West Australian Nut & Tree Crop Association YEARBOOK --7 --1982

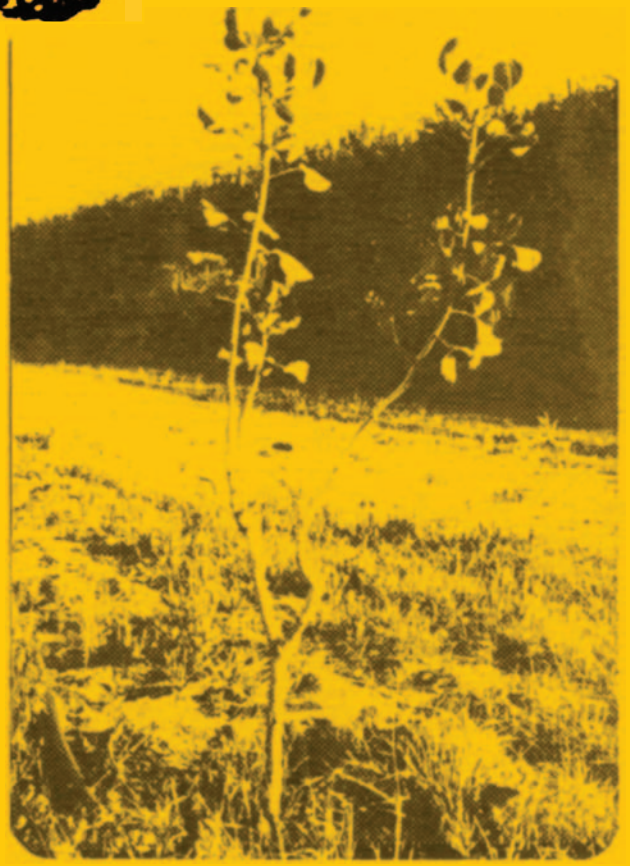
ISSN 0312-8997

WANATCA YEARBOOK

Supplement to

QUANDONG

ISSN 0312-8989



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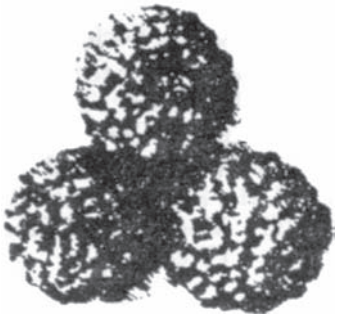

West Australian Nut & Tree Crop Association

Incorporating the West Australian Nutgrowing Society

Yearbook

Volume 7 - 1982

COVER PHOTO:

Pistachio (*Pistacia vera*), a 2-year tree of the Australian selection 15-11 ('SIRORA'), growing at Wanneroo. Photo taken in early June as tree was entering dormancy.

W.A.N.A.T.C.A. YEARBOOK - VOLUME 7, 1982

This Yearbook was edited by Lois Evans and was published in 1982. It follows on from the W.A.N.S. Yearbook - Volume 6, 1980, which was published by the West Australian Nutgrowing Society in 1981.

WEST AUSTRALIAN NUT AND TREE CROP ASSOCIATION

The Association incorporated the West Australian Nutgrowing Society as from 1981. It has continued publishing the quarterly newsletter 'Quandong' and the Yearbook. For details of membership and subscription rates, write to the Secretary, W.A.N.A.T.C.A., PO Box 27, Subiaco, W.A., 6008, Australia. Members are welcome from outside Western Australia, and overseas as well as in W.A,

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PO Box 27, Subiaco, WA, 6008, Australia

West Australian Nut & Tree Crop Association

Incorporating the West Australian Nutgrowing Society

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EDITORIAL - JUNE 1982

Apologies for the late issue of this 1981 Yearbook. However, David Noel has been breaking a new Editor to harness - me.

Apparently an Editorial is in order so, very briefly, here it is - so that I can race the copy back to David and say, "Well, what's next?"

Actually, this is an ideal opportunity to draw attention to the very major role David Noel plays in the success of the Association, having given most generously of his time and talent ever since its inception.

David has quietly and willingly borne much of the workload involved, and recently saw the fulfilment of one of his most cherished ambitions when the first Australasian Conference on fruit and nut crops was held in Perth this year.

During 1981 the West Australian Nutgrowing Society (W.A.N.S.) re-organised and became the West Australian Nut & Tree Crop Association (W.A.N.A.T.C.A.). This change was made to cater for the rapidly expanding interest in tree crops of all kinds.

Ideas on future Yearbook articles are solicited. What are your interests? Suggestions are always welcome.

---Lois Evans

THE RELUCTANT MIGRANT*

"The Reluctant Migrant". That is the name applied by David Noel, President of the W.A. Nut & Tree Crop Association, to the whole body of Australian Agriculture.

"Australian agriculture was brought over from Europe with the successive waves of migrants",, says David. "The whole basis of agriculture in Europe is different. England's 'Green and Pleasant Land', Ireland's 'Emerald Isle', got that way because their climates included regular, soft summer rains."

"Because of this, the agricultural techniques that the migrants brought with them are quite unsuited to our conditions of hot dry summers and cool wet winters", he says. "Those techniques have been made to work in Australia, but at a cost which is only now starting to be realised. The most important of these costs is the relentless increase in the amount of salted-up and eroded agricultural land".

Now the Nut & Tree Crop Association is in the forefront of efforts to reverse these trends. Instead of annual crops, which depend on catching erratic rains at just the right times, and put the land under the plough, they promote tree-based crops which are able to ride through the seasons and do not expose the soil to erosion through regular ploughing.

"There is clearly a place for field crops and animal grazing on the Australian agricultural scene", David Noel says. "After all, wheat and sheep have been the basis of our agricultural economy. But if erosional and saltation problems are to be avoided, these techniques must be integrated with the complementary technique of tree cropping".

David points out that the basic limitation to plant growth in the European scene, from which our agriculture came, is winter cold. The frosts and snows of temperate Europe greatly inhibit physiological processes in plants, and trees and other perennial plants have evolved to survive through the cold season until favourable conditions return.

In Australia, the main limitation to plant growth is summer drought. Here, too, trees have evolved to beat the local limitations, but because the limitation is different, the trees function quite differently to the European models. Annual crops like wheat are different again. Our wheat farmers have put themselves in the precarious position where they are totally dependent on getting just so much rain at just the right time, for successful harvests.

As well as putting in wheat crops and running grazing animals, farmers should be planting trees, David feels. And not just for soil stabilisation and wind protection, but also for useful agricultural products -- nuts, fruits, animal forage, honey, cork, and resins, to name just a few. Farmers should design their output to include complementary portions from the triple spectrum of tree, field, and animal crops.

* Based on an article published in the "West Australian", Jan 16 1982

I talked to Milan Mirkovic and Alex Sheppard, WANATCA members who this year won a $20,000 Rolex Award for Enterprise for their development of a technique for raising trees from seed under arid conditions. Their technique is based on specially designed foam containers, which are filled with the local soil to which a synthetic water-holding material is added.

These containers, which have been assigned the name of 'Pocket Oases', provide a favourable microclimate which enables suitable tree seeds to grow and prosper where it would be too hot and dry to survive otherwise.

"Many farmers are now realizing the importance of planting trees on their farms", they say. "But farmers often cannot afford the sheer time needed to nurse young trees through to the stage where they can look after themselves. In many cases, our technique allows trees to be raised from just the one single planting operation. This operation can be fairly costly, of course, but we are trying to get these costs right down by mechanizing the planting process. And, of course, they are once-only costs. Farmers are used to going through a cycle of operations, say ploughing, fertilizing, and perhaps spraying, not once but time after time, year after year."

"Another thing that farmers are realizing is that these trees can be more than just a means of helping their cropping or grazing incomes", they say. "These trees can themselves produce productive crops, and can produce them with very much less effort than their traditional methods. For example, feed for animals can be grown as tree foliage, and does not need constant seeding and attention for good results."

One of the tree crops that Milan and Alex have concentrated on is the jojoba nut. This plant originated in the deserts of northern Mexico and southwest U.S.A. (in 'High Chaparral' country), and so is a naturally drought-resistant species. Under natural conditions, however, the plants would be slow and erratic to become established -- only the seed that happened to encounter good conditions would win through. With the Pocket Oasis technique, reliable results can be got from seed plantings.

The jojoba nut has attracted world-wide interest in recent years because it is the source of a valuable oil which substitutes almost perfectly for sperm whale oil. Sperm whales are now on the protected species list in the United States, and the oil may not be imported. With its possibility of growing under arid conditions, the jojoba has become a doubly attractive proposition.

I talked to Warren Boucaut, a WANATCA member who runs a commercial retail nursery in Perth. He has become a member because of the increasing proportion of his business who has dealt with nuts and other tree crops, especially tropical fruits.

"Local interest in these new fruits has built up tremendously in the last couple of years", Warren said. 'Names like sapodilla, tamarind, tamarillo, and durian were only things which overseas travellers ever heard about, now they are appearing on my stock labels. The demand seems to be insatiable. At a recent auction of some of these newer fruit trees in Queensland, a grafted mangosteen went for over $250!".

Warren points out that although many of these fruits originated in the tropics, many of them came from high mountain areas which have quite cold conditions, and so are well suited to

local conditions. Cherimoyas (one of the custard apple family), sapotes, and some pawpaw species are examples.

All of these, which originated in the Andes of South America. have done extremely well in California, under conditions quite similar to those in Perth. Others, like litchi, rambutan, and jujube, came from similar areas in China.

Although they have a tropical origin, some of the newer fruits have actually been developed as commercial crops in New Zealand, which has relatively cool conditions. The first of these was the Chinese gooseberry, which the New Zealanders took over and renamed the Kiwi Fruit. They now export it all over the world. Their second crop was the tamarillo (or tree tomato). Both these crops are now beginning to be grown commercially in Western Australia.

Another tree crop which has turned into a real glamour fruit is the avocado. This extremely nutritious and tasty fruit, which also originated in South America, is gradually becoming more common in Perth.

At Wanneroo, on the northern fringe of Perth, a wholesale nursery producing only nut trees and avocadoes has been set up by Ted and Lois Evans, and their friends Mal and Nola Washer. "Avocados have a great future in W.A. provided the growers are careful about certain basic points", Nola told me. "The seed used for the grafting stock is especially important if vigorous plants are to be produced. We use rootstock of the Guatemalan race, and the results are streets ahead of what can be grown from the average commercial avocado pip".

Even though a very attractive tree can be grown from an ordinary pip, the resulting fruiting ability of the tree produced is often very poor. "Partly this is because the fruiting ability of a seedling of any species is rather variable", she says. "But in the case of the avocado, there is a strange flowering pattern to take into account. There are two types of tree; in type A the flowers open as females in the morning, close around midday, and open as males in the afternoon of the second day. In type B the flowers open around midday as females, close at night, and reopen the following morning as males".

The W.A. Nut & Tree Crop Association realizes the immense task of meeting the public demand for information, and is planning accordingly. "The W.A. Department of Agriculture are doing a very good job in answering specific queries from backyard or commercial growers on particular fruits", David Noel says. "But they only have a limited staff, and cannot be expected to do training in depth in the culture of all these new fruits. In fact, for anyone seriously interested in going into fruit production on even a semi-commercial scale, they must be prepared to do quite a lot of research themselves. Our Association can only hope to point them in the right direction, showing them sources of information and plant material, and the like".

Two important events are being undertaken by the Association in the near future, in their efforts to promote the flow of information. The first of these is a Summer School course on 'Growing Nuts and New Tree Crops', to be put on with the University of W.A. Extension Service next January. This is an introductory course for prospective local growers.

The second event is a larger undertaking, and although it will not be held until May 1982, preparations have been underway for some months. In May the First Australasian Conference on Tree and Nut Crops will be held at the University of W.A. This conference will be jointly

sponsored by similar associations from Victoria, Queensland, Tasmania, New South Wales, and New Zealand,

"We will be arranging speakers from overseas as well as our Australasian experts", I was told by Peter Rolfe of the Extension Service. : 'We see tree crops as an important part of the agricultural scene, as crops in their own right as well as aids to producing field crops and animal products. I am involved with a W.A. Wheatlands Research group, and this group has come to accept the need for tree planting on wheatbelt properties, for salt and erosion control. If trees can be selected which also make useful products, they should have a great future".

(The address of the Association is PO Box 27, Subiaco, and the Association's Secretary is L . M. Budd).

AVOCADO RESPONSE TO SALT STRESS

W.J.S. Downton*, D.McE. Alexander**, and A. Frodsham*

Avocado trees do not grow well in saline conditions. They are particularly sensitive to sodium chloride or common salt, which may be present in the soil, in the water used for irrigation, or which may be carried by salt-laden onshore winds. Salt damage to avocados is especially common in low rainfall regions.

Early symptoms of excessive chloride (Fig. 1c) are leaf tipburn and chlorosis (yellowing) of the interveinal regions, especially at the tip end and along the margins of the leaf. As chloride continues to accumulate, the chlorotic areas become necrotic and, under severe stress, the leaf abscisses. Sodium, on the other hand, is retained in the roots of the avocado and symptoms of sodium toxicity in leaves may appear quite suddenly after the capacity of the roots to retain this ion has been exhausted. Sodium toxicity symptoms (Fig. 1b), which may occur together with chloride burn on the leaves, consist of necrotic spots along the margins and centre of the leaf. Leaf abscission, tip dieback and bud abscission may result from sodium accumulation. Flower buds and young fruit may also be shed.

A way of overcoming the adverse affects of salinity in perennial fruit crops is by using rootstocks that prevent the movement of the salts into the scion (Fig. 1).

Avocados have been grouped into three separate races, namely Mexican, Guatemalan and West Indian. These reflect the probable areas of origin of the trees, and the races vary with respect to several attributes. In general, Guatemalan race varieties are considered to be more effective at restricting the uptake of chloride than Mexican varieties (Haas, 1950; Embleton et al., 1962; Kadman, 1963), whilst West Indian material is reported to be even more salt tolerant (Haas, 1950; Kadman and Ben Ya'acov, 1976). At present, however, there is little West Indian material available in Australia.

The CSIRO Division of Horticultural Research has been studying the effects of salinity under controlled conditions on the performance of avocado scions grafted to different rootstocks, and has been evaluating potential avocado rootstocks under field conditions. This article details some of this research.

In a glasshouse trial (Downton, 1978), one year old avocado trees consisting of Fuerte scion (the principal commercial variety in Australia) grafted to seedlings of either the Mexican race (AVI)***, the Guatemalan race (AC23)***, or the named variety Zutano (a Mexican/Guatemalan hybrid) were subjected to different salt treatments. Frequent heavy waterings of 5, 10 or 20 mM (293-1170 ppm) sodium chloride (NaCl) in nutrient solution were given so that the salinity in the rootzone remained close to that of the solution applied. The different salt treatments ended after nine weeks, and the trees were then given tap water (containing a maximum of 2 mM NaCl) for a further twenty weeks. A control group of trees received salt-free water throughout the trial.

* CSIRO Division of Horticultural Research, G.P.O. Box 350, Adelaide, South Australia, 5001.
** Private Mail Bag, Merbein, Victoria, 3505.
*** These codes refer to mother trees in the CSIRO avocado collection at Merbein, Vic.

Measurements of stem diameter of the scion showed that the three rootstocks used in the trial made little difference to the growth of the control trees receiving salt-free water. However, obvious differences showed up in the groups given saline water. Fuerte scions on the Mexican rootstock were the worst affected, displaying chloride toxicity symptoms similar to those seen in some commercial orchards, ranging from tipburn to extensive leaf burn and leaf fall. The scions on the Guatemalan rootstock also displayed leaf symptoms of chloride toxicity, but the effect of salt on stem diameter was less than when Mexican rootstocks were used. For example, watering with 5 - 10 mM NaCl did not affect stem growth in trees on the Guatemalan rootstocks but reduced the stern growth of trees on the Mexican rootstock by about 10% to 40%. Similarly, the most saline water used in the trial (20 mM NaCl) gave only a 30% reduction in stem growth in trees on the Guatemalan but halved the rate of stem thickening in the trees on the Mexican rootstock. Throughout the range of salinity used, Zutano as a rootstock gave intermediate results, perhaps consistent with its being a hybrid of the two races.

Interestingly, even though salt treatments stopped after nine weeks, stem growth continued to be affected until the termination of the experiment, twenty weeks later. The inhibition of stem growth brought about by salt was apparently not immediately relieved when the trees were returned to more favourable conditions.

Measurements of total scion dry weight at the end of the experiment confirmed the pattern found in the rate of growth in stem thickness (Fig. 2). Salinity effects were most obvious in the trees on the Mexican rootstock and least obvious in those on the Guatemalan stock. Zutano, again, gave intermediate results.

The trees began to flower about eight weeks after salt treatments stopped. Salt stress had mixed effects on flowering. Mainly, it led to a marked increase in the number of buds formed but, where the stress was particularly severe, as in trees on the Mexican rootstock given 20 mM solution, it severely inhibited flowering. The apparent stimulation of flowering at the low salinity levels was possibly due to a growth check provided by the salt treatment under glasshouse conditions. In the field situation, other environmental factors are likely to affect flowering behaviour, and it is not yet known whether this effect would then be observed. The ability of the Guatemalan rootstock to protect the scions from salt stress was further confirmed by the fact that the 5 mM solution had no effect on flowering in these trees, although the more concentrated solutions stimulated increased flower production.

In avocados, however, a large number of flowers does not necessarily mean a good yield of fruit, as this crop normally flowers profusely but retains only a few fruit. The effect of salinity on the important processes of fertilization and fruit set requires further investigation, but there are indications of complete crop loss due to excessive salt in some orchards along the Murray.

Overseas studies have shown 20 mM chloride to reduce fruit production of Hass scions grafted to a rootstock of Mexican race, whilst 20 mM sodium completely stopped fruit production (Bingham et al., 1968; Bingham and Nelson, 1971).

In summary, this trial shows that irrigation of avocado plantations with saline water will lead to salt toxicity problems if scions are grafted to salt-intolerant rootstocks. Of the seedlings selected as rootstock material in this study, the Guatemalan selection was about four times more salt tolerant than the Mexican selection, based on growth data. However, it must be remembered that many different varieties of Mexican and Guatemalan races exist. So, while

Guatemalan stocks are generally more salt tolerant than Mexican stocks, each race has within it a range of tolerance that overlaps with the other. Further, Mexican race varieties have some desirable horticultural features. They are more cold tolerant than Guatemalan race varieties and they produce a smaller tree without appreciable drop in yield.

At present, growers do not have much choice as to what their trees are grafted to. Demand for trees is so great that any sort of seedling material available is being used as a rootstock. This study does, however, sound a warning against the indiscriminate use of seedling material where an adequate degree of salt tolerance may be a prerequisite to successful avocado growing.

The Division has also planted field trials involving a range avocado rootstocks to assess salt uptake and field performance. Wherever possible, available West Indian race material has been included in these trials that are located at Kingston-on-Murray in South Australia, Coomealla in New South Wales, Merbein in Victoria, and at Darwin in the Northern Territory. Trees from the earliest of these trials have now commenced flowering, but several years of yield data are required before any accurate predictions on the performance of different rootstock scion combinations are possible.

