This illustrates the best mathematical positioning of the various genotypes, indicated by numbered 'balloons', on a three-dimensional field. The 'balloon' numbers refer to the following genotypes. 1-A4; 2-Renown; 3-A16; 4-A344; 5-814; 6-Beaumont; 7-781; 8-246; 9-Daddow; 10-'Bellthorpe'; 11-800; 12-*M. tetraphylla*.

var-specific markers. Equally, if markers can be found to identify advantageous features they can also be used to identify lines that contain undesirable features such as:

- * premature nut-drop in certain cultivars ego 246;
- * susceptibility of certain cultivars to disease, eg. husk spot;
- * susceptibility of kernels to rancidity in certain cultivars;
- * varietal incompatibilities;

Varietal Identification

Since the establishment of macadamia as a crop in Australia, plant improvement has continued in one form or another, resulting in new selections being added to the industry. With each new addition, the industry has attained incremental gains in yield.

Visually, these new additions are very similar to existing cultivars. Therefore, to ensure correct material is purchased the industry would need a validation system. At a time when large macadamia plantings are being established in most areas, it is important to have an accreditation scheme to make sure that cultivars planted out are true to type. The DNA typing technique would form the basis for such a scheme.

Tracing Parentage and pollen flow in orchards

Whilst plant improvement through breeding is important for developing superior cultivars for the future of the industry, in the short term, improvements could still be made with existing cultivars by developing better planting designs.

Once we have a simple means of identifying a cultivar, then it can be used as a tool to address problems that affect the industry. Take the example of cross pollination and self pollination.

At the moment, we do not know how high yields can come about in certain varieties; whether self or cross pollination is responsible for this. Pollination leads on to a series of events culminating in nut formation.

The pollen responsible can come from either the same tree, an adjoining tree of the same cultivar or it can come from a different cultivar planted at a different place in the orchard. Each new nut formed on the tree will have its own marker which is a combination of individual markers from the two parents. Therefore, if we have a simple marker to identify each of the potential pollen parents, a simple comparison of the markers of the individual nuts formed with those of the potential pollen parents will indicate the true pollen parent of the new nut as we would already know the marker of the maternal parent.

This problem has already been addressed by using another marker technology, isozymes. However, the drawback in isozymes is that it can be carried out only in orchards with a particular cultivar combination as most of the common cultivars have shared isozyme markers. In reality most orchards have several cultivars either interplanted in rows or planted out in separate blocks. Therefore, the DNA typing offers a more reliable, robust technique which is applicable to a wide range of orchard situations.

This type of paternal testing is being successfully carried out in forensic sciences using the

same technology. Advances along these lines are being made in other crops such as wheat, rice, tomato, cabbage just to name a few. How could this technology help macadamia?

Our current knowledge on crop production of macadamia is far from complete. How do single cultivar blocks compare with mixed blocks? What are the best combinations of cultivars that can be planted out together in a given area? How do these relate to natural pollen flow in orchards? We need answers to these questions. Researchers are currently working on these questions, but as stated previously, the isozyme technology only allowed the pollen flow question to be addressed in a limited manner. However, if accelerated results can be achieved by using the new marker technologies, then the benefits to the grower will come that much sooner rather than later. Californian Almond industry figures show that in the 1970s, 2000 lb. of meat/acre was considered a top yield. Today it is 3000 lb/acre and this difference is entirely due to improved planting designs which shows the importance of better cross pollination and better varietal bloom overlap in almond production.

Conservation

The DNA typing may also help in 'scanning' wild types in natural stands in order to understand their closeness or otherwise to the cultivated varieties as shown with the genotype from Bellthorpe area. Depending on their uniqueness, strategies can be formulated for their conservation in order to maintain biodiversity of macadamia for future plant improvement programs.

Future benefits

The major benefit from the DNA typing work will be in the enhancement of the breeding project by offering short cuts to the selection process thereby adding value to it. Verification of nursery material, tracing parentage, monitoring pollen flow in orchards and identifying unique populations in the wild for long term preservation are some of the benefits that will accrue along the way. Perhaps, as the industry expands, it may want to use the technology to set up an accreditation scheme for all the planting material.

DNA typing technology is a vital tool in horticulture as certainty of identification is essential for all aspects of orchard management. Therefore, this technology will not only help us in our immediate problems of plant authentication but also will help in the long term goals of plant improvement and orchard management.

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Based on an article in the May 1997 News Bulletin of the Australian Macadamia Society (Suite 5, 76 Woodlark Street, Lismore NSW 2480)

THE FUTURE OF DATE PRODUCTION IN THE U.S.

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Date palm (*Phoenix dactylifera* L.) is an exotic species in North America, an ancient plant native to the warm, dry desert areas of the Middle East, where its fruits comprised an essential component of human and animal diets for many centuries. The date palm tree is a rather recent addition to North America, and the first centennial of its introduction will be celebrated 7 years from now.

Although the tree is known for its tolerance to environmental stresses such as heat, drought, soil salinity, soil compaction, and poor nutrition, these stresses are increasing with time partly due to improper management practices. There is a need to address these serious issues that may decide the future of the date industry in the U.S.

History

The history of the date tree and the date industry in the U.S. begins with Bernard G. Johnson who is referred to as 'The American Arab' and the 'Grandfather' of the date industry in the U.S. While travelling in the Middle East and North Africa early in this century, Johnson realized the economic importance of the date tree and noted that the climatic conditions under which it thrived had much in common with the hot Southern interior low desert of California, and Arizona.

Under his leadership, the U.S. Department of Agriculture imported and planted in 1904 to 1908 the first palms on a 4-ha field at the U.S. Government Experiment Station near Mecca California where Johnson lived. By 1918, 19,000 offshoots of North African varieties - mainly 'Deglet Noor' - and 9,000 offshoots representing over 100 Persian varieties were imported and sold to farmers and companies mostly in the Coachella Valley of California. A few were shipped to the Imperial Valley (California) and Yuma, Arizona, and planted there. These imports comprised the nucleus of the date industry in the U.S. A 1993 survey shows a total of over 300,000 trees (94% are in the bearing ages between 5 and 55 years), occupying an area of 2535 ha.



Profile and uniform distribution of roots along 2-m depth of soil profile.

Distribution

Expansion of the date growing area in the U. S. has been limited by the strict environmental requirements of the tree. Most date varieties require 4000 to 6500 degree-days (sum of the number of degrees of daily mean temperature above 18°C between blossom and fruit ripening). Rain, during fruit development and ripening, reduces yields and quality, and low temperatures below -5°C inflict frost damage on the tree. These strict climatic requirements are well met in the Coachella Valley - a 31,000-ha area surrounded by mountains, and irrigated by water from the Colorado River.

The Valley extends from Palm Springs to the Salton Sea in the Imperial Valley. Elevations range from a high of 480 m above to 75 m below sea level. Date palm groves of various sizes and ages spread all over the Valley and occupy 2282 ha forming 90% of the total acreage planted into date palms in the U.S. The remaining 243 ha are located in the neighbouring Bard area of Imperial County, California, and in Yuma, Arizona. Deglet Noor occupies 88 % of the total acreage, followed by Khadrawi (4%), Zahidi (3%), and Majhool (2%).

Economic and social importance

The date palm occupies 9% of the crop acreage of the Coachella Valley presently under production. Annual date production is about 24,000 tons with an approximate value of 62 million U.S. dollars. Date production is an intensive culture in which most farming and marketing operations depend on manual labor. It provides year-round employment opportunities to the Valley residents whose population has increased from 31,000 residents in 1956 to over 250,000 in 1994. Major field operations include climbing trees several times each year to remove old fruit stems, prune thorns and older leaves, collect pollen from male trees, hand-

pollinate female trees, thin the young fruits, cover the bunches with paper to protect from rain and insects, and make several harvests. Additional ground work includes cultivation, fertilizing, and watering. Postharvest operations include drying, grading, packing, and storage.

Encountered problems

The major problems in the Coachella Valley are soil and water related. Soils were formed from sediments that had been moved down into the Valley from the surrounding mountains, by water and wind, and from Lacustrine deposits. Soils are sandy, very low in organic matter, and extremely stratified and variable.



Root number and distribution are restricted to the clayey loam zone of the soil profile that has moisture and nutrients.

Strata that restrict down-movement of water and nutrients can be found at any depth including the surface layer. This stratification limits root growth to layers where water and nutrients are available and often leads to shallow, unevenly distributed, root systems which make tall top-heavy bearing trees subject to lodging by strong winds that prevail in the Valley (Figs. 1,2,3).

Excessive use of machinery in farming operations adds to the soil compaction and makes it the most serious problem. So, when 12-15 cm of water are applied at each water application as flood irrigation, the most common irrigation method for dates, water covers the soil surface from 2 to 20 days depending on the magnitude of soil compaction. (Fig.4.). These shallow temporary pools formed by irrigation water, combined with water temperatures above 25°C, create ideal breeding grounds for mosquitoes (*Psorophora columbiae*). This problem prevails every year from May until September.

Since Colorado River water became available for irrigation in the Coachella Valley, per-acre use of water has increased and new areas have been brought under irrigation. As a result, the watertable has risen to levels of 4 m or less beneath 16,000 ha. Furthermore, the Colorado River water contains about 750 ppm of total dissolved solids. Every three ha-m of water required annually by the date orchards, the water carries about 2.5 tons of salt and creates salinity problems. Tiling and slip plowing have been implemented to improve water penetration and reduce salinity buildup. These problems, along with soil stratification and low fertility, have reduced plant growth, yields, and fruit quality of many orchards.



Fully grown trees with shallow roots due to soil stratification and compaction are subject to damage by wind.

Outlook

The outlook for the date industry in the Coachella Valley ranges from optimism to concern. On the positive side, being the only production area in the U.S., the products occupy a special niche not only in the local markets but also among exotic foods and delicacies in food markets and cuisines in Europe and South America.

Prices are lucrative and the demand for high quality products exceeds the supply. Production can be increased, though at high cost, by putting additional acreage into new plantations, and quality can be improved by selecting better varieties such as "Majhool" and improving management practices.

Application of modern research tools, such as tissue culture, can speed up production of young plants from better varieties, reduce time and cost of propagation, and create a highly



Poor penetrability of water into compacted soils induces artificial swamps that reduce root growth and serve as breeding grounds for mosquitoes.

profitable opportunity by selling disease-free plants of improved varieties to date growing countries including the Middle East and North Africa.

On the gloomy side, soil stratification, water salinity, and the rise in groundwater table continue to impose adverse effects on yield and quality, and add to the cost of maintaining existing fields as well as adding new acreage. All these problems lend themselves to research that may lead in each case to a partial or total solution. Yet, no substantial research has been carried out on dates in the Valley since the Agricultural Research Service of the U.S. Department of Agriculture closed its Research Station at Indio, California, in 1984.

Present cultural practices in date growing in the Coachella Valley are typical of what was applied half a century ago. We believe that many of the current problems can be reduced or eliminated by decompacting the soil by slip plowing and shifting into no-tillage practices and by incorporating cover crops that will improve water penetrability and increase soil organic matter. A small research project was initiated in 1996 in a collaboration of the Agricultural Research Service, the Natural Resources Conservation Service and a few date growers in the Valley to investigate the effects of cover crops in a no-tillage system on water use efficiency, soil compaction, and soil fertility. It will take several years before significant responses will be noted.

Based on an article in the No.1, 1997, issue of 'Chronica Horticulturae', the magazine of the International Society for Horticultural Science (K. Mercierlaan 92,3001 Leuven, Belgium).

THE TRUE CHERRIES: DESCRIPTION OF SPECIES

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Introduction

There are a large number of useful cherry species which form the majority of species within the *Prunus* genus. Of the useful species, many have edible fruits, though few are as sweet as the fruits from cultivars of *Prunus avium*, the sweet cherry. The species list below contains information on all known useful cherry species; note that the 'sand cherries', *P. besseyi* and *P. pumila*, are closer to the plum family and have been included in the article on minor plum species in Agroforestry News, Vol 4 No 2.

Most cherries like a well-drained light soil and sun or part shade. Flowering can be very early to quite late, hence some care may need to be taken not to expose flowering trees to late frosts if fruit are wanted. Flowering and fruiting is always better in a sunny position. Cherry species vary from large trees of 18 m to small prostrate shrubs, only 50 cm high, and a species can be chosen for almost any position.

A small number of cultivars bred for fruit quality of the minor cherry species are still available in North America, although most of the hardy selections from breeding programmes 80-100 years ago have been lost. Where available, these cultivars are mentioned below. Cultivars of the sweet cherry (*P. avium*), duke cherry (*P. x gondouinii*) and sour cherry (*P. cerasus*) are not included below, as they will be treated with greater detail in another article. Apart from these three, the species with the best potential for fruiting and quality fruits in Britain are *P. canescens*, *P. dawycensis*, *P. fruticosa*, *P. humilis*, *P. serotina*, *P. tomentosa* and *P. virginiana*.

All fruits contain a single seed. The seeds (kernels) of many species can be edible; however, most, if not all members of the *Prunus* genus produce hydrogen cyanide, a poison that gives almonds their characteristic flavour; it is found mainly in the leaves and seed and is readily detected by its bitter taste. It is usually present in too small a quantity to do any harm but any very bitter seed or fruit should not be eaten, and similarly references to edible leaves should be treated with great caution.

All cherry species are insect-pollinated, and although only those known definitely to attract bees have been listed as bee plants, in all likelihood all will attract bees. The leaves and fruits of all species can be used for dyeing. The leaves give shades of green; the fruits generally give green to dark grey.

§ Member, WANATCA

General propagation methods

Seed: The easiest method of propagation is by seed. Seeds require 2 - 4 months cold stratification; if in doubt, give 4 months, or if possible sow in the autumn. To cold stratify, mix with moist sand or peat and keep in a fridge, or leave outside (protected from rodents). Seeds can sometimes wait a further year before germinating.

Cuttings: Cuttings of half-ripe wood with a heel in July-August under glass. Softwood cuttings can be taken from strongly growing plants in spring to early summer under glass. Root cuttings in winter can be taken from suckering species.

Layering: In spring.

Division: For suckering species, division of suckers can be undertaken in the winter.

Budding: Named selections are usually propagated by budding.

Species List

Prunus alabamensis - USA

A tree, where native, to 10 m high. White flowers in May-June are followed by 1 cm thick, round fruits, eventually nearly black. Hardy to zone 7 (-15°C.)

- Edible fruits - raw or cooked; the flesh is thin and sour.
- Edible seed.

Prunus apetala - Japan

A bushy shrub or small tree to 5 m high. White flowers in May are followed by nearly round black fruits, 8 mm across. Hardy to zone 6 (-20°C.)

- Edible fruits - raw or cooked.

Prunus avium - Bird cherry, Sweet cherry, Wild cherry, Gean, Mazzard - Europe, W. Asia

Vigorous trees growing to 18 m high, occasionally more, with a pyramidal upright form. White flowers in April-May are followed by blackish-red or yellow fruits, ripening in July-August. Fruit buds are mainly on spurs. Wild sweet cherries can bear fruit with varying colours, shapes, tastes and sizes and are sometimes small and bitter. Hardy to zone 3 (-31°C.)

- Edible fruit - raw or cooked. Many cultivars have been selected and bred.
- Edible gum exudation from trunk.
- The fruit stalks and fruit are used medicinally. The stalks are diuretic and anti-uricaemic.
- Bee plant: source of nectar and pollen for honey and bumble bees in April.

- The bark contains varying amounts of tannins, in some trees high enough amounts to be of use for tanning.

- Various selections have been made for use as sweet cherry rootstocks including wild selections ('mazzard').

- An important forestry tree with valuable timber, used for furniture, musical instruments, veneer, inlays, fuel.

Prunus bifrons - Himalayas

A small shrub, only 1-1.5 m high, sometimes prostrate, closely related to *P. jacquemontii*.

Pink flowers, appearing with the foliage, are followed by roundish amber-red fruits, 8 mm thick. Hardy to zone 5 (-23°C.)

- Edible fruit - raw or cooked.

