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WEST AUSTRALIAN NUT & TREE CROP ASSOCIATION

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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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AVOCADO SUNBLOTCH VIROID:
Importance of Pollen and Mechanical Transmission in Control Programs

P. R. DESJARDINS AND R. J. DRAKE
Department of Plant Pathology,
University of California, Riverside, California

INTRODUCTION

When one reviews the history of the sunblotch disease of avocado and considers the very limited information on the nature of many infectious agents 50 years ago, it is not difficult to see why Coit (3) first described the disease as being a physiological disorder. Coit is probably the first to call the disease sunblotch, and we assume he did so because of the yellow streaks and blotches on stems and fruits and the distinctive chlorotic patterns on the leaves of infected trees exhibiting symptoms.

Because of the graft transmissibility of the causal agent, it was eventually considered to be a virus (10, 11). Research on sunblotch disease was for many years based on the premise that the causal agent was a virus (8, 22).

Before describing the evidence from later studies that shows that the sunblotch agent is other than a virus, we would like to discuss two other aspects of the disease (i.e. the interaction of the avocado host with the causal agent). The two aspects we wish to consider initially are the recovery phenomenon (which results in a symptomless carrier condition) and seed transmission of the causal agent. Keep in mind that with seed transmission the progeny seedlings receive the causal agent from the female parent tree as distinct from pollen transmission in which case the male parent is the source of the causal agent. We will, of course, be discussing pollen transmission later.

About 30 years ago certain seed sources used for rootstocks were found to be carrying the sunblotch agent even though they were symptomless. The first indication that they were infected was shown by a high rate of transmission through their seed. Wallace and Drake (22) eventually demonstrated that the symptomless carrier sources developed as the result of certain symptomatic trees "recovering" from symptoms of the disease although they were still carrying the sunblotch agent. They further demonstrated that when recovery occurred the rate of seed transmission increased dramatically. This increase involved a transmission rate change from 0-5% for symptomatic trees to 90-100% for recovered trees.

Recovered trees cannot be induced to exhibit symptoms. Also progeny seedlings from

recovered trees that are carrying sunblotch agents are symptomless and cannot be induced to exhibit symptoms. The sunblotch agent is, of course, detected when sunblotch-free scions are grafted to the symptomless carrier seedlings.

Because of the very high rate of seed transmission we initiated research involving heat therapy to see if the agent could be eliminated from seed, budwood and seedlings (Desjardins, Drake and Wallace, unpublished). We failed, and the results indicated that the sunblotch agent has a pronounced thermal stability. The high resistance to heat and our failure to find typical virus particles in either highly fractionated extracts or in ultrathin sections of infected tissues led us to suspect that the agent might be a viroid rather than a virus. Consequently in 1974 we redirected our research with this possibility in mind. Since other viroid agents had been shown to be mechanically transmissable, we redoubled our efforts to mechanically transmit the sunblotch agent (6, 8). (To be discussed further under section on Mechanical Transmission.)

Subsequently biochemical and biological evidence from Australia, New Zealand, South Africa and our Department in Riverside demonstrated that the causal agent is indeed a low molecular weight RNA which is characteristic of viroids (4, 5, 8, 9, 12, 13, 18, 19). Two laboratories have independently shown that purified sunblotch viroid RNA can cause sunblotch disease (2, 20).

POLLEN TRANSMISSION

As described above the transmission of sunblotch viroid from infected mother trees to progeny through seed has been known for some time (22). Occasionally a seedling was found to be infected with the viroid when the seed-mother tree was known to be free of the viroid. Since these infected progeny seedlings had germinated and grown under conditions which precluded either possible natural root grafts or accidental mechanical transmission, the most logical explanation for their being infected was that pollen transmission of the viroid causal agent had occurred.

As a result of these observations, research was initiated to experimentally demonstrate pollen transmission of the viroid. To demonstrate the presence of the viroid in pollen, pollen grains, which were completely free of other floral parts and were from infected trees, were implanted under the bark of test seedlings. The viroid was successfully transmitted to the test seedlings using this technique (7).

This did not, however, conclusively prove that pollen transmission occurs in nature. Initial attempts to demonstrate pollen transmission involved hand pollinations. Since these proved unsuccessful for various reasons, especially low fruit set, honey bee pollination was utilized using healthy Zutano variety field trees as pollen recipients. These were enclosed in an insect-proof cage with 3-4 viroid-infected trees (growing in 32-gallon metal cans) which served as pollen donor trees. A colony of bees was maintained in the cage during the pollination period. The bee pollination experiment was repeated yearly for five years. During the first two years the pollen donor trees included both symptomatic and symptomless carrier trees. In the third and fourth year experiments the pollen donor trees were symptomless carrier trees only, while in the fifth year they were symptomatic trees only.

It had been known for some time that flowers of avocado varieties are of two types, so-called “A” and “B” (7, 15). In each type the male and female organs of the flowers do not function at the same time and the cycle of the ‘’A” and “B” types differ from one another.

Therefore, for maximum fruit set it is recommended that varieties with both flower types be interplanted. Since the pollen recipient Zutano trees have “B” type flowers, the infected pollen-donor trees were selected to include complimentary “A” type varieties to insure maximum cross pollination.

Pollen transmission was obtained in all but the third year of the bee-pollination experiments. In 1979 there was a severe frost and a crop of only seven seeds was obtained, and no infected progeny were found in that year’s crop. The rate of pollen transmission was found to be relatively low (9) varying from about 1 to almost 4% (actually, 3.92%). However, since it did occur in four separate years and under conditions which would preclude other types of transmission, it has been adequately demonstrated.

We were, of course, interested in knowing whether the progeny seedlings which did not show symptoms were carrying the viroid in a symptomless carrier fashion. Each year the symptomless seedlings from that year’s crop were therefore indexed for the viroid by budding healthy Hass variety buds to them. None of the symptomless progeny were found to be infected with the viroid.

We were also interested in determining whether the pollen-recipient trees themselves became infected during the course of pollen transmission. The Zutano trees used as pollen recipients were tested for the presence of the viroid by indexing on healthy test seedlings. Forty-eight to sixty budsticks were taken for indexing immediately after harvesting the fruit for the year. One tree was tested for five years and the second one for two years. To date there is no evidence that the pollen-recipient tree becomes infected with sunblotch viroid during the course of pollen transmission.

MECHANICAL TRANSMISSION

In 1974 when we first began to suspect that the sunblotch agent might be a viroid we renewed our efforts to mechanically transmit it to avocado and to several herbaceous plant species. Initially we utilized buffered extracts from infected tissues as inoculum and the conventional leaf rubbing technique used for viruses as the inoculation method. The results with the leaf-rubbing technique were negative. Subsequently we used the razor-slash technique which had been successfully used by Semancik and Weathers (17) to transmit the citrus exocortis viroid. When inoculating directly from an infected tree to a healthy test seedling, an alcohol-sterilized razor blade was passed through a diseased avocado shoot and immediately passed through shoot tissues of the healthy test seedlings. This was repeated 10 times on each seedling. This method proved to be a successful one although the rate of transmission was only 13.7%. The incubation period for disease development with the inoculations directly from avocado to avocado had a range of 10 to 22 months (see Table 1).

We subsequently utilized this technique to test the infectivity of various concentrated fractions of infection extracts (8) and purified viroid RNA (20). As indicated in Table 1, the percent of successful inoculations with concentrated fractions varied depending on the type of inoculum, but was considerably higher than that obtained with direct inoculations from infected to healthy seedlings. We interpret this to be due to a higher concentration of the viroid in the inoculum in the fractionated and concentrated extracts. One should also note from Table 1 that some shorter incubation times were obtained with the concentrated fractions. We believe this is also due to the higher viroid concentrations in these fractions.

Undoubtedly the rate of accidental mechanical transmission of sunblotch viroid by con-

taminated pruning and budding tools in the field would be much lower than what has been demonstrated experimentally, but nevertheless such accidental transmission could occur. It is therefore desirable to use cultural practices that would prevent such transmission. Since it has been shown that sodium hypochlorite (chlorine bleach) can inactivate the exocortis viroid of citrus (16), we routinely use it to decontaminate our cutting tools from sunblotch viroid. We presently have research underway actually testing the efficacy of this and other chemicals in inactivating the sunblotch viroid (9).

IMPORTANCE IN CONTROL PROGRAMS

Programs for the control of sunblotch disease are based on the establishment of sunblotch viroid-free propagating stock of various commercial avocado varieties, and the use of this stock in setting out all new groves. Because of the low rate of pollen transmission and the relatively low rate (13.7%) of mechanical transmission from avocado directly to avocado, it might at first seem that the two types of transmission do not present much risk for control programs as described above. We feel, however, that by the very nature of the two types of transmission they present considerable potential hazard for viroid-free avocado plots. Since fruit set in avocado is dependent on bee pollination, bees carrying viroid-infected pollen veritably become winged vectors of the sunblotch agent. Obviously it is essentially impossible to control bee flights in the field.

In the sunblotch-free avocado registration program in California, the minimum distance that a candidate tree (candidate to be tested in the program) could be from a known or suspected sunblotch viroid-infected tree was 50 ft. This was to preclude the possibility of natural root grafts. Now because of the experimental demonstration of pollen transmission this minimum distance is being increased (probably to at least 300 ft.).

It is fortunate that the pollen recipient tree does not become infected during the course of pollen transmission to progeny seed. Although only a single variety (Zutano) was utilized as the pollen recipient trees in our tests, we assume that other varieties would respond in a similar way.

It would appear that it would be prudent to routinely decontaminate pruning and budding tools with chlorine bleach to minimize the chances of spread of sunblotch viroid in the field.

In spite of the seemingly low rates of both types of transmission, we feel that the symptomless carrier phenomenon (recovered trees) increase the potential hazard of infection by both types of transmission. Indeed some years ago when pollen transmission was first suspected because a repeatedly indexed avocado tree occasionally produced infected seedlings, it turned out that the suspected pollen source in the grove was a symptomless carrier tree.

There are biochemical methods (polyacrylamide gel electrophoresis and complementary DNA probes) which can be utilized to detect avocado sunblotch viroid in infected tissues (1, 5, 14, 21), and these should be utilized to the fullest advantage along with conventional methods to establish viroid-free propagating stock. In the actual design of control programs pollen transmission and the symptomless carrier phenomenon should be kept in mind, and finally cultural practices that eliminate or at least minimize the chance of accidental mechanical transmission should be utilized.

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BIOGRAPHICAL INFORMATION.

Dr. Paul R. Desjardins is a Professor of Plant Pathology in the Department of Plant Pathology, University of California, Riverside, California, U.S.A. 92521.

Mr. Robert S. Drake is a former Staff Research Associate IV in the same Department at Riverside.

TABLE 1

Mechanical transmission of the Avocado Sunblotch Viroid by the razor-slash inoculation technique

Inoculum	*Infections**	*Percent*	*Incubation Range (Mos.)*
Avocado to avocado	7/51	13.7	10-22
Tissue fractions after centrifugations**	16/48	33.3	4.5-16
Alcohol and dialystate ppt.***	20/25	80.0	4.5-3.4
Alcohol ppt'd fractions***	25/38	65.8	4-34

* Numerator = number of infections; denominator = number seedlings inoculated.

** Data from both low and high speed centrifugations.

*** Separate experiments both with alcohol pptd.

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PISTACHIOS - A GROWER'S EXPERIENCE

DAVID McCARTHY
WANATCA Member, Merbein, Victoria

In 1965, after not making my fortune in W.A., I returned home to Merbein where, with next to no capital, I purchased a pretty run-down property of 21 and a bit acres. The plantings comprised 15 acres of grape vines, mainly sultanas for drying and a few currants, and 5 acres of citrus. The citrus was past it so I pulled out most of the trees and replanted half again with oranges and for a year or so left the other half bare.

I went along to the CSIRO, not very far from home, enquiring about the possibilities of Macadamia nut culture, and there met Don Maggs. He mentioned to me his confidence in the growing of Pistachio nuts in this area. I had never heard of them but he gave me a booklet that he was just about to have printed. This was about 1973 or 74. After reading it 20 times over before I could understand it, I believed these Pistachios could be a goer.

Don gave me a few trees of unknown origin which I planted but had to bud and the CSIRO put in a trial of 12 trees, planted bare-rooted, of which 5 died and one grew from the stock. All the male trees died and the surviving trees were, 1 Kerman, 2 Sirora (15/11) 1 Bronte, 1 Lassen and 1 15/19. All trees were on Atlantica stock and growing well except for the Lassen which seems incompatible with Atlantica, though it had a few nuts on this year.

The Bronte had its first crop this year - fairly light and the 2 Sirora produced very heavy crops. I weighed this years dry nuts from the 15/19 - after floating off the empty shells, I had over 170kg. This tree had a good crop last year as well. The 15/19 were not as stained as I had expected but they did have a high percentage of unsplit nuts, which were included in the 17 kg measurement. The Kerman has had only light crops so far, partly due to pollination problems, I think.

But, how to get more trees! After many trips to the CSIRO, Don Maggs said that there were a few Atlantica seedlings growing under a row of trees at the Station and I could have them. The trees were only 25-30 cm high and the ground was still wet; so with a garden trowel I dug up several hundred and potted most of them in milk containers. Others which I planted in large seed-boxes failed because their tap-root was disturbed at planting.

Most of the trees in milk containers survived and I planted them out at a spacing of 10' x 22' - believing hedge-row could be a good system. I ended up with approximately 170 trees in about 1 acre. The other 11/2 acres or so were being planted with avocadoes, as I was finding pistachio seedlings hard to get.

In the Autumn of 1975 I chip-budded 68 trees, of which 5 Kerman took and 1 male (19/8). The trees were still growing well and I budded again in 1976 - often 5 or 6 buds per tree, as the Atlantica's were very vigorous. The results were very satisfying - over 90% took.

I had originally kept the two varieties I was now concentrating on - Sirora & Kerman - separate, but I kept changing my mind which variety was best so budded a few trees with both varieties. I still had a problem not enough male trees, so I began budding Atlantica stock to males, mainly 19/8, anywhere there was a group of larger female trees, with the result I now have a few too many males and the 19/8 seems a better pollinator for Sirora than Kerman, as the latter flowers a few days later than Sirora - often up to a week.

The trees, now at 10' x 22' plantings are beginning to grow into one another. This could inhibit flowering due to shading and it also makes driving down the row difficult. The trees are irrigated by furrow about 5 times a year. They are now ready for their last irrigation for the season (March) as I have finished picking all the nuts.

I have a few *P. Vera* seedlings but they are badly infected by root-rot nematode and will have to be grubbed. The soil is a sandy loam of excellent deep drainage.

Last year, 1982, I had picked quite a few trees and had about 50 kg of nuts. I was busy picking grapes so I left them in the husks in a heap, where most went mouldy and the lot were of no commercial value. Well, we learn by our mistakes so this year I was a bit better prepared.

The winter of '82 brought with it a week of extremely severe frosts in June and then another couple in July. These were the most severe ever recorded. Whilst my avocados were looking more terrible by the day, right next to them the Pistachios must have relished those conditions. That spring the flowering was very heavy and the many male trees were flowering in time with the Sirora. I hand-pollinated a few Sirora but especially the Kerman. I did this by gathering male flowers, after they had opened, and after putting several in a nylon stocking, I'd hang it in the tree on the windward side or in the middle. It may have worked, for the Kerman had excellent crops on most of them.

I was still busy with the grape harvest, so I decided to pick the Sirora with the Kerman which normally ripen a couple of weeks later than Sirora - to save time two of us used two tarpaulins 24' x 12' each, between the trees I knocked the branches until most of the nuts fell. We tried to avoid too much damage, but any buds knocked off were put in plastic bags, labelled and sold to a local nurseryman for bud-wood.

After, we filled a car-trailer with nuts and proceeded to dehusk them via a commercial potato peeler. After about 3 minutes the nuts were tipped into a wheel-barrow of water, the floaters (empty shells) were discarded and those that sank sieved out and kept.

By the time the trailer was emptied (it took over 4 hours) we had about 150 kg of wet nuts, which we spread thinly on dried-fruit berry mesh on a drying rack. We left the nuts about 10 days or so to dry. After going through this routine for several days we ended up with over 50 yds of nuts on the rack. We had a heavy rain one night which wet all the nuts and a few, where they were spread a bit too thick, began to sprout.

I am now in the process of sorting, by hand, all the unsplit, badly stained etc. nuts. Two of us can do about 50 kg a day. I hope to have 200 - 300 kg of nuts this year for sale.

As far as I can ascertain, C.S.I.R.O. Merbein, Dept of Agriculture S.A. Loxton, Martin Simpfedorfer Renmark, and I have about 11/2 tons of nuts for sale this year. This would comprise nearly all the Australian production. I sold 10 kg of nuts in Mildura last Friday 11th March as a trial order, comprising 5 kg salted and lightly roasted and 5 kg of dried raw

nuts. They both returned me $8 kg. They were selling at $16 kg.