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Figure 1

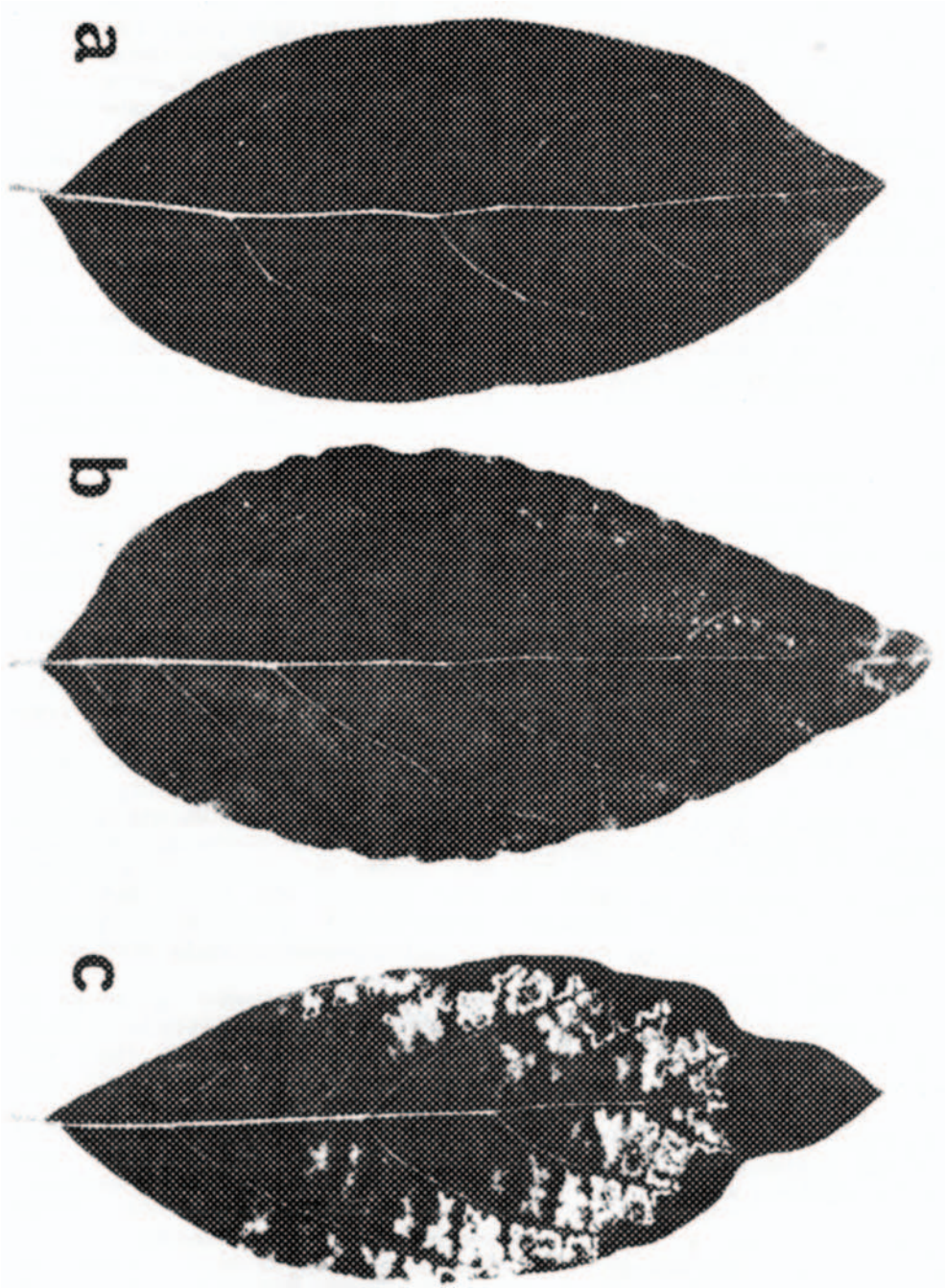
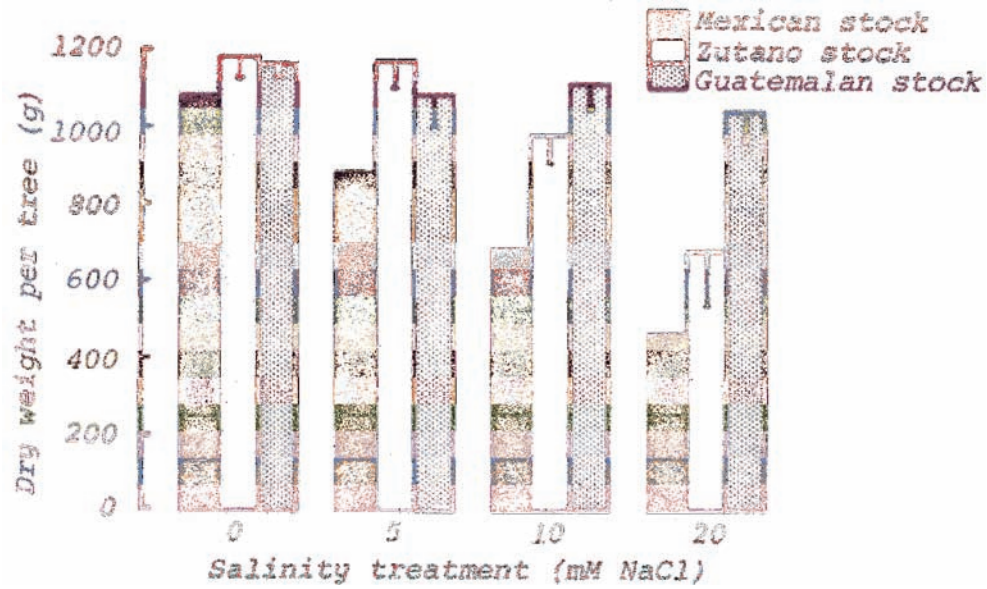


Figure 2

Avocado Response to Salt Stress



LITCHI (*Litchi chinensis*)

B.W. Cull & B.F. Paxton
Dept. of Prim. Maroochy Hort. Res. Station Industries Nambour, Qld.

The litchi, less preferably known as Lychee, has its origin, as can be seen by its specific name, in China. There, it has grown and been cultivated in the southern KWANGTUNG province for thousands of years. Belonging to the family *Sapindaceae* it is closely related to the Rambutan, Pulasan and Longan, also well known fruits of South East Asia.

THE TREE

The tree can be slow growing in the first year or two. However, with good nutrition and cultural conditions, it develops rapidly thereafter. The appearance of the tree is ornamental and, although large at maturity, is suitable for commercial and backyard use. The larger varieties can reach 10-15 metres in height and breadth at 30 years, while some of the less vigorous but commercial types reach only half this size.

The leaves of the tree appear as either light green or brownish red flushes. This colour characteristic, along with the leaf structure and leaflet shape, aid in the identification of varieties. The leaf is a compound structure with two to five pairs of leaflets arranged in opposite positions along a central stem. Leaflet length varies from 5 - 20 cm. Smaller leafed varieties also appear to be less vigorous, and this is relevant in that the lower vigour trees are producing more reliably in Southern Queensland.

Flowering occurs in spring and fruit matures in mid-summer. The flowers are insignificant, being carried in masses on panicles at the end of the branches. Five flower types have been described on one plant but, in practical terms, there are separate male and female flowers on the one panicle. The main difference is that the males have six to ten stamens, each up to 5 - 7 mm long and no ovary development. The females have rudimentary very short stamens, which do not produce pollen, and a well developed central pistil with an obvious two lobed ovary.

The male flowers open first followed by the females. Overlapping occurs, however, to some extent on the panicle and usually between panicles within a given tree. In some instances only male flowers form on some panicles, resulting in no fruit set. This is thought to be due to juvenility.

The fruits, described as “One of the daintiest packages that has been wrapped by Nature’s hand,” are relished by most people. Only one fruit normally forms from the twin ovary, although rarely twins form, each with a seed. The fruit range in size from 2 - 4 cm and are round to heart-shaped to conical, depending on variety. The outer skin is leathery and covered by rough protuberances. The colour ranges from yellow, through yellowish red, bright red to dark red, which is also a varietal characteristic. The leathery skin, on exposure to drying, becomes brown and brittle and cracks like a shell. In the dried form, the Americans had their first experience of litchi and, because of the above character, called them “Litchi Nuts,” a term not to be encouraged.

The flesh, which is white and translucent, tastes like a scented grape. Australians tend to like varieties with a balanced sugar-acid ratio, as some varieties are sickly sweet and may become bland when over mature. Varieties also vary in their juice content and, although Asians prefer those with a lower juice level, which they described as crisp, some Australians relish the juicy types.

The seeds are brown, varying in size and shape. Normal seeds can be round to oblong to bullet shaped, filling from one quarter to one half the fruit volume. Size is also related to the formation of the seed in that, in some varieties, they are aborted. The aborted seeds, because of their shape, are termed “chicken tongues” and such fruit are prized because of the high flesh to seed ratio. The number of fruits containing such seed varies from a few percent in some varieties to all the fruit in others. The occurrence can vary from year to year and appears to be under climatic control while, in other varieties such as No Mai Chee, no normal seeds are ever formed.

CLIMATIC REQUIREMENTS

Climatically, the litchi prefers a sub-tropical location, not performing well in semi-tropical or tropical countries. The trees, when mature, are capable of withstanding light grass frosts. Young tree s should be fully tree guarded on all sides for the first twelve months to stimulate growth and prevent frost or cold damage to which they are highly susceptible at this stage.

Reports of mature trees surviving below zero temperatures are available, but damage does occur to foliage and normal flowering is upset below 5 C. In commercial practice, sites registering any frost are best avoided at this stage of knowledge.

The litchi appears to perform best with an annual climatic pattern which has a consistently dry, cool autumn for three to four months preceding flowering in late winter. The weather at flowering should be mild and fairly dry.

During fruit development, warm conditions with good, evenly spread rainfall up to mid-summer at harvest is desirable. Following harvest, temperature and rainfall should be such to give strong active vegetative growth. The reasoning behind this is related to the competition between vegetative and flower development which is critical in this crop. This aspect is more fully covered under the section, ‘Crop Management.’

Both plant growth and flower development are strongly retarded and damaged by strong winds. Dry, hot winds at flowering can eliminate the flowers, while flowering does not occur on sections of the tree pounded by prevailing winds. For these reasons, wind breaks are a must. Depending on the site, permanent external breaks, such as Eucalyptus or Pinus species established prior to planting the litchi, are desirable. In exposed and hilly positions, internal temporary breaks, such as Barner Grass are required until the orchard canopy is large enough to provide some self-protection.

SOIL REQUIREMENT

The litchi has been found to grow well on most soil types, even those with poor drainage. For this reason, it has an advantage in that it can be used in locations were crops such as avocado will fail. Although it will stand wet soils, it will not stand water logging and, in wet sites, landing of the soil on a row basis to give ridges some 30 cm high is an advantage.

Experience is showing that lighter, lower fertility and water holding capacity soils may be easier to manage with respect to crop control. This is related also to being able to control tree vigour. It is thought, however, the less vigorous varieties, such as No Mai Chee and Wai Chi, may be able to be managed on heavier soils.

At the present state of knowledge, preference in soil selection is given to lighter sand and red loam soils.

VARIETIES

A range of varieties are present in Queensland. Their characteristics are described in the following table. The naming of varieties has gone through some change over the years. The first name listed and the spelling is the most recent agreed version and relates closely to that used in China, but may not fit those reported in Hawaiian or Florida literature.

PROPAGATION

The litchi seed is viable although its life is short, a matter of one or two weeks once taken from the fruit. Dehydration is the problem and storage is best in the fruit or moist peat moss in a refrigerator. Seedlings are, however, highly variable, slow to grow at first and reluctant to bear unless juvenility is overcome by cincturing.

Commercial propagation is by way of air layers (marcottage), although grafting and striking of cuttings is possible. The ease and surity of the first technique tends to offset any efficiency in use of propagation material afforded by the latter two techniques.

Air layers can be obtained at any time of the year. However, the late summer/autumn and spring/early summer periods are preferred. This is because, in warmer months, root development is rapid while, in winter, the rate of development is too slow. The vegetative maturity of the branch on which the air layer is placed is important. The most recent vegetative growth should be well matured, as recently flushed wood has depleted reserves and roots poorly.

The size of the wood used in air layering is quite variable. A small branch, 2 - 2.5 cm in diameter at the air layer and 45 - 60 cm long, establishes a good plant without excessive use of the mother tree.

The air layer used is the standard technique, where wet peat moss is encompassed in a clear plastic sleeve to make a root ball 10 - 15 cm in diameter. Care must be taken with the cincture as the wood of the litchi is often furrowed. It these furrows are not cleaned back to white central wood, the cambium layer will regrow and rooting will not occur.

The air layers are removed when six to eight roots, which can be seen through the plastic, turn from white to creamy-brown. The plants are best established in nursery bags or pots. They should be held for two to three vegetative flushes, under wind protected and shaded conditions, before hardening off in the open and planting out. When potting litchi air layers, the root system is easily damaged or the root ball fractured from the stem. The mix should be well drained and, when potting, should be well pressed around the root ball to gain good soil contact.

LITCHIS - MAJOR VARIETIES IN QUEENSLAND

Variety	Season (Sth Qld)	Yield (Sth Qld)	Vigour	Fruit Quality	Av. No. Fruit/kg	Av. Proportion Edible	Seed Size Mean chicken tongue seeds	Tree Identification	Comments
Tai Tso (Qld Kwai Mi)	Mid-Dec./ Early Jan.	Moderate	High	Fair to Good	53	65	Large 11	Open spreading shape. Leaflets glossy dark green with distinct upward curl from midrib - canoe shaped.	Weak crotches - branches very susceptible to wind damage.
Bengal	Early Jan.	Moderate	High	Acceptable	48	56	Large 3	Well shaped structure. Large leaflet blades held horizontally to midrib - slight wave to tip.	Very poor flesh/seed ratio.
Haak Ip	Mid-Jan.	Regular	Medium	Very Good	50	72	Large	Slightly upright spreading shape. Leaflets dark green, long, narrow tapering to a pointed tip with a slight curl from the midrib.	
Kwai May (orange) Bosworth 3	Mid-Jan.	Regular	Medium	Good	58	72	Medium 53	Upright shap with strong branch development. Leaflets medium length, narrow with well-defined curl upwards from midrib.	
Kwai May (red) Bosworth 10	Mid/Late Jan.	Regular	Medium	Fair	-	70-83	Mostly Small	Upright shape. Leaflets long & broad with a slight curl upwards from midrib.	Sweet-scented fruit. Sweet long before full maturity.
Gee Kee	Mid/Late Jan.	Erratic	Low	Good	65	72	Medium 59	Compact dome shape with many growing points. Leaflets broad, flat, and recurved at the tips.	
No Mai Chee	Late Jan./Early Feb.	Consistent	Low	Excellent	66	81	Small	Slightly open dome shape. Leaflets small pale green	Lateral variety. Good market potential.

PLANTING

The aim with early tree establishment is to gain rapid growth and then, at year four, to reduce vigour to induce flowering and fruit set.

Good preparation of the planting site three months before planting aids this vigour. The incorporation of decomposed organic matter and 500 g of single superphosphate to a depth of up to 30 cm over a square metre are is suggested. Where soils are very sandy and infertile, the superphosphate may be replaced with a similar quantity of a fertiliser, mixture 12:12:17. The litchi prefers slightly acid conditions. However, when the pH is below 5.0, then lime at 1 kg per square metre is required. Where magnesium is known locally to be deficient, then dolomite should be used as an alternative to lime.

Care should be exercised, when planting, not to wrench the root system off and, for this reason, the potted plant should not be carried by the stem. On planting, assure firm contact between the root system and the soil mass. The plant should be firmly staked and tied to avoid wind damage, unless a tree guard is used. A tree guard of four stakes and hessian or synthetic
cloth to one metre high on four sides affords good protection. This gives easier and faster establishment, protection from light frost and higher growth rates for the first twelve months. After this time, they may be removed.

Mulching with organic materials is desirable in that they assist with moisture control, give a steady supply of nutrients, and assist with weed control.

TREE TRAINING

Only minimal tree training is practiced. Nursery trees should be pruned to give a single leader and this is planted in an upright position. In early years, the branching can give rise to acute crotch angles, which are subject to splitting. As this early development forms the basic framework of the tree and, should it collapse in later years, the tree can be ruined completely. Limbs formed and lost in later years do not result in such drastic losses. Hence, for the first three to four years, where acute crotch angles form, one of the offending limbs should be removed as early as possible.

One aim in litchi training is to develop sufficient fruiting terminals and some varieties tend to produce excessively long branches with limited branches. Where these occur, tipping of branches in the early years can induce a more balanced tree. Severe pruning should be avoided, as this reduces tree development and increases time to first harvest significantly.

TREE MANAGEMENT

Young trees are grown as vigorously as possible, to achieve greatest tree size and bearing surface in the first three years. To achieve this, a continuous supply of nutrients and water are required throughout the whole year.

Trees from three years onwards require careful management to induce regular flowering and fruit set. The litchi is very responsive to environmental conditions which control the vegetative and flowering cycles of the plant. It is known that excessive vegetativeness and particularly, vegetative growth during the autumn/winter period (April/July), will reduce or

inhibit flowering. This is believed to be related to the dissipation of carbohydrate reserves into vegetative growth and with this growth not being physiologically mature to flower.

As the litchi is a terminal flowering species, it must make sufficient growth each year, followed by time to mature this growth, before flowering.

For the above reasons, tree management is directed firstly to gaining maximum vegetative growth in the natural flush period immediately following harvest in mid-summer. The second requirement is to maintain the plant in a state of dormancy for three to four months before flowering and fruit set.

In fruiting trees, the fertiliser programme is directed to supplying the maximum nutrient input prior to the summer flush. Organic fertilisers and other residual fertilisers are not recommended to avoid the carry-over of large nutrients reserves into autumn. Irrigation, if good rain does not fall at this time, is used firstly to gain maximum growth and benefit from the fertiliser and, secondly, to leach away excess fertiliser. For this reason, permeable less fertile soils are preferred, as they are easier to manage in this way.

Cincturing of trees after the mid-summer flush has matured, and just prior to, or as an autumn flush commences, has been found to induce a dormant autumn stage and good flowering. A cincture the width of a saw cut is sufficient and may be applied to the main stem or major limbs. The timing is related to stage of growth and not a specific calendar date. Trees must be fairly vigorous to respond well without damage to the tree and reduced fruit size. Vigour is maintained with the pre-harvest fertiliser application, the actual level of vigour can only be assessed by experience.

The watering programme is somewhat dependant on the normal rainfall pattern. Localities which have a constantly dry autumn/winter are more suitable for litchi and management is far easier. Irrigation in the four months before fruit set is managed, with light applications to prevent severe stress occurring while preventing ideal conditions for vegetative growth.
Once again, lower water holding capacity soils are easier to manage. No objective guidelines are presently available for water management during this period and one must depend on personal experience.

This stressing is continued until flowering parts fail from the fruit and they become obvious on the panicle. Watering should be gradually increased, using light applications. Heavy applications at this time have been associated with shedding of fruit.

The fruit development period is another management stage. Once fruit are set, the increasing applications should rise to high rates to prevent any stress. Litchi fruit approaching maturity are subject to splitting if excessive rainfall occurs. This condition is greatly increased if early fruit development is retarded by water stress. Retarded development also results in a lower flesh to seed ratio and this is particularly evident in the big seeded variety, Bengal.

NUTRITION

Fertiliser applications at and prior to planting have been previously described.

