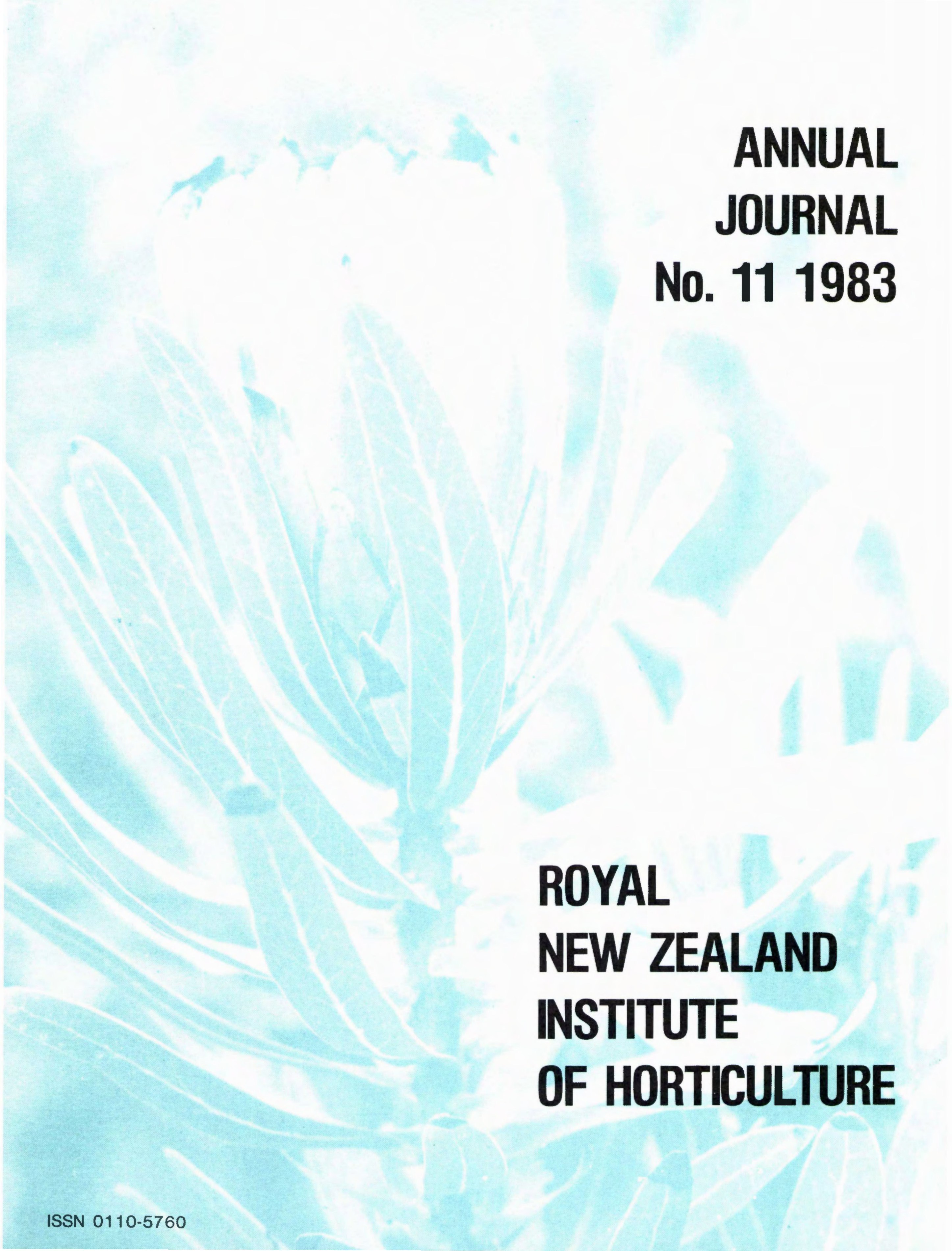

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ROYAL NEW ZEALAND INSTITUTE OF HORTICULTURE (INC.)

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COVER PICTURE

Protea neriifolia. A South African species with salmon to deep rose pink flowers, 125 mm long and 75 mm across. Possibly the most commonly cultivated species in New Zealand gardens. (Photo - Mike Oates)

Contents

The Environmental Role of Amenity Horticulture

by

The Rt. Hon. Dr I. Shearer, Minister of the Environment.

Opening address given to the R.N.Z.I.H. Annual Conference, Auckland, May 1983.

Ladies and Gentlemen,

You have asked me to speak today on the subject of "The Environmental Role of Amenity Horticulture" which I am delighted to do. Amenity Horticulture, I see, is defined as "the use of flowering and foliage plants, trees, shrubs, and lawn for the betterment of environmental values in conjunction with natural and artificial features".

As I see it, you as horticulturists have an important role to play in helping to reverse the massive and continuing loss of New Zealand's native timber species. Since 1840, 11 million hectares, or nearly half of our indigenous forests, have been cleared for farming. Last year, 68,000 cubic metres of native timber was taken from land in private ownership in New Zealand. In the past ten years, over 1 billion cubic metres of timber have been extracted. Every hectare of native forest felled and cleared means a hectare of wildlife habitat irretrievably lost. And what many farmers are doing to the bush here in New Zealand is being repeated on a quite staggering scale internationally.

The world's forests are being felled at the rate of an estimated 18 to 20 million hectares a year. By the year 2000, 40 percent of the remaining forest cover in the world's less developed countries will have gone.

Scientists have warned that mankind stands to lose an immensely valuable reservoir of plant and insect species, species which could provide new foods, pharmaceuticals, natural pest predators, fuels, and building materials.

Take the recent report that two American scientists have identified more than 1,000 plants from South African rainforests which have potential economic benefit to mankind. Tropical rainforests are said to contain at least half of the world's 10 million estimated plant and animal species. So far, man has examined a mere 1 percent of them for their potential benefits.

For example, six plants are known to be used as contraceptives by forest inhabitants in some parts of South America. What potential here for a safe birth-control technique free of the controversy that surrounds the Pill or Depo Provera? Other discoveries include a cure for fungal skin infection, an oil-producing coconut fruit with a high protein content that could be used for feed and fertilizer, a legume high in fat and protein, and a seed which can be used to make soap.

Several important discoveries have already been made here in New Zealand, despite the fact that the pharmacology of our native plants is still in its infancy. Solasodine, a raw material for more advanced steroids, has been extracted commerically from the native plant poroporo. Steroids with the ability to affect the lifecycles of insects have been extracted from our native conifers. A painkiller called pukateine has been extracted from the New Zealand laurel tree. A Canterbury University team has succeeded in isolating antibiotic compounds from the leaves of our native seven-finger and red horopito. This research has now attracted the interest of an international drug company. Chemical compounds with potential as laxatives and diuretics are also known in many species of New Zealand hebe and its relatives. Many of our poisonous plants are likely to yield useful drugs, among them tutu, titoki, karaka, kowhai, and the giant New Zealand tree nettle, ongaonga. A long-acting local anaesthetic present in this nettle is currently being investigated at Otago University.

Some 85 percent of New Zealand's forest plants are native to this country, and together they constitute a rich and varied genetic resource. That resource is a powerful argument for applying a conservation-at-all-costs approach to our diminishing reserves of lowland indigenous forest. Biogenetic engineering and gene splicing technology are developments which have great significance for horticulture in terms of their potential to supply an exploding world population with food, fibre, fuels, and pharmaceuticals. Preserving our remaining native forests preserves a potentially valuable gene pool.

Put simply, you don't know what you have lost until it is gone!

Basically, I am talking about the development of a land ethic - an ethic of wise land use and management today which guarantees the survival of all forms of life tomorrow. This seems an ideal opportunity to speak about the BEAUTIFUL NEW ZEALAND project, and the need to preserve and expand wilderness areas in the New Zealand countryside. The Advisory Committee states that projects to improve New Zealand landscape may be put forward by individuals, community and service groups, local authorities or Government bodies. Chief amongst its concern are that a specific project should clearly improve the urban, rural, or natural landscape; that it should be associated with a main tourist route; and that it should help create jobs for the unemployed, or promote skills leading to potential longer-term employment. The guidelines include this statement about planting in rural areas.

> "Emphasis should be placed on the functional value of planting. Tree shelter belts, farm forestry plantations, soil and water conservation planting, all activities funded by Government, should be co-ordinated with planting under the Beautiful New Zealand scheme at the district and regional levels."

My argument is that Beautiful New Zealand should not be simply a State programme. It should involve the nation's farmers in a co-operative exercise to provide this country with more diverse landscapes. A trip up the length of the North Island, for example, provides graphic evidence of the impact of 100 years of commercial farming on the New Zealand landscape. We see a rural landscape which is often monotonous. Hundreds of acres of green grass dotted with white sheep may be of particular pleasure to the Japanese tourists who seldom see sheep, or to the Australian tourists who seldsom see green grass, but to the three million New Zealanders, it is not visually exciting.

In many areas, the pressure to extract the last dollar from every bit of land available has produced hillsides denuded of vegetation; bare paddocks penned in by barbed wire; eroded, sterile landscapes almost devoid of native birds and animals. Adding their quota of visual pollution to the New Zealand landscape are the myriad crumbling concrete and wooden buildings which were once cowsheds, piggeries, implement sheds, and the like. I would like to see farmers demolishing decrepit and unwanted farm buildings, or at the very least planting groves of native and exotic trees around these visual "disaster areas". I would like to encourage farmers to plant trees, shrubs, and hedgerows in profusion along road edges and right across their land. This will enhance both the visual appeal and the commercial value of their properties, and very importantly it will provide new habitats for wildlife. Farmers may say: What about the cost? My answer is that a replanting programme could be done at minimal cost. Existing catchment authority subsidies for erosion control could possibly be used to help plant more trees. At the same time, local nurseries could be encouraged to supply quality plants that fit well into the rural scene. Local tree crop societies could also be asked to contribute. Competitions organised by local authorities or Federated Farmers could be held for the "Farm with the Best Road Frontage", and extend beyond this to the "Best Farm Layout". Farmers may also say: It is only 20 or 30 years ago that I won this land from the bush, and now you talk about putting it back! My answer is that what they have done has been done at a cost. A cost to generations to follow in potential erosion and loss of wildlife habitat. However, there is a growing trend in rural communities towards balancing productivity and maximum commercial return against the conservation of areas of native bush. What we need is a partnership between the State and farmer "free enterprise" to beautify the New Zealand countryside.

But farmers can make an even more effective contribution to a Beautiful New Zealand by preserving areas of native forest on their land instead of clearing them for grazing. The figures for the clearance of native bush on private land show the dimensions of the problem. The positive news is the many farmers who have voluntarily placed remnants of native bush under covenants administered by the Queen Elizabeth II National Trust. I also understand that the Farm Forestry Association has committed its 3,200 members to increasing tree planting from 8,000 plus hectares next year to 16,000 hectares a year by the end of the decade. The dominant interest is in diversifying production, but amenity planting is very much part of the Association's aims. Eucalyptus, Tasmanian Blackwood, Chestnuts, and Pecans are some of the exotic tree species being planted with both productive and amenity values in mind.

In sum, I am asking our farmers to reverse the process of destruction - to plant for wildlife, for erosion control, to preserve a valuable genetic resource, to enhance the beauty of the New Zealand countryside. Remember that tourists travel to this country not to see hydro dams, irrigated paddocks, pine forests, and cities. They come in the main to see New Zealand's mountains, forests, lakes, rivers and the unique wild creatures they contain. They come to see all the natural things about this country that pollution and congestion are denying them in their home countries. Returning the "wilderness" to our countryside will both enhance their experience of New Zealand and our ability to attract the tourist dollar. It will also increase our own pride as New Zealanders in a unique and beautiful country. With the right will, there is no reason why we cannot match the superb colours and contours of the English countryside which have proved such a magnet to so many Kiwi and foreign tourists. There, centuries of careful landscape management in rural areas has created a beautiful and harmonious blend of towns, villages, fields, and forests. The evidence of man's loving care for an ancient land.

In conclusion, I would like to point to one personal contribution to the cause of landscape improvement in New Zealand. That is the appointment of Dr Tony Jackman to the Biological Resources Centre of the DSIR to help develop a national landscape inventory. It was upon my initiative that Dr Jackman was encouraged to return to New Zealand rather than accept some very lucrative offers made to him in the United States. I know that the contribution he will make to New Zealand as a result will be impressive and long-lasting. Dr Jackman will use computer techniques to identify outstanding New Zealand landscapes that should be preserved for their environmental or tourist potential. The computer, wisely used, thus becomes an effective tool for the landscape planner in the same way that the paintbrush was for those early New Zealand painters Heaphy, Fox, and Barraud.

It remains only for me to reiterate an earlier point on the role of your profession. Amenity horticulture, and you as practitioners of the art and science of horticulture, have a significant part to play, both in improving the visual appeal of the New Zealand countryside and in helping create new habitats for our unique wildlife species. I look to your expertise for help in protecting, conserving, and enhancing this land of ours.

On that note, I have much pleasure in declaring this Royal New Zealand Institute of Horticulture Conference officially open.

A New Commercial Crop, The Pepino (*Solanum muricatum* AIT) and Suggestions for Further Development

by

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INTRODUCTION

The Spanish were responsible for the exchange of many plants between Europe and the Americas. The cucumber was taken from the Old World to the New. In the New World the South American Indians introduced the Spanish to the fruit from the plant, *Solanum muricatum*. The Spanish finding this fruit similar, although sweeter than the cucumber, named it 'pepino'. Pepino is also the Spanish name for cucumber.

Naming plants after existing similar plants is not unusual. The Americans have called *Solanum muricatum* both the "Melon Shrub" and the "Melon Pear". This practice only serves to confuse plants with each other and retards recognition of each plant's own virtues. The local names for the pepino in Bolivia, Peru and Ecuador are "Cachuma" and "Cachum" in the Hymara and Quecha languages. *Solanum muricatum* is thought to have originated in Peru but it had been disseminated within Central and South America by the time of the Spanish arrival. (Fig. 1)

Botanical descriptions and studies of *Solanum muricatum* occurred with its importation to France and England. It was at the Royal Botanical Gardens Kew that Aiton (1789) described and named the plant *Solanum muricatum*. There are much later reports of the plant being grown in the U.S.A. in the 1880's and the Canary Isles in the early 1900's. During this current century occasional interest has been shown in the plant outside of South America with reports of cultivation in Morocco (1955), Spain (1974) and in recent years New Zealand.

The pepino was first noted in New Zealand by the D.S.I.R. in 1942. However, this plant material had probably been in the country for a few years prior. Crooks (1982) reports that Yates advertised the plant in their seed catalogues in the late 1930's. In 1973 further seed introduction was made after a visit by S.N. Dawes, D.S.I.R. to South America. This seedling population generated the first series of New Zealand plant selections, in particular "Miski". It is probable the Lincoln College selections and 'Golden Litestripe' are also of the same background. Since 1973 there have been further introductions of both seed and rooted cuttings of South American cultivars.

The published literature on pepino is rather uneven. Many of the references to pepino refer to pest and disease incidence where the pepino may act as a host plant. The botanical studies tend to refer to various members of the Solanaceae family including pepino. Vavilov (1951), who is generally known for his theories regarding geographical centres of origin, pointed out that "the high mountains of Peru, Bolivia and Ecuador are full of endemic species". In a list Brucher (1968) again referred to the genetic reserves of South America. He stated among the Solanaceae wild varieties of *Solanum muricatum* could be improved by breeding.

The identification and description of pepino as an endemic plant in South America occupies part of the two treatises on the historical and geographical occurrence of various Solanum fruits. Patino (1962) reviewed the historical records of *Solanum quitoense*, (naranjilla), *Solanum topiro* and *Solanum muricatum* (pepino). He noted the

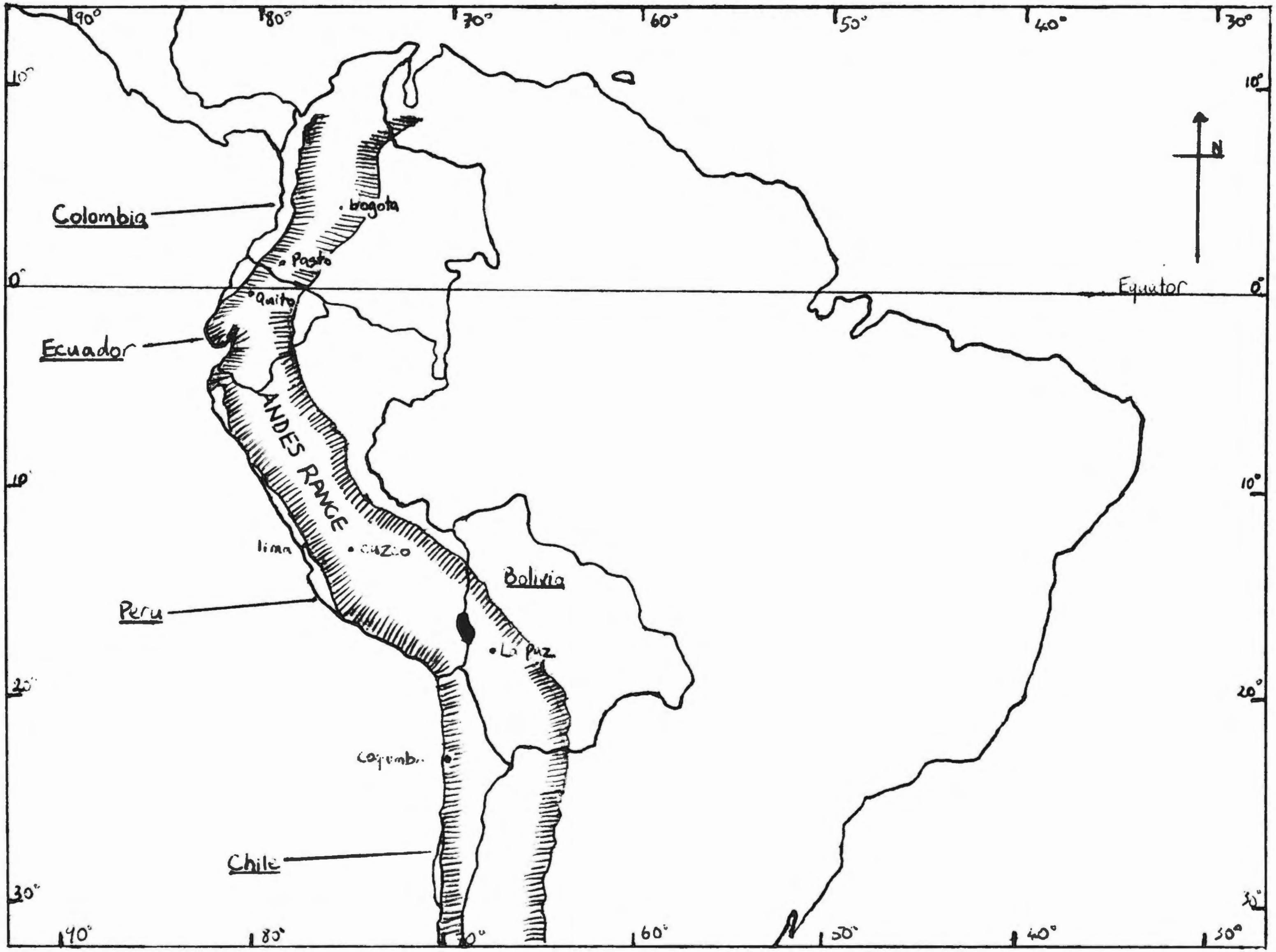

Fig. 1: Extent of pepino (*Solanum muricatum*) occurrence in South America in the 1550's.

places where the fruit was encountered by visitors to South America. Schultes and Castaneda (1962) noted the occurrence of various edible Solanum fruiting plants in Columbia including the pepino. Both authors make comments on the lack of appreciation of the pepino despite its acceptance and use by people in South America.

The origin and the variability within the species including cultivated plants was discussed by Heiser (1964). He observed fruit in the Ecuadorian fruit markets. He noted that in the marketplace there was a wide overall variation in pepino size, shape, colour and seed content. However, individual stalls had fruit of uniform character. By deduction it would suggest that the fruit came from different plots with different mother plant origin. Most of the pepino propagation in Ecuador is by vegetative means. Heiser noted that when he grew seedlings from fruit purchased in the Quito market the variation between seedlings from the same fruit was considerable. This variation in plant and fruit character has important implications regarding the future development of the pepino.

The heterozygosity (i.e. mixed genetic composition) allows considerable range in character selection. There has been little market consensus regarding desirable traits for selection. As a consequence the pepino does not have a standard appearance.

The prospects for pepino as a developed commercial crop have been considered in a number of papers from countries such as Chile, Morocco and Spain. The Dutch have also considered growing the pepino as a glasshouse crop (1951). In 1955 Chapot reported that a small planting in 'Souss a Inezgane' had made sales to markets in Morocco, France and England. A more recent European experience was reported on the Malaga coastal plain de Seidel (1974). Both reports seem to be of isolated incidents and one can presume that although the pepino may occasionally appear in the markets in France and West Germany the supply of the fruit originates from outside of European and Mediterranean region. In a recent publication from Chile an economic appraisal was made of pepino production. Endt (1982) also refers to Chilean production but makes no reference to export from Chile. The Chilean article suggests that pepino export to California and Europe does occur.

It would be the New Zealand media that has talked most about pepino as a commercial crop. Reports have fluctuated in optimism, for example "Future of Pepino in Good Hands", New Zealand Herald 5/3/82; "Good Market for Pepinoes", Christchurch Press 16/4/83; and "Markets not yet developed", Horticulture News November 1980; and lastly "No assured sale for new fruit", New Zealand Herald 17/10/80.

A certain amount of caution about the pepino's prospects should be observed. Trial work indicates that the pepino plant, as a crop producer, can be further developed. Cropping systems have not yet been investigated in depth. Lastly markets are not yet stable in their reaction to fruit sendings. The question in the headline "The pepino: a garden curio or a new 'king kiwi'?" New Zealand Gardner, August 1982, is not unreasonable. The kiwifruit developed from being a curio in Mr Allison's garden in Wanganui. That was in 1906.

PLANT DESCRIPTION

The pepino is a free standing bush but tends to spread and sprawl outwards. It is a frost sensitive perennial with a woody base and fibrous roots. A mature bush may be 90 cm high and 120 cm wide. Several stems may arise from the plant base or axillary positions on the main stem. Rooting on soil contact is common.

Leaf size, shape, and conformation varies between selected strains and plant age. Simple leafed forms may have leaves up to 15 cm long and 4.5 cm wide. Compound leaf forms are odd pinnate with 3 to 7 leaflets. Plants that are simple leafed when young may later produce lobed or pinnate leaves. Correl (1962) classified the pepino into two types: *S. muricatum* simple leafed, and *S. muricatum* var. *protogenum* compound pinnate. Seedlings from self pollinated fruits have exhibited either leaf form, thus the distinction may be arbitrary. The simple leafed forms seem to be the usual cultivated form in

Chile according to visitors to Chile. Correl (1962), Brucher (1968) suggest that simple leafed types have been subject to most domestication pressure.

Flower production is pseudoterminal. This means that like the tomato there is a stem continuation beyond each flowering truss. There is also a strong lateral growth in the leaf axil immediately prior to the flowering branch.

The flowering truss is a leafy branch. There may be up to 12 flowers present. The petals are fused to form a flower face up to 4 cm in diameter. They may be purple or white marked with purple. The hermaphrodite flowers contain an erect ring of yellow anthers surrounding and below the stigmatic surface. This exerted stigma is known to cause fruit set problems in tomato and may do so in pepino.

The fruit is botanically described as a berry. It is variable in size, shape and locule number, two or three locules being common. Large fruit may be up to 18 cm long and 8 cm wide. A more usual size is 10 cm long and 6 to 8 cm wide.

The fruit shape varies from round globose shapes to egg and pointed tapering shapes. In the ripe fruit the skin background colour may be creamy to yellow orange. Purple, grey or green striping or blush colourations on the skin make the fruit distinctive in appearance.

The flesh is yellow and sweet to taste. There is a melon-like flavour. In some selections there may be a slight astringency and after taste, particularly in fruit not fully ripe. The Vitamin C content is similar to some citrus at about 35 mg Vit. C/100 gm. Refractometer tests for sugar have given high values of up to 16% Brix in some Auckland produce. A level of 6-10% Brix is more commonly attained in field grown fruit. The acidic character decreases with maturity.

The fruits have been tested for tannin and alkaloid content. Little or no presence has been noted. The fruit flesh softens with ripening. The flavour components have not been identified. It has not been possible to provide a convenient measure of ripeness to date other than using fruit colour.

There have been many observations of seedless pepino fruit both in New Zealand and South America. A parthenocarpic fruit mechanism would tend to support the view that the pepino is self sterile. Heiser (1964) suggested that cross pollination between genetically different plants was necessary for good fruit set as well as seed. Brucher (1968) reports finding self sterility. Heiser also reports low viability in pollen in many plants. However, the Lincoln College selections have had high pollen viabilities even after mutation exposure.

Poor fruit set has been reported in South America and New Zealand. The South American reports infer that the cause is self incompatability between pollen and ovules. New Zealand experiences indicate a more complicated condition. Firstly, pollen release may be poor in some conditions. In the glasshouse the vibrator methods used for tomato fruit set increased fruit set for the first pepino truss in an experiment in Levin. Secondly, pollen viability and longevity may be variable with temperature, moisture and other environmental conditions. Fruit set can be erratic in a crop with some periods being more conducive to fruit set than others. Fruit set variation is also observed when clonal selections are grown in different New Zealand localities. Thirdly, the pepino appears to regulate crop load through fruit size, and fruit number. The latter is controlled by both fruit set and fruit abscission. Experiments at Levin and Lincoln have shown this mechanism at work. The vibrator treatment in the glasshouse did not maintain a yield advantage after the first truss relative to the control, nor did a manual brushing pollination treatment (see Table 1). At Lincoln bagging flowers for differing clones to check self fruitfulness did reduce the number of trusses with fruit. The reduction varied for the different clones. However, where the bagged trusses carried fruit the number set per truss appeared to be higher than the number set on trusses without bags.

The variation between clones in both phenotype and performance indicates a considerable genotype range. Brucher (1968) states polyploids exist and Dr Fautrier believes that he has produced a polyploid with colchicine treatment. The chromosome

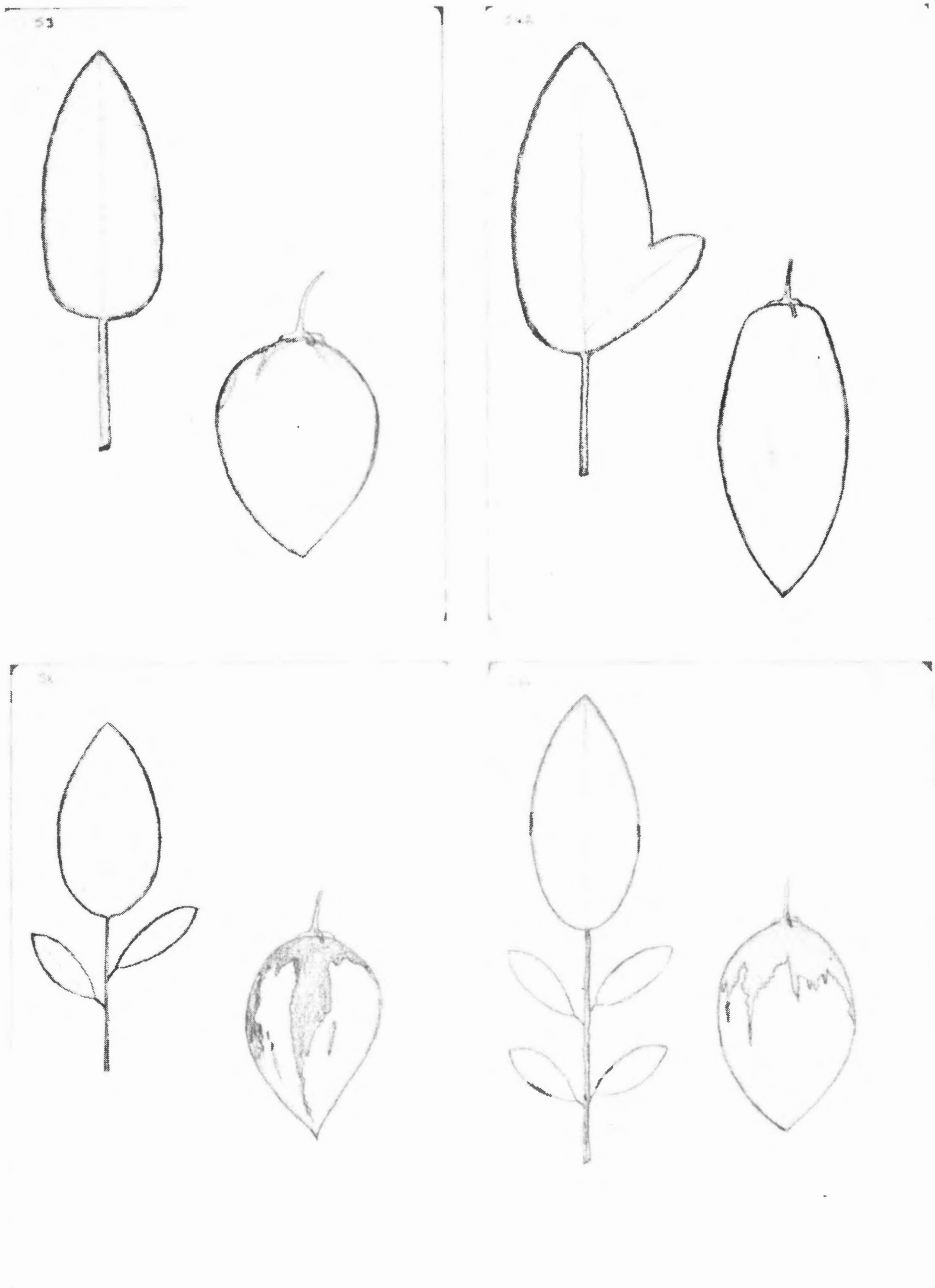

Fig. 2: Drawings of leaf and fruit characters of four seedlings derived from a self pollinated flower of the pepino cultivar, Lincoln Gold. Note the difference in leaf configuration and fruit shape. Drawings by J. Restieaux.

TABLE 1: The effect of pollination enhancement treatments to increase pepino fruit set on successive flowering trusses.