To salt the nuts I mixed six parts water to I part salt and swilled around for a few minutes, then put about 3 kg on shallow trays and placed them in the oven. I left the oven on about 70°C all night and then tasted for crispness. When crisp I turned the oven up to 120°C for ten minutes. They tasted great, but I was surprised to find how many people preferred them raw. This would be an easier market to service.

To cook the nuts after salting, probably a baker's oven would suffice or even a dehydrator or something similar. As I have not got as far as this yet these are merely ideas.

That, I think, just about covers it all, except to say that at present they are a "fiddly" crop and to attract good prices standards must be kept high. Also, if Pistachio nuts are to be sold at high prices by the retailer, the producer should aim for a fair slice of the nut as well!

MYCORRHIZA OF TREES:

A Useful Relationship

J. F. TITZE

CSIRO, Division of Forest Research, Kelmscott, W.A.

DEFINITION

There are many examples of the occurrence of symbiotic, e.g. mutually-benefiting, relationship in the plant and animal kingdoms. Some plants are living in association with microscopic organisms. For example, thickened roots of sedges and plants living in sand on the sea shores have encrustations of sand and salts glued together with microbial slime. The blackboys possess an association with blue-green algae for the purpose of obtaining nitrogen. Family of *Proteaceae* (f.e. banksias), and even jarrah, form under certain conditions thick-spreading, interwoven masses of fine roots, called *proteoid*, which host many bacteria helping with nutrition of the plant.

Some trees have another symbiont, in clusters of short roots (*coraloid nodules*) which are infected with *actinomycetes* (filamentous bacteria). These, also, very effectively provide the roots with nitrogen, in analogy with *Rhizobium* bacteria in root nodules of legumes. Typical examples are elders, or our own sheoaks (*Casuarina* spp.), and are therefore sought, all over the world, for improvement of poor soils, sand dunes and mined sites. Beside their main symbiont, they can also form mycorrhizae.

The term mycorrhiza (plural mycorrhizas, mycorrhizae) means 'fungus-root' and is used for quite a wide range of root structures produced as a result of an association between fungi and plant roots. Many different plants and many fungi enter into such relationship, including grasses, cereals, orchids, native and horticultural shrubs, and practically all trees.

Mycorrhizae were originally described by Frank in Germany in 1885, and investigated ever since. His findings were doubted at first, but later and still now, the researchers studied the many different aspects of their biology, distribution, effectiveness, chemistry, all because

of their usefulness. As in other symbiotic associations, both partners benefit. The fungi, by supply of proteins, sugars and other compounds, are able to grow and produce reproductive structures, some of which, in the association of higher fungi with trees, show themselves as mushrooms growing underneath. In turn, the fungi provide the plant roots with highly-desirable mineral elements, especially phosphorus salts in an easily-available and digestible from. Mycorrhizae are therefore most important for plants growing on soils poor in mineral and nitrogen contents. These fungi also synthesize plant hormones. Better growth of the trees results from richer and more balanced nutrition, combined with increased vigour and health. Some mushroom-formed mycorrhizae, were for example, reported by Marx and Davey in the United States to protect pine roots from the dieback disease caused by *Phytophthora cinnamomi*, so well-known in Western Australia as killer of the jarrah forest.

DESCRIPTION AND CLASSIFICATION

On the infection of tree roots by the appropriate fungal strands, the roots become modified in different ways. The plant hormones produced by the fungus, help here not only for the modification, but contribute also to stronger root system and above-ground parts. It should be pointed out here, that some mycorrhizae are highly-specific, forming an association between only one tree and one fungus species. Others are more general in their infection patterns, able to form mycorrhiza of one fungus with one or more plant families, or that more different fungi can be associated with one or more tree species. In such cases, the most effective and vigorous association wins over the others.

Learning to know about them, the scientists, for systematic convenience, describe them as different types according to their infection patterns and root structures produced as typical for such fungus-root system. In forestry, agriculture and horticulture, they are described as *ecto-trophic*, in which the fungus resides mainly on the root surface and under its skin, *endo-trophic*, where the fungus forms internal structures within the roots, and in-between, *ectendo-trophic*. Each particular association has different shape, colour, structure, and even effect on the plant growth, some being more active, or beneficial, than others. With some, it is known that even the beneficial influence can take a turn to worse, become pathological when the fungus takes over. Fortunately, such cases are quite rare. On excavating carefully the roots of a mycorrhizal plant, some may be seen by the naked eye or with a hand lens as root clusters or multiply-branched short roots, different to other, normal straight plant roots. Some can only be detected under the microscope.

Unknown ones are investigated by culturing the fungi on special jelly plates in the laboratory, in order to identify the fungus and name it, by chemical reactions, by inoculating them into roots of different trees, and by other techniques.

Most tree mycorrhizas are of the ecto-trophic type, formed with higher fungi (mushrooms). However, quite widespread in nature, in forest vegetation and in agricultural fields are so-called *vesicular-arbuscular* mycorrhizae which form mainly microscopic structures under the root skin. They cannot be cultured on jellies, but we have learned to propagate them in glasshouse pots sown with wheat or corn. They also contribute extensively to plant nutrition. In orchids, the mycorrhizae are formed with the seed germination. In these, the fungi are a necessity for germination and successful development of the plant to flowering.

DISTRIBUTION OF MYCORRHIZAE IN NUT CROPS, HORTICULTURAL TREES AND CONIFERS

During an almost-century of research into mycorrhiza, it was shown that its formation in trees is almost universal. In the nut trees, different workers have found efficient mycorrhizae on pecans, hickories, hazelnuts and filberts, and chestnuts; in fruit trees with apples, pears, rowan, citrus and related genera. Practically all conifers form mycorrhizae: fir, cedar, larch, spruce, pines, Douglas fir, yew, cypresses, junipers. Forest and ornamental trees insofar reported as mycorrhizal are willows, poplars, elders, beech, oaks, elms, hawthorns, ash, limes, :Irish strawberry tree (*Arbutus*), birches, sheoaks, and of course, most of our own native eucalpyts.

As conifers, like Monterey pine, and other *Pinus* spp. were introduced to African countries and to Australia for plantations of softwood, research into their mycorrhizae intensified greatly. That of eucalypt mycorrhizae was initially stronger in overseas countries which brought in their seed for timber or fuelwood plantation establishment. It was found sometimes, that for lack of introduced or native mycorrhizae, both pine and eucalypt plantings were unsuccessful. In some cases, however, the trees started to form mycorrhizae with fungi of indigenous trees, or with those which are of world-wide distribution.

SOME MYCORRHIZAE ARE DOUBLY-USEFUL

The increasing use of mycorrhizal establishment for better tree growth is predated by centuries by use of mushrooms from the forest, which are edible. We know now thousands of mycorrhizal fungi. Some are not edible, even poisonous to humans and livestock. Our own native fungi were insofar little investigated as to their edibility. On the other hand, there are some mushroom species, which were introduced to Australia with pines (true pines, Pinus spp., were never indigenous in this country). Continental Europeans who settled here, are used to collect them for culinary uses and do so here during the autumn season in the pine plantations. Two of the main ones deserve a mention here.

Two closely related and very similar species of mycorrhizal fungi which form association with Monterey (Radiata) and other pines, are *Suillus luteus* and *S. granulatus*, belonging to the family of *Boletaceae* (bolets). They are now almost universally-widespread through pine stands in Australia. Dark-brown, slimy caps of these mushrooms have a bright yellow pore surface underneath. There are, of course, similar fungi associated with eucalpyts, which have lighter, red or scaly caps, with white, yellow or other colour of pores underneath, and some blueing on bruising, which must be avoided, especially in mixed stands or edges. The above two, are, however, excellent (after peeling off the slimy brown skin of the cap), as fried alone, with scrambled eggs, pickled with herbs in vinegar, or with strong mushroom aroma for soups and sauces when dried as thin slices.

Another species, an agaric (with gills underneath the cap, instead of pores), *Lactarius deliciosus*, has insofar not established with pines in Western Australia, but is present in most other States, and is much sought-after. With orange colouring throughout, including on the gills, sometime with green spots on older mushrooms, and exuding orange spicy milk when cut, cannot be mistaken for other fungi growing in pine plantations. As its name applies, it is delicious for many mushroom dishes, fresh or processed.

ESTABLISHING MYCORRHIZAE

The necessity of mycorrhiza in establishing exotic pine plantings in Australia and many overseas countries, where these have failed, brought in a wave of investigations into the means of nurturing such healthy relationship. Forestry workers were naturally the first ones to realise that nurseries installed in virgin bush or on previously tree-less agricultural soils, need also seedlings which are mycorrhizal from the start, in order to bring the association with them into the planted forest.

Earlier such techniques were to bring-in soil or mulch litter from places where mycorrhizal associations were observed as working well, or interplanting with known mycorrhizal seedlings, or spreading chopped-up mycorrhizal mushrooms underneath the trees. For container-grown seedlings, soil from plants known as mycorrhizal, was, and in cases still is, mixed with standard potting soils. Nowadays, use of pure cultures of specific fungi is becoming increasingly available for inoculation of seedlings in pots, nurseries, or even young stands. Strand masses of the mushroom (*mycelium*) are cultured in the laboratories in liquid, nutrient solutions of salts, sugars and vitamins, or on peat, straw or grains. Such techniques collaborate also with the requirements of plant quarantine services, which in most countries prohibit the importation, or even movement of soil or other complex substrates of doubtful nature, for the danger of bringing in pests and diseases surviving on organic particles. As the substrate for the ‘’spawn” was sterilised prior to establishment of the inoculum on it, it guarantees only the pure culture to grow on it. Other modern methods of mycorrhizal inocula production being developed, are using the well-known principle of agricultural practice, that of seed pelleting with peat-grown legume bacteria.

If, and once mycorrhizal fungi become active in a location, and with particular plants, they remain there for many years. It can, of course, happen, that the association was of a weak nature, overtaken by other organisms, or that the plant crop was removed and not replaced with another which could maintain the same type of mycorrhizae. With mushroom-formed mycorrhizae, the typical root structures are formed quite readily early in the association, but it may take few years, before the mycorrhizae start producing mushrooms underneath the trees. The benefits are, however, observable in the first year from increased growth, vigour, and colouring of the seedlings. Conifers, it seems, benefit more than other trees, but they were the most investigated. Although comparable results can be achieved on some soils by proper dosage of balanced fertiliser application, the effects diminish after some years by exhaustion of the nutrients, while well-established mycorrhizae of efficient type continue to contribute steadily.

In respect of application of mycorrhizal benefits in the field of horticulture, the reports are still scanty for fruit trees or for varieties of ornamental shrubs and trees, including the species of famous Australian wildflowers. Their propagation may benefit by including mycorrhizal research.

COMMENTS ON THE TOUR TO BRUNEI, SABAH, PHILIPPINES AND SINGAPORE

November 21-30, 1982

M.G. HAWSON
Senior Adviser, Vegetables, Western Australian Dept. Agriculture

BRUNEI

We flew from Perth to Brunei on Sunday, November 21. On the next day we were met by Karmis Hj. Tarmin, Extension Officer, and Dr Yussof Haji Mohiddin, Soil Scientist with the Brunei Department of Agriculture.

They drove us out to inspect the Research Station at Birav where we inspected fruit tree plantings. The Station is established in a delightful valley, with paddy grown in the lowlands and fruit crops on the surrounding hills. Terraces have been cut into the hillsides and planted to the fruit crops. Crops noted were liberica and robusta coffee, (liberica appears to do better in Brunei), citrus, rambutans and mangoes.

The fertiliser programme is based on NPK 15:15 applied every 3 months. About 2 lbs per tree was used although this was varied depending on plant age. Two points arose from our discussions, the pattern of root growth was not known and with a crop such as mangoes, vegetative growth could be stimulated at the expense of floral and fruit formation.

Officers present were:

Pg Hassan Pg Hj Damit, Agronomy Section, Department of Agriculture, Brunei.

Dr Serudin bin Dato Setiawan Haji Tinggal, Plant Pathologist, Department of Agriculture, Brunei.

Yap Sooh Kiat, Agriculture Officer, Department of Agriculture, Brunei.

Sabli Yassin, Ent. Section, Department of Agriculture, Brunei.

Md Zain Hj Abd Ghafar, Agronomy Section, Department of Agriculture, Brunei.

Many of the officers were very interested in the role of minor elements in fruit tree nutrition and keen to discuss symptoms and leaf sampling techniques. From the symptoms observed, zinc, copper and magnesium appear deficient in many trees.

Citrus varieties had been imported from California several years ago and established in a block with some local selections. There appears to be more scope in concentrating on cultivars growing in South East Asian countries including Thailand rather than bringing in planting material from a Mediterranean climate.

Brunei would be considered to be the wet tropics with a dry period recognised from April to July/August. Sometimes this is a 'wet' dry and sometimes a reasonable 'dry' dry. Unfortunately it is too unreliable to induce flowering and consistent crops of mangoes each year. A number of problems were noted including anthracnose in mango flowers and fruit, sooty mould on citrus leaves and other insect and pest disorders.

SINAUT AGRICULTURE TRAINING CENTRE, TUTONG

We met Shahri Awang Haji Besar, Director of the centre and Ramon F. Santiago one of his staff. This centre commenced as the Shell Agricultural Centre in 1964 with 54 acres for the purposes of investigating three farming systems based on rice, rice and fruit and rubber and fruit. In 1974 the Brunei Government decided to enlarge the area to 135 acres, expand the programme and the name Sinaut Agricultural Training Centre was adopted. Officers from the Shell Co. still cover some courses at the Centre. We met Mr Brian Webb from New Zealand, a lecturer in Agriculture Engineering. Courses now include:

1. Training of young farmers and technicians.
2. In-service training for staff in Department of Agriculture and those engaged in development programmes.
3. To continue investigating small holders cropping programmes.

After a pleasant lunch we toured mango, rambutan, durian, coffee, avocado, citrus and pepper plantings. Most had been established in sufficiently large blocks in order that students would gain experience in managing a commercial enterprise. Produce is marketed from the farm and students are encouraged to record data for the development of cost/benefit programmes.

A herd of cattle and flocks of ducks, and chickens, were sighted.

Recently the staff and students had erected a greenhouse (under Mr Webb's supervision) which consisted of a metal frame and sheets of firm plastic. These were arranged to leave sufficient space between the sheets for air movement and ventilation. The sides were not covered in. The greenhouse certainly appeared cooler than the surrounding area. Also, of interest was a nutrient film observation comparing liquid nutrition to various local mixtures containing peat.

Towards the end of our visit we met with many staff members. Agricultural and S.A.T.C. staff were keen to have copies of our information sheets on tropical fruits. These were made during our stay and left with relevant officers.

Our last call was to Danial Haji Hanafiah, Deputy Director of Agriculture, Brunei. During discussions two interesting points arose:

1. He advised that the Saliah Government was developing a semi temperate vegetable production project at Mt. Kinabalu for supplying vegetables to Brunei and Singapore. A larger percentage of these markets is now supplied from Australia and particularly from Western Australia. Apparently Sarawak is also setting up a project where vegetables produced will compete with those from Australia.

2. The Brunei Government has purchased Willeroo cattle station near Katherine in the Northern Territory. They are hoping to produce cattle and some fruit crops such as mangoes for importing into their own country.

TUESDAY, NOVEMBER 23 1982.

We departed from Brunei at 8.30 a.m. in a small boat powered by two large outboard motors for the small town of Sipatang in Sabah. Time taken about 11/2 hours. After some confusion about meeting our contacts we eventually arrived at the Tropical Fruit Farm (plantation), which has been established by the Rural Development Corporation. This corporation is one of the many government agencies set up by the Sabah Ministry of Agriculture to promote primary industries in this country. Apparently, they have some authority to plant reasonably large areas of tropical fruit crops as a means of demonstrating to potential fruit growers what can be achieved in this field.

This centre was managed by Haji Abdul Au - a pleasant personality who spoke good English. We inspected citrus, cacao (60 acres), mangoes, durian, mangosteen, rambutan and passionfruit crops. A legume, *glyricida* sp. was planted for high shade in the cacao fields.

At this centre was a Peace Corp worker, Miss Sandy ? who is an agricultural graduate from USA. She accompanied us to the cashew farm (Sabah Cashews). The road from Sipitang to Beaufort is constructed of stone and very rough on vehicles and passengers.

SABAH CASHEW NUTS SDN BHD - PAPAR

The Sabah Cashew project was visited on November 23, 1982 and developments discussed with Mr Chin, the resident manager.

The property is situated on the coast, some 40-45 km south west of the capital Kota Kinabalu. The soils consist of poor, well leached sands. Earlier experimental plantings were 4-5 years old with the majority at 3-4 years. Flowering takes place in April-June with harvesting into July/August. A 3-4 year old tree is expected to produce 10-15 lbs of nuts (Kernel percentage 16-20%).