Planting to Bearing Stage

The fertiliser programme in young trees commence when they show their first growth and little and often is the principle. Excessive amounts early especially on shallow, poorly drained soils can result in death of the plant.

In the first year apply 30 g of a high nitrogen fertiliser, such as Urea, monthly and at three monthly intervals, an additional 30 gms of a 12:5:15 mixture or similar fertiliser. The rate in each case is increased to 50 gms in the second year.

Each fertiliser application should be followed by irrigation. In cold areas plants should not be forced into growth coming into winter as flushing plants are more sensitive to cold damage.

In years three and four, and in slow growing localities, in year five, applications using 12:5:15 mixtures, rise to a total amount per tree per respective year of 900, 1200 and 1500 grams. This is broken into six even monthly treatments. Additional Urea may be applied if growth rate is slow or leaf colour is light to pale.

On poor soils, organic fertilisers may be used to great advantage in the first three years. Rates equivalent to eight litres of decomposed fowl manure for the second year and twelve for the third year are suggested.

The management of the fertiliser type and the rate used depends greatly on the soil type, the rate of growth being achieved and the experience of the grower. Higher rates than those indicated above can be used on heavier soils and should be tried if growth rates are not sufficient. If, at four years, trees are excessively vigorous and loathe to bear, fertilising should be stopped until leaf colour falls and fruiting commences. Cincturing will also assist greatly under such conditions. In soils where phosphorus is known to be deficient, high levels should be applied in these establishment years. Similarly, where minor elements are a problem, these may be provided, either by way of commercial mixtures or as supplementary sprays.

It is suggested that a leaf analysis should be taken after two years' field growth, to explore the possibility of gross deficiencies or excesses. This is a good management guide for both well grown and poor trees.

Bearing Stage

With bearing trees fertilising is limited to the period immediately prior to the mid-summer vegetative flush. Based on commencing at the end of the fourth year in well grown trees, when fruiting should have commenced, the following treatments are suggested. A 15:4:11 mixture at the rate of 900 g two weeks prior to harvest and again two weeks after harvest. The rate per year per treatment time increases by 200 g, up to year twelve (i.e., twelve year trees receive two applications of 2300 g). Trees thereafter receive the twelve rate if they are in a hedge row configuration, with a in-row spacing of six to eight metres. Wider spaced trees, as they grow, should receive proportionately higher rates.

The above rates are only a guide and nutrition management should be assisted by, firstly, leaf and soil analysis and, secondly, a recording of yield and vegetative vigour of the tree. The former tools will provide a guide to the balance of elements used and the inclusion of minor elements. The assessment of yield, vigour and leaf colour will guide the upwards or

downwards movement of rates. The ultimate rate used is very dependent on variety, soil type, climatic conditions and crop load and, for this reason, local management and adjustment of rates used is vital.

FRUIT HARVESTING AND HANDLING

On the east coast, fruit maturity commences with the Tai Tso (Qld Kwai Mi) variety in North Queensland in late November. The season concludes in March, in New South Wales, with No Mai Chee.

The fruit can be eaten over a range of maturity which is related to the level of acidity. People differ in their taste requirements and the best test for establishing harvest time is by tasting the fruit on the tree. Harvested fruit do not ripen once picked, hence fruit forwarded to markets too early, in an attempt to gain high early prices, only ruin the grower's name and the name of the litchi in the marketplace.

The majority of fruit can be removed from a given tree in one harvest. One variety on a given property will require picking within a two week period. This can be slightly extended by selective picking early and, in some cases, odd trees tend to be one to two weeks out of phase with the majority of the trees of the same variety.

This compression of the harvest period tends to necessitate the use of a range of varieties to spread the harvest workload and also the use and size of equipment required to facilitate the marketing of the crop. Likewise, to established a viable market, the fruit has to be before the public for an extended period to develop awareness, both in the given year and the longer term. This can only be done by encouraging a range of production centres with varying harvest times and by adding to this the spread, achievable by the varieties.

If fruit are allowed to reach a good stage of ripeness, each panicle can be cut from the tree as one. As the fruit are carried on the outside of the tree picking platforms and ladders are used to reach higher fruit. Fruit should be treated carefully and kept out of the sun. However, they are fairly robust and surface rub is not a major problem.

Presently, fruit are marketed as singles and the removal of fruit from the panicles is a time consuming chore, as they are generally hand clipped to avoid damage. A range of containers are being used and tested for marketing. These range from strawberry punnets through to 5 kg trays.

Dehydration is the major cause of fruit deterioration. Fruit not protected, dry very quickly, and the colourful skin turns brown within a few days, causing the product to be very unattractive. Efforts to maintain humidity tend to cause post harvest rots to develop. For these reasons pro-cooling, cool storage, covering with a PVC film and a fungicide dip are employed.

The fungicide dip employs hot water at 52°C and Benlate (R) at 1.0 g/litre with a dipping time of two minutes. When covered in trays with PVC film, they remain in a good condition for up to eight days without refrigeration, and for longer with cool storage. The litchi fruit can withstand temperatures down to almost 0°C without damage.

PESTS

Several major pests occur, including the universal pest of litchi, the Erinose Mite (*Eriophyes litchi*) which attacks both leaves and flowers. It causes a felting of the affected parts turning from light green, in young growth, to dark red-brown on the underside of leaves when they mature. Every effort should be made not to introduce this pest with planting material.

A range of flower eating larvae can remove the potential crop and the Macadamia Nut Borer (*Cryptophiebia ombrodelta*) in some localities in Queensland is a major pest of developing fruit. Other pests include a soft brown scale, a stem girdler, various leaf eating beetles, fruit sucking moths and fruit fly.

The native fruit bat, or flying fox, can also be a problem.

DISEASES

No major disease is recognised. A parasitic algae attacks some trees and causes minimal decline. A collar rot has been recognised in a few instances, while odd young trees collapse for presently unknown reasons. Nematodes are recognised as a problem and the Dagger nematode has been associated with tree decline.

LATERAL THINKING ABOUT TREE CROPS

I.M. Laszlo, MA*

Some years ago, I was invited to a conference in Inverell, New South Wales. That was in 1962 and, at the time, I was teaching at Tamworth High School in the New England area of New South Wales. Whilst there, I managed to obtain some hazelnut suckers and planted them at home. They grew exceedingly well in the remaining ten years that we were there. However, they never fruited, and my wife decided to pull them out. She was angry at putting effort and hope into shrubs that produced nothing.

Today, I understand what happened. We probably had suckers (from a New South Wales research station) that all came from one stock, and hazelnuts are self-sterile. You may ask, "What has this to do with lateral thinking and tree crops?" I ask you to hold your judgement because, as the title says, this article is about lateral thinking on tree crops generally, with some specific experiences and research results. Lateral thinking is approaching the situation sideways, so to speak, to see what sort of ideas one may get that can be put into action.

Tree crops - how to approach them

This was the problem when we started to develop our small property near Yass in New South Wales. There were two separate possible approaches. One, the orthodox one; the other is what I term a lateral one. We will look at both of them and you may make your judgement then.

Horticulture in relation to fruit trees means basically the commercial production of apples, pears, plums, cherries, apricots, perhaps mulberries, citrus fruits, and sometimes walnuts (only *Juglans regia* and only one geographical race of that). That is about all.

If you look at this list, you will see, thinking laterally, that most of these fruit trees belong to two botanical families. The apples, cherries, peaches, plums., etc., are all *Rosaceae* that is, the rose family. The other main one is the *Rutaceae* or citrus family. What about the rest? Yes, what about them?

My wife and I started to gather information and found a rather interesting picture. The commonly accepted idea of tree cropping is clean cultivation and the use of mostly these two botanical families. The picture was familiar - tractors, irrigation, sprays, insecticide, pesticide, etc. The rose family has one only nut tree (the almond), and the citrus group has none. However, Menninger refers to roughly 1300 edible types of nuts. Most are tropical but, even so, there are about 200 or so species that could fruit in our area, if we leave the rose and the citrus family out.

However, the others have one interesting quality in common. Look at the walnuts, the hazels, the pines, and the tree legumes, etc. , and one finds that all these are either woodland or forest trees, while most of the rose and citrus family are smaller, either scrub trees or mediterranean woodland trees. Therefore, lateral thinking indicates that one should investigate the woodland and forest tree crops and nut bearers. Almost all of these are exotics and are taprooted

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hardwoods. The rose family is not taprooted in general; therefore, the taprooted trees require different geographical conditions and, indeed, have a lifestyle as trees quite apart from the trees that we are used to using as horticultural crops.

To a retired geography teacher, this means that one should look at tree crops from two lateral aspects. One is the significance of the taproot and the other the old and reliable standby, the Koeppen classifications of climate.

This Koeppen classification is mighty important regarding tree crops. It is part of lateral thinking, too.

Koeppen was a professor of geography in the Austrian Graz University when, in 1919, he published the first textbook that made sense of how climate comes about and what it means. Let us look at what Koeppen has managed to find out about climate.

Climate is the result of three main factors: latitude (or distance from either of the poles - longitude DOES NOT count); distance from the sea; and Iandform. These three together add up to climate. How and why is not relevant here but, if you are interested, as you should be, try to understand how the pressure belts on the Earth's surface move, and why.

So, climate is caused by latitude, distance from the sea, and landform, in this order of importance. Climate itself is rainfall, temperature, and the direction and reliability of the main rainbearing wind. Normally, when one reads about climate, it is temperature and rainfall that are mentioned, and wind is not spoken of. Winds are usually caused by movements of the pressure belts, and they can be compared with a more or less regular train running on its usual track, up or down. The proper term is prevailing wind. Now comes the hard part. Climate and the factors causing climate create soil; that is, the decay or debris of rock, combined with water and the minerals found in that rock or in that water. Vegetation may modify soil but cannot usually create it.

Natural vegetation (untouched by man) is a response to the challenge of the environment. That is what soils, landforms and climatic factors do permit. Vegetation is a response, the least important of all these. Keep this in mind.

Look at three maps of Australia. One shows the summer climate, one shows the winter climate; that is, the main prevailing winds and where they come from. On a basis of these two maps, one can construe a third one, which is the Koeppen classified map of the climatic zones of Australia.

Now, supposing that the same winds would come from the opposite direction, the response would be quite different and, therefore, the distribution and nature of the vegetation would be different, also. Of course, the Koeppen classification has been improved upon and modified by others since. Koeppen, to use a simile, discovered the wheel, but he did not discover the mag wheel. It was a later improvement on the basic idea. Now, let us get back to lateral thinking. Botanical families have developed over a period of time, possibly from some ancestry of a species or genus. When climatic conditions change, and the challenge to survive is stronger, the conditions must either be accepted and the species modifies or it becomes extinct. At one stage, there were a number of species related to the Ginkgo tree (Maidenhair tree); today, there is only one. What happened to the rest? They became extinct because they could not adapt.

Another example: before the last ice age, there were a number of species of the walnut family (*Juglandaceae* in Europe, including hickories. Most of these are now extinct and found only as fossils or in isolated locations. Only those now exist that did not need to adapt because they were outside danger, or that adapted and survived.

Now to the crux. If you look at a botanical family as a whole, however distanced are the individual genuses or species, there is something that the family, in general, has in common. The walnut family has over 40 species - about 15 true walnuts, 25 hickories, and about 10 winged walnuts (which are not edible). Each of :these is taprooted - meaning that they developed possibly in a very dry or seasonally dry environment. However, the hickories have taproots that are twice as long as, or even longer than, walnut taproots. This suggests that they probably evolved in an even drier, warmer environment. In general, hickories occur in the natural state closer to the equator than do walnuts. Therefore, if you look at a botanical family, laterally thinking, and know the Koeppen classification of your land, you have a choice of possible plant material to try that developed or adapted to an environment similar to yours. There are tropical and near-equatorial TRUE walnuts that would feel at home only in northwestern Australia or in northern Queensland.

Tree legumes are very numerous in many climates, including Australia. There are at least 800 species in almost every latitude. Many of them are spiny, the leaves are often pinnate, and most fruit is some kind of a pod. The Beech family (which includes the oaks) has, between the various genuses, variations on the same theme. They may be evergreen or deciduous; may be semi-oaks (*Lithocarpus* spp.) and the family includes chestnuts, beeches, plus other genera, not forgetting their Australian representative, the *Nothofagus* spp. However, almost all of these are taprooted, have a similar kind of leaf system (whether lobed or not), and there is a similarity in the reproductive mechanism of all.

But, this is not our main concern. For fruit production, the rose family is most commonly used today. Members of this family are almost all shallow or fibrous rooted, mainly temperate climate trees and shrubs with a similarity in their reproductive mechanism and their capacity for vegetative reproduction (from cuttings).

The citrus group is well recognizable, and its many members represent adaptations to specific environments and some hybridizations that may have occurred in nature. The mulberry and olive species each show similar adaptations and hybridization.

Therefore, it is suggested that recognizable species from another part of the world and from a similar climate, according to the basic Koeppen classification (to use a technical term, a "Homoclime"), generally may be considered to be adaptable to a similar climate in other parts of the world. That is, it may well be possible to grow it well in a similar "Homoclime."

I have to issue here a warning. Southern hemisphere west coasts have climates similar in latitude to the northern hemisphere east coasts; the southern hemisphere east coasts find a parallel more in the west coasts of other northern continents. This is caused by wind "tracks" as well as by ocean currents and the rotational direction of the Earth from west to east. This means that the coastal latitude equivalents of Western Australia are probably in Louisiana or Virginia for homoclimes, as well as in Fukien Province in China. New South Wales coastal homoclime similarities may be in North Africa, in the islands of Sicily and perhaps Portugal, or a stretch along the California coast to San Francisco.

and tropical Andes (*Juglans neotropicale*). We tried the latter but lost the young seedlings to frost. There are also desert or semi-desert varieties - the Texas walnut (*Juglans microcarpa* and the Arizona walnut (*Juglans rupestris*), and still another dry-climate-tolerant one (*Juglans major*). All true walnuts have edible seeds, not all hickories produce edible and none of the winged walnuts (that I know of) produce edible seeds.

True walnuts have a taproot, which indicates reasonably dry climate development. On the average, they can live on rainfall from 600 to 800 or 900 mm. Hickories have deeper taproots, approximately twice as deep as true walnuts, and their moisture requirement is 1300 mm or so. Walnuts in their native habitats are roughly between 35-50 N (and S) latitudes, while hickories are closer to the tropic lines roughly from 25°N to 40 ON but, in both cases, there are exceptions. There are tropical walnuts and some hickories that can stand very cold conditions indeed. There are some other differences, especially in the pith of the seed. In hickories, it is continuous but, in walnuts, it is not; however, the leaf structure and general habits of growth are similar in all cases.

To get tree crops growing in Australia, one must look at the homoclimes where a specific walnut family member species has originated. There are major differences in most species, and some of these are of vital importance. For example, that old favourite of mankind, *Juglans regia* has four geographical races and, in Australia, we have the least suitable for most areas except Gippsland. By a geographical race, I mean localised natural selection and development. What we have in Australia are mainly French types (and their Californian hand-me-downs), which have a reddish tinge on the shoots and young leaves. These are, in some cases, 200 year old selections from southeastern France (Franquette, Mayette from Grenoble), and they require the most rainfall and best conditions.

Other geographical races are the Carpathian, which is a great success in the United States of America because it can stand cold well; the Himalayan, which is little known in Australia (the Carpathian has straw yellow shoots, the Himalayan clean green); and last but not least, the Turkestani walnuts, which are both Dominant and Climax vegetation with little over 500 mm rainfall a year and from natural forests.

The Carpathian walnut is pomyotic in habit. That very important characteristic means that between 10% to 40% of the female flowers are self-fertile. They self-fertilize themselves before opening. This characteristic could dispense with the need to graft, as all the self-pollinated nuts would breed true. The Turkestani walnuts are not only pomyotic and drought tolerant, but they also have the habit of lateral budding; that is, they can and do fruit on OLD wood. Now, there is a walnut for you (and me, if we can get seeds from Russia!). The Turkestani walnuts are the ones from which we ought to obtain genetic material as they seem to be the most suited to our environment.

The hickories are quite outstanding members of the walnut family but, of the 25 or so species, only about three are important for tree cropping. The Pecan, the Shagbark Hickory, and the Shellbark Hickory. Of these, the Shagbark Hickory is the toughest and can stand very considerable cold as well as dry conditions. We grow Pecans by preference, as they come to bearing quite quickly - half the time of the others. The other hickories are mostly inedible or bitter or suitable only for pig feed, although the timber of almost all the Hickory genus is both valuable and useful.

Lateral thinking comes to the fore again. Under Australian conditions, I suggest that the most important walnut family member requiring introduction and selective breeding on a large-scale is the *Juglans microcarpa* or Texas walnut. This would grow and fruit even in places like Broken Hill. When fully mature, it grows only about 7 m high (cherry tree size) and its nuts are the size of cherries, too. Notwithstanding this, it has grown and developed in West Texas, a semi-desert area. The Arizona walnut is thought by some to be the same species, but it is slightly more delicate - it grows as a street tree in Canberra.

Lateral thinking in places that are tropical would suggest the introduction, especially in the northwest of Western Australia and the Rockhampton area of Queensland, of the *Juglans insularis* from Cuba, the *Juglans mollis* from Central America, the *Juglans neotropicale* from Peru or Columbia, the *Juglans honorei* from Equador, or the *Juglans henryi* from the Andean area. Another suggestion is the *Juglans australis* or Argentine walnut ('australis' simply means southern in Latin). The latter grows in Argentina in mountainous areas of relatively high latitudes. All these have commercial potential. In particular, the *Juglans microcarpa* (meaning 'small bodied') is the most desirable choice to work with. If it can be crossed or improved over time with *Juglans regia* it may be a walnut that is already drought-and frost-tolerant.

Now, back to lateral thinking. Looking at a homoclime with a Koeppen classification world map related to landforms, rainfall quantity and distribution, one can 'target' a walnut, oak or hazel and try to grow these in that environment. If the homoclime is close, and other conditions (soil, wind pattern) are not too different, it is likely to be successful. Lateral thinking is not a new idea: anyone travelling on the French Riviera is struck by Blue Gums flourishing there, and Snow Gums in the Himalayas and in Equador. Lateral thinking means to match the tree with a homoclime.

4. THE HAZELS

Lateral thinking on hazelnuts is a particular hobbyhorse of mine. Walnuts are produced commercially in Australia, but hazelnuts are not. In May, 1979, one ton of hazel in shell landed at Melbourne at the cost of $3,200.00. Today, it is likely to be much higher. There is a world undersupply (as with most other nuts, especially pine nuts), and I am led to believe that the undersupply is about 55,000 tonnes per annum!

The hazels are one of the six groups (genera) of the botanical family of the birch trees. Among the divisions, six are shrubs or bushes and three are proper trees. The two main macrospecies are the *Corylus avellana* group, which has one related species each in North America and in Asia (*Corylus rostrata* or Beaked Haxel in North America and *Corylus heterophylla* in Asia). The other second group is the *Corylus maxima* type; again, one on the Asian mainland and one in North America. The *Corylus maxima* type is more drought resistant than the *Corylus avellana* which requires moisture all the year round, especially in summer. Guess what we have in Australia? Right - *Corylus avellana* - probably because it grows in England! *Corylus maxima* is growing in Turkey, in Greece, in Yugoslavia, and in North Africa. Not in Australia.