Treatment	Mean fruit number per truss			
	Truss 1	Truss 2	Truss 3	Truss 4
Control	2.0 b	2.1 ab	3.4 a	7.5 b
Vibrating flowers	6.0 a	1.1 b	2.0 a	9.1 ab
Brushing flowers	7.2 a	1.6 ab	3.0 a	11.8 a

Burge, G.K. (1982)

number of the diploid is 2n = 24. Another related species *Solanum caripense* has the same number. Heiser reports a successful hybridisation with *S. muricatum* as the mother plant. *Solanum muricatum* may have introgressed in the wild with *S. caripense*. Other natural hybridisations may also have occurred.

The heterozygosity in pepino plant material is such that seeds out of self fertilized fruit produce seedlings that are extremely variable (Fig. 2). Very little vegetative vigour loss has been noted in three generations of selfing of the cultivar Lincoln Gold. The creation of new character combinations in pepino seedlings can be screened to look for improvements on the existing clones. As selection for locality and agronomy conditions in New Zealand has a short history, this screening of a seedling population is still likely to produce improved cultivars.

PEPINO GROWING

a) Fruit Yields

The pepino is grown as an open ground crop in South America. In Chile 417 ha was reported under cultivation (Lizana and Levano, 1977). The introduction of pepino into New Zealand was with the same open ground conditions in mind. Most New Zealand investigation has been in-field trials.

The yield production pattern of pepino shows that simultaneous flowering and fruiting may occur. An observation trial was conducted to describe plant habit with the cultivar Lincoln Gold. After 72 days in a hydroponics system the typical plant had three trusses with fruit, and in excess of seven lateral growths either carrying or of sufficient length to carry flowers or fruit.

Lizana and Levano commented that 80 fruit/plant could yield up to 100 tonnes/ha in Chile. Aglink HPP208 reports that Levin pepino plots in 1978 yielded between 40 and 60 tonnes/ha. Extrapolating plot yields at Lincoln in 1982 gave approximately 80 tonnes fruit/ha. However, the Lincoln yield included green and ripe fruit. In Canterbury the open field season ends with the majority of fruit still green. Although green fruit can be consumed if cooked as a vegetable it has no real market value. Commercial growers in Canterbury in the difficult 1983 season marketed between 1.5 to 3 kg of ripe fruit/plant (15-30 tonnes/ ha). The percentage of non marketed green fruit was very high, when the autumn frosts enforced an end to fruit cropping. Obviously the full expression of set fruit into ripe fruit is of considerable importance. Treatments designed to ripen green fruit is one approach to investigate. Cropping under cover to nullify the seasonal nature of field cropping is the other approach.

b) Propagation

The propagation of pepino is simple. Significantly most of the reports about

South American pepino growing mention that cuttings are used for plant production. There is even an inference that field production may be commenced with the placement of non rooted cuttings straight into the field. Simple cutting techniques work and enhancement treatments may not be absolutely essential. Nevertheless at Lincoln we have found a successful procedure is to take young softwood stem pieces, about 8 cm long with a terminal shoot or prominent axillary bud. These are lightly dusted with 1% IBA rooting hormone (softwood grade) and placed in a very free draining media, e.g. sand or pumice under mist, with bottom heat thermostats set at 22°C. Rooting takes place after 3 to 5 days but we delay potting up until the cuttings are firmly rooted at about 10 days. The rooted cuttings are potted into PB$\frac{3}{4}$ in a peat, bark, sand mix with a complete fertilizer dressing. They are kept for about four weeks in a glasshouse and then hardened off before field planting. We prefer planting out well grown plants in the field rather than using newly rooted cuttings.

At Lincoln we can keep mother plants for propagation purposes for considerable lengths of time. The mother plants must be selected carefully. They should be virus and disease free. With occasional hard pruning we produce softwood shoots for cuttings. We prefer to grow long lengths of shoots to make into cuttings, rather than regularly strip off young emerging shoots every four weeks.

It is possible to adopt tissue and meristem culture techniques for pepino propagation. Leaf discs will form callus and these can be encouraged to proliferate shoots (Owens y de Novoa, 1983). Whether these techniques have commercial value when cutting techniques appear efficient, has yet to be proven.

Seed propagation is not difficult but the new plants will not resemble their parents. Each seedling is likely to be very different from every other seedling. This is because the plants are very heterozygous. However, if seeds are to be used then we have found it best to first remove the seed and placenta from the fruit. Then we separate the seed from the fleshy tissues, and wash and dry the seed clean. Before sowing we refrigerate the seed for 48 hours. We suspect that the refrigeration treatment satisfies an after ripening mechanism. The seed germinates readily, we treat it like tomato seed.

c) General Culture

The time of planting must be chosen for the length of the frost free season, and last spring frosts. The earliest time for plantings without protection in Canterbury is early November, at the same time as tomatoes. With frost free protection and extra warmth, planting could be earlier. Early planting may be best in other warmer New Zealand regions. This would allow flowering and fruit set to commence before summer temperatures are at their highest. In Northland pepinoes may be better grown as an autumn, winter and spring crop.

Estimates of growing degree day requirements have been made, but more investigation is required. Using a GDD base temperature of 10°C we estimate between 900-1100 GDD units are required for plant growth and cropping. Fruit ripening may take between 700-900 GDD units. From our observations we believe that there is some variation in cultivar requirements for GDD.

The plants will spread during growth and a 1 m square spacing may not allow movements between plants. Spacing can be varied with wider between-row spacing for access and closer in-row spacing to get rapid plant cover on the ground or trellis. Pruning may help keep plants in check.

Early root growth should be encouraged. The roots are fibrous and relatively shallow. They respond well to warm soil temperatures, ample moisture with good drainage, and open loose soil. Black plastic mulches may be useful but although early growth and earlier ripening was observed, yields did not appear to be particularly higher in a Lincoln College investigation. Ridging treatments have also been considered. The fruit gets reasonable light exposure hanging on the ridge, and early plant growth appeared to be enhanced. However, final yields were not noticeably higher than planting on the flat. Ridging may be a complication if trellising is also used.

Irrigation is important for plant establishment. It is probably also important for fruit set. However, the plants do show tolerance to water stress and recovery of vegetative growth even if yield depression occurs.

Attempts in 1981 to assess fertilizer needs in a Lincoln College field trial were not conclusive. In the absence of specific recommendations for pepinoes we have used tomato fertilizer recommendations with no proviso. We have noted strong nitrogen response and overproduction of vegetative growth. Therefore we generally restrict nitrogen nutrition to a base dressing only.

The full grown pepino canopy will smother many annual weeds. However, the young plants are not tolerant of weed competition especially perennial weeds. Rhizomatous grasses such as twitch are particularly aggressive. A weedfree plot should be prepared for planting, hand weeding may be needed subsequently. Herbicidal trials are being evaluated. Pre-transplant application of Trifuralin and post-establishment spraying with Metribuzin may give some control of weeds.

Some growers have adopted trellising in an effort to produce fruit with a clean well-coloured skin. The disadvantage of trellising is the cost and effort. The plant needs some pruning to get it to conform to a trellis approach. Where growers have used the tomato trellising techniques that use strong end posting and double wires to hold the plants in a hedge-like manner they have also pruned out the weakest basal growths. This helps in producing stronger upright stems that can then be held in place with the wires. Thereafter a minimum of pruning is practised.

At D.S.I.R., Riwaka, another training approach was investigated. A Y shaped low trellis to hold the plants from the ground was used. However, this was reported to have not succeeded. A further approach may be the use of single stem plants. This is mentioned later (future prospects).

Early investigations in Canterbury encountered very little pest or disease problem. Nevertheless, the collected bibliography has a preponderance of reports concerning the pest and disease nature of the plant. Workers in New Zealand and overseas have reported virus infections, some of the isolated virus particles may even be new virus discoveries. Canterbury field crops have not suffered major disease infections although *Phytophthora infestans* (late blight) and sclerofina have been noted.

The main problems have been with pest infestations. White fly, aphids, and two spotted mite have been present in the glasshouse. In the field there have been problems with two spotted mites, looper caterpillars, potato tuber moth and poroporo stemborer moth (*Sceliodes cordalis*). The latter two moths have larvae which bore into the fruit making the fruit unsaleable. The calyx end of the fruit is a common point of entry. It is possible to monitor the adult flights beginning in about January for population build up, which can be swift. Azinphos-methyl has been used to control the fruit boring larvae with a 10 to 14 day protection period.

d) <u>Fruit Harvest and Use</u>

Chapot (1955) described the fruit as having the flavour of a melon, being very sweet, and having a distinctive smell.

The fully ripe fruit has an orange yellow skin colour. This is the preferred appearance for most buyers and this is probably the best stage for eating. The fruit may also have a purple skin striping or blush. The purple pigmentation is light induced and is less likely to be found on fruit sheltered under the bush canopy. The additional purple colouring adds appeal to the fruit's appearance.

Other characters beside skin colour have been considered as indicators of the fruit's ripeness and eating qualities. Fruits that are not orange yellow may still be edible as fresh fruits. Green-yellow and even light green skinned fruits may have a light lemon yellow flesh. However although edible these fruits are not usually the best flavoured. Significantly the reports from Chile recognise this because fruits are picked green as well as yellow and ripe. The green fruit are then store ripened off the plant before sale.

At Lincoln College we have attempted to determine how to ripen harvested green and partially yellow fruit and how to enhance the condition of yellow ripe fruit. We have found that skin colour can be altered while keeping the fruit at high temperatures but desirable levels of firmness, sweetness, acidity and flavour have deteriorated. Alternatively we have found keeping the fruit at a lower temperature of 10°C tended to enhance the eating quality of the ripe fruit but for the partially ripe and the green fruit the skin colour change was variable and usually insufficient for market purposes. This partially ripened fruit was also of poor eating quality. Our experience suggests that the fruit should be kept on the plant as long as is practicably possible. Williams (student thesis unpublished) considers that the soluble solid levels in the pepino are mainly derived from imports of sugar from the leaves to the fruit. This is different from apples where fruit starch levels are hydrolysed to produce the sweetness associated with ripeness. Keeping the fruit on the bush as long as possible may improve both fruit colour formation as well as soluble solid levels.

Unfortunately the fruit bruises easily when ripe and fully yellow. Finger markings show up easily. Harvesting must be done carefully. Fruit with good colour does have a shelf life of up to two weeks and at 10°C this may be extended for at least one month. The author believes that the acidity decrease in ripe fruit, held for four weeks at 10°C, actually improved the eating qualities! Freezing of the fruit will occur if it is kept at -1°C or lower, depending on the soluble solid content. According to Lizana and Levano (1977) some chilling injury can occur at temperatures of 0°C to 3°C. However, we have kept fruit for short periods in household refrigerators for one or two weeks without a significant deterioration in appearance.

The development of a new crop requires the development of both crop agronomy and the marketing of the product. New Zealanders are not familiar with the pepino as a market and household item. Several people have been approached to investigate the uses of the product. Mr Kesseller, Chef Tutor at Christchurch Polytechnic, considers that the fruit is extremely versatile, and notes it can be used in a menu as an appetiser or starter, as part of an entree or main dish, or as a dessert. He has used the fruit frozen, jellied and in a dried crystallised form besides using it fresh. It is possible to can or bottle the fruit. Home recipes for jams and relishes have been sent from various correspondents. The rather bland flavour is enhanced if the sugar level is fairly high. The fruit blends well, particularly with slightly acid fruits. Lemon juice is a useful additive to the fruit as it also hinders oxidation and browning of the cut surfaces of the fruit.

Crop producers have been encouraged to present their fruit as attractively as possible. A uniform tray presentation and the inclusion of information leaflets have been some of the marketing measures adopted by Canterbury growers. Turners and Growers (Auckland) have exported fruit and prepared an information card with an attractive picture to go with their consignments.

THE PROSPECTS FOR PEPINO CROPPING

The recent sales of pepino plants and fruit in New Zealand, indicates an awareness of the plant. The question is whether this is a temporary curiosity or a permanent interest. It depends on how the public rates the merits of the plant and product they presently know. Yet the pepino they presently know need not be the pepino that could be made available in a few years time. An examination of the plant and fruit shows that if nothing else it is very versatile. The fruit may be used in many ways, it can yield heavily, and the form of the fruit and plant is variable. A low level of selection pressure has been applied and further plant improvement is possible. Improvement should be possible as there is a wide genetic range because of the heterozygosity of the plant.

A choice then presents itself. Should further development be made to enhance the existing distinctive features of the pepino? Alternatively, should the development attempt to initiate another plant and product

Pepino cultivar Lincoln Gold and tomato.

Pepino cultivar Lincoln Long and tomato.

Fig. 3: Pepino (*Solanum muricatum*) and tomato plants maintained by lateral pruning as single stem fruiting plants.

that is popular and well known?

Fruit sales, both in New Zealand and overseas have been of the fresh ripe product. There have been many comments that the pepino resembles a melon in flavour. Should the subterfuge be taken further? It would be possible to produce a fruit of similar size, shape and sweetness. However, the distinctive appearance of the fruit could standardise as a yellow fruit with purple stripes, smaller than a melon, and slightly pointed. Is market distinctiveness better than similarity? The versatility of the product means that a substitution for a melon in a recipe is not the only option. The salesman will have to decide on which appearance and which end use to try and sell in the market place.

Similarly the approach to growing the crop has several choices. In culture there is a similarity with other solanaceous plants, particularly the tomato. Should the plant be grown as a free standing bush with its natural habit of growth and fruiting matched to climate and agronomy? The plant could be grown as a trellis supported and pruned crop, under cover or in the open. The latter option immediately suggests the application of tomato technology. Two comparative measures of success become appropriate. How well did the crop perform as a pepino or how well did the crop perform as a tomato style crop?

There are advantages to adopting tomato style agronomy. First of all it is easy to instruct prospective growers as tomato growing is understood as a concept. Secondly we can use materials, perhaps with slight modifications, that are used for tomato. At Lincoln College we have grown the pepino as a glasshouse crop, training it as a single stem plant, capitalising on the regular production of flower trusses from a central stem. The fruit appearance and yield was good and compared favourably with some tomato plants grown alongside (Fig. 3). However, we did not get a fruiting continuity in the pepino because fruit set was retarded after heavy fruiting on the lower trusses. To continue this development trend we have to produce a pepino plant that suits tomato technology.

The central issue to the development of the pepino as a commercial crop is genetic selection. As the plant is highly variable in character the options are not restricted. The problem is the reverse, what should be the criteria for selection? Is the pepino to be a tomato style crop bearing melon flavoured fruit, but looking like pointed ostrich eggs with a yellow skin and purple stripes? Would the gardening public prefer a bush smothered with plum sized, yellow-orange pepino fruit that are seedless, thin skinned, sweet tasting without any astringency? Given time the pepino could be anything to anyone. The tomato took centuries before it gained its present day world wide reputation. Linnaeus coined the word "Lycopersicon" inferring it was poisonous! The pepino prospects, taking on historical precedent, may be bright, but the change from curiosity to familiar crop may still be some way in the future.

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Teaching Plant Identification Skills

by

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Plant nomenclature and identification have always been difficult areas for those involved in training practical gardeners and nursery workers. The reason for this is that both skills find their roots in botany - essentially an academic subject - yet have to be applied in the park or nursery in a practical manner.

The problem has always been a prominent feature in the nursery stock industry, but has become more evident recently as formal proficiency tests at craft level make plant identification a compulsory part of the candidate's assessment in Britain. With this in mind the Agricultural Training Board has developed training techniques which embrace both the academic and practical aspects of plant identification and treats them in a manner which the trainee can readily relate to.

Traditionally the Agricultural Training Board has been responsible for practical courses in budding, grafting and other skills which can readily be equated with increased productivity. Not so plant identification, for it is only the far-sighted who can appreciate the potential benefits to their staff and business, and these people are mostly nurserymen. The frequent comment of garden centre operators is that if the nurserymen get the names and labels correct, the garden centre has nothing to worry about. A very sad state of affairs.

Producing a practical course on a largely academic subject is fraught with difficulties and the original concept was altered with experience. However, the Agricultural Training Board is now satisfied that the course is as near perfect as it can be, given the nature of the subject. Indeed, it is now a national course and aids and references are being prepared for use in colleges as well as individual holdings.

The major difficulty in devising the six hour session has been to keep the full attention of the trainee. Constantly resorting to the blackboard, particularly at craft level, is self defeating. So trainee involvement has been a prime consideration and the liberal use of live plant material has proved to be essential.

Two levels of course have been devised, only differing in their complexity. One for horticultural managers and supervisors, the other for nursery workers. In this article, I am going to describe the supervisory course, as the craft level course is merely a much reduced version of this.

No more than twelve trainees should be assigned to one instructor and the target population for the course should have been clearly defined at the outset. Unlike many of the practical horticultural skills which can be uniformly acquired by trainees with a widely differing background, those engaged on the plant identification course should have a fairly uniform spread of knowledge and understanding.

An introduction to the course first of all defines the knowledge of the trainees, not only as regards plant identification, but also their knowledge of simple botany. It is surprising how many nursery managers are not sure of the difference between stamens and stigma, sepals and petals. To save embarrassment, a simple glossary of familiar botanical terms is provided.

A "buzz group" exercise then highlights the reasons for learning plant identification techniques and discusses the reasons for plant names causing difficulties. The causes

FIGURE 1: The Naming of Plants

Term		Correct Citation
Genus	Describes a plant group, e.g.	*Pinus*
Species	Describes the specific plant from that group (which occurs in the wild) e.g.	*Pinus sylvestris*
Subspecies	Variety, form. In a horticultural context describes a variation of the species sufficiently distinct to be named, but unable to stand on its own as a species, e.g.	*Pinus sylvestris lapponica*
Cultivar	Garden varieties and selected forms from the wild maintained in cultivation, e.g.	*Pinus sylvestris* 'Watereri'
Hybrid	The union of two species (e.g. *Pinus ayachuite*, *Pinus wallichiana*) which creates a third distinct plant, e.g.	*Pinus* x *holfordiana*
Bigeneric Hybrid	The union of two species from different genera (e.g. *Cupressus macrocarpa* x *Chamaecyparis nootkatensis*) which creates a third distinct plant, e.g.	x *Cupressocyparis leylandii*

IMPORTANT NOTES

1. The generic name should always be written with the first letter a capital.
2. The specific epithet or species should always be written with a small first letter.
3. Sub-species, varieties and forms should always be written with a small first letter.
4. Cultivars should always be written with the first letter in each word of the cultivar name a capital and the cultivar name itself enclosed by single quotation marks.

of difficulties in understanding plant names are many and varied, and these are discussed at length, with the instructor giving background information as to how the problems arise, particularly with regard to the rule of priority, which requires scientifically valid older names to replace those that perhaps have long and common usage. Synonymy, misidentification, better scientific knowledge and a mixture of Latin and local names, and their effect upon plant nomenclature, all create confusion, as do the use of trade abbreviations.

All these problems having been discussed, the first practical exercise is undertaken. It is important at the outset that the instructor and trainees appreciate that all the exercises of the day are not to teach new plant names, but to teach observation and systematic thought. This is started in a modest way by asking the trainees to separate examples of plant material into Dicotyledons and Monocotyledons, having first explained in theory the groups Pteridophyta, Gymnospermae and Angiospermae (and the division of the latter into Dicotyledons and Monocotyledons). The trainees usually regard the explanation of the main groups as largely irrelevant, and to a certain degree it is. However, it gives a splendid opportunity to bring them to attention by introducing a fern into the plant material being examined. It is surprising how many believe it to be a Dicotyledon, having not paid full attention to the theoretical discussion about relevant divisions within the plant kingdom. This simple ploy usually cuts the most ebullient or disruptive trainee down to size and indeed the whole group then regards all the plant samples for the rest of the day as not

FIGURE 2: Conifer Identification - Genus Only

1. Foliage flat and fern-like - 2.
   Needle-like foliage standing clear of twigs - 3.
2. Tips of growths thin and harsh, roundsih cone, *Chamaecyparis*.
   Tips of growths smooth and fleshy, strongly aromatic, slender cone, *Thuja*.
3. Needles borne in groups - 4.
   Needles borne singly - 5.
4. Needles in groups of 20 or more, *Larix*.
   Needles in groups of 2 or 5, *Pinus*.
   Needles in groups of 3 without pegs, *Pinus*.
   Needles in groups of 3 with pegs, aromatic, *Juniperus*.
5. Needles with pegs - 6.
   Needles without pegs - 7 & 8.
6. Needles pointed with pegs, *Picea*.
7. Needles flattened without pegs, irregular in length, *Tsuga*.
8. Needles flattened, more or less even in length without pegs - 9.
9. Flat needles without pegs resinous buds, *Abies*.
   Flat needles without pegs, leaf scales to buds, *Taxus*.
   Flat needles without pegs, papery buds, *Pseudotsuga*.

perhaps being what they first thought. This is an essential for the success of the course, for trainees must be instructed to see what features an individual plant sample possesses and not make assumptions on past knowledge.

Plant classification is then discussed, showing that natural classification is based upon the sum total of characters and not on one single prominent feature. A simple exercise using the animal kingdom as an example usually brings the message home.

Trainees are asked to identify the odd man out from a group of animals. These are: Man, Chimpanzee, Guinea Pig, Manx Cat, Rabbit. Most trainees will select man and give their reason as being based either upon his intelligence or reason, or the fact that he walks in an upright manner. It can then be quickly pointed out that the observation has been based upon what man does, rather than what man is, and one would no more classify a garden pea and a clematis together just because they both climb. The observation of what is there to be seen is all important and it is suggested that in an artificial classification that the rabbit would be the odd one out because it is the only animal with a tail. Therefore, if we take one single prominent feature, it results in us placing man, chimpanzee, guinea pig and Manx cat in the same family. Conversely if we take another group of animals - Lion, Tiger, Jaguar, Manx Cat and Leopard - we see that based upon a single major factor the Manx cat is removed from that family because it is the only animal without a tail. However, if we look at the sum total of features in the last list of animals the lack of a tail is only one differing feature, whereas there are maybe twenty or more closely related characteristics.

This analogy is then applied to the plant kingdom, and a widely varying family like the *Rosaceae* is looked at. Examples of material from genera as diverse as *Fragaria* and *Cotoneaster* can be used to illustrate individual diversity, but collective similarity, but with two or three examples from other families included. While in a practical sense the need for a nursery worker to understand plant families is not vital, the appreciation that all red fruited shrubs are not necessarily closely allied and that size is of little importance is vital if he is going to grasp basic identification techniques.

The separation of plants into genus, species, cultivar, etc., is looked at in theory and the correct citation for each group is discussed (see Fig. 1). A strictly scientific view is not taken of some of the divisions as this is regarded as confusing. Thus from a practical horticultural point of view subspecies, variety and form are regarded as the same, although to the botanist they are clearly quite distinct. The importance of correct citation, however, is stressed, and what this can indicate to the nurseryman is discussed. Not only the fact that the name is correct, but that single quotation marks indicate a cultivar; small first letter to a specific epithet; a species; and so on.

A simplified flora is next used to teach logical thinking (see Fig. 2), the trainees coming to a decision by selection and elimination of specific characteristics. The flora is not, in botanists terms, an accurate tool, but a practical horticultural means of separating plants into different genera. Conifer material is used as this is available all the year round and does not depend upon floral characteristics for mere separation into genera. Trainees should be told at the outset that the flora is a training aid and not a ready means of conifer identification as it has been over-simplified to render it comprehensible to practical horticulturists. This means that it loses some of its botanical accuracy. The instructor should be aware of this and only select plant material of species of each genus that fall within the accuracy of the flora. A number of commonly found suitable species of each genus can be recommended to the instructor at the outset.

It is important during this exercise that the instructor ensures that each trainee comes to a conclusion about a plant example via the key, and not through prior knowledge. Thus it is useful to introduce an occasional "red herring", *Calocedrus decurrens* is often taken for *Thuja* and *Sequoiadendron* will often be mistaken for a *Juniperus* if the key is not followed diligently.

Trainees are next introduced to the meaning of specific epithets which tell them something about a plant. For example, alba for white, pinnata for pinnate and so on. A glossary of the most popular and frequently used epithets is given to the trainees, covering leaf characteristics, flower characteristics, plant habit, colour and fragrance. Examples of living plant material are then shown and the relevant points described by the specific epithet are discussed. A further selection of material is then given to the trainees to examine and they are asked to suggest descriptive epithets for each. The correct specific epithet can be found in the glossary for about half the examples, the remainder the trainees must suggest epithets for, or alternatively note the characteristics upon which they believe the specific epithet will be based.

Following on from this a single genus is studied, but first of all a further sequence of elimination processes is discussed. Is the plant herbaceous or woody? Foliage, deciduous or evergreen? What is the leaf arrangement, growth habit? What are the characteristics most noticeable - flower or fruit? Fragrance? Having looked at all these facets, the remainder of what has been learned can be added and the trainees are ready to tackle eight or ten examples of a single genus. The material used should obviously be as diverse as possible, representing the broad embrace of the genus. Checking of trainees conclusions should be done using a standard reference.

It is rare for a trainee not to learn at least one new name after a course, but if he does not, it is no reflection upon his instructor. The course is not about teaching specific plant names, but is intended to teach a means of making positive identification possible on the holding. Much of what is learnt concerns observations, sensible thought processes, and a basic understanding of the rules of nomenclature. All conveyed in a manner which is more appealing and constructive than in the past.

The only minor difficulty that has been encountered at present is the interpretation by the instructors of the aids and the manner in which they are used. To ensure uniformity all instruction in Britain has emanated from one instructor who has taught all other instructors during master classes, not only the structure of the course, but all the associated instructor problems too. Now courses are being established through Britain, not only in the field, but in the majority of horticultural Colleges as well.

* Philip Swindells devised the Plant Identification Course with the Agricultural Training Board, ran the pilot courses and was responsible for instructor training.

Stapeliads, Propagation and Cultivation Auckland, New Zealand.

by

B. Buchanan

Extracts from a thesis for the National Diploma in Horticulture (N.Z.), submitted by B. Buchanan in 1980.

INTRODUCTION

Stapeliads or carrion flowers are a large group of succulent, perennial herbs belonging to the Family Asclepiadaceae. Native to the tropics and centred in Africa, the Family has 130 genera and 2000 species containing erect or twining shrubs or perennial herbs, sometimes fleshy and with reduced non-functional or absolescent leaves.

The Stapeliads have demonstrated an unusual power of adaptation to a semi-arid habitat. Their successful culture requires a knowledge of natural conditions and considerable skill by the grower.

This thesis outlines the habitat conditions by reviewing appropriate literature and discusses culture by describing conditions and experiences of several growers. The author's collection has been established over ten years, and, except where indicated, the cultural information has been gained from personal experience.

The Family Asclepiadaceae is marked by the milky or watery juice of its stems. In the Stapeliads, this juice is usually of a slimy, watery consistency only, but in a few species, as in *Caralluma cicatricosa* N.E. Br., it is quite milky.

Its closest ally is the Apocynaceae from which it differs in a further floral specialisation.

The Family Asclepiadaceae has been subdivided into six Tribes; in all but one, some form of succulence has evolved in some species.

Succulence has developed in widely dissimilar groups of plants though the origin is not clear. The plants store water in specially enlarged spongy tissue of roots, stems or leaves. They range in size from tiny annual weeds to towering trees and occupy a vast range of habitats. Many with reduced or adapted leaves are often referred to as 'cacti' but the word is misused to cover anything from prickly pear to carrion flower.

The single Family Cactaceae is of distinctive appearance being indigenous to the New World although naturalised elsewhere. Aizoaceae, Cactaceae and Crassulaceae are the three major families of succulents, each with over 1500 species.

In approximately 33 other Families, succulence has evolved independently in one or more species, representing 600 genera. They can withstand periodic drought but must receive some water. Those most popular with collectors flourish in areas where the annual precipitation may be 50-80 cm and should therefore be described as semi-desert plants - the Stapeliads being a typical example - rather than desert plants. An ecologist defines a desert as an area that averages less than 25 cm of rain a year.

CLIMATE

The only feature the diverse habitats of succulents have in common are the periodic drought, and temperatures generally above freezing. Freedom from frost is not universal; cacti in the high Andes, the northern U.S.A. and southern Canada freeze annually, though protected from the lowest temperature by a blanket of snow. Inspection of maps of

<table>
<tr><td colspan="6">ASCLEPIADACEAE - a breakdown to genus level (succulent members)</td></tr>
<tr><td>Filaments free, pollen granular</td><td colspan="5">Filaments united or stamens sessile, pollen massed into pollinia</td></tr>
<tr><td rowspan="4">Caudiciform</td><td>Pollinia pendulus</td><td colspan="4">Pollinia erect</td></tr>
<tr><td rowspan="3">Cylindrical more or less fleshy stemmed climbers or shrubs</td><td>Anthers with a very large inflated membranous appendage</td><td colspan="3">Anthers not so</td></tr>
<tr><td rowspan="2">Massively caudiciform</td><td rowspan="2">Corolla tube length more than twice its diameter midway with the lobes usually united at tips</td><td colspan="2">Corolla tube length less than twice its diameter midway, with free lobes</td></tr>
<tr><td>Caudiciform with slender non succulent leafy shoots</td><td>Stem succulents with scale leaves or leafless (Exc. Frerea indica)</td></tr>
<tr><td>Tribe 1
PERIPLOCEAE</td><td>Tribe 3
CYANCHEAE</td><td>Tribe 4
MARSDENIAE</td><td>Tribe 5
CEROPEGIEAE</td><td>Tribe 5
CEROPEGIEAE</td><td>Tribe 6
STAPELIEAE</td></tr>
<tr><td colspan="6">G. Rowley Illustrated Encyclopedia of Succulents</td></tr>
</table>

TABLE 1

STAPELIEAE

Tribe 6

Caralluma	R. Brown, Mem.Wern.Soc., i.14 1811
Duvalia	Haworth, Syn.Pl.Succ., 44 1812
Echidinopsis	Hooker fil., Bot.Mag., t. 5930 1871
Edithcolea	N.E. Brown, Kew Bull., 220 1895
Frerea	Dalzell, Journ.Linn.Soc., viii 10 1865
Hoodia	Sweet.Hort.Brit., 2 Ed., 359 1830
Huernia	R. Brown, Mem.Wern.Soc., i. 22 1811
Huerniopsis	N.E. Brown, Journ.Linn.Soc., xvii. 171 1878
Orbea	Haworth, Pl.Succ. 1812
Pectinaria	Haworth, Suppl.Pl.Succ. 14 1819
Piaranthus	R. Brown, Mem.Wern.Soc., i. 23 1811
Pseudopectinaria	Lavranos, Cact. & Succ.J.Amer., XLIII:9 1971
Rhytidocaulon	Bally, Candollea 18:335 1962
Stapelia	Linnaeus, Crit.Bot., 13 1737
Stapelianthus	Choux, The Stapeliaceae, 1 Ed., 71 1933
Stapeliopsis	Pillans, So.Afr.Gard., xviii 32 1928
Stultitia	Phillips, Flow.Pl.So.Afr., text ad t. 520 1933
Tavaresia	Welwitsh, Bol.Cons.Ultr.Lisb., No. 7, 79 1854
Trichocaulon	N.E. Brown, Journ.Linn.Soc., xvii 164 1878
Tridentea	Haworth, Pl.Succ. 1812
Whitesloanea	Chiovenda Malpighia XXXIV:541 1937

CEROPEGIEAE

Tribe 5

Brachystelma	R.Br. in Bot.Mag., t 2342 1822
Ceropegia	L.Sp.Pl., 1:211 1753

TABLE 2

South Africa reveals big differences in the season when rain is expected and in the total amount. When seeking cultural assistance from the homeland we need to know how much rain it normally receives and at what time of the year.