Prunus buergeriana - Japan, Korea

A small tree to 9-10 m high. White flowers are followed by nearly round, black fruits.

Hardy to zone 5 (-23°C.)

- Edible fruits - small, poor quality; sometimes preserved (salted) and used as a condiment.

- Twigs and leaves have an insecticidal effect against fruit flies (*Drosophila hydei*).

Prunus campanulata - Taiwan cherry, Bell-flowered cherry - S. Japan, Taiwan

A tree in its habitat to 7-10m high, often a large shrub in cultivation. The flowers in April-May are an unusual deep wine-red, appearing before or with the foliage; fruits are red, conical, 11 mm across by 15 mm long. Hardy to zone 8 (-12°C) - only for mild areas.

- Edible fruit - raw or cooked. May need astringency removed.



P. campanulata (from Krussmann)

***Prunus canescens* - Greyleaf cherry - C & W.China**

Forms a dense bushy shrub, 1.4-2 m high with steeply ascending branches; light pink flowers in April-May are followed by light red, round fruits, 10- 12 mm across. Hardy to zone 6 (-21°C.)

• Fruits are edible with a pleasant cherry flavour. Several hybrid selections are being developed as cherry rootstocks, including the clone GM 79.

***Prunus cerasoides* - Himalayas**

A small tree to 10 m high, flowering in April and closely related to *P. campanulata*. Carmine flowers are borne well before the leaves in February-March, followed by yellow or red, thin-fleshed fruits. Only hardy to zone 9 (7°C.) The variety *rubea* is a large tree from Bhutan/Burma/China/India with ellipsoid red fruits, 15 mm long, *majestica* is hardy to -10°C: in its native habitat, this flowers in November, the fruits ripening in April-May. For the mildest areas only.

- Edible fruits - acid and astringent, usually cooked or used for brewing.
- Edible gum exudation from trunk.
- Twigs, leaves and kernels are used medicinally in Ayurvedic medicine.
- Bark is used for tanning.
- The wood is moderately hard, strong, durable, aromatic; used for walking sticks, furniture, tool handles.

***Prunus cerasus* - Sour cherry, Pie cherry - Europe, W. Asia**

Trees varying from small and round to large and spreading, most often small, 5-8 m high, and suckering. White flowers in late April-early May are followed by blackish-red round fruits. Fruits are acid, the flesh varying from almost colourless through shades of red to nearly black. Hardy to zone 3 (-31°C) and tolerant of bacterial canker.

Edible fruits - usually cooked. An important commercial species with numerous cultivars. The dark-fleshed types with red juice (var. *austera*) are classified as morello or griotte, the light fleshed forms (var. *caproniana*) with colourless juice as amarelle or kentish, and the types with very small, dark, bitter fruit (var. *marasca*) as Marasca (used to make a distilled liqueur and a speciality jam). Note that 'Sour cherry' is often applied to cultivars and selections of other species and hybrids.

- Fruit are edible, usually cooked, or made into preserves.
- Edible gum exudation from the trunk; also used in fabric printing as an adhesive.
- Edible oil from the kernel (needs refining before use); also used in perfumery.
- Edible leaves - used in teas and pickles.
- Fruit stalks and juice are used medicinally.
- Various selections have been made for use as sour and sweet cherry rootstocks.

- Bee plant in April-May.
- Timber is used for turnery, inlay, musical instruments, furniture.
- Can be used in hedges - fairly wind-tolerant.

***Prunus cerasus* var. *frutescens* - Bush sour cherry**

A population of a dwarf natural variety, with a shrubby habit to 1 m high in dry mountainous areas, higher in cultivation. Fruits with light colourless juice, always sour. A suckering shrub. Same uses as above.

Prunus cerasus* x *P. pennsylvanica

• Edible fruit. A number of cultivars were bred and released in the early 1900's in the USA.

***Prunus concinna* - C. China**

An ornamental shrub or small tree, only 2-4 m high. Abundant white flowers appear before the leaves, followed by purple-black fruits.

- Selections are being tested as very dwarfing cherry rootstocks.

***Prunus cornuta* - Himalayan bird cherry - Himalayas**

A small tree to 5 m high in cultivation (much taller in its native habitat). White flowers in late May, after the leaves emerge, are followed by round, pea-sized (8 mm), purple-brown fruit. Hardy to zone 5 (23°C.)

- Edible fruits - raw or cooked; acid.

***Prunus dawyckensis* - Dawyck cherry - China**

A small tree to 5 m or so high sometimes more. Light pink flowers in April, before the leaves, are followed by ellipsoid, yellowish-red fruits, 15 mm long, juicy and quite sweet. Hardy to zone 6 (-21°C).

- Edible fruit - sweet.
- Several hybrid selections are being evaluated as cherry rootstocks, including the clone GM 61/1.

***Prunus dielsiana* - N. China**

A shrub or small tree up to 6 m high. White to reddish flowers appear before the leaves in April, and are followed by oval red fruits, 8 mm thick. Hardy to zone 6 (-21°C).

- Edible fruit - raw or cooked.

Prunus x eminens

Hybrids between the sour and ground cherries (*P. cerasus* x *P. fruticosa*), often included in lists of 'sour' cherries. Upright shrubs, 1-3 m high. Hardy to zone 4 (-25°C).

- Edible fruit - raw or cooked. In some doubt.
- Several selections are being tested as cherry rootstocks from the Giessen series.

Prunus x fontanesiana

Hybrids of sweet and St Lucie cherries (*Prunus avium* x *P. mahaleb*). Large, fast-growing trees, similar to *P. avium*, with white flowers in April-May and small numbers of small, deep red-black, somewhat bitter fruits. Hardy to zone 5 (-23°C).

- Edible fruit - raw or cooked: somewhat bitter.
- Several hybrid selections are being evaluated as cherry rootstocks, including the M x M and OCR clones.

***Prunus fruticosa* - Ground cherry, Steppe cherry, Dwarf cherry, Mongolian cherry, Siberian cherry - C & E. Europe, Siberia**

Generally a spreading, suckering bush 1-1.3 m high with pendulous branches and tough glossy leaves. White flowers in April-May are followed by dark red fruits with doubly-pointed stones. The fruit can be round, oval, or pear-shaped and 1-3 g in weight; and varies from acidic to sweetly acidic, always having a mild astringency. In cultivation the shrubs lives for 10-12 years. Extremely hardy, to zone 2/3 (-38°C). Used ornamentally as a street tree when grafted high on a standard rootstock.

- Edible fruit - usually cooked (harsh, acid raw), with a cherry-like flavour. Of some economic importance in the former USSR, where much selection has taken place to improve fruit size and sweetness; large fruited selections are sometimes called 'sour cherries'.
- Various selections have been made for use as sweet cherry rootstocks, inducing good precocity.

***Prunus glandulosa* - China, Japan**

Dwarf flowering almond, Chinese bush cherry, Flowering almond, Korean cherry

A small shrub to 1.5 m high. White to light pink flowers in late April are followed by roundish dark purple-red fruits, 1 cm thick, often freely borne, ripening in late September. Notable for being resistant to plum pox (sharka) virus. Likes a warm sunny position.

- Edible seed - small.
- Edible fruits - usually in preserves or pickles.

***Prunus x gondouinii* - Duke cherry, Royal cherry**

Hybrids between the sour and sweet cherry (*P. cerasus* x *P. avium*). A small or medium sized tree, intermediate between its parents, growing 10-20 m high, flowering in April-May. Hardy to zone 4 (-29°C). Fruits are large, like a heart cherry, generally sour.

- Edible fruit - usually cooked as they are sour. A number of cultivars (about 65) have been bred, often included in lists of 'sour' cherries. Cultivars bear fruits varying in quality from sour to sweet. Yields from Duke cherries are low, and only cultivars with early ripening fruit and a high sugar content are usually grown which receive a premium price at market.
- Timber - used for turnery.
- Selections from the Giessen series are being tested as cherry rootstocks.

***Prunus grayana* - Japanese bird cherry, Gray's bird cherry, Gray's chokeberry Japan**

A small tree, 5-7 m high in Japan but often smaller in cultivation. White flowers in June are followed by roundish pointed fruits, becoming black, 8 mm thick, with smooth stones. Hardy to zone 6 (21°C).

- Edible fruit - raw or cooked. Eaten young, salted in Japan with salted flower buds.
- Edible flower buds - though not recommended seeing as leaves are insecticidal!
- Leaves have an insecticidal effect against fruit flies (*Drosophila* sp.).
- The timber is hard and used for printing blocks, engraving, turnery, handles, furniture, utensils.

***Prunus humilis* - Bunge cherry - N. China**

An upright shrub to 1.5 m high found on dry sunny mountain slopes. Whitish-pink flowers appear with the foliage on the previous year's wood in April-May, and are followed by nearly round, bright red fruits, 12-15 mm thick. Notable for being moderately resistant to honey fungus (*Armillaria* spp). Hardy to zone 5 (23°C). Sometimes included with the plums rather than the cherries.

- Edible fruits - somewhat acid and sour, usually cooked. Cultivated in N. China for its fruits.

***Prunus incana* - Willow cherry - SE. Europe, W. Asia**

A small open shrub, 1.5-2 m high, loose and upright growing. Bright pink flowers, appearing with the foliage in late April, are occasionally followed by round, red, pea-sized (8 mm) fruits. Hardy to zone 6 (21°C).

- Edible fruit - raw or cooked.

***Prunus incisa* - Fuji cherry - Japan**

A round-crowned shrub or sometimes a small tree, to 3-5 m high or more. White flowers in late March-April are occasionally followed by oval, purple-black fruits, 6-8 mm long. Cultivated as an ornamental bush in Japan. Hardy to zone 6 (-21°C), moderately resistant to bacterial canker.

- Edible fruit - raw or cooked.
- Can be used for hedging.
- Selections are used as a dwarfing cherry rootstock.

***Prunus japonica* - Flowering almond, Chinese bush cherry, Japanese bush cherry, Korean bush cherry - C. China, E. Asia**

A small, finely-branched shrub, 1-1.5 m high. Whitish-pink flowers appear with the leaves in April-May, and are occasionally followed by roundish, wine-red fruits, 8-13 mm thick, with doubly-pointed stones. Hardy to zone 4 (-29°C) but subject to die-back in the UK. Notable for tolerating seasonal flooding. The natural variety *nakai* is a smaller shrub, only 50 cm high, with large, plum-like fruits up to 5 cm in diameter.

- Edible fruit - usually cooked, variable quality. Those from the *nakai* variety are sweet with a cherry flavour. A number of cultivars were bred and released in the early 1900's in the USA.
- Leaves have an insecticidal effect against fruit flies (*Drosophila hydei*).
- The leaves, seed kernels and roots are all used in Chinese medicine.

Prunus japonica* x *P. besseyi

- Edible fruit. A number of cultivars were bred and released in the early 1900's in the USA.

***Prunus maackii* - Amur cherry, Manchurian cherry - Korea, Manchuria**

A broadly conical tree to 10 m high with highly ornamental brownish yellow peeling bark. White flowers, on older wood, in April are followed by small, black, round fruits, 5 mm thick. Extremely hardy, to zone 2 (-40°C).

- The bark & flowers are insecticidal against mosquitoes (*Aedes punctor*) and bed bugs (*Cimex lectularus*).

***Prunus mahaleb* - St Lucie cherry, Mahaleb cherry, Perfumed cherry - Europe, W. Asia**

Upright to spreading, fast growing small trees to 10-12 m high, often bushy, found growing wild on gravelly, well-drained, infertile soils throughout central Europe and Asia. Grow 5-7 m high in cultivation. White fragrant flowers in May are followed by 6-7 mm black or yellow fruits with red-black astringent flesh, ripening in July. Hardy to zone 6 (-21°C), moderately resistant to bacterial canker.

- Edible fruit - usually cooked.
- Edible leaves - used for flavouring.
- Edible seed kernels - cooked; use with care.
- The seeds have been used medicinally as a tonic.
- Various selections have been made for use as sour and sweet cherry rootstocks on calcareous droughty soils.
- The hard, aromatic, brown-veined wood is used for turnery, cabinet making and to make pipe stems.
- Used in forestry in Germany and E. Europe, in reforestation projects and windbreaks.

***Prunus maximowiczii* - Miyana cherry - N. China, Japan, Korea**

A small, dense-headed tree to about 7 m high, sometimes more. Creamy-white flowers appear in May, after the foliage, and are followed by small, roundish reddish-black fruits, 5 mm across, which ripen in August. Hardy to zone 5 (-23°C).

Edible fruit - raw or cooked, but very small.

Edible flowers - used in preserves.

The timber is hard, close grained, very heavy; used for furniture, utensils, sculptures.

***Prunus microcarpa* - Asia minor**

A variable species, shrubby to 1-2.5 m high, densely branched. Whitish-pink flowers in April are followed by dark red or yellow fruits, 10-12 mm long. Hardy to zone 5 (23°C), likes a hot dry location.

- Edible fruit - raw or cooked. Some doubt about this one.

***Prunus mugus* - Tibetan cherry - W. China**

A low compact shrub, 90-180 cm high. Pink flowers are followed by dark red fruits.

Selections are being tested as very dwarfing cherry rootstocks.

***Prunus nipponica* - Japanese alpine cherry - Japan**

A tall open shrub to 5 m high. White flowers in April-May are followed by round, purple black fruits, 8 mm thick. Hardy to zone 6 (-21°C).

- Edible fruit - raw or cooked.

***Prunus padus* - Bird cherry - Europe, Asia**

A medium sized tree to 15 m high with a dense crown and somewhat nodding branches.

White fragrant flowers appear in April-May, after the foliage, and are followed by round, pea sized, black fruits, bitter and acid. Hardy to zone 4 (-29°C). Very tolerant of shade. The

seeds are poisonous.

- Edible fruit - cooked: variable quality, usually bitter.
- Young leaves have been eaten cooked, and the bark used in tea but these are not recommended (see below).
- Edible flowers.
- The whole plant is insecticidal against flies, lice and midges; the bark, shoots and leaves are insecticidal against fruit flies (*Drosophila* sp.), mosquitoes, ticks, and house flies (*Musca domestica*).
- Bark & shoots have been used medicinally. The bark is diuretic, sedative, a mild pain-killer and alleviates fever; it is cut when the tree is in flower and dried in the shade. Caution - poisonous.
- Bark can be used for dyeing: gives yellowish brown with alum mordant.
- Bee plant: Source of nectar and pollen for honey and bumble bees in May.
- Used in forestry for screen plantings and reforestation projects. Timber is used for furniture, shipbuilding, joinery. The young stems are tough and have been used in the past for cooperage rings.

***Prunus pennsylvanica* - Wild red cherry, Pin cherry - Canada, USA**

A fast-growing large shrub or small tree varying from 4-12 m tall. White flowers appear with the foliage in May, and are followed by round, red, 6 mm fruits, ripening July-September. Extremely hardy, to zone 2 (-39°C.)

- Edible fruit- cooked: usually sour with thin flesh.
- Edible gum exudation from trunk.
- Inner bark used medicinally.
- Bee plant in May.
- Wood is used for turnery.
- Used in reforestation as a soil stabiliser, especially on burnt land.

***Prunus prostrata* - Rock cherry, Mountain cherry - Mediterranean, W. Asia**

A variable prostrate or small, spreading, gnarled shrub only growing 50-100 cm high, found in



P. pennsylvanica (from Krussmann)

the mountains of the Mediterranean region. It bears pink flowers in May which are followed by roundish black-red fruits, 8-12 mm thick. Hardy to zone 6 (-21°C.) Likes a hot dry position.

- Edible fruits - poor quality.

***Prunus pseudocerasus* - Chinese sour cherry, Bastard cherry, False cherry - N. China**

A variable small tree or shrub 2.5-8 m high resembling the sour cherry, *P. cerasus*. Pinkish white flowers appear before or with the foliage in March and are followed by oval, yellowish red fruits, 15 mm long and somewhat sweet, ripening early - in June. Hardy to zone 6 (-21°C). Propagates well from cuttings.