The third group is hazel trees or, as an American renamed them in an excellent neologism, "Trazels." There are three acknowledged species nowadays, although ten years ago there were five. Due to botanical reclassification, two have been amalgamated into the other three. Very few people have seen any of them in Australia - there may be isolated specimens of

one species that, being rather lonesome, do not bear, and the other two have recently been introduced, of which one group has germinated. The other species is still seed, and one can only hope that, as germination of tree hazels is fiendishly difficult and slow, it may be successful.

Tree hazels do not sucker, and are taprooted. Each of these trees is ornamental, beautiful and, although closely related to the birches, looks quite different. The smallest one is *Corulus tibetica* and is about 7 m (cherry tree size) when fully grown. The Himalayan strain is about 14 m, or apple tree size. The next species is the Turkish hazel which, apparently, is capable of surviving summer drought, and grows about 25 m high. The third one, *Corylus chinenis* (which was once thought to be a variant of *Corylus colurna,* the Turkish hazel), is now an independent species.

The Chinese Hazel is a huge tree to 50 m fully grown. It occurs naturally in conditions with as little as 530 mm of rainfall, mostly in summer.

All these hazels - shrubs, bushes, trees (large and small) - can interpollinate. Hybrids developed from these are known, and their seeds appear to be true to type. So, what should we do with hazels in Australia? I think we should mix them. The reason why ray hazels in Tamworth did not fruit was that they did not have pollinators.

On purely a lateral thinking basis, the hazels for most of temperate Australia should be from dry areas (summer dry preferably, except for Gippsland and Tasmania). As pollinator species, use whatever serves best - perhaps hybrid hazels or a large variety of dry climate hazels from different geographical sources (some Asian, some North American, some European) and develop over a period of time one or several that do best in Australian conditions. If you do not follow the lateral thinking of finding homoclime material to develop, you may end up as we did: trees or shrubs grow like mad and do not fruit because they were not being pollinated. Hazels, to have nuts at all, need their "hanky-panky" and, owing to the fact that there is a difference in time of six weeks to three months between the pollinator male catkins dispersing their pollen and the female flowers being mature, there should be a pollinator species shedding pollen at the time when the female flowers are receptive. The solution for an Australian hazel industry, I think, is ONLY with a wide range of interspecies planting in one area, where you base your main planting on a species most suitable for your Koeppen classification. Tree hazels could be used as rootstocks, a few branches could carry other species' grafts, which are apparently not difficult to succeed with, and all could interpollinate freely and set good crops.

AN ACTUAL CASE STUDY IN LATERAL THINKING REGARDING TREE CROPS

It all started with Gondwanaland. Once upon a time, about 60 million years ago, the Great Southern Continent broke up into sections - South America, Australia (but not New Zealand), and India, Madagascar, etc. These bits, which once formed a continent, drifted away, and their dominant types of vegetation dispersed. The bits and pieces are found on all continents, some changed beyond recognition.

If one knows about Gondwanaland and the fact that the botanical family of Proteaceae is found only in the remnants of Gondwanaland and not on the co-existent Great Northern Continent of Laurasia, then it is possible to piece the bits and pieces of this jigsaw puzzle together and see how it fits.

In the cold southern tip of South America, there are Antarctic Beeches. These occur also in eastern Australia (*Nothofagus* spp.)

The *Proteaceae* are also found in most ex-Gondwanaland conditions except, of course, in Antarctica. Of all of the *Proteaceae* the most important tree crop is provided by the Macadamia. This has about seven species, of which some are toxic. Some are to be found in Madagascar and the Philippines, as well as Australia, but all the Macadamias are tropical and/or subtropical. Comes lateral thinking: is there a *Proteaceae* with an edible nut that was separated and so adapted differently?

Upon receiving from WANATCA a copy of Menninger, I noticed, quite by chance that, opposite to the page of the Macadamia description, there was a very similar nut and the description of a cold-tolerant *Proteaceae* nut tree called *Gevuina avellana* the Chile Hazelnut. This tree, although not a true hazelnut at all, tastes like one. It is related to the Macadamia, the Grevilleas, and the other genuses of the Family *Proteaceae*. A search started. Textbooks showed three Gevuinas - one in New Guinea, which is discounted as it is nearly equatorial; one in North Queensland, which is tropical; and the third one is referred to as cool temperate. Darwin refers to this dispersal already in the Voyage of the Beagle without mentioning the genus. It turned out that *Gevuina avellana* is very similar to the other *proteaceae* but frost and cold tolerant. Some seeds have been brought to Australia and some germination has been undertaken. Germination has been successful, but mortality, for reasons not known to us yet, is very high, and it is almost impossible to transplant these seeds. However, some day, enough trees may survive to provide a genetic pool from which better cultivars may be bred.

It appears that the species is a temperate climate rainforest tree, and little is known about it even in its homeland, Chile. As for its cultivation, it appears that the only way to establish it is to plant a germinating specimen into the ground and hope for the best. If it can be established, then one may perhaps use the Silky Oak or other hardier grevilleas as root stocks. But, this is in the future.

The Koeppen classification equivalent (Homoclime) exists in Australia. Rainfall and soil conditions can be duplicated if we could know for sure what the requirements are. It appears that the tree is not responsive to irrigation. It also appears that rainfall can be high (temperate climate rainforest) and not so high (scrub up to the snowline).

There seems to be two types within the species: one is taprooted and one is fibrous rooted. However, laterally, thinking, the use of the Koeppen maps and some research have proven that there IS a cold climate 'Macadamia type' around. This, then, is lateral thinking: somewhere there is or should be a useful plant with the potential of a tree crop, either nuts or fruit, that would fit into our environmental picture on the basis of homoclime investigation.

The beauty of lateral thinking is that you do your homework before spending any money or trying to get seed material. If the plant is available, obtain seed and try to germinate and establish it. Each successful lateral thinker would have a tree crop that is new to this country and has the potential of economic significance. This is a field where university geographers or people trained in climatology and soil science can work together with botanists, foresters and horticulturally trained people. If the piece fits the jigsaw, it may be likely to work. Good luck, and try it.

TROPICAL FRUITS OF THE PHILIPPINES

LANGSAT

Lansium domesticum

Lanson (Lansones)

August-November
Remove skin. Translucent meat is sweet and a little tart. Watch out for small, bitter seeds.

Santol

July - September
Peel first. The meat is tart and can be eaten with salt. Large translucent seeds have a delightfully sweet edible pulp.

Sandoricum koetjape

Citrullus vulgaris

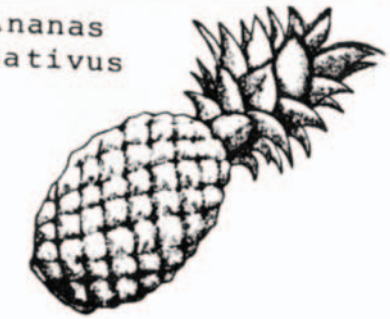
Watermelon (Pakwan)

April-November
The Philippines produces a rich variety of this popular fruit. Best served chilled.

Pineapple (Piña)

All year round.
Very popular with visitors. Extremely rich in flavour and juicy.

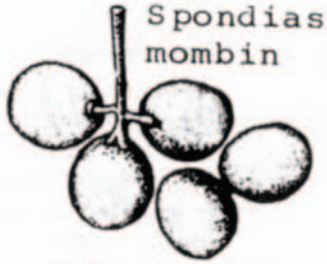
Ananas sativus



Spanish Plum (Sineguelas)

April - June
This fruit is shaped like a plum but has the texture of an apple. Eat it skin and all.

Spondias mombin



RED MOMBIN

GRANADILLA

Passiflora edulis

Passion Fruit (Pasionaryo)

March-October
Remove skin. Meat is surprisingly sweet and juicy and the numerous seeds can be eaten. Slice lengthwise and eat with spoon.

Star Apple (Kaimito)

January - March
Milky, soft pulp with a mild pleasant taste. Slice lengthwise and eat with a spoon. Best served chilled.

Chrysophyllum cainito

CALAMONDIN

Kalamansi

All year round.
Most versatile of Filipino fruits, it is a cross between a lime and a lemon. Makes a refreshing cold drink. Visitors prefer to mix soda with it.

Citrus mitis

Nephelium lappaceum

Rambutan
August-October
Remove shell carefully with sharp knife. Meat is translucent and mildly sweet.

Garcinia mangostana

Mangosteen (Mangostan)
Open carefully as shown with sharp knife. White meat has marvelous texture and delicate flavour.

Durio zibethinus

Durian
August-October
Unique flavour. Some love it. Others hate it. Everyone must try it once. Best opened by an expert.

Eugenia malaccensis

Curacao Apple (Makopa)
May - July
Can be eaten skin and all. Meat is surprisingly tasty. Filipinos prefer to add salt. Watch out for the small seeds.

Artocarpus integrifolia

Jack Fruit (Langka)
February - July
Cut into halves. Yellowish meat is tender and tartly sweet.

Citrus nobilis

Native Orange (Dalanghita)
October-February
Smaller than the variety you're probably used to. Very sweet and satisfying.

Annona squamosa

Sugar Apple (Atis)
July - October
Break in half. A spoon is helpful in removing seeds. Soft white meat has outstanding flavour and texture.

Mangifera indica

Mango (Manga)
February-September
The Philippines produces some of the best varieties in the world. Slice lengthwise and eat with spoon. A great favourite with visitors.

PHYTOPHTHORA CINNAMOMI IN RELATION TO MACADAMIA

George A. Zentmyer*

The object of this paper is to bring you up-to-date on the situation regarding the soil fungus *Phytophthora cinnamomi* and the Macadamia. It has been 20 years since Wells Miller first called my attention to a new canker disease on two of his Macadamia trees in Vista in 1959. I isolated the fungus *P. cinnamomi* from the cankers (5); this was the first occurrence of this pathogen, the cause of avocado root rot, on the Macadamia tree. The next year in Hawaii, Dr. R. Hamilton, Dr. R. Hine and I found a number of Macadamia trees with the same type of rough canker on the trunks, on the island of Hawaii (Keaau Orchards) and on Oahu (Waimanalo Experiment Station); *P. cinnamomi* was isolated from these cankers also. (2)

The two original trees infected with the disease on the Miller property in Vista were: a seedling of *Macadamia integrifolia,* and a tree of clone 508 of *M. integrifolia* grafted on *M. tetraphylla*. In the latter case the canker occurred on both rootstock and scion.

Dr Storey and I published the results of our greenhouse inoculation work in 1960(6); these tests showed that *M. integrifolia* seedlings were more susceptible to the pathogen *P. cinnamomi* than were *M. tetraphylla* seedlings. Of 25 seedlings of each species inoculated, 21 of the *M. integrifolia* seedlings became diseased in 6 months, while only 4 of the 25 *M. tetraphylla* seedlings developed cankers in the same period.

My early inoculation tests with Macadamia also showed that:
1. a wound was required for *P. cinnamomi* to invade Macadamia trunks;

2. isolates of *P. cinnamomi* from avocado as well as from Macadamia caused cankers on Macadamia trunks;
3. Macadamia roots were quite resistant to the pathogen.

In the early 1960s many Macadamia plantings in old avocado root rot areas were examined to obtain further information on the effect of the avocado root rot fungus on Macadamia. Only one additional tree was found with Phytophthora canker; no Macadamia trees were affected with root rot. Further observations over the years indicated that this disease is not a serious problem on Macadamia in California.

Avoiding wounding of trunks is one means of preventing the canker disease. If canker should become more of a problem in a particular planting, the disease could be controlled by spraying the trunks of the trees with a copper fungicide or one of the new effective organic fungicides recently developed for control of diseases caused by species of Phytophthora. One of the most effective of these is a chemical produced by the Ciba-Geigy company in Switzerland, known as Ridomil (CGA 48988); chemically this is an acyl alanine. Another organic fungicide, Terrazole, has been recently registered for use on avocados for control of root rot; this chemical is not as effective as the Ciba-Geigy chemical when used as a spray.

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Reprinted from the California Macadamia Society Yearbook, 1979

In additional research on this fungus problem, we have found some variability in our isolates of *P. cinnamomi* from Macadamia; they differ in growth pattern in culture and in mating or compatibility type. The Al and A2 mating types of the fungus both occur on Macadamia; the A2 type is the more common. The Al type of *P. cinnamomi* isolated from Hawaii in 1969 is very low in pathogenicity to avocado. Macadamia seedlings, however, are susceptible to isolates of *P. cinnamomi* from avocado, eucalyptus, cinnamon, camellia, and pine.

Mr Tom Cooper wrote an article for the January 1978 issue of the Avocado Grower magazine on the Macadamia as a replacement crop in avocado groves affected with root rot (1). As noted above, Macadamia trees replanted in avocado root rot areas in southern California have generally done well.

Phytophthora canker of Macadamia trees was reported from Australia in 1972. Australian plant pathologist K. Pegg noted (4) that a survey in southeastern Queensland showed the disease to be present in most plantations and to be serious on sites where the soil drainage was impeded. He further noted that considerable loss occurred from Phytophthora canker in one of their large Macadamia nurseries. About a year ago, Ken Pegg wrote me that surveys showed that approximately 5 percent of the Macadamia trees in plantings in Queensland had Phytophthora trunk canker, and that at least 50 percent of those trees died from the disease. He further commented that up to 10 percent of the trees are affected by canker on some plantations.

Dr Storey informs me that on his recent trip to Australia he observed some trunk cankers on Macadamia trees; he noted that most of the rootstocks used there are *M. integrifolia*, which according to our tests are more susceptible to the disease than *M. tetraphylla*. The Australians are also trying the new fungicide "Ridomil"; we have found this very effective in tests for control of avocado root rot.

Thus, the Macadamia trunk canker disease does not seem to be a severe problem in California, and we do not hear much more about it from Hawaii, but it is causing more trouble in the native home of the Macadamia, Australia. Another species of Phytophthora, recently reidentified as *P. capsici* (3) has been reported to cause some damage in the form of a blight of racemes and young nuts in Hawaii.

In closing, for the benefit of the Macadamia growers who also grow avocados, I will comment on two phases of our research on control of avocado root rot that are showing considerable promise: resistant rootstocks and soil fungicides. The rootstocks Duke 6, Duke 7, and G6 (the latter from Guatemala) are showing good resistance in our numerous field plots over the past four or five years in particular, in most of the avocado-producing counties in California. Also one soil fungicide, the organic sulfur chemical Terrazole, has finally been labelled for use on avocado trees in California. It is a very good fungicide in laboratory and greenhouse trials, and has given good results in controlling root rot in several of our field trials, when applied in the irrigation water or as a granular formulation around living trees. The one newer fungicide mentioned earlier, "Ridomil" or Ciba-Geigy 48988, is even more promising for control of Phytophthora, but has not yet been registered for use on avocado trees.

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TREES AND SHRUBS FOR FODDER

Milan Mirkovic

Various trees and shrubs can be utilised for animal fodder. They can be grown to provide feed supplements or to provide feed in times of severe drought. Trees are particularly useful because of two characteristics:

1. They draw moisture and minerals from deep within the soil where grass roots cannot reach.

2. The leaves of most trees retain their nutritional value even when they are mature.

Trees and shrubs for fodder can be either native or exotic species.

Native trees eaten by stock generally contain enough protein for maintenance but many are fairly low in minerals such as phosphorous.

Pruning to provide fodder is best done by removing the centre of the tree leaving some lateral branches above the reach of stock. The tree will then generate new growth. Enough is cut when stock leave a few leaves on the branches before moving on to the next tree.

If trees are to be grown for fodder it is better to grow introduced species. They are generally of a higher quality for fodder and are often easier to establish.

EXAMPLES OF TREES

MULGA suitable for heavy pruning leaving some lateral branches.

TREE WILGA all branches can be pruned back above the reach of sheep.

KURRAJONG high in energy but low in protein. The whole tree can be cut off above the reach of animals. Recovery is very rapid.

CAROB Female trees produce a profusion of dark brown pods about 2 cm wide and 10-15 cm long. These highly nutritious pods are readily eaten by stock. Once established, the trees are also excellent for shade and shelter.

TAMARIX APHYLLA grows well on alkaline and saline soils. Grows rapidly and Is readily eaten by stock. Leaves are high in fodder value.

MULBERRY leaves are very palatable and nutritious. By annual pruning it can become an important source of fodder. The fruits are readily eaten by pigs.

TREE LUCERNE Very leafy shrub or small tree up to 4m high. In New Zealand it is grown in hedgerows between wire netting fences. The stock eat the leaves that grow through the netting. This pruning stimulates heavy new growth.

CORK OAK a large-growing tree yielding an abundance of acorns. These are high in carbohydrate and contain some protein. Pigs will eat them off the ground or they can be collected and stored.

The aforementioned represent a small sample of the possible trees which can provide multiple benefits. Some would only be utilised in severe drought as a last resort. Others like the carob and tree lucerne can be grown as dual purpose fodder trees and windbreaks or shelter areas.

When planning tree planting it may be an advantage to incorporate fodder trees into the design for possible future use.

EDITOR'S FOOTNOTE

CHESTNUTS - Fast growing, early bearing, providing shade, shelter and an annual crop of nutritious nuts which are relished by pigs, cattle (and people, sometimes fetching $7 kg!)

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PASSIONFRUIT (*Passifloraceae*)*

P.R. Deal & P.J. Farlow**

The unique flavour of the passionfruit, and its economic importance as a concentrate, is making this fruit increasingly attractive to tropical fruit growers.

BOTANY

The family Passifloraceae includes 550 species in 12 genera (Killip. 1938). The most important genus *Passiflora* has about 400 species which are mostly indigenous to tropical and South America but include about 40 in Asia and the South Pacific Islands. Passiflora species have easily recognised bisexual flowers generally with a colourful and complex corona and a superior ovary on a gynophore. They have tendrils to aid their climbing habit and their alternate leaves often have glandulate petioles. The fruit is a capsule or berry containing numerous seeds with a pitted testa surrounded by a fleshy aril.

The ornamental flowers and edible fruit of many species have influenced their spread outside their original areas of distribution. Although 50 or 60 species bear edible fruit (Martin and Nakasone, 1970) most of these are unknown outside of the limited areas where they grow wild or are sometimes cultivated.

CLIMATIC REQUIREMENTS

Passionfruit are adapted to tropical and sub-tropical situations with a moderately high rainfall. The purple passionfruit *P. edulis*, which is native to Brazil, thrives in the warm humid coastal areas of Eastern Australia and on the tropical highlands. Although it withstands light frosts it is injured by temperatures 1-2 degrees below freezing and commercial sites should be free of frost. The golden passionfruit *P. edulis f. flavicarpa,* the granadilla *P. quadrangularis* and water lemon *P. laurifolia*, in particular, are less cold tolerant and require more tropical conditions than *P. edulis*. However, some species are more cold tolerant than *P. edulis*, such as *P. incarnata* (indigenous to the south east of USA), *P. ligularis* (indigenous in mountainous areas of Mexico and Central America) and species in the subgenus *Tacsonia* such as *P. mollissima* and *P. antioquiensis* (which re adapted to high altitudes). Pattersen et al (1976) classified species in the subgenus *Granadilla* in order of increasing chilling tolerance as *P. edulis f. flavicarpa, P. maliformis, P. incarnata, P. edulis* and *P. caerulea*.

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* Reprinted from Australian Horticulture Feb. 1982. Vol. 80, No. 2.