Many dwarf perennial succulents are adapted to pass the dormant season underground, bulbs and caudices being ideally suited to tide plants over long periods of dessication. Close relatives of the Stapelieae, *Ceropegia* and *Brachystelma* demonstrate this adaptation. One of the most densely populated areas is South Africa, a land of varied physical features with the vegetation showing great variety and richness. It is of three dominant types; forest, grass veld and the arid and semi-arid forms which dominate the country west of the 26th meridian east of Greenwich. It extends from above the tropic to the Cape Province's south coast and embraces the Kalahari, Karroid semi-desert and west coast desert strip. In the Kalahari Thorn country the elevation runs from 600 to over 1200 m. Rainfall averages 38 cm per year with long winter droughts. Stapeliads are found on the sandy flats and among rocks or under bushes on the hills and mountain slopes. In the Karroid areas rainfall varies from 12-38 cm being highest in the south east. Winter rains occur in the west and south. Most of the Karoo Stapeliads grow on the slopes and as elsewhere, under bushes or anchored between rocks.

The Karoo is wrongly looked upon as a desert. Though rainfall is low, abundant moisture is derived from dews and frosts at night and the soil is one of the deepest and richest in South Africa. An important factor determining succulent flora is the strength of the actinic rays of sunlight. Stapeliads and other succulents from the open veld of the Karoo cannot stand full sun in the Western Province although the latter has good rainfall and a moister, cooler atmosphere. In those regions where there is a large amount of quartz, as in the Knversvlakte, the whiteness reflects light and heat thereby keeping the roots cool. It also condenses moisture from mists.

As a general rule the majority of Stapeliads in South Africa grow under bushes, generally on the southern aspect of the hills. Some species find shade in the clefts of rocks.

The large *Trichocaulon* and *Hoodia* grow in the open where clumps stand dotted about.

CLASSIFICATION

Class:	Angiospermae (Angiosperms - Flowering Plants)
Subclass:	Dicotyledoneae (Dicotyledons)
Superorder:	Asteridae
Order:	Asterales
Family:	Asclepiadaceae

(Heywood 1978)

The Tribe Stapelieae consists entirely of perennial stem succuelents with thick, often soft and juicy branches covered in low ribs or tubercles, often tipped with a scaly bristle which is all that remains of foliage. A superficial resemblance to cacti is to be found in several species, e.g. *Trichocaulon* and *Whitesloanea*. *Frerea indica* retains flat, semi-succulent leaves and is regarded as a pointer to the ancestral prototype from which the Tribe has evolved. About half of the 400-500 species belong to the two largest and widespread genera *Stapelia* and *Caralluma*. The flower of *S. gigantea* can reach 30 cm, among the largest of flowers in the plant kingdom.

The generic name *Stapelia* was first proposed by Linnaeus in his Critica Botannica, Leyden May 31, 1837, naming the genus after Johannes Bodaeus a Stapel (von Stapelius) a physician and botanist of Leyden.

FLOWER STRUCTURE

The flowers of the Stapelieae are structurally the most complicated of all succulents and show a high level of evolution comparable to that of orchids with which the group shows certain evolutionary parallels. They come nearest to qualifying as plants with succulent flowers as the texture is thick and leathery and they can stay expanded in the sun for two days or more without unduly draining the plant's reserves of water.

The following is an explanation of the structure of the commonest species *Orbea variegata* (Fig. 1, based on Rowley 1978 and White & Sloan, 1937). The calyx is make up of five small, free, green sepals. Next is the corolla of five petals which are more or less united basally to form a saucer-like or cup-like tube. The corolla surface is smooth, sometimes glossy or covered in ridges, pimples or tiny bristles. The margins and even the surface may be covered in fine hairs which wave to and fro in the slightest breeze. Combined with purplish-brown markings and rank odour they give an uncanny resemblance to fresh carrion. This attracts flies for pollination. Some Stapeliads have an outgrowth of the Corrolla called an annulus ("little-ring), which surrounds the essential organs at the centre.

The pollen content of the anther cells is united into waxy masses, which are attached in pairs to pincer-like organs called pollen carriers. In the centre of the flower is a hollow columnar body (staminal column) which serves as the stigma. In the upper part of this staminal column are embedded five anthers, with their attendant pollen carriers. Also from the column arises one series or two series of five-fold lobes, which are called the corona (corona = crown). When the corona consists of two series of lobes, these are called outer corona and inner corona; when it consists of only one series it is said that the outer corona is absent. The contents of each anther lobe remain united, each pair being linked by a yoke bearing the wing-like pollen carriers. Such an organ is named the pollinium. In the centre of the flower are two free carpels each containing numerous minute ovules. Above the carpels is a solid disk of tissue that unites the tips of them to the staminal column and immersed anthers.

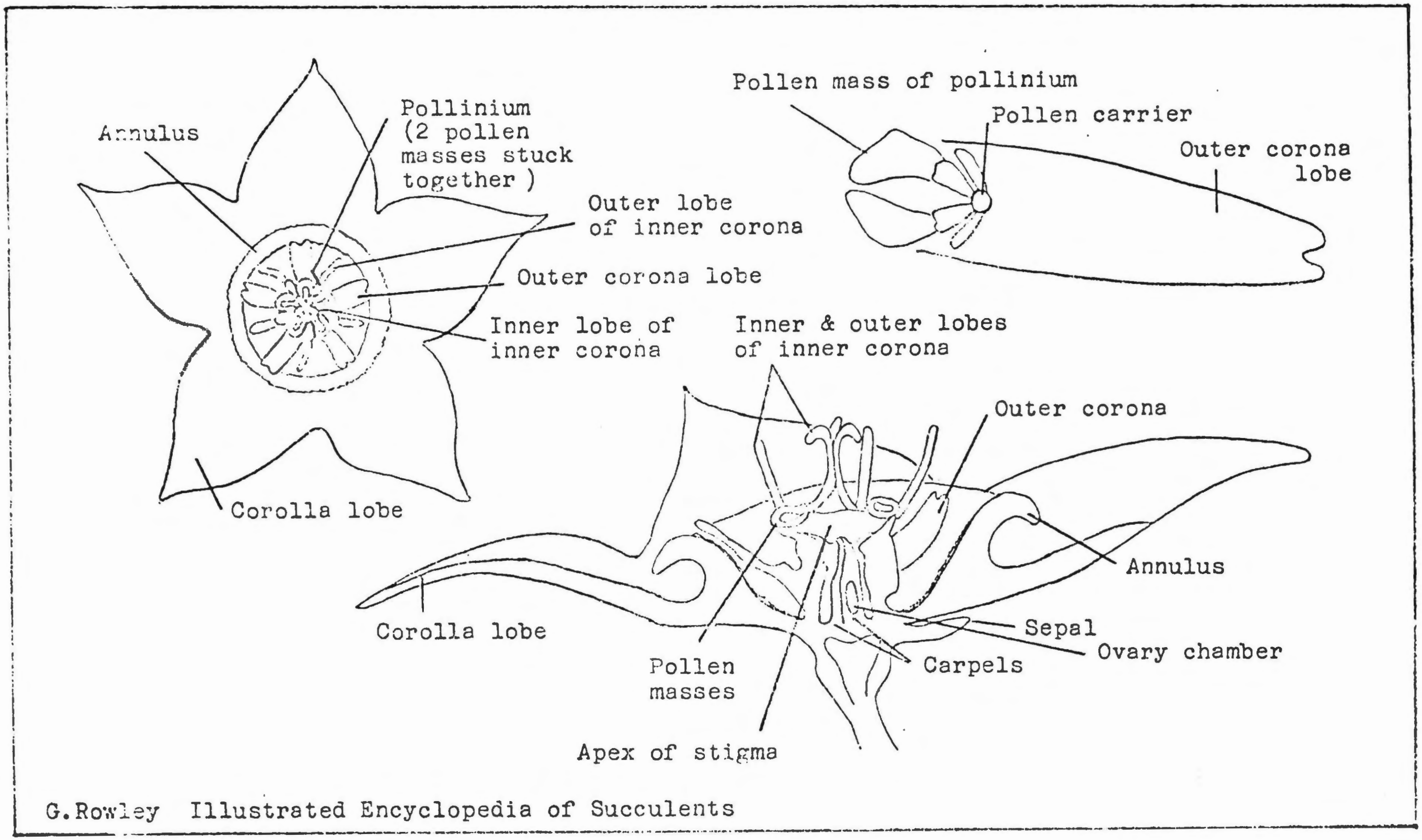

Fig. 1: Flower Structure of Stapelieae, Based on *Orbea variegata*.

POLLINATION

Rowley, 1978, p. 218, records the following description by Reece 1973:

> "The strangely formed lobes of the two coronas are functionally guide barriers which ensure that an insect randomly exploring the flower is eventually drawn to face the staminal column. Unwanted visitors are excluded. There is a narrow vertical groove or cavity between the five corona lobes. These grooves are the site of the receptive surfaces where, for fertilization, the pollen mass must arrive. The hairs on a leg or proboscis of the insect readily remove the pollinium by its yoke. Similar exploring by the insect of another flower of the same species results in the pollinium falling or being dragged off its body into the groove. There the pollen tubes grow inwards towards the carpels to fertilize the ovules. The mechanism is very specific and is responsible for the rarity of hybrids even when different species grow in the wild side by side.
> Following fertilization, the two free carpels grow out into a pair of slender cylindrical fruits which may be up to 20 cm long. When mature, each splits lengthwise to release a cloud of seeds, each with its own white parachute of hairs."

Little work has been done on artificial hybridising because of the complexity of the pollination process. In the 1980 seed-list of the Asclepiadaceae Society (Great Britain) six hybrids are listed. The crosses have been effected by staff of Karoo Botanic Garden (South Africa) and resultant seed offered.

Bailey (1976) lists four hybrids and several species known only in cultivation. These could be hybrids, botanical varieties or cultivars.

CEROPEGIEAE

The main difference between the Ceropegieae and the very closely related Stapelieae is the structure of the flower. The tube is longer and lobes are united at the tips. However, recent discoveries such as *Pseudopectinaria* have broken down these distinctions and some botanists combine both Tribes.

Jacobsen (1960) lists 66 *Ceropegia* species of interest to the grower. Some produce clusters of tuber (*C. woodii* Schlechter) which provide suitable grafting stock for Stapeliads. In habitat they tend to grow in isolation in the shade of the densest shrubs. The flowers are tubular, narrow and 2-12 cm long. At the top of the corolla tube the lobes separate but then usually unite again to form a canopy or umbrella over the top. A few species have developed succulent stems which in *C. stapeliiformis* Haw. resemble those of *Stapelia*.

CULTURE

The successful culture of some members of the Stapelieae can represent a considerable challenge whereas others such as *Orbea variegata* and *Stapelia hirsuta* L. are some of the easiest succulents to grow and are represented in most succulent collections. Unfortunately, beginners luck in establishing a collection may lead to over confidence when the grower observes how rapidly the young plants grow through the summer months. The testing time will be the wet cold winter months and losses at this time may disillusion the grower to the extent of his foresaking all Stapeliads. Experienced growers will recommend that the novice expand his collection gradually, learning about the plants and gaining growing skills which he will need when he collects those species difficult to cultivate.

Those members from equatorial areas require warmer winter temperatures but the majority will overwinter satisfactorily in a greenhouse which averages a minimum of 4°C (E. Lamb, 1957).

In their native habitat the plants favour the slight protection of bushes or rocks against the fierce sun (E. Lamb, 1957) and in cultivation require lightly shaded conditions.

In Auckland few specimens will grow in the garden because of the continuously wet winter conditions. The only specimen seen growing outside a glasshouse or cold frame was a plant of *Orbea variegata*, growing in a pot under the house eaves.

CONDITIONS

The author's glasshouse is timber framed, the roof and walls being glazed with horticultural glass lightly shaded with white acrylic paint diluted at 1 part by volume of paint to 9 parts of water. The house measures 5.5 m wide by 7.6 m long, and shape is conventional. It has a ridge ventilator and 35° roof pitch. Two sets of louvres are fitted to each side for extra ventilation. The house is used to grow a range of succulent plants as a hobby, most being staged on benches. As the walls are glazed to the ground, under bench space is used for growing plants requiring some shade, including the Stapeliads. Ventilators are left open in the summer and provide satisfactory air circulation. Temperatures in the summer will rise to 35°C and succulent plants, other than cacti, will quickly show signs of dehydration if not watered liberally. This occurs because, under these conditions, growth is softer than would be found in native habitat conditions.

In winter the ridge ventilator is completely closed to exclude rain. Louvres are partially closed to prevent draughts, but allow some air circulation. Winter day temperatures will rise to 27°C, night temperature sometimes dropping to 1°C. Light frosts are usually experienced on the property three or four times during the winter but no frost damage has occurred in the glasshouse.

A comparison of the glasshouse temperatures recorded in August 1980 and habitat temperatures of the most favoured areas, South and South-west Africa, reveals higher winter means over most of the habitat. The lower temperatures in cultivation will lead to some deterioration in the health of plants through the winter. Summer habitat temperatures are not as high as experienced in cultivation (35°C in the author's glasshouse) and plants require compensating shade and watering.

The Stapeliads are grown under the bench in pots placed on a bed of fine scoria which keeps the pots clean and well drained. The scoria is kept dry - contrary to usual practice - because of the need to maintain a low glasshouse humidity. Because the property is well drained the plants can remain under the bench the year around without risk of dampness.

The author's plants were originally grown on the bench, with glasshouse roof and walls being lightly shaded. These conditions allowed stem colouration to develop to the fullest, but pots dried out rapidly, requiring frequent watering. Conditions in a small pot in a hot glasshouse appear to be more extreme than in the native habitat. Plants in the author's collection have deteriorated when watering is less than liberal and summer temperatures are high.

MEDIA

The chief requirement of the growing medium is that it is open and well drained. A mix which included some loam was recommended in earlier publications (Jacobsen, 1960) but has lost favour with many growers. Bunt (1976) cites the ease of plant nutrition as the principle advantage of the loam compost.

Improved drainage and a greater standardisation of materials is possible in a loamless compost. Disadvantages described by Bunt (1976) include:

1. Control of the supply of nitrogen, phosphorus and minor elements (such as boron and copper) is more critical.
2. Lack of general 'buffer' capacity, i.e. they are more likely to show rapid changes in general nutrient levels. If allowed to become too dry, the medium is difficult to wet and salinity problems can arise.

Keller (1971) makes reference to the success experienced by E. & B. Lamb (1963) using a fine leafmould and coarse sand growing medium.

K. & N. Johnson (pers. com.) of Blockhouse Bay, Auckland pot grow in a mix made up of 60 parts by volume peat and 40 parts coarse pumice. The pots are topped with a washed scoria which drains water from around the stems but prevents the top of the medium becoming completely dry, the peat/sand mix being difficult to wet once it becomes bone dry.

Watering is carried out according to season, allowing the medium to become almost completely dry. Plants are fed every other watering using 50 p.p.m. nitrogen, 15 p.p.m. phosphate and 100 p.p.m. potash. The in-between waterings are liberal to leach out unused chemicals. Dr Johnson does not use trace elements regularly, considering

Auckland water supply sufficiently supplied with them.

R. Russell (pers. com.) of Mt Roskill, Auckland, grows his plants in a two tier system suggested by E. Lamb (1957). His medium consists of 50% pumice sand, 25% peat and 25% loam. The pot is half filled with this mix, the remainder filled with a mixture of 50% medium and 50% fine scoria. A fertilizer mixture of two parts by volume superphosphate, two parts Bonedust and one part sulphate of potash is used at 1% by volume of the growing medium. Plants will fill a two litre container in two years, after which cuttings are taken and old plants broken up. Mr Russell uses no supplementary feeding, his programme of regular replacement making it unnecessary.

The author uses a mix which includes some loam because it has the advantage of buffering moisture and nutriment. A high loam content should be avoided because it retains moisture too long in the winter. The two examples below have been used with equal success:

1. 25% loam 25% peat 50% pumice
2. 16.6% loam 33.4% peat 50% pumice

Fertilizer additions have been similar to the mixture below, recommended by Massey University. Rates per cubic metre:

Urea formaldehyde	.4 kg				
Superphosphate	1.2 kg	N	P	K	Ca
Potassium sulphate	.6 kg	5.4	4.2	8.3	6.4
Agricultural lime	.6 kg				

The top 25 mm of medium surrounding the bases of the main stems should contain extra pumice sand or fine washed scoria; or consist solely of washed fine scoria. The latter provides a neat topping to pots in a collection, preventing soil washing out and contaminating the material on which the pots stand. Since the scoria topping prevents a visual inspection of the medium for moisture content, a wire prong can be used to check. Push the prong into the medium, withdraw and inspect. With a little practice, the grower can gauge the moisture content of the medium from the appearance of the prong.

In the author's experience, plastic pots are satisfactory being cheaper and easier to obtain than clay. Provided the pots are stood on a base of scoria or similar free draining material, scoria for drainage within the base of the pot is unnecessary. A few pieces placed over the pot's drainage holes prevents the potting medium running out and ensures that they do not block.

Plants grown in a bed rather than pots can be displayed very well (The Exotic Collection, E. & B. Lamb). They still require regular, though not as frequent attention to watering and feeding because they can forage for themselves. Plants will grow larger than in pots and infestations of pests can build up undetected because of the mass of closely growing stems. Lack of room precludes this technique for most growers.

POTTING

Growth habit of *Huernia macrocarpa penzigii* is typical of most species, the bases of the main stems having up to half their diameter below the medium surface. As the new shoots grow, older stems deteriorate and may collapse. Regular propagation and potting is thus necessary to keep the collection healthy. Most species with this type of growth when propagated in early spring will flower in 18 months, as shown in Fig. 2.

A scoria layer on top of the growing medium is advocated by some growers as it keeps the stems out of the medium which may stay wet for many days. The roots appear from the underside of the base of the stem (Fig. 3) which can conveniently be kept from contact with the medium by the scoria layer.

Lamb (1957) advocates a three layer method; a rich but moisture retaining bottom layer from which the roots may derive moisture by establishing themselves deep down; a middle layer which is well drained, but which helps to support the plant; a top layer of gritty sand to be 13-25 mm deep. He notes it is applicable to both pot culture and beds. This practice was adopted because in their native habitat the surface conditions are arid and the plants produce long roots.

Examinations by Lamb of failures in otherwise healthy plants revealed the cause as the soil remaining wet for too long around the neck of the main stem at ground level. Further study indicated that while the medium was itself quite

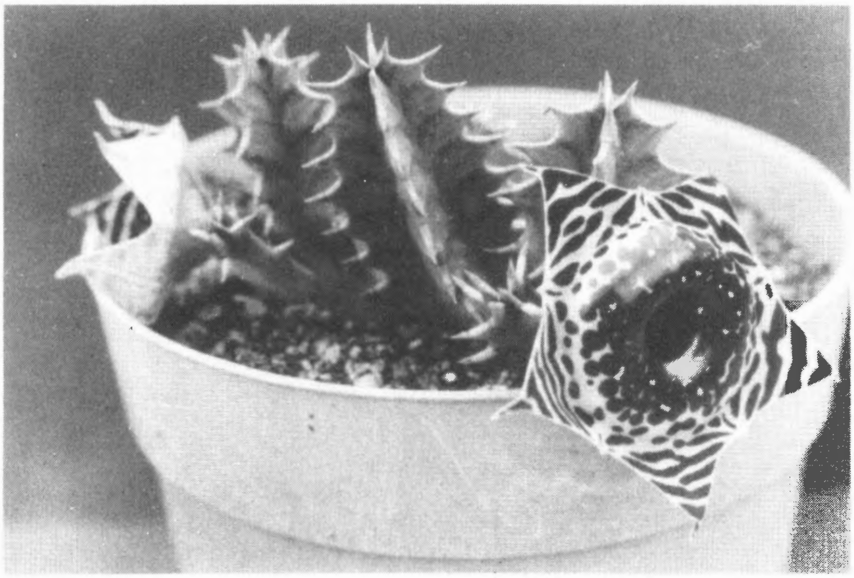

Fig. 2: *Huernia transvaalensis* Healthy plant in flower.

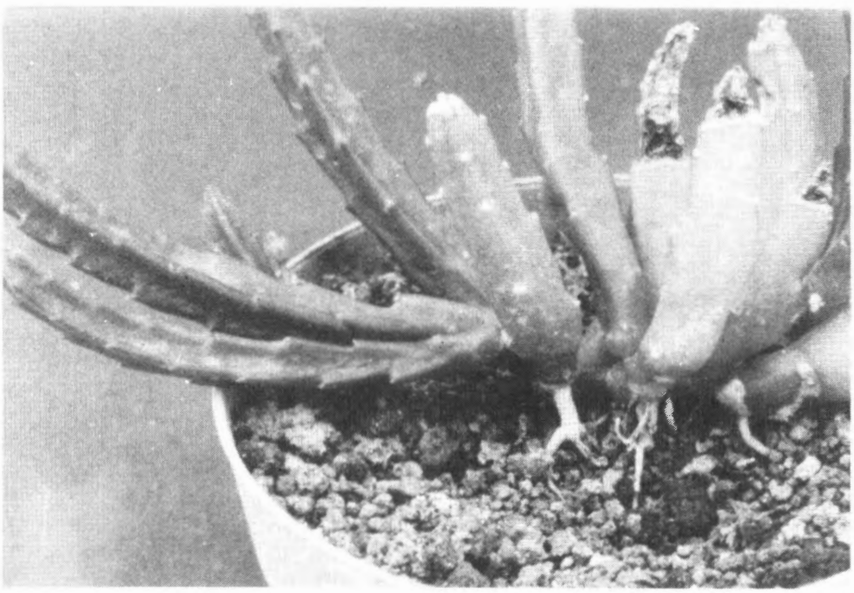

Fig. 3: *Stapelia divaricata* Old and new growth. Flower bud appearing at left rear. Roots typical of most species.

suitable for growing the plants, once regular watering had begun the roots deep down were taking their requirements; yet near the surface, moisture was being lost by evaporation only. In dull, damp weather this would be very slow. As the plant became more branched, so the damp area around the main stem had less chance of drying out; resulting in rotting.

In the author's experience Stapeliads are intolerant of disturbance. Potting in spring when growth is strongest is the best time. Potting in summer when growth slows in the heat or in autumn when the stems should be hardening to tolerate low winter temperatures may lead to failure. A knowledge of the vigour of the species is necessary and care should be taken to choose a pot size in which the plant will establish quickly.

At potting time, the medium should be moist, according to standard practice. When potting, the roots of established plants may be disturbed a little and long roots trimmed. Hold the plant in the pot and trickle the medium into it, filling within 25 mm of the final level. Settling the medium by tapping the pot on the bench avoids damage to roots and excessive compaction. The top 25 mm is filled with a well drained layer as described earlier.

Settled into their new pots, rooted cuttings and plants are placed in warm shaded conditions without watering. Water is supplied in a few days, giving enough to keep the medium moist so that new roots do not dry out and die, but no so much that the medium remains wet. The plants have adequate reserves of moisture and must be given time to heal wounds and adjust to new conditions. Similarly, when new plants are brought into the collection, water must be given sparingly until the plants have adjusted.

WATERING

Stapeliads are gross feeders and when well supplied with nutriment and liberal watering through the summer will make rapid growth and produce many flowers.

Glass and Foster (1976) advocate a rich, well-drained mix and liberal watering except in the dormant season. They have had the most success in leaving their Stapeliads nearly completely dry throughout the winter months. Though they look weak and floppy they soon revive with the first watering.

When temperatures are rising on a warm fine morning, water may be applied liberally over the plants as free water quickly evaporates. Watering at times when it will lie on stems or glasshouse bench creates undesirable humidity which may promote conditions leading to rotting of plants. If watering is necessary on overcast days or during the evening it should be confined to the growing medium and not splashed over plants and benches.

Species which grow naturally in areas of low rainfall must be watered carefully as a combination of media saturation and low temperatures may prove fatal. Double pot culture has sometimes been used. The clay pot containing a plant is placed in a pot of sand which receives the water. Moisture reaches the roots without wetting the stems.

FEEDING

Most growers do not give adequate attention to feeding; as a result, plant growth is seriously checked. Many species will survive for at least one growing season in apparent good health, but will eventually die. A decline in health is difficult to arrest in many species. Plants should be kept growing strongly in order to tolerate temperatures lower than exist in native habitat and to provide healthy growths which flower well. Flowers are produced on new growth.

Plants weakened by poor nutrition are more likely to succumb to pests and diseases.

The principle requirement of all nutriment supplied to Stapeliads is that it be comparatively low in nitrogen. In the author's experience, 'Osmocote' is satisfactory when ½ teaspoon is applied to the top of the growing medium at the beginning of spring and late summer.

'Osmocote' is a proprietary brand of a resinous coated fertilizer which releases nutrients by diffusion. Since the amount released is influenced by moisture content of the medium, there appeared little risk of excess nitrogen promoting soft growth because watering is, on average, once a week through the summer.

Results over the two recent summers were very satisfactory - the only disadvantage being the high cost of 'Osmocote'.

PROPAGATION

Seed

Though White and Sloan (1937) report that seed may remain viable for several years this appears to be questionable. The exact age of seed from overseas sources is not usually known and little work has been done on viability testing. Fresh seed should be obtained and sown immediately. In the experienced of K. & N. Johnson (pers. com.) and the author, any seed which has not germinated within a week or two will not do so.

Seedlings may be sown in the medium described previously, the fertilizer being substituted by superphosphate at 1 kg per m^3; or in a loamless mix as practised by N. and K. Johnson.

Seedlings must be kept growing without checks and given sufficient light to produce sturdy plants. Sowings by the author in November in the glasshouse with warm spring temperatures and partial shade of under bench conditions, resulted in good growth. After a summer's growth, plants were large enough to overwinter satisfactorily. For the serious grower a small propagating cabinet with a heat source is essential. Fitted with a light source, a unit located within the grower's home makes regular inspections and attention easier and therefore more likely.

The author has used Gro Lux fluorescent tubes controlled by a time clock to extend winter day length and a soil warming cable as a source of bottom heat. Fitted to a cabinet within the glasshouse it made possible the sowing of seeds on receipt.

Fresh seed will usually germinate in a few days and seedlings will grow rapidly.

Cuttings

In propagating by cuttings, best results are obtained by selecting a stem which is mature and healthy. All species contain a thick sap, clear in most, milky in a few. This must be allowed to dry by lying the cuttings in a cool, shaded position for 24 hours.

The 50% peat:50% pumice sand mixture is a good rooting medium as it is free draining and reduces transplanting shock by clinging to the roots; reducing the damage and drying out. The cuttings are laid on the mix with the lower third of the base of the cuttings in the medium. Roots are produced from the underside of the base. If the cutting is inserted in the medium according to standard practice, the base will curl and come out of the mix. Larger cuttings need to rest on the side of the propagating tray with the base settled as described. This technique does not apply to species such as *Hoodia* (usually grown from seed) which would be kept vertical with the basal 10-20 mm below the surface of the propagating medium.

The best times for propagating by cuttings are in September when the plant is beginning to show signs of growth after the winter, but before new stems are produced. The plant has several months to establish before being subjected to cold winter temperatures. Cuttings will root at other times, the ease with which they do so depending on the species and growth stage of the plant. For example, periods of little or no growth in winter or height of summer are unfavourable times.

By propagating in early spring, the healthy cutting will root quickly and can be potted into the first pot size at the beginning of the growing season. Some species will grow rapidly enough to be potted on before the heat of the summer slows growth. Others can be potted on at the end of the summer in time to establish in the larger pot before the winter.

After growing a few plants obtained locally, the author imported a parcel of cuttings from Australia. Mostly species of *Stapelia*, *Huernia* and some *Caralluma*, they were 50-80 mm long and arrived late August. They had been lightly crushed in transit but the slight dehydration they experienced prevented damage. They were laid on a mixture of 50% peat and 50% pumice sand within a plastic propagating tray under the glasshouse bench. Within a month most had made roots and were potted.

Grafting

In Auckland most species will grow satisfactorily on their own roots but a few will not tolerate anything less than the habitat conditions to which they have adapted, e.g. *Edithcolea*. Grafting may be the only way of growing these difficult species, or it may be good insurance to keep one plant of a temperamental species on a hardy stock in case the plant on its own roots collapses.

In Europe species of the genera *Hoodia*, *Trichocaulon*, *Tavaresia*, also some *Huernia* and *Stapelia* are difficult to grow because of the fungus disease called 'the black death'.

W. Rauh and W. Dinklage (1974) describe the technique used in grafting this group of plants. The tubers of *Ceropegia woodii* are used as stock as they are hardy and freely available. The cactoid stapeliads require larger diameter tubers - 30 to 50 mm - than the more slender *Huernia*, *Stapelia* and *Tavaresia*. They are potted so that the growing point is orientated laterally. This is done so that a big grafting plane is provided and the growing point of the tuber remains undamaged. It will then continue producing shoots and leaves for the assimilation and storage of nutritive substances in the tuber. If this is not done, the tuber will shrink.

Other suitable stocks include *Stapelia hirsuta*, *S. grandiflora* Mass or *Ceropegia dichotoma* Haw,

The grafting technique is simple, the freshly cut surface of scion is placed on the freshly cut surface of stock and held in place with a rubber band. Carried out in spring the union will heal quickly. The results include more rapid growth, freer branching, ready flowering and freedom from the 'black death'.