The manager indicated that about 3000 acres had been established with the final object of planting 5000 acres. Shortage of funds was curtailing further development. Apparently, a processing plant was to be imported but this has been shelved due to lack of funds.

This project and the one on tropical fruits is one of many such projects under the jurisdiction of the Rural Development Cooperation. Others include Sabah Rice, Sabah Cattle, Sabah Vegetables, Sabah Tobacco, etc.

That evening we spoke to Dr Bobby Tee of the Rural Development Cooperation. He is a Ph.D. from California USA and seconded to Sabah from MARDI in West Malaysia. He was enthusiastic about a number of projects including the one to produce semi temperate vegetables at Mt. Kinabalu. However the tight financial situation would delay progress of many of them. Also, he advised that the Sabah Government had invested in 3 cattle stations

in the Northern Territory.

KAI NGUONG NURSERY (SABAH)

This nursery was situated about 10 miles from Koto Kinabalu, the capital of Sabah. The roads were now bitumenised. The nursery appears to be extremely well organised for the production of potted plants, orchids and fruit trees. An interesting pummelo and a navel orange from Taiwan were noted.

Recently a mushroom project has been established by one of the partners - Mr Patrick Lau to produce paddy straw mushrooms - Volvariella volvacea. Sheds of about 60 x 20 ft had been constructed with sides of hessian and palm leaves. Compost was produced from rice straw and other additives (?). After composting and hand placement on continuous timber and wire beds in the sheds it was treated for 12-14 hours with steam. Spawn, which was brought in from Taiwan originally and now cultured at the nursery is seeded into the compost. No casing is used. Harvesting commences about 5-7 days after spore placement. Two to three picks were made with total yields of about 1/2 lb/ft^2. Apparently the market potential is good.

MANILA, PHILIPPINES

We flew by 737 from Kota Kinabalu to Manila. On November 25, 1982 Manila to Legaspi City and return.

This trip was made overland by car, a distance of 1080 km (both ways). The road varies from excellent to very rough. In the mountainous areas, travelling is fairly slow due to the tortuous roads, which in many places in need of repairs. Time taken about 11-12 hours.

Main crops were coconuts with rice planted in the lowlands. Other fruit crops were chiku (*Ackras zapata*), langsat (*Lansium domesticum*), citrus, guava, tamarind with a very few coffee, avocado, etc.

Housing and these crops virtually crowd the roads for the whole distance. Houses are generally small with 1-2 rooms and although the people looked very happy and well fed, personal possessions would be few in number. Only a small number of private cars and bicycles were observed. Most travel was by the jeepneys, buses and a 3-wheeled motor cycle-powered machine similar to the 3-wheeled foot-peddled machine seen in other countries.

The water buffalo appeared to be the main source of power for the farmers. Buffaloes pulled the different types of cultivation equipment used in the paddy fields and a small sledge for carrying personal possessions and the mature coconuts from the plantations.

The main objective for this long trip was to see the pili nut tree (*Canarium commune*) growing in the generally hilly to mountainous areas of the provinces Carmarines Norte and Stir. The tree grows naturally in this environment and was seen in farmers gardens and through the Bicol National Forest area near the border between these two provinces.

Although the tourist driver knew the tree and recognised the fresh fruit and nuts in the local markets he was not able to provide a great deal of other information. We called in to see a Mr Torres, Senior Extension Officer with the Ministry of Agriculture, Pili, and he was able to provide further information.

The tree has not been planted on a plantation basis. Nuts are harvested by farmers from self sown trees. Trees produced either male or female flowers. We were not able to determine how pollination took place. Large trees were seen at relatively low heights above sea

level and in the mountains up to 2000 ft. Soils were either volcanic or an ironstone gravelly clay of some depth over volcanic soils. Trees appeared to be slow growing with no apparent pests and diseases.

At the time of our visit green mature nuts were observed on the trees. Flowering and fruit formation appeared to have occurred from last season's vegetative growth. Approximately 400-500 nuts were observed on 1 female tree.

The leaves are dark green, about 15cm long and 7cm wide. The midrib was prominent on the underside of the leaf. Leaves in pinnate formation. Mr Torres explained that some experimental work was in progress by a university group to develop grafting and budding techniques. Plantation type development of pili nut would then follow.

Apparently female forest trees commence to flower at 2-3 years, then only produce very few nuts until they reach 7-8 years of age. Production increases steadily from this age.

The fruit was inspected in a local market at Lagaspi City. Fruit is oval in shape (rounded at one end and pointed the other) and about 5-6 cm long and 3 cm in cross section. Nuts are triangular in shape and pointed at both ends. In cross section it had a 3 sided star appearance.

A vendor selling the nuts, cracked the fresh nut by hitting the sides with a large heavy knife. Consistency of flesh smooth and creamy, with a flavour similar to that of walnut.

From Manila we flew to Singapore in a 747.

SINGAPORE COLD STORAGE

The fresh fruit and vegetable section of this supermarket was inspected.

Vegetables noticed on display were:

Potatoes (Australia) Delaware. Good quality but variable in size.

Tomatoes (Australia) Floradade. Variable in size.

Lettuce (Australia).

Cabbage. Round and long (Chinese).

Pumpkin (Australia).

Capsicum (Cameron Highlands)

Bringal (Cameron Highlands)

Carrots (Australia and USA). (The carrots from USA were packed in a light orange coloured plastic bag with deep blue coloured ends. When the carrots were removed it was noticed that their overall colour was dull with greening at the leaf end with some breakdown. The bag appeared to have been designed to enhance the colour of the carrots and hide their defects).

Brussels Sprouts (New Zealand). Very small and breaking down. On arrival outer leaves of sprouts are generally yellow. These are removed with further removals as required. The sprouts observed during the time of the visit had been in the shop several days.

Fennel (USA). Good quality.

Globe artichokes. Small and over mature.

Sweet corn (USA)

Local greens - a whole range. and others.

Possibly not a good time to inspect first thing on Monday morning as produce was on the shelves over the weekend.

FRUIT

Local Papaya.

Mango (Philippines).

Apple - Granny Smith

Large Red Japanese $7.90 (S) each

Orange (Australia and USA).

Melons - Water, Rock and Cantaloupe.

Guavas (Thailand). Green 59c (S) per 100gm.

Pummelos (Thailand). Green $3.90 (S) each.

Grapes (Thailand).

Persimmons (Japanese). 59c (S) each.

Avocados (USA). $3.45 (5) each.

CUPPAGE ROAD FOOD MARKETS

This market was not air conditioned. A whole range of fruit and vegetables were on display similar to that seen in the Singapore Cold Storage.

Mangoes (Philippines) Senorita. Also local and from Indonesia.

Strawberries (New Zealand). Very good quality.

Water chestnuts from China. A botanical description of the plant was quoted from one unnamed source:

"ELEOCHARIS CYPERACEA

Mostly perennial rushlike plants, allied to *Scirpus*, adapted for planting on the edges of ponds, or boggy places; leaves commonly reduced to sheaths; flowers in solitary terminal spikelets. Originally spelled *Heleocharis* but corrected later.

Chinese water chestnuts MA-HAl (*Scirpus tuberosus*). Slender rushlike plant with narrow leaves shorter than the articular culrus, often not fruiting. Plant produces a solid tuber or corm at the base 2 inches or less in diameter. Much eaten by the Chinese and sold in their shops. Propagated by offsets from the corm, in moist conditions East Asia - Pacific Islands"

Pears (Japan).

MAIN IMPRESSIONS:

1. The Department of Agriculture contacts in Brunei and Sabah were most helpful and it was unfortunate that similar contacts had not been made in the Philippines and Singapore.

2. We tended to be placed in the role of having more information than local Departmental officers and others. Rather than learning from the "locals" we tended to be the "experts" or teachers.

3. Many of the fruit crops were not in season and therefore of little interest to the party. July/September would be a more appropriate period to visit these countries.

4. The intensity of cropping in the Philippines compared to the relatively low density in Brunei and Sabah. As Brunei has large royalties from oil production, many farmers have left their properties for a more secure and better paid position in the Government or private sector.

BLUEBERRIES - BEAUT' BERRIES

Mountain Blue - Rare Fruits

RIDLEY BELL BSc. DIP AGR SCI.
Federal NSW

INTRODUCTION

I have borrowed the slogan "Blueberries Beaut' Berries" from the Australian Blueberry Growers Association which has adopted it to promote blueberries throughout Australia and overseas. Coupled with the brand name BLUROO BLUEBERRIES the association is aiming to have distinctly Australian presentation which it is hoped will be successful as the New Zealand promotions of the Kiwi fruit as a distinctive product.

THE POTENTIAL

Blueberries are still a young crop in Australia with the shortage of suitable planting material being the prime obstacle to a quick development of the industry. According to the statistics from the ABGA census in 1982 there were less than 40Ha of blueberries planted in Australia, although these figures probably do not represent all of the plantings. However, even if they were understated by 100%, there would still be a long way to go before 500Ha are planted and fully bearing, which is what I estimate would be required to meet the **domestic** market potential in Australia. Any major increase in planting over this figure would need to carried out with definite **export** prospects in mind.

The blueberry is an established crop in the northern hemisphere both in Europe and North America, where it may fruit from May to September according to the location and variety selection. The blueberry is a fruit that is best eaten fresh which blueberries to the northern hemisphere markets from October to March when there would be very little competition.

In the United States there are over 32,000 acres of blueberries recorded and the plantings there are increasing at a rate of 1200 acres per year. In Europe blueberries are being planted in West Germany, Holland, Denmark, Poland and Scandinavia.

The potential export market for Australian blueberries in the northern hemisphere is difficult to gauge due to a number of factors. The possibility that quarantine restrictions against entry of Australian fruit into the United States is high because of the Mediterranean Fruit Fly and air freight costs may put the price of our product up to a level that may not be entirely acceptable to consumers.

THE RETURNS

Blueberries have received a lot of press coverage in Australia over recent years, although the fever has not reached the peak that it did in New Zealand some years ago where potential growers were paying $3.00 for a piece of unstruck blueberry wood of unknown origin.

However, figures varying from $50,000 to $100,000 per hectare return have been bandied about and these figures have been generally arrived at by juggling high yields with top of the market prices in a market where demand is certainly greatly in excess of supply. Like most other agricultural enterprises, horticulture is subject to the uncertain nature of prices and yields, droughts, floods and pestilence. But what can we realistically expect to return

from blueberries? The many variables make a precise economic analysis difficult but the following could be seen as some sort of a guide for a 1 Hectare venture.

(i) **Plant Spacing**

Varies from 3M x 1.4M (2380 plants/hectare) to 3M x l.6M (2080 plants/hectare)

(ii) **Yields**

At maturity (year 7) healthy plants should bear an average of 5kg/bush. On a well managed planting between 80 and 100% of the plants should bear this well.

(iii) **Prices**

This year prices have ranged from $20 to $40/20 punnet (5kg) carton but this would be likely to fluctuate more as supply meets demand, hence I would estimate a safe return price in the vicinity of $30,000 per hectare.

(iv) **Picking/packing costs**

Picking labour runs at approximately 22.5 cents/punnet or 90 cents/kg. The cost of cellophane, stickers, cartons, and punnets runs at approximately 50 cents/kg.

(v) **Annual operating costs**

These vary from property to property but on a family-run 1 hectare patch $5000 per annum would more than cover these costs.

(vi) **Net Returns**

- in the vicinity of $10,000 to $15,000 per hectare would seem to be a more realistic figure for the average grower to aim for.

IS IT COSTLY TO START?

In most areas of life one must certainly "spend money to make money" and blueberries are no exception. For example, in establishing a blueberry planting the initial preparation will include -

(i) Establishment of a suitable water supply and water reticulation system.

(ii) Establishment of wind shelters, initial soil preparation and fencing.

(iii) The purchase of machinery including a medium range tractor, cultivating implements according to the soil type, a slasher, spray outfit, carryall and trailer.

(iv) Numerous items such as spades, crowbars, fencing implements, chainsaws and sundry equipment.

(v) A working shed and cool room facilities.

(vi) Mulching materials.

(vii) Purchase of plants. These figures will vary according to local conditions and the proposed planting size, and because they are so variable I shall not attempt to give even an approximate figure. I would say however that they should not be underestimated in the preparation of the budget.

BLUEBERRY CULTURE

The blueberry plant is shallow rooted with a fibrousy system that has no root hairs. The plant requires light, well drained soils with high organic levels preferable. The plant has a preference for acid soils with a pH between 4.5 and 5.5.

The blueberry has a high water requirement particularly during fruit development. Under dry summer conditions and trickle irrigation approximately 2 million litres of water should be stored per hectare of blueberries grown to allow for the bad years. There is no such thing as the perfect blueberry variety for all areas. In warmer areas where chilling between 3°C and 10°C ranges from 200 to 600 hours the varieties that may be grown are either the tetraploid hybrid types which provide very early seasons fruit or rabbiteye types which are very productive and hardy, but which have very little seasonal advantage over the cool climate highbush types. For the cooler areas the highbush varieties are preferred and individual variety choice needs to be made on the basis of several factors including -

* season (early-late)
* fruit size (for fresh or processing)
* suitability to hand or mechanical harvesting
* disease resistance (eg phytopthora resistance in heavy soils)

The most formidable cultural problems that I envisage facing the blueberry industry in the future include the following.

(i) **Labour**

Blueberry culture is labour intensive in the preparation and planting, the general maintenance of the crops - particularly in pruning, but most importantly in the picking of the fruit for the fresh fruit market. Machines are available in the US (at a considerable cost) that will harvest the fruit, but the fruit drop and damage

associated with these machines means that the bulk of machine harvested fruit ends up being processed. We in Australia would be foolish to try and compete on the world processed blueberry market. Our future lies in high quality, hand picked fruit marketed with the "fresh is best" mentality. Hand picking requires labour.

(ii) **Birds**

To date the birds have been the most formidable problem facing Victorian growers. Netting, scareguns and other forms of bird control have been mooted but I firmly believe that the answer lies in the careful use of the bird repellent Methiocarb (MeasurolR). This chemical is registered in both New Zealand and the United States for use on blueberries and has been applied successfully, particularly early in the season. Its emetic effect on the birds is

quickly associated with the blueberry and has a lasting effect. However, in Victoria it has not proved very successful with some of the larger birds plundering blueberry plantings.

(iii) **Suitable growing land**

Blueberries will adapt to a wide range of soils but in many areas where the soil is too heavy, the water too saline or the native pH too high, it would be preferable to look at alternative crops rather than take a risk on blueberries.

THE FUTURE

It is always a difficult question to answer when someone asks what is the potential for investment in blueberries. Obviously the potential growth of the industry in Australia above 500 hectares will depend largely on our ability to penetrate overseas markets with our fresh "out of season" product.

Early indications are that the most attractive markets would appear to be in Europe and South East Asia.

The presence of fruit fly in Australia, particularly Queensland Fruit Fly in the north and Mediterranean Fruit Fly in Western Australia would appear to me to be the negative factors against exporting our fruit to the United States. Similar quarantine restrictions apply to Japan and with the added disincentive of severe tariffs on the US blueberries already entering that market.

The above restrictions do not apply for most European countries, but to export to Europe we must bear the following points in mind.

(a) Volumes of fruit enough to make promotions worthwhile and for as long a season as possible.

(b) High quality fruit marketed under a distinctive Australian label and at reasonable price.

(c) Reliability and continuity of supply.

At present the total production of fruit in Australia is too small to warrant serious attempts at export yet, but because of our unique situation in this ever shrinking global village the future for a blueberry industry in Australia still looks promising.

PINES AS A SOURCE OF EDIBLE NUTS

JOSEPH J. HAVEL
Director of Research, W.A. Forests Department

The interest in trees as a source of food, particularly nuts, is now well established in Western Australia. In addition to the better known nut trees such as walnuts, chestnuts and pecans, pines are also a useful source of small, but very tasty nuts, known as pinons or pignolos.

Pines (genus *Pinus*) are a very large group, containing 90-105 species, depending on whose scheme of classification one accepts. There are still arguments whether some species are only varieties and vice versa. For practical purposes this is of little consequence - what is more relevant is what species or varieties produce edible seeds, and how suitable they are for local conditions.

Basically, the usefulness of pine seeds as a source of food depends on their size, the larger seeds being easier to gather and having large kernels. Taste is also important, in that excessively resinous taste tends to be unpleasant, but in my experience those seeds that are of sufficient size are also pleasantly tasting. The pine seeds range in size from 2 mm in length for the lodgepole pine (*Pinus contorta*) to more than 20 mm for the digger pine (*P. sabiniana*) and Torrey pine (*P. torreyana*). Another way of describing the size is in terms of number of seeds per kilogram, the range being from 220,000/kg for lodgepole pine to 1100/kg for Torrey pine.