- Edible fruits - quite sweet. The fruits are of some economic importance in N. China. In Victorian times, plants were 'forced' in pots in glasshouses for early fruit production in Britain.
- Edible flowers - salted and used in tea.

***Prunus rufa* - Himalayan cherry - Himalayas**

A small wide tree to 6-7 m high with ornamental bark. White to pale pink flowers in May are followed by ellipsoid, dark red fleshy fruits. Hardy to zone 8 (-12°C.)

- Edible fruit - raw or cooked.

***Prunus sargentii* - Sargent cherry - Japan**

A tall, broad upright tree, 15-18 m high with ornamental reddish bark. The pink flowers appear in April before the leaves, and are followed by oval-oblong, glossy dark red fruits, 1 cm long. Very colourful leaves in autumn. Hardy to zone 5 (-23°C.)

- Edible fruit - raw or cooked.
- Bee plant: Source of nectar and pollen for honey and bumble bees in March-April.
- Used in forestry for erosion control. Timber is used for turnery and furniture.

Prunus x schmittii

A hybrid of *P. avium* x *P. canescens*, intermediate between its parents but nearer *P. canescens*. A small to medium tree with a narrow upright habit and ornamental bark.

- Edible fruits.

***Prunus serotina* - Ram cherry, Black cherry, Wild black cherry - Canada, USA**

A large forest tree, growing to 35 m high in its native habitat, rather less in cultivation - small to medium in Britain. White flowers in late May-June are followed by egg-shaped fruits, 8-10 mm thick, dark purple, bitter, ripening in August-September. Hardy to zone 4 (-29°C.) Flowers and fruits well in Britain.

• Edible fruit - usually cooked: variable, can be sweet or bitter, sometimes with a vinous flavour. Good cooker and made into cider. A number of cultivars were bred and released in the early 1900's in the USA.

- The shoots are used to make a tea.
- A bark extract is used commercially to flavour soft drinks, sweets etc.
- The root bark and shoots have been used medicinally.
- A reddish-purple dye is obtained from the roots with an alum mordant.
- Bee plant in May-June.
- An important forestry species in Central Europe and North America. The timber is valuable, used for cabinet making, musical and scientific instruments, and joinery.

***Prunus serrula* - Birch bark cherry, Tibetan cherry China**

A vigorous small tree or multi-stemmed shrub, growing 7-12 m high, with highly ornamental glossy older bark. White flowers appear with the foliage in April-May, and are followed by red oval fruits, 6-12 mm long. Hardy to zone 6 (-21°C.)

- Edible fruit.
- Occasionally used as a rootstock.

***Prunus serrulata* - Chinese mountain cherry, Japanese mountain cherry, Japanese flowering cherry - Japan, China, Korea**

A shrub or very small tree, reaching 2-3 m high with pure white flowers opening with the foliage in April-May, followed by round, dark reddish-black fruits, 7 mm thick. Hardy to zone 6 (-21°C), moderately resistant to bacterial canker. Many of the ornamental Japanese flowering cherries belong here.

- Edible fruits (6-8 mm across). Not borne on many ornamental cultivars.
- Edible flowers - pickled in salt in Japan.
- Bee plant.
- Used for erosion control in forestry.
- Selections can be used as cherry rootstocks.

***Prunus speciosa* - Oshima cherry - Japan**

An open-crowned small tree, to 10-12 m high. White flowers appear with the foliage in

April. Many of the ornamental Japanese flowering cherries belong here.

- Much used in Japan as a rootstock.
- Timber is used for furniture and turnery.

***Prunus ssiori* - NE. Asia, Japan**

A small tree to 10m high (larger in Japan) with a broad crown. White flowers appear before the foliage, and are followed by flattish-round fruits, 1 cm thick, eventually black. Hardy to zone 5 (-23°C.)

- Edible fruit - raw or cooked.
- The wood is heavy, hard, strong, close grained, durable; used for shafts, utensils, engraving.



P. serotina (from Krussman)

***Prunus subhirtella* - Higan cherry, Rosebud cherry, Spring cherry - Japan**

A large shrub or small forking tree (much larger in Japan). Pinkish-white flowers appear in April before the leaves, and are followed by oval-rounded fruits, purplish-black, 9 mm long. Hardy to zone 6 (-21°C.) Valued as an ornamental in Japan.

- Edible fruit - raw or cooked: poor quality.
- Edible flowers - salted and used in tea.
- Bee plant: Source of nectar and pollen for honey and bumble bees in April.
- Selections are under trial for use as cherry rootstocks.

***Prunus tomentosa* - Nanking cherry, Manchu bush cherry, Downy cherry, Korean cherry - China, Japan, Himalayas**

A dense spreading shrub usually 1-1.5 m high (sometimes double) with numerous branches and many suckers. White flowers appear with the foliage in March-April, and are followed by roundish fruits, yellowish pink to dark red, 1 cm thick, slightly hairy, varying in weight from 1 to 4.6 g, ripening in July. Well adapted to cold areas - hardy to zone 3 (-31°C.) Susceptible to honey fungus (*Armillaria* spp), Crown gall, bacterial canker and plum pox.

• Edible fruit: sweet or sub-acid, juicy. The unripe fruits can be pickled. A number of cultivars were bred and released in the early 1900's in the USA, including 'Baton Rouge', 'Drilea', 'Eileen', 'Monroe', 'Orient' and 'Slate'; there have been many breeding programmes in Russia, and recent Russian releases include the good flavoured and large-fruited (15 mm) 'Alisa', 'Chereshnevaya', 'Detskaya', 'Natali', 'Okeanskaya', 'Smuglyanka' and 'Vostochnaya'. Most seedlings produce tasty fruit.

- Used as a windbreak in the severe climates of C. USA.
- Occasionally used as a dwarfing peach rootstock, although it induces small fruit size.



P. tomentosa (from Krussman)

Prunus tomentosa* x *P. besseyi

Extremely hardy hybrids, hardy to zone 3 (-37°C.)

- Edible fruit. A number of cultivars were bred and released in the early 1900's in the USA
- Occasionally used as a dwarfing peach rootstock.

***Prunus virens* - USA**

A semi-evergreen shrub or small tree. Fruits are purplish-black.

- Edible fruits - raw or cooked: bittersweet.

***Prunus virginiana* - Chokecherry, Virginian bird cherry - Canada, USA**

A suckering shrub or small tree. White flowers appear before the foliage in late May-June, and are followed by round, reddish purple fruits, 1 cm thick, ripening July-October. Very hardy, to zone 2 (-40°C), moderately resistant to bacterial canker. The natural variety

demissa is more shrubby, to 1-3 m high; *melanocarpa* bears nearly black, bitter fruits. Fruits only moderately well in Britain.

- Edible fruit - bittersweet: usually cooked. Can be eaten raw if dried. The cultivar 'Johnson' has larger and sweeter fruits.
- Twigs & bark used to make a tea.
- Edible kernels - care should be taken.
- Bark has been used medicinally.
- Dyes are obtained from the fruit, shoots, and leaves: shoots & leaves give fast dyes, gold with alum mordant, chestnut brown with chrome, dark gold with copper, orange with tin,



P. virginiana var *demissa* (from Krussman)

olive green with iron, tan with no mordant; fruits give fading dyes, pinkish-tan with alum, olive green with chrome, tan with copper, light olive with tin, grey-green with iron, pink-beige with no mordant. The inner bark gives a green dye in spring.

- Bee plant in May-June.
- Used in forestry in the USA for erosion control.
- The wood is close-grained, strong, hard, heavy; used for skewers etc.

***Prunus* x *yedoensis* - Tokyo cherry, Yoshino cherry - Japan**

Hybrids of unknown origin, making small to medium rounded trees, 12-15 m high. Pinkish white flowers in late March-April are followed by round, black, 1 cm fruits. Hardy to zone 6 (-21°C.)

- Edible fruit - raw or cooked.
- Good bee plant: Source of nectar and pollen for honey and bumble bees in April.
- A selection is under trial as a cherry rootstock.

Numerous hybrids have been bred, and are continuing to be bred, selected and tested throughout the world. These include selections of the following crosses:

Prunus avium x *P.pseudocerasus* - The 'Colt' cherry rootstock is of this parentage, resistant to bacterial canker.

Prunus canescens x *P. avium* - Includes a Giessen clone.

Prunus canescens x *P. cerasus* - Several Giessen clones

Prunus cerasus x *P. canescens* - Several Giessen clones.

Prunus fruticosa x *P. avium* - Includes some Giessen clones.

Prunus fruticosa x *P. cerasus* - Includes 'Oppenheim' and some Giessen clones.

Prunus incisa x *P. serrula* - Includes the 'GM9' rootstock.

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PRUNING TAMARILLOS - INFLUENCING YIELD, FRUIT SIZE AND SEASON OF MATURITY

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Tamarillos are small, shrubby trees that fruit on current season's growth. The yield, fruit size and season of maturity can all be readily manipulated by the time and severity of pruning.

The results outlined in this article come from an unpublished pruning trial conducted by Drs Greg Pringle, Kevin Patterson and Grant Thorp (now of HortResearch) in Kerikeri during the early 1980s, and are used with their permission.

The basic pruning strategy for tamarillos is to maintain a sturdy framework with new growth originating from the previous season's wood.

This sturdy framework is important due to the brittle nature of tamarillo wood. Compact, sturdy trees are less prone to breakage than leggy trees, and they can also be picked satisfactorily from the ground.

It is also important to cut back into the previous season's wood when pruning, as cutting into older wood gives a much more variable response, usually being comparatively unfruitful. It is normal practice to remove dead or broken branches at the annual spring pruning.

The time of pruning influences the time at which the following season's crop will mature. After pruning, there is a period when it appears as if nothing is happening before the new growth starts. This period is a little longer under the lower temperatures that generally prevail in early spring as compared to those likely to be experienced some



Plate 1: Moderately pruned tamarillo in a Katikati orchard

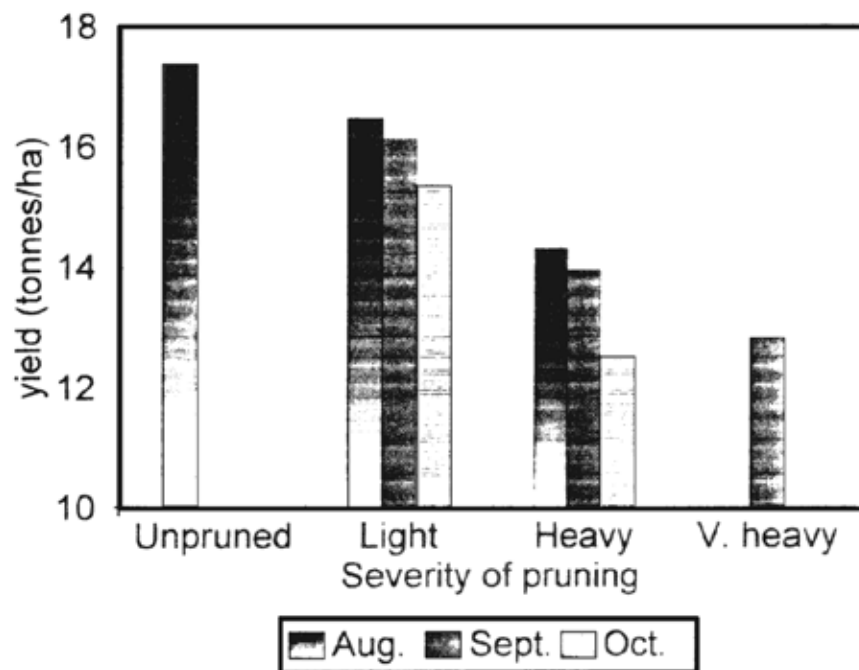
weeks later in mid to late spring. However, as new season's flowers are produced on new season's growth, the new growth must occur before flowers are produced, and this is influenced by the time of pruning.

It takes approximately 20-26 weeks from fruit set to maturity, so the earlier the fruit is set, the earlier the harvesting season is likely to be. So early season pruning leads to an early harvesting season and late pruning leads to a late harvesting season (Figure 4).

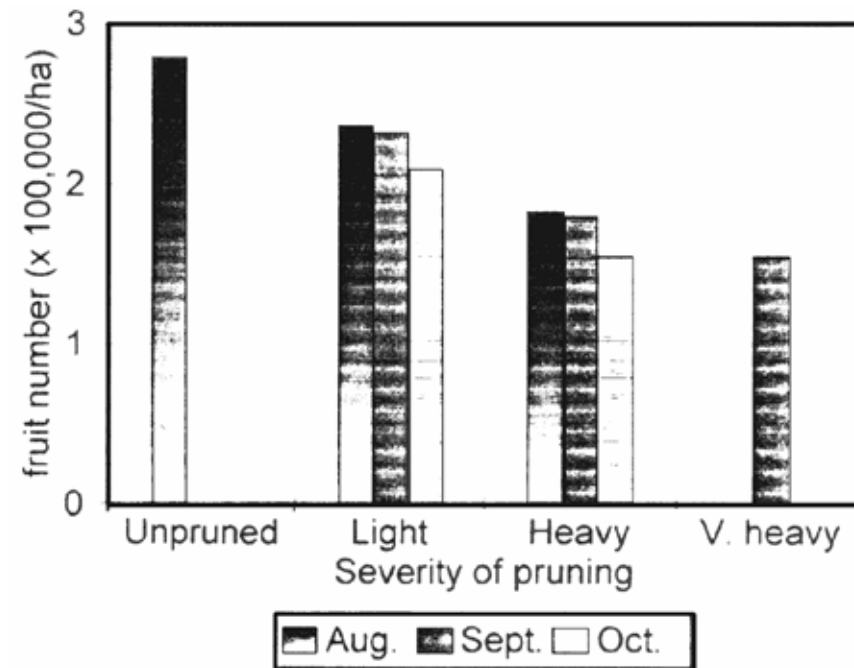
The severity of pruning influences the potential yield, fruit size and season of maturity. A general principle of pruning is that the harder the cut, the more vigorous the vegetative response is likely to be.

The heaviest and earliest crops will be produced by unpruned trees (see Figure 1). Light pruning gives rise to weak regrowth that branches and sets flowers quickly and in turn leads to reasonably heavy and early maturing crops.

Hard pruning, on the other hand, gives rise to more vigorous regrowth, provided the tree is not cut back to old wood. Some of these regrowths may be so vigorous they need to be pinched out at the appropriate height to cause branching and flower production in a tree manageable from the ground. Such vigorous regrowth takes longer to reach the stage where flowers are produced and so has the tendency to delay the harvest season, as compared to more moderate pruning.



1. Total yield from mature tamarillo trees with pruning to different degrees and at different times (August 1, September 8 and October 15).



2. Fruit numbers from mature tamarillo trees under the same set of pruning regimes.

Fruit size is also affected by the severity of pruning (Figure 3). Unpruned trees produce many fruit on weak multi-branches shoots and this gives the potential for high fruit numbers at the expense of fruit size.

At the other end of the scale, hard pruning leads to a small number of more vigorous and substantial shoots which tend to produce lower numbers of large fruit. Moderate pruning comes somewhere in between. The response to pruning in fruit size is, of course, limited by the genetics of the tree. It is not possible to get very large fruit from a small fruited variety simply by hard pruning. They can only be as big as their genetics dictate.

Water shoots have thick green stems with long internodes. They tend to originate either from the main trunk or from deep within the canopy. They bear few fruit and only serve to direct the plant's resources away from the remaining crop. As such, they should be pruned out completely as they arise during the growing season.

Time and severity of pruning can then be used as a means of manipulating the yield and season of the crop as well as fruit size.

There may be many reasons for a grower wishing to manipulate the crop towards early or late harvesting, and towards a smaller or larger fruit size. Each individual case must be judged on its own merits and treated accordingly.

These variations in pruning can be used to get a comparatively steady, but very long harvesting season from April to November by pruning different blocks over an extended period of time from early spring to early summer. They could also be used to get either an early or late crop for economic, management or other reasons.