The stock must be actively growing, the scion healthy and the time of year suitable if the graft is to succeed. The author's attempts at grafting Stapeliads were not successful because it was attempted after a plant had collapsed and the scion was therefore not healthy. Grafting of cacti was successful.

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Hayward Reginald Wright Nurseryman, The Importer and Raiser of New Fruits

by

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"This is a good opportunity to pay a tribute to the man who is belately recognised as the Luther Burbank of New Zealand - the late Mr Hayward Wright of Avondale, Auckland."

Turner 1974

Hayward Wright would have been flattered by such a comparison - Burbank was one of his heroes. Indeed, the comparison may at first appear unduly flattering. Wright has not enjoyed anything like Burbank's fame and amazing adulation - nor has he been exposed to the same public scrutiny or suffered the same notoriety. He did not die rich, his work was of much more limited scope, he is little known even in this country. How he did resemble Burbank was in being an extraordinarily skilled plantsman with a remarkable ability to recognise the potential of new plants. He is commemorated by the most successful of all his plants - the 'Hayward' kiwifruit now grown throughout the world. The kiwifruit, however, is only one of his many successes and his other achievements deserve more recognition.

BIOGRAPHY

Hayward Reginald Wright was born at Waimate North 25/11/1873. The name Hayward came from his godfather, Samuel Hayward Ford, whose wife was a great frient of Wright's mother. Ford was one of the first European doctors in the Bay of Islands and was present at Wright's birth.

Wright's father, Ernest Edward Hamilton Wright, was the blacksheep of a good family - one of his cousins was Earl Haig. A remittance man and an alcoholic he came out to New Zealand as a schoolmaster. In 1870 he married Sarah, eldest daught of Frederick Thomas Radcliffe and Harriet Atkinson. The Atkinsons had settled in New Zealand in 1855, living first at Mercury Bay and then at Waimate North where Frederick took over the Bedggood Mill and opened one of the first stores (Atkinson, 1976).

After their marriage, Ernest and Sarah Wright lived in Waimate for about 15 years until they took over a plantation on Munia (Wright, 1953a), a small island in the Northern Lau Group of Fiji. Life was not easy - when Ernest was incapacitated he would make use of his good education and lounge about reading the Greek classics, while Hayward, at the age of 13, would have to supervise the native workers on the plantation. Sarah Wright wanted to come back to New Zealand and eventually her parents sent money for her and the children to return to Russell. Ernest Wright remained in the islands - a cruel man, he does not seem to have ever learnt how to deal with the native workers and in 1895, when in the Solomon Islands, was killed in a tomahawk attack. Sarah's reaction on hearing the news was to fall upon her knees and give thanks unto the Lord for her deliverance.

Hayward did not get much of an education and as a result he always wrote slowly and painstakingly. On the return to New Zealand he was apprenticed at 16 to his grandfather in the grocery trade. He found this unsatisfying and when he was old enough he hit the trail to Auckland. His mother joined him and took over a boarding house in Clairmont Street, Grafton.

Hayward, who inherited an interest in plants from his father, was apprenticed to David

H. R. Wright

FIGURE 1: Reproduced with permission from 'The Orchardist of New Zealand' 11 (1983), 326.
The signature is taken from a letter written in 1953.

Alexander Hay of Montpellier Nursery (D. Hay & Son) in Shore Road, Hobson Bay. For many years this was the leading nursery in Auckland offering an extraordinarily wide range of plants - the Montpellier catalogue of 1905 contained just on 2500 different plants, many of which were specially imported from overseas. David Hay was "on the look-out at all times to engage keen, energetic young men who showed a liking for the nursery profession". Wright "was not only a splendid worker, but he had a studious mind which urged him on to greater endeavours" (Hale, 1955), and in his eleven years with Hay he rose from apprentice to foreman. Initially, he concentrated on the propagation of rhododendrons and azaleas (Hale, 1955), but he soon became more interested in the selection and propagation of fruit trees and the choice of suitable stocks.

Wright left Montpellier Nursery in 1902 when he bought a block of land off Rosebank Road and established Avondale Nurseries. The total area eventually comprised about 25 acres, the part bought by Wright himself, part owned by his wife and part leased. An aerial photograph of the property was used to illustrate some of his catalogues and a reasonably detailed map of the nursery, as it was in 1938, is given in Paynter and Greig (1938-39).

In 1906 Wright married Ada Florence Maud Statham (1870-1957). Ada had been born in Bermuda where her father, William Henry Statham, was caterer to the 53rd Shropshire Regiment. The family returned home when Ada was three years old and, after living in various parts of Britain, emigrated to New Zealand in 1906 to live in Rosebank Road, a short distance from Wright's nursery. She and Wright were married within a few months of their first meeting. On first moving to the nursery, Wright had lived in a cottage at one end of the property, but after marriage he and his parents-in-law built a large house which they intended sharing. Wright soon proved too difficult to live with and the Stathams moved out.

Hayward and Ada Wright had three children, Ezilda (now Mrs Cummings of Whiritoa Beach, Waihi), William 1908-1921 and Hayward 1915-1921. Wright never fully recovered from the deaths of his two sons less than a month apart. It affected him severely, all the joy went out of his life and he became intensely religious, constantly reading the bible. A window, dedicated to the memory of the boys, was placed in St Barnabas' Church, Mt Eden, by the Statham grandparents (Hill, 1966).

Wright was a tall man, intense and austere, who often appeared forbidding. He tended to be somewhat intolerant, and inclined to stern dicta such as "He who does not work, neither shall he eat". He was not the sort of man to go round laughing; rather he concentrated on the job at hand. He was certainly not an easy man, but difficult and impatient. One acquaintance describes him as "irascible and MOST difficult to get on with", another as "cantankerous" a third as being "a man whose temper was legendary". In most photographs he looks decidedly glum and the only exception in which he appears really happy is one photograph taken when he had caught a large snapper. Much of this grimness may have been due to the chronic pain caused by a plate inserted in his right leg after it was badly smashed in an accident. His daught suggests that an equally likely explanation was the memory of childhood mistreatment by his father (Cummings, 1983). Although he liked animals - Paddy the horse, the cats and the parrots - he was not fond of children. He would chase them from the orchard, perhaps concerned that they would take fruit of new introductions still under test or fruit resulting from experimental crosses. A rare exception was D.R. Connell who, as a lad, used to follow Wright around the orchard waiting for handouts. Wright would cut up any new fruit and hand round pieces for tasting (D.R. Connell personal communication; Copsey, 1982).

His one interest - his consuming interest - was plants. He was not interested in people or money but plants. He could talk of nothing but plants. The house was always a mess, full of seeds or cuttings - this did not greatly perturb Mrs Wright as few people ever came to the house. Every night he would be working, taking cuttings, grafting, telephoning David Hay, reading catalogues, writing to his overseas correspondents. Even on the very rare holiday he would be talking to growers or plantsmen and looking at plants and yet more plants. He was continually spending money on plants - nothing was stinted for tools or plants. His great excitement was anything new and his daught describes him as being "like a kid with a new toy" when new plants arrived. He would get involved in long programmes for many years but once he had achieved what he wanted he would lose interest.

"Research is the foundation of progress" (Wright, 1953b). Although Wright has been described as "essentially a scientific observer" (Paynter and Greg, 1938-39), it does not detract at all from his achievements to suggest that it is inappropriate to consider him a scientist or research worker: he lacked any formal scientific training or understanding, his dogmatic statements are not always correct or justified, he did not work systematically, he did not test his conclusions. He believed, for example, that certain citrus rootstocks were the most suitable for New Zealand conditions, but it took others many years to establish that he was, indeed, correct. He did not keep records but "without reference to notes or labels, Mr Wright could give the pedigree of every one [of his citrus] ... he had the true scientist's memory for names and the peculiarities of each tree" (Anonymous, 1935). Perhaps more realistically, Paynter and Greig (1938-39) in summarizing his citrus work wrote "we feel it necessary to impress upon the readers that the nursery is not set out, tabulated and labelled ... Mr Wright has retained all the information by memory ...". He apparently believed that it was not safe for him to label his plants (W.M. Hamilton personal communication).

Wright was no businessman. D.R. Connell (personal communication) suggests that his life was one of continual frustration - the cares of commerce competed with his love of plants. He was continually harassed financially, it was always an effort to find the men's wages, he was always spending excessive amounts on new plants. There was the problem that by the time he had produced a plant, fashions would change. "... he has been greatly handicapped by having to earn his livelihood from the nursery trade, and thus been subject to all the whims of the purchasing public" (Paynter and Greig, 1938-39). Wright was an enthusiast for plants, he loved to talk about them, he would given away plants but he was not a good salesman. Many customers would find it easier and less time-consuming to buy their plants elsewhere (Copsey, 1982). Those who were prepared to listen, however, could learn a lot as Wright was willing to impart any knowledge and never restricted his information. Jack Clark, for instance, as an apprentice, was frequently sent to Avondale to collect plants or budwood: he considers that much of his knowledge of plants and nursery techniques came from long conversations with Wright (J. Clark personal communication).

John Gracie, Wright's foreman for many years, joined him in 1926 shortly after arriving from Scotland. Eventually Gracie and Mrs Wright ran the business and Wright did less and less around the nursery, concentrating on his citrus work. Mrs Wright had kept the books for her father - she was a strong woman with good business sense. It was not, however, easy to run the nursery. There was a constant turnover of staff because Wright could be very difficult and he and his wife would often spar vigorously over the staff - one appointing, the other dismissing.

Wright's general approach is well illustrated by accounts of a vice-regal visit made to the nursery in the early 1930's. Although such a visit would have been planned well in advance, he did not dress up in any way - according to his daughter he went out as usual in his shirt without a collar. Nor did he wait round for the Governor-General. When Lord Bledisloe arrived, the car had to be driven slowly through the nursery with Lord Bledisloe standing up in the back shouting "Mr Wright! Mr Wright! Where are you? Mr Wright!" The Governor-General was an agriculturist, Lady Bledisloe was perhaps less interested in plants; partway through the lengthy tour of the nursery, she sat down firmly, refused absolutely to taste any more fruit and simply waited for her husband (Copsey, 1982).

Wright continued in business until 1943 when he retired to Otumoetai near Tauranga. In 1948 came his only public recognition when he was elected an Associate of Honour of the Royal New Zealand Institute of Horticulture because of his having "devoted most of his seventy years to horticultural research and development" (Anonymous, 1948). He continued to be active until his late 80's, gardening and experimenting with plants right up to his death on 14/7/1959.

CONTRIBUTIONS TO HORTICULTURE

During his long association with the nursery trade, Hayward Wright made many contributions to New Zealand horticulture,

FIGURE 2: Wright holding kiwifruit canes. Reproduced from 'The New Zealand Small Holder' 12 (1930), 276. The original caption read, "Chinese Gooseberries. A fine sample of the crop of winter gooseberries grown by Mr H. Wright at Avondale, near Auckland".

especially fruitgrowing. Many of these contributions were of purely local significance: the introduction of useful plants from overseas or the selection of cultivars suitable for New Zealand conditions. Some of his achievements - such as the development of the 'Goldmine' nectarine, 'Paragon' peach or 'Hayward' kiwifruit - were of worldwide importance. It has been suggested that his efforts were "passed over by many contemporary growers" (Paynter and Greig, 1938-39), but this is only partly true. His stonefruit selections were rapidly taken up by the already established stonefruit industry. It did, however, take much longer for his work with citrus to be accepted, and the value of his 'Hayward' kiwifruit was recognised only with the development of the kiwifruit industry and the export of fruit to overseas markets. Wright would have been very proud had he lived long enough to know that his kiwifruit selection is the most important fruit cultivar ever developed in New Zealand. He would not have been fully satisfied, however - undoubtedly he would have started looking for new and improved kiwifruit.

Wherever possible when discussing his contributions to horticulture, I have allowed Wright to speak for himself, making only minor changes to spelling and punctuation. This has its dangers: his catalogues and the articles published in the "New Zealand Smallholder" were written to promote trade, his letters to the "New Zealand Gardener" and to Dr Harold Mouat were written when he was an old man, over 80. He was still interested in plants but, as he himself admitted, his memory was fading and he was often writing about events that had occurred 50 or 60 years previous. It is not surprising that there are sometimes small discrepancies between accounts written 30 years apart - this may indicate that he was relying on his memory and that the different accounts were written independently.

Only his work with citrus was described in any systematic way (Paynter and Greig, 1938-39). He left no private papers, notes or diaries. When Lord Bledisloe last visited the nursery he said, "Mr Wright, I command you to write all this knowledge down for posterity". Wright's reply was, "When I die, it dies with me" (Cummings, 1980).

Plant Introduction

In Wright's day, just as at present, development of fruit-growing industries was dependent on the free exchange of plant material. In May 1936, Wright placed an advertisement in "The Orchardist of New Zealand" (Wright, 1936), an advertisement which was also printed in his catalogues:

> "Notice to Fruitgrowers and Intending Planters.
> For over 30 years I have made a special feature of importing from various parts of the world, the very latest novelties that science can produce by way of hybridization in stone fruits, viz. peaches, nectarines, and plums. My recent importations comprise absolutely the finest and most expensive consignment of new fruits ever imported into this Dominion, specially bred for size and quality. Whether for home use, market, or factory, they will inevitably revolutionise fruit growing in this country.... Please note extra fancy fruit will always bring its price, even on a glutted market.... Imported and grown by H.R. Wright, Nurseryman, Avondale, the Importer and Raiser of new fruits."

Wright had served his apprenticeship under David Hay who was, in his own day, the greatest importer of new plants. In particular, Hay was a correspondent and frient of Luther Burbank and introduced many of his plants including his Japanese plums, into New Zealand. "The name of D. Hay and Son is now famous throughout Australasia and intimately associated with Japanese plums." "The introduction of 'Burbank' alone gives to our firm a name and reputation that will be long remembered in these colonies" (D. Hay & Son, 1899). Wright "followed in the steps of his former employer" (Paynter and Greig, 1938-39) and he has been credited with the introduction of many important plants. It is obvious that he spent much time and money on plant introduction. He received catalogues from nurseries throughout the world. His own catalogues sometimes state, frequently imply, that the plant being described had been newly imported by him. Nurserymen, of course, often emphasize the novelty of their stock of plants. Several nurserymen might independently introduce the one plant, each honestly believing that he was the first. A good example is the Tangshi cherry (see Anonymous 1923a, 1929c, 1932). Usually it is not possible to establish who was the very first with a particular plant, especially as propagating stock could be dispersed rapidly amongst nurseries. The number of plants that Hayward Wright introduced into New Zealand cannot, therefore, be determined.

The scale of his plant introductions can, however, be assessed from the detailed descriptions of his work with citrus (Paynter and Greig, 1938-39). At his nursery in Avondale he built up an amazing collection of citrus - 6 cultivars of citrons, 24 of lemons, 12 limes, 32 mandarins, 6 kumquats, 40 oranges, 2 shaddocks, 29 pomelos or grapefruit. It has been estimated that three quarters of these had been brought into the country by Wright himself (McPherson, 1949).

Plant introduction can be frustrating and difficult, requiring both persistence and skill. The difference in season between hemispheres caused problems. Material also often arrived in poor condition. "One of my last transactions [with the Yokohama Nursery Co.] was an order for 50 lbs of Trifoliata seed from which not one seed germinated, which proves the seed was old" (Wright, 1953a). Citrus seed is particularly susceptible to drying out and, in all, he was to make 10 separate importations of trifoliata seed before he was successful in getting germination (E. Cummings personal communication). In desparation he imported trifoliata plants (Paynter and Greg, 1938-39). Budwood, too, would arrive in poor condition: "Many times when Mr Wright has received [citrus] buds from overseas they were in such a decayed state that they were useless" (Paynter and Greig, 1938-39).

Material would often not live up to the advertising claims: "Years ago when the great apple planting boom was on at Huapai we nurserymen could not produce apple trees fast enough to meet the demand, and I happened to look through a Japanese catalogue where it mentioned an appled called *Pyrus toringo* [*Malus sieboldii*] was their national stock for working apples and as the price was reasonable I ordered 5,000 with the assurance from them that it was aphis-proof. Well I got over the 5,000 they arrived in our Summer and they had not been planted more than a month or two when became white with woolly aphis which shows how little dependence you place on a Japanese word" (Wright, 1951b). "They got the money, while I am now wiser for the experience" (Wright, 1927b). It was not all loss, however: as described later, the crab 'Gorgeous' was introduced as a chance contaminant in this shipment of plants.

It was expensive to import plants. Material could, however, be multiplied up very rapidly once it was in the country, even if this did require considerable horticultural skill. "My present stock [of *Malus prunifolia*] stands now at about ten thousand, and was worked up from two very small plants posted me from Japan" (Wright, 1921c). A few years later he was boasting - and justifiably so - about a remarkable success at propagation (Wright, 1925a). In March 1924 he had received by post from England a new nectarine, 'John Rivers': "The tree when opened up was so shriveled that it looked dead to all intents and purposes. However, there was too much at stake to throw it away, the Home price being 25/- each, with an additional 10/- for packing and postage, bringing up to 35/- landed cost.

Dead or not, I decided to give it the benefit of the doubt, and buried the whole tree in a shallow trench, covering it with about two inches of earth, after a good watering.

It was resurrected about four days later. Next it was subjected to both bottom and top heat, with the result that it threw up a shoot half an inch from the border line of the union. This shoot grew through the winter and by the end of September it had attained the length of six inches. It was then removed and used for spring budding. Seven trees resulted, ranging in height from three feet to six feet four inches. The buds were placed in the stocks in the beginning of October, 1924. They then had to unite with the stock before starting into growth, and by April 16, 1925 - practically six and a half months later [and one year after the original introduction] - they had provided bud wood for budding over of 1685 trees."

Plant Exchanges with the United States Department of Agriculture

"Mr Wright has always been very co-operative in the exchange of plant material between this section [Plant Introduction Section, USDA] and himself ..." (Whitehouse, 1955).

Wright collected catalogues from many different countries. He read overseas journals

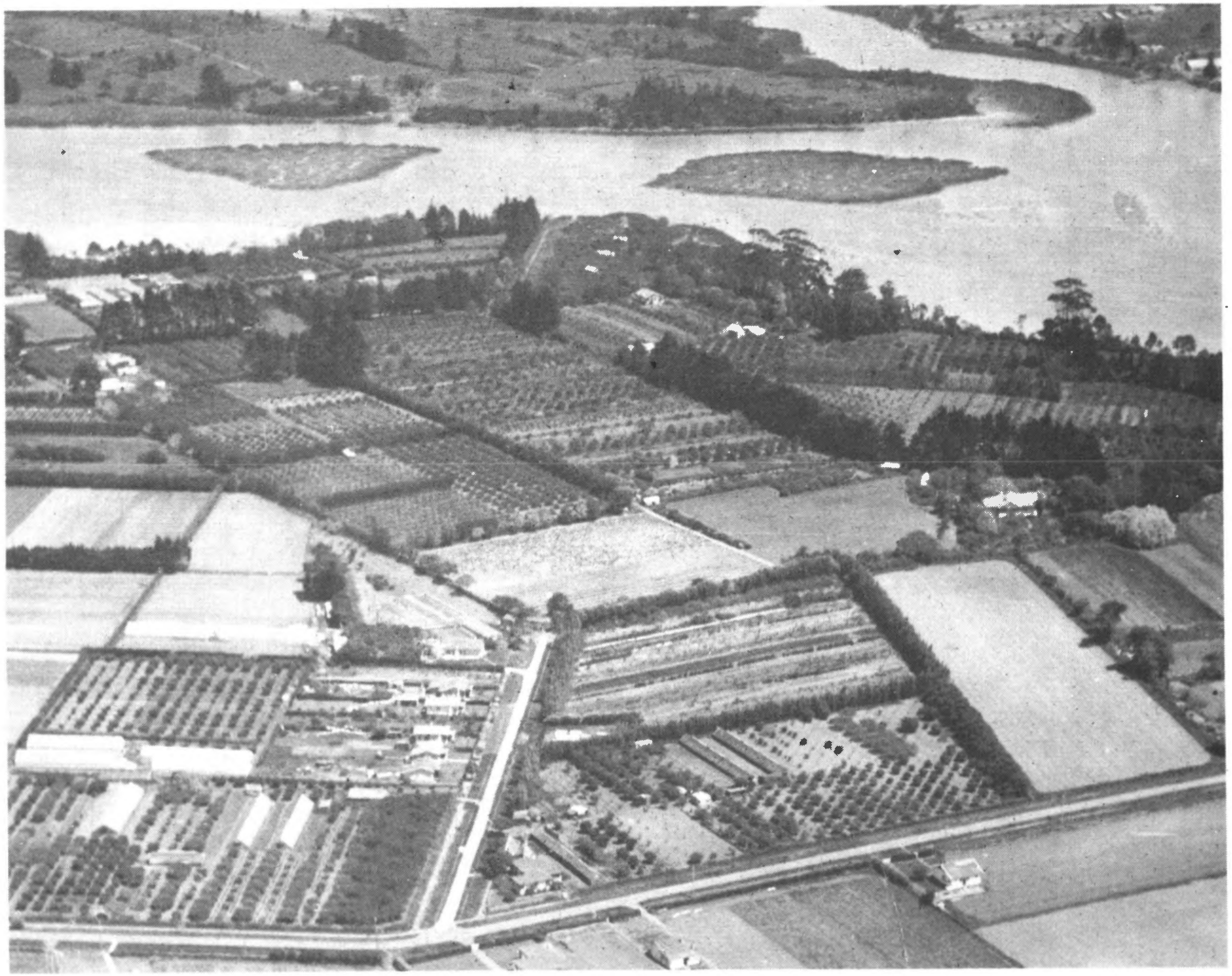

FIGURE 3: Wright's nursery off Rosebank Road, Avondale. The driveway to Wright's house (far right surrounded by trees) runs from the top of the small side road (The Avenue, now part of Mead Street). Apart from the two blocks on either side of the first part of the drive, the bulk of the nursery, partly surrounded by macrocarpas and pine trees, stretched from the house-end of the drive towards Avondale Road and the Whau Creek.

This photograph (Whites Aviation photo) was taken in 1938, but a similar photograph was used to illustrate some of Wright's catalogues. (Reproduced with permission of Whites Aviation.)

and reports, there were many overseas visitors to the nursery, and he had correspondents in so many parts of the world that his daughter Ezilda started collecting stamps (Copsey, 1982). Any letters that he had retained were destroyed at his death. However, the Plant Introduction Section of the USDA published detailed lists of all the plants introduced into the United States through their offices, and from these records it is clear that Wright was a regular and much valued correspondent: it seems that whenever he came across a particularly interesting plant he would send seed or budwood to Washington (Wright, 1935; 1953c). The USDA files have not been searched in any systematic way but some examples can be quoted of plants received from him:

1916: 4 nectarine selections (Ackerman, 1958). The same year he sent a number of apples and the following April he wrote (Wright, 1917) to describe the use of one of these, 'Willie Sharp' as an aphis-resistant roostock. At some stage he also sent propagating wood of 'Albany Beauty', 'Kidds Orange' (Red) and 'Oratia Beauty' (Hyland, 1957).

1918: "a collection of strikingly ornamental [native] trees and shrubs from New Zealand, sent in by our correspondent, Mr H.R. Wright" (Fairchild, 1922).

1930: 4 nectarine selections (Ackerman, 1958).

1935: seed of *Actinidia chinensis* (Division of Plant Exploration and Introduction, 1940) together with a description of the plant (Wright, 1935).

1935: "plants of 13 varieties, including new local forms of peach, apple, pear, oriental persimmon and mandarin orange ...
These, of course, are destined for trial in the Southern States and the Pacific Coast, where some of Mr Wright's earlier introductions have already become successfully established" (Morrison, 1940). These plants included the kiwifruit "a form with very large fruits" - the form that we now know as 'Hayward'.

It is not clear what plants Wright received from the USDA - one obvious possibility is the 'Meyer' lemon. We do know that he received a range of other citrus cultivars. A letter from the USDA (Whitehouse, 1939), in response to an enquiry from Plant Diseases Division, DSIR, stated that "it might be advisable to get in touch with Mr H.R. Wright ... to whom we have been sending citrus varieties for a number of years ...".

This exchange of plants continued for many years, even after Wright's retirement and up to the time of his death. In 1955, when Wright was over 80, DSIR was sending a number of plants to the USDA on his behalf (Farmer, 1955), and he was still receiving plants, especially citrus (Wright, 1952a; 1955a).

Plant Breeding

"The raising of new fruits has been a hobby of mine since the days of my apprenticeship, which were served with Messrs D. Hay and Son, of Parnell, and it was whilst in his employ that I first conceived the idea of raising new fruits, and there my first hit was the well-known 'Kia Ora' peach, followed later with 'Osprey Improved', 'Maoriland', and 'Mahuta'.

... Some of the varieties raised since being in business on my own account are [in peaches] the 'Paragon', 'Up to Date', 'Wright's Early', 'Wright's Late', 'Wright's Ruby', 'Wright's Midseason', 'Phenomenal', 'Ideal', 'Ice-Cream', and 'Shipper'; in plums, 'Wright's Early', 'Wright's Late', 'Wright's Gigantic', Wright's Prolific', 'Early Golden', 'Export' and 'Federation'; in nectarines, 'Surecrop' and 'Wright's Late'" (Wright, 1921a).

Initially, Wright concentrated on the selection of stonefruits and his many successes are listed in his catalogues and those of D. Hay & Son - the 'Goldmine' nectarine, the 'Paragon' peach, the 'Purple King' plum were probably the most valuable. He did not restrict himself to stone fruit, however. He did some work with apples and in 1923 the Pomological Board of Australia, in considering some apples produced by him, commended him on his work and enterprise (Anonymous, 1923c). He also worked in crab-apples, persimmons, kiwifruit, feijoas and citrus, perhaps the fruits that appealed to him most of all. His successful selections were almost always chance seedlings or sports and it seems that very few, if any, were the result of deliberate crosses. He gave the parents for many of the selections he named and propagated but usually these identifications were based on inference (Farmer, 1966).

It does, however, require a good plantsman to recognise potential qualities and select. Wright was a superb plantsman. "The raising of seedling fruits is in itself somewhat an art inasmuch as it takes an experienced eye to detect the points of breeding. The 'Purple King', as a seedling 18 in high, took my eye at a glance as a plum with a future, and so impressed me that I ventured to top work over five larger trees with it before it ever showed a fruit ... The famous 'Goldmine' nectarine had a very big change of passing into oblivion, in which case the fruit-growers would have been the poorer for it. This nectarine, like the 'Purple King', so impressed me by the fine appearance of the growth and foliage that I also worked up about six trees before it ever fruited, another instance where breeding showed itself" (Wright, 1921a). According to John Gracie (personal communication), Wright believed that "quality in leaf" indicated "quality in fruit". We know of the rare cases in which this proved true but we don't know of the many exceptions to the rule.

Wright was conscious of the inadequate rewards received by the raisers of new plants. A full-page advertisement in "The New Zealand Fruitgrower", announcing his new plum 'Purple King', stated: "Seeing that the raiser of new varieties has no protection by Act of Parliament, it is necessary to accumulate sufficient orders to absorb the present stock of trees before any can be distributed" (Wright, 1921b). He returned to the subject later the same year: "... [the] raising of new varieties [is[an enterprise which is yearly soliciting legislation on behalf of raisers, for is it feasible that this tedious, long, and painstaking work can be carried on indefinitely without remuneration to the raisers for their achievements, which will often benefit generations to follow long after the raisers have passed away?" (Wright, 1921c). One correspondent (Tonar, 1921) wrote in his support: "Take for example the case of the 'Paragon' peach (raised by Mrs [sic] Hayward Wright). This variety, so vigorous and a heavy cropper, must have placed 20,000 into the pockets of growers, and I doubt if the raiser recieved anything like the compensation he was entitled to". Perhaps it is just as well that Wright did not see the success of his kiwifruit.

Root Stocks

"I have been over 50 years in the nursery business, and in that time I have delved quite a lot into the hidden mysteries that exist between stocks and scions" (Wright, 1951b).

Wright's fascination with stocks and scions may have been stimulated during his apprenticeship by the success of Auckland nurserymen in developing root stocks resistant to woolly aphis, a development essential for the survival of the apple industry. Wright himself made several unsuccessful attempts to produce new apple root stocks. As already described, he imported over 5,000 *Pyrus toringo* (*Malus sieboldii*) stocks only to find that they were not, as had been claimed, aphis resistant (Wright, 1921c). Starting with only two plants he multiplied up over 10,000 stocks of *Pyrus prunifolia* (now *Malus prunifolia*) which had most of the attributes of a good root stock "of easy propagation, a very free grower and possessing absolutely the finest root system ... It is also immune to woolly aphis" (Wright, 1921c). The only trouble was that, surprisingly, most commercial apple varieties wouldn't take to the plants he had produced.

"The lack of affinity between stock and scion I liken unto present day marriages: there are three phases, viz, perfect, partial, none at all ... In the use of any stock that differs materially from the variety being worked on to it, one must expect some failures through lack of affinity ... some do well others only fair, others no good, for the failures we resort to double working" (Wright, 1951b). "The nearer the relation between stock and variety, the longer they take to come into fruiting, and the more distant the relationship the quicker they come into bearing" (Wright, 1927a). He thought a lot about these and similar problems and tried different combinations of stocks and scions with many plants - apples, cherries, citrus, plums, persimmons (Wright, 1923; 1927a; 1951a; b; 1954a; c; 1955c).

It was his work with citrus root stocks that was the most important, particularly his pioneering work with trifoliata (*Poncirus trifoliata*). Today the two root stocks of any importance in New Zealand are sweet orange, used mainly for lemons, and trifoliata, used for all other citrus. Fifty years ago, sweet orange and citronelle (rough lemon) were the most important root stocks (Hamilton, 1937); although trifoliata had been in the country since at least the turn of the century (Anonymous, 1899), it was little used except for mandarins in home gardens (W.M. Hamilton personal communication).