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SOIL REQUIREMENTS

Experience with *P. edulis, P. edulis, f. flavicarpa* and *P. quadrangularis* in Queensland indicates passionfruit are not generally exacting in their soil requirements. They do best on fertile well drained barns. The main needs are good soil moisture combined with adequate sub surface drainage. Vines succumb rapidly to water logging and on shallow soils are best planted on raised beds. They grow best in soils with a pH above 6.0 and on strongly acid soils (below pH 5.5) lime is required.

GENETIC DIVERSITY

Only about 40-50 species have been investigated agronomically or cytologically by workers in various countries. These mainly comprise edible types in the subgenera *Granadilla* and *Tacsonia,* weed species, the native Australian species as well as solely ornamental types. Also, little breeding has been carried out and the genetics of the genus is poorly understood. However, substantial diversity, which is potentially most useful in passionfruit improvement, is known to exist within and between species for pollination system, vigour, yield and production season, climatic and ecological adaptability, tolerance of passionfruit woodiness virus PWV), resistance to *phytopthora* blight, brown spot, septoria spot, nematodes and fruit characteristics including size, pulp content, colour and flavour.

Storey (1950) and Beal (1968) have now established chromosome numbers in 46 species of forms in the genus. The number 2 n = 12, 18, 20, 24, 36 were determined although other numbers or series could exist considering the large number of uncounted species. The 2 n 18 group species (including the subgenera Granadilla and Tacsonia) generally have vigorous growth and show the greatest expression of flower and fruit development. The 2 n = 12, 20, 24 species tend to have small fruit with insipid taste and vines of moderate vigour.

Breeding and selection for improved agronomic characteristics in the major edible species and evaluation of rootstocks has been emphasised in Australia and Hawaii in the last 20 years. Selection has been practiced for improved tolerance of *alternaria* spot and resistance to *fusarium* wilt in *P. edulis f. flavicarpa* in Hawaii (Ito, 1978), and Australia respectively. *P. edulis x P. edulis f. flaricarpa* hybrids combining high production, winter and summer cropping, tolerance to PWV, nematodes and fusarium wilt were selected by Groszmann and Meurant in the early 1960s and have been exploited in Queensland since that time. Interspecific hybrids involving species within the subgenus Granadilla were produced by Beal (1972) and Torres and Martin (1974) of which some were fertile. This is contrary to the contention that interspecific hybrids were invariably sterile in spite of ease of crossing (Storey, 1950).

PRODUCTION SEASON AND TIME OF CROPPING

Production season in passionfruit is strongly influenced by the nature of the species exploited although cultural procedures and location are modifying factors.

The purple passionfruit produces a heavy summer crop followed by little or not winter crop in Queensland. The golden passionfruit differs from the purple passionfruit in having a single extended production season over late summer, autumn and early winter. Cropping of commercial passionfruit hybrids in Queensland is continuous with peaks in summer and winter.

The variation in time of cropping known in *P. edulis* and its intraspecific hybrids has also been observed in Queensland between species such as *P. incarnata* and *P. herbertiana* (autumn cropping). *P. seemanni* (winter), *P. quadrangularis* (autumn and spring), *P. mollissima* and *P. antioquiensis* (spring and summer cropping).

YIELD POTENTIAL

The purple passionfruit generally yields about 5-10 tonnes/ha/yr when PWV is not severe while commercial *P. edulis* hybrids yield up to 25 tonnes/ha/yr. In contrast yields of 35-45 tonnes/ha/yr have been recorded in commercial plantations of the golden passionfruit in Hawaii (Anon, 1954) and in South Africa and in P. mollissima in Colombia (Martin and Nakasone, 1970). Yields of 70 to 150 kg fruit/vine/yr are produced from P. quadrangularis.

The average yields in Queensland and in NSW are around 14.8 and 11.8 tonnes/ha/yr. respectively. More favourable growing conditions in Queensland account for the higher yields recorded in this state. The golden passionfruit does not always yield as well as its profuse flowering would indicate. Self-incompatibility is known in *f flavicarpa*. *P. cincinnata* and *P. laurifolia* and the need for hand pollination is recorded in *P. quadrangularis*. *P. laurifolia* only grows well and yields successfully in north Queensland.

The influence of season in reducing pulp content in the P. edulis hybrids 3-1 and E23 in March-April and October-November was recorded by Bradley (1972).

MARKET ACCEPTABILITY

Market acceptability is related to traditional consumer preferences and whether a fresh or processing market is being supplied.

P. edulis hybrids, *P. edulis f. flavicarpa* and *P. ligularis* are the most common passionfruit of Australia, Hawaii and Mexico respectively.

The fresh market in Australia demands a blemish-free, well filled, sweet, flavoursome fruit with an attractive purple-black skin. This requirements is currently met by the *P. edulis* hybrid Purple Gold. This preference by Australian consumers is probably related to past exploitation of the purple passionfruit which is now not commercially important.

The processing market is more discriminating than the fresh market with respect to pulp content and flavour and to a lesser extent acidity and SS.

EXPORT POTENTIAL

Australian passionfruit production fluctuated from 3654 to 2966 tonnes each year from 1972 to 1978. Imports of juice plus pulp in the same period ranged from 139 to 1039 tonnes fruit equivalent. Local processors have claimed that the Australian market is currently satisfied completely with 2500 tonnes of fresh product intake. The overall market for passionfruit products may require further market development, product innovation and possibly some penetration into overseas markets. Europe and the USA may offer some scope for expansion, however transport costs are a major problem facing exporters.

The high cost of processed passionfruit relative to other fruit juices is a major factor restricting expansion.

In other countries commercial passionfruit production is mainly based on lines of *P. edulis f. flavicarpa*. Countries involved include Hawaii, Brazil. Sri Lanka, Fiji, Papua New Guinea, West Samoa and France, Malaysia. Cook Islands, Nuie and African countries. Many of these countries can produce low cost pulp because of the availability of cheap labour. Recently soil borne diseases have reduced production in Brazil and Sri Lanka. Some of these countries experience fruit setting problems because of the self incompatibility of the flavicarpa material they are using.

CULTURAL DETAILS

Propagation - Species of Passiflora are generally readily propagated by seed, cuttings and air layers. In Queensland commercial P. edulis hybrids, which do not come true to type from seed, are grafted on to the stock *P. edulis f. flavicarpa* which is resistant to fusarium wilt and nematodes. The present authors have also found that many species may be readily grafted on to *f. flavicarpa* and grow satisfactorily giving a quick and acceptable method of propagation.

Management - Successful passionfruit growing is dependent on selection of suitable location, good land preparation, and management expertise in trellising, pruning and training, irrigation, nutrition, pollination needs pest and disease control, weed control and harvesting. In Queensland about 540 to 790 vines/ha are established for *P. edulis* hybrids.

Such cultural requirements for commercial production of *P. edulis* arid its hybrids, *P. edulis f. flavicarpa* and *P. quadrangularis* have been well described in various countries including Australia, Hawaii, and South Africa.

Irrigation - Adequate soil moisture during flowering and fruit development is necessary to obtain maximum yields. Some form of irrigation (overhead or trickle) is necessary when rainfall in normally low or unreliable. Lack of soil moisture in spring and early summer can directly reduce the summer crop and also affect the development of flowering laterals.

Fertilizer - Passionfruit require a plentiful supply of plant foods to maintain growth and yield. In some situations small quantities of a complete chemical fertilizer are applied several weeks before planting. Subsequent applications are made during the year, and timing, and quantity and type of fertilizer used depends on the cropping potential of the vines, irrigation practices and rainfall. During winter foliar sprays maybe used. In Queensland rates of 0.8 to 1.2 kg N, 0.3 to 0.5 kg P and 1.1 to 1.5 kg K are applied per vine/yr.

Pest and Diseases - Major problems in *P. edulis* and/or *P. edulis f. flavicarpa* are PWV (a necrotic strain of this virus (PWV-N) being a major problem in Queensland at present), base rot (undetermined), septoria spot (*S. passiflorae*), phytophthora blight (*P. nicotianae var parasitica*) and brown spot (*Alternaria passiflorae*).

Other problems which can be severe at times are fruit fly, mites, scale insects and cucumber mosaic virus (CMV). CMV is a problem in cooler areas (e.g. NSW). The synergistic action of mutual infection with CMV and PWV causes rapid death of vines. Fusarium wilt (*F. oxysporum f. var passiflorae*) and nematodes (*M. javanica*) are not problems in Queensland at this time.

Brown spot was a severe problem in *P. edulis* but has only been a minor problem in the hybrids. In contrast septoria spot which was not of substantial concern in *P. edulis* is a major problem in the hybrids. The hybrids are susceptible to leaf and fruit infections of *phytopthora* blight which is favoured by warm wet conditions. However the use of resistant *f. flavicarpa* rootstock has provided effective protection against phytopthora infections of root and stem.

HARVESTING METHODS

Orchard trellis or arbor systems are planned to minimise high harvesting costs. Fruit of *P. quadrangularis* is clipped in commercial harvests and handled very carefully thereafter. Fruit of *P. edulis* hybrids and *f. flavicarpa* is normally allowed to fall on the ground and collected once or twice per week in Hawaii (Anon, 1954) and daily or more frequently in Queensland to reduce sunburn. Also, it is recommended that fruit be kept as cool as possible during handling (Wills, Stephens and Groszmann, 1961). A prototype mechanical harvester has been developed in Queensland to overcome the costs of manual harvesting.

MARKETING CHARACTERISTICS

In Australia, approximately 3000 tonnes of passionfruit are produced annually at a value of about $1.8 million. More than 80% of Australia's passionfruit is produced in South East Queensland. Queensland's production of 2780 tonnes in 1979 was consigned to the local fresh market (7%), interstate (25%) and to processors (68%). In 1979 fresh market prices ranged from $6.00 to $18.00 per carton (10kg) and the processors paid 33c/kg. Import of pulp and juice (see section 8) mainly from Fiji and Sri Lanka increased the total Australian apparent consumption.

The principal processed passionfruit products are juice and pulp. The major uses for these are as ingredients in yoghurts, ice cream, jams, flavouring and in fruit juices.

STORAGE CHARACTERISTICS

Passionfruit stored at room temperature for a few days will shrivel as the rind dries. Fruit will store for up to 4-5 weeks with minimum loss of fruit weight if rots are controlled and if held at 5 degrees C and 80-90% RH. Waxes and fungicidal dips are often used to extend shelf life in fresh fruit and prevent withering of skin and rots.

Passionfruit pulp and juice are normally extracted, sterilised by heat and held in frozen storage (-18 degrees C) in 20 kg containers. Manufacturers generally specify microbial counts before final use.

TRANSPORT CHARACTERISTICS

In Australia fruit of *P. edulis* hybrids is transported by road and rail to the fresh market in 10 kg cartons and to the processor in bags or bulk bins. The fruit is well protected by the tough leathery rind and is very tolerant of the rigours of transport. The species *P. ligularis and P. maliformis* have much harder rind than *P. edulis* whereas *P. quadrangularis* is soft skinned and sensitive to damage. The last species is generally packed and consigned in crates lined with wood wool. The holding conditions for pulp and juice which would be required during transport are described in section 12.

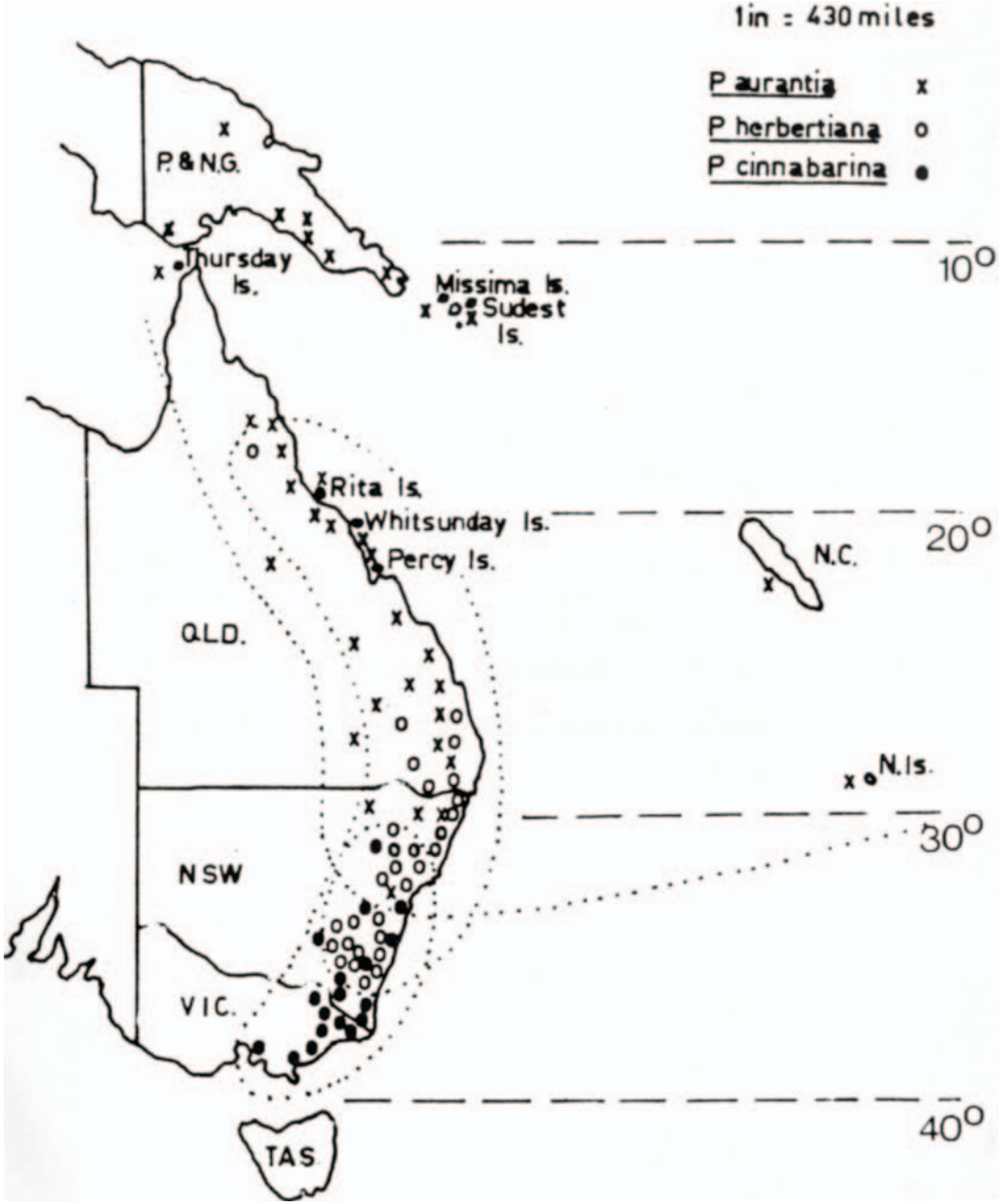

Figure 1. Distribution of Native Species of Passiflora in Australia

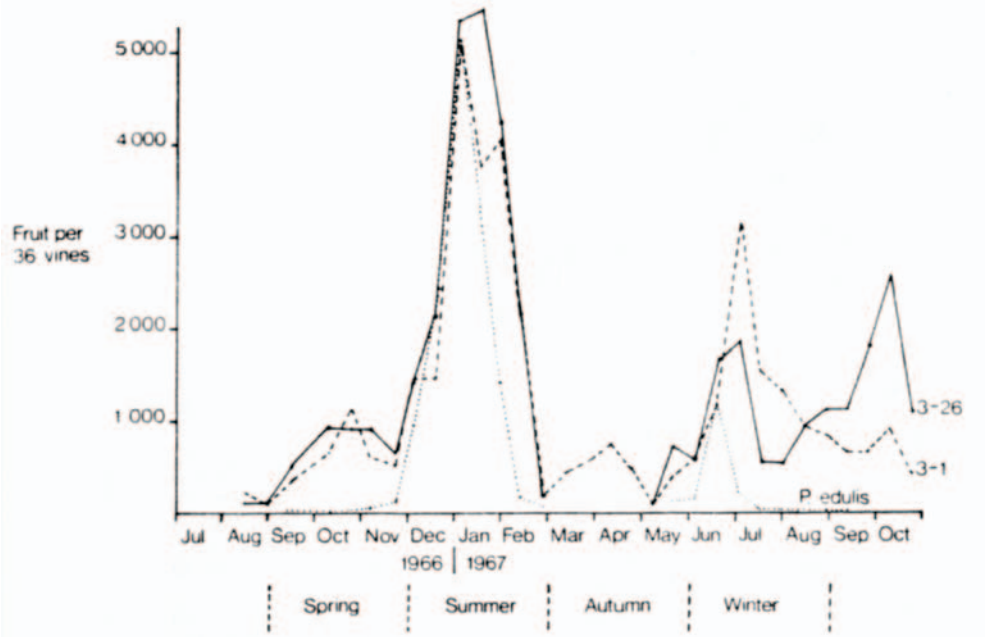

Figure 2. Number of fruit produced at two-weekly intervals.

TABLE 1

Climatic Tolerance of Selected *Passiflora* Species			
	Native Distribution (Killip, 1938)	Location	
Tropical		°Latitude	Altitude (m)
P. laurifolia	W.Indies to N of South America	0 - 10	
P. quadrangularis	Colombia	0	1100
P. maliformis	Colombia	0	1200
P. edulis f flavicarpa	----	---	---
Temperate			
P. edulis	Brazil to Argentina	0 to 30	---
P. incarnata	S.E. of U.S.A.	30 to 40	---
P. caerulea	Brazil to Argentina	30	---
P. ligularis	Mexico to N of South America	10	1000
*P. mollissima**	Andes	20	1000 to 2000
*P. jamesonii**	Ecuador	0	4000
* Subgenus *Tacsonia*			

TABLE 2
Beal (1968) D.P.I. Report:

Pulp colour in species of *Passiflora*	
Black	*P. penduliflora, P. suberosa*
Red	*P. gracilis, P. caerulea*
Orange	*P. warmingii, P. mollissima, P. edulis f. flavicarpa*
Yellow	*P. edulis*
Grey-Yellow	*P. maliformis, P. quadrangularis*
Grey	*P. aurantia, P. ligularis, P. incarnata, P. foetida*

TABLE 3
Pulp Characteristics in *P. edulis*, *P. edulis f. flavicarpa*, Hybrids 3-1 and 3-26 and in 36 Other Hybrid Lines from the Redlands Research Station (1967)
Bradley and Jordan (1968) D.P.I. Report

Accession	% Pulp	pH	% av. SS	% av. tit. acidity (citric)	Total Volatile Esters ppm (Hexyl Caproate)
P. edulis	49	3.1	15.3	2.4	159
P. edulis f flavicarpa	37	2.9	15.3	3.4	83
3-1	46	2.9	14.5	3.2	122
3-26	57	2.9	14.1	3.4	149
Other hybrids	35-68	2.7-3.1	13.4-16.1	2.3-3.6	49-200

TABLE 4
Pulp Characteristics in Seven Species of *Passiflora* (1967)
Beal (Unpublished)

Species	pH	TSS	Titre 0.1 NaOH to 10 mls juice
P. edulis	2.8	17.7	48.1
P. edulis f. flavicarpa	3.2	17.6	66.7
P. maliformis	3.4	16	43.2
P. subpeltata	5.1	13.4	6.7
P. mollissima	3.2	11	31.4
P. herbertiana	3.8	10.5	20.0
P. suberosa	5.7	11.5	---

TABLE 5
Occurence of Bivalents and Micronuclei in Pollen Mother Cells in Six *Passiflora* Hybrids and Species
Beal (Unpublished)

Accession	Mean No. Bivalents/PMC	% of PMC with micronuclei
P. caerulea-quadrangularis	7.1	38
P. alato-caerulea	3.8	29
P. caerulea-racemosa	9.0	64
P. edulis-incarnata	9.0	21
P. edulis-caerulea	6.5	10
P. filamentosa	1.2	69
P. subpeltata*	9.0	0
	* Normal Behaviour	

TABLE 6
Fruit Characteristics in Selected *Passiflora* Species
Minimum of 10 fruit per sample in August 1966, Ormiston) Beal (Unpublished)

Species	Fruit Weight (g)*	Pulp Percentage*	Mean Number Seeds/Fruit*
P. edulis	36 ± 2	48 ± 5	122 ± 57
P. subpeltata	17 ± 5	34 ± 18	158 ± 43
P. quadrangularis (small)	870 ± 170	20 ± 5	159 ± 48
P. seemanni	68 ± 13	30 ± 5	332 ± 76
P. mollissima	41 ± 8	54 ± 22	110 ± 21
P. edulis f. flavicarpa	72 ± 7	35 ± 3	50 ± 48
P. suberosa	0.9 ± 0.1	---	29 ± 6.1
	* ± Standard Deviation		

PROCESSING CHARACTERISTICS

Australian processors have generally demanded that fruit for processing have the same flavour as *P. edulis* whereas the more acid, aromatic and orange pulp of the golden passionfruit is traditionally processed in Hawaii. Bradley and Jordan (1968) showed that the old commercial hybrids Redlands Triangular (3.1) and Redlands Pink (3-26) were as good as *P. edulis* for the manufacture of carbonated juice but that f. flavicarpa was not suitable. The low ester value (84 ppm) recorded for *f. flavicarpa* compared to the hybrids (122 and 159 ppm) suggested that this may have influenced panel unacceptability. Chemical identification of the volatile flavouring constituents involved may be useful to test this suggestion.