Returns for tamarillos, like other seasonal crops, tend to be highest when supplies are short at the beginning or end of the season. So an early harvest, where a significant percentage of the crop is harvested by the end of May, can be worthwhile. However, to get the most out of a very early season crop requires a lot of time in select picking the earliest fruit to get them onto the market as early as possible.

Over the years, it has been noted that returns from the New Zealand market tend to be at their lowest in June through to August, when supplies are normally heaviest. From September onwards, prices can be expected to rise as supplies dwindle.

On the New Zealand market, large fruit will normally get a better return than medium or small fruit. However, with the high returns early in the season, earliness could be expected to be more important than fruit size at the very start of the season.

Export requirements seem to be for a reasonable, medium-sized fruit, rather than the very largest. This must be taken into the equation by growers producing for export.



Plate 2. Moderately pruned tamarillo in a Tauranga orchard showing the quantity of growth removed.



Plate 3. The response to hard pruning is vigorous growth with a moderate number of large-sized fruit.

It is always a good policy to keep in touch with the chosen exporter over the specifications required, including fruit size, and if necessary adjust the orchard management to meet them.

On sites with a greater risk of getting a winter frost, it would be desirable to have most of the fruit off early, before the high risk period in June and July.

It may also be that tamarillos have to be worked into a mixed orchard calendar and manipulating the harvest time to suit is a worthwhile practice. Where a grower deals with a lot of kiwifruit harvesting from sometime in April to early June, an early tamarillo crop would be a complication, as it could also be for growers producing a

significant quantity of feijoas or passionfruit. Conversely, with satsuma and Clementine mandarins that can run on through into August, it would be more convenient to get the tamarillos in early and be well through their season before the mandarins get into full swing.

Yield, fruit number, fruit size and season of maturity of tamarillos are all affected by the timing and severity of pruning. The earliest and heaviest yields of the smallest fruit are produced on unpruned trees. The largest and latest maturing fruit are produced by pruning hard and late. There are no overall recommendations, but each grower can take this basic information and use it how it best fits into the overall management of the orchard.

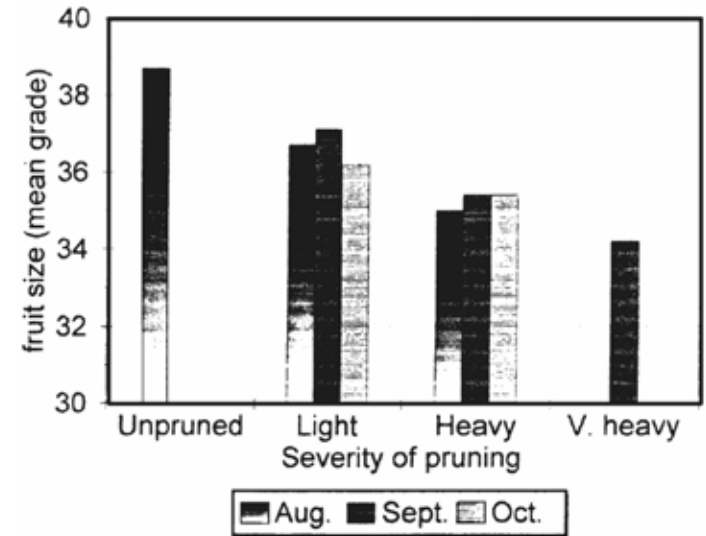


Fig. 3. Mean fruit size from mature tamarillo trees under various pruning regimes. Note that higher grades equate to smaller fruit; the very heavy pruning treatment had the largest fruit.

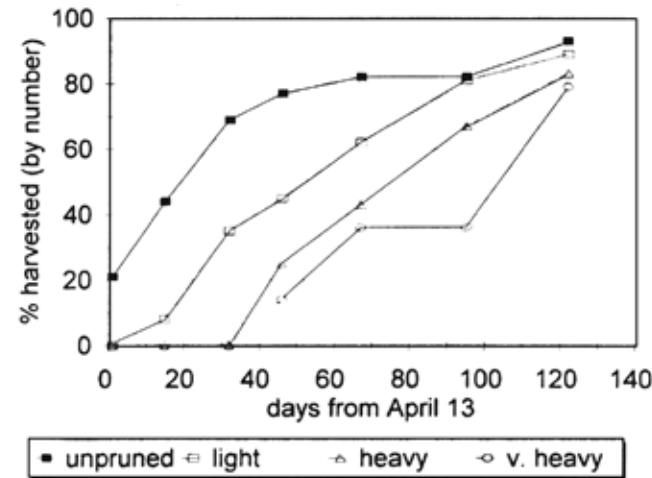


Fig. 4. Cumulative progression of harvest season from September pruned trees with different degrees of pruning. The last harvest (day 122) corresponds to August 13.

Based on an article in the August 1996 issue of 'The Orchardist', magazine of the New Zealand Fruitgrowers Federation (PO Box 2175, Wellington, New Zealand).

COCOCUMBE - THE RETURN TO NEW ZEALAND OF A LONG LOST PALM?

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Long ago in the mists of time, New Zealand was a much warmer place than it is today. Warm subtropical waters lapped its shores. Even coconuts lapped its beaches, coconuts with a difference. Fossil 'coconuts' the size of walnuts have been washed up on Coopers Beach, Northland, dislodged from submerged lignite and sandstone layers reputed to have been laid down more than ten million years ago. On closer examination these fossilised nuts carry the characteristics of all coccoid palms still present in our day - the three eyes so typical of the coconuts.

What makes the seeds even more interesting to us now is the fact that a recently introduced coccoid palm from Ecuador carries almost identical seeds, both in size and appearance. Botanically known as *Parajubaea cocoides* it occurs only in high altitude regions of Ecuador and Southern Colombia in a climate zone which, although near the equator, is very similar to our climate in northern New Zealand. Ecuador shares other plant genera with New Zealand, notably *Dodonea* and *Podocarpus*. Is it possible that a very closely related coccoid palm once adorned our native forest in New Zealand?

Seeds of the *Parajubaea cocoides*, known in Ecuador as Cococumbe, were first introduced into New Zealand by the writer during the mid-seventies. Notoriously difficult to germinate, these first few seeds resulted in only one seedling which today is the first palm of its kind to bear its own seeds in this country. A notable occasion, perhaps, as these seeds are the first to germinate in New Zealand after a break of at least two million years. It must be said, however, that the Ecuadorean palm is not likely to be identical to its ancient New Zealand counterpart.

The Cococumbe palm in New Zealand

It is now almost twenty years since those first seeds were introduced to New Zealand. For me the challenge was to propagate this palm, which grows very well here. When it comes to propagation we were faced with the problem of lack of germination of expensive imported seeds. The only source of these seeds has been from Ecuador, and although only a few of those imported have germinated, there are a small number of Cococumbe growing in various parts of New Zealand. At Landsendt we have about thirty, which are more than eight years old and planted in the field. Invariably they have grown fast, the oldest and tallest having a three metre trunk.

The Cococumbe bears a close resemblance to the tropical coconut, its graceful arching fronds and shiny leaves making it an outstanding addition to the range of palms in New Zealand.

land. Recent intensive efforts to propagate the Cococumbe have met with limited success, and three year old Cococumbe seedlings will be released from our nursery for the first time this year.

Seeds are never very easy to come by due to the popularity of the nuts for consumption. It is becoming more and more difficult to obtain seeds from Ecuador due to recent restrictions in the trade of plant products from most Andean countries. At this stage, the value of the palms already in New Zealand is more for the production of seeds rather than for ornamental purposes. It will not be until our own seeds become available that increased production of this palm species will become a reality. That will not be before the turn of the century.

A brief description of the genus *Parajubaea*

This group of palms is native to isolated parts of South America. Found growing native only in the high inter-Andean valleys in Bolivia, a separate species occurs in the highlands of Ecuador and Southern Colombia. In Ecuador *Parajubaea* has never been observed in the wild. Many palms of this genus are planted in the highland cities and farms for ornamental purposes, and no doubt for the usefulness of the edible nuts and the fibres surrounding the slender trunks.

Recent botanical studies have determined that three species of *Parajubaea* occur in South America. All species are tall growing, have large pinnate leaves with leaflets shiny green above and silvery beneath, and branched interfoliar inflorescences. Seeds are coconut-like, with thick hard shells usually carrying one or two seed kernels, in some cases as many as three kernels may be present.

Parajubaea cocoides from Ecuador closely resembles the tropical coconut, while the Bolivian species seems to be more similar to the Chilean wine palm, *Jubaea chilensis*, mainly due to the thick trunks the latter have.

Parajubaea cocoides

This graceful palm is only found in Ecuador and Southern Colombia and is the most beautiful of the three species of *Parajubaea*. It has a tall slender trunk, densely covered



Mountain Coconut, Parajubaea cocoides, mature specimen carrying fruit. Photo: Dick Endt

in fibrous mats when young, but cast off as the palm matures. The conspicuous peduncle emerges erect, arching over well away from the trunk of the palm. Seeds are numerous, contained in peach-sized fibrous husks. It occurs at high altitude at an elevation between 2500 and 3000 m asl. Here the climate is cool with light frosts only, generally dry and low relative humidity, heavy showers often happen during late afternoon. The palm tolerates frost to -4 °C, beyond which damage to foliage occurs. Seeds of the *Cococumbe* average 5 cm by 3.5 cm in diameter.

Parajubaea torallyi* Var. *microcarpa

Parajubaea torallyi* Var. *torallyi

Two varieties have been identified in two separate populations of this palm in Bolivia. Although the palms themselves appear very similar, the main features of identification are the different sizes of the nuts. The palms themselves grow taller, their trunks more robust, compared to *P. cocoides*. The crown of leaves is often 'untidy' and lacks the graceful shape of *P. cocoides*. These palms occur naturally in the Southwest of Bolivia, on steep hillsides at an elevation of 2000 to 3400 m asl.

Very few of these palms are planted as ornamentals, one exception being the two rows of *Parajubaea torallyi* Var. *microcarpa* planted at the Botanic Gardens in Cochabamba, Bolivia. The nuts are only small, no larger than 3 cm by 2.5 cm in diameter. I did not observe *Parajubaea torallyi* var. *torallyi* myself, but photographs indicate this palm grows very tall, with a trunk almost as thick as the Chilean wine palm, *Jubaea chilensis*. The leaves are very upright and dense. In Cochabamba the raw kernels cracked from the hard shell are offered for sale in the markets, obviously for consumption. The nuts of var. *torallyi* are the largest in the genus, 6 cm by 4 cm. The shell is grooved and has three wing-like protrusions rather like the fins on a rocket.

Parajubaea sunkha

The third species of *Parajubaea* is known only in a few isolated valleys in an area known as Valle Grande in central/south Bolivia at a lower elevation than *P. torallyi* (1700-2000 m). These palms are more slender in their trunks and of smaller stature than *P. torallyi* with seeds very similar to *P. torallyi* var. *microcarpa*. This palm is intensively utilised for the making of fibre objects such as ropes, baskets and mattresses. Leaves too are utilised for baskets etc. Although this harvesting does not destroy the palms it does prevent the formation of flowers and fruits. Because of this there is little chance of regeneration and hence this palm is now considered endangered.

A feature of all Bolivian *Parajubaea* different to *P. cocoides* is the relatively small, strongly recurved peduncle. The seeds are placed close to the trunk of the palm. *P. cocoides* has the seedhead well spaced out away from the trunk.

In New Zealand by far the most numerous palms of the genus *Parajubaea* are *P. cocoides*. A small number of *P. torallyi* have been imported over the last ten years or so, the identity of which is not certain.

Based on an article in the June 1997 issue of the New Zealand Tree Crops Association magazine 'The Tree Cropper'. It first appeared in the newsletter of the New Zealand Palm and Cycad Society.

LYCHEE AND LONGAN BECOME MAJOR INDUSTRY IN AUSTRALIA

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For years, Australians knew the lychee (*Litchi chinensis*) as a tinned fruit commonly served in Chinese restaurants. But now, not only are locally grown lychees readily available as fresh fruit in Australia, the crop is becoming a major export earner.

Lychees, longans (*Dimocarpus longan*) and rambutans (*Nephelium lappaceum*) all belong to the Sapindaceae family. Natives of subtropical southern China and Vietnam, lychees and longans grow best from 17-32° latitude, while rambutans are found in the more tropical Malay peninsula.

Many Australians are probably not familiar with the longan, but in Asia, longans comprise a larger share of the market than lychees. The longan has a unique taste and texture - a taste so euphoric that botanists initially named it *Euphoria longan*. Where the lychee has a red skin, the longan is a yellowy-green to brown colour. The fruits of both crops have an aril (fleshy seed coat) of translucent, firm flesh around a smooth black inedible seed.

In Asia, a crisp, sweet flesh and a small seed are regarded as marks of quality. Varieties with small seeds (called 'chicken-tongue' by the Chinese) have the best flesh to seed ratio and so fetch the highest prices. Fruit of lychee and longan ripen on the tree and are best eaten as soon as possible after harvest before they discolour.

World production of lychees exceeds 400,000 tonnes annually, grown mainly in China and India. Of this harvest, much is processed and tinned. The internal market with southern China and northern Indochina is estimated at 300,000 tonnes, but production is seasonal. Australia produces fruit in the northern hemisphere off season, and export prices are highest in January when many Chinese families traditionally give gifts in the month before the Chinese New Year.

The market for southern hemisphere produce among the growing number of affluent consumers in China and South East Asia appears limitless. However, lychees are a specialty item and fruit has to be of the highest quality to command the best price and to ensure repeat sales.

Lychees in Australia

Total production of lychees in Australia is just a drop in the Asian ocean; we now produce some 3000 tonnes of fruit (worth \$15 million); production has increased five-fold over the past five years.

The number of lychee growers is estimated at about 300, with roughly a third in north Queensland, a third in central Queensland, and the remainder in southern Queensland and northern New South Wales. Many north Queensland growers are based around Mareeba on the Atherton Tablelands behind Cairns, a district once famous for its tobacco growing, but rapidly branching into fruit orchards since deregulation of that industry. As with many other fruit crops, the first fruit to reach the market come from the north, beginning in November and fetching the highest prices, and supply then extends southwards with the final harvests from Lismore and Coffs Harbour in March.

Over the years, Australia has introduced about 50

accessions of lychee, with some varieties chosen more for their ease of propagation than for fruit quality. Four varieties now dominate: Tai So, with 40 per cent of production, has large fruit but tends to a less attractive brown skin colour; Kwai Mai Pink (25%) attracts a 20-30

per cent price premium due to its higher flesh to seed ratio; Bengal (15%) is a large-seeded variety; Wai Chee has 10 per cent of production while the remaining 10 per cent comprises a mixture of varieties including the promising small-seeded Salathiel - a local selection from one old lychee tree on a property near Cairns.

The major problem for Lychees growers has been inconsistent yield - some years few trees flower, and sometimes flowering occurs but fruit fail to set. Researchers internationally have blamed poor fruit set on many causes, among them: too few bees; lack of cross pollination between varieties; and too much dry weather.



Lychees, like other subtropical fruit, need a period of cool weather to induce flowering. If the leaves of the plant are cooled (15-20°C) when new buds start to grow, the shoot is all floral (above); if buds are between 2 and 3 mm long, the new shoot is part floral, part vegetative (left); if buds are over 3 mm, the new shoot is all vegetative (below)



Day temperatures below 20°C are required to cause flowering, and it was thought that the terminal branch buds that give rise to flowers had to be dormant during this time. This belief was based on the observation that trees entering the winter in full growth flush failed to flower, whereas those not flushing tended to flower well. As a result, growers were advised to make every effort to make their trees dormant, for example by reducing fertilisation and withholding irrigation. Unfortunately, successful fruit production did not follow.

Research explodes myths

The Australian Lychee Growers Association, with funding from the Rural Industries Research and Development Corporation, called in researchers from NSW Agriculture, CSIRO Division of Horticulture and the Queensland Department of Primary Industries to help solve the problem.

Using potted plants in controlled environment chambers and field experiments, the scientists set about investigating the alleged causes of poor fruit set, and soon exposed many as myths.