Wright considered that both citronelle and sweet orange had serious defects, e.g. on citronelle "the skin is thick, coarse and quality definitely poor, and for frost resistance it is the most tender of all stocks ..." (Wright, 1951b). He therefore tried a number of different stocks concentrating on citronelle, sweet orange, trifoliata and sour orange (Paynter and Greig, 1938-39). He was also one of the first to double work citrus (Hamilton, 1937): many stocks would not necessarily meet the two requirements of suiting the soil and having an affinity for the scion. He was impressed with trifoliata: "I have a lot of time for the Trifoliata stock, particularly as a quality producer and for frost tender varieties" (Wright, 1953c). As a stock it had a number of advantages:

1) citrus worked on it were more handy "due of course to winter dormancy of the stock, it is the root that counts for frost resistance" (Wright, 1953c). "On the deciduous Trifoliata stock one may grow citrus in districts where they never grow before" (Wright, 1951a);
2) it induced early bearing. "The heavy and precocious cropping of varieties worked upon *Poncirus trifoliata* is really phenomenal ...". "come into bearing earlier than any other root or stock. From one to two years will see most varieties in bearing upon it" (Wright, 1927a). Such precocity was important, commercially, although it could lead to exhaustion of young trees;
3) it affected the quality of fruit - the fruit had a thinner skin of better colour, less rag, more sugar and retained its juice for far longer when held on the tree;
4) the smaller trees allowed easier management and cropping.

Wright was an enthusiastic proponent of the use of trifoliata. From before 1920 and for many years he was essentially the only nurseryman to offer a range of grapefruit, oranges, lemons and mandarins worked on trifoliata (Paynter and Greig, 1938-39). "I was the first nurseryman in New Zealand to try out Trifoliata in a big way; this stock was condemned by all other nurserymen, for their slogan was, 'we don't recommend that which we do not possess'" (Wright, 1954c). In this criticism of other nurserymen he was unfair: trifoliata did have a tendency to "stunt" trees, particularly as it is susceptible to exocortis or scaly-butt virus. It was acknowledged to be a very promising root stock (e.g. Hamilton, 1937), but was not generally recommended. Trifoliata was accepted as the best root stock for most citrus only after many more years of experimentation and observation.

Wright's achievements with trifoliata can be summarised by an excert of a letter written to him by Dr H.M. Mouat (1952) after a trip north to look at old seedling oranges and oustanding worked trees. "It will give you satisfaction to know that in <u>every</u> case where we found an outstanding type of good quality orange, the tree was on trifoliata stock and had been obtained from you. Trees 20 years old were still growing well and producing large sized fruit of the usual excellent quality. I can foresee very much greater use being made of this stock in the future for commercial plantings of orange. The citrus industry will have cause to be grateful to you for your pioneering work with trifoliata".

<u>Stonefruit</u>

1. 'Goldmine' Nectarine.

The 'Goldmine' nectarine is one of the best known and most important fruit cultivars originating in New Zealand. Hayward Wright gave two detailed almost identical accounts of the discovery of 'Goldmine'. These have been combined:

"Messrs Ansenne Bros. were at college in

Belgium, and they bought some nectarines in a shop. They were taken with the quality of the fruit, and as they were shortly to be leaving for New Zealand, they decided to take the stones with them. One of them was given to Miss Lundon of Claybrook Road Parnell, and when the tree was about two years old [1895] someone told Miss Lundon unless it was budded it would not bear fruit, so she asked Hay to send up a man to bud over the tree. At that time the 'Burbank' plum had been recently introduced and was highly esteemed for its cropping, so Mr Hay said to me, take budwood of 'Burbank' and work over Miss Lundon's tree, that will please her" (Wright, 1952b).

"After finishing the job, Miss Lundon came out to inspect the work and greeted me with the remark, "Well, I suppose this tree next year will bear nectarines', to which I replied, 'No, it will be a Burbank plum tree'. Miss Lundon was horrified, for she said, 'We want nectarines, not plums'. That being so, I told her to give it time, next season it would probably bear fruit for it was then showing well for fruit buds" (Wright, 1921a).

"I was so impressed by the setting of fruit-buds that I put on a few buds before it had fruited. My Hay worked it commercially the following year" (Wright, 1952b). Miss Lundon was asked to name the new cultivar and it appeared as 'Goldmine' in the 1898 Supplementary Catalogue and Novelty list of D. Hay & Son: "The original tree growing in an open and exposed situation, first attracted our attention by its extreme hardiness, beautiful foliage, vigorous, sturdy and upright growth. From subsequent observations, we have no hesitation in recommending this remarkable new seedling nectarine as superior to all others for productiveness and all-round good qualities". The account in the Descriptive Catalogue 1899-1900, was even more enthusiastic: "We cannot speak too highly of this grand new variety, and have no hesitation whatever in pronouncing this local seedling the best nectarine in existence, being far ahead of all others. It must take the place amongst nectarines that 'Burbank' does amongst plums, a triumph of which we are truly proud".

Wright (1952b) stated that 'Ansenne', 'New Boy' and 'Goldmine' all came from the stones brought to New Zealand by the Ansenne brothers, whereas the D. Hay & Son Catalogue describes 'Ansenne' as being the "parent" of 'Goldmine'. Both 'Goldmine' and 'New Boy' were very successful cultivars, in their own right, in New Zealand, Australia and South Africa. In addition, 'Goldmine' has been used extensively in breeding programmes. One cultivar, 'Surecrop', raised by Wright from a 'Goldmine' stone, has itself been used in breeding programmes (Farmer, 1962).

2. 'Paragon' Peach

For most of this century the 'Paragon' peach has been one of the leading peach cultivars both for commercial orchards and home gardens in New Zealand. It is one of Wright's most important cultivars, whereas his other peach selections are now of lesser interest.

"'Paragon' peach came from an Elberta' stone and 'Elberta' came as a cross between 'Yellow Crawford', a freestone, and 'Chinese Cling', a very large, white flesh cling with a fuzzy skin. This trait is to be found in many of the 'Elberta' seedlings, their size and cling stone came from the 'Chinese Cling' and the yellow flesh from the 'Yellow Crawford'" (Wright, 1952b).

The stone was planted in the nursery at Avondale, and trees were offered to the public shortly afterwards, possibly in 1903 (Wright, 1952b; Farmer, 1954), although this seems unlikely as it would be only a year after Wright had moved to Avondale. It has sometimes been suggested that Mrs Wright planted the stone (Tonar, 1921; Farmer, 1976), but the earlier report may simply be a misprint as Mrs Wright did not arrive in New Zealand or marry until 1906 (Cummings, 1983).

3. 'Million Dollar' ('J.H. Hale') Peach

Wright imported many stonefruit, especially from California and Japan, but details are usually lacking. An exception is the notable 'J.H. Hale' which was so successful in the United States that it was popularly known as the 'Million Dollar Peach'. The catalogues of several different Auckland nurserymen (e.g. Mackay, 1922) record that 'Million Dollar' was introduced to New Zealand by Wright. It soon became popular in this country - it was a heavy cropper, the fruit was large and of good colour and, although a freestone, the flesh was of a good, firm consistency making it an excellent shipper.

4. Plums

"The late Mr D.A. Hay (nurseryman) was responsible for the introduction of all the first Japanese plums that came into this country, and when I left Hay's employment I took over the introduction of the newer introductions" (Wright, 1955b). All Hay's introductions came from Luther Burbank. Wright's came from Stark Brothers (who took over Burbank's estate) and Armstrong: they included the cultivars 'Elephant Heart', 'Mariposa', 'Late Satsuma' and 'Inker's Gold' (Wright, 1955b). In addition, Wright selected and named a number of Japanese plum cultivars. The most important of these were 'Purple King' and 'Billington' ('Billington's Early').

"The new Japanese plum which I have named 'Purple King' originated as a chance seedling in the vicinity where grew a 'Hale' and a 'Doris'. It is without doubt a cross between these two, as it takes the size and shape of 'Hale' with the deep purple colour and texture of the 'Doris'" (Wright, 1921a). Wright first noticed the plant as a seedling growing against a wall on the property of Mr P. Gillard of Avondale. He was so impressed by its appearance that, before it had even fruited, he named it 'Purple King' because of its colour and size (Wright, 1921a; Farmer, 1954). The plant was first noticed in 1915, but Wright did not offer it for sale until 1921, when he had been able to raise a large stock of trees (Wright, 1921b).

'Billington' was a chance seedling growing on the property of a Mr Billington of Glen Eden, Auckland. Wright bought the propagation rights (Farmer, 1954) and was responsible for its development, plants first being sold in the early 1920's (Mackay, 1922). In his catalogues he suggested that it might be a cross between 'Cherry Plum' and 'Satsuma'. It was a good commercial proposition as the tree carried large crops, which hung well, and the fruit was a good shipper.

Citrus

"The nursery of Mr Hayward R. Wright, of Avondale, has been the scene of many valuable and practical trials of all types of citrus during the past 35 years, and the experimental work done in this nursery will prove the foundation of the citrus industry in New Zealand" (Paynter and Greig, 1938-39). He built up a large collection of citrus, "one of the most extensive in the Southern Hemisphere" (Anonymous, 1935). He obtained new cultivars, mainly by importation but also by selection of bud sports or seedlings and by deliberate hybridizations. "As Mr Wright walked around his 25-acre estate on the Avondale flats, he pointed out citrus trees of countless varieties, raised from trees or seeds imported from every country where citrus growing is established, and he showed how new varieties had been raised by crossing and budding on different stocks until one was almost bewildered by the limitless possibilities of research in the plant world. For more than 20 years, so he explained, he had been engaged, absorbed in this work. There were citrus trees from Jaffa and other parts of Palestine, from California and Florida, from India and China, from Japan, from all the important citrus States of Australia and from the islands of the Pacific" (Anonymous, 1937). By maintaining contact with leading citrus authorities throughout the world and through his own experimentation and observation he amassed a tremendous wealth of information on root stocks, cultural practices and propagation methods. He obtained new cultivars, mainly by importation but also by selection of bud sports or seedlings and by deliberate hybridizations. Fortunately, a comprehensive account of his "citrus observations and experiences" was published a few years before his retirement "in order that the valuable data acquired should not be wasted". This "recording of his valuable information has been gleaned in the course of many long and interested talks with Mr Wright" (Paynter and Greig, 1938-39). Several reports of his work with citrus also appeared in newspapers of the time (e.g. Anonymous, 1935; 1937; Vine, 1937). Wright continued working on citrus in his retirement, importing new cultivars, testing new combinations of stock and scion, working up new seedlings from crosses. Even at 82 he was budding Kusai lime seedlings, "I only hope I will be spared to see some of them fruit" (Wright, 1955a).

Wright's greatest achievement with citrus was undoubtedly his work on root stocks and his promotion of trifoliata. He has also been given much of the credit for establishing that suitable cultivars of sweet orange and mandarin could be grown successfully in New Zealand; that there was no need for the importation of fruit (Anonymous, 1928c; 1935). His work on citrus introduction and selection was less successful - only a few of the cultivars he brought in are today commercially important and his crosses produced nothing of any value. What was probably required at that stage in the development of the New Zealand citrus industry was a critical comparison of a few promising cultivars rather than the importation of many new and different cultivars (Hamilton, 1937). He did, however, have a number of successes: the 'Clementine' mandarin, the 'Meyer' lemon, various oranges, the 'Wheeny' grapefruit, and the 'Tineura' tangelo.

1. Mandarins

Wright has been credited with the introduction of 'Clementine' (Anonymous, 1948), now the most important mandarin grown in New Zealand. The date of its importation is not known but by 1939 he had already sold 300 trees to an orchardist at Tauranga (Paynter and Greig, 1938-39). Two years later the 'Clementine' was inluded in a list of five new citrus cultivars that he considered outstanding (Anonymous, 1941).

He also offered a number of 'Satsuma' strains in his catalogues but the origin of the strains now grown is not certain.

2. 'Meyer' lemon

The 'Meyer' is not a true lemon but a natural hybrid between the lemon and some other species of *Citrus*. It was collected by the plant collector Frank Meyer near Beijing, China and introduced into the United States by the U.S. Department of Agriculture in 1908.

Wright introduced the 'Meyer' lemon into New Zealand in the mid 1920's (Anonymous, 1928a; Gibson, 1931; Cummings, 1973). He may have received it because of his links with the USDA, since he was able to advise in the supplementary list to his catalogue of the early 1920's: "PLEASE NOTE - We are the sole distributors of this sterling variety in the Dominion. NO AGENTS. Prices: 7/6, 10/6 and 15/- each", remarkably high prices when his apples and stone fruit generally cost only 2/6 each and his other citrus 4/- or 5/- each.

According to his catalogue:

"This is undoubtedly the most wonderful lemon ever introduced for hardiness, early fruiting and perfect shaped fruit. It stands unequalled by any other lemon ... In looking down the nursery rows, the trees are a sight to behold with fruit from end to end, bunches carrying 6 to 10 lemons; in fact, no tree is too small to bear, and will commence bearing from 5 inches in height and upwards ... The wealth of bloom in the spring would commend it as a shrub, even if it never bore fruit. No garden in the Dominion should be without this variety."

"For early fruiting and heavy cropping the [Meyer] ... stands unequalled by any other lemon" (Wright, 1927b).

The 'Meyer' is still grown commercially to some extent although it does not have the pronounced lemon flavour of the standard lemon cultivars. It is, however, a most suitable plant for home gardens.

3. 'Wheeny' grapefruit

The 'Wheeny' takes its name from the Wheeny Creek district near Kurrajong in Australia where it is thought to have originated as a seedling (Farmer, 1974). It was introduced to New Zealand by Wright and commended by him, in his catalogue of about 1930, as "a fruit of large size, thin skin, with an abundance of juice, bitterness and sweetness well blended". Trees were sold to private gardeners and commercial growers and by 1947 the first sizeable quantities of fruit were being marketed (Anonymous, 1947). The 'Wheeny' is still grown in home gardens but is of minor commercial importance.

4. Oranges

Wright seems to have been responsible for importing 'Carter's Navel', a strain of the 'Washington Navel' developed in the United States, and for propagating 'Robertson's Navel' a strain obtained from a Mr Robertson of Avondale (Paynter and Greig, 1938-39; Anonymous, 1941; 1948). He was also responsible for the propagation and development of 'Best's Seedless Navel'. This originated when, after the death of the scion, a sweet orange seedling stock grew up into a large, heavily cropping tree. In 1911 or 1912 Mr Best of Avondale brought a few of the fruit to Wright. "Upon sampling, I was most impressed by the deep coloured and delicate flesh of superior quality to any other variety previously samples... In honour of the raiser, we named it, 'Best's Seedless Navel'" (Wright, 1924), a name later shortened to 'Best's Navel'. This cultivar demonstrated the effectiveness of trifoliata in inducing early bearing: on sweet orange it took 20 years to come into bearing, on trifoliata only four years (Paynter and Greig, 1938-39).

5. 'Tineura' Tangelo

"The 'Tineura' tangelo came from the Cook Islands and was raised by a native, and was named after him. It was the late Mr W.C. Berridge who sent me the bud wood... This Mr Berridge used to live in Tauranga and was appointed fruit inspector down in the Cook Islands and that is how he came in contact with the Tineura" (Wright, 1953a). The Tineura is still grown today although it is being replaced by better tangelos.

Persimmons

In many of the older suburbs of Auckland there are fine examples of persimmon trees, 40-60 years old. Most of these would have come from Hayward Wright: "I made a specialty of Persimmons when in business in Avondale. I had about 20 of the leading varieties in fruit; consequently was able to test the quality of all of them... I was able to supply all the nurserymen and seedmen in Auckland, even as far as Wellington, with Persimmons" (Wright, 1945b).

"The persimmon ... has been much neglected in the past, owing, no doubt, to its astringency when eaten in an unripe state, as when thoroughly ripe it is a most luscious and much appreciated fruit among those who have learned to appreciate its excellent qualities... Their sugar content is very high, and when dried they make a splendid sweetmeat, equal if not superior to the best dried figs, possessing the advantage of having no seeds.

Apart from its utility, the tree is a most handsome and striking object throughout the summer with its large, glossy green leaves which turn to the most gorgeous tints in autumn. Its beauty is still further enhanced by the numerous golden fruit which often cling to the tree long after the leaves have fallen" (Wright, 1923).

Almost all the persimmons offered by Wright in his catalogues were astringent and he continually stressed that "fruit should not be eaten until it is quite soft naturally, then it will be ripe and appreciated and looked for more" (Wright, 1954b). His personal favourite was "Tsura Gaki" (Cummings, 1967). Two of his cultivars were non-astringent, one a seedling of his own raising, and 'Twenty (Twentieth) Century' which Wright considered to be the same as 'Fuyu' (Wright, 1954b).

Pepino

The pepino is currently creating interest amongst horticulturists but is by no means a recent arrival in New Zealand. In his catalogue of about 1930, Wright offered:

"A NEW FRUITING SHRUB FROM PERU. Known as the PEPINO or Peruvian Melon Shrub. Here is a remarkably useful subtropical fruiting plant unknown in New Zealand, and yet which should have a place in every garden, being a dual purpose plant, combining beauty with utility... The large fruits are carried through the best part of the year, and are from 4 to 6 inches long, shaped like a Tree Tomato, yellow when ripe, splashed with violet. The fruits are described as tender, aromatic, juicy and have a rich flavour, that no doubt will appeal to everyone... Offered only by me for the first time in the Dominion."

This seems to be the first record of the pepino in New Zealand. Wright's strain had "small fruit, yellow with purple splashes and good sweet melon-like flavour - not vaguely tobacco-flavoured" as are some of the more recent introductions (McKenzie, 1983). His introductions were not, however, particularly successful and, until the last few years, the pepino has remained an ornamental curiosity being offered only occasionally by nurserymen.

Feijoa

Although Hayward Wright was one of the first nurserymen to propagate and distribute the feijoa he seems not to have been responsible for its introduction to New Zealand. Indeed, it is not clear who did first grow it. An un-named Auckland nurseryman introduced feijoas from Australia about 1908 (Bailey, 1952). One planting was established in the Bay of Plenty at about the same time (Sydenham, 1946). Another report (Anonymous, 1946) has it that Alexander Allison was the first, introducing three cultivars. One enormous tree still remains in what was Allison's garden at Wanganui, and feijoas on the property of his brother, James Allison, had reached 10-12 feet in height by 1934 (Whelan, 1934). Initially the feijoa seems to have made little impact - one early report (Anonymous, 1916) stated that feijoas had "not proved of any value in this country as an edible fruit".

Wright's feijoas were grown on from seed brought in from the Elasf Botanical Garden, Egypt, by Mr Poynton S.M. of Epsom (Anonymous, 1929a; Rice, 1929; Gibson, 1932). A photograph of the feijoa flower was published in 1920 and the caption said (in part), "The fruit was 1½ to 2½ inches long, with a thick, white pulpy flesh, of a sweet and highly perfumed flavour, suggesting pineapple and guava. It ... gives every indication of making a useful plan for hedges or windbreaks besides being very attractive when grown as a single bush. The Feijoa was introduced by Mr Hayward Wright ..." (Anonymous, 1920). In his catalogue of abour 1925 Wright listed only *Feijoa sellowiana* with fruit resembling "a half-withered green passion fruit of delightful flavour".

Wright imported plants of the cultivars 'Superba' and 'Coolidgei' from Australia and also acquired 'Choiceana' (Gibson, 1932). Cultivars of these names as well as 'Magnifica' "a new seedling of our own raising; fruit of large size and heavy cropper" were offered in the 1930 catalogue. It is interesting to note that Frank Mason and several other Manawatu nurserymen were also propagating and selling feijoas 'Superba' and 'Coolidgei' at this time (Whelan, 1932). Their material may have originated from a different source.

Wright raised a large number of seedlings from seed of the imported 'Choiceana' and John Gracie made a number of selections (Mouat, 1953; J. Gracie personal communication). Two, 'Coolidgei' and 'Superba', were given their names because of their resemblance to the cultivars as described in catalogues from overseas: another two were named 'Mammoth' and 'Triumph' and these have remained the most important local selections for many years. The origin and status of the different named cultivars that have been sold by nurserymen is not always clear: the names 'Coolidgei' and 'Superba' have been used, apparently indiscriminately, for material imported from overseas and material raised in New Zealand (Bailey, 1952).

In 1937 Wright presented 200 feijoa plants to the Mt Albert Borough Council (Gibson, 1937). These were planted in Alberton Avenue where a number still remain.

Kiwifruit (Chinese gooseberry)

Wright did not, as has sometimes been suggested, introduce the kiwifruit to New Zealand - nor was he the first nurseryman to grow it or sell it. He did, however, select the cultivar 'Hayward'. This is now the only kiwifruit cultivar of any commercial significance in New Zealand and the predominant cultivar in all other countries where kiwifruit plantings have been established. As a detailed history of the kiwifruit is being prepared, only a brief account is given here.

The kiwifruit had been in New Zealand from 1904 and Wright was offering plants for sale in his undated catalogue of about 1922, advertising them in 1925 (Wright, 1925b). By then he had probably grown vines for a number of years (J. Clark; J. Gracie personal communications). The source of the first plants in Auckland is not known but they appear to have been introduced by the Plant Branch of the Auckland Acclimatisation Society (Anonymous, 1923b; 1926).

Wright was impressed by the kiwifruit: "In this new plant, we have beauty and utility combined. For covering arbors, pergolas, or for training on porches, it will be found unsurpassed for beauty, while its fruit will prove a much-needed addition to our short supply of salad fruits for early winter use" (Wright, quoted in Anonymous, 1926).

"It can be eaten with sugar and cream in fruit salads, pies, or made into jam or jelly. The fruit in appearance is oval, bronze colour, covered all over with short spines or hairs, which are easily removed by rubbing in the hands. The flesh is pale green, with minute seeds about the size of the raspberry. It is in no way related to our English gooseberry, but merely takes the name Chinese gooseberry from its flavour ... One grower in Feilding claims to have taken 50 lb of fruit off a three-year-old vine. In size the fruit is about as large as a fair-sized passion fruit" (Wright, 1927b).

Initially, not everybody was convinced. Wright displayed some of his newer fruits at a welcome in Auckland to the visiting Director of the Royal Botanic Gardens, Kew - the Chinese gooseberries were doubtfully described as being "very ornamental and perhaps palatable when ripe" (Anonymous, 1928b). Within a few years, however, more favourable reports were appearing: "During the past few seasons there has been a demand by the clients of high class fruit shops, while many confectioners have been using finely sliced rings of this attractive fruit for sponge and cake decorations, the flavour imparted being very suitable for such a purpose" (Rice, 1936).

Wright sold fruit as well as plants: "I sold on the Auckland market the first Chinese gooseberries. I put them up in strawberry chips, by way of giving them a wider distribution. For the larger fruit I received 1/- a chip, and for the smaller 6d a chip" (Wright, 1951b). "We find the best way to deal with the fruit is to grow the seedlings on until they fruit, then select the largest fruit and best croppers, then work them on to seedling stocks. I find that they will bud or graft, they will sometimes grow from cuttings but I prefer the budding or grafting. We send them out in pairs of one male and one female. On a large scale I think one male would do a dozen females planted in centre but care should be made to see that the male flowers at same time so as to clash, for I have found them variable in the time of flowering" (Wright, 1935).

He recognised that "it is the large fruiting varieties that top the market" and he selected two large-fruiting plants from a row of seedlings: "I received a small case of fruit of the Chinese gooseberry from a Feilding auctioneer ... I quite forget what his name was. It was from this fruit I got the seed that produced the Wright's giant, a short thickset fruit. I also raised from this seed a large, long fruited variety" (Wright, 1953a).

The auctioneer from Feidling was almost certainly Norman Gorton who had acquired his plants from Alexander Allison. The seed would have been planted in 1924 or 1925 and a row of some 40 seedlings was grown up. The 'Wright's Giant' was renamed 'Hayward' by Mouat (1958) and the other good-fruited plant was called 'Gracie', after John Gracie. 'Hayward' was first being sold in the mid 1930's. It has large fruit, of fine flavour, which store extraordinarily well. The selection of this remarkably good cultivar was one of the critical steps in the development of the kiwifruit industry.

Ornamentals

Although Wright was interested in ornamentals his catalogues contain comparatively meagre lists. Not surprisingly, for a nurseryman who concentrated on fruit trees, one of his specialties was his range of ornamental *Prunus* - flowering almonds, cherries, peaches and plums. He was the first to bring the Taiwan cherry, *P. campanulata* into the country (McPherson, 1949). There was a good collection of crab apples (including several of his own raising such as 'Gorgeous' and 'Bledisloe'), there were rhododendrons (some of which are still growing in the streets of Mt Albert), roses, and an amazing collection of lilacs. In the early 1930's he had over 90 distinct lilac cultivars available for sale and he was undoubtedly correct in claiming that this was the largest collection in New Zealand. Probably the most noteworthy of the ornamentals he developed or introduced are the 'Gorgeous' crab and *Cedrela sinensis*.

1. 'Gorgeous' crab

"The 'Gorgeous crab' was one of four seedlings that were mixed in a consignment of *Pyrus toringo* that I imported from the Yokohama Nursery Co., Japan. These four seedlings had the normal leaf of an apple, while the Toringo has a cut leaf like the hawthorn. The four seedlings I planted out to see what sort of fruit they would produce ..." (Wright, 1925b).

When they fruited each one was different and one was markedly superior - "unequalled by any other crab for productiveness and brilliancy of colour, and for jelly is unsurpassed, while for decorative purposes in garden or shrubbery it is an object of beauty. This crab was first exhibited at a chrysanthemum show in the Auckland Town Hall, where it attracted great attention, and at the conclusion of the show was transferred to a seedman's window in Queen

Street, where it immediately drew a crowd, among whom were two ladies, who said that the fruit was tied on or gummed on; but when assured by the writer it was no fake remarked "Well, that is gorgeous". Being an unnamed seedling, 'Gorgeous' now it remains, and today it is circulating over the two hemispheres" (Wright, 1927b).

Thus the 'Goregous' crab was not actually bred by Wright but was instead a chance seedling introduced, selected and named by him. It is still a popular plant in nurseries today. The 'Bledisloe' crab was a hybrid between 'Goregous' and 'Delicious' apple and according to Wright's catalogue was "approved and named by his Excellency the Governor-General, on his recent visit to our nurseries". 'Goregous' was also one of the parents of the well-known 'Jack Humm', probably the best of available crabs (Challenger, 1960).

2. *Cedrela sinensis*

In recent yeras the *Cedrela* (or Chinese toon) has been widely planted for its spring foliage, a sharp, almost unnatural pink. Originally a common tree in China, it was introduced to Europe in 1862 where it soon became popular. According to John Gracie, the *Cedrela* first arrived in New Zealand in a bundle of plants from Holland, some time in the early 1930's (Copsey, 1982). The *Cedrela* does not appear in any of Wright's catalogues, and he does not seem to have propagated or sold it. Some years after Wright's retirement to Tauranga Miss Norah Copsey collected suckers from the site of the old nursery. Plants given to Jack Clark were propagated on a large scale and are the origin of probably all *Cedrela* now growing in New Zealand (J. Clark; N. Copsey personal communications).

Catalogues

Three complete catalogues and a copy of part of a fourth catalogue are held in the library of the Mt Albert Research Centre, DSIR. No other catalogues by Wright have been located. All are undated but the approximate dates of publication can be determined:

1914-1918 An 11 page excert listing about 120 apple cultivars. A note at the beginning of the catalogue states that "owing to the war we have been compelled to reduce list of varieties to curtail expenses".

1922 "General catalogue of fruit, shelter and ornamental trees", H.R. Wright, Avondale Nurseries. Brown cover, 20 pages with 4 page supplementary list.
This catalogue includes the 'Purple King' plum first released in 1921, and 'J.H. Hale' ('Million Dollar') peach. Wright's advertisements in the May and June 1922 issues of "The New Zealand Fruitgrower" announced the publication of a new catalogue. The supplementary list probably dates from about 1925 as it includes the 'John Rivers' nectarine.

1930-1932 H.R. Wright, Avondale Nurseries. "General catalogue of fruit, shelter and ornamental trees ..." (inside cover). Yellow-green cover, aerial view of nursery on front cover, 39 pages plus 4 unnumbered pages of photographs in centre.
This catalogue lists as a new fruit the Worcester Berry, a hybrid between the gooseberry and black currant, and the peach 'Salberta'. The Worcester berry was first grown in New Zealand in 1929 (Anonymous, 1929b) and a photograph of the fruit was first published two years later (Anonymous, 1931a). A photograph of 'Salberta' peach, described as a "new pedigree peach" was also published in 1931 (Anonymous, 1931b).

1935 H.R. Wright, Avondale Nurseries. "General catalogue of fruit, shelter, and ornamental trees ..." (inside cover). White cover with design by Jo Gernert in blue and black of sun, fruit trees and basket of fruit, aerial view of orchard on back cover, 39 pages plus 4 unnumbered pages of photographs in centre. According to Mrs Cummings (1967) this was published in 1935 or possibly 1936, and was Wright's last catalogue.

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Citations for the Award of Associate of Honour A.H.R.I.H. (N.Z.) 1983

Sydney (Charlie) Challenger

Charlie Challenger as he is known throughout New Zealand began his horticultural career when he gained his B.Sc. in horticulture at Reading University in 1943. From here he entered the Royal Air Force (air crew) and served until 1947, being demobilised as Flight Lieutenant where he was Education Officer, India Command.

He gained wide horticultural experience in Great Britain, much of it in commercial horticulture prior to qualifying with the N.D.H. in 1951.

In 1956 he was appointed lecturer in horticulture at Lincoln College where he remained as a member of the academic staff until his retirement in February 1983.

His enthusiasm and vigour in the early days of horticultural teaching at Lincoln College led to the steady buildup of student numbers and his influence throughout New Zealand is profound indeed and particularly so where Lincoln Old Students are to be found.

His interest and knowledge in nursery production, flower production, amenity and environmental horticulture is extensive and for many years he was much sought after as a speaker at meetings, seminars and conferences.

He was a senior judge of home gardens, streets and factory gardens in Christchurch for many years and served on Committees of the Canterbury Horticultural Society and the N.Z. Alpine Garden Society (Canterbury Branch). For two years, 1960-62, he wrote the gardening notes in the Christchurch Press. In 1962 he was appointed lecturer in charge of the Horticultural Department at Lincoln College, and was the College representative on the Nursery Stock Research and Advisory Committee up until 1966.

As the Lincoln College representative on the Dominion Council of the Institute, Charlie Challenger kept a close interest in the affairs of student training. He was the Chairman of the Sub-committee of the Canterbury District Council which produced the booklet "Careers in Horticulture" of which 10,000 were printed and distributed.