The difference is in the number of seeds one would have to collect and crack is obvious. Less obvious is the proportion of kernel to shell, which also improves with size, as the seeds tend to have a strong, thick coat. Just what the cut-off point is, is hard to say, but any seed less than 15 mm long would not be very attractive, and any seed than 10 mm long would not be worth the bother of collecting and cracking it. The species that I propose to discuss are those at the upper end of the range.

As regards **suitability** for local conditions, two options are open. A field test is obviously the better alternative, particularly if the trial plots cover a wide range of climates and soil conditions. The disadvantage is the length of time needed for this. Fortunately some of the useful species have been fairly adequately tested. Others have been tested inadequately or not at all, and in such a case some indication can

be obtained by comparing the local conditions with those under which a particular. species grows naturally. This is less reliable than might at first appear, as pines tend to be pioneer species which fill empty spaces and infiltrate disturbed areas, and do not compete well with broad leaf species capable of forming dense stands. For instance, *Pinus radiata* has a very restricted natural range in California, but has proved successful over a very wide range of soils and climates in the southern hemisphere. However where there are no prior trials, an intelligent comparison is better than nothing. In south western Australia, the outstanding environmental characteristics are a strongly seasonal climate with hot, droughty summers and soils of mediocre to poor quality. The latter is significant, as it is unlikely that pines will be planted on best agricultural land except perhaps as windbreaks, but on the other hand fertility is readily improved by application of fertilisers. In any case, pines have a relatively efficient mechanism for picking up scarce nutrients through their association with mycorrhizal fungi, which form absorbent sheaths around their roots.

Although it would be possible to compensate for summer drought by irrigation, this is unlikely to be profitable. However, moisture stored in the sub-soil can be made to last longer by wider spacing and control of weeds under the pines.

Using the criteria discussed so far, that is the **size of seed and the environmental suitability,** it is possible to focus on a few significant groups of pines. There is one group of pines which, although possessing seed of suitable size of known commercial value, can be dismissed because they are unlikely to be suited to local conditions. These pines, which resemble each other, occur in cold climates, either at high altitudes or high latitudes, in N. America, Europe and Asia. They are limber pine (*Pinus flexilis*), Swiss stone pine or Zirbe (*Pinus cembra*), the Siberian stone pine or kedr (*Pinus sibirica*) and the Korean pine (*Pinus koraensis*). The only one tested here, *Pinus flexilis*, failed even in the relatively moist, cool locations.

The pine that is probably locally best known and tested is the Mediterranean **stone pine** (*Pinus pinea*). Its natural range is somewhat doubtful, as it has been cultivated so long around the Mediterranean Sea, but it is unquestionably well suited to south western Australia. Many magnificent old specimens with broad umbrella shaped crowns occur throughout the metropolitan area and the southwest. A superior Portuguese strain has been imported by the Forests Department 15 years ago as seed and began bearing at an early age (5-6 years). The cone bearing the seed is round, resembling a squat ball 100-120 cm in diameter. The seed scales have blunt ends. The cone contains numerous elongated seeds 12-16 mm long, covered by sooty black powder and containing long narrow kernels.

The next best known group of useful pines is a group of related but not particularly similar-looking pines from central and southern California - the **digger pine** (*Pinus sabiniana*), the **Torrey pine** (*Pinus torreyana*) and (*Pinus coulteri*). All were once an important source of food of the Californian Indians. They not only come from a comparable climate, but have been extensively tested in the south west by the Forests Department over the past half a century. The older plantings date back to between the two World Wars, and are now mature trees, generally taller and better formed than the descriptions from their home range would indicate. The digger pine at the Manjimup aboretum is over 30 m tall and of good form. Coulter pine, whilst less vigorous, has shown good form both at Manjimup and Ludlow.

Younger plantings at Collie and Nannup, dating to the early seventies, have also given quite good performance, though of course they cannot match the faster growing radiata pine. There is thus no question that they can handle

the wetter parts of the south west, but judging from their natural range, they should be also able to grow at least in the western part of the wheatbelt, especially if not planted at close spacing. Unfortunately, this has as yet not been adequately tested.

Digger pine has an upright habit of growth, but the trunk generally forks into two or more vertical main branches. The foliage is very light, almost feathery. The cone is relatively large, 150-250 mm long. The seed scales end with a stout uncurved hook. The seeds are large, elongated, over 20 mm long, light brown in colour, with a long, narrow kernel.

Coulter pine is less prone to forking, so that the crown tends to be more symmetrical. The foliage is stiffer and more bunched up. The crown is not particularly dense, but more spreading than in the digger pine. The cones are the heaviest of all pine cones, over 250 mm long, with vicious curved ends of the cone scales. They could inflict a nasty head wound on falling. The seed is slightly smaller than that of digger pine.

The **Torrey pine** has a very restricted natural range, of one island and one coastal locality in Southern California. There is a relatively low, crooked, broad crowned tree less than 15m high. In cultivation under good conditions it does better, exceeding 30 m in height, with a spreading crown of medium density. However, it has been also successfully grown in California under desert conditions. The cones are 10-15 cm long, chocolate brown. The seeds are the largest of all species, over 20 mm long.

The next major group of pines producing edible seeds, the pinons, consist of about seven species from desert ranges in south western USA and adjacent Mexico. They are related and share common factors such as the capacity to grow on droughty sites, large seeds, short trunks and irregularly shaped crowns. They differ chiefly in the number of needles per bundle. There are species with four (*Pinus quadrifolia* or **Parry pinon**), three (Pinus *cembroides* or **Mexican pinon**), two (Pinus *edulis* or **nut pine**) and one (*Pinus monophylla* or **single leaf pine**). Little is known about the remaining three rare Mexican species, *Pinus pinceana, P. nelsonii* and *P. culminicola*. Because of their small size and poor form they have been largely neglected by foresters in their introduction programmes. There should be little doubt about their capacity to grow in the wheatbelt. They have been grown in coastal localities in California, even as bonsais in suburban gardens. The cones are smaller than those of the preceding group and rounded, generally about 5 cm in diameter. The seeds are shorter than in the preceding group, but broader.

The final group comes from Afghanistan, northern India and Pakistan. It consists of two related species, *Pinus gerardiana** and *P. griffithii*. They are mountain species reaching into relatively dry climate, and are widely used as a source of edible nuts. As they have been recently described at A.C.O.T.A.N.C., I shall not discuss them further, particularly as little is known about them locally.

There are some points that should perhaps be made about the growing of pines.

Firstly, because the seed coat is thick, there is a tendency for slow and spread-out germination. This can be speeded up by stratification of the seeds, that is by soaking in water for a few hours and then storing them for several months at just above the freezing point.

Secondly, young pine seedlings are prone to fungal attack near ground level, often described as damping off. It can be prevented by sterilisation of the soil, dusting of the seed by

fungicides and by using well drained soil, such as loamy sand. For good survival on transplanting, a well developed system of lateral roots, rather than a single tap root, is needed. This is achieved by periodic root pruning, and by using a nursery with a light textured soil, such as sand or loamy sand. Optimum planting time is in June, after good starting rains.

Fourthly, as the mycorrhizal association is important for efficient nutrient uptake, the nursery soil should be inoculated by suitable fungi. Mixing in some soil from under an established pine stand is generally sufficient.

As soil moisture is generally limiting during south western summers, it is desirable to keep the pines well spaced, and in the initial establishment stage, free of weeds, especially grasses, either by cultivation or careful weedicide application. Wide spacing of more than 6 m apart has further advantages in pines bearing edible seeds. It encourages broadening of the crown rather than height growth, stimulates earlier and heavier flowering and facilitates cross pollination. Pines are wind pollinated, and have separate male and female flowers, the male flowers occurring in the lower part of the crown.

Unless there is a strong vertical updraft, pollination occurs by lateral drift of pollen from neighbouring trees, rather than self pollination. For the same reason, planting of several individuals rather than single trees is necessary.

Trees grown for seeds are best left unpruned, at least initially, to ensure adequate production of pollen. However, once pollen is produced higher in the crown, lower branches can be pruned to facilitate collection of seeds under the trees. There are two options for collecting seed. One is to wait until the cones open and the seed is shed. This is only efficient if the ground under the pines is either kept clear or covered by a tarpaulin. It is also possible to collect cones by climbing before they open, and extracting the seeds artificially by drying the cones and tumbling them to dislodge the seeds. It is advisable to give the extracted seed additional drying before storage.

RARE AND COMMON FRUITS:

Conservation of Genetic Resources in Malaysia

DR. BOBBY TEE
Rural Development Corporation, Sabah

ABSTRACT

The diversity of tropical fruits and other crop plants in Malaysia suggests that Malaysia flora contains valuable genetic resources. Wild relatives of the cultivated species are also found in abundance in the primary forests. However, agricultural development and modern technology are encroaching into the areas of diversity threatening to denude and extirpate the gene pool. There is an urgent need to save these valuable botanical species. Efforts to collect, conserve and document these species are limited owing to lack of funds, facilities and personnel. Land development on a large scale to maintain these collection as a conservatory of genetic resources is expensive and few government institutions have the capacity to embark on such a project. A new concept for the development of a genetic resources centre is proposed, aimed at reducing establishment and maintenance cost, and concurrently developing the centre into a commercial orchard to mobilise financial resources for the maintenance of the centre. The long-term projection is designed to establish the centre into a major scientific institution within a garden of fruits and flowers.

INTRODUCTION

Southeast Asia has been regarded as a major centre of origin and evolution of cultivated plants. Many of these plants have evolved and have been domesticated through the ages to become important crops sustaining the livelihood of millions of people. Introduced crops have also contributed substantially to the agriculture of these regions notably rubber *Hevea braziliansis*, oil palm *Elaeis guineensis* and cocoa *Theobroma cacao*. The success of these crops, indigenous or introduced, has made Southeast Asia an important region for the production of many essential primary agricultural commodities.

Malaysia lies within this important centre of origin. The greatest diversity of a number of tropical fruits and other crops are located in Malaysia. Wild relatives of crop plants especially tropical fruits such as bananas, *Durio, Artocarpus, Nephelium* occur in the lowlands as scattered species amidst valuable forest trees. Cultivated species are also plentiful growing haphazardly in the villages and at the jungle fringes. These indigenous Malaysian species together with the wealth of introduced crop plants represent an invaluable treasure of genetic resources of tropical fruits and other crop plants.

However, the impact of modern agricultural development is gaining momentum in every Southeast Asian country and Malaysia is no exception. Large scale cultivation of economic crops like rubber, oilpalm, cocoa, sugar cane is displacing the virgin forests and destroying an irreplacable pool of plant genetic variability. While land schemes are eliminating valuable botanical species, agricultural extension is also taking a heavy toll on the ancient agricultural land races. New high-yielding varieties and clones are being extended to the peasant farmers to replace their indigenous land races. Invariably these traditional species, which have survived through generations of natural and artificial selections, will be denuded and eventually obliterated. Land races possess valuable genetic resources which are useful in crop improvement programmes.

The purpose of this paper is to discuss the state of genetic resources in Malaysia in relation to the problems of exploration, conservation, documentation and utilization, and also to focus attention on the urgent need to protect, collect and conserve valuable botanical species to enable systematic documentation and utilization of the genetic resources of Malaysia. In this respect, a revolutionary approach to the conservation and management of genetic resources centre as a farm is suggested.

BACKGROUND INFORMATION

Germ Plasm in Malaysia

The recent series of papers in the Malayan Nature Journal (1970-71) present an interesting account of the expeditions of noted scientists and conservationists into the national parks of Malaysia. The papers give descriptive information on the richness of the fauna and flora and the extent of the natural resources to be protected, carefully collected and systematically developed for agriculture and scientific studies.

However, efforts to collect, preserve and evaluate the economic potential of these plants are not adequate owing to lack of funds, facilities and personnel. Fortunately these national parks still exist in their primitive state and many naturalists and scientists have advocated strong legislation to prevent any commercial encroachment into these parks. As long as these parks are preserved in their entity where the flora and fauna co-exist in the never ending biological ecosystem, the plant and animal resources will remain protected. While national parks provide sanctuaries for the indigenous fauna and flora, the pressure of land development schemes are encroaching into the undesignated primary forests. A great variety of fruit trees and relatives of local fruits are found in these forests. Presently, there are at least 20 government agencies involved in land development in Malaysia and up to 1980 nearly one million hectares of new land, formerly primary forests, have been utilized for agriculture of one form or another. The pattern of agricultural development undertaken by these agencies has always been associated with complete annihilation of the primary forests after timber extraction, and

replacing the vegetation with productive crop plants. While these programmes are necessary in the interest of the economic well-being of the country, such aggressive process of land development extirpates entirely in the indigenous species, and along with these plants, valuable genetic resources of tropical fruits and other potential crop plants.

In the light of dwindling genetic resources, steps must be taken to modify this destructive system and consolidate land development with conservation. Development programmes should be planned not only to extract timber but also to collect valuable botanical species in primary forests and preserve them for future use. Botanical expeditions into these forested regions should precede land development to enable collection of useful plants before full scale clearing and burning, thus preserving potential species for the future.

Another urgent problem related to the dwindling germ plasm resources is the fate of the land races scattered among the rural community, in abandoned wastelands and jungle fringes. These species which have survived artificial and natural selections represent a store house of genetic variability and adaptability. Some species may have little economic value, but many remain to be tested and evaluated. The introduction of new varieties and clones is invading the niches of these land races, and urbanization is threatening their very existence. Already some local fruits that were once popular and common in the market place have become rare. For example, Nam nam (*Cynometra caulifora*), Jambu Bol (*Eugenia malaccensis*) Kudang (*Bouea gadaria*) to mention only a few, are no longer easily available in the market. The success of agricultural extension is made at the expense of some of the indigenous fruits. While many institutions like Department of Agriculture, Malaysian Agricultural Research and Development Institute (MARDI) Rubber Research Institute (RRI) have collected and maintained local fruits and other crop plants at their various research stations the list is by no means exhaustive. Many valuable varieties, clones, types and species still await to be discovered, collected and maintained in the interest of science and agriculture.

The major problem associated with the exploration, collection, evaluation and documentation of the vast arrays of crop plants and botanical species in the country is the lack of funds to provide facilities for the maintenance and documentation. Expeditions into the forests of Malaysia to collect botanical species may be inexpensive, but the cost of establishment and maintenance of these species as an arboretum of crop plants for systematic documentation can be prohibitive.

Though seed storage offers a cheaper means of conservation, seed viability deteriorates rapidly in storage under tropical conditions of high humidity and temperature. Proper storage facilities will be necessary for the maintenance and storage of seeds for medium-term preservation.

However, many tropical species have recalcitrant seeds which do not retain their viability upon drying making dry storage difficult, and conservation impossible.

Obviously, the most practical method for the conservation of tropical crop species, especially tree crops, is to maintain them as living plants. This system requires large land areas and involves high financial outlay towards land development, establishment and subsequent maintenance. It is not surprising that few institutions have the capacity in terms of availability of funds and personnel to embark on the establishment of a proper genetic resources

centre to conserve the majority of crops plants and botanical species. Only limited collections of local species and occasional introductions are maintained in small botanical parks or museums here and there. These efforts are commendable but the system is far from satisfactory. Such small parks are generally incomplete and the level of technology needed to evaluate and document the crop plants are not available. It is vitally important that greater coordination is needed to organise an extensive project for the collection and preservation of the dwindling genetic resources that will otherwise be lost forever.

Land development on a large scale just to collect and maintain crop plants and indigenous species is expensive, and institutions of this nature are always associated with public financing. Therefore, this new concept for the development of a genetic resources is suggested with the intention to reduce initial establishment and maintenance costs and at the same time develop the centre into a commercial orchard to earn revenue.

IMPLEMENTATION OF THE SCHEME

A. Garden of fruits and flowers

The approach calls for systematic land development and establishment of crop species basically for conservation and for production. Fruit clones and other plants having commercial demand should occupy larger land areas. Botanical species with limited commercial potential, but having scientific interest can be maintained in small organised experimental blocks. Provisions should be made to develop recreational facilities designed to attract the public to visit, enjoy and buy the produce of the centre, thus providing revenue towards maintenance of the centre. More importantly, a tourist complex should be incorporated within the centre with the intention to attack local and foreign visitors and efforts made to create an awareness of the importance of such a conservation centre and to impress upon the public the richness of the tropical flora of Southeast Asia. The basic concept is to develop the genetic resources centre, not only as a scientific institution, but also as a commercial garden of fruits and flowers.

B. Development of the programme

The majority of tropical fruits and tree crops grow into large trees. Generally wide spacing between plants is practised and hence substantial land area is unproductive during the early growth.

Under such circumstances the development programme should incorporate intercropping with short-term crops to maximise land utilization and minimise maintenance cost. A high degree of organization will be essential to launch the centre as a commercial concern while preserving it as scientific institution.