They found that bees are not essential for fruit set, but do help. Generally Lychees pollen supply and individual pollen grain longevity do not limit fertilisation of the female flowers, which are themselves generally unaffected by the weather conditions that prevail during flowering in the major growing regions. Lychees are responsive to cross pollination, but do not need mixed varieties for successful cropping, and neither dry weather nor water stress induce flowering.

However, poor fruit set can be due to flower infertility, presumably due to unfavourable conditions prior to flowering, while prolonged high temperatures (above 30°C) may increase fruit drop. Provided the trees have adequate nutrition, they do not generally respond to strategically timed fertiliser application.

Irrigation experiments showed that six weeks without rain during flowering and early fruit development, on soils of reasonable water-holding capacity, had no detrimental effect, as the trees can tap soil moisture to 1-2 metres depth. However, severe droughting during early fruit development can reduce fruit size and yield. Dry weather late in fruit development may actually increase production, possibly by redirecting nutrients that would otherwise go to producing new leaves.



The row of trees on the right were pruned in autumn to give a synchronized flush of new vegetative shoots. Unpruned trees on the left have spasmodic new growth.

Wet weather can cause problems; male and female flowers rapidly lose fertility if wetted, but only if they are open. Rain for one or two days is all right because new flowers open sequentially, over several days. Extended rainfall or repeated overhead irrigation during flowering could reduce fruit set. (Persistent rain is unlikely during flowering in the current production area.)

Growth and temperature

Lychee specialists, Dr Don Batten of NSW Agriculture, and Dr Cameron McConchie of the Division of Horticulture, found growth and temperature to be the most important factors for flowering with these subtropical species. However, contrary to earlier beliefs, they found that cool conditions trigger the growing, not the dormant, buds.

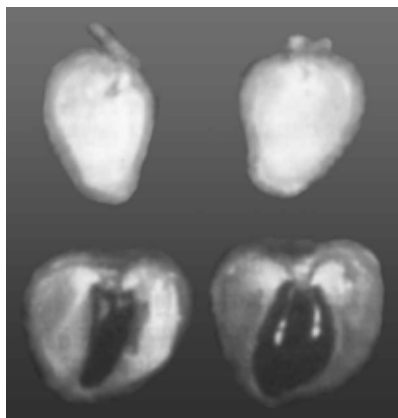
In experiments with potted plants in controlled environment chambers, the researchers forced plants to begin growth at high temperatures and then transferred them to a low temperature environment when buds were at various sizes. With low temperatures, small buds reliably produced flowers with no leaves, whereas larger buds produced progressively fewer flowers but more leaves at the base.

Low temperatures induce flowering for only a short time, from when the buds for a new flush start to swell, to when they are just a few millimetres in length. After this, new growth will be entirely vegetative. It only takes a couple of days of low temperature to trigger flowering.

The optimum temperature to induce flowering is between 15 and 20°C, whereas the optimum for vegetative growth is around 29°C. Fruit set is reduced if temperatures are consistently above 26°C or below 15°C, as the number or viability of the female flowers is reduced. Thus, the key to economic yields in commercial orchards is to induce flowering by getting the trees to begin growth just before or during cold weather. If growers could promote growth at the latest time that low temperatures are expected, they could reduce the likelihood of sterile flowers, as flower development would be delayed until the weather is warmer. These new insights are radically transforming the prospects for commercial lychee production.

Lychees grow by producing flushes of new reddish coloured leaves. The leaves of each flush have to harden before there can be another flush. Dr Batten showed that the pattern of flushing can be predicted because the period between flushes while the leaves harden depends largely on temperature. With this knowledge, bud growth can be synchronised to occur with cool conditions.

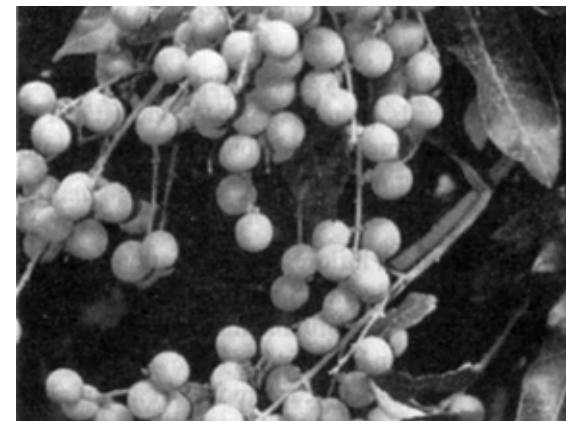
Growth normally occurs after harvest, but trees can be synchronised to begin growth again during winter - thus ensuring flowering. At the calculated date, trees are tip pruned with a hedging machine, stimulating buds in the axils of leaves immediately below the cut to produce a new flush. This new growth then hardens and the buds of the next flush form - by which time the weather is cold. The resulting new shoots develop into inflorescences full of



The best lychee fruit have small 'chicken tongue' seeds (left) and a higher ratio of flesh.

male and female flowers. However, if the weather is too warm during early bud formation, leaves, rather than flowers, form.

Tip-pruning is not the only method of regulating growth. Chinese researchers have developed methods using sprays of ethephon to kill or defoliate the shoot tips and restart growth. In Australia, this method could be used as a back-up if growers have been unable to prune at the right time. However, the concentration of ethephon is critical- too little is ineffective, too much will cause all the leaves to drop. The response depends on the weather and differs between varieties.



Longans - unique taste and texture

Pruned trees smaller

Strategic pruning has other benefits. Growth and yield depend on the reserves stored in the fruit-bearing branches and on the amount of photosynthesis in the leaves supporting the shoot. As excessive foliage causes shading of lower leaves, a pruned canopy allows all leaves to be exposed to sunlight and can increase yields.

Small trees are easier to net against birds, flying foxes, and fruit piercing moths, and to protect from hail. Pruned trees also need fewer pesticides and are easier and cheaper to harvest.

However, smaller trees mean wasted solar radiation and more weed growth unless they are planted closer together. Conventional lychee orchard spacing has been 6 x 6 or 6 x 8 metres, giving a density of 230-250 trees per hectare; densities for small trees may need to exceed 1000 per hectare, with a spacing of 4 x 2.5 metres at establishment, but with pruning and thinning as the trees grow to prevent overshadowing. Chinese researchers are investigating even closer spacings of 2 x 1 metres, similar to the mini-apple tree orchards.

Another advantage of small trees and closer spacing is the shorter time to first productive harvest after planting - an important factor in the economics of orchard establishment.

The researchers have planted experimental orchards with close spacing at Mareeba and Bundaberg in Queensland, and at Brooklet in northern New South Wales, to verify the models they have developed to calculate the correct timing for pruning according to latitude and local weather conditions.

The introduction of smaller trees brings a new problem. Traditionally, lychees have been propagated by air layering or marcotting. Marcotting is done by wrapping a small branch, which has had a ring of bark removed, in damp moss inside a plastic bag. Over the next three months roots develop in the ball of peatmoss, the branch is cut off and grown in a pot, and then planted in an orchard. Marcots require a lot of plant material and are too expensive for high density plantings.

Dr McConchie has shown that using rooting hormones (auxins) on cut leafy shoots in propagation beds, plantlets can be produced just as successfully and much faster. Each plant needs less plant material, although the rooted cuttings are smaller than marcotted plants, and may take an extra year to reach first harvest.

The longan

The patterns of inflorescence initiation and tip growth in the longan are similar to those of the lychee. While lychees have been the main crop in northern Australia so far, the longan may have an even more profitable future. During the northern hemisphere season, consumers eat more longans than lychees, but there are no major southern hemisphere producers. Longans tend to be biennial, but can produce yields of 60-100 kg/tree. The longan has an interesting flavour and different texture to lychee. It can fetch an equivalent price on export markets.

The Australian longan industry at present is small, at only three per cent of the weight of lychees in the Sydney market, but is expected to reach 25 per cent over the next three years.

With only a couple of commercial growers, production was negligible in 1990, but reached 200 tonnes (worth \$1.4 million) by 1994. More than 10,000 trees have been planted around the Dimbula-Mareeba area, and new orchards are being established. A major limit to more rapid expansion is the availability of planting material of the best cultivars. The QDPI predicts that Australian production will reach 1200 tonnes by 1997, rising to 2000 tonnes by the year 2000.

Further reading

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Based on an article in the Autumn 1997 issue of the CSIRO magazine 'Rural Research'

THE NUT INDUSTRIES OF RUSSIA (Part 2)

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Introduction

This is the second half of an article of which the first part, dealing with nut crops generally and with walnuts in particular, appeared in the 1996 WANATCA Yearbook.

Hazelnuts

Hazelnuts encompass various species belonging to the genus *Corylus*, from the family Betulaceae.

Wild species and cultivars produce nuts of great economic importance, as they contain up to 72% fat, 21 % protein and 6% carbohydrates, vitamins and micro elements. The total number of fatty acids in hazel oil is 15. On Galdich's classification, the hazel belongs to the first group because the nuts contain up to 80-90% unsaturated fatty oil and the quantitative ratio of fatty acids is similar to that in olive oil.

Hazel nuts will keep for 2 years or more. They are reckoned to be three times more costly than pome or stone fruits (Kovalenko, 1983).

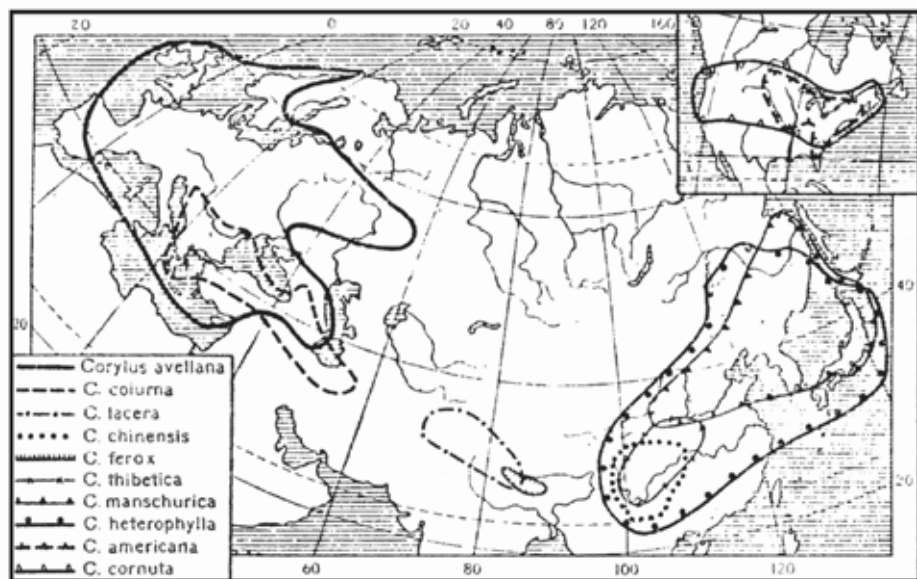
The kernel of hazel nuts contains 68-70% fat and 17-20% protein, while butter contains 82.5% and 10%, milk 4% and 3%, sunflower seed 44-65% and 21 %, soybean 21-23% and 41 %, peanut 54.5% and 25.8% respectively. In calorific value, the kernel surpasses wheat bread by 2-2.5 times and milk by 8-9 times (Tsuladze, Korablev 1980).

The bark of the hazel contains up to 8% and the leaves up to 10% tanning substances. The need for hazel nuts in the former Soviet Union was determined as 180,000 tonnes annually. In fact production covered only 15-20% of demand. The main commercial zone for hazel was in the Transcaucasus and in the Krasnodar region of Russia.

Within the former USSR, 7 species are grown in their natural habitats: the European hazel (*C. avellana* L.), the Turkish hazel (*C. colurna* L.), *C. heterophylla* Fisch, the Manchurian hazel (*C. manshurica* Max.), *C. breviflora* Kom., the Caucasian hazel (*C. pontica* K. Koch) and *C. colchica* Albov. (Pavlenko, 1978).

Shrub type species and cultivars of hazel begin producing fruit in the 5th - 8th year after sowing and in the 3rd to 4th year after grafting. The Turkish hazel and its tree-type hybrids begin bearing fruit only in the 11th - 17th year.

§ Member, WANATCA



Distribution of hazelnut species, *Corylus L.*

The European hazel is a tall shrub 8 metres high (sometimes up to 12 metres). The nuts are round, oblong or ovoid. The kernel is firm and oily.

Hazel grows everywhere in Europe, the Transcaucasus, and Asia Minor as an understorey in the broad-leaved and pine forests on rich soils. In the European part of the former USSR the northern border of the range runs through a line from St Petersburg - Tikhvin - Belozersk - Vyatka - Krasnoufimsk. In the east the line reaches the Ural Mountains.

Six selected forms of Hazel have been distinguished, mainly by morphological characteristics of the leaves. Yields vary from 0.5 to 3 kg per bush.

Winter hardiness of this species is very high, but drought resistance is low. The European hazel possesses great climatic plasticity, so it can grow in the subtropics, while further north it withstands frosts up to -50 degrees C.

The hazel crop is most developed in Azerbaijan. In the Zakataly-Nukhi area it reaches a height of 8-10 metres and in favourable conditions yields 5-12 kg per bush. The life span of the hazel bush is 60-80 years. When the bushes are rejuvenated (by regenerative pruning), lifespan reaches 150-200 years. Yield reaches its maximum at the age of 30 (Mamedov, 1962).

The species *C. heterophylla* grows as an undersized, multi-stemmed bush up to 1.5 - 2 metres in height. The nuts are round and asymmetrical. The shell is thick and solid.

In the wild this species is widely distributed in the forests of the south-eastern Transbaikal and in the south of the Amur region, Khabarovsk and Primorski territories. Beyond the borders of the former Soviet Union it grows in Eastern Asia (North and Central China, Korea and Japan).

In mountains this species does not grow above 300-350 m. The plant is very frost and

drought resistant. It withstands frosts to -45 degrees C (Strogy, 1928). In the north-east of China *C. heterophylla* is tolerant to snowless winters and severe frosts below 30 degrees C. Fruit ripens in the second half of August or in early September and falls easily from the bush.

The plant is very tolerant to shade. Early fruiting is the distinctive feature of this species. Up to 100 kg of nuts per hectare can be gathered in natural stands. The weight of 1,000 nuts is 1,100 g. In the forests of the Russian Far East, up to several thousand tons annually may be collected.

The Turkish hazel (*C. colurna*) grows in the wild in the Caucasus, Asia Minor and the Balkans. In the natural habitat, trees reach 28 metres in height and 90 cm trunk diameter. The life-span is 200 years. Fruit is formed in a cluster of 2-7 nuts, rarely 14. The nuts are broad to oval, angular, with a prominent base. The shell is thick and solid. The kernel is firm and rather oily and is hard when extracted from the nut. Fruit ripens in September and persists on the tree for a long time.

The Turkish hazel grows with beech, hornbeam and oak in the forests of the Transcaucasus, North Caucasus and Krasnodar Territory. As a crop it has been cultivated for more than 100 years. Trees bloom in March and begin to produce fruit at the age of 16-20 years. Blooming and fruiting occur almost annually. Abundant yields of nuts occur every 3-4 years (15-20 kg per tree). The plant is tolerant to shade but grows and fruits better in well lighted places.

In the Ukraine this species withstands frosts to -36 degrees C. Plants survived satisfactorily at the Forest-Steppe Experiment Station in the Lipetzki Region (Central Russia) in severe winters, when the temperature fell to -40 degrees C. Therefore a Turkish hazel crop is possible in the central regions of Russia, Byelorussia, the Ukraine and north Caucasus.

The Turkish hazel is a drought resistant plant, only inferior to walnut. The species is widely recommended for growing in arid zones (Bortkevich, Giller, 1941).

The Caucasian hazel (*C. pontica*) is a bush up to 6 m high. The young shoots and petioles are pubescent. Fruit is formed in clusters of 2-3. The nut is large, round or slightly flattened. This species grows in Asia Minor and in the west of the Caucasus. Winter hardiness is poor. The Caucasian hazel is the ancestor of many cultivars.