In 1966 he returned to Great Britain for two years to study landscape architecture at the University of Newcastle on Tyne. He obtained the post-graduate Diploma in Landscape Design with Distinction and upon returning to New Zealand he was instrumental in establishing the first New Zealand courses in Landscape Architecture.

Charlie Challenger set high professional standards for these courses from the beginning, and because of this, the profession of Landscape Architecture quickly gained recognition and membership of the International Federation of Landscape Architects.

He was foundation editor from 1974 to 1981 of "The Landscape", the journal of the Landscape Institute.

The N.Z. Institute of Landscape Architects recognised Charlie Challenger's significant writings and contribution to the landscape education in New Zealand by recently announcing the Charlie Challenger award in his honour.

Philip J. Jew

Philip Joseph Jew joined the Parks and Reserves Department of the Auckland City Council as an apprentice in May, 1946. In February 1949 he transferred to Messrs Duncan & Davies Nursery in New Plymouth. After completing his apprenticeship in June 1950 he returned to work for the Auckland City Council. He completed the National Diploma of the Royal N.Z. Institute of Horticulture in 1956.

In August 1952 Phil Jew travelled overseas and in the five years spent in Britain he gained student gardeners Certificates from the Cambridge University Botanic Garden and the Royal Botanic Gardens, Kew. Whilst at Kew he won the Matilda Smith Memorial Prize, the Dummer Memorial Prize and the Hooker Prize. He also obtained the English National Diploma in Horticulture. He attended a year's training course at the Park Administration College and obtained their Certificate. He returned to New Zealand in September, 1956 and again started work with the Auckland City Council where he later became Officer-in-Charge of Horticulture. Aucklanders must thank him for making their inner city greener for it was at his instigation that semi-mature trees were moved to small vacant plots and traffic islands landscaped.

In March 1966 he was appointed to the staff of the newly established Auckland Regional Authority as Manager, Parks and Reserves.* One of the regional projects of the Authority was to establish a system of rural/coastal parks. They had already taken over the administration of the Centennial Memorial Park in the Waitakere Ranges and the first regional park, Wenderholm, had been opened to the public. In the intervening seventeen years Phil Jew's diligence and foresight has played a major role in the establishment of a further eight regional parks and two reserves. The responsibility for the development and maintenance of the Mt Smart Sports Centre is also now the concern of his Department. All the coastal parks feature pleasing layouts and well planned facilities which cater for most of the needs of the high influx of summer visitors; all are immaculately maintained, a feature that we are apt to take for granted. Great care has been taken to preserve the unique natural features of the area. Parklands not covered with indigenous forest and at present not required for park facilities are farmed efficiently. All these facilities are an important tourist attraction and a joy to Aucklanders.

Improved educational facilities in the Centennial Park such as the development of a Nature Trail, the building of an Information Centre, the conducting of guided walks at weekends and public holidays and the development of facilities for overnight stay for school children and youth groups have encouraged a greater appreciation of this unique asset - it has become something more than a 'bush' reserve used by hardy trampers. In all cases a policy of conservation of the indigenous forest and regeneration of the cut-over areas has been firmly emphasised.

Throughout his career in horticulture Phil Jew's greatest ambition has been to establish a Botanic Garden in Auckland. With the support of the Auckland Horticultural Council and the District

Council of the R.N.Z.I.H. the Auckland Regional Authority bought 42 hectares of land at Manurewa in May 1967. A further 22 hectares has since been added. Lack of finance held up development but with quiet persistence and thoughtful planning, work continued and the Gardens were opened in February 1982. As the English conservationist, Dr David Bellamy noted, "only mad New Zealanders could open a Botanic Garden in the midst of a world depression".

Phil Jew was a member of the inaugural committee which established Eden Garden in 1964. This garden, run by the Eden Garden Society is a horticultural feature in Auckland. His active interest in horticultural education saw him teaching practical horticulture at night classes at Tamaki College for five years in the early 1960's, and from October 1966 to May 1971 he gave popular home gardening talks on Radio 1YA. With the increasing interest in horticultural education and the establishment of the Botanic Gardens, Phil Jew was approached to organise an examining centre for the National Diploma of Horticulture Oral and Practical examinations in Auckland. The first examinations were held at the Botanic Gardens in 1980. His efforts are greatly appreciated by the students in the northern area.

He is an Associate Member of the Institute of Park Administration (Great Britain) by examination, a member of both the N.Z. Institute of Park Administration and the N.Z. Institute of Public Administration, he is a fellow of the R.N.Z.I.H. and has served on the Executive of the Auckland District Council, R.N.Z.I.H. and various Committees of the N.Z. Institute of Park and Recreation Administration.

We in Auckland greatly appreciate the work that Phil Jew has done for horticulture and conservation in this area.

* The Auckland Regional Authority has supplied the following information:

Centennial Memorial Park and Waitakere Ranges Reserves	8612 ha
Regional Parks	2952 ha
Mt Smart Sports Centre	22.4 ha
Botanic Gardens	64.7 ha

R. Winsome Shepherd

Mrs Shepherd has had a ver long, continuous and varied service in horticulture. Her academic career gained a degree in Botany and Zoology from Auckland University and she then worked for five years as a timber technologist with the Plant Diseases Division, D.S.I.R., studying moulds and borer in housing and the introduction of chemical controls. For three years she worked for Shell Oil Company and during this time wrote the Biological Section of the Shell Handbook on Orchard Pests & Diseases and their control. She then changed to another field of horticulture and worked for two years on a commercial vineyard, in Auckland.

In the mid 1950's she became a foundation member of the Riccarton Horticultural Society and was also an early and involved member of the Canterbury Cloche Society. Mrs Shepherd was both a grower and exhibitor of chrysanthemums with the Canterbury Horticultural Society. Her involvement with the Riccarton Horticultural Society included the organisation of displays at the Hagley Park Show. The Society won an R.H.S. Bronze Medal for an exhibit on the Riccarton Bush and made innovative use of floral arrangement in presenting a three dimensional bush scene. It was this initial concept of presenting plant material in a pleasing aesthetic and interesting manner that Mrs Shepherd has given great emphasis to throughout her service and the dissemination of this concept and its development owes much to Mrs Shepherd's ideas, energy and enthusiasm.

Mrs Shepherd was an executive committee member of both the Wellington Horticultural Society and the Wellington District Council R.N.Z.I.H. in 1961 and continues to be an executive member of the Wellington District Council. She has also served as the District Council's Secretary.

With the Wellington Horticultural Society she worked on displays for the senior floral art section and also organised displays with the Wellington Botanical Society. She organised a Floral Art Group for the W.H.S. for two years.

Mrs Shepherd was the R.N.Z.I.H. member of the first Floral Art Judges Course, run by W.D.C. and lectured on horticulture in floral art. She was one of the initiators of the first issue of Floral Art Definitions and assisted in writing a floral art section in Flowers for Shows. She has worked continually to ensure that the R.N.Z.I.H. Floral Art Handbook is accepted as the standard in New Zealand.

For the Floral Art Society in New Zealand Mrs Shepherd has lectured to judges courses in various parts of New Zealand for several years.

Mrs Shepherd has been a most active District Council Executive member, organising and participating in talks, lectures and displays. She became the District Council's representative on Dominion Council and was elected to the National Executive in 1976 and has served continuously since then.

Mrs Shepherd has worked to introduce the Notable and Historic Trees Scheme and is currently the Acting Chairman of this Scheme.

She has also worked to introduce the Plant Evaluation Scheme which while still in its initial stages has required considerable effort.

Through her position as Chairman of the Regional Horticulture Committee she has also been involved with environmental matters, a judges register, and other aspects relating to District Council organisation.

Mrs Shepherd has also organised a Home Gardeners page for the "Dairy Exporter" which has required the contribution of a high standard of articles.

For the last 2½ years Mrs Shepherd has been working on Early Plant Introductions to N.Z. 1840-1875 with the N.Z. Historic Places Trust. The W.D.C. Historic benefitted at their 1981 A.G.M. from a lecture on "Introduction of Plants to the Wellington Region 1840-1875" - a most thoroughly researched lecture. At present she is working on information on trees planted by early settlers in Wellington for the Notable & Historic Trees Committee.

Mrs Shepherd has assisted the N.Z. Girl Guide Association as a Floral Art Tester, coached cubs for environmental badges and organised a most ambitious Combined Scout & Guide Floral Art Festival in Karori in 1980. She has also assisted the Wellington Camellia Society with exhibitions and displays and until recently was a long serving member of the Wellington Floral Art Club.

Mrs Shepherd's energy and enthusiasm is reflected in this long and varied summary of her involvement over many years in horticulture. Her influence and dedication has obviously had a much wider impact than with the many groups and associations listed.

A Botanic Garden - Values to a City

by

W.J. Scadden

Summary of an address given to the A.G.M. of the Canterbury Region R.N.Z.I.H.

INTRODUCTION

The Christchurch Botanic Garden, I believe has something of a unique location - 30 hectares of space within a loop of the Avon River, adjacent to 180 hectares of active recreation area in Hagley Park and having as immediate neighbours the McDougall Art Gallery, Canterbury Museum and the Christchurch Arts Centre. Yes, all of these tremendous facilities and within just fifteen minutes of the city centre.

Much has been said and written about what a Botanic Garden should be, but a number of functions need to be met and these come within four main categories.

1. Botanical

To provide an extensive collection of plants, correctly identified and labelled.

To maintain a complete set of records about the Botanic Gardens, its plants and other work.

To maintain and improve the herbarium for scientific and record purposes.

To preserve, propagate and make available plants which are classified as rare or endangered.

To act as an import station and trial ground for new plant species and cultivars.

To conduct research into various aspects of botany.

2. Horticultural

To cultivate the widest range of plants which will grow within the climate and soil extremes of the site.

To cultivate in an artificial environment, the widest possible range of plants.

To display plants to their best advantage and provide examples of good landscape detail.

To preserve trees, shrubs and plants in the best possible condition utilising the best horticultural and aboricultural techniques.

3. Educational

To provide opportunities for people to learn during their visit.

To be a training establishment for young gardeners and students.

To provide an educational service to schools.

4. Recreational

To provide a peaceful and relaxing area for people to participate in passive recreational activities.

Botanic Gardens or a Beautiful Park

It would be a simple task to have this area maintained as a beautiful park, where people could pursue different forms of recreation, but, I believe that by achieving the functions we have just considered these factors give the distinction of a botanic garden.

Import Station and Plant Exchange

A vital function is the introduction

into New Zealand of seeds from Botanic Gardens, Arboretums and private collectors around the world. The Christchurch Botanic Garden produces an Index Seminium (seed catalogue) of New Zealand native plants and distributes this to over 500 gardens. As part of the exchange, Index Seminiums are received in return, from which seed of species not grown in the garden is selected. Apart from printing and postage costs, no finance in involved.

Not only are the introductions of benefit to improving the collections at Christchurch, but the plants which are excess to requirements are available for distribution to other authorities within New Zealand and in this way horticulture in general is benefited.

Trial Areas

For the purposes of plant assessment for both the Botanic Gardens and the interest of the public, plants which are newly released by the New Zealand Nurseryman's Association are grown. After a period of two or three growing seasons within this area plants are placed in permanent positions elsewhere in the garden.

Similarly, seed of annual bedding plants is received from supplies both within New Zealand and overseas. These trial plots are available for public inspection and assessment is made for general plant vigour, disease resistance, flower form, colour and length of flowering period.

Training Area for Horticulturists

With a wide coverage of horticultural operations, the Botanic Garden serves as an important training area for young horticulturists. Either as apprentices, or pre-entry Lincoln College students, a programme operates, whereby practical experience, aided with regular demonstrations covers a wide spectrum of horticultural skills.

The Needs of the Community

With an increasing interest in horticulture, both within amenity and the commerical area a botanic garden has an ever-increasing role of importance to fulfil.

Some of the factors which we need to be aware of:

- Horticulture can be taken as a school certificate subject at many schools now.
- Homes with small section sizes, need careful selection of plant material and other elements within the garden setting.
- People have an increasing amount of leisure time brought about by:
  - (i) automation in industry
  - (ii) job sharing
  - (iii) the fast approaching 35 hour week
  - (iv) unemployment
- Increasing fuel and general motoring costs affect the distances and frequency of travel and people will tend to increase their patronage of local facilities.

What Are We Providing Now?

A fine collection of plants outdoors and within conservatories.

A toast rack vehicle for guided tours of the garden.

Talks to garden club groups and school groups on conservation, plant collections, wildlife and plant propagation.

Summer band concerts and displays by morris dancers.

Information sheets concerning the various plant collections.

Monthly news/views item in the daily newspaper.

Information boards at each of the entranceways concerning items of particular interest at the time.

Some of the Opportunities for the Future

Open instructional classes on Saturday mornings, on apsects of propagation, plant culture, pruning, pest and disease control, etc.

Greater use of the lawn areas for the performing arts.

A closer link with the Art Gallery in exhibiting sculpture within the garden area.

Greater use of the trial ground to evaluate garden landscape materials such as paving materials, windbreak designs, hedging plants.

An education centre where permanent displays could be set up dealing with topical material.

CONCLUSION

Judging by the signs within our community during the early 1980's people are very likely to have a huge increase in the amount of leisure time before the end of the decade.

Many have an intense interest in horticulture others are idle and have few interests. Whichever category people are in, a botanic garden has something to offer all - the need is to encourage a greater use, to be able to provide an improved service and to be ready in advance of the increasing numbers of patrons.

The Banks Lecture, 1983
The Export of Ornamental Plants

by

B.L. McKenzie

Topline Nurseries, Glen Eden, Auckland.

Mr Chairman, Ladies and Gentlemen. It is an honour and a pleasure to be invited to address the Royal Institute of Horticulture and to present the Banks Memorial Lecture.

When on researches the works of this man it is worth noting that over the 200 years that have passed many parts that were identified by him are today making a significant part of New Zealand ornamental exports into England. Two plants well known to us all are Phormiums and Leptospermums.

When one goes to the dictionary and looks up the word Horticulture it is regarded as the science of growing flowers, bulbs, vegetables, fruits and plants, along with the care of the garden. Many years ago the word horticulture was used in academic levels but today it is as common as the word inflation and Bank Managers, likewise 15-20 years ago it was a subject seldom heard of in Secondary education or Universities but if one compares it to today's standards, it is now making a very large and significant impact both throughout our Universities as well as other forms of Secondary education.

Undoubtedly this has been brought about by the Actinidia Chinensis boom, or better known to us in New Zealand and now world wide, as Kiwifruit. This fruit was originally from China and brought to New Zealand, and the work undertaken by several enterprising New Zealanders has certainly put this country on the map in the production of quality fruit, but also has made New Zealand known for its other products throughout the horticultural circles, and in my particular case, the green plant.

For many years the Dutch have been world leaders in plant production and still are. Ghent in Belgium was also noted for its plant production many years ago especially with flowering plants, such as Azaleas, but this has changed due to the fact that they have not kept up with modern trends and changing standards that are now put on us by such perfectionists as the Dutch and Japanese growers.

Ornamental exports from New Zealand go back many many years, but it is only over the last 15-20 that we have seen significant increases in the developing of an industry as we know it today. Such companies as Duncan & Davies and its founder are world known for the impact they made in Horticulture both in New Zealand and around the world. Exports from these companies were in small quantities, however, and mainly more to the hobby gardener and smaller plant enthusiasts but today we see not only airfreight but shipping containers leaving New Zealand to ports in the Northern Hemisphere with New Zealand live plants. I believe considerable progress has been made in the past 5-10 years and what we will see in the next 5-10 years is very difficult to estimate.

The question that many people ask is why can New Zealand export when it is 12,000 miles away from its large markets. Along with distance we are confronted with higher freight costs, few flights out of New Zealand relative to other international airports, the difficulty in communication and language barriers in some countries.

New Zealand is regarded as a clean country; it has a high standard of quarantine; it has a large coast line which is not associated to any other large land mass and as a result of this it can offer and guarantee high quality produce grown in an ideal climate which provides high light intensities, good soils, adequate water plus possibly our biggest advantage that being in the opposite hemisphere, when it is our Autumn it is the beginning of their Spring. As a result of this the landing of plants at this time alleviates much of the over wintering problems that can be experienced in nurseries.

As a result of the oil price hike some ten years ago which affected the heating costs in glasshouse production throughout Europe, it caused many nurserymen to think seriously of what crops carry the most value to them and what should be held in glasshouses for over wintering. Many plants acceptable to our New Zealand climate do not stand in their juvenile stages the harsh English and European winters, and as a result of this require protection in houses. This form of protection, especially where heat is required, is expensive. This brought about English growers to think seriously about alternative markets for the product and although distance was a disadvantage, New Zealand had an opportunity to supply much of the stock as it was already being produced in New Zealand for our own domestic market. Plants such as Mahonias and Viburnums are two that come to mind.

We then also had the opportunity to introduce new crops from New Zealand which provide not only colour and flower but that during the period of acclimatization will stand lower temperatures in England. One plant, the Phormium, has proven most successful in this capacity, although in the early days it suffered some setbacks with the 1978 and 1981 harsh winters but has survived and today makes a significant contribution to exports. The Leptospermums previously mentioned is still a significant plant being produced in Europe not only as a house plant but as a garden plant outside.

To boost and encourage nurseries to look at exports, Government assistance through incentives have allowed us to make moves into these areas and with the assistance of our Embassies this has aided the New Zealand producer and marketing people to search out and find these new markets.

If one wishes to have a look at individual markets, our largest at this stage is England, which is known for its gardening people, its flower shows, parks and allotments and the prime time garden programmes that they have on television. With a country of approximately six million people who are so interested in plants who have approximately one million small glasshouses attached to the back of their residences if only ten per cent of these were tapped with one plant this would give approximately 100,000 plants, which represents approximately five ton of green plant material leaving New Zealand. The potential of these countries with their hundreds of thousands of enthusiasts can offer a significant boost when one is producing a new product such as the Phormium. As mentioned previously the nurserymen, and in particular the wholesale grower, was looking to avoiding over-wintering when the result of this, the arrival of our plants in the spring, coupled up with the rapid growth that they were capable of, the little need for acclimatization has boosted the range in garden centres today. Looking at Danish plant production as a comparison there are many small growers but the volume that is produced is most significant. They have a very successful co-operative which runs a major marketing body for them, feeding in first class material from the whole horticultural range whether it be flowers, pot plants, trees and shrubs or vegetables. In Germany the system is similar to the Danish scheme and works just as well but here we are faced with harsh winters and cold drab conditions when spring starts to emerge. Colour is what is demanded and if one can produce stock timed correctly to take advantage of this spring growth movement, high prices and large quantities can be moved. The acceptance of the New Zealand Kiwifruit as a fruit to eat in Germany has been known as most significant and although it may sound somewhat gimmicky there is considerable interest in the purchase of New Zealand Kiwifruit plants as ornamental vines to be associated with the sale of our fruit. Of course these will never produce fruit for commercial or even back yard basis but the use of the plant in a window box or in a window of a house is quite common. Germany is very central to the many markets in its neighbouring countries and therefore is a very useful point to distribute to other growers.

In the Dutch system there is no doubt that Aalsmeer opens the eyes of any grower from any part of the world. The volume of sales that are fed in daily, and the volume that then goes to all points of the globe is quite shattering and one wonders when you are 12,000 miles away whether there is any opportunity for countries such as our own. The quality control that is stringently adhered to is a credit to the Dutch organisation and with the government research that is put into horticultural products they can guarantee both quantity and quality to meet the world demands.

Japan has also been noted as a country with a strong emphasis on horticulture. To open up markets for ornamental plants in such a country it is necessary to understand the people, their culture and not to go with too many preconceived ideas of what they should have. When one looks at their horticultural production, their landscaping and the uses that they put plants to, there are many items that we grow in New Zealand that could be quite acceptable to this market.

The offering of samples to establish goodwill between two parties is essential and the trailing of the goods is most important to the Japanese. Once they have the confidence and the proof that the product will meet their requirements the quantities that they require are significant and long term arrangements can be established. Quarantine does cause difficulties in such a country but with understanding on both sides this can be met by the exporter and certainly follow up visits are essential.

The Japanese are noted for their close follow up to the producing country and it is quite common that many groups of visitors come to visit the nursery to see the techniques that are being used, the product being produced and the quality prior to export is there. Once this is firmly established long term relationships are quite common.

Where does it take us in the future? There is little doubt that research into both plant production, quality controls, pests and diseases, storage and transport are essential and it is for this reason that all exporters should work closely with Government departments and the Universities.

We are lucky to have in New Zealand our Government departments which are closely allied to the Universities and in these areas some of the top scientists of the world. It is through such people that exporters and horticultural producers can liaise closely so that they get the assistance required to research their crops out thoroughly before attempting to establish markets out of New Zealand. Quality control is closely associated with the research work and this is essential so that we establish a name for the New Zealand product overseas.

It is difficult for us to determine market potential and produce a quantity that some people require but nevertheless New Zealand has got quality producers of nursery products and although licencing and controls are not particularly in favour amongst growers a combined effort of exporting New Zealand produce under a quality control symbol similar to that of the woolmark is worthy of consideration in the future.

With such potential markets out there, future planning and marketing is essential, this being available through many professional organisations today, but they cannot succeed in the market place unless we have the true horticulturists working within the nursery, producing the plant to the quality standards.

Culture of Container-Grown *Ficus macrophylla* I. Influence of Nutrition on Foliage Growth

by

M.B. Thomas and S.L. Teoh

Department of Horticulture, Landscape and Parks, Lincoln College, Canterbury.

ABSTRACT

The nutrition of *Ficus macrophylla* grown in peat:sand (1:1, v/v) medium was examined using a central composite design with N, P, K, and lime at five levels each, and a 5 x 2 factorial experiment with 5N and 2P levels. This species was found to be highly responsive to NPK fertilization. Increasing N levels promoted plant height, stem thickness, leaf area, appearance and foliar dry weight. The response to N was further enhanced at high P and K levels due to strong N x P and N x K interactions. Lime fertilization generally depressed quality, however, these effects were considerably modified by N, P, K levels and increasing lime levels at high N P K can produce good quality plants. Well established rooted cuttings could be potted-up into a soilless medium supplied with 4 kg/m³ of 8-9 month Osmocote (N P K 18/2.6/10) plus 1.5 kg/m³ superphosphate, liming to a pH of 5-5.5 and the addition of trace elements.

INTRODUCTION

Ficus elastica cultivars are popular indoor plants in many parts of the world and the nutrition of this species has been studied by various workers (Bloome and Herregods, 1967; Seager, 1969; Seager, 1979). In contrast, there is limited information on the container-nutrition of *Ficus macrophylla* (Moreton Bay Fig) which is increasingly important as an indoor plant in Australia (Brooks, 1978) and New Zealand. Two experiments on the nutrition of *F. macrophylla* are reported here. The first experiment was designed to examine the response of container-grown *F. macrophylla* to various levels of N, P, K, and lime fertilizers in a peat:sand (1:1, v/v) medium using response surfaces to describe nutrient interactions. The second experiment was a factorial experiment initiated to further study the inter-relationship of N and P fertilization.

MATERIALS AND METHODS

Experimental Design, Media and Fertilizers

Experiment A - a four factor response surface Box-Hunter design, of Cochran and Cox (1957) of the composite second order type with incomplete blocks was used. It involved N, P, K, and lime with 30 treatments arranged in blocks, each consisting of three sub-blocks and four replicates per treatment. This was started on 30.11.78 and harvested on 10.6.79. Nutrient levels for the treatments are shown in Table I and Figure 2.

Experiment B - a 5 x 2 randomised block factorial design was used with ten replicates involving 5 N and 2 P rates and run from 1.4.79 to 1.10.79. Nutrient levels for the treatments are shown in Table II.

The medium used for both experiments was equal parts (1:1, v/v) Mataura sphagnum peat and coarse sand (crushed shingle grit - particle size, 40%: 3.6-2.00 mm, 22%: 2.0-1.0 mm, 38%: 1.0 - 0.1 mm). Rates of N, P, K, and lime for Experiments A and B were supplied using Osmocote (26% N), superphosphate (9% P), sulphate of potash (39% K) and 3 parts (w.w.) dolomite lime to 1 part agricultural lime ($CaCO_3$). All treatments received a basal dressing of 75 g m^{-3} 'Sequestrine' iron chelate (Na EDTA Fe with 12% Fe) and 150 g m^{-3} 'Sporumix A' (containing 1.14% B, 0.62% Zn, 1.27% Cu, 5.44% Mn, 0.06% Mo, 0.05% Co, 9.78% Mg). The media and fertilizers were well mixed and then transferred to PB5 (2½ litre) planterbags just prior to potting.

Growing Conditions

Both experiments were carried out in a heated glasshouse equipped with automatic fan ventilation set with a minimum glasshouse temperature at 15°C, and a maximum temperature close to 5°C above the ambient temperature. The plants were hand-watered when required.

Media Analysis

Samples from equivalent treatments (Experiment A only) were collected after final harvest and bulked to give a composite sample from which a saturated extract was used to determine nutrient levels in the medium. Nitrate N was analysed using the colorimetric salicyclic acid method, NH_4-N by NH_3 gas sensing membrane probe, P by the colorimetric molybdovanadate method and K, Ca, and Mg by Atomic Absorption/Emission. Available nutrients and pH levels for an experiment of the same design (as Experiment A), media and fertilizers were given by Thomas (1980).

Foliar Analysis

Samples of leaves and stems were randomly selected from replicates of specific treatments aggregated and finely ground to give a composite sample from which sub-samples were taken and analysed for N, P, K, Ca and Mg using the techniques described by Parkinson and Allen (1975) and Nicholson (1978). Only foliar N and P were determined for Experiment B.

Data Collection and Analysis

Growth was assessed on visual rating (0 = dead plants; 5 = high quality, vigorously growing plants), plant height, internode length and stem diameter. Total leaf area was determined by measuring the area of all fully expanded leaves while oven dry weight of plant tops was determined at the completion of each experiment.

Plant height was measured from the media to the node of the last fully expanded leaf while internode length was determined by dividing stem length by the number of internodes. Stem diameter was measured 5 cm above the medium.

All data was statistically analysed for F-test and analysis of variance while data presented in graphic form in this paper were calculated from equations of the response surfaces.

RESULTS

Experiment A: Foliage Growth

Generally, the addition of N, P or lime strongly influenced foliage growth while K only mildly affected the response to nitrogen (Table 1). Fertilizer N and P strongly enhanced plant growth and appearance with the optimums at approximately 450 g N/m^3 and 375-500 g P/m^3. However, it was noticeable that N failed to influence internode length and leaf area was unaffected by P levels, and there was no main effect inlfuence from K. Plants given the highest rates of N and P tended to be the tallest and highest quality, and have the greatest stem diameters and dry weights.

Liming depressed foliage growth (Table 1) with visual ratings, leaf area and dry weight highest at nil lime in the peat/sand medium (pH 4.1). However, lime strongly enhanced the plant internode length (data not shown) and the height response to N (Figure 1) with the strongest N effects occurring at 12 kg lime/m^3. The influence of N on leaf area (Figure 2) and dry weight was similarly increased by the presence of added K. The plants therefore had the largest leaves when high rates of N and K were combined.

Foliar nutrient levels were influenced by added N, P, and K. There was a strong linear increase in foliar N which went from 0.9 to nearly 1.5% of dry weight when fertilizer levels were increased from 150 to 450 g N/m^3. Foliar K linearly increased from 1.2 to 1.5 with increasing K additions while there was a correspondingly strong decrease in foliar Mg. Fertilizer P only mildly influenced foliar N and calcium. Media analyses obtained after harvest indicated the following ranges: NO_3-N 4-26;

P 5-4; K 1-5; Mg 34-35; Ca 108-117 mg/litre saturated extract. The pH was 4.1, 5.3, 5.8, 6.1 and 6.3 at 0, 3, 6, 9 and 12 kg lime/mg³ respectively.

Experiment B: Foliage Growth

Generally, the results were similar to Experiment A. Nitrogen and P strongly enhanced foliage growth (Table 2) while plants grown without fertilizer N or P were stunted (Figures 3 and 4). It was noteworthy that in most cases, added N and P strongly interacted to influence growth (Table 3). Both additions enhanced plant appearance, height, internode length, leaf area, and dry weight, but when highest levels of N and P were combined, growth was depressed (Figures 3 and 4, Table 3). The optimum growth was generally maintained at 150 g N/m³ plus 300 g P/m³; plant quality was highest with this combination, although it was notable that foliar dry weight was greater at higher levels of N and P but plants were shorter and had smaller leaves (Figure 5). Similarly, foliar colour was further enhanced by a higher added N level of 450 g N/m³ (Table 3). Foliar N and P concentrations increased strongly with added fertilizers (Table 2) and these two nutrients were correspondingly highest in the foliage at 1050 g N/m³ and 300 g P/m³.

DISCUSSION

Generally, *Ficus macrophylla* was very responsive to added fertilizers in both experiments. Plants grown at 450 g N/m³ were taller, heavier, had thicker stems, more leaf area and higher quality gradings than those at low N rates. In addition, the influence of N was enhanced by P and K fertilization. This was particularly so in Experiment B where a strong N x P interaction was observed in Experiment A and may be associated with the high P levels (up to 500 g P/m³) used in this experiment. The difference in optimal levels of N in both experiments was probably due to the strong interactions between N and other additions.

Thomas (1981) found similar results with *Ficus elastica* where it was unusually responsive to P fertilization, particularly in the presence of high N. Generally, fertilizer N had only a minor influence on plant growth. However, contrary to this, Seager (1969) reported that *Ficus* species reacted more strongly to K than to N. The results in the present study were opposite to this and may be associated with excessive K in Experiment A and adequate levels in Experiment B. However, the N:K ratio appeared to be more important than absolute levels of N and K. Bloome and Herregods (1967) recommended a 1:2 ratio while Joiner and Waters (1970) indicated that it is common for the N:K ratio of foliage plants to exceed 2.0. Optimum growth in Experiment A occurred with a N:K ratio of 2.1, similar to that reported by Poole *et al.* (1976) for *Ficus elastica* and *Ficus benjamina*. However, Seager (1979) and Thomas (1981) found considerably lower N:K ratios for *Ficus elastica* than those reported by Poole *et al.* (1976). This could be due to the different conditions in the experiments of these researchers. For example, light levels may affect nutrient requirements (Conover and Poole, 1974).