Economy of size suggests that a minimum area of 2000 hectares will be necessary to enable the centre to function economically and at the same time have sufficient land areas to establish, conserve and maintain the germ plasm collections. However, at this

present moment it is virtually impossible to finance and develop the entire 2000 hectares immediately owing to lack of facilities and planting materials. The development should be planned in stages and the most urgent programme is to initiate surveys to collect fruit clones and useful botanical species for propagation and multiplication in the nursery. Short term crops like papayas, bananas, pineapples and melons and other crops could be intercropped to derive revenue during the first years and provide funds for future development. Priority in this endeavour should include the establishment of the following sections:-

(1) Nursery Development

The centre of activity of the garden is the nursery to initiate produce and multiply plants for the whole complex. Establishment of the physical facilities will require capital investment. The inputs include sprinkler systems, greenhouse, potting sheds plants sheds and budwood nursery. Proper coordination, direction and supervision will be necessary to develop the nursery in stages according to priorities, designed to produce plants rapidly to supply the needs of the complex and to develop fruits and flowering plants for sale. To facilitate long range planning, a 20 hectare reserve should be allocated to nursery development.

(2) Commercial Orchard

Based on an estimated 80 cultivated fruit types in Malaysia (Table 1), slightly over 10 types are in great demand. These include durians, rambutans, mangosteen, duku, duku langsat, citrus, papayas, bananas, pineapples, nangka, cempedak, mangoes, guavas, anona. Another 10 fruit species have good commercial potential if available in large quantities. Approximately 50 hectares should be allotted to each of these marketable fruits selected from the best known clones.

The development represents the dollar-earner for the centre and must be operated efficiently. An understanding of the botanic and agronomic features of each specie is essential so as to plan the development in stages incorporating intercropping with short term crops to maximise land utilization and minimise maintenance cost.

For an example papayas, banana and pineapples should be intercropped at the initial stage with fruit trees to earn revenue for the centre within the first few years. Managerial expertise is needed to organise and integrate the planting of the various commercial fruit species harmoniously into one massive dusun and orchard of mixed fruits. At least 1000 hectares will be necessary for this commercial enterprise.

(3) Germ Plasm Collection

There are approximately 80 cultivated fruit species in Malaysia and within each specie, numerous clones or varieties exist. Assuming that there are 50 clones per fruit specie, and maintaining 4 plants per clone, a total of 16,000 plants will have to be planted. Such fruit trees can be spaced at 200 plants to a hectare, an area of 100 hectares should be sufficient to assemble the majority of the cultivated fruit species in Malaysia. Here again the establishment of the germ plasm need not be necessary organised strictly on institutional basis. Much of the area can be intercropped at the initial stage. However, subsequent maintenance must adhere to the requirements for the establishment of the genetic centre.

(4) Plant Introductions

An adjunct to the germ plasm collection, an area for plant introduction, must be provided to allow for the constant introduction and collection of genetic materials. In considering the genetic centre as a whole, provisions will be necessary for new materials, indigenous or exotic, to be tested and evaluated for their economic

potential. This is a long range programme to be developed as part of the general upgrading of the centre as a major scientific institution for the assembly of the germ plasm of Southeast Asia and other tropical regions. Sufficient land area must be assigned for these studies.

(5) Flowering Plants

Malaysia has a wealth of flowering plants and colouring tropical foliages, many are indigenous while others have been introduced. Orchids command the greatest popularity and orchid cut flowers production is a dynamic industry producing flowers for local and foreign markets. The centre as commercial orchard will not be complete without the inclusion of orchids to attract tourists. The initial venture in orchids should be purely commercial designed to produce and market cut flowers. Ultimately the centre should establish a museum of wild orchids and orchid relatives found in Malaysia for Southeast Asia to serve as a gene pool for institutions in Malaysia that maintain a sizeable collection of wild orchid and orchid relatives. However, owing the lack of funds, the care and maintenance of this extraordinary garden has suffered from neglect. There is an urgent need to revive the garden and plan for future exploratory trips to collect and conserve the dwindling resources of rare and wild orchids.

Other tropical flowers such as bougainvilleas, hibiscus, museanda, and other colourful foliage plants grow in profusion all over the country. Information on these species is scanty and no systematic documentation is available. Nevertheless, many varieties are produced in floriculture nurseries supplying flowering shrubs and pot plants. These flowers have a good market potential, and genetic collections can serve both commercial and scientific purposes for the genetic resources centre.

(6) Tourist Complex

The complex, as a market outlet and a recreational pursuit should feature facilities such as lakes for fishing, boating, footpaths for hiking, with stalls to provide eats and drinks produced from local fruits, toys and trinkets made from local seeds and nuts creating a care-free atmosphere. The complex should serve as market strategy to attract tourists to visit and buy the produce of the centre. The development programme is a long-term project involving landscaping an area of 50 to 100 hectares to capture the lush greenery of Malaysian flora geared to display the economic crops and fruits in its cultivated state blending aesthetically amidst lakes and ponds to stimulate the complex of genetic resources as a wonderland of fruits and flowers.

POTENTIAL AREA FOR THE COMMERCIAL ORCHARD

Malaysia fruits are adaptable to a wide range of soils though climatic conditions may cause problems in flowering and fruit set for certain species. Generally most tropical fruits of economic importance can be grown in all parts of Malaysia. Topography is an important consideration. Mountainous terrain presents special problems in development and accessibility. Flat contiguous lowland, though most suitable for planting lack form and aesthetic character. Undulating terrain has the most appeal in order to incorporate the tourist complex into the genetic resources centre. However, more important is the strategic location of the centre to command the flow of tourists both local and abroad. For costs and other reasons, it would be ideal to site the centre within easy reach of an urban area to attract visitors. Any excess produce from the centre can be conveniently marketed in the urban centre.

While the vicinity of cities like Kuala Lumpur, Penang, Johor Bahru, Ipoh offer the best prospects, with Kuantan and Kota-Bahru, Kuching, Kota Kinabalu high in priority, only one centre is sufficient to display the agricultural wealth of the tropics. It is not within the scope of this paper to locate the site for the genetic centre. The actual location will depend on the decision of the federal government to go along with the proposal, and probably in consultation with the State or states concerned. Land survey will have to be conducted and the soil and climatic conditions studied before a final decision can be made on the location of the genetic centre.

ORGANIZATION AND MANAGEMENT

The basis for the development of the genetic resources centre as a commercial orchard is to exploit the commercial potential of fruits, flowers and crops and develop the centre into a tourist complex as an important outlet for the produce of the centre. It is recognised that the scientific role of the centre is equally important, and the development must be coordinated initially to mobilise financial resources for the maintenance of the centre and subsequently to establish the centre as the foremost institution for the assembly of genetic resources of crop plants for Southeast Asia.

In order that the centre may function more efficiently as a commercial institution, it would be more appropriate to organise the centre as a public corporation. Upon completion of the whole infrastructure, the management of the centre can still remain within the corporation, but the centre will need trained personnel to explore, collect, evaluate and document these valuable genetic resources. While these activities may not be of direct financial benefit to the corporation, the programme represents the main function of the centre.

Research activities of the centre could be collaborated with other local and international institutions on a cooperative basis.

FINANCIAL ASPECT

The genetic centre as a commercial orchard will function initially as a commercial concern and subsequently the profit will be channelled to the development of the genetic resources centre. Obviously it will require initial capital from the government to launch the corporation and carry out development project as a commercial organization. Subsidies from international organizations will be necessary to provide the capital costs for laboratories and equipment and nominal operating expenses in the employment of qualified personnel to identify, document and maintain the genetic collections, and to conduct research activities associated with the conservation of genetic resources. Expenditure on the maintenance of the entire complex should come from the sale of fruits and flowers of the centre and from the tourist complex. In effect this concept is intended to minimise government expenditure and eventually develop the centre into a self supporting institution.

TABLE 1. LIST OF MALAYSIAN FRUITS

	Malaysian Name	Botanical Name	English Name
1.	Ara	*Ficus carica*	Fig
2.	Anggor	*Vitis Vinifera*	Grape
3.	Asam Gelugor	*Garcinia atroviridis*	-
4.	Asam Jawa	*Tamarindus indica*	Tamarind
*5.	-	*Persea americana*	Avocado pear
6.	Bacang	*Mangifera foetida*	(Horse mango)
7.	Bedara	*Zizyphus jujuba*	-
8.	Belimbing Manis	*Averrhoa carambola*	Star Fruit
9.	Belimbing Masam	*Averrhoa bilimbi*	-
**10.	Betek	*Carica papaya*	Papaya
11.	Berangan Betul	*Castanopsis inermis*	-
12.	Berangan Dun	*Castanopsis wallichii*	-
13.	Binjai	*Mangifera caesia*	
14.	Buah Brazil	*Bertholletia excelsa*	Brazil Nut
15.	Buah Melaka	*Phyllanthus emblica*	-
**16.	Buah Mentega	*Diospyros discolor*	Butter fruit
**17.	Buah Pala	*Myristica fragrans*	Nutmeg
**18.	Cempedak	*Artocarpus champeden*	-
19.	Cermai	*Phyllanthus distichus*	-
**20.	Ciku	*Achras zapota*	-
21.	Delima	*Punica granatum*	Pomegranate
**22.	Duku	*Lansium domesticum*	-
**23.	Duku Langsat	*Lansium domesticum*	-
**24	Durian	*Durio zibethinus*	Durian
**25.	Durian Belanda	*Annona muricata*	Soursop
**26	Gajus	*Anacardium occidentale*	Cashew
27.	Jambu Air	*Eugenia aquea*	Water apple
28.	Jambu Air Rhio	*Eugenia javanica*	-

**29.	Jambu Batu	*Psidium guajava*	Guava
30.	Jambu Bol	*Eugenia malaccensis*	-
*31.	Jambu Mawar	*Eugenia Jambos*	Rose apple
32.	Kedondong	*Spondias cytherea*	Otaheite apple
33.	Kelumpang	*Sterculia monosperma*	-
34.	Kenari	*Canarium commune*	Almond Tree
35.	Kerendang	*Carissa congesta* (*C. carandas*)	Karanda
*36.	Kuini	*Mangifera odorata*	-
37.	Kundang	*Bouea gadaria*	-
**38.	Langsat	*Lansium domesticum*	-
**39.	Limau Besar	*Citrus grandis*	Pomelo
*40.	Limau Cula	*Citrus reticulate*	Neck Orange
**41.	Limau Cula	*Citrus sinensis*	Sweet orange
*42.	-	*Citrus paradisi*	Grape Fruit
*43	Limau Nipis	*Citrus aurantifolia*	Lime
*44.	Limau Kesturi	*Citrus microcarpa*	Lime
**45	Limau Langkat	*Citrus reticulate*	Orange
**46.	Limau Manis	*Citrus nobilis*	Orange
47.	Limau Purut	*Citrus hystrix*	-
48.	Limau Susu	*Citrus Medica*	Citron
49.	Longan	*Nephelium longana*	-
50.	Lontar	*Borassus flabellifera*	Paimyra Palm
**51.	Mangga	*Mangifea indica*	Mango
**52.	Manggis	*Garcinia mangostana*	Mangosteen
53.	Marang	*Artocarpus odoratissima*	-
**54.	Markisa	*Passiflora edulis f. flavicarpa*	Passionfruit
55.	Mata Kucing	*Nephelium malaiense*	Cat's eye
*56.	Melinjau	*Gnetum genemon*	-
57.	Nam Nam	*Cynometra cauliflora*	-
**58.	Nangka	*Artocarpus integra*	Jackfruit
59.	Nona Kapri	*Annona reticulate*	Custard Apple
*60.	Nona Sri Kaya	*Annona squamosa*	Sugar Apple
61.	Pauh	*Mangifera pentandra*	-
62.	-	*Guilielma speciosa*	Peach Palm
**63.	Pisang	*Musa sapietum*	Banana
64.	Pisang Kaki	*Diospyros kaki*	Persimmon
*65.	Pulasan	*Nephelium mutabile*	Pulasan

66.	Rambai	*Baccaurea motieyana*	-
**67.	Rambutan	*Nephelium lappaceum*	Rambutan
*68.	Rokam Manis	*Flacourtia rukam*	-
*69.	Rokam Masam	*Flacourtia inermis*	Lovi-lovi
70.	Salak	*Zalacca edulis*	-
71.	Sentul	*Sandoricum koetjape*	-
72.	Sukun	*Artocarpus communis*	Breadfruit
73.	Tampoi	*Baccaurea sapida*	-
74.	Temikai	*Citrullus vulgaris*	Water melon
75.	Tempunik	*Artocarpus rigidus*	-
76.	Timun Belanda	*Passiflora quadrangularis*	Grenadilla
**77.	Nenas	*Ananas comosus*	Pineapple

** In great demand

* Potential demand

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UNDERSTANDING THE BACKGROUND BEHIND MACADAMIA CROP MANAGEMENT

With Respect to Water and Nutrition

B. W. CULL
Principal Horticulturist, Dept. of Primary Industries,
Nambour, Queensland, Australia

THE AIMS OF WATER AND NUTRITION MANAGEMENT

The aims of such management are threefold, firstly to maximise yield, secondly to assure nut quality and thirdly to maintain control of the tree, particularly its size. These are the common aims of most growers; it is in the process of attempting to achieve these aims where differences occur.

Research in macadamias in Australia is in its infancy; therefore, to expect someone to give you a cut and dried full management package is premature. What is offered is a basic philosophy of how the tree works and performs and the probably role and place of water and nutrients. With an understanding of this philosophy the results of our management decisions may be better understood and hence a fuller management package can be built.

HOW HAVE YOU MANAGED WATER AND NUTRITION

Growers adopt one of three general guides to management. Firstly there is the approach based on "when the feeling strikes" or time or money is available. Secondly, it can be based on years of observation by yourself or that acquired from other reputable growers and thirdly, using guidelines as developed and presented by advisory bodies. The values and problems associated with each of these approaches may be debated but one over-riding constraint, limits the value of any of these systems. This is the fact that the tree doesn't know them, nor care, and the tree wishes to perform differently from year to year, district to district, variety by variety and soil type by soil type.

Therefore, to adapt any management system to your property you must first know your tree and how it functions. Secondly you must observe how it is performing with respect to what is expected for high yielding trees and thirdly test it to see if it is receiving the nutrition it needs. At this stage this may sound involved but the cold facts are you have two options; the guess and good luck approach or knowing how a tree should perform and if it isn't, adopt techniques which will adjust it so it approaches the desired line of excellence.

THE PHILOSOPHY OF TREE MANAGEMENT

When attempting to understand the management of trees some basic principles must be understood and accepted.

(a) A tree produces both vegetative growth (leaves and branches) and nuts.

The production of both these are somewhat in competition with one another. It is true that good leaf development is a precursor of good nut development but excessive vegetative growth can be to the detriment of nut production.

(b) The make up of both vegetative growth and nuts are water and solids. The solids in the main are approximately 95% carbohydrate and 5% mineral. This places the emphasis on carbohydrate production. Carbohydrate (sugars, starch and oils) are expended as energy required in growth and development. It also forms the oils and sugars in the nuts and much of their structure.

(c) Carbohydrate is formed basically by photosynthesis in the leaves. The amount formed depends on the health and status of the tree on one hand and the inputs of light, heat (temperature), water and minerals. Light and temperature are the strongest controlling factors over which we have little control. Water and minerals although of lesser importance are vital to the formation of the total framework. Any missing or weak link in the structure obviously brings production down.

(d) Water and minerals are the factors which can be manipulated and managed during the life of the crop and hence receive the greatest attention. Heat and light are related to the initial management decisions with respect to where you locate your planting and the spacing and direction in which you site these trees. Once established these cannot be manipulated.

(e) The strong influence of light on production is readily seen. Actual yields per unit volume of tree canopy in fact decline as trees get older. Nuts are carried through the whole tree in early years but contract to the outside as they get older. Where trees crowd and merge into one another nut production is reduced in that area and the yield per tree falls. By removal of every second tree the yield again rises markedly in the remaining tree.

One management area related to light is excessive growth. Trees can be grown faster than need be when they commence cropping, reaching the status of overcrowding prematurely. Excessive nitrogen plays the major role in this management error.