Another species, *C. colchica*, is a small bush up to 1m high. The fruit is collected in clusters of 2-3. The nut is ovoid. The plant is very hardy. Therefore it is desirable to introduce this species to the Steppe zone of Russia.

The Manchurian hazel (*C. manshurica*) is a bush with multiple trunks to 4.5 m high. The fruit is collected in clusters of 3-4. The nut is small and round. 1,000 nuts weigh 500-700 g. Seed germination exceeds 79%. These trees blossom in April to early May and the fruit ripens in September.

This species grows as understorey in mixed and coniferous forests in the Primorski and Khabarovsk territories and in the south of the Okhotsk coast. In the mountains it is found at altitudes up to 700 m. The plant is tolerant to shade and is winter hardy. It was introduced to the European part of Russia.

The species *C. breviflora* is very similar to the Manchurian hazel, but has a different leaf formation and larger nut. It grows in mixed forests of the Russian Far East.

More than 50 cultivars of hazel are known in the territories of the former USSR. They are mainly grown in zones with warm, humid climates. In addition, Soviet breeders developed more than 50 cultivars during the last 40 years for areas with more severe climatic conditions.

A valuable collection of hazel was established at the Zakataly substation of the Azerbaijan Research Institute of Horticulture, Viticulture and Subtropical Crops. This collection contains 153 accessions of different ecological and geographical origin. Much work has been done on the development of new cultivars by the breeders F. H. Kazi-zade and N. V. Bozhko. As a result of a long-term project, twelve new cultivars were selected and recommended for commercial nut growing.

At present, the most important cultivars are : in Azerbaijan - Atababa, Ashrafi, and Yaglyfunduk; in Georgia - Gulshishvela, Futkurami, Hachapura, and Saivanobo; in the Krasnodar territory of Russia - Cherkessky-2, Adygeisky-1, and Panakhesky. The cultivars Nemsa, Adygeisky-1, and Cherkessky-2 are promising for other areas of the North Caucasus.

Adygeisky-1 : This cultivar is a seedling of unknown parentage, which was discovered in a home garden in the Teuchezhsk region of the Adigei Republic. The bush is of medium height (2.5 - 3.5 m). It is hardy, relatively resistant to drought, diseases and pests. The fruit ripens mid season (end of August). The plant produces 3-5 nuts per cluster. The nut is medium in size (1.7 g) and is round to oblong. The shell is thin and the kernel averages 50 - 60% of the total weight of the nut. The kernel is firm. The fat content is 65.6%. The cultivar yields crops of 0.7 - 1.7 tonnes per hectare. It is recommended for commercial growing in Krasnodar territory and Kabardino - Balkarian Republics of Russia.



Hazelnuts, variety Kudryavchik

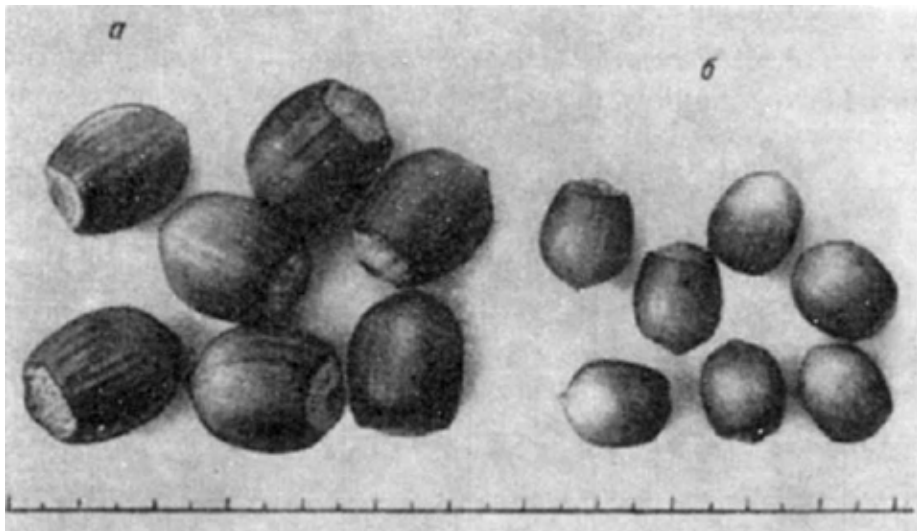


Hazelnuts, variety Prekrasnay

Panakhesky is a seedling of unknown parentage that was discovered in home gardens in the Teuchezhsk area of the Adigei Republic. The bush is of medium height (5 m) and the fruit ripens mid season (end of August). The nut is large (2.2 g) and almost round. The shell is thin. The weight of the kernel averages 50% of the total weight of the nut. Fat content is 65.6% and protein 17.9%. The average yield is 1.1 tonnes per hectare. The cultivar is relatively resistant to pests and diseases. It is recommended for commercial growing in the Krasnodar Territory.

Saivanobo is a local cultivar of Georgia. The bush is medium in height. The fruit ripens 14 days earlier than other commercial cultivars. The nut is large (2.6 g), with surface colour light tan. The weight of the kernel averages 56.3% of the total weight of the nut. The fat content is 67.2%. The cultivar yields crops of 0.5 - 1.3 tonnes per hectare. The plant and fruit is relatively resistant to diseases and pests. It is recommended for commercial growing in Georgia.

Cherkessky-2 is a local cultivar in the Krasnodar Territory. The bush is vigorous but not as hardy as other commercial cultivars. The fruit ripens early in the season. The nut is large (1.8 - 2.1 g) and round. The shell is thin and striped. The kernel is firm. The weight of the kernel averages 49.4% of the total weight of the nut. The fat content is 66.9% and protein content is 16.09%. The cultivar produces an average yield of 0.73 tonnes/ha and its maximum yield is 2.1 t/ha. The plant and the fruit are relatively resistant to diseases and pests. It is recommended for commercial growing in the Krasnodar Territory and in the Kabardino - Balkarian Republic of Russia.



Selected variety *Sovetskii-86* (left) compared to wild hazels

Hazel cultivars are propagated by layers, rhizomes, grafting and by dividing the bush. It is possible to produce 3 - 5 layers from each shoot by using the trench layering method. The mound layering method is also used, although the short-coming of this method is the cessation of formation of shoots when the bushes fill up with soil. Therefore layering is needed for one year.

Grafting and budding are used for the establishment of tree-type hazel plantations. In Spring grafting (bark, cleft, whip) is done. The best time for budding is July in south Ukraine, the Crimea and the Carpathians, but towards the north the best time is the first part of August. The optimum date for budding is the beginning of July on the Black Sea Coast (Sochi) (Kuznetsov, 1955).

Tree-type plantations yield as well as bush-type plantations. The first are more suitable for mechanisation, especially for machine harvesting. Seedlings of the Turkish hazel and its hybrids are used as rootstock because they do not form suckers.

Hazel plantations are established on the plains or on slopes (up to 10 degrees), where it is possible to use mechanisation. The bushes are planted at a distance of 7 x 8 m or 8 x 8 m on irrigated plots with fertile soils, and at distances of 6 x 6m on non-irrigated plots.

Female hazel flowers are borne on buds of the previous season's growth. Some pruning is needed to obtain 15 to 20 cm new growth each year, but a large bearing surface is required for a full crop, due to the small size of the nut. Bulk pruning of hazel can be done every 3 or 4 years, rather than annual pruning. This practice, however, results in too vigorous growth and poor yield the first year after pruning.

Irrigation should be applied 2-3 times during the season May to July, and once in autumn, at a rate of 0.3 - 0.5 cu m of water per bush, during the first 3 years after planting. The rate increases up to 0.7 - 1.0 cu m at 4 - 5 years, and up to 1.5 cu m per bush at maturity.

Fruit harvesting is very difficult to mechanize because hazelnuts do not ripen simultaneously.



Western hazelnut varieties, *Cosford* (left) and *Louise*

This problem is more difficult with bush-type hazel, since it needs a special machine that can transmit vibrations to each separate trunk. Some years ago the first nut harvester was constructed for bush-type plantations. This machine uses the principle of clamping several groups of trunks. The highest yield (94.4%) was harvested by shaking 16 times per 15 seconds (Mamedov, Aliev, 1975). A commercial machine, the FUM-22, was built on the basis of this prototype. Another machine was constructed by the Research Institute of Mountain Horticulture and Floriculture with a rolling shaker. In any case it is necessary to prepare the bush-type plantations for machine harvesting. The bush must consist of no more than 10 - 12 trunks. (Slepokurov et al, 1984).

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[Illustrations reproduced from Shchepot'ev (1969)]

PRUNING PINES IN NEW ZEALAND - TIMING, VARIABLE-LIFT, EQUIPMENT, GROWTH BEHAVIOUR

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Pruning radiata pine

New Zealand has over 1.6 million ha of intensively managed plantation, with about 90% in radiata pine. Over half the plantations are pruned, and more than 100,000 ha of pruning operations are scheduled annually. The main objective of pruning is to increase plantation profitability through efficient production of clearwood.

This is best achieved by pruning at the right time, to achieve a uniform diameter-over-stubs (DOS) within the tree, and within the stand. Experience has shown that as a general rule pruned and unpruned trees should not be grown together, particularly if the stocking is high, and the stand is not about to be thinned. Pruning costs can be contained by avoiding belated operations and pruning a minimum number of trees required to produce the final crop. Pruning operators need to be skilled, and to use the appropriate equipment. Mechanised systems have not been able to compete with manual methods, because of the difficult working conditions, and because of the need for multiple pruning lifts.

The realisation in the 1950s that with appropriate timber grading and preservation, radiata pine could fill a very wide range of market niches, and concerns about degrade of timber due to large bark-encased knots, have led to increasing pruning effort being applied to second rotation and newly planted stands of this species. Over the past 15 years, on average, more than 30,000 ha/year of young radiata pine stands are added to the 'intensively-managed' category, which includes pruning (Ministry of Forestry, 1996). If we assume that each stand receives on average three pruning lifts, to six metres, then typically at least 100,000 ha of pruning operations are carried out each year.

The single most important reason for pruning is to improve the profitability of plantation investment, through the production of clearwood. With an annual internal timber demand of 6 million cubic metres able to be met from about 300,000 ha of plantations, New Zealand growers and processors are clearly looking to international markets, and in particular to that part of the market vacated by the naturally pruned 'old growth' temperate and tropical forests. Pruned log volumes available for export (either in the round, or processed) are expected to increase significantly by the year 2005.

Current situation

Clearwood recovery from early pruning was variable, and often disappointing. At the time the reasons were not always apparent, but intensive research over the past 30 years has resulted in a high level of understanding of the key variables involved in clearwood production and an increasingly well informed and professional approach by field practitioners.

Nominal FOB prices for export pruned logs have varied over the last 4 years between \$US 95/ cu m and \$US 290/ cu m, indicating the need to use long term moving average prices in evaluating the economics of an investment in such pruning. The current price is around \$US 133/ cu m, which represents a margin over the equivalent unpruned log of \$US 57/ cu m.

Good management practice in producing clearwood in New Zealand can be described as pruning on time, to the correct height, and at minimum cost. The following gives details of these aspects.

Pruning on time

The timing of any pruning operation is a compromise between pruning too soon or pruning too late. Pruning too soon unnecessarily slows down the growth of the stand because of green crown removal, or also the tree is visited too often, incurring unnecessary costs. Pruning too late results in a large diameter over branch stubs (DOS), resulting in an inadequate clearwood sheath and increasing costs as branches become larger.

Trials have shown that almost any pruning of green branches reduces tree growth (Knowles and West, 1986) but that the size of the DOS at the time of pruning needs to be restricted to 14-18 cm, depending on site fertility (Knowles et al., 1987). With radiata pine a practical trade-off between these growth, cost and quality objectives is achieved by pruning in 3-4 lifts to leave 3-5 m of crown length after each pruning (Knowles, 1990).

Achieving a uniform DOS within the tree

Studies have shown that the DOS arising from successive pruning lifts in a log needs to be similar, otherwise clearwood yields decline rapidly (Knowles, 1990). An uneven DOS can result in a considerable quantity of short length (shop) clears. At one extreme, if a stand is left so that pruning can take place in a single lift, to say 6 m, then the critical DOS size at the base of the tree may be far too large, particularly if the stand has been thinned. In practice, most pruning to 6 m is done in 3 lifts (4 lifts on fertile sites). The key to achieving the same DOS in each lift is to have a good decision support system that will accurately schedule stands for pruning.

Achieving a uniform DOS within the stand

If all trees in a stand are pruned to the same height at the same time, the normal variation in tree sizes within a stand results in smaller trees becoming over-pruned, and larger trees under-pruned. Growth trends which are already divergent between these two elements are therefore exacerbated. By pruning the stand to leave a similar crown length on all trees, a more uniform DOS is achieved (Koelher, 1984), and subsequent growth variation is also reduced.

This is called 'variable-lift pruning' and is aided by the use of a stem calliper. Use of the calliper ensures that all the trees have a similar quantity of foliage after pruning and therefore similar potential for growth as well as similar DOS sizes. The size of the calliper may be calculated by measuring the stem diameter at the base of the desired crown length, i.e. 3-4 m from the top of the tree. When the operator can fit the calliper over the stem at an internode, pruning ceases. Calliper sizes that will give the desired quantity of green crown (for radiata pines) are normally in the range 9-12 cm.

Pruning all trees in the stand

If trees within a stand have been pruned to different heights, those in each pruned height class can be described as belonging to an 'element'. An early practice of leaving some trees in dense stands unpruned, to be removed in a subsequent production thinning, has been shown to be very detrimental to the growth of pruned trees (West et al., 1982). Because of their larger crown length, such an element is able to grow faster and dominate the high-pruned element, even when the larger, more dominant trees were initially selected for pruning. Any regime which allows unpruned stems to remain for more than a year or two amongst pruned stems should be monitored closely, however the more recent practice of planting fewer trees per hectare reduces such loss of dominance.

Pruning to the correct height

Most pruning has been to 6 m, with recent trends to 6.5 m and in the case of one company supplying the Asian veneer market, to 8.5 m. Assessment of stands pruned in the 1960s and 1970s has shown a very wide range of pruned heights, with subsequent problems of log segregation and marketing. Pruning to a variable height (versus fixed height) may require a final operation to allow pruning to be brought up to a minimum height on the smaller trees. The optimum pruned height in New Zealand has been found to vary from 4.3 m to 8.5 m depending on timber prices, product specifications (eg, veneer length), rotation age, and discount rate (Knowles, 1990).

Containing pruning costs by pruning on time, and pruning minimum stems per hectare

Because branch size is partly a function of the age of the tree, belated pruning results in not only a large DOS but also large branches which become more expensive to remove and take longer to occlude. With timely pruning, the cost per hectare is more or less directly proportional to the number of stems per hectare pruned. Considerable effort has been placed on identifying for each site the numbers of trees required at each pruning lift in order to provide adequate selection of the final crop. The role of genetic improvement has been particularly valuable, with most organisations now planting 800 stems/ha or fewer, to provide a final crop of 250 to 300 stems per hectare (Wilcox & Carson, 1990). Thirty years ago initial stocking rates of 2400 stems/ha were common.

On fertile ex-pasture sites, evidence is accumulating for radiata pine that trees grown from 'aged' cuttings will be much straighter than those grown from seedlings (Menzies et al.,

1991), thus yielding significantly higher clearwood yields. Cuttings may also allow lower selection ratios, thus reducing costs of the earlier pruning lifts. On the other hand, fertile farm sites tend to produce larger branches and larger DOS sizes, so to compensate for this, pruning lifts may have to be scheduled more frequently, with perhaps four or five lifts scheduled instead of three, and with less crown remaining after each lift.

Current pruning of 250 to 300 stems/ha to 6.5 m height in three/four lifts on a typical forest site costs around \$NZ 900-1,100 per hectare, and requires 5 - 6 man days of labour.