Generally, liming strongly depressed the growth and appearance of *Ficus macrophylla*. However, this was moderated at high levels of N, P, or K fertilizers to such an extent that the liming was beneficial when these nutrients were at high levels.

The levels of foliar nutrients for optimal growth were similar to those reported for *Ficus elastica* and *Ficus benjamina* by Poole *et al.* (1976). However, it was noticeable that P levels in *Ficus macrophylla* were approximately twice that for other *Ficus* species. This may be luxury uptake of P, but may also indicate a high requirement coupled with a tolerance for high foliar P concentrations.

PRACTICAL IMPLICATIONS

Ficus macrophylla responded well to added nutrients and liming, if these additions were applied in a balanced application. Phosphorus appeared to be an important nutrient to apply when combined with medium rates of N, while lime and K were also important if used to compliment N and P.

Well established young plants could be potted up into a soilless mix containing 4 kg/m³ of 8-9 month Osmocote (NPK - 18/2.6/10) plus 1.5 kg/m³ superphosphate, liming to a pH 5-5.5 and the addition of trace elements.

TABLE 1: Experiment A - The influence of N, P and lime on foliage growth - significant responses <u>only</u>.

(*** = P<0.001; ** = P<0.01; * = P<0.05; # = P 0.05-0.10; for all tables.)

Added Nutrients (g/m^3)	Height at 7 months (cm)	Internode Length (cm)	Stem Diam. (cm)	Visual Rating	Leaf Area (cm^2)	Dry Weight (g)
Nitrogen						
150	44.7 **		1.14 #	2.19 ***	1984 ***	27.3 **
225	49.5		1.16	2.64	2078	29.8
300	52.4		1.18	3.00	2203	32.0
375	53.4		1.20	3.27	2359	34.0
450	52.7		1.22	3.44	2545	45.8
Phosphorus						
0	43.4 *	3.94 **	1.08 *	2.27 **		27.0 *
125	49.0	4.77	1.14	2.68		30.0
250	52.4	5.15	1.18	3.00		32.0
375	53.5	5.09	1.19	3.22		33.1
500	52.4	4.58	1.17	3.35		33.4
Lime kg/m^3						
0	64.0 *			4.23 **	2980 ***	44.2 **
3	56.0			3.38	2471	36.4
6	52.4			3.00	2203	32.0
9	52.0			3.09	2178	31.0
12	55.1			3.65	2394	33.5
Significant Interactions	N x Lime *	N x Lime *			N x K #	N x K #
CV (%)	16	15	8	25	15	18

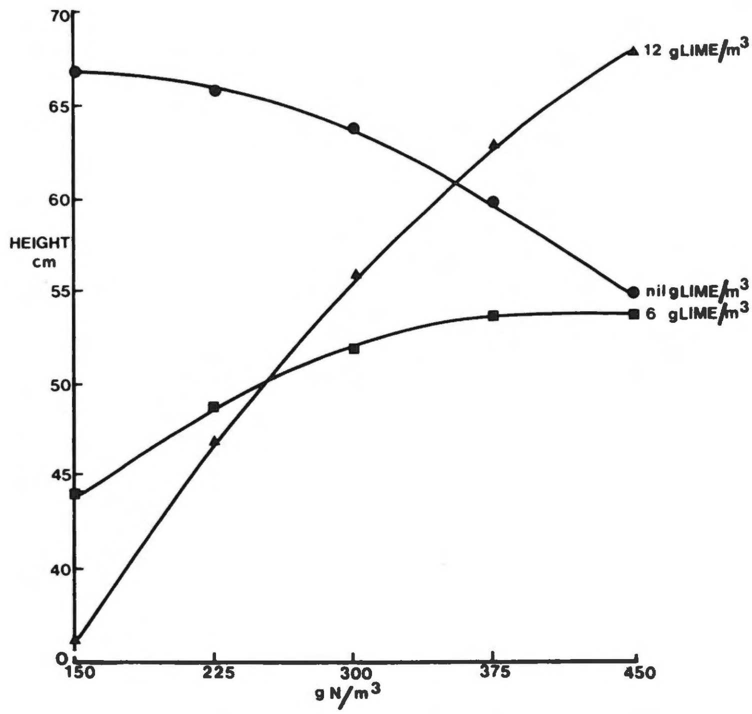

FIGURE 1: (Experiment A) The interaction of N and lime on plant weight (cm); showing the importance of adequate lime (and correct pH) with N fertilization.

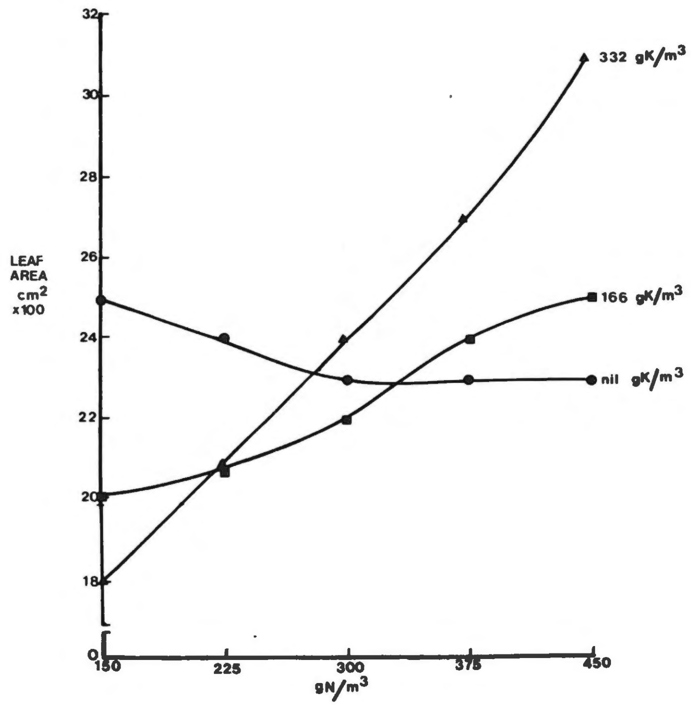

FIGURE 2: (Experiment A) The interaction of N and K on leaf area (x 100 cm^2); showing the importance of high K rates with N fertilization.

TABLE 2: Experiment B - Effect of N and P on quality ratings, growth parameters and foliar N and P.

Treatment	Visual Rating	Colour Rating	Height (cm)	Internode Length (cm)	Stem Diam. (mm)	Leaf Area (cm^2)	Dry Weight (g)	Foliar N (% dry wt.)	Foliar P (% dry wt.)
N (g/m^3)									
0	1.7 ***	1.8 ***	25.2 ***	2.3 ***	8.2 ***	834 ***	10.3 ***	1.43 ***	0.16 *
75	2.8	2.8	36.0	3.4	9.6	1358	18.4	1.86	0.19
150	3.4	3.2	37.7	3.7	9.9	1487	20.5	2.47	0.19
450	3.4	4.1	39.3	3.9	9.2	1583	20.6	2.75	0.22
1050	3.1	4.2	34.7	3.3	8.3	1416	17.8	3.20	0.23
LSD 5%	0.64	0.32	6.08	0.64	0.64	176	2.56	0.06	0.06
P (g/m^3)									
0	2.5 ***	3.2	31.9 ***	2.9 **	8.6 ***	1141 ***	15.2 ***	2.28 ***	0.18 *
300	3.3	3.3	37.3	3.7	9.4	1530	19.8	2.41	0.22
LSD 5%	0.32	0.32	2.88	0.32	0.32	112	1.6	0.03	0.03
Significant Interactions	***	***	***	***		**	***	***	#
CV (%)	18	14	15	23	9	16	18	2	17

TABLE 3: Experiment B - Interaction of N and P on quality ratings, growth parameters and foliar N and P.

		VISUAL RATING		COLOUR RATING		HEIGHT (cm)		INTERNODE LENGTH (cm)	
		P Level (g/m^3)							
		0	300	0	300	0	300	0	300
N level	0	1.38	2.00	2.00	1.63	23.7	26.7	2.1	2.6
(g/m^3)	75	2.25	3.38	3.00	2.50	29.2	42.8	2.5	4.3
	150	2.38	4.38	3.00	3.38	30.9	44.6	2.8	4.6
	450	3.13	3.75	3.63	4.63	39.9	38.8	4.0	3.8
	1050	3.25	3.00	4.25	4.13	35.8	33.6	3.3	3.3
	LSD 5%	0.85		0.76		8.68		1.26	

		LEAF AREA (cm^2)		DRY WEIGHT (g)		FOLIAR N (% dry wt.)		FOLIAR P (% dry wt.)	
		P Level (g/m^3)							
		0	300	0	300	0	300	0	300
N level	0	730	928	9.9	10.8	1.37	1.50	0.15	0.16
(g/m^3)	75	1076	1639	15.3	21.5	1.90	1.81	0.19	0.19
	150	1145	1828	15.5	25.5	2.53	2.41	0.18	0.20
	450	1399	1767	18.2	23.1	2.50	3.00	0.17	0.27
	1050	1356	1476	17.3	18.3	3.08	3.32	0.19	0.26
	LSD 5%	352		5.42		0.09		0.04	

FIGURE 3: (Experiment B) The influence of increasing N levels on foliage growth (nil added P); showing the key significance of N fertilization.

Left to right: 0 150 1050 g N/m³

FIGURE 4: (Experiment B) The influence of increasing N levels along with high P fertilization (all at 300 g P/m³).

Left to right: 0 150 1050 g N/m³

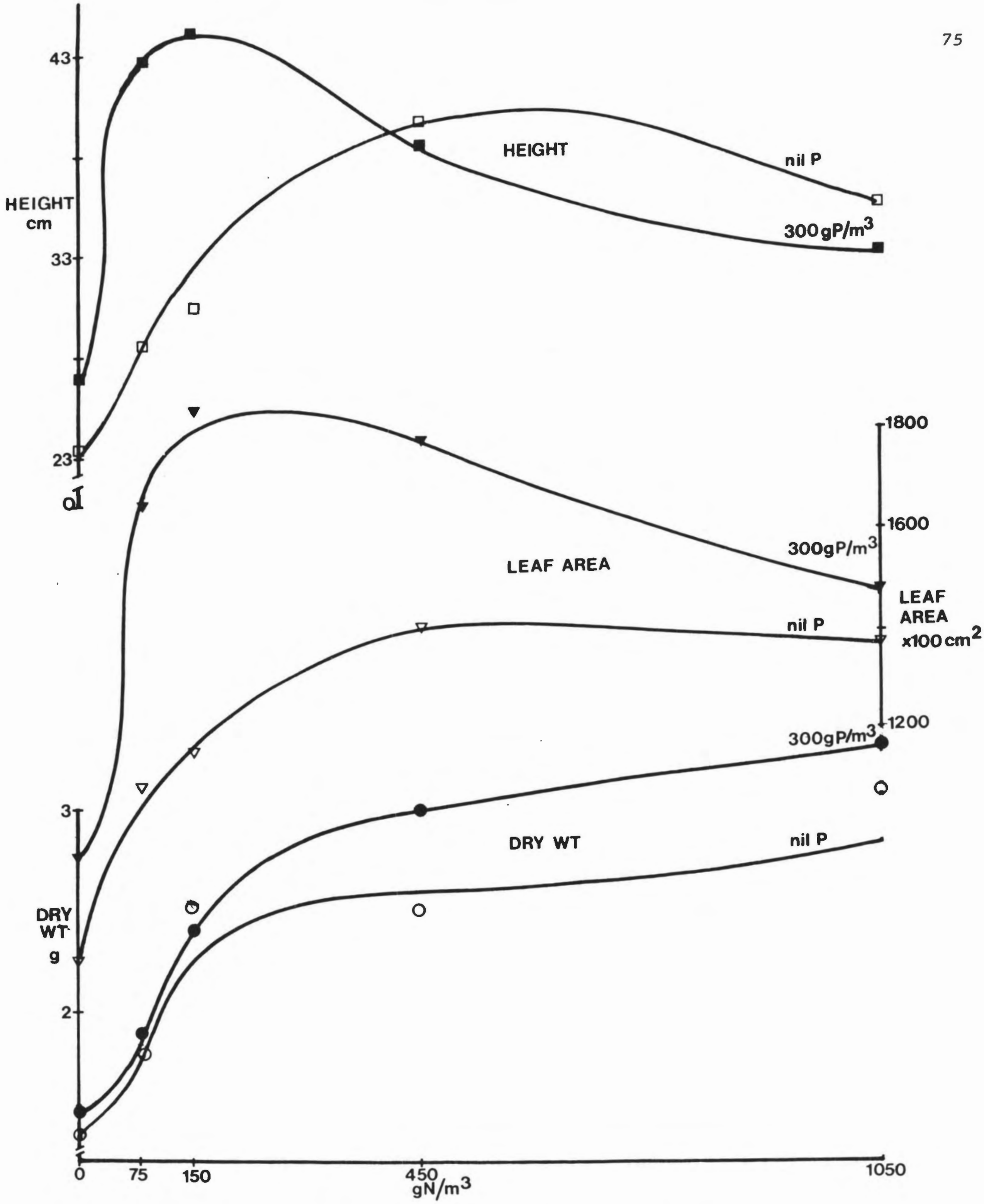

FIGURE 5: Experiment B - The interaction of N and P on foliage growth which indicates the value of moderate or medium levels of N and P on plant quality although foliar dry weights were greater at higher levels.

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Culture of Container-Grown *Ficus macrophylla* II. Influence of Shading and N Fertilization.

by

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ABSTRACT

A 3 x 3 split-plot design was used to study the influence of 3 N and 3 shade levels on the growth of *Ficus macrophylla* in a peat:sand (1:1, v/v) medium. Leaf size, colour, shape, and orientation were strongly influenced by shading while chlorophyll levels and leaf-drop were unaffected. Generally, shading strongly depressed plant growth and it is suggested that *Ficus macrophylla* required relatively high light levels for optimum growth. Foliage growth was strongest at low shading and medium to high N fertilization, while N had only a minor influence at 80% shade. Plant height, internode length, stem diameter, leaf area and foliar dry weight were all greatest at 20% shading and 300-375 g N/m³. Leaf colour and visual ratings of foliage were enhanced by 60-80% shade levels but chlorophyll content remained greatest at 20% shade.

INTRODUCTION

The influence of environmental factors on plant growth and nutrient requirements have been well documented (Schmidt and Blasser, 1969; Patel *et al.*, 1974; Conover and Poole, 1974a, b; Conover and Poole, 1975). Many foliage plants favour some degree of shading. For example, the foliar colour of *Dracaena marginata* was improved with increasing shade at low fertilizer levels (Conover and Poole, 1975). Similarly, the highest quality *Ficus benjamina* and Areca palm (*Chrysalidocarpus lutescens*) were produced under heavy shading and high fertilization rates (Conover and Poole, 1975; Joiner *et al.*, 1977). *Ficus benjamina* plants remained in excellent condition even under stress after leaving the production line (Joiner *et al.*, 1977). Conover and Poole (1974b) reported that the growth and quality of *Philodendron oxycardium* was better at 40% than at 80% shade. Conversely, other plants prefer higher light levels. *Brassaia actinophylla* plants showed greater growth under high light (40% shade) than under low light (70% shade) levels (Vlohos and Boodley, 1974). While the best quality *Dieffenbachia amoena* were produced under high light conditions (60% full sunlight) when combined with medium fertilization (Joiner *et al.*, 1977). Thus, shading and fertilization interact to influence plant growth and quality but this depends on both the genus and the species. The objective of this study was to determine the effects of shade and N fertilizer levels on growth and quality of *Ficus macrophylla* during nursery production.

MATERIALS AND METHODS

Experimental Design, Medium and Fertilizers

A 3 x 3 split-plot design involving three shade levels (main plot) and three N levels (sub-plot) were used to study their influences on *Ficus macrophylla* growth. The main plots were replicated eight times.

The N levels were 225, 300, 375 g/m³ supplied from Osmocote (26% N). In addition, each treatment received a base dressing of 125 g P/m³ (superphosphate, 9% P), 83 g K/m³ (potassium sulphate, 39% K), 3 kg lime/m³ (3:1 w/w dolomite to agricultural lime), 75 g/m³ 'Sequestrene' iron chelate (12% Fe) and 150 g/m³ 'Sporumix A' (trace elements).

The medium consisted of equal parts (1:1 v/v) Southland Springhill peat and coarse manufactured sand. The physical and chemical properties of the constituents were similar to those described by Goh and Haynes (1977). The medium and fertilizers were mixed and transferred to 2.5 litre (PB5) planterbags just prior to potting.

Growing Conditions and Environment

The experiment was carried out in a heated glasshouse with automatic fan ventilation. The minimum glasshouse temperature was 15°C while the maximum was close to 5°C above ambient temperature. Plants were hand-watered when required. The glasshouse was shaded on both roof and sidewalls with a light covering of whitewash.

Shadecloth (40% Netlon and 50% Sarlon polypropylene shadecloth) was attached to wooden frames (1.0 m x 1.0 m x 1.3 m) and placed over the plants. Lightmeter readings taken in midsummer on a sunny day indicated a light intensity of 100,000 lux outside and shade levels of 20%, 60%, and 80% for the three shade treatments repsectively.

Data Collection and Analysis

The experiment was initiated on December 8 1978, shading implemented on January 18 1979, and harvested on June 28 1979. Foliage assessment, using a rating system (0 = dead; 5 = very vigorous and healthy) was carried out. While colour ratings of top leaves, were designated 1 if very chlorotic and 5 if green and uniformly coloured. Chlorophyll content was measured using the method described by Arnon (1949). All data was statistically examined for analysis of variance and F test.

RESULTS

The growth of *Ficus macrophylla* was strongly influenced by shade and N levels (Table 1). Generally, increased shade depressed top growth and visual rating (Table 1, Figure 1). However, chlorophyll content was not affected by shading (Table 1). Figure 1 shows the marked reductions in plant height, stem diameter and foliage growth with increasing shade levels. Plants grown under shade, however, had uniformly green leaves (Table 1) while plants grown at 20% shade had chlorotic top leaves. It was also noticeable that the plants grown at 20% shading had developed a strongly growing secondary stem (Figure 1).

There was a strong foliar response to N (Table 1, Figure 2) which was enhanced by low shade levels (Table 2). Internode length, leaf area, height and dry weight all tended to be at their maximum with 375 g N/m³ and 20% shade.

DISCUSSION

The growth and appearance of *Ficus macrophylla* was strongest at low shade and high N levels. This agrees with Joiner (1981) who classifies *Ficus* species as pot plants requiring high light and NPK fertilization. He states that some *Ficus* species intended for interior use in Florida (U.S.A.) are initially grown in full sun to increase stem diameter. The value of adequate light was confirmed in the work reported here, where stem diameter, height, and internode length were all highest at 20% shade. However, leaf colour was greatest at 80% shade and this agrees with Conover and Poole (1978) who found this quality of *Ficus benjamina* was enhanced by shading. Similarly, shading with *Ficus nitida* to 70% increased leaf area (Clohos and Boodley, 1974). It was also found in the experiment reported here that leaves on plants in 60 and 80% shade were thinner, longer, narrower, more horizontally positioned as well as being larger than those on plants at 20% shade. The decreased thickness of leaves from plants grown at low light intensities has been previously reported by Peterson *et al.* (1976) who found that these leaves consisted of one palisade cell layer and spongy parenchyma tissue. Sun grown plant foliage consisted of two palisade cell layers (Peterson *et al.*, 1976).

While not measured, it was noticeable that root growth was influenced by shading. Generally, plants grown at low light intensities produced small root-balls in comparison to vigorous, extensive, root systems of plants grown at 20% shade. Mastalerz (1977) who reported that high light levels promoted root development and increased root/shoot ratio while Conover (1972) considered the root/shoot ratio to be important in affecting leaf-drop when plants were transferred to dim interior environments. Leaf-drop can be a problem with *Ficus macrophylla* (Cox; pers. comm.). However, no leaf-drop was observed in this experiment.

As expected, fertilizer N strongly enhanced plant growth. This was particularly so at low shade levels. Conover and Poole (1974b) found similar results with *Philodendron oxycardium* and proposed that this was due to a higher nutrient requirement at high light intensities than at low levels. At high shade levels, N supplied at the rates above had little or no effect. It is presumed that at 80% shade growth was limited by the lack of light.

The highest chlorophyll levels were at 300 g N/m^3 while Conover and Poole (1978) reported that *Ficus benjamina* chlorophyll levels were not influenced by fertilizer applications. However, the chlorophyll content of *Draceana marginata* has been reported to be increased by shade and N levels (Conover and Poole, 1975).

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TABLE 1: The effect of Shade and N levels on *Ficus macrophylla*.

(*** = P<0.001; ** = P<0.01; * = P<0.05; # = P<0.10; N.S. = not significant)

Shade (%)	Height		Visual Ratings	Colour Ratings	Chlorophyll Content (g/cm^2)	Internode Length (cm)	Stem Diameter (cm)	Leaf Area (cm^2)	Dry Weights (g)
	4½ months (cm)	6 months (cm)							
20	37.4**	38.9**	3.08*	3.5**	0.28 NS	4.2***	1.14***	2528#	34.4***
60	34.1	36.7	3.13	4.1	0.27	3.7	1.08	2655	30.0
80	29.7	32.1	2.33	4.9	0.25	3.2	0.98	2240	16.5
LSD (5%)	3.4	4.3	0.63	0.28	0.03	0.6	0.08	339	3.7
C.V. (%)	18	20	37	11	11	20	11	23	22
N (g/m^3)									
225	31.5**	32.5**	2.13***	4.0#	0.25*	3.5#	1.02#	2119***	23.1***
300	35.8	38.5	3.38	4.3	0.29	3.7	1.08	2597	29.4
375	34.0	36.8	3.04	4.1	0.25	3.8	1.10	2707	28.4
LSD (5%)	2.5	2.8	0.40	0.28	0.03	0.2	0.08	305	2.8
C.V. (%)	13	13	24	12	12	16	12	21	18
Significant Interactions	N.S.	**	**	N.S.	N.S.	#	N.S.	**	**

TABLE 2: Interaction of Shade and N levels on height, internode length, visual rating, leaf area and dry weight. (LSDs are based on sub plot standard errors.)

Shade (%)	Height (6 months) (cm) N level (g/m^3)			Internode Length (cm) N level (g/m^3)			Visual Ratings N level (g/m^3)		
	225	300	375	225	300	375	225	300	375
20	33.4	41.8	41.5	3.8	4.2	4.6	1.9	3.9	3.5
60	32.6	38.1	39.6	3.7	3.6	3.7	2.4	3.5	3.5
80	31.6	35.6	29.3	3.1	3.4	3.2	2.1	2.8	2.1
LSD (5%)		3.52			0.42			0.50	

Shade (%)	Leaf Area (cm^2) N level (g/m^3)			Dry Weights (g) N level (g/m^3)		
	225	300	375	225	300	375
20	1882	2493	3207	27.4	37.4	38.3
60	2427	2802	2737	26.1	33.1	31.0
80	2047	2494	2178	15.8	17.7	15.8
LSD (5%)		373.0			35.5	

FIGURE 1: The influence of increasing shade levels on foliage growth.
<u>Left to right</u>: 20, 60, 80% shading

FIGURE 2: The influence of increasing N rates on foliage growth with 20% shade.
<u>Left to right</u>: 225, 300, 375 g N/m^3

An Area of Difficulty in the Teaching of Plant Propagation

by

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Despite the availability of several valuable texts on the principles and practices of plant propagation, the subject has never really been organised in an academic fashion. Generally the components of the subject are dealt with piece-meal and without any reference to a standard terminology.

One of the greater problems which is encountered by the propagator, who is involved in education, or indeed in any aspect of communication concerning his subject, is the difficulty in finding a common language of terms which clearly defines the activities which are to be employed or described.

Throughout the world, even in the English language, there is a great deal of jargon, local usage and a diversity of terminology. In many cases a confusion exists in so far as one activity may be described by several names or alternatively one term may have several interpretations (e.g. stolon, corm, etc.) and even represent different activities.

It would therefore be of considerable advantage if a reasonably concise formula could be established and accepted, so that all people involved could be clear as to the exact interpretation and status of any particular term or activity.

The area of definition however is bedevilled by this multiple use of terms; which may ultimately prevent their adaption for a particular use. It may therefore be necessary to invent or adopt a series of terms in those areas which prove difficult. However, the problem is not just a requirement for defining activities, terms and systems, and then naming them: there is also a need for a hierarchial system for the classification of propagation, which places all the activities and defines their status in relation to each other.

The necessity for such a system will be particularly evident to any teacher who may need to set and assess examinations for other than one's own students. It is assumed that one's own students will understand the terminology used and will respond within the understood parameters: however, the problem arises with others who are constrained by other parameters defining the same terms.

The answers to what appears to be a simple and straight forward enquiry:- 'Describe a technique for the propagation of softwood cuttings' may elicit several responses varying from descriptions for making cuttings, to a description of aspects of environmental control; or even a description of the condition and physiological status of the material. All responses representing correct interpretations, according to the concepts of the teacher.

It is not perhaps surprising that a concise classification of plant propagation has not yet been established, as the modern history of the subject as an academic discipline is hardly thirty years old. The subject also involves a wide spectrum of science and technology, and it would be expected that the relatively few specialists in this field have tended to limit their interest to particular and fairly narrow problems, rather than diversifying and taking a general overview of the whole subject.

It is not pretended that the author has any real vision or authority for the discussion of this particular problem, but currently the difficulties encountered in communication, with students especially, have prompted these notes in the hope of stimulating a wide ranging discussion with an eventual resolution.

Although these notes represent only the views of the author, much informal discussion has helped to formulate ideas and a debt is owed to all who have contributed to this preliminary formula.

As the object of the exercise is to propagate plants, it would seem logical to base any classification of such activities on the plant material involved and how it is used; so that a system could be developed, based on the part or parts used for propagation.

Initially this classification would depend on a dichotomy into Seed and Vegetative Propagation. By eliminating references to sexual and asexual systems it would alleviate the eccentric position of apomixis and related phenomena.

However, the real problem arises in defining the status of these two divisions and I am much taken with the usage proposed by P.K. Willmott who suggests the term "MODE OF PROPAGATION" at this initial stage, as it suggests a passive stance and requires further delineation into detail before any practical activity is involved.

Having thus overcome the problem of reducing to these two fairly obvious modes of propagation which, one assumes, will have a general acceptance, it is now necessary to further sub-divide. Unfortunately a dichotomous key is no longer feasible. It is not possible within the space available to detail all the classification and it will therefore be necessary to limit reference to specific areas for illustration. Thus Vegetative Propagation further sub-divides into three types or METHODS OF PROPAGATION:-

i) Division - which provides at propagation more than one complete new plant in so far as all the parts (i.e. the stem and root systems) of the plant are already present as a result of normal growth patterns. The success of the operation is merely dependent on establishing the new plant.

ii) Grafting - which provides all the parts of a complete new plant, but as two separate entities (usually as a potential shoot system and a root system). Propagation involves the joining of these two together to produce a new plant, which is then established.

iii) Regeneration - involves the provision of one plant part (a stem, root or leaf) with a capacity to initiate and develop (regenerate) the missing parts so that a complete new plant is produced and can be established.

It is this latter category which promotes the greatest discussion, for if the definition is reduced to 'separated parts' (i.e. from the original stock plant) then it could be called 'Cutting Propagation' (Cuttage). However, this leaves Layering and Suckering, which physiologically fall into this category, to be transferred to Division.

Within this initial classification of Plant Propagation into modes and methods it is now possible to categorise each method into a series of 'TECHNIQUES PROPAGATION'. Inevitably each technique may well require to be sub-divided on detail, but one example should provide an illustration sufficient to indicate the likely system: probably by some form of numerical distinction:-

2. <u>Grafting</u> (or Graftage)

2.1 Approach Grafting

- 2.11 Inarch
- 2.12 True Approach
  - 2.121 Spliced
  - 2.122 Tongued

2.2 Detatched scion grafting

- 2.21 Apical grafting
  - 2.211 Whip (splice) a) Simple
    - b) Tongued
    - c) Based
  - 2.212 Wedge a) Simple
    - b) Inverted
    - c) Saddle
    - d) Crown (Double tongue etc.)
    - e) Cleft
- 2.22 Side grafting
  - 2.221 Wedge
  - 2.222 Veneer
  - 2.223 Budding, etc.

Thus, in this instance, initial categorisation has occurred on whether the scion is still attached to the parent or is separated prior to grafting; subsequently on the treatment of the stock, while further division is based on the carpentry used at the join.

Further in assessing what terms fit into the classification it is important to eliminate miscellaneous terms which although important are not hierarchical viz:-

a) Field grafting	f) Nurse grafting
b) Bench grafting	g) Double working
c) Bare root grafting	h) Stem building
d) Root grafting	i) Cutting grafting
e) Seed (nut) grafting	j) Top working, etc.

These terms refer to systems involved in the process of propagation and in most cases are self explanatory.

It is also evident that the term 'Propagation' is a portmanteau concept which in practice describes a series of activities.

For ease of definition and clarity it would be useful to categorise these series of activities into an overall pattern so that each aspect can be dealt with logically and all relevant pieces of similar information can be consigned to the same area. Subsequently these activities can be categorised into a sequence of phases. The idea presented here is not new and is a development of the philosophy already suggested in 'Container Plant Manual' and 'Commercial Production of Climbing Plants' (Grower books).

Propagation, as a descriptive term still tends to be associated generally with the straight forward practical operation of taking cuttings, grafting, etc.; with perhaps a modicum of attention given to subsequent environmental conditions. Much observation and research has been allocated to improving success rates by attention to these environmental conditions and to treatments at the preparation stage. However, modern day interest is beginning to polarise on the development of propagating material which has a high potential capacity to produce a new plant. This has occurred largely as a result of the recognition that the capacity of plant material to respond is not uniform and that it can be influenced by treatment of the material to be used for propagation.

It is these varying changes of emphasis and impetus over the years which has highlighted the necessity for dealing with Propagation as a complete entity - that the whole system is important and not just one particular sector or phase. This is particularly relevant when the various interactions, which are apparent, come to be considered.

As with any system it is important to analyse the overall pattern and be able to determine each of the component areas. This then allows each piece of information to be filed where it is relevant.

It also permits the whole pattern of components to be organised as a sequence of events, that eventually it becomes apparent that it is the system which is important and that equal attention should be given to all aspects of the complete pattern.

This overall analysis indicates the position of existing information and highlights those areas which might lend themselves to discussion and improvement.