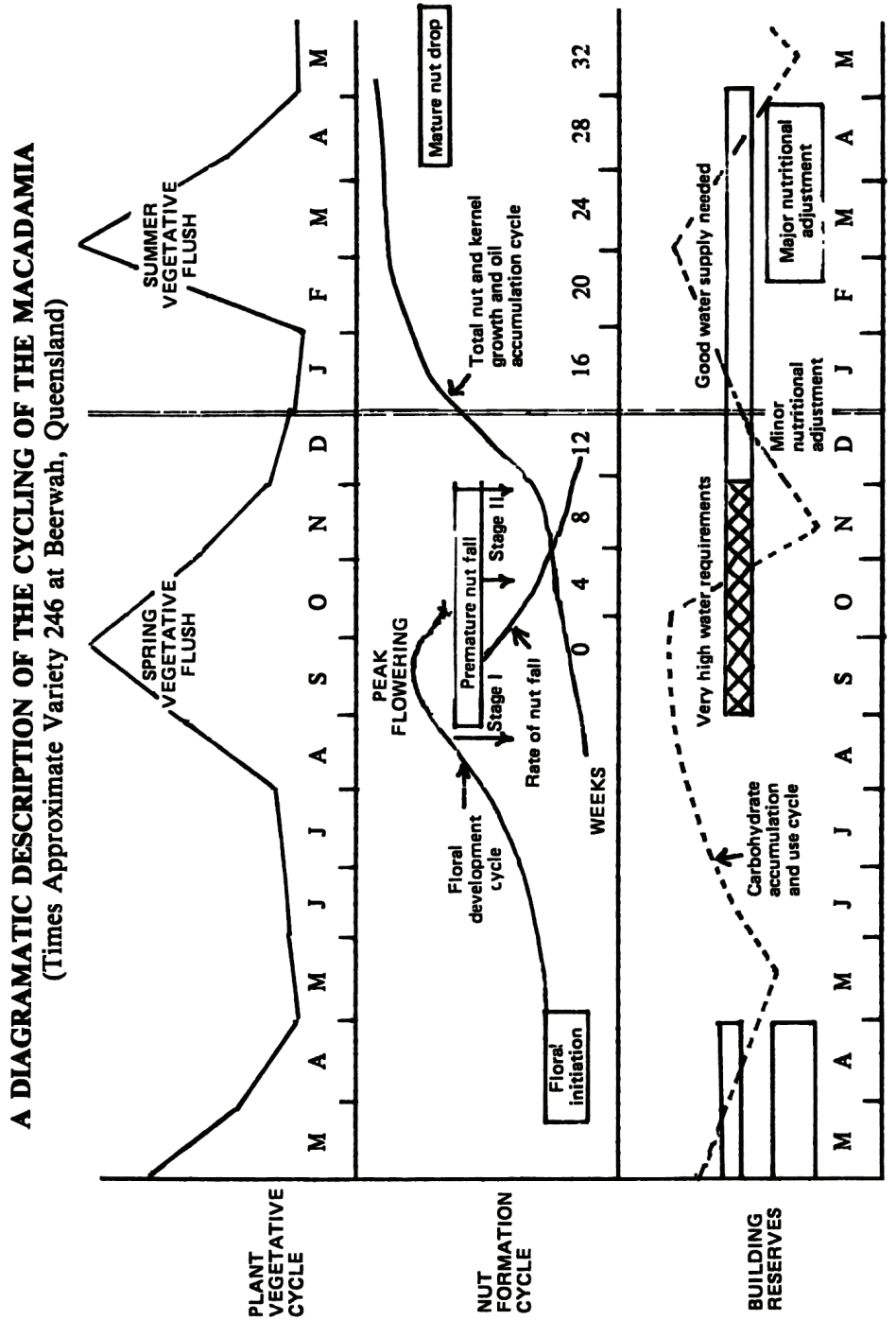
(f) The reason for manipulating water and minerals is to maximise carbohydrate production, its storage and effective use in the formation of nuts both with respect to their number and content. Content affects quality. Many people believe you can force feed plants to make them perform, however, plants require only sufficient to build the framework. Water, light and temperature actually have a greater control on the outcome. The actual performance of a variety in a given locality is related to the ability of that variety to manufacture carbohydrate, store it and deliver it to nuts at the correct time to optimise production and quality in that environment. This is what determines the success of a va-

riety.

(g) The major management is therefore in producing, controlling, and manipulating carbohydrate. Carbohydrate production is related to the leaf area which is exposed to medium to high light intensity. In practice, dense foliage trees may not be better off than open trees with a reasonable level of active leaves. The activity of leaves is limited if water or nutrition are lacking. Reserves of carbohydrate can be expended in the production of excessive vegetative growth to the detriment of nut production and management should be such to keep this in balance. Manipulating carbohydrate therefore is related to ensuring that its production is maximised at the appropriate times and that it is available for channelling into nut production and not expended into excessive vegetative growth especially when nuts have a high requirement.

(h) The major manipulators of carbohydrate formation and its control available to growers lie in water, nitrogen and potassium. Temperature however has a stronger influence on the plant and controls rate of carbohydrate formation, as well as flower and vegetative growth. Because of this one factor the benefits of water and nutrition application are often overridden and hidden unless they are extremely deficient. When temperatures are too low no matter how much water and nutrition are available the plant is not active. While temperatures are optimum for growth then the effect of deficiencies will be felt. The Macadamia appears to have a ceiling of somewhere in the 30-35°C range, where problems occur and carbohydrate production is probably markedly reduced.

What is learnt from the above is that the approach which must be adopted in water and nutrition management is to have the required levels close to the optimum during those periods of the year when the plant is actively in need of them. In addition it will be very difficult to define the precise level of water and nutrition required because of the overriding influence of other factors, a major one being temperature. A range in which it is known plants perform very well is the best that can be hoped to be offered.



(i) The period of the plant's cycle when it has active and high needs may be determined from the included diagram. (The actual cycle presented, approximates that of one variety in one locality in one year. To establish your own cycles you will need to observe each variety in your locality over several years. However, a good guide to start with is available from this example.) The two major factors in the cycle would be the accumulation of carbohydrate reserves in later summer-autumn early winter period. This reserve is believed to play a major role in the potential size of the crop, the degree of nut set achieved in spring and to some extent nut development. The second period if the active nut growth-oil accumulation period in late November, December and January. Factors in this period could affect quality.

The suggested optimum situation would be for the plant to replace or form its effective leaf area in the summer vegetative flush period. This should be followed by a period with ample water and nutrition to maximise the accumulation of carbohydrate in the plant for the spring flowering and fruit set period. In theory a minimum of vegetative growth should be made during winter and the spring vegetative flush period to avoid expenditure of reserves on unnecessary vegetative growth. This should maximise availability for nut set and nut retention. Excessive vegetative growth in spring is believed to promote premature nut fall. This however is probably modified by the level of carbohydrate storage achieved, and the availability of water and the temperatures experienced in the nut fall period.

The development needs for the rapid nut formation and oil accumulation period, depends on the carbohydrate reserves in part and partly on that formed at the time. Excessive vegetative growth prior to and in this period may lead to reduced nut quality. Nutritional and water deficiencies would also aggravate the situation.

(j) The role of water in carbohydrate production is well documented. Plants in water stress are known to stop production and there can be a lag phase following the restoration of supplies.

The spring period with heavy flowering followed by strong vegetative growth and nut development must have a very high water requirement. Once premature nut fall ceases and the spring vegetative flush eases, water requirements would fall. During nut filling and the summer vegetative growth period and the incorporation of surface applied fertiliser, good water supplies are needed. For the remainder of the year any stress periods would reduce the potential to accumulate carbohydrate. The significance of such breaks in accumulation on the final level at flowering is not known.

(k) The elements nitrogen and potassium are mobile in the soil being incorporated and leached readily by water. They are readily available to the plant but likewise can be lost from the root zone and become deficient. Phosphorus moves slowly into and through the soil while magnesium and calcium derived from dolomite and lime are similarly slow in movement and action. Once incorporated they are available for an extended period and only need to be applied once per year. (This may not apply on extremely open sand soils.) The minor elements boron, zinc and copper from experience appear to need adjustment only once per year. The period February to April appears to satisfactorily meet both the needs of incorporation through late summer rains and time for nutritional adjustment leading up to the coming period of carbohydrate accumulation and flowering and nut set period.

(l) Nitrogen has the most dramatic effect on plant growth. It is required in sufficient quantity for plant growth and nut development. Amounts above these requirements stimulate excessive vegetative growth which as described previously can cause upsets in nut set and development and tree size control. Potassium if kept in balance with nitrogen in other crops offsets to some extent the detrimental effects of high levels. This is not understood in macadamias but it is important that potassium levels are maintained close to optimum during both the periods of accumulation of carbohydrate as it has an important role in its formation.

Problems have been encountered in Australia with phosphorus deficiency and excess, magnesium, zinc, copper, boron and iron deficiencies. Some of the latter deficiencies while being natural have also been caused by antagonism from excess phosphorus.

To maintain nutrients near optimum levels is difficult by looking at the tree alone. A system presently available to us is leaf and soil analysis which takes the guess work out of decision making. This subject is covered in another paper.

The management of nitrogen is most important and the colour of the tree, the denseness of the canopy and the period over which growth extends and the intensity and amount produced are all indicators of nitrogen levels in the plant. Excessive vigour in a producing tree is detrimental and the challenge lies in striking an appropriate balance in each variety on your property. Observation of tree growth and performance is basically the only reliable monitor for such management.

BENEFITS FROM MANAGEMENT

The benefits to be derived by managing trees through a knowledge and study of their vegetative and nut cycling characteristics must pay dividends where individual varieties, blocks of trees and even individual trees fail to perform on a set management schedule. The effects of adjustments made can be monitored not only be yield but also by growth patterns, flowering level, premature nut fall and also by leaf and soil analysis.

The strong influence of temperature often awakens dormant growth and reaction by tree. Many growers presume response in a tree is due to their recent applied treatment. This may be so or it may be due to a previous accumulation in carbohydrate and a change in temperature. A knowledge of the plant cycle will give a better interpretation of results achieved by treatment and hence better management.

SUMMARY OF MANAGEMENT STRATEGIES

(a) Have an understanding of the crop cycles.

(b) Be prepared to observe and record over a period of years the cycles of individual varieties and blocks on your property.

(c) Construct cycling patterns for varieties and blocks.

(d) Monitor nitrogen levels by crop colour, vigour and growth patterns.

(e) Monitor other nutrient levels by way of leaf and soil analysis.

(f) Be prepared to adjust water and nutrient application rates in relation to cycling patterns and monitored levels and record response of trees.

(g) Remember management is based on knowledge, observation, recording, adjustment of treatments followed by observation and recording and so on. Hence management is not a single decision but an ongoing process.

An address given at Lismore, New South Wales, November, 1980.
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PERSIMMON

A New Look At An Ancient Crop

A. P. GEORGE AND R. J. NISSEN

INTRODUCTION

The persimmon (*Diospyros kaki L.*) is a native of China, however, most development of the crop has occurred in Japan where it is regarded as the national fruit (275,000 tonnes produced annually). Smaller but expanding persimmon industries are being developed in Italy, California and Israel. Although the tree is widely grown throughout Australia, the fruit has not gained popular appeal. The main reason for this is that the astringency of the fruit renders the fruit inedible until completely soft and ripe. The softness of the fruit at eating ripe makes the fruit difficult to transport and market. However, the introduction of newer non-astringent cultivars from overseas and the development of chemical methods to remove astringency should overcome these problems.

In comparison to other sub-tropical tree crops, the persimmon has a few production problems. The crop has potential for utilizing more marginal frost prone areas in this region. The current Australian market appears well below saturation as indicated by the recent importation of fruit from the U.S.A. Average prices received on the Brisbane markets in the 1981 season were between $8-$12 per tray. Prospects of developing out of season markets to Japan and South-east Asia are good as the fruit is well-liked in these regions. Prices paid for early season fruit on the Tokyo markets can be as high as $8-$10 per kg. The future of the industry will depend on the selection of high quality cultivars and efficient marketing technique to ensure a firm non-astringent persimmon reaches the consumer.

CULTIVARS

Over 1000 named cultivars of persimmon are known with most of these originating in Japan. Selection from within seedling populations has also occurred in Australia with some six cultivars grown commercially on a small scale. Of all the known cultivars, only about fifteen are recognised as having ideal qualities for commercial plantings. Most cultivars can be classified into two main groups:-

1. Astringent these cultivars do not normally lose their astringency until soft and fully ripe.

2. Non-astringent - these cultivars have no astringency even when the fruit is firm. These cultivars can be eaten crisp like an apple, if preferred.

Some cultivars may fall in between these two categories, being astringent if the fruit develops part parthenocarpically and non-astringent if seeded.

In Japan approximately 60% of total commercial plantings consists of non-astringent types. Two non-astringent cultivars, Fuyu and Jiro, alone, occupy about 50% of the plantings, with Fuyu being the most highly regarded cultivar. Future development of the persimmon will most likely be based on non-astringent cultivars.

Of the present astringent cultivars tested only two cultivars could be considered suitable for commercial plantings, Flat Seedless and Nightingale (Hachiya). Several strains of Flat Seedless exist with varying maturity periods. All strains exhibit excellent flavour characteristics, have low astringency and possess good shelf life. The major disadvantage of growing astringent cultivars is that they need to be chemically treated to remove astringency prior to marketing. The main technique used is CO, gassing. The advantage of this method is that there is little or no reduction in fruit firmness. Although procedures to chemically remove astringency are relatively simple, the techniques would need to be adopted by all growers of these cultivars to ensure buyer confidence. Characteristics of the principal non-astringent cultivars potentially suitable for sub-tropical regions of Queensland are presented in Table 1.

CLIMATIC EFFECTS ON ASTRINGENCY

The persimmon is readily adaptable to a wide range of sub-tropical and warm temperature climates. Trees are deciduous and enter a rest period however most cultivars appear to have little or no chilling requirement to satisfy rest and to ensure uniform budbreak. Most cultivars flower later (Oct.) than other deciduous fruit crops and consequently are seldom subject to injury from late spring frosts. The fruit requires a long season to ripen fully and plenty of autumn sunshine is necessary - as much as 1400 hours with average temperatures in the autumn months of between 16 and 22°C. Astringency levels decrease with increasing temperatures during the fruit maturation period. Non-astringent cultivars such as Fuyu require warm conditions for fruit maturation. Under cooler conditions, these cultivars do not mature properly and have a low sugar content and poor colour. In more marginal, cooler areas, early maturing non-astringent regions of Queensland are well suited to growing the complete range of non-astringent cultivars.

POLLINATION REQUIREMENTS

Trees of most Japanese cultivars bear only pistillate (female) flowers. Some cultivars have a strong tendency to set fruit part parthenocarpically and produce good yields regardless of pollination. Others such as Fuyu have low parthenocarpic ability and the flowers must be well pollinated in order to set a commercial crop. A number of cultivars e.g. Jiro, Maekawa Jiro are intermediate in their requirements for pollination. A few cultivars bear both pistillate and staminate (male) flowers and are used as pollinators.

Pollinator cultivars:

Zengimaru - the most widely used pollinator in Japan. Available in Australia.

Dai Dai Maru - an old Australian cultivar.

Gailey - used extensively in U.S.A and N.Z. Available in Australia.

Akagaki - currently being imported from Japan.

Omiyawase - currently being imported from Japan.

In Japan, two or three different pollinators are included in the plantings to ensure that good overlap of flowering occurs. One pollinator tree should be interplanted with every 8-10 trees of cropping cultivators. Fruit shedding is reduced by good pollination.

ROOTSTOCKS

Three rootstock species can be used.

1. *D. kaki* - oriental persimmon.
2. *D. lotus* - date plum.
3. *D. virginiana* - American persimmon.

Of the three rootstock species used, *D. kaki* is most preferred. This species exhibits higher resistance to crown gall. Fuyu is incompatible on *D. lotus*. Some varieties on D. lotus also exhibit flower and fruit shedding. *D. virginiana* is subject to excessive suckering, however can stand waterlogging better than the other two species. Due to variation in seedling vigour a range of cultivars of *D. kaki* is presently being tested for use as rootstock. Clonal propagation of selected rootstock lines would also be desirable.

ORCHARD MANAGEMENT

Management requirements for persimmons are similar to other deciduous crops. Dwarf and semi-dwarf cultivars e.g. Fuyu can be close planted at 6 m x 3 m apart (556 trees per ha). These trees can be thinned out to 6 in x 6 m in the 5th-7th year from planting. Mature trees can yield between 20-30 tonnes per ha. The naturally dwarf and semi-dwarf types e.g. Fuyu can be pruned to a modified central leader system. More vigorous cultivars such as Flat Seedless need to be trained to an open vase system. The dwarf and semi-dwarf types are precocious bearing coming into production 2-3 years after planting. The more vigorous types commence production 3-4 years after planting, however techniques to widen crotch angles and cincturing may bring these into earlier production. Pest and disease problems such as Queensland fruit fly and angular leaf spot can be readily controlled.

RESEARCH NEEDS

The present research programme is aimed at evaluating recently introduced non-astringent cultivars. In conjunction, evaluation of suitable pollinator and rootstock species will also be carried out. Studies on chemical methods to remove astringency are being carried out by various research institutes.

Outline of proposed research:

a. introduce superior cultivars from Japan, Israel and Italy.

b. screen cultivars for fruit quality, maturity times and yield potential.

c. propagate and release selected high quality lines to industry.

d. establish replicated field trials and observation blocks in a range of environments of sub-tropical Queensland to evaluate environment x genotype interaction.

e. collect data on climatic influences on maturity times, fruit quality and pest and disease problems.