The hybrid E23 is the highest yielding commercial cultivar and is readily accepted by Australian processors because of its desirable flavour. Also, E23 has a pulp content ranging from 40 to 50% and is less subject to seasonal variation than the hybrid 3-1 (35 to 50%) and is less likely to fall below the 38% minimum acceptable level (Bradley, 1972).

The SS and pH are of less importance as passionfruit juice is used primarily in low concentration for flavouring and sugar and citric acid levels can be easily altered.

SUGGESTED RESEARCH

Research needs to be directed at existing problems and opportunities in the industry. Useful avenues are in plant improvements, pathological research and market development.

Plant improvement avenues include:

Breeding - to incorporate resistance to PWV-N, which is known in *P. edulis x P. incarnata*, in to the current commercial cultivars.

Evaluation - of rootstocks for cold tolerance and resistance to base rot. The evaluation of new species (e.g. *P. ligularis*).

Pathological - investigations need to be conducted in respect of: PWV elimination and control by use of meristem culture and production of elite material, respectively.

Determination of the cause of base rot and isolation of sources of resistance or development of other suitable control measures.

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THE SMALL AVOCADO INDUSTRY IN GREECE

Nickos P. Psarros*

A few years ago, the Greek Ministry of Agriculture imported a number of avocado cultivars, and a collection was established by the Institute for Subtropical Fruit Crops in the District of Chamia, on the Island of Crete.

The total number of commercially growing avocado trees is about 12,500, and the total avocado production is up to 100 tons (1980). The total avocado area is 75 hectares and the main avocado growing district is Chamia (72 ha), followed by Hirakleio (1 ha), Messinia (1 ha),, and the Province of Trsizinia (1 ha), as indicated on the map.

The usual avocado rootstocks used are 'Topa Topa' and 'Mexicola.'

The number of avocado trees and production in the area of Chamia are, respectively, 11,813 and 84 tons, in 1980. The distribution of cultivated varieties and their corresponding production for the same area are:

Cultivar	Tree Number	Production (tons)
Fuerte	8,592	65.9
Hass	1,320	7.9
Zutano	1,290	6.6
Nabal	396	2.3
Etiger	215	1.4

The harvesting period for each of the above mentioned avocado cultivars is shown in the table below.

Cultivar	Beginning of Harvesting	End of Harvesting
Fuerte	1/11	30/5
Hass	1/2	30/8
Zutano	30/12	1/9
Nabal	15/1	30/5
Etiger	15/11	15/1

The distribution of avocado cultivars, according to their adaptability and productivity in Chamia, is as follows:

Adaptability	Productivity
Fuerte (excellent)	Etiger, Hass (excellent)
Hass	Fuerte
Zutano	Nabal
Nabal	Zutano (poor)
Etiger (poor)	

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It is evident that the best adapted avocado cultivar in the district of Chamia is the Fuerte,' while from a productivity point of view it is the cultivars 'Etiger' and 'Hass.'

No deficiency problems have been observed as yet in this district. From the plant pathological point of view, the fungus *Phytophthora megasperma* caused some tree losses in two locations last year (1990),

The avocado grower prices for fruit marketing for local consumption depend upon the marketing period, and which for the 1980/81 period per cultivar were indicated below.

Month	Drachmas/kgm ($US1 = 50.50 Drch)
November	60 - 80
December	65 - 85
January	70 - 90
February	72 - 97
March	75 - 102
April	80 - 105

The fruit that was exported by air cargo to Western Europe (Munchen) achieved a price in the market of 4 D.M./Kg. This export took place during the months of February and March, 1982, corresponding to 3,350 kgms.

The main problems encountered at the stage of production were those of fertilization, fruit set, alternate bearing, and of grafting. A small decrease in fruit production was observed in trees growing in dry soils after the sixth year of planting.

The district of Chamia is considered suitable for avocado culture. The quality of water is excellent, and the deep, fertile soil with a pH value equalling 6 - 7, with low $CaCO_3$ content, sindy-sandy to sandy-clay type soils, gives good results.

In the district of Messinia (Kalamata City), there is an avocado trial grove consisting of 200 trees with four cultivars ('Fuerte' 105 trees, 'Zutano' 25 trees, 'Rincon' 25 trees, and 'Hass' 25 trees). One hundred and sixty (160) trees out of 200 are of bearing age. The total production was 3.5 tons (1980).

From the adaptability and productivity points of view, the best cultivar is the 'Fuerte,' followed, in this order, by 'Zutano,' 'Rincon,' and 'Hass.' No phytopathological problems have been encountered as yet, while it seems that the cultivars 'Bass' and 'Rincon' are the more sensitive to cold conditions.

The Research Institute for Subtropicals in Chamia studies the adaptability and the general behaviour of a number of avocado cultivars under the local environmental and soil conditions. In its collections, there are 18 avocado cultivars under study; that is, 'Hass' (California), 'Fuerte' (Cal.), 'Nabal' (Cal.), 'Bacon' (Cal.), 'Reed' (Cal.), 'Zutano' (Cal.), 'Anaheim' (Corse), 'Rincon' (Cal.), 'Etiger (Israel), 'Benic' (Israel), 'Mexico' (Israel), 'Fuerte Mae Arthur' (Corse), 'Booth 8' (Corse), 'Booth 7' (Corse), 'Dickinson' (Corse), 'Waldin' (Florida), 'Fuerte' (Israel), and 'Hass' (Israel).

In 1970, a new avocado experimental plantation was established at Grysopigi, Chamia; in 1972, another one was established at the same location and a third one at the location Gortyma, Messara, on the island of Crete. These experimental plantations consisted of the above mentioned 18 avocado cultivars. The data collected for the evaluation of these cultivars are:

a) tree characteristics (that is, compatibility/ incompatibility, tree size, blooming periods, production and resistance to diseases);

b) fruit characteristics (that is, weight, fruit size, oil content, maturity season).

Until now, the best avocado cultivars, from the commercial point of view, are 'Fuerte,' 'Hass,' 'Zutano,' 'Bacon,' and 'Reed.'

In 1977, another avocado rootstock experimental plantation was established by the Institute. Four different rootstocks are used: 'Topa Topa,' 'Mexicola,' 'Duke,' and 'Cander.' and seven different cultivar scions: 'Fuerte.' 'Hass,' 'Zutano,' 'Nabal,' 'Rincon,' 'Bacon,' and 'Reed.'

THE MANGO -- *Mangifera indica* L.*

A.W. Whiley**

The mango is not as widely known in Australia as the quality of its fruit justifies. It is the most important emerging fruit crop in tropical America.

The mango is thought to originate from the Indian/Burmese border region and has been under cultivation in India in excess of four thousand years. It is widespread throughout the tropics and sub-tropics and is consumed fresh in larger quantities than any other fruit. It is the most important emerging fruit crop in tropical America.

BOTANY

All the cultivars of mango belong to the single species Mangifera indica L. The genus Mangifera, however, contains 62 species distributed from India and Ceylon to the Philippines (Mukherjee 1949) with many producing edible fruits.

The mango is a deep-rooted, dome shaped, evergreen tree growing up to 40 m tall. The leaves are simple, entire, leathery, 8-40 x 2-10 cm, narrowly elliptic or lanceolate and produced in flushes; the young leaves are usually reddish in colour, later turning dark shiny green and retained for approximately one year.

The inflorescence is a widely branched terminal panicle, 10-60 cm in length with 1000-6000 flowers. It is polygamous with male and hermaphrodite flowers in the same inflorescence at a ratio of 1-36 per cent of the latter - higher in some cultivars.

Both flower types are about 6mm in diameter when open. They usually have five green, pubescent sepals, five off-white, pink or purplish petals, and a five-sectioned, yellow-green nectary disc. Male flowers usually have one functional and four abortive stamens. Hermaphrodite flowers contain, in addition, shiny, green, globose superior ovary and a style with a single stigma. The fruit is a fleshy drupe, variable in size from 2.5-3.0 cm long, in shape from rounded to ovoid-oblong and sometimes literally compressed, and in colour with varying tonings of green, yellow and red.

The seed is enclosed in a stony endocarp, variable in size, two fleshy cotyledons. Some seeds monoembryonic with zygotic embryo only; others polyembryonic with 2-12 embryos in which apomictic embryos are produced from the epidermal cells of the nucellus and in which the zygotic embryo may or may not be suppressed. Most Indian cultivars are monoembryonic with the evolution of polyembryonic lines in Malaysia and the Philippines regions.

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* Reprinted from Australian Horticulture 11/81, Vol. 79, No. 11

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CLIMATIC REQUIREMENTS

The mango grows under a wide range of climatic conditions but its profitable cultivation is limited by temperature and precipitation patterns. It is reported that growth is minimal at 4-10 degrees C with optimum growth and productivity around 24-27 degrees C. In areas of low humidity fruit sunburns when temperatures exceed 46 degrees C and vegetative growth ceases.

The susceptibility of the mango to frost varies with its age and stage of growth. Young plants in active growth are killed at temperatures of -l degrees to -2 degrees while older trees with low growth activity usually escape damage at this range provided the duration of low temperature is not prolonged. Some varieties are more sensitive to frost injury than others.

Low temperatures at flowering can cause increased numbers of parthenocarpic fruit. Lakshminarayana and Aguilar (1975) report 73% parthenocarpy with the variety Haden when ambient temperatures fell to 2 degree C during flowering but only 53% when temperatures were maintained at not less than 10 degrees C. Kadman and Oppenheimer (1978) report parthenocarpy with i-laden in Israel with low temperatures during flowering. Similar results have been observed with Carabao in S.E. Queensland. Some cultivars appear more sensitive to temperature than others.

The mango grows over a wide range of moisture regimes being quite drought tolerant as well as capable of standing up to heavy rainfall. However, productivity of the tree is related to rainfall distribution with flowering and fruit set requiring a dry season. Trees tend to remain vegetative in tropical regions receiving regular heavy rainfall. Beal and Newman (1978) investigating climatic influences on mango production patterns at Bowen, Queensland, obtained correlations between annual production and summer rainfall and annual rainfall. They also significantly correlated the number of cold days in May-July (preflowering period) to annual production.

Mango trees in the tropics grow from sea level to 1200 m, but seldom bear at the higher elevation. In South Africa, commercial viability ceases at 600 m. Altitude has a pronounced effect on time of flowering with every 120 m increase in height delaying time of flowering by approximately four days. Similarly for each degree of latitude south or north of the tropics flower initiation is delayed by approximately four days.

SOIL REQUIREMENTS

Mango trees will grow on a wide range of soils but prefer deep well-drained sands to barns with the water-table no higher than 2.5 m. The trees can withstand occasional flooding and are probably one of the most tolerant of the sub-tropical/tropical fruits to “wet feet”. High productivity can be obtained on light, low fertility soils, possibly due to stress promoting heavy flowering and fruit set while heavy fertile soils with good water retaining capacity often produce vigorous vegetative growth at the expense of fruitfulness.

The mango will tolerate calcareous soils with a pH to 8 but does best at a range of 5.5 to 7. It does not thrive in very acidic soils with a pH lower than 5.0.

GENETIC DIVERSITY

Immense diversity of type exists in this species which is best typified by the 100 named varieties in India. No doubt this is a reflection of both the monoembryonic character and the length of cultivation of the mango in this country. However, in the commercial sense the industry is based on 30 varieties in this country of which 12 could be considered of major importance (Chadha, personal communication). Like most tree fruit crops all major varieties have risen as chance seedlings.

Meulen (1971) estimates the number of mango cultivars grown commercially throughout the world to exceed one hundred and suggests narrow environmental adaptation of each variety as the reason for this large number. Within the recognised mango varietal population is a wide range of:

1. Tree habit - ranges from the compact, low vigour to the fast growing, very large trees.
2. Fruit size and shape - from 0.2 Kg to 11Kg and rounded to ovoid/oblong.
3. External fruit colour - Red, pink, blue/green, green, yellow.
4. Internal flesh quality - ranges from heavily fibred (undesirable to very slightly fibred.
5. Flavour - Meulen (1971) describes four flavour types

i) pronounced turpentine-like taste;

ii) “wild” pungent flavour sometimes with carroty taste;
iii) fine flavour and very sweet without any acid;
iv) delightful mango flavour blended with acid being most acceptable to the European palate.

Srivastura et al (1978) are selecting dwarfing rootstocks based on stomatal leaf count and have established a relationship for selection while Kadman et al (1978) found sufficient genetic diversity in seedling populations to It for salinity tolerance.

PRODUCTION SEASON AND TIME OF CROPPING

Some polyembryonic mango seedlings start bearing at five to six years of age but can take up to 10 years (Meulen 1971, Valmayor, 1968). Some grafted monoembryonic varieties bear in their third or fourth year after planting out with most in production by their sixth year (Beal, In Press).

Flower initiation usually occurs during autumn with flowering occurring from mid-winter to early spring depending on the variety and temperature. The time of development after fertilization to maturity of fruit is 2-5 months. Some cultivars in the tropics set a few fruits throughout the year in addition to their main cropping period.

The harvesting of mangoes in India extends over a period of 7 months (Chadha, 1975), in South Africa it extends for around 4 1/2 months (Meulen, 1971) and in Florida about 4 months (Malo, 1977).

The period of cropping can be greatly extended by the choice of early/mid and late season cultivars in any one district. In Australia, the mango industry is based predominantly on one variety with the major production centre in the Dry Tropics. This has led to a short mango season of approximately 6 weeks. Beal (In Press) concludes that with ‘utilization of selected

varieties from the early and late groups together with Kensington Pride could extend the mango production season in the Bowen district to at least 12 to 14 weeks".

The potential for a greater extension of the season in Australia exists by use of environmental factors. The tree will grow and crop from the northern tip of Australia to coastal areas at approximately latitude 28 degrees S. Disease problems encountered with Kensington Pride in the southern areas may be overcome by use of tolerant varieties such as Tommy Atkins, Florigon and Carabao.

YIELD POTENTIAL

Biennial or irregular bearing is well known with the mango (Popenoe 1920, Meulen, 1971, Chaudhri 1976). While these patterns can be partially attributed to climatic influences (see section 2) the cultivar can have an over-riding effect. The flowering intensity of cultivars varies markedly as does the sex expression of the flowers, Meulen (1971) states that perfect flowers account from 2 to 20% depending on cultivar while Purseglove (1968) gives a range of 1 to 36%. The other major contributing factor to low yield, which may be either climatically or nutritionally controlled, is the failure of mature fruit bearing shoots to differentiate flower buds for the following crop after harvest (Rao et al, 1978).

Few production figures are available in the literature however mature trees of select cultivars may produce up to 500 kg per tree.

MARKET ACCEPTABILITY

The mango is claimed to be the most important fruit of the tropics. Once known in India as the 'Fruit of Kings", the "King of Fruits" it is now the "Fruit of the Masses". (Chadha, private communication).

While the external appearance of the fruit can be considered attractive - smooth skin with green/yellow with pink blush through to red/crimson - the internal quality is a decisive factor on acceptability. Undesirable features include coarse fibrous strands through the flesh and the "wild" pungent and turpentine flavours of some varieties. The latter is acceptable to Asian consumers but not the European palate.

However, many excellent varieties exist which should find a place in the Australian markets.

EXPORT POTENTIAL

Outside of the tropics and sub-tropics the mango is little known. Export of fresh fruit from Australia would have to be aimed at high priced western markets to off-set freight costs. One of the greatest problems is the landing of fruit onto northern hemisphere markets in their winter as green/ripe fruit are severely damaged at temperatures below 10 degrees C (Meulen, 1971). India is finding a high priced market for fresh fruit in the Middle East and this is a possibility for the Australian produce.

As a processed product the mango should find ready acceptance in the world markets.

CULTURAL DETAILS

Propagation - The mango can be multiplied with ease by seed or by several vegetative methods of propagation.

Polyembryonic types come true to type from seed and may be successfully propagated in this manner. Monoembryonic types however, require vegetative propagation to retain all the desired characters and are generally worked onto rootstocks.

The selection of a suitable rootstock is as important as the selection of scion varieties. It has a strong influence on the growth, yield, and fruit maturity and may be selected for adaptability to soil type and salinity tolerance. It is of comparatively recent years that orchards in South Africa and India have been established on nucellar seedlings from polyembryonic mangoes. The Kensington variety in Queensland is polyembryonic and as traditionally been propagated from seed.

There are as many ways of grafting and budding mangoes as there are propagators. However, experience in south-east Queensland suggests that actively growing rootstocks, hardened scion material and warm temperatures (25 - 30 degrees C) are a successful combination.

Management - The mango is grown as an orchard tree and can be clean cultivated or under sward.

Spacing - this is largely determined by the environment and the vigour of the cultivar. Meulen (1971) recommends 12 in squares under South African conditions with interplants that can be removed after 10 years while in Queensland spacings of 9 to 15 m x 0 to 15 m are commonly used.

Cropping Manipulation - many techniques have been used to improve productivity. Smudging is an old technique reported from the Philippines for inducing off-season flowering but this has been largely given away to chemical induction. There are many reports from India, South Africa and the Philippines on flower induction with ethrel however, results have been inconsistent in some places and the technique has not been generally adopted at a commercial level.

The application of KNO, is claimed to be a more reliable inductant in the Philippines where it has been commercially accepted (Bergonia et al, 1975). Irrigation - Successful mango production is generally associated with areas having a pronounced (try season during the winter and spring months with a summer rainfall. Under such conditions irrigation is beneficial from flowering until the "wet" period begins. To induce heavy natural flowering irrigation should be withheld for three months prior to flowering.