For the purpose of these notes it perhaps will be less confusing by limiting the detail presented to those techniques involving the regeneration of cuttings. Hopefully it will be evident that the same outline and basic format can be applied to all methods of propagation whether vegetative or by seed.

It will be seen that while emphasis is still on plant material in the overall pattern, the various propagation systems (cold frame, cases, mist, etc.) all find their place in considerations of the environment necessary for achieving regeneration. It also allows for the placing of any aspect of developing the capacity of the material or its enhancement.

PROPAGATION AS A PHASE SYSTEM OF SEQUENTIAL OPERATIONS

1. Preliminary Phase - the selection, establishment and maintenance of the stock material which is to provide the basis for propagation:

   i) Selection
      a) correct nomenclature
      b) acceptable clonality

c) freedom from pests and diseases (especially virus diseases)
d) high regenerative capacity

ii) Establishment
a) level of pH
b) control of nutrition
c) pattern of planting (i.e. spacing, orientation, etc.)

iii) Maintenance
a) provision of shelter/protection
b) control of water status
c) control of nutrition
d) elimination of competition
e) pest and disease control
f) control of pH

2. Initial Phase (Manipulation Phase?) - the continuing cyclical, usually annual, process involving the manipulation of the stock plant to produce material suitable for propagation, i.e. having a high potential capacity for regeneration.

i) Encourage a suitable pattern of growth (and hence (?) physiological condition) by:-
a) pruning and pinching
b) environmental control (forcing, etiolation, etc.)
c) chemical control (Plant Growth Regulating Substances)
d) controlled nutrition

ii) Knowledge of any seasonality of this potential capacity for regeneration. A monitoring of the actual expression of regenerative capacity to determine whether it is influenced by particular seasonal patterns of growth or physiological condition.

3. Preparation Phase - the selection, removal, maintenance, storage, preparation and insertion of the propagating material:
a) select for uniformity
b) maintenance of water status
c) avoidance of temperature extremes
d) use of chemicals for pest and disease control
e) supplementation of Plant Growth Regulators (hormones)
f) size of propagule
g) maintenance of polarity
h) spacing of cuttings

4. Regeneration Phase - the provision of:

i) a suitable substrate for regeneration

ii) a suitable environment for the survival of the propagating material prior to regeneration

iii) suitable environmental conditions for the enhancement of the regenerative processes by reference to:-
a) provision of sport
b) maintenance of water status
c) light - photoperiod, intensity patterns, photosynthetic
d) gaseous balance
e) temperature - aerial, substrate
f) pH of substrate

5. Establishment Phase - the subsequent development of the initially regenerated material to the production of an integrated plant (i.e. the establishment of a new young plant in which all the growth patterns are normal and is capable of independent survival). An integrated plant is developed as a result of the normal combined and inter-related growth patterns of root and shoot systems which is achieved by the provision of:-

a) suitable photoperiods

b) suitable temperature patterns

c) adequate nutritional status

d) suitable water status.

It will be seen that the phases proposed in this sequence are necessarily inter-related and cannot be regarded as water-tight compartments, similarly areas of overlap are likely to occur. However, the object is to attempt to develop an overall sequence which can lend itself to developing a teaching, observation or research programme.

As this concept again only represents a further refinement of a previously expressed idea, any criticism for improvement would be welcome, as would the various uses of names - perhaps the development of a mnemonic for the titles of the phases?

Obviously much detail has already been sorted and space prevents its presentation but the author would be pleased to hear from any correspondent who has constructive ideas to improve the idea.

The Culture of Proteaceae

by

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INTRODUCTION

In 1735 Carl Linnaeus applied the name *Protea* to what was at that time a largely unknown group of South African plants. Not only were they relatively unknown, but to Europeans they were also quite strange with flowers and foliage unlike the plants they were familiar with. Linnaeus was apparently struck by the variability of the proteas with flowers and foliage changing in form from one species to another. Being familiar with Homer's legend of the Greek God Proteus who could change his shape at will to avoid his pursuers, the name seemed appropriate. He could not have realised just how appropriate his naming was. Within the proteaceae family we find an incredibly diverse range of genera, with representatives found not only in South Africa, but a large number in Australia and even two in New Zealand. When one looks at the differences between the genera and indeed the variability of one species from another within a genus, the name Protea is appreciated even more.

To name just a few examples of proteaceae, we have from South Africa; proteas, leucospermums, leucadendrons, serruria, aulax, paranomus and mimetes. From Australia there are the banksias, telopeas ("Waratahs"), grevilleas, isopogons, petrophilas and macadamias. A New Zealand example is the native honeysuckle tree, *Knightia excelsa*, with leaves similar to a macadamia and flowers like grevilleas.

Many variations are heard in the pronunciations of the words *Proteaceae* and *Proteaceous*. Without being too arbitrary, I hope, we prefer to say "proteeaycea" and "proteeayshus". I have heard students of latin disagree with one another even on these pronunciations, but no doubt there is a correct pronunciation.

NATURAL HABITATS

It is important to consider the natural habitats of proteaceae and to relate this at least in part to both commercial and home plantings. In advising clients we have a short list of the basic requirements. These are:
An open, airy situation in full sun.
An acid soil that is preferably fairly light in texture and free-draining.
Heavier soils that are not so well-drained can be suitable if they slope to allow excess water run-off.

It should be emphasized at this point before I "rush in where others fear to tread", that extensive research is being carried out in several countries on the requirements of proteaceous plants. Many aspects of their culture are still not fully understood. In this address all my comments are purely from personal experience, with some conclusions drawn from reading scientific reports.

By New Zealand standards, the soils in which proteaceous plants are found naturally in both South Africa and Australia are very

* *Reprinted from the Proceedings of the 1982 Commercial Flower Growers Seminar, held in Nelson.*

poor - usually very acid and low in nutrient levels. The plants have evolved a complex root structure known as the "Proteoid" root system to enable them to seek out both nutrients and moisture under these harsh conditions. These delicate, waxen white rootlets which extend from the main roots are the source of the basic problems associated with successful cultivation of proteaceae in this country.

SOIL TYPE AND NUTRIENT REQUIREMENTS

As already mentioned, a free-draining soil is essential. Without adequate aeration of the soil the proteoid rootlets will often die, and additionally a more favourable environment for soil-borne fungus diseases such as phytophthora occurs. Lower incidence of such disease is the case in light, even sandy, very free-draining soils. We consider that sandy loams and river silts overlying gravel are among the most suitable soils.

As a general rule when soil testing we look for low nutrient levels right across the range. High levels of both calcium and phosphorus are recognised as being detrimental to the successful cultivation of proteaceae. They destroy the proteoid rootlets, and while the plant may appear healthy and even quite lush for some time, a period of stress, especially drought, may have the effect of the proteoid rootlets not being present to seek out additional moisture for the plant, resulting in collapse. Sometimes this has been unjustly blamed on phytophthora as some of the symptoms are similar.

We have a saying regarding proteaceae - "If they grow fast, they die fast".

To be on the safe side, we recommend avoiding fertilizers completely, although some will disagree. Scientific research is finding that limited amounts of artificial nutrients can be applied to some benefit, but as this is usually in the controlled environment of a container, we prefer to stay with our original comment at this time - "don't".

Some observations from personal experience are valid at this point. In our experience, on one property, with phosphate levels in the order of 60 to 70 (MAF figures) *Protea magnifica* (*barbigera*) has been a total write-off. Leucospermums have developed a lush, sprawling growth habit. *Protea cynaroides*, while surviving quite satisfactorily has not produced the growth we would normally expect. Leucadendrons and one Banksia species, however, have exhibited normal characteristics and are producing well after one year. It should be mentioned however, that to reduce the availability of phosphorus in the soil, sulphur was broadcast over the entire property at the rate of 2 tonne/hectare. This increased the acidity from pH 6.6 to 6.2 within 2 months and because of the slow bacterial action created by the sulphur, the soil is still increasing in acidity. It should come down to pH 5.6 on the level of application.

On another property with P levels of 40 to 46, leucadendrons have been successful again, but most proteas and banksias and also leucospermums have given trouble - either dying or becoming lax and sprawling in habit.

In total contrast, on a property with P levels of 6, calcium 4 and a pH of 5.5, superb growth in all proteas and leucospermums has been noted. Leucadendrons on the other hand, while quite healthy, flowering freely and with good growth characteristics have not produced the number of flowering stems normally expected.

We have had soil tested on many proteaceous projects, and have reached the following conclusions from a pure observation viewpoint - I stress that it is not a scientifically proven fact.

We believe that: pH should be under 6 which we regard as the upper maximum. pH 5 to 5.5 appears ideal. However, if one is to go by levels in South Africa, as low as pH 3 is acceptable to some species.

Calcium - we have found that a level of under 10 appears to be the safest. There are some contradictions with this one however, and obviously further research is required.

Potassium - does not appear to be critical, but under 20 appears to be desirable.

Phosphorus - up to 30 appears satisfactory, but under 20 is more ideal if a broad range of proteaceae is to be grown without any problems. One overseas source quotes 15 as the safe upper level.

Magnesium - this is an uncertain one, but it appears best if the level if below 30. A high level of 50 on one property seemed to be the only thing out of line which could have caused the problems being experienced.

Iron - tests for iron, although apparently more difficult from a technical point-of-view with tissue tests being required, may become necessary and of more importance than previously thought. Applications of iron in various forms have almost magical effects in curing chlorotic foliage in banksias.

While on the subject of phosphorus toxicity in proteaceae it is probably worth mentioning that in South Africa it is becoming obvious to researchers that genetical variation occurs within species in relation to phosphorus tolerance.

AIR CIRCULATION AND SHELTER REQUIREMENTS

It is generally recognised that proteaceous plants dislike sheltered, humid environments. They appear to need good air circulation around the bushes, and in fact a certain amount of wind may be beneficial in assisting to dry moisture from the foliage after rain. If water lies on the foliage for lengthy periods, fungal probelms are more likely to occur.

On the other hand, only a few species will tolerate gale-force winds. Most have comparatively shallow root systems and if these are disturbed through rocking or swaying of the bush in winds, the resultant damage may allow pathogens to enter the plant. This aspect of wind damage is more serious than foliage burning which is not often a problem.

In exposed, wind-prone situations we usually recommend a shelter belt planting to create a "filter" effect as opposed to dense, heavy shelter. Fairly widely spaced trees of Casuarina are the type of preferred shelter.

In commercial row plantings we also recommend a post and wire system of support or "staking", clipping the main leaders of the shrubs to wire using PVC kiwifruit ties. This is a particularly economical and permanent system that is proving very satisfactory.

PLANTING DISTANCES

Planting distances are determined by two main considerations; the ultimate size the bushes will grow to, and the method of maintenance. For instance, if a small tractor of around 1 m wide is to be used for mowing and spraying between the rows, and the species is say, *Leucospermum cordifolium* which has a normal spread of about 2 m, the rows will need to be a minimum of 3 m apart. (From centre to centre, that is.)

Contrary to some advice being given, we do not believe in "cramming" plants, as in the case of Leucadendron "Safari Sunset" to force the bushes to throw longer stems. Some growers are planting and recommending that "Safari Sunset" should be planted at 60 cm (2 ft) apart. We regard 1.2 m (4 ft) as the minimum - after all, bushes can reach 1.5 m (5 ft) in width in open situations - even with some pruning. They do need space to "breath", and it will be found that less problems - particularly in terms of disease and premature losses will occur in a less dense planting. Penetration of sprays is more difficult in densely planted rows also.

To summarise this aspect of the culture of proteaceae, we believe that some air space between bushes will give greater longevity plus less maintenance problems.

PLANTING TECHNIQUES

Rows should be marked out according to growth habit of the bushes and the method of maintenance to be used. Compacted ground should be sub-soiled to break up any pan that could impede drainage. Where weeds and grasses are of annual varieties, spray off 0.6-1 m wide strips using paraquat/preeglone type of herbicide. Problem perennial weeds and grasses such as couch, paspalum and similar should be sprayed with a herbicide such as Round-up® to eliminate them. If wide spread, the entire block should be sprayed off. With chemicals such as Round-up® caution should be exercised not to exceed the recommended concentration - otherwise problems can occur of some retention of the chemical on the soil.

The strips where the rows are to be planted should ideally, in most soils, be rotary-hoed. This enables the roots to spread out quickly into the surrounding soil without impedance. Digging holes in straight pasture situations often slows the growth of the plant while the roots penetrate the harder surrounding ground. This varies with the soil type of course.

At this stage, if the post and wire support system is to be used, it can be installed. Block the posts, use 10 gauge galvanised wire and in-line permanent strainers that can be tensioned at any time. This also serves to provide a perfectly straight line for planting to. The height of the first wire will vary according to the size of bush being planted out, but is usually only about 15 cm (6") from the ground. A second wire is installed later as the bushes grow and is normally about halfway up the posts.

When planting out into rotary-hoed ground, the bushes should be planted slightly deeper than appears necessary to allow for the soil to sink and compact again as all newly rotary-hoed ground does. Do not stamp the soil down around the plants - firmly press them in only. They may then be fixed to the wire using the PVC clips on main leaders.

MULCHING

We are not in favour of usual mulching methods. While weed control can be facilitated through the use of mulches, our experience and observation has shown that plastic mulch material tends to reduce the aeration of the soil about the roots and may have long-term detrimental results.

Sawdust and straw mulches tend to take nitrogen from the soil, which, long-term, is to the plant's disadvantage. Such mulches may also tend to cause types of collar rot - particularly if sawdust builds up around the plant in windy situations. Pathogens may also be harboured in such mulches.

WEED CONTROL METHODS

Herbicides

Paraquat is satisfactory for control of annual grasses and weeds. Use caution with others such as Round-up^{R}.

Hand hoeing and "Dust Mulches"

Ideal method, but more labour intensive, although costs would need to be weighed up against those of chemicals.

Pre-emergent Herbicides

Ronstar^{R} appears very suitable, giving control for several months. It is important to apply it using low pressure and anti-drift guards to prevent foliage damage to the plants.

MOWING INTER-ROW STRIPS

Mowing is the most common method of inter-row grass control. Avoid clippings being thrown onto foliage or around the trunks of plants. They can cause blemishes on the foliage and collar rot around the trunks. In more intensive plantings where it is not possible to get machinery between rows, either hand-hoeing or chemical weed control is normally used.

PEST AND DISEASE CONTROL

As with any flower crop, if blooms are to be acceptable on home or export markets, perfection is required. Of all proteaceous crops, leucadendrons are the most susceptible to caterpillar damage - this is probably the single most common cause of substandard quality in cut blooms. Unfortunately, some of the best species and hybrids are the most affected - notably leucadendron hybrids "Safari Sunset" and "Red Gem", also the species *L. discolor*.

Broad spectrum insecticides with good lasting qualities should be used and as with most sprays, it is desirable to alternate types to avoid the possibility of immunity building up.

Some fungus diseases can occur from time to time and it is usually recommended that prevention is better than cure. As a result we usually recommend adding Benlate^{R} to the spray tank every six to eight weeks.

Frequency of spraying to some extent is determined by the type of chemicals used. Obviously systemics will need to be applied less frequently.

In ideally suitable sites, as mentioned earlier, there is less likelihood of pests and diseases being a problem.

HARVESTING THE FLOWER CROP

It is critical to pick at the right stage of development to ensure that blooms travel well and have a good vase life in the consumer's hands.

Leucadendrons

The majority of the popular picking varieties are female forms and the main criteria is to pick when the "bracts" - the colourful terminal leaves which surround the central, seed-bearing cone, are at their most colourful and yet firm to the touch. Soft and "floppy" bracts have little or no lasting qualities. In the case of male flowers, such as *Leucadendron discolor*, and others which are used for commercial picking, it is vital to catch the crop at the stage when it is showing good colour and yet before the pollen is shed. Experience will make this side of picking quick and easy.

Leucospermums and Banksias

Leucospermums and banksias should be picked just as the first styles begin to unfold - this not only makes for less damage in transit, but fits more stems in per carton and also ensures maximum vase life at the other end. More open blooms damage more easily and are usually bulkier.

Proteas

As a general rule should be picked just as the flower begins to open. If the bud is too tight it will not usually open. Flowers that are too far open have less vase life, are bulkier to pack and are more likely to harbour bugs - bees, wasps, etc.

Stem Length

Maximum stem length is the word for export purposes. It is not as critical for the home market. Leucadendrons, leucospermums and even banksias can be picked almost as far down into the bush as is possible without affecting future growth. Proteas generally should not be picked on stems beyond the previous season's growth, as they do not generate much new growth from old wood. Distinct growth lines are easily observed which show each season's growth. *Protea cynaroides* is the one exception, which benefits from being cut hard.

Handling

Avoidance of crushing of the foliage is essential as it may produce leaf blackening when in transit. Depending on the market, a few of the bottom leaves can be carefully stripped off the stems - this helps prevent excess moisture on the foliage - which may also lead to foliage discolouration when in transit. Chilling has been found to reduce the incidence of foliage blackening (or "oxidising") while being shipped. Excess moisture needs to be shaken off the blooms for the same reasons.

Bunching and Tying

Most larger flowered varieties are not bunched. Slimmer stemmed leucadendrons are usually bunched into 5s or 10s, but this depends on market requirements.

PRUNING

Pruning is a controversial subject, with many growers having their own very definite view-point. Leucadendrons certainly need to be cut well back at the end of the flowering period to encourage plentiful new clean growth for the following season. On vigorous hybrids such as "Safari Sunset" it may also be desirable to thin some shoots to encourage longer stems. Waratahs obviously need to be pruned well down after flowering to encourage vigorous new flowering stems that can be picked easily. Proteas can be shaped, straggly branches eliminated and unpicked spent flowers cut back to the point just above the season's growth. Leucospermums need little pruning, but can have surplus buds removed where several occur on one stem.

VARIETIES

"What shall I plant?" is becoming a familiar cry. It is not for me to say, except for the following advice: just because a particular protea, for instance, has an "aura" of rarity or exclusiveness about it does not mean it is a good picking subject. *Protea nana* is a classic example - greatly sought after and loved by enthusiasts and home gardeners, it is not regarded in this light by florists - here or overseas - having a small, pendulous flower that "hides its face" - everything is against it in terms of a desirable export flower (even the local florists have not time to wire it). Yet in spite of this, would-be commercial growers are trying to procure stocks of it because they have heard it is something "special".

There is a simple list of criteria for export proteaceae:-

Long, straight stems.
Clear, bright colours.
Prominent "terminal" blooms.
Must pack and travel well.
Good lasting ability in the consumer's hands.
Market appeal.

Saffron

by

J. Palmer

Crop Research Division, D.S.I.R., Private Bag, Christchurch.

The source of the true saffron is the flower style along with the three branched stigmas of a sterile triploid crocus, *Crocus sativus* L. This is a lilac-blue, autumn-flowering species, which in N.Z., as in much of Northern Europe, has a reputation for infrequent flowering. The saffron crocus may be readily distinguished from two other common blue autumn flowering species, *C. speciosus* and *C. nudiflorus*, by the presence of leaves and the bright orange-scarlet stigmas which are long enough (c. 3 cm) to hang outside the flower between the tepals.

Saffron has been cultivated in the eastern Mediterranean for more than thirty five centuries. Excavations of the ancient city of Knossos in Crete by Professor Spyridon Marinatos of Athens University have revealed murals on the walls of merchants houses depicting the saffron crocus. Coloured reproductions of these have recently been published by Dr Luke Meyer (1982). It appears that Knossos was the centre of the saffron trade before it was destroyed by the disastrous volcanic eruption on the neighbouring island of Santorini (Thira) somewhere around 1500 B.C.

The use of saffron passed from the Greeks to the Romans who, apart from using it in medicine, thought it was capable of warding off drunkeness. So those of bibulous habits either dissolved it in their wine or wore some in a chaplet around their heads. Incidentally the word crocus is the Latin for saffron.

Returning crusaders probably reintroduced the use of saffron into Western Europe. The scarcity and high value of the product commonly led to adulteration and stringent laws were inforced to combat the practice. In 1305 the Fundacari, keepers of public warehouses in Pisa, were required by oath, and enforced by heavy penalties, to denounce the owners of any adulterated saffron in their custody. The Pepperers of London were made similarly responsible about the same time (Fluckiger and Hanbury, 1879).

The German authorities were even more severe. A Safranschau (saffron inspection) was established at Nuremberg in 1441 and 13 lbs of adulterated saffron burnt publicly that year. Three years later a certain Jabot Fandeker was burnt along with his saffron. Apparently this was still an insufficient deterrent and in 1456 two men and a woman implicated in the same offence were buried alive.

The cultivation of saffron in Spain is thought to have been introduced by the Moors, and there is evidence (Fluckiger & Hanbury, 1879) that it was a cultivated product of that country as early as AD 961. Elsewhere in Europe it was probably not commonly grown before the middle of the 15th century.

Porchaires, a French nobleman, is credited with having brought the first corms to Avignon towards the end of the 14th century and to have started cultivation there and in the district of Gatinais south of Paris (Conrad & Waldman, 1846).

In England the first reference to saffron occurs in the manuscript poem 'The feate of gardening' by John Gardener, thought to have been written about 1440 (Crisp, 1924). Safren d'Engleterre appears

Figure 1: *Crocus sativus* from Green's Universal Herbal, 1823. The lower figure 'a' shows style and one (of 3?) stamens.

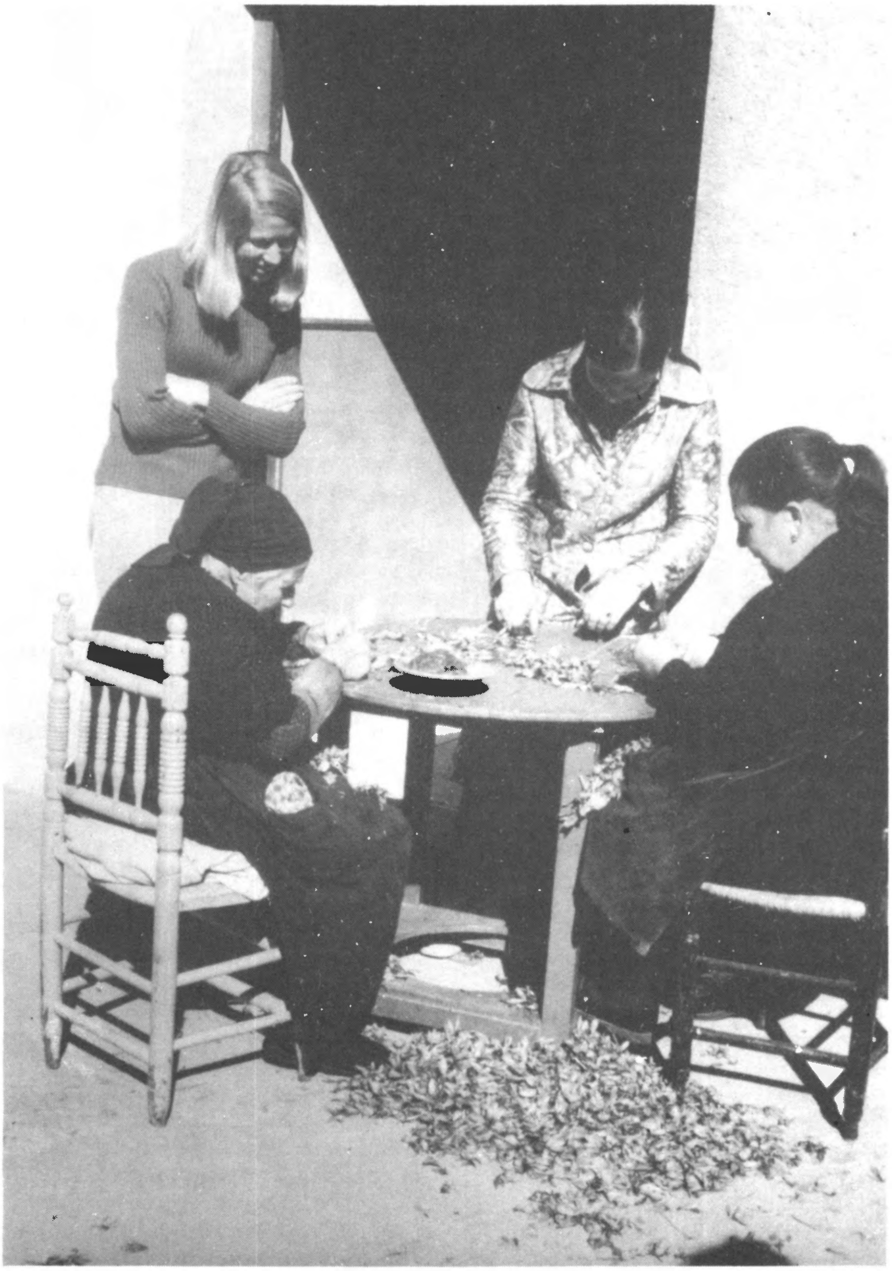

Figure 2: Women separating saffron stigmas from petals in Almagro, Spain (1976). Photo - C.M. Bezar.

on a priced list of spices sold by the apothecaries in the north of France 1565-1570, and is the most valuable of the three kinds listed. A little later Tusser (1573) included saffron culture in his 'Five hundred points of good husbandry'.

"Pare saffron between the two St Marie's days or set or go shift it that knoweth the waies. What yeere shall I do it (more profit to yield) the forth in the garden, the third in the field."

The town of Saffron Walden in Essex, was once the centre of the English saffron trade. It received its charter in 1550 during the reign of Edward VI and its Coat of Arms includes three saffron plants.

Charles II, when visiting the district in March 1666 to purchase the adjoining manor of Audley End (as a suitable place to leave the ladies of the court whilst he travelled on to the Newmarket races and some more sporting ladies), was presented with a silver cup filled with saffron at a civic reception (Phillips, 1822).

Philip Miller (1731) in his Gardener's Dictionary quotes at length a report given to the Royal Society on saffron culture by a Dr James Douglas. He includes an estimate of the cost per acre for a three year rotation, then £23.12.0. He states that some 392,000 corms were planted per acre in mid summer. The plants flowered sparingly the following autumn but yields increased over the next two seasons to give a total of 26 lbs of dry saffron, then worth £39.

However, he goes on to say yields could vary markedly: 'Sometimes five or six pounds of wet chives are got from one rood; sometimes not about one or two; and sometimes not enough to make it worthwhile to gather and dry'.

The harvesting methods mentioned by Miller are not much different from those current in India today. Whole flowers were gathered, seven days a week in the short season, before 11 o'clock in the morning. The stigmas were then removed and the flower discarded. The fresh stigmas were carefully dried on sieves made of hair cloth or metal.

During the 17th and 18th century the use of saffron in medicine was at its peak in Europe. Johann Hertodt von Todenfeld in his famous list of recipes 'Crocologia seu curiosa Croci regis vegetabilum enuncleatio etc.' published in 1670 at Jean, has a remedy using saffron for almost every known disease. One popular one for jaundice is worth quoting: 1 pint of malmsey wine, 2 egg yolks and one dram of saffron. Half a pint to be drunk on retiring, the rest on rising in the morning.

However, the increasingly enlightened medical opinion towards the end of the 18th century questioned the value of saffron. Whereas Sir John Hill in 1789 referred to saffron as 'a noble cordial', by 1838 John Lindley then professor of medical botany at London University, wrote 'In modern practice it (saffron) is little used except as a colouring ingredient'. For this latter purpose saffron remained in the British Pharmacological Codex till the edition of 1954.

The decline in the cultivation of saffron in England coincided with its fall from medical grace. Thomas Green (1823) noted: 'The quantity of land occupied in cultivating saffron has now been gradually decreasing during the last twenty or twenty five years, which is supposed to arise from the importation of foreign saffron. It is now confined to three parishes only, of which Stapleford is one, and if some means be not employed to encourage it, the cultivation of saffron will probably be entirely lost to this country'.

The growth habit of the saffron crocus is adapted to the true Mediterranean climate where dormancy during the hot rainless summer months is an asset and the winter growing season is relatively mild and warm. So it is not hard to see why the climates of Spain and Italy enabled saffron growers there to undercut the British market. But there was another factor involved and stressed later by Morton (1855). The warm relatively moist summers of East Anglia favoured the spread of a corm rotting fungus (violet root rot?). New Zealand does not have a suitable climate and difficulty has been experienced in getting the bulbs to flower successfully.

At the present time saffron use is

limited to folk medicine and the colouring of edible products. The former use is largely confined to the East and the latter subject to competition from a range of carotenoid pigments derived from cheap vegetable products such as annatto *Bixa orellana*, grape skins, beetroot, and in Southwest Asia, turmeric *Curcuma longa*. The famous saffron cakes of western England no longer include saffron. The slight bitterness imparted by saffron is not always appreciated by those unused to the product.

Today, India is probably the world's foremost producer of saffron, although almost the entire crop is grown for home consumption. According to Madan *et al.* (1966) some 3,350 acres of saffron were grown in Kashmir in 1966.

Saffron is still widely used in the Arab states of the Middle East. Saudi Arabia imported an average of 20 tons a year during the early 1970s, the supply coming from Iran, India and Spain (UNCTAD/GATT, 1977). Iran was selling a further 500 kg a year to the Soviet Union during the same period.

Another major user (around 3 ton/annum) is Yugoslavia where saffron is widely included in home cooking.

The latest price for Spanish saffron is US$290 a pound (USDA, 1983), down from a high of $460 in 1981.

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Management and Establishment Principles of Major Shelter Plant Species in Bay of Plenty and Waikato Areas

by

G.G. Rossiter

Extracts from a thesis for the National Diploma of Horticulture (N.Z.), submitted by G.G. Rossiter in 1982.

The thesis is divided into four main sections:
1) *Shelterbelt theory and applications in situations.*
2) *Management principles.*
3) *Establishment principles.*
4) *Some major diseases of plant shelter.*

The extracts are taken from sections 2 and 3. *Ed.*

SHELTERBELT ORIENTATION

The correct placement of shelterbelts is important for maximum protection from winds. Always remember that wind direction can vary from season to season and siting of the shelterbelt should not be based on the first sign of wind. Ask local residents to confirm your findings. Shelterbelt placement although determined by wind direction initially, may not really be placed at direct right angles, in an effort to avoid maximum shading effects. When placed against cross winds, shelterbelt length needs to be at least 24 times its height. In orientating the plant shelterbelt there are various agents controlling final shelterbelt placement. These are summarised as follows:

Factors governing shelterbelt orientation

(i) Continuity of shelter from existing plantations or shelterbelts.
(ii) Any farm