Selecting the correct final crop stocking

High tree stockings invariably provide higher overall yield of roundwood, but because of smaller log diameters may lead to lower sawn conversions, and higher growing, harvesting and sawing costs. Studies have shown that final crop stockings of around 200 - 250 stems/ha yield near-maximum sawn clearwood volumes (Knowles, 1990), however the optimum final crop stockings in terms of profitability depends on site quality, clearwood price, rotation length and discount rate (Maclaren, 1990). Because the favourable growth potential on farm sites results in both larger stem and branch sizes, final crop stockings may be higher than on less fertile forest sites, as a means of containing branch size in the unpruned logs (Maclaren, 1993).

Tree selection should favour the straightest, most vigorous, trees in the stand (Maclaren, 1987). Individual tree spacing is a secondary consideration.

Employing skilled operators, using appropriate equipment

Developments in work methods and tools have proceeded rapidly with the phasing out of remuneration on wages, and replacement with highly motivated contract workers. Until the late 1960s 'Porter #2' loppers were used for the first lift from the ground, followed by curved pruning saws mounted on poles for the higher lifts. Pole saws were replaced by using specifically designed frame-tensioned hand saws from a ladder, with improvements in productivity of up to 50%, and improved work quality (Terlesk, 1969).

More recently a combination of using a modified lopper from a ladder, improved timing of operations, and genetic improvement resulting in fewer large, steeply angled branches, has meant that the hand saw is carried only for the odd large branch, if at all. Several brands of NZ designed or modified loppers are available, together with several design of ladder, all with their advocates.

Some brands of ladder clip on to the tree, giving greater stability & safety. Considerable effort and ingenuity has gone into developing and testing a wide variety of mechanised pruning equipment (Mason & Cullen, 1986), however to date none has been shown to be competitive with the manual methods.

Based on an article in the June 1997 issue of the 'Subtropical Farm Forestry Newsletter' (PO Box 1320, Lismore, NSW 2480), from a paper presented at the Australian Forest Growers Conference, Mt Gambier, Australia, in September 1996.

SANDALWOOD IN AUSTRALIA

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Sandalwood (a generic term for the *Santalum* genus) has been known for over two thousand years by cultures of the east and Pacific, inextricably linked to their social life, religion, ceremonies, and handicrafts. There are about 26 species which occur in a natural distribution that starts in India, reaches eastward through the Indonesian archipelago, embraces Australia, and fans out across myriads of islands in the Pacific, stopping just short of the coast of South America at the Juan Fernandez Islands.

Sandalwood attracted attention because of the fragrance of its yellow brown wood, and because the heartwood is capable of resisting the dreaded white ants of the tropics. The material is so hard and close grained that it resembles ivory and ebony in its ability to be worked to a fine finish, and has much value in the ornamental woodworking trade. The oil is reputed to have antibacterial properties and is used in modern soap making and it is an essential ingredient in the perfume industry. The fragrance is extremely smooth and sweet.

Of the various species only few are promising for wood and oil. The principle species which have been used and in some cases still being exploited are *S. austrocalidonicum* Vieill., *S. freycinetianum* Gaud., *S. marchionense* Skottsbo., *S. yassi* Seem, and the Australian species *S. spicatum*.

Six species of *Santalum* grow naturally in Australia: *S. acuminatum*, *S. lanceolatum*, *S. murrayanum*, *S. spicatum*, *S. obtusifolium* and *S. album*. Indian Sandalwood, *S. album*, is found in coastal areas of Northern Australia, where pre-European trade with early Indonesian seafarers may explain the distribution of this mainly equatorial species. The other *Santalum* species occupy habitats ranging from coastal sand dunes and the central desert to forests. Most of the species are restricted to the drier, lower rainfall (or seasonally dry & north) areas of the continent. The exception is *S. obtusifolium* which is restricted to the moister central and southern east coast.

The Australian industry

From 1844 a sandalwood industry was developed in Western Australia, and later South Australia, based on harvesting natural stands of *S. spicatum*.

The Northern Queensland industry began in 1886 and was based on *S. lanceolatum*, the only local species of the area. The sandalwood industry ceased in Queensland in 1940, but was revived again in 1982 when the 1934 sandalwood act was revoked. Currently sandalwood may only be harvested from private land and problems still exist from collection of material by unregistered harvesters. *S. lanceolatum* is only harvested from a small area in northern Australia. The species is very wide spread through the arid and seasonally arid zone and is well represented in reserves. The threat to this species comes from overgrazing by cattle and the annual burning of grazing areas. Sandalwood is very palatable to stock, both native and introduced, and is susceptible to intense fire. After large floods, the species germinate in profusion, but few survive in sufficient numbers to ensure viable populations.

The sandalwood industry in Western Australia is still based on *S. spicatum*. For the last 50 years there has been tight control on all aspects of harvesting and marketing. All operators are licensed and the sandalwood can only be sold through the Australian Sandalwood Company. Strict control on marketing and annual cutting quotas is observed. The area harvested and the management of the field operation is carried out by CALM (Conservation and Land Management Department), with due regard for conservation and regeneration capacity.

In the arid zone of WA, for successful regeneration *S. spicatum* require 3 years of above average rainfall (a rare event), this coupled by grazing pressure can significantly affect the regenerative capacity of the species. Only live trees with a girth diameter of greater than 40 cm at 15 cm above the ground can

be removed, while any dead material can be collected. The current system of harvesting and exporting sandalwood has proven to be viable.

More recently, there has been an increasing interest in the use of the kernels of *S. spicatum* as a commercial food nut, and some research along these lines has been carried out at Curtin University, WA. The cultivation of Sandalwood nuts in the winter rainfall agricultural regions of Australia could possibly become a useful rural industry.

The large oily edible kernel of *S. spicatum* is approximately 50 % oil, a high proportion of which is of an acetylenic fatty acid, ximenynic acid (similar in proportion to quandong) which has no obvious adverse pathological or physiological symptoms; by-products of the oil do appear to have some anti-inflammatory activity. Its suitability as a human foodstuff or medicine, however, is still undecided.

The area of natural distribution of *S. spicatum* in South Australia has largely been used for agricultural and pastoral activities and only a remnant population now exists.

Natural populations of sandalwood species are under threat, and in a depleted state, in many countries. This is not the case in Australia, although some species certainly have had their range reduced by agricultural activities, and there are few active programs designed to protect sandalwood species from grazing.

What has protected species is that they occur over huge areas (*S. spicatum*, *S. lanceolatum*, *S. acuminatum*) or in remote locations (*S. album* and *S. murrayanum*) or persist in crown forests (*S. obtusifolium*).

Santalum album The prospects for clonal material

Indian researchers have done a lot of research on the tropical sandalwood, *Santalum album*. It has been possible through tissue culture techniques to produce large numbers of identical plants. One particularly useful trait of this species is that somatic embryos can be produced in culture, these 'artificial seeds' have also been successfully germinated. Unfortunately this is the only *Santalum* species that has been successfully reproduced through tissue culture, and although some progress has been made with *S. acuminatum*, efficient rooting of shoots is still the limiting process. For *S. spicatum*, root formation from shoots has proved very unsuccessful.

Germination and growth of *S. spicatum* and *S. lanceolatum*

The germination characteristics of *S. spicatum* and *S. lanceolatum* appear to be similar to quandong, except that higher temperatures (25-27 degrees C) encourage earlier germination of fresh kernels (2 weeks for *S. spicatum* and 3 days for *S. lanceolatum*), temperatures at which quandong shows little or no germination. Gibberelic acid has also been effective in enhancing growth of *S. spicatum* seed.

The lateral roots of *S. spicatum* may run for 25 to 30 metres, but rarely extend more than 200 mm deep, even in sandy soils. Observations have indicated that under extreme drought stress *S. spicatum* will die before the host. Prior to host attachment, seedlings protected from direct sun survived three to five months longer than exposed seedlings. Similar observations have been observed with quandongs. This shade effect has been quantified with *S. album* seedlings, best growth characteristics have been observed in 80 % shade.

S. lanceolatum and *S. album*, but not *S. spicatum*, can produce coppice shoots and produce suckers from the roots of existing trees, particularly those that have been disturbed or wounded.

Future of the industry, including quandongs

Irrigated Australian sandalwood plantations (quandong also has scented wood, similar in texture to satin wood) could develop into a timber crop in its own right. Some consider the growth rate of the tree a major limiting factor (50 to 90 years for non-irrigated *S. spicatum* in WA). Although the genus grows in a variety of habitats, many authors report the most fragrant wood is believed to come from trees growing in rocky and dry sites, and those from moist sites with good soil are degenerate.

The quandong industry should not ignore the development of the 'Sandalwood industry', as not only a sister crop, but also a source of rootstock (initial observations indicate compatibility amongst the genus) and disease resistance. The non-suckering habit of *S. spicatum*, for example, may have value as a root stock, as may *S. murrayanum* for heavy clay soils.

The Arid-land Growers Association (AGA) fact sheet reports that the timber of sandalwood was worth \$14,000 a tonne in 1994. A once common tree through the arid zone of Australia, it is now rarer due to collection of its timber for Asian markets. The species is suitable for heartwood collection after about 10 to 15 years after planting. The mature tree (3 to 5 years) also produces in Oct-Nov an oily edible nut which has the potential of a dry land Macadamia crop.

Bryan Chambers (Richmond, Queensland) who appeared as “the Sandalwood Man” on the ABC Landline program in Jan 1992, indicates that in 1997 the sandalwood industry is alive in Northern Queensland, but wild harvest by unregistered collectors could threaten the long term prospects of the industry. The natural regeneration of sandalwood through germinating seed is restricted to periods of rain of at least three weeks duration which can be a rare event in the drier parts of the state. Root suckering of harvested trees is a common occurrence. Gidjee is often found associated with sandalwood trees, and careful observation of older trees indicates that mature trees may not rely on a host for survival. Timber quality can vary quite markedly with location, and excessive water is not good for high quality wood.

According to Graham Herde, the WA industry is also productive. Time will tell whether irrigated commercial woodlots are a viable enterprise.

S. album, probably because of the success at regeneration through tissue culture, has potential as a plantation crop in tropical northern Australia, and this is being looked into as a solution to the projected limiting production of natural stands of sandalwood in 50 years or so.

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Based on an article in the Autumn 1997 issue of ‘Acuminatum’, magazine of the Australian Quandong Industry Association (PO Box 236, Upper Sturt, SA 5156).

PERFECTING THE WALNUT

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The Persian walnut (*Juglans regia*), although an introduced species, has a long history in the British Isles. The date of introduction is debated by various authorities, some think it was brought over by the Romans while others suggest it came from France in the fifteenth or sixteenth century. Records show, however, that trees were sufficiently well established in England to form part of the local economy as early as the late thirteenth century.

Throughout the following centuries the walnut tree was prized for its nuts and high quality timber, as well as other products such as walnut oil, dye and even a decoction for killing earthworms. Although enthusiasts made sporadic efforts to promote homegrown walnuts, imports from France and Italy, and lately California and China, have always been important in supplying demand.

Historically, walnut growing in Britain has constantly faced two problems: spring frosts coincide with flowering and may prevent cropping altogether, and walnuts are hard to propagate by budding or grafting. The former difficulty may be overcome by selecting trees which are later leafing than normal, but the latter has meant that seedlings have been the traditional way of producing trees. Unfortunately, seedling walnuts are very variable and there can be no guarantee that a particularly good tree will give equally fine offspring. As a result most British trees have, in general, been poor to mediocre nut producers.

In the early 1920s this situation led one amateur grower, Howard Spence, to persuade the East Malling Research Station in Kent and the Ministry of Agriculture to see if something might be done to promote commercial interest in walnuts in the UK. Much hard work by the staff of East Malling provided valuable information about the vegetative propagation of walnut cultivars, as well as a proper scientific investigation of all aspects of walnut culture. Allied to this was a country-wide search for outstanding trees, culminating in 1929 with a walnut competition held under the auspices of the Royal Horticultural Society (RHS).

Five trees were selected as having walnuts suitable for both fresh use and storing, with two more identified as being particularly suitable for pickling. The names given to these cultivars - ‘Champion of Ixworth’, ‘Excelsior of Taynton’, ‘Lady Irene’, ‘Leeds Castle’, ‘Northdown Clawnut’, ‘Patching’, and ‘Stutton Seedling’, are now mostly memories as Mr. Spence’s dream of an indigenous British walnut industry ultimately proved to be uneconomic, and East Malling’s research was curtailed by World War II.

While Spence’s vision of commercial walnut groves in Britain was never realized, home grown walnuts are quite possible, providing that suitable cultivars are planted in the appropriate site.

Walnut trees are usually too large for small gardens; their ultimate dimensions are variable depending on cultivar and site but mature trees are typically in the region of 18 m tall with a spread of up to 14 m. They require plenty of space and light, 9 m between trees should be taken as a minimum, and 12 - 15 m is better. Walnuts are tolerant of most soil types but relish one which is deep, moist, and fertile with a good proportion of lime.

Select cultivars of walnut are now propagated using seedlings of the Persian walnut (*J. regia*) and the American black walnut (*J. nigra*) as rootstocks. Both have their own particular merits and problems. *Juglans nigra* is a slightly dwarfing rootstock giving a precocious, heavy cropping tree. It is susceptible to infection by the root rot fungus (*Phytophthora cinnamomi*) but fairly resistant to honey fungus (*Armillaria mellea*). It is also prone to a condition known as 'black-line', caused by the cherry leaf roll virus, where a thin black line of dead tissue forms at the junction between the rootstock and the graft. Walnuts on *J. nigra* may grow satisfactorily for many years before the virus enters the tree by way of infected pollen. Once inside, the virus slowly spreads in the sap until it comes into contact with the rootstock causing the dead layer to be formed. Affected trees eventually die and the use of *J. nigra* as a rootstock is no longer recommended in areas where the virus is prevalent.

Juglans regia stock produces vigorous trees and is more tolerant of limey soils than *J. nigra*. It is susceptible to honey fungus but not subject to the problem of black-line.

Trees respond well to nitrogenous fertilizer, which should only be applied in the spring to avoid frost sensitive growth late in the year. As a guide trees require 150 g of 20: 10: 10 NPK fertilizer per year of growth. This, together with any manure, should be spread evenly over the area covered by the canopy. Irrigation is beneficial to walnuts in all but the wettest summers.

Walnuts are commonly grown as standards and initially trained to have a clean stem of around 2 m. Thereafter 4-6 branches spaced around the trunk should be allowed to grow out to form the main scaffold of the tree and the leading shoot then tied down to form the last branch or pruned out to given an open centre. Any pruning is best carried out in late autumn/early winter, as they bleed sap profusely if pruned in the spring.

Both male catkins and female flowers are borne separately at the ends of the shoots and all walnut trees are theoretically self-fertile. Unfortunately, there is a tendency for the two types of flowers to mature at slightly different times, necessitating some cultivars to be planted along with a pollinator tree. Certain cultivars have both flowering periods overlapping and are reliably self-fertile and will crop heavily even when grown alone. Others have their flowering times near enough together to allow the occasional crop to set if the weather is favourable. Walnut pollen is wind dispersed and may be effective for up to 200 m. However, pollination is far more assured if trees are no more than 80 m apart.

The two main diseases of walnuts in Britain are walnut leaf spot or anthracnose (*Gnomonia leptostyla*), and walnut leaf blight (*Xanthomonas juglandis*). The former is a fungal infection causing brown blotches on leaves and young fruit which may lead to defoliation and crop failure in severe cases. Spores overwinter on dead leaves, and burning these is probably the best way to prevent its spread.

Leaf blight is caused by a bacterium and is worst in a cold wet spring when angular black spots appear on the leaves, shoots, and fruits. It is rarely a serious problem in the UK on selected cultivars. Walnut leaf gall mite (*Eriophyes tristriatus*) is the most frequently encountered pest and gives rise to conspicuous pouch shaped galls on the leaves. The damage is mainly cosmetic and best ignored.