From an address given at the Maroochy Horticultural Research Station, Qld. Nov. 1982.

UNDERSTANDING THE GROWTH OF THE AVOCADO TREE

A. W. WHILEY

The avocado tree passes through various growth phases in the course of the twelve months it takes to produce a fruit crop. It is important to recognise these phases and to realise that some are more sensitive than others to management practices such as fertilizer and irrigation.

The other important consideration is that growth phases and nutritional requirements of our two main varieties, Fuerte and Hass, are different. This means that these varieties should be managed separately, particularly when fertilizing.

If we look more closely at these varieties the following growth pattern unfolds. For the sake of this discussion assume that the first growth phase begins in March.

PHASE 1

March sees the maturing of the summer flush which is to produce flowers and carry next years crop. Flower bud differentiation in both varieties occurs sometime during March and April with the floral buds quite distinct by May. Sometimes a false flowering occurs in May if abnormally warm temperatures are experienced but few set fruit. These trees usually flower again in the spring, setting normal crops.

It is the nutritional preparation of this flush which greatly influences the fruit set and retention of the crop to follow. Nitrogen is the most important element to monitor and adjust. Experimental results from a Palmwoods, Qld., orchard has shown that with Fuerte leaf nitrogen levels, taken in May, most favourable for fruit set are between 1.5 and 2% while with Hass, between 2.4 and 2.7%.

While some fertilizer should be applied earlier in the summer to stimulate this flush, most of the application is during this phase.

PHASE 2

During May tree growth ceases and by June both varieties are at rest. Compared with deciduous trees this period is very brief, particularly in the case of Fuerte which begins flowering in July. Temperature has a direct effect on fruit set at this time of the year. At 20°C and below, the floral biology is upset and fertilization rarely takes place. Thus, most early flowers of Fuerte are wasted. However, by mid-August, temperatures have improved sufficiently to allow normal pollination to occur. It is at this time that Hass, a more cold sensitive variety, begins to flower.

While many fruit may appear to set it is shortly after flowering that a large drop of pea sized fruitlets occurs. These can be categorized into two groups:

1. Those that are the result of pollination but unsuccessful fertilization.

2. Those that are the result of successful pollination and fertilization.

It is the second category which must be minimized. While there is no positive answers to this problem it seems likely that it is a reaction to the competing demands between vegetative and reproductive growth within the tree. It has been noticed that trees that produce vigorous vegetative flushes stimulated by excessive nitrogen levels and plenty of water will have a large fruit drop. It is suggested that assuming nitrogen levels have been correctly adjusted during phase one that irrigation should be carefully managed to prevent too vigorous a flush occurring.

PHASE 3

Fruit grow rapidly during November and December. During December the spring flush hardens and there is a pause in vegetative growth. This is generally accompanied by a second fruit drop which can be severe. Water relations appear to be a dominant factor influencing the size of this drop and the timing and quantity of irrigation during this period is critical. It is suspected that water stress occurs in many trees though not through the lack of irrigation but because root systems have been damaged by Phytophthora root rot during the past summer. While the aerial portions of a tree appear normal both fruit and shoots develop at the expense of renewed root growth so that an imbalance between root and shoot occurs.

During January and February the tree flushes again. This flush helps fill the current fruit crop as well as being the flower bearing flush of the next seasons crop. Once fruit fall has stopped fertilizer should be applied to ensure that this flush develops to its full potential. Irrigation is seldom necessary in S.E. Queensland during January, February and early March.

CONCLUSION

From the charting of a growth in a Palmwoods avocado orchard a distinct pattern of development emerged which can be considered as three growth phases. During each phase changes occur within the tree which can be influenced by normal management procedures. Abnormally large fruit drop which occurs in phase 3 is thought to be associated with water stress caused by Phytophthora root rot during the preceding summer. In the long term root health needs to be improved. Little consideration has been given to this area as they are not easily seen. However, Phytophthora activity can be found under normal-looking trees. Two methods of improving root health are by the use of resistant rootstocks and by the application of fungicides.

From an address given at the Maroochy Horticultural Research Station, Qld. Nov. 1982.

SOIL MANAGEMENT TRIALS ON AVOCADO TREES

MR.TIM TROCHOULIAS
Senior Horticulturist,
Tropical Fruit Research Centre, Alstonville, N. S. W.

The avocado root rot soil management trial has been in progress for 9 years at the Tropical Fruit Research Station, Alstonville. In this time large amounts of data have been collected on tree growth and yield. Soil chemical and microbiological data have been gathered annually and these data will be statistically analysed in the near future. In the meantime I have tabulated some of the trends which are emerging from the trial and which were presented to the Australian Avocado Growers' Federation Field Day held at Alstonville on 27-28 April, 1982.

BACKGROUND INFORMATION ON THE TRIAL

The trial was established by Pat Broadbent from the Biological and Chemical Research Institute, Rydalmere to assess various management regimes with high levels of organic matter, calcium and nitrogen in their ability to suppress root rot. These ideas were formed from analysis of rainforest soils and avocado groves suppressive to Phytophthora (Broadbent and Baker, 1974).

Trial details - The trial was established in 1973 on a NE 12° slope covering 1.8 ha. The trees were Fuerte scions grafted on to Fuerte rootstock. The spacing is 9 x 9m with each trial plot made up of two test trees surrounded by 12 common buffers (guard trees).

Each test plot was replicated four times with the following treatments applied:

1. Bare ground extending beyond the root zone with a strip of kikuyu between rows for erosion control. Weed growth was suppressed by paraquat herbicide.

2. Mown kikuyu sod.

3. Mown kikuyu sod + dolomite (5 t/ha annually) + calcium nitrate at a level equivalent to 25% of basal N, applied in November and April.

4. Mown kikuyu sod + dolomite (5 t/ha) + urea at a level of N equivalent to 25% of basal N in November and April.

5. Cover crops (Lablab in summer and oats and lupins in winter).

6. Cover crops + dolomite (5 t/ha) + fowl manure (10 t/ha annually).

7. Cover crops + gypsum (10 t/ha annually) + fowl manure (10 t/ha annually).

Applications of basal fertilizer were made in January (5.0-7.3-4.0 NPK), March (9.6-2.6-16.7 N-P-K) and November 9.6-2.6-16.7 N-P-K) at 150 g per tree per year of tree age.

RESULTS TO DATE

(a) **Yield** - Figure 1 shows that from 1977 to 1980 yield was higher in the gypsum (No. 7) treatment. In 1981 the trial area was badly affected by Anthracnose. The overall average (including 1981) still favours the gypsum treatment.

(b) **Soil analysis** - Figure 2 shows that pH has increased in the dolomite treatments (3, 4 and 6), has remained stable in the gypsum treatment (7), and decreased in treatments not receiving dolomite (1, 2, and 5). The calcium treatments (dolomite or gypsum) have about three times as much Ca in the soil solution compared to the non-calcium. Aluminium levels are present only in the non-Ca treatments.

Figure 3 shows that the gypsum treatment has the highest phosphate level in the soil solution with treatment 6 following. All other treatments have relatively low phosphate levels. The organic matter level is similar in all treatments.

Figure 4 shows that except for the gypsum treatment which is getting on the low side for magnesium all other treatments have magnesium levels which are too high in proportion to calcium. This is even the case in treatments 1, 2, and 5 which do not receive dolomite. The proportion of aluminium in the cation exchange capacity is increasing markedly in treatments not receiving dolomite or gypsum.

(c) **Leaf Ca levels** - Figure 5 shows that treatments 6 and 7 have slightly higher leaf levels of Ca compared to all other treatments. Soil calcium levels are not reflected in the leaf for treatments 3 and 4.

(d) **Calcium and tree health** - from the spring of 1981 the trial area showed up pockets of serious decline. A tree health rating based on visual assessment of foliage colour was made in January, 1982. The scores showed that trees receiving Ca (dolomite or gypsum) performed better than the non-Ca treatments (Figure 6).

DISCUSSION

Avocado roots do not have root hairs which help absorb water and minerals in most plants. Under conditions of stress roots suberize which means that a corky protective layer is formed which renders the roots ineffective. This is one of the reasons it is necessary to provide protection for the root system with mulches. The presence of white active roots is a sign of a healthy root system.

Young trees have a higher root to shoot ratio than older trees. This is why young trees can withstand root rot or waterlogging better than old trees. Figure 7 shows that apple trees as they age increase fruit production mainly at the expense of the root system. It is likely that the same occurs in avocados.

In other words as the tree ages, fruit is favoured over roots for photosynthates or energy materials and the root system becomes a very much dependent organ.

As avocados have 15-30% oil in the fruit it requires approximately twice as much energy to make 1g of oil compared to carbohydrate for example in apples. This is likely to make additional demands on the root system.

The elements which are most important for healthy root growth are phosphorus, calcium and boron. Calcium has been used most on our coastal soils because they are low in natural calcium. Pegg (1977) stated that losses in Queensland plantations due to *Phytophthora* root rot had been minimal where the content of exchangeable calcium is high compared to devastated plantations where the calcium content is low. The data being collected in this trial is the first replicated trial where this observation has the chance to be proved.

Calcium also improves soil structure and the effects of this factor will be investigated later this year.

Another benefit of Ca is that it counteracts the effects of harmful metals like aluminium.

It is interesting to note that in the treatments that have not had calcium 1, 2, and 5) the Ca to Mg ratio is about 2:1 when it should be about 5:1. This could be improved in a commercial situation by the application of lime. All the dolomite treatments have too high a level of Mg and this will be corrected by the application of lime in the future. Leaf Ca levels in all treatments are within the 1 to 3% classed as adequate by Goodall et al (1965).

Levels of pH, organic matter and type of nitrogen do not appear so far to be contributing to tree health. Although all details of calcium uptake and accumulation are still poorly understood (Millaway, 1979) there is evidence that lack of calcium is implicated in many fruit and vegetable disorders and as a fertilizer additive has contributed to the reduction of certain pathogenic diseases in cotton (Wiles, 1959).

In conclusion, I would like to re-emphasize the preliminary nature of these observations and stress that the calcium effects of this trial which are emerging now are the result of many years of applying large quantities of calcium fertilizers. Growers should keep this in mind and not expect spectacular effects from short term calcium applications.

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FIGURE 1: The effect of various treatments on tree yield from 1977 to 1981 (mean of 8' trees).

Yield (kg/tree) YEAR	1977-80	1981*	1977-81
1	31.4	56.4	36.4
2	25.9	27.1	26.9
3	31.9	54.3	37.9
4	31.9	28.5	31.9
5	36.0	64.5	43.2
6	35.0	56.1	40.2
7	56.9	38.6	50.9

* Affected by Anthracnose

TREATMENT

FIGURE 2: Soil Analysis 1981 (mean of 8 determinations) 15cm depth

	pH (1:2 $CaC1_2$)		Ca	Al
	1976	1981	ppm	me/100g
1	4.8	4.5	1128	.485
2	5.0	4.6	1180	.181
3	5.5	6.0	3450	0
4	5.6	6.3	3774	0
5	5.0	4.7	1382	0
6	5.9	6.3	4478	.236
7	5.0	5.2	4128	0

TREATMENT

FIGURE 3: Soil Analysis 1981 (mean of 8 determinations) 15cm depth.

	Bray P	OM
	ppm	%
1	17.0	10.9
2	10.0	9.1
3	12.88	11.0
4	13.0	11.3
5	11.25	11.0
6	35.25	10.3
7	54.25	11.5

TREATMENT

FIGURE 4: Soil Analysis 1981 - The effect of various treatments on the percentage distribution of the cation exchange capacity.
Mean of 8 determinations.

Cations	Desirable range of CEC(%)	Treatment 1	2	3	4	5	6	7
Ca	65-80	59	56	55	56	58	63	86
Mg	10-15	26	29	40	40	27	32	8
K	1-5	7	12	4	4	12	4	5
Na	1	.8	.8	.3	.3	.5	.2	.4
Al	0	5.5	1.3	0	0	2.3	0	0

FIGURE 5: Mean Ca leaf levels (8 trees) from 20 samplings over the period 1977 to 1980.

	Ca %	range %
1	1.22	1.05-1.62
2	1.11	0.71-1.42
3	1.13	0.66-1.50
4	1.14	0.69-1.58
5	1.23	0.96-1.73
6	1.46	1.10-2.10
7	1.52	1.03-2.33

TREATMENT

CURRENT MARKETING STRATEGY IN AVOCADO PROMOTION

N. L. GOWARD
Advertising & Promotions Manager
Committee of Direction of Fruit Marketing, Queensland

It gives me great pleasure to be invited here today to talk about current avocado marketing strategy. Before we examine in depth what is necessary to specifically motivate increased avocado purchasing/consumption, it is wise to review some current Australian consumer attitudes and trends that will either advantage or disadvantage the avocado industry.

We are aware that the 1980's will bring a time of change and a time of consolidation following the surge of activities during the 1970's. The fresh fruit and vegetable industry in Australia now exists in a society that has constantly changing attitudes and it is most important that our industry accepts that consumers are not particularly concerned about the problems, hopes or wishes of this industry.

Over the past few years we have seen considerable changes in ideas, attitudes, technology, labour and education affecting almost every way of life that we have known for the past few years. These changes, of necessity have made an impact on the way we market our produce. It must affect what we say about them, how we say it, why we say it and where we say it.

I would like to comment upon two components of industry marketing:

1. An understanding of consumer attitudes and consumer research findings.
2. Current and future advertising for avocados in Australia based upon such findings.

Let us therefore review some basic consumer attitudes known to us:

Women now represent 43% of the total workforce in Australia and this is growing at the rate of over 1.5% each year. These women are all well educated, they enjoy cooking and are more adventurous about the foods that they prepare at home, than women who do not work. She is the manager of the home rather than the housekeeper and the home is a place of relaxation and enjoyment to her. She is interested in nutrition and committed to what she believes to be important. She also states that children should be given good nutritional food yet she still supports the fast food industry and other foods that are not necessarily in the best interest of her family.

The 1980's will bring a further development as advertising is restricted in certain advertising content. This means we, as an industry, will need to be more aware and responsive to issues of social importance and to make social responsibility evident in all of our activities.

Let us review the consumer attitudes that we know about today:

We know the housewife who makes the buying decisions insists on value for money. She wants more leisure time, has more sophisticated attitudes, more discriminating. She wants more information generally about all types of food, she compares more and she questions continually. It would be very foolish however, for our industry to form an opinion that housewives will continue to buy fresh fruit and vegetables at an increasing rate. This does not necessarily apply because of opposition from other professional marketers. Our products are under attack continually as many alternative food suppliers fight for a share of consumer food spending.

The "in-thing" is to talk nutrition and economical spending but yet at the same time the Australian public is turned on by aggressive advertising from alternative foods. On the one hand we say that people are more interested than ever before in fitness, health, dieting and nutrition, and conversely this means that there are a greater number of products on the market today that have been developed and marketed to cater for these interests. Perhaps, consumers pay lip-service to these issues (as seen by increased, fast food consumption) and there appears little real comprehension about nutrition or more consumers would be turning to fresh fruit and vegetables and not experimenting with refined substitutes such as ''health foods'' and vitamin supplements. Our industry competes against a wide range of products, goods and services, namely:-

1. The processed foods.
2. Fast Foods.
3. Changing life styles of consumers.
4. Consumer indifference.

We cannot assume that Australian consumers will purchase greater quantities of avocados. Recently we researched Brisbane consumer attitudes on purchasing of fruit and vegetables. Weekly purchases varied from $6 to $40 per week per household, with a weekly average of $15. We believe that avocados are low in profile in a typical weekly shopping list.

We must accept that consumers perception of avocados is different. In many cases there is indifference and lack of appreciation for avocados, perhaps we could even comment upon other negative attitudes held:

1. Overpriced - not value for money.
2. Uncertain how to prepare avocados.
3. Cannot tell a ripe avocado.
4. Confusion about varieties.
5. Cannot afford purchasing from already stretched household budget - a very real problem indeed for Australian consumers today.
6. Previous bad experiences with avocados - What about seedlings?
7. Exclusive fruit - not seen to be for the average household.

We know that consumer awareness of avocados is low compared to other attractive family eating fruit; namely, apples, oranges, bananas. Possibly we should emphasize again some

of the strong negative factors in the minds of consumers. Immature fruit reaching consumers via indifferent retailers is a major problem that you face today. There is nothing worse than paying $1.50 to $3.00 per avocado to find that such avocados won't ripen properly and when opened, are black. This by no means excuses an indifferent retailer, because he hasn't possibly done enough to supply good fruit to the public. But again, growers must bear the responsibility for placing avocados "top of mind", amongst Australian consumers.

When we question the buying public we find that avocados are perceived to be very high priced. We also suggest that consumers see avocados as an entree in leading hotels when they go out to dinner, and perhaps not part of household spending.