Fertilizers - A general criteria with mango nutrition is that care must be taken not to over fertilize thereby promoting vigour at the expense of fruitfulness. This is particularly true for nitrogen applications.

Meulen (1971) in South Africa and Chadha (1975) in India both agree that timing is critical with bearing trees which should be fertilized at flowering and immediately after harvest. The reasoning here is to supply adequate nutrition for fruit development with the first application and to promote the flower bearing summer flush with the second application. In Queensland,

applications of fertilizer are recommended at harvest and again two months later.

Various schedules are available but appear to be based on whims rather than experimental results. Ultimately critical levels should be defined and nutrition predicted from leaf analysis.

Pests and diseases - The mango is attacked by several insects the most important being fruit fly, mango weevil, scale, and gall wasp.

The universal disease of mango is anthracnose (*Collectotrichum gloeosporioides*). The only other disease of any consequence is bacterial black spot caused by an *Erwinia* sp.

Harvesting methods - Fruit is gathered by hand from the trees or with the use of picking aids when at a green/ripe condition. Trees are very large and mechanical aids such as cherry pickers could be gainfully used to assist in harvesting.

Because fruit may be easily bruised bulk handling containers would need careful design.

MARKETING CHARACTERISTICS

The fruit matures in the early summer when fruit prices are generally high. The pre-Xmas trade is important. It is attractive in appearance and eagerly sought by those familiar with the fruit. It is felt that a basic problem with the Australian industry is the short production season which reaches "glut" proportions. Many people in the southern states are unfamiliar with this fruit which would gain greater acceptance with increased familiarity through longer market exposure.

STORAGE CHARACTERISTICS

The mango has a relatively short shelf life at ambient temperatures. Picked at the green/ripe stage, fruit is fully ripe in 7-14 days.

The cold-storage requirements of mangoes are highly variable ranging from 7.2 - 12.8 degrees C. These temperatures are determined by the cultivar as well as the stage of maturity, production area and cultural practices. However, in general, 12.8 degrees C is considered to be the lowest safe level for commercial purposes. Fully ripe mangoes for processing may be stored at 0-1 degrees C for up to 6 weeks. The skin blackens but the flesh remains in good condition
(Anon, 1975).
Apelbaum et al (1976) investigated subatmospheric pressure storage (L.P.S.) of mango and found that prolongation of storage life is inversely related to the pressure. Storage was at 13 degrees C and extended storage life was achieved at pressures below 100 mm Hg. At 50 mm Hg fruit damage occurred and no effect was recorded above 250 mm Hg. Spalding and Reeder (1977) found similar results though there was differential varietal responses.

Ethylene may be used to shorten the time from green mature to fully ripe. Fuchs et al (1975) demonstrated that a 100 ppm ethylene treatment for 48 hours at 25 degrees C and 90% relative humidity reduced time of ripening from 10-15 days down to 8-10 days. It also enhanced fruit colour.

TRANSPORT CHARACTERISTICS

The fruit bruises easily and must be handled carefully. In most organised marketing systems fruit is packed in shallow single layered trays. Removal of field heat to 13 degrees C is desirable to prolong shelf life (Meulen 1971) and in India waxing has also been beneficial in prolonging shelf life (Chadha, 1975).

Breakdown of fruit due to anthracnose is a problem with fruit in transit in Queensland and various fungicidal treatments have been investigated. Muirhead (personal communication) recommends a post harvest benomyl dip 500 ppm active ingredient at 48 degrees C for 5 minutes.

PROCESSING CHARACTERISTICS

The mango can be made into a range of processed products. It can be canned, frozen, and dehydrated as well as used in jams, jellies, chutneys, pickles, juice, nectar and a range of ice-confectionery. Processed mangoes in India in 1971 amounted to 16 thousand tonnes (Chadha, 1971).

Second grade fruit and inferior varieties are processed into varying products in Queensland.

SUGGESTED DIRECTION OF RESEARCH

1. Continue to evaluate the reaction of genotype with environment with the object of expanding the harvesting period in Australia through a greater range of varieties and production in southern districts.

2. Investigate rootstock performance selecting for precocity, dwarfness, productivity and salinity tolerance.
3. Investigate biennial bearing problems.
4. Investigate nutrition by establishing critical leaf levels and time of leaf sampling.
5. Investigate post harvest and storage treatments to improve shelf life.

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BEECHES

329. つのはしばみ (ながはしばみ)
Corylus Sieboldiana *Blume*

348. いぬぶな (くろぶ
Fagus japonica *Maxim.*

347. ぶなのき
Fagus crenata *Blume*

JAPANESE CHESTNUT

OAKS

349. くり
Castanea crenata *Sieb. et Zucc.*
(=C. pubinervis *Schneid.*)

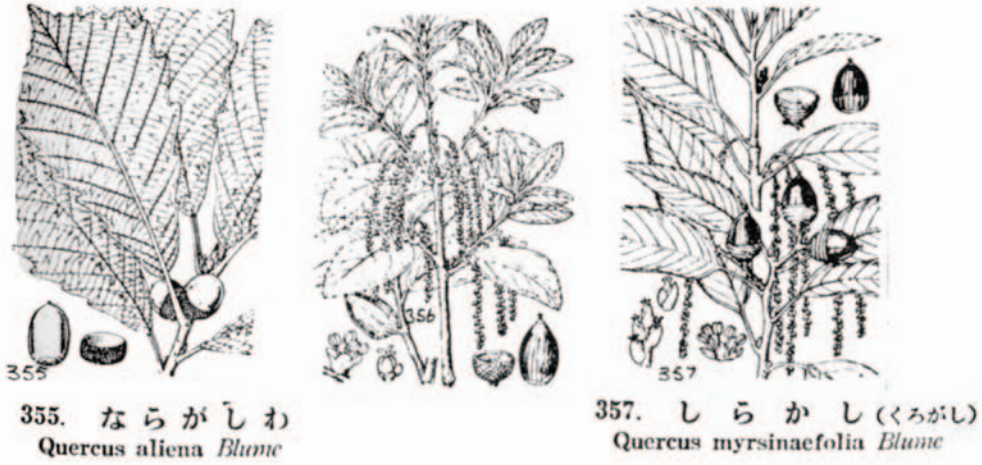
351. みずなら (
Quercus crispula *Blume*

350. こなら (ほおそ, なら)
Quercus serrata *Thunb.*

352. くぬぎ
Quercus acutissima *Carruth.*

354. かしわ
Quercus dentata *Thunb.*

353. あべまき (
Quercus variabilis *Blume*



355. ならがしわ
Quercus aliena *Blume*

357. しらかし (くろがし)
Quercus myrsinaefolia *Blume*

356. うばめがし (いまめがし, うまめがし)
Quercus phillyraeoides *A. Gray*

358. あ ら か し
Quercus glauca *Thunb.*

359. よ こ め が し (しまがし)
Quercus glauca *Thunb.* var. fasciata *Blume*

360. ひりゅうがし
Quercus glauca *Thunb.* var. lacera *Matsum.*

361. あ か が し
Quercus acuta *Thunb.*

362. つくばねがし
Quercus paucidentata *Franch.*
(=Q. salicina *Blume*)

363. うらじろがし
Quercus stenophylla *Makino*
(=Q. salicina *Blume*)

CHINQUAPIN

364. い ち い が し
Quercus gilva *Blume*

366. つ ぶ ら じ い (こじい)
Shiia cuspidata *Makino*
(=Castanopsis cuspidata *Schottky*)

365. い た じ い (すだじい, ながじい)
Shiia Sieboldii *Makino*
(=Castanopsis cuspidata *Schottky* var. Sieboldii *Nakai*)

TROPICAL OAKS

367. ま て ば し い (まてじい)
Lithocarpus edulis *Nakai*
(=Pasania edulis *Makino*)

368. しりぶかがし (しりぶか)
Lithocarpus glabra *Nakai*
(=Pasania glabra *Oerst.*)

425. や ま も が し (かまのき)
Helicia cochinchinensis *Lour.*

LOTUS NUT

651. はす (はちす)
Nelumbo nucifera *Gaertn.*
(=Nelumbium speciosum *Willd.*)

EARTH NUT

1273. ほど (ほどいも)
Apios Fortunei *Maxim.*

PILI NUT

1359. かんらん (うおのほねぬき)
Canarium album *Raeusch.*

JAPAN WOOD OIL TREE

1401. あぶらぎり (とくえ)
Aleurites cordata *Muell. Arg.*

HORSE CHESTNUTS

1486. とちのき
Aesculus turbinata *Blume*

1487. うまぐり (まろにえ)
Aesculus Hippocastanum *L.*

WATER CHESTNUTS

1687. ひし
Trapa natans *L.* var. bispinosa *Makino*

1688. おにびし
Trapa natans *L.* var. quadrispinosa *Makino*

1689. めびし
Trapa natans *L.* var. rubeola *Makino*
(=T. japonica *Flerov* var. rubeola *Ohwi*)

〔ひし科〕

CHINESE WATER CHESTNUT

1690. ひめびし
Trapa incisa *Sieb. et Zucc.*
(=T. natans *L.* var. incisa *Makino*)

SCREWPINE

2765. たこのき
Pandanus boninensis *Warb.*

3065. くろぐわい (くわいづる, いご, ごや, ぎょ, す)
Eleocharis Kuroguwai *Ohwi*

FOOD VALUE, FRUIT MATURITY AND RIPENING OF AVOCADO FRUIT

Lois Evans

The Avocado tree provides a crop of most desirable fruit with the combined qualities of a delicious flavour, wide versatility and high nutritional status.

The ripe fruit has a melt-in-the-mouth texture, and a deliciously smooth savoury flavour. Due to its very unique flavour, the flesh of the avocado compliments many other foods. It may be served in cold or hot dishes, including soups, or as a stimulating entree. Avocados' also provide a wholesome, easily digestible alternative in the diet of invalids or diabetics.

If you are one of the many people yet to sample an avocado fruit, do not be disappointed if at first taste it does not appeal. Individual fruits can vary greatly depending on the variety. (Personally I'm hooked on "Hass") and due to widespread ignorance of the technique for establishing ripeness, you may be served an unripe fruit. Can you imagine sampling unripe grapes or oranges! Consumer education is most important where any new fruit is concerned. Also, for some people the avocado is an acquired taste. Can all the olive addicts remember their first olive? Once acquired, a taste for these superb food-fruits becomes almost obsessional.

It being such a provider of nutritious and useful food, an avocado may soon be found growing alongside the predictable lemon tree in every backyard. As the fruit does not ripen on the tree, it may be left in-situ and just several picked to ripen as they are required. In this way the tree will provide a convenient food source over many months.

FOOD VALUE

Although bursting with vitamins and minerals, the avocado is low in starch. In addition the fat or oil content of about 20% is unsaturated and in good proportion with the saturated fatty acids. Avocados contain no cholesterol.

The following table will compare the composition and food values of three common fruits with the avocado.

	APPLES	BANANAS	ORANGES	AVOCADO
Edible Portion of Purchased Mass (%)	78	70	74	70
Water (g)	84.9	75.4	86.1	74.7
Protein (g)	0.3	1.1	0.9	1.7
Fat (g)	0.3	0.3	0.2	15.8
Carbohydrate (g)	13.8	22.5	11.1	6.3
Energy (Kj)	222	364	188	674
Calcium (mg)	6	9	39	12

	APPLES	BANANAS	ORANGES	AVOCADO
Phosphorous (mg)	9	27	22	34
Iron (mg)	0.3	0.6	0.4	0.6
Potassium (μg)	115	377	173	455
B -Carotene Equivalent (μg)	39	200	136	163
Riboflavin (mg)	0.03	0.05	0.03	0.21
Niacin (mg)	0.2	0.7	0.3	1.5
Thiamine (μg)	36	62	84	87
Ascorbic Acid (Vit. C) (mg)	6	11	50	13

FRUIT MATURITY

RULE 1: THE FRUIT MATURES ON THE TREE, IT RIPENS OFF THE TREE

It is necessary to know how to recognize mature fruit, as it is not left to ripen on the tree but is picked when mature, then allowed to ripen over a period of days.

As maturity is a major component of avocado quality it is also a prime factor in palatability. Unless producers, wholesalers, retailers and the buying public are educated many potential customers will be lost to the industry.

Research carried out by Dr Lewis and his team at Wollongbar, has indicated that as an avocado matures its oil content and dry matter content increase simultaneously with its level of palatability. (Dry matter refers to the quantity of dried flesh remaining after complete removal of its moisture.) Within an acceptable range, oil content and dry matter content are closely related. Testing the level of either is a reliable test for maturity. Regulations in Israel and USA are actually based on oil content tests. It is however, much matter for mature fruit as 21 %. If immature avocados (less than 21 % dry matter) are presented for sale, they may be confiscated and destroyed. Heavy legal penalties await persistent offenders. These controls are essential as poor quality fruit presented to the market will discredit the industry and deter potential consumers.

TO JUDGE MATURITY

When taking samples for dry matter testing, select fruit which generally represents the standard to be marketed. Mature fruit will exhibit the following characteristics;

- Fruit appears generally larger (Not always applicable).
- Immature fruit has a shiny skin, when mature this becomes dull, lustreless and has a powdery appearance.

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- The normally green fruit stalk will show a distinct yellowing, and will be large and swollen.
- On opening the fruit, the testa (seed coat) will be dark, dry and shrivelled, instead of pale or whitish as in immature fruit.
- Some say that gentle pressure by the fingertip should give a feeling approximating the softness of the tip of your nose!

Skill and confidence will be obtained as growers gain experience in comparing the outward features of maturity with dry matter testing results.

RIPENING

Virtually all avocado fruit are marketed in the hard unripe (though mature!) state, and ripening is left to the consumer. Even if several fruit are picked from the same tree at the same time, they may differ in their ripening times by as much as ten days.

To spare the consumer this inconvenience, avocados can be exposed to very small amounts of ethylene gas in air, and will then all ripen at the same time. Ethylene is a naturally occurring product of ripening fruit, and therefore cannot be considered as a foreign chemical in treatment of the fruit. Ethylene treatment merely speeds up the normal ripening process, and makes the time of ripening more uniform.

Mature, recently picked avocados exposed to 10 ppm of ethylene in air at 18 degrees C (64 degrees F) for 36 - 48 hours will ripen 3 - 4 days following removal from the treatment.

Once ripe, avocados will keep in excellent condition for at least two weeks if stored between 2 - 6 degrees C (36 - 43 degrees F) at high humidity.

Consumers may also make use of ethylene to stimulate uniform ripening. Ripe apples, pears, bananas or avocados all produce ethylene. Place one of these ripe fruit along with up to six unripe avocados in an approximately 26 x 50 cm (10" x 20") polyethylene bag. close with a rubber band and punch 12 holes about 1 cm (3/8") diameter in the bag.

The holes will cause enough ethylene to accumulate from the ripe fruit but prevent over-accumulation of carbon dioxide. If too much $C0_2$ were allowed to accumulate, ripening would not occur in spite of the presence of ethylene.

Once the fruit are soft, they can be stored in the refrigerator at 2 - 7 degrees C (36 - 45 degrees F), the temperature at which most 'fridges . Placement in the crisper is ideal, and the fruit may be left in the original bag.

AVOCADO ... THE SENSUAL FRUIT!

If the avocado has perhaps not been your 'thing' thus far, do yourself a favour and try a little harder to get to know them. Otherwise you really are missing out on a delicacy. Don't expect a sweet fruit, as it is really more like a vegetable in flavour. Probably the best introduction is to try it with a prawn cocktail filling, or alternatively, peel and dice, squeeze fresh orange juice over and season with rough-ground black pepper. - Have as a side-salad with your next salad meal. When you pop a piece into your mouth, savour the cool flesh as it yields to your

tongue, and leisurely appreciate the subtle, sensual, natural flavour of the fruit.

Just a few tips - Don't poke hard with a finger to test for ripeness, or you will leave a trail of bruises. Gently squeeze the fruit between both palms, it should have 'give', arid feel resilient. A skewer should pass easily through the flesh at the stem end. Avocados, like apples, should not be exposed to air for too long before use, as oxidation will spoil the flavour and appearance. One method of preventing this is to sprinkle the cut surface with lemon or lime juice.

Overcooking can also cause the avocado to change colour, and it may become acid-tasting. Do not prepare complete dishes beforehand and reheat, as the flavour will be ruined. Prepare all else beforehand, but add the Avocado just before serving.

Happy eating! the following is a beautiful way to try out your newly acquired expertise in selecting and ripening these superb fruit.

AVOCADO SEAFOOD SALAD

2 ripe avocados
250 g (1 1/2 lb), cooked, shelled prawns, or crab meat
2 tablespoons mayonnaise
4 tablespoons whipped cream
1 tablespoon very finely chopped shallot or parsley
1 tablespoon tomato sauce (or to taste)
1 scant teaspoon Worcestershire sauce
1 tablespoon lemon juice
salt and pepper to taste

PLACE Mayonnaise, parsley or shallot, sauces, lemon juice into blender, blend well.

COMBINE Blended ingredients, seafood, whipped cream, until a thick smooth creamy consistency. Add pepper and salt to taste.
SLICE the avocados in half, lengthwise and remove the stems from each. Using a spoon remove the flesh from the Avocado, being careful not to pierce the skin of the fruit. Dice the flesh and marinate in lemon juice. Brush the inside of each Avocado half with lemon juice to prevent it from discolouring.

Combine the seafood mixture with the drained, diced avocado and fill the avocado shells Garnish with salad trims and serve on a lettuce cup in individual dishes.
Serves four.

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California Avocado Society Yearbook 1980 67-70

Commonwealth Department of Health, "Metric Tables of composition of Australian foods".
"The Avocado Cookbook" Hensley Spain

Thanks to Helen Duncan of the "Avocado Grove", Wanneroo, for recipes.

TRAINING MACADAMIA TREES*

Lois E. James

Only two significant articles on pruning have been reported in the Yearbooks of the Californian Macadamia Society. The first was by G.T. Shigeura in 1956 and the other by E.T. Fukunaga in 1960. Aside from various articles merely mentioning that training was important, Hamilton (1958) described a treatment for weak V-shaped crotches in an article on tree maintenance, Storey (1963) explained cross bracing by marching, and Rosedale (1966) made a few statements concerning the advisability of some early training to prevent trees should be pruned, that they should 'have a single leader, and that V-branches should be avoided. There has been no article describing training of *M. tetraphylla*. Both Shigeura and Fukunaga worked on *integrifolias*.

After seven years of experimenting at the Keaau Orchard in tub, Shigeura (1956) concluded that Macadamia trees, at least at that orchard, should have a central leader, have branches 6-18 inches apart along the length of the central leader, have fruiting twigs on these laterals, and have no V-crotches. He states that a tree with a central leader does not take up the space that a wide b V-crotches are much more likely to split when subjected to strong winds than ones with wide L-shaped crotches. Shigeura emphasizes the importance of "fruiting twigs" which he explains are any and all small branches within the crown of the tree. He points out that the yielding potential is related to the amount of these small fruiting twigs on the tree, and that the formation of fruiting twigs in some varieties is natural but in others they have to be induced by pruning. This is accomplished by leaving short stubs when cutting off excess laterals. Shigeura states that any time of the year is suitable for pruning since dormancy, or lack of dormancy, in a Macadamia tree is inherent in the plant itself rather than related to season. In Hawaii there are not clear cut growing and dormancy seasons.