The nuts may be harvested in July for pickling before the shell hardens, or left to ripen and fall naturally in September/October. The advantage of pickling walnuts is that they are still immature enough to be unattractive to grey squirrels. Always wear rubber gloves when handling freshly harvested nuts as they can stain human skin an indelible nicotine brown. Nuts for storage should be collected immediately, cleaned and washed before being dried indoors as quickly as possible, taking care not to heat them above 40° C. If not dried promptly they soon go mouldy, whilst nuts that are dried at too high a temperature develop a rancid flavour.

The following are the fruiting walnut cultivars commonly available in the UK:

'Broadview'. A first rate cultivar from British Columbia. The tree is moderately vigorous and has healthy disease resistant foliage and high quality nuts. It is only partially self-fertile but is very productive when cross pollinated. It has been under test in Holland since the 1950's and has been found to be well adapted to Northern Europe.

'Buccaneer'. A Dutch variety named to commemorate the village of Neer. It is very vigorous with an upright growth habit. The foliage is not prone to disease and the nut quality is good. It is self-fertile although the productivity is less than that of 'Broadview'.

'Franquette'. An old French cultivar which makes a large, vigorous tree with a spreading growth habit. It is late leafing and not particularly susceptible to spring frost damage or foliar diseases. Nut quality is excellent but it is slow to bear and has low productivity. It is only partially self-fertile and requires a pollinator to crop well. Still a good choice for the amateur growers.

'Northdown Clawnut'. This is the only one of the 1929 RHS walnut competition winners to be commercially available in the UK. The tree is partially self-fertile, medium size, and leafs out mid-season. It is a 'bannut' or 'double walnut' type having very large nuts, often borne in clusters. The flavour is said to be only fair but they are exceptionally well filled for this type of nut.

'Geisenheim No. 26' and 'Geisenheim No. 139' are two promising German cultivars not yet generally available. The first is very late leafing with good quality small nuts whilst the latter has medium sized nuts, leafs out medium-late and is recommended for the amateur planting a single tree.

Based on an article in the 1995 Annual Report of the Northern Nut Growers Association (9870 S. Palmer Rd, New Carlisle, OH 45344, USA).

NATIVE INDIAN WILD FRUIT

(Trees and Shrubs)

GOKAL CHAND

Managing Director

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India is a home of wild fruit which are extremely hardy and resistant to diseases and insect pests and hence, free of contaminants of insecticides and fungicides. They are an excellent source of vitamins, minerals and proteins apart from being medicinal in nature. Many of them are used as root stocks for domesticated varieties. Important species are given below.

Name	Adaptability	Uses
<i>Aegle marmelos</i> (bael)	Tropical Subtropical	Fruit possess aromatic pulp, medicinal value and cure for chronic diarrhoea and dysentery.
<i>Anacardium occidentale</i> (cashewnut)	Tropical Subtropical	Commercial edible fruit
<i>Annona squamosa</i> (custard apple)	Arid Submontane	Fruit sweet, aromatic and edible
<i>Ampelocissus amottiana</i> (Indian wild vine, jangli angur)	Tropical Subtropical	A climber giving edible purple berries
<i>A. barbata</i>	-do-	A woody climber giving sweet and palatable berries
<i>A. latifolia</i> (panibel)	-do-	The edible berries are blackish purple. The plant is highly resistant to frost and diseases
<i>Artocarpus heterophyllus</i> (jackfruit, kathal)	-do-	Fruit and seeds are used as vegetable
<i>A. hirsuta</i> (aini)	-do-	The ripe fruit has edible creamish pulp
<i>A. lakoocha</i> (monkey jack, barhal)	-do-	The edible pulp is sweet. Fruit is also used for pickle making
<i>Baccaurea sapida</i> (latka, lateku, kanazo)	-do-	Fruit pulp is delicious and edible
<i>Bassia buttasrasia</i>	Temperate	Edible oil

<i>Borassus flabellifer</i> (palmyra palm)	-do-	Tree sap is sweet and is used for sugar production. Alcoholic drink is also prepared from the sap
<i>Buchanania lanzan</i> (chiron ji, cuddapah almond, charoli)	Subtropical Semiarid	Ripe fruit are eaten. Seeds are edible and regarded as dry fruit. Bark of the tree is used for tanning
<i>Capparis decidua</i> (ker, teet, dela)	Subtropical Arid	The green immature acid fruit are used for pickle. Rich source of protein. Medicinal
<i>Carica candamarcensis</i> (mountain papaya)	Temperate	Edible fruit
<i>C. papaya</i> (papita)	Subtropical	Tall or dwarf varieties, excellent edible fruit
<i>Carissa carandas</i> (karonda)	Tropical Subtropical	Fruit are used for pickle, jams and chutneys. Plants make good hedge. Fruit are edible, medicinal
<i>C. inermis</i> (karonda)	Tropical	-do
<i>C. spinarum</i> (karaunda, kalivi, chiru, kila)	Tropical Subtropical	Grown in hedges for its fragrant flowers and fruit. Leaves are considered a source of tannin
<i>Caryota urens</i> - (jaggery palm, fish tail palm)	-do-	A decorative tree, produces wine and palm sugar
<i>Citrus limettioides</i> (sweet lime)	-do-	Edible fruit
<i>C. maireraspatana</i> (kichili)	-do-	-do
<i>C. indica</i> (wild mandarin)	-do-	-do
<i>Cocos nucifera</i> (coconut palm)	-do-	Edible fruit, yields coconut oil
<i>Cordia gharaf</i> (gondi, gondri)	Subtropical	A deciduous tree. The brownish ripe drupes have gelatinous sweet pulp
<i>C. myxa</i> (lasora, gonda, Indian cherry, sebasten)	Subtropical Arid	Ripe yellowish brown fruit with mucilaginous pulp are edible. Unripe fruit are used as vegetable and pickle

<i>Clausena indica</i>	Tropical	Fruit are half inch across and edible, aromatic leaves are used for flavouring curries
<i>Dillenia indica</i> (Dillenia, elephant apple, chalta)	-do-	Fleshy pulp of yellowish fruit is consumed. Fruit used for jams, jellies and beverages
<i>Diospyros chloroxylon</i> (Green ebony persimmon)	Subtropical	The ripe fruit is palatable
<i>D. exsculpta</i> (Nepal ebony persimmon, kendu)	Tropical Subtropical	The ripe yellow fruit has sweetish pulp
<i>D. embryopteris</i> (Indian persimmon, gab, kala tendu)	Tropical Subtropical	Small dark fruit are edible, dye obtained from fruit is used for colouring cotton and timber
<i>D. lotus</i> (amlak)	Temperate	Edible fruit
<i>Emblica fischeri</i> (myrobalan, emblic, star gooseberry, otaheite gooseberry)	Subtropical	Fruit is more ridged and edible. Produces crop throughout the year
<i>E. officinalis</i> (Indian gooseberry, myrobalan, aonla)	-do-	Fruit are pickled and also made into preserve, are used as diuretic and laxative and in dried form in diarrhoea and dysentery
<i>Elaeagnus angustifolia</i> (oleaster)	Temperate	Edible fruit
<i>E. floribundus</i> (jalpai)	-do-	Edible fruit
Eugenia jambos (rose apple)	Tropical	Fruit spherical, white and sweet with a rose scent, can be used for jams, jellies, pickles and syrups, medicinal value
<i>Euryale ferox</i> (gorgan nut)	Subtropical	Edible fruit
<i>Feronia limonia</i> (wood apple, elephant apple, kaith)	Subtropical	Fruit has sweet and aromatic pulp, eaten fresh or used in drinks, chutneys, jelly, etc.
<i>Ficus auriculata</i> (tirmal, timla)	-do-	A tall tree. The brownish insipid fruit are used for curries

<i>F. glomerata</i> (cluster fig, gular, domor)	-do-	Fruit are small, become reddish on maturity and have flavour of cidar apple, used for jellies
<i>Flacourtia indica</i> (kantai)	-do-	A thorny shrub. The small pisiform berries are acidic, consumed raw and good for jellies, jams and tarts
<i>F. jangomas</i> (puneala plum)	-do-	The cherry size fruit is dark red when ripe, with tart flavour, used for jams, marmalades and preserves
<i>Fragaria nilagerrensis</i> (wild strawberry)	Temperate	Edible fruit
<i>Garcinia cowa</i> (cowa)	Tropical	Fruit are edible and gum obtained from trunk and branches is used for preparing yellow varnish
<i>G. indica</i> (kokam, vishambit)	-do-	The fleshy ripe purple fruit possesses sweetish to acidic pulp, also taken with sugar and water as a drink. Dried pulp is used as a substitute for tamarind, medicinal
<i>G. xanthochyus</i> (egg tree, dampel, tumul)	-do-	Acidic fruit are edible and made into preserves and jams, unripe fruit give gum resins which is used in water colour
<i>Grewia elastica</i> (pharsia, dhaman, bimal)	Subtropical	Fruit are edible
<i>G. subinequalisa</i> (phalsa)	-do-	Fruit are edible and eaten as such or used for preparation of cold drinks
<i>G. tenax</i> (chaben, godni)	-do-	Evergreen shrub. The edible orange-red drupes are acidic
<i>G. tiliaefolia</i> (dhamni)	-do-	Fruit are edible
<i>Juglans regia</i> (walnut)	Temperate	Nut edible, commercial
<i>Madhuca indica</i> (mahua, butter)	-do-	Flowers are used as vegetables and also as a source of alcohol. The fruit is eaten cooked. Seed oil is used for cooking and soap making
<i>Manilkara kauki</i> (khirni)	-do-	Sweet edible fruit

<i>Malus baccata</i> (crab apple)	Temperate	-do-
<i>M. sikkimensis</i> (kafal)	-do-	Medicinal edible fruit
<i>Mimusops elengi</i> (malusari)	Tropical	An evergreen tree. The small olive shaped edible berries are orange yellow
<i>Moringa oleifera</i> (drumstick)	Subtropical	Fruit edible as vegetable and pickle, medicinal, bee flora
<i>Morus alba</i> (white mulberry)	-do-	Fruit sweet and delicious, bee forage, timber, silk worm rearing
<i>M. indica</i>	Temperate	-do-
<i>M. nigra</i> (black mulberry)	-do-	-do-
<i>M. serrata</i> (Himalayan mulberry)	-do-	-do-
<i>Musa balbisiana</i> (wild banana)	Tropical	Edible fruit
<i>Murraya koenigii</i>	Tropical Subtropical	Beautiful shrub fruit and leaves edible
<i>Myrica esculenta</i> (kafal)	Temperate	Edible fruit
<i>Olea ferruginea</i> (Indian olive)	Temperate	Important olive tree
<i>Phoenix acaulis</i> (jangli khajur)	Tropical Semiarid	A pigmy palm. The drupes are fleshy and sweet
<i>P. humilis</i> (dwarf date, palm, hill date)	-do-	The fruit are sweet
<i>P. sylvestris</i> (wild date, palm, khajur, date sugar palm)	-do-	A tall palm. The ripe drupes are sweetish, pulp eaten as such, also made into jams and jellies
<i>Pinus gerardiana</i> (chilgoza)	Temperate dry	Extremely precious edible nut
<i>Pistacia vera</i> (pista)	Temperate	Nut, commercial fruit

<i>Prosopis cineraria</i> (khejri, chhoker, jand, shami)	Subtropical Arid	Tender pods are chopped and cooked as vegetable. The seeds are very rich in protein. Dried fruit form a five star hotel delicacy.
<i>Prunus armeniaca</i> (wild apricot, chuli)	-do-	Fruit yield edible oil
<i>P. cerasoides</i> (Himalayan wild cherry)	Temperate	Edible attractive fruit
<i>P. persica</i> (kateru)	-do-	-do-
<i>Punica granatum</i> (daru)	Temperate	Orange red edible fruit, seeds used as condiment
<i>Pyrus pashia</i> (mehal)	Temperate	Juicy fruit
<i>P. pyrifolia</i> (sand pear)	Temperate	-do-
<i>Randia dumetorum</i> (emetic nut, banegara fruit, main phal)	Tropical	Fruit are edible, pulp relieves dysentery. Boiled pulp is used as a vegetable
<i>Rhodomyrtus parviflora</i> (hill guava, hill gooseberry)	Tropical	Evergreen shrub. The olive-size fruit is eaten and also made into jams and jellies
<i>Rhus sinuata</i> (dansaru)	Tropical Subtropical	Small pisiform brownish red fruit are subsweetish
<i>Ribes glaciale</i> (karu dhak)	Temperate	Excellent edible fruit
<i>Rubus ellipticus</i> (Himalayan yellow raspberry)	Temperate	-do-
<i>R. fruticosus</i> (blackberry)	-do-	-do-
<i>R. niveus</i> (Mysore raspberry)	-do-	-do-
<i>R. rosaefolius</i> (Mauritius raspberry)	-do-	-do-
<i>Sorbus aucuparia</i> (baltal)	-do-	-do-

<i>Spondias pinnata</i> (ambarella, great hog plum, amra, otaheite apple)	Tropical	Fruit are used as juice, squash, jam or preserve, have flavour like that of mango or pineapple
<i>Syzygium cuminii</i> (jamun)	Subtropical	Timber tree, edible aromatic fruit of medicinal value
<i>S. fruitcosum</i> (wild jaman, jamao)	-do-	Fruit is edible and grown as an avenue
<i>Tamarindus indica</i> (imli, tamarind)	-do-	Fruit used as precious condiment, medicinal in nature
<i>Terminalia catappa</i> (Indian almond, tropical almond, desi badam)	Tropical Subtropical	Kernels (seeds) are edible and bark and fruit are used for tanning
<i>T. bellirica</i> (belleric myrobalan, bastard myrobalan, bahera)	Subtropical	Fruit pulp is used in dropsy, diarrhoea and leprosy. Half ripe fruit are purgative
<i>T. chebula</i> (yellow myroblan, chebulic myrobalan, harara)	Subtropical	Fruit are used in medicines as laxative, stomachic, tonic and purgative. Main component of ayurvedic medicine preparation "triphla"
<i>Vitis parviflora</i> (Himalayan wild wine, barain)	Temperate Subtropical	The black purple berries are sweet with good flavour
<i>Zizyphus mauritiana</i> (ber)	Tropical Temperate	Fruit are eaten fresh and dried and processed into delicious candy. Rich in vitamin A, B and C and sugar.
<i>Z. nummularia</i> (jharber)	Arid Subtropical	The brownish red fruit are sweet
<i>Z. oenopha</i> (makoh)	-do-	A scandent shrub. The small reddish brown fruit are sweet
<i>Z. rugosa</i> (dhaura)	-do-	A climbing shrub. The creamish ripe drupes are subsweet
<i>Z. vulgaris</i> (sijhuli, unab)	-do-	The oval shaped drupes are subsweet

Submission of Articles

The WANATCA Yearbook is devoted to useful longer articles, likely to have continuing reference value, about any aspects of nuts, fruits, and other tree or perennial crops.

Articles would be gladly received from any source - there is no requirement to be a member of WANATCA. If the text is available on a computer or word-processor disc, this is greatly appreciated. Text and enquiries can also be sent by fax or e-mail.

The WANATCA Yearbook is produced at the Tree Crops Centre, Perth, for the West Australian Nut & Tree Crop Association Inc.

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WEST AUSTRALIAN NUT & TREE CROP ASSOCIATION (Inc)

Founded in 1974, the Association has built up a wide membership among professional growers, amateurs, researchers, horticultural bodies, libraries, nurseries, and investors. Members are based throughout the State, all over Australia, and in many overseas countries.

Membership fees cover subscriptions to all WANATCA publications. Currently these are: a quarterly magazine, **Quandong**, and the **WANATCA Yearbook**.

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The **Australasian Tree Crops Sourcebook (ATCROS)** is our major reference work, containing regularly-updated tables of all sorts of useful material about tree crops (common and botanical names, growing conditions, recommended areas etc.), membership lists, lists of useful tree crop organizations world-wide, and a commercial-sources list, acting as a Directory of Tree Crop Services for the whole of Australia, New Zealand, and adjacent areas. Relevant services (e.g. seed suppliers) are listed world-wide. This information has now been updated and converted into a major World Wide Web site on the Internet - address is <<http://www.AOI.com.au/atcros>>.

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