During September 1981, C.O.D. representatives in Brisbane, Sydney and Melbourne interviewed a cross section of retail outlets; in regards to handling, selling and retailer opinions of avocados. In all, there were a total of

128 interviews made up of:

21% Small Fruiterer/Green Grocer

44% Medium size Fruiterer/Green Grocer

18% Large Fruiterer/Green Grocer

6% Chain/Group Store

11% Food Barns

Let us review some of the conclusions given by the retailers of Australia in regards to avocados.

1. From the 128 retailer interviews some interesting points came out of the research investigations. Let me assure you the information gained from such research is useful for a guideline only because we cannot guarantee a 95% accuracy. Please bear in mind also that this research cost the industry nothing whatsoever and is additional assistance for future market planning.

2. It is obvious that retailers recognise that the expansion of varieties means that the avocado availability selling season extends to 9 months. January through to March is seen as a low spot of avocado retailing.

3. Most retailers are enjoying an upward sales trend in avocados - probably in the order of 25% per annum. It would appear that the Melbourne market is not yet as developed as Brisbane or Sydney it would appear that sales per retailer outlet are lower and the upward sales trend prevalent in Sydney and Brisbane is not as obvious in Melbourne. It has been stated that publicity and associated consumer awareness are the main reasons put forward for the sale increase followed by better prices.

4. Fuerte and Hass are the varieties retailers are most aware of, followed by Sharwil. Edranol appears unknown in Brisbane. Fuerte, Hass and Sharwil tend to dominate in terms of stocking, although Hazzard and Wurtz have some Brisbane support, while Fuerte is clearly the overall best seller followed by Hass, with the exception of Melbourne where Sharwil is a stronger best seller than Hass. It would seem that consumer and retailers stick with the varieties they know, or more correctly, in the case of the consumer, recognising in terms of colour, shape and flavour.

5. Most retailers consider that their customers are unaware of individual varieties. Retailers further suggest that increased sales would result if customers knew more about the varieties of avocados available.

6. 60% to 70% of retailers stated they displayed a range of ripeness for sale.

7. It was mentioned that the retail store Safeways Melbourne, provide their own sticker for avocados. This sticker is about the size of a 10 cent piece with the word "ripe" being black on a fluorescent red background and applied when the fruit is ripe.

I am sure that this concept is particularly good as it reduces the risk of consumers purchasing immature fruit which would result in a poor industry image. In addition, it would appear that similar self-adhesive stickers showing the variety of avocado would assist with increased consumer knowledge. As a majority of retailers consider that increased consumer knowledge of varieties will increase sales it is felt that this practise should be thoroughly investigated on an industry basis. It would also tend to show that each item of fruit has been carefully handled and quality checked prior to being placed on sale at retail level and even has the implied guarantee of grower personal supervision of his fruit.

8. There would appear to be potential for retailers to improve the usage of their cool rooms in assisting their display of varying stages of ripeness as per the retailer information sheet we accept that this concept sounds good, but making the retailers do this is another matter.

9. A large number of retailers in all states perceived their customers having difficulties in judging ripeness.

10. Emphasis on special retail displays would appear to increase the further south sales are made. This is probably because avocados are perceived to be more exotic in Melbourne than Brisbane. Considerable number of retailers always display avocados with tropical fruits, kiwifruit or strawberries.

11. Retailer response to the three items of point of sale and promotional material is extremely positive and enthusiastic. A significant number of retailers, particularly in Melbourne, said they could put further supplies to good use. A large number of retailers suggested that additional recipes for avocado usage be prepared and made available to their retail customers.

12. Although better prices was the overwhelming response to increasing avocado sales the more practical suggestions were publicity to increase consumer awareness, knowledge and in-store tastings to further educate consumers about new ways to use avocados.

PROMOTIONAL, CONCEPT

I would now like to comment upon current and future advertising for avocados in Australia.

Let us examine some of the original objectives of avocado advertising at the start of 1981:

1. Increase awareness and understanding of avocados and make them more suitable in the minds of consumers for regular in-home usage.

2. Educate consumers about increased ways of using avocados with emphasis on ease of usage and simplicity of preparation.

3. Stimulate increased consumer purchase.

4. Reinforce the "something special" image that avocados have in the minds of consumers. We all know that the total advertising budget for avocados in 1982 and previously 1981, is very limited throughout Australia. For this reason the promotional/advertising material that you use, and indeed will use in the future, must be relevant to motivate consumers. All material therefore has to give special emphasis to the following points:

1. Impact.
2. Attraction.
3. Practical in Content.
4. Practical in Format.
5. Cost Efficient.
6. Most importantly the product itself must be hero.

Because of the extremely limited budget in Australia it has been determined to introduce various aspects of promotional marketing for avocados.

1. The promotional point of sale merchandising material is now being used for a second year. This is being done for two valid reasons; firstly, the material itself has had widespread acceptance throughout Australia and we are pleased to say that the acceptance has been at a greater level than most other promotional material published or prepared by the fresh fruit and vegetable industry; secondly, your budget does not allow any change of material at this stage as the cost would erode your budget.

2. You have three distinct promotional components that have proved successful

(a) The retailer education sheet providing on-going education for retailers.

(b) Consumer leaflets presenting an attractive message to consumers. For this reason the same leaflet is being used in 1982 with a change of recipe content.

(c) The existing avocado merchandising point of sale card has been reprinted and is being used during 1982. Again let us be aware of the tremendous interest in avocados due to this merchandising poster. Whilst no specific varieties of avocados are nominated, three separate varieties are shown; namely Hass, Fuerte, and Sharwil.

3. Because avocados are perceived to be an exclusive fruit and apparently out of reach of the average household it is necessary that you stimulate increased awareness and taste sensation for avocados in the minds of consumers. The best way this may be done is by selected in-store demonstrations and taste samplings. Firstly, to acquaint consumers with the taste of avocados if they have not already tried them and secondly, to show new and exciting ways to use this perceived exotic fruit. This type of consumer awareness is necessary in the southern states i.e. Melbourne as most people there have had limited dealing with avocados. During 1981 we did use taste samplings in Sydney and Melbourne with considerable success.

I recall a successful avocado promotional day at Mt. Tamborine in Queensland during the latter part of 1981 when many people tried avocado samples and in many cases they stated they had never tried avocados before.

4. In Brisbane and Melbourne we are able to present television market reports and we present a suitable avocado message wherever possible. We are also mindful that leading Home Economists/Cookery writers do produce articles for national distribution about various fruit items, if they believe that such items are in the best interests of consumers. We have always found tremendous response and goodwill from such ladies who are always prepared to assist in providing an avocado message to the Australian public. This is not to be assumed that we take such leading people for granted far from it.

Our own Nutritionist and Home Economist are both highly qualified in their respective fields. Both are actively involved in avocado promotion not only in media presentations but also public presentations and food recipe concepts.

5. At different times this industry is approached by national food manufacturers who wish to combine advertising activities because such organisations have a far greater budget than your industry. One recent case was a proposal from the H. J. Heinz Co. Melbourne, for a strong campaign in New South Wales to be carried out in conjunction with their canned tuna.

6. It is in your interests to continue aggressive promotion on avocados, bearing in mind that you have limited advertising funds at your proposal. The amounts of funds available this year is a total of $55,000 broken up into the following state allocation.

SYDNEY	$19,440
MELBOURNE	$20,840
BRISBANE	$12,425
ADELAIDE	$2,295

7. You will therefore see that the funds available are very limited in each city operation particularly when we consider inflation is rapidly eroding our advertising dollar, by at least 15% per year.

SUMMARY

To sum up, what I have tried to say to you today is that promotion or marketing of avocados at consumer level is necessary for the very survival of your industry in Australia. You

cannot afford to be complacent and finally you must be mindful of the following basic factors appropriate to successful avocado marketing.

1. The presentation of first quality avocados at retail level.
2. Well-presented retail displays incorporating top quality avocado merchandising material.
3. The hope that market forces permit reasonably priced avocados that satisfy growers, retailers and consumers.
4. Ongoing effective promotion and advertising activities to ensure the survival of this industry.
5. Realistic advertising budgets set yearly to allow for rapidly rising media/inflation costs and to stimulate increasing purchasing habits by consumers for avocados.

An Avocado Field Day Address, Australian Avocado Growers Association, Alstonville, April 1982.

ARMILLARIA ROOT ROT

(*Armilaria luteo-bubalina*)

MR. R. F. DOEPAL, SEN. PLANT PATHOLOGIST
Plant Pathology Branch, W.A. Dept. Agriculture

Armillaria root rot can cause severe losses in young orchards planted on recently cleared areas of forest. The fungus (Armillaria luteo-bubalina) exists naturally on the roots of native trees, including marri, jarrah, karri, tuart,

Banksia and wattle, and can survive for several years on large root pieces of these trees remaining in the soil after clearing. It spreads through the soil by means of black threads (rhizomorphs) resembling shoelaces, which penetrate roots of fruit and other susceptible host trees. Apples, stone fruit and citrus have been the main crops affected on newly-cleared land in the Hills and South-west districts. English walnuts, almonds, Chinese chestnuts, Pistachio and Hazel nuts are also susceptible but there are no records of any of these hosts being attacked Western Australia. Pecans are resistant to infection. Susceptible fruit and nut trees would therefore be at high risk if planted immediately after clearing a timbered area. This risk would be considerably higher if the area is not ripped and cross-ripped so as to bring to the surface as many native timber roots as possible.

SYMPTOMS OF THE DISEASE

ABOVE GROUND: Leaf yellowing, stunting, limb dieback, eventual death.

BELOW GROUND: Rotted roots with white felt-like areas of fungal mycelium occurring as a layer in and immediately below the bark. The rot may extend up to and involve the collar. Badly rotted roots have a characteristic mushroom smell. Clusters of brown mushrooms may develop at the base of affected trees.

CONTROL MEASURES

Before planting new ground:

1. Rip the area thoroughly. Remove and burn all large roots.
2. If possible leave the area 2 to 3 years before planting to allow small roots to rot away.
3. Ensure adequate drainage.

Creamy white areas of fungal mycelium found in and immediately under the bark.

Clusters of brown mushrooms at the base of an affected tree.

Treatment of diseased trees:

1. Remove soil from around butts of slightly affected trees for about two feet exposing larger roots. Cut out and burn all diseased roots and paint cuts with a bordeaux paste (3 : 3 : 4). Leave roots uncovered for several years. Similarly expose the butts of surrounding trees to permit annual inspection for diseased roots.
2. Remove and burn all badly affected trees, including roots.

Before replanting:

Fumigate the replant sites in late summer, when the soil has dried to a depth of several feet with methyl bromide as follows:-

(a) Apply at the rate of 1 kg per 9 square metres under a suitable gas proof sheeting, (0.2 mm outdoor formulation P.V.C.) using a special applicator.

(b) Before releasing the gas, note that this chemical is highly toxic and should be handled with care, bury the sheet edges 30 cm into the ground, and support the remainder of the sheet a few inches above ground level. This will permit adequate diffusion of the gas over the enclosed area.

(c) Remove the sheet two days after treatment. Allow a further two weeks before replanting.

Do not treat the ground closer than 2 metres to surrounding healthy trees.

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: CSIR0 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 la 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 68583, 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 and 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 1J0, 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 Dc 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 2263, 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.

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

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.

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

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

Venezuela: Foundation 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 Nut & Tree Crop Association, 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 AND COMMERCIAL SOURCES

Please notify the Editor of any omissions or errors, especially where WANA TCA members are involved. (+ + indicates WANATCA Member)

WESTERN AUSTRALIA

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

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

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

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

+ + NUTLAND NURSERY, 97 Carabooda Rd, Wanneroo 6065. Plant production, specializing in avocad's, pecans, chestnuts, macadamia, pistachios and others.

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

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

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

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

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

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

VICTORIA

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

BLUEBERRY HILL NURSERY, Cherrys Rd, Toolangi 3777. Blueberries.

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

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.

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.

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

SOUTH AUSTRALIA

BALHANNAH NURSERIES, Balhannah, 5242. Traditional fruits.

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

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

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

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

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

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

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

+ + VERONA PECANS “Kilbeg” Baerami Creek, NSW, 2333.

QUEENSLAND

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

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

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

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

+ + TURNER HORTICULTURAL, PO Box 109, Spring Hill 4000. Grafted macadamias, grapes, tropical fruits.

MEMBERSHIP LIST 1983

896 N Ablett Swan Garden Centre 125 Hampton Rd South Fremantle 6162
104 Abravanti Devi River Rehab Roebourne 12 Starling St Hamilton Hill 6163
138 Accessions ISSN 0312-8989 State Library 102 Beaufort St,Perth 6000
718 P Adams 3 Elizabeth Cres Bunbury 6230
110 J K Adamson 12 Beagle St Mosman Park 6012
788 Mr W J Aitken 6 Wroxton St Midland 6056
412 Mr A A Albuquerque 334 The Boulevard City Beach 6015
104 J Alexandra Tanderra Nursery Mt Macedon VIC 3441
100 J Alitti 114B Crawford St E Cannington 6107
317 Mr A D Allen Hortic.Adviser PO Box 69 Wangaratta VIC 3677
91 Mrs K Anderson 52 Burnside St Bayswater 6053
890 J G Andre PO Box 319 Esperance 6450
377 Mr T D Anthoine ‘Tanridge’ RSM 239 Busselton 6280
50 Mr R Armfield PO Box 145 Wanneroo 6065
923 D Atkins 97 Gooseberry Hill Rd Gooseberry Hill 6076
992 BK & B J Atkinson Kindal Sullivans Rd Valla NSW 2448
930 T B Aylward 112 Birkett St Bedford 6052
841 D Barker Beyond the Black Stump RMB 412 Gidgegannup 6555
351 C Barnard Jandakot Field Nursery 15 Muriel Rd Jandakot 6164
118 Mrs J Barrett 75 Seymour St Miramar Albany 6330
997 D S Bartlett 1 Surfers International Hanlan St Surfers Paradise QLD 4217
905 T G Bateman 4 Lygnern Cres Kallaroo 6025
854 P Baxter 13 Loma St East Ringwood VIC 3135
547 L & A Bazzani RMB 44 West Manjimup 6258
42 Mr J G Bennett 30 Hobbs Ave Dalkeith 6009
910 B Benson 51 College Rd Claremont 6010
93 Bentley Tech School Jarrah Rd Bentley 6102
981 C J & B J Bernacki Farleys Rd Dwellingup 6213
971 B H Bernard Lot 9 Estuary Rd Dawesville 6210
755 J Betts RMB 853 Ascot Lane Tamworth NSW 2340
695 D & K Bicknell RMB 13 Manjimup 6258
450 Biol Abstracts Service, 2100 Arch St Philadelphia PA 19103 USA
747 P W Bird 14 East St Guildford 6055
107 K Bligh 9 Windich Rd Bull Creek 6155
106 J M Blight RNB 237 Beverley 6304
968 Miss S R Boon 1342 Harpenden Rd Huntingdale 6110

106 Dr L Borowitzca PO Box 151 Willeton 6155
103 K J Bossley 70 Blantyre St Katanning 6317
867 W Boucaut Kelmscott Azalea Gdns 41 Roberts Rd Kelmscott 6111
109 T Boughton PO Box 108 Pemberton 6260
889 V J Bourke PO Box 9 Wundowie 6560
817 I N Bragg 698 Yambla Ave Albury NSW 2640
109 0 J Brenkley Tenindewa 6632
420 Mr P F Brinsden 60A Riley Rd Dalkeith 6009
343 D 11 Brown 61 Charles St Northam 6401
813 R Bruce PO Box 49 Nannup 6275
568 M Bruekers 127 Glen Rd Lesmurdie 6076
386 A V Bryant PO Box 45 Balingup 6253
857 B A Bucktin Lot 77 Greenwood Way Barraghup 6210
256 Mr R M Buehrig Scarp Road North Dandalup 6207
109 L Bunker 48 Albany Hwy Mt Barker 6324
963 T W Burleigh PO Box 504 Esperance 6450
819 J A Byatt 8 Edgefield Way North Beach 6020
100 PJ & S P Byfield PO Box 30 Grass Valley 6403
874 California Rare Fruit Growers State University Fullerton Fullerton Ca. 92634 USA
960 A B Camerer Post Office Bolgart 6568
542 Mr N V Carew-Hopkins 'Broadview' Bodallin6424
985 Carlan Nursery 1062 Grand Jnctn Rd Holden Hill SA 5088
883 J Carrington 41 Ross Ave Sorrento 6020
510 Dr G Cartmel 666 Beach Rd Hamersley 6022
720 Central Library Dept Agriculture 3 Treasury P1 Melbourne V1C 3002
731 Central Library CSIR0 314 Albert St East Melbourne VIC 3002
104 Central Library Ministry of Ag & Fish Wellington New Zealand N.Z.
105 F Cerny 60 Muriel Rd Jandakot 6164
934 J K Channer 41 Bombard St Mt Pleasant 6153
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