Fukunaga (1960), in describing branching in *integrifolia* varieties, states that the whorl of branches at the base of each flush of growth forms wide-angled L-type crotches and also are weaker, have less vigour, than branches originating above the base. He maintains these two characteristics make these basal whorls excellent laterals. The base of a flush can be recognized because each successive flush is different in colour and texture of the bark until they are quite mature. Also the first node of a flush generally has no leaves or rudimentary leaves, but does have branch buds. Normally in undisturbed trees, branching occurs only at the nodes at the junction where one flush ends and the other begins. In some trees branching sometimes does occur in leaf axils above the base of a flush and always will when the tip bud is removed or destroyed by insects. The branches forming in the axils of the leaves immediately below the destroyed or cut end or in other leafy axils, usually have V-crotches and will tend to be vigorous.

* A review of articles in the Yearbooks from 1955 through 1978 on training Macadamia trees. Reprinted from the California Macadamia Society Yearbook 1978.

Fukunaga also observed that in pruning if a cut is made in a young part of a branch (near the end) the top buds in the leaf axils develop. He suggests that two of the three developing buds be removed and the third allowed to grow with the expectation that it will start forming wide-angled branches at the base of each flush. If a cut is made lower on the stem where the bark is well formed, the top two buds in each of the three leaf axils below the cut may develop, which means six branches developing at a single node.

There are two visible and one buried bud in the axil of each leaf. Branches from the top buds have V-crotches, but the branches can be selected as a leader and the other two cut off. The three L-crotch branches are left as good laterals. Fukunaga explained that sometimes the new leader does not produce laterals at a desirable distance and the process has to be repeated. Repeating the process slows down the growth of the tree, but Fukunaga believes it is well worth it in the long run. Few California growers have attempted the detailed training reported by Fukunaga. Most do little other than removing low hanging branches which interfere with irrigating and harvesting, repairing damage after wind storms, and sometimes cutting back long whiplike branches. Trees obtained from nurseries are not likely to be sold with V-crotches, but since many novices have grown trees from seeds or started with young seedlings, there are a good many older trees around with bad V-crotches. Many others have been damaged during Santa Ana winds.

On one of the field trips of the California Macadamia Society the group visited a grove where a number of fairly large trees had been lost from V-crotches splitting the trees to ground level. It is possible to avoid damage or loss of a tree with a V-crotch without cutting off one of the arms of the V. Methods have been explained by Fukunaga (1960) and Storey (1963) and mentioned by others. Fukunaga has suggested tying the V-branches together with staples and wire. The tree will gradually grow around the staples and wire but this does not harm the tree. Wire should not he placed around the trunk or branch because it will result in girdling. This is true also when tying trees to stakes. Sometimes it is feasible to bolt limbs together. Perhaps a better method, described by both Fukunaga and Storey, is to cross brace by marching. Where there is a V-crotch a limb from one trunk is grafted to the other trunk or branch, thus tying the two together. The process can be repeated at successively higher levels. This should completely prevent a V-crotch from splitting. The cambiums of each of the two being grafted together are exposed where they meet and are nailed together or bound with tape, covered with tree seal and then with white water-based paint to avoid excessive heating. Weak limbs as well as entire trees can also be supported by marching seedlings planted under the tree and sometimes by marching suckers from the stock.

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Storey, W.B. 1963. Cross bracing. Calif. Macadamia Soc. Yrbk.9:23.

LITTLE KNOWN AUSTRALIAN RELATIVES OF THE PILI NUT

Lois Evans

When David Noel suggested that I investigate *Canarium australasicum*, I wondered where he even got the name!

A telephone call to the W.A. herbarium provided very authoritatively the information that the plant did not exist -- but that there was a plant called *Canarium australianum* which occurred naturally in tropical Australia from the Kimberleys to Cape York. Nothing else was known about it.

This posed a mystery. Were there two species in Australia, one of which was not known to the W.A. herbarium, or did I simple have a mis-spelt name?

Letters to the NSW and Queensland herbariums provided some answers.

There are two known species in Australia. The previously mentioned *Canarium australianum* occurring in the Kimberleys, and also *Canarium australasicum*.

Canarium australasicum, family *Burseraceae*. Natural distribution is in north eastern NSW and Queensland. However, even though scattered specimens may occur over this range it is considered quite rare and only extends as far south as the Richmond River.

Its common name is "Mango Bark" due to the family characteristic it displays which is the exudation from the bark of an aromatic resin. The resin of the NSW and Queensland species *australasicum* having a strong mango-like smell.

The crown is dense and spreading, it grows to a large tree of 40 m in height with trunk around 120 cm in diameter. Leaves are pinnate, with entire margins and are green and shining on both surfaces. Flowers are deep red, in panicles borne at the ends of the branchlets or in the forks of the uppermost leaves. Flowering period November - December. The fruit is a drupe (e.g. Plum and Apricot) with a fleshy covering over a single hard stone. Fruit blue or purple in colour, 10 - 12 mm, long, ripening March to May. Reportedly eaten raw in Queensland.

Canarium australasicum's natural habitat is warm temperate and gully rainforests on poorer soils derived from rhyolite or metamorphic rocks.

The timber it produces is grey coloured, moderately hard, close grained, greasy. Easily worked. This timber is suitable for furniture, joinery, plywood, cases, flooring, lining. Sapwood is subject to attack by borers.

The Aborigines of the Pennefather River area were said to have rubbed and crumbled the bark in water to make a milky resinous liquid which was drunk for gastro-intestinal troubles.

The white sticky exudate was used as a cement either after warming and pounding or after boiling with stingray fat in a baler shell. The tree was also used as a fish poison by the Aboriginals.

Apart from specific botanical descriptions which would bore you to tears, this is all the information I can gather. If anyone reading this has any knowledge, or especially any personal experience of the plant we would appreciate hearing about it. Best of all, make sure your life insurance is up to date and try tasting the fruit and seed. After all the Macadamia nut remained unnoticed right under our noses until it was exploited elsewhere!

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ADDRESS BOOK -- USEFUL ORGANIZATIONS

This list of useful addresses will be reprinted each year in the Yearbook. It includes Societies, Associations, and Government or Quasi-government departments. Please notify the Editor of errors or omissions.

Australia: CSIRO Division of Horticultural Research. GPO Box 350, Adelaide SA 5001

Australia: CSIRO Horticultural Research Station, Merbein, Victoria 3505, Australia

Australia: Forestry Branch, Department of Primary Industry, Banks St, Yarralumla, ACT 2600, Australia

Australia: Rare Fruit Council of Australia, PO Box 707, Cairns, Queensland 4870, Australia

Australia: Society for Growing Australian Plants, 860 Henry Lawson Drive. Picnic Point, NSW 2213

Australian Macadamia Society, PO Box 445, Caboolture, QLD 4510 California

Macadamia Society, PO Box 666, Fallbrook, California 92028,

USA California Rare Fruit Growers, Fullerton Arboretum,

California State University, Fullerton, California 92634, USA

Connecticut Nut Growers Association, 27 Baldwin Rd, Manchester, Connecticut 06040, USA

Costa Rica: Institute Interamericano de Ciencias Agricolas de is OEA (P.G.Sylvain), Turrialba, Costa Rica

Illinois Nut Tree Association, 1498 Urbandale Dr, Florisant, Missouri 63031,

Indiana Nut Growers Association (Merna Dicoff), 9805 E.100 St., Zionsville, Indiana 46077, USA

International Association for Education, Development, and Distribution of Lesser Known Food Plants and Trees, PO Box 599, Lynwood, California 90262, USA

Iowa Nut Growers Association, Stewart Road, RR 6, Iowa City , Iowa 52240, USA

Israel: Department of Subtropical Horticulture, Volcani Centre. PO Box 6, Bet Dagan, Israel

Korea: Institute of Forest Genetics, Seung Kul Park, Swon, Kyunggi-Do, Korea

Michigan Nut Growers Association, 199 Strongwood, Battle Creek, Michigan 49017, USA

Nebraska Nut Growers Association, 207B Miller Hall 8N, University of Nebraska, Lincoln. NE 08583, USA

New South Wales: Department of Agriculture, 157 Liverpool St, Sydney NSW 2000

New Zealand: Crop Research Division, Department of Scientific and Industrial Research, Private Bag, Christchurch, New Zealand

New Zealand: Lincoln Agricultural College, Lincoln College, Canterbury, New Zealand

New Zealand Tree Crops Association, PO Box 1542, Hamilton, New Zealand

North American Fruit Explorers (Ray K Walker), PO Box 711, St Louis, Mo. 63188, USA

Northern Territory: Department of Northern Australia, Animal Industry & Agriculture Branch, PO Box 146, Katherine NT 5780

Northwest: CSIRO Division of Tropical Crops & Pastures, Kimberley Research Station, Kununnura WA 6743

Ohio Nut Growers Association, 1807 Lindbergh NE, Massillon, Ohio 44646, USA

Ontario : Society of Ontario Nut Growers (R. D. Campbell). RR 1, Niagara-on-the-Lake, Ontario L0S 1JO, Canada

Oregon: Nut Growers Association of Oregon, Washington, and British Columbia, PO Box 23126, Tigard, Oregon 97223, USA

Pennsylvania Nut Growers Association (Albert Magee), RR 3 Box 78, Duncannon, PA 17020, USA

Queensland: Department of Primary Industry, William St. Brisbane QLD 4000

South Australia: Department of Agriculture and Fisheries, 25 Grenfell St. Adelaide SA 5000

South Australia: Woods and Forests Department, 135 Waymouth St, Adelaide SA 5000, Australia

Spain: Centro De Experimentia Agraria, Apartado 415, REUS, Tarragona, Spain

Tasmania: Department of Agriculture, GPO Box 19213, Hobart, TAS 7001

USA: Agri-Silviculture Institute, PO Box 4166, Palm Springs, California 92263, USA

USA: Friends of the Trees Association, PO Box 567, Moyie Springs, Idaho 83845, USA -

USA: International Tree Crops Institute USA Inc., Route 1, Gravel Switch, Kentucky 40328,

USA: International Tree Crops Institute USA Inc., PO Box 1272, Winters, California 96594,

USA: Northern Nut Growers Association, RR 3, Bloomington, Illinois 61701,

USA: People of the Trees, 1102 Snyder, Davis, California 95616, USA

USA: Rare Fruit Council International, 3280 South Miami Avenue, Miami, Florida 33129,

USA: Tree Crops Research Project, 230 East Roberts, Cornell University, Ithaca, New York 14853.

United States Pecan & Field Station, USDA-ARS, PO Box 579, Brownwood, Texas 76801, USA

Venezuela: Fundacion para el Desarrollo de la Region Centro Occidental de Venezuela, Apartado 523, Borquisimeto, Venezuela

Victoria: Department of Agriculture, Scoresby Horticultural Research Station, PO Box 174, Ferntree Gully, VIC 3156

Victorian Nut Growers Association (A.D. Allen), PO Box 69, Wangaratta, VIC 3677

West Australian Nutgrowing Society, PO Box 27, Subiaco, WA 6008, Australia

Western Australia: Department of Agriculture, Jarrah Rd. South Perth WA 6151

Western Australia: Permaculture Association of W.A., PO Box 430, Subiaco, WA 6008

ADDRESS BOOK -- NURSERIES & COMMERCIAL SOURCES

This is the first edition of this list. Please notify the Editor of any omissions or errors, especially where WANATCA members are involved. (-+ indicates WANATCA Member)

WESTERN AUSTRALIA

++ KELMSCOTT AZALEA GARDENS, 41 Roberts Rd. Kelmscott 6111. Retail garden centre with large range of tropical and exotic fruits.

++ NUT TREE AND CONIFER NURSERY, 52 Croydon Rd. Roleystone 6111. Independent propagator producing temperate nuts and avocadoes.

++ OLEA NURSERIES, RMB 44, West Manjimup 6258. W.A.'s largest producer of temperate fruit and nut trees.

++ SPREADING CHESTNUT, PO Box 27, Subiaco 6008. Retail outlet, has wide range of nut trees and unusual fruits.

++ NUTLAND NURSERY, Lot 6, Carabooda Rd. Wanneroo 6065. Wholesale producer of avocadoes, pecans, chestnuts, and other nuts.

++ DAWSONS NURSERY, Hale Rd. Forrestfield 6058. General garden centre with range of traditional temperate fruits and nuts.

+-- WALDECK NURSERIES, Russell Rd, Wanneroo 6065. Large Perth chain of garden centres, stock more popular fruits and nuts.

++ PECAN INDUSTRIES, PO Box 69, West Perth 6005. Wholesale producers of pecans, jojobas, pistachios, chestnuts. Planting and management services.

++ MICROCULTURE, Lot 60, Russell Rd, Lansdale 6065. Tissue culture propagators.

A RICHARDS, 1369 Albany Highway, Cannington 6107. Propagation and nursery needs.

PACKSADDLE PRODUCE CO., PO Box 249, Kununurra 6743. New wholesale producer of tropical fruit seedlings.

VICTORIA

JOHN BRUNNING & SONS, Somerville 3912. Fruit tree wholesaler with large traditional range.

LES J COLES, Fernbank Nursery, Flinders Rd, Tyabb 3913. Temperate fruit trees, walnuts.

FLEMINGS MONBULK NURSERIES, Macclesfield Rd. Monbulk 3793. Temperate fruit tree wholesaler.

W A SHEPHERD & SONS, Moorooduc, 3933. Good range of temperate fruits and berries.

BLUEBERRY HILL NURSERY, Cherrys Rd. Toolangi 3777.

Blueberries.

AUSTRALIAN BLUEBERRY NURSERIES, Boundary Rd West, Narre Warren East 3804.

LUCAS LINERS, PO Box 81, Olinda 3788. Mass producers of 1-year seedling trees, including some nuts.

MABUHAY GARDENS, PO Box 3, Monbulk 3793. Seed of exotic fruit trees, wholesale only.

SOUTH AUSTRALIA

++ FRESHFORD NURSERY, Highbury, 5089. Grafted walnuts, persimmons, and pecans.

BALHANNAH NURSERIES, Balhannah, 5242. Traditional fruits.

TOLLEYS NURSERIES, PO Box 2, Renmark 5341. Citrus specialists, supply trees, seeds, and budwood.

TASMANIA

++ SELF-RELIANCE SEED CO, PO Box 96, Stanley 7331. Seeds of useful crop plants.

NEW SOUTH WALES

PREMIER NURSERIES, PO Box 400, Griffith 2680.Wholesale and retail supplier of fruit trees.

SUNRAYSIA NURSERIES, Sturt Highway, Gol Gol 2739. Grapes, olives, citrus and avocadoes.

MOUNTAIN BLUE NURSERY, Waltons Rd, Federal via Lismore 2480. Blueberry specialists.

RIVERINA NURSERIES, Farm 645, Griffith 2680. Range of fruit trees.

H C KERSHAW, PO Box 84, Terry Hills 2084. Wide range of tree, shrub, and palm seeds.

QUEENSLAND

++ TURNER HORTICULTURE, PO Box 109, Spring 1-1111 4000. Grafted macadamias, grapes, tropical fruits.

++ FITZROY NURSERIES, PO Box 859, Rockhampton 4700. Very good range of tropical fruits and nuts, pecans, macadamias.

LIMBERLOST NURSERIES, Freshwater, Cairns 4870. Range of tropical trees, including some fruits and nuts.

LANGBECKER NURSERIES, PO Box 381, Bundaberg, 4670. Avocadoes, pecans, custard apples.

B W WHOLESALE & EXOTIC NURSERIES, PO Box 125, Childers 4660. Avocadoes, lychees, custard apples, pecans.

THE LYCHEE NURSERY, Bingil Bay, 4855. Lychee specialists.

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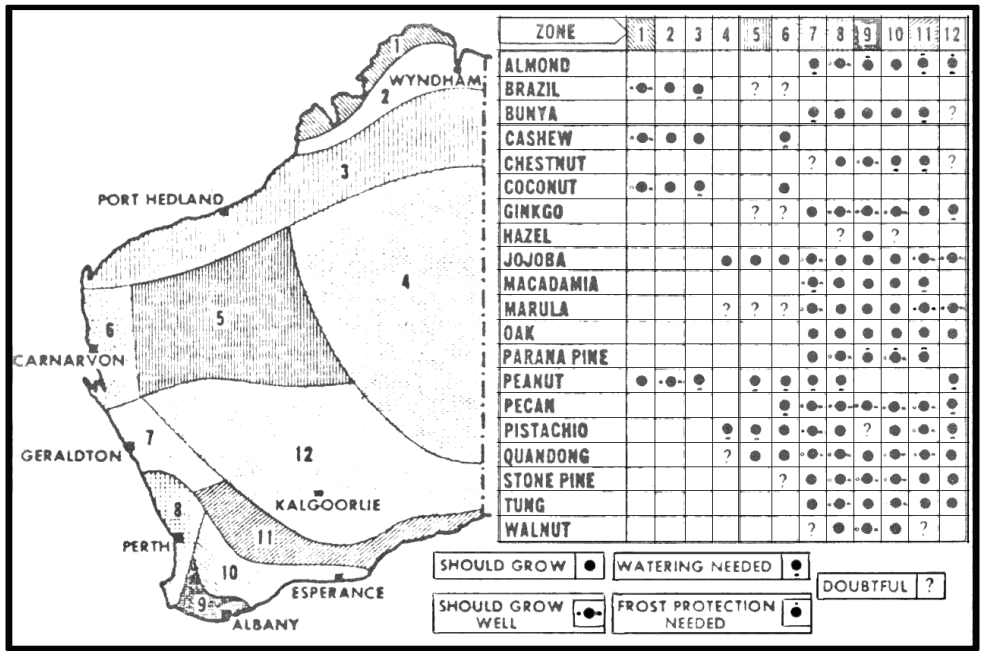

When it is considered that there exist over one thousand species of nut plants, it will be appreciated that a leaflet such as this can only touch upon a small fraction of all the information available on the subject. Nuts grow within the Arctic circle, in tropical jungles, in deserts, and in marshes. They grow not only on trees, but also underground, underwater, within giant gourds on vines, and floating on lake surfaces.

The interested horticulturist will be able to grow almost any of these thousand nut plants somewhere in Western Australia, but those who are more interested in growing nuts to eat or sell will want to chose ones which are likely to thrive without special care and attention. The map above gives a very general indication for some common nuts. In the cooler and moister areas of the Southwest, the best prospects are probably for the pecan, chestnut, hazel, and walnut. The first two will also grow in the drier inland areas, although appreciating some irrigation. The macadamia will grow anywhere in the State as long as adequate water is available and there are no severe frosts.

The pistachio and the almond will grow under quite dry conditions, but need cool winters for good crops. Almonds are prone to bird damage and hardshell varieties should be planted in small orchards which cannot support bird-deterring gear. In arid areas with no irrigation possible, jojoba and certain other desert nuts may be planted. Cashews grow well in the Kimberleys, and brazil nuts and other tropicals should do well in the extreme north. Coconuts will grow all along the northern coast as far south as Carnarvon.

The West Australian Nut and Tree Crop Association aims to help everyone interested in growing nuts, fruits, and other tree crops, whether as a commercial venture, a profitable sideline, or an interesting hobby. Current services to members include informative quarterly newsletters, a Yearbook containing research and reference material, tree and seed supply, and a book supply service. Contact the Association at PO Box 27, Subiaco, W.A. 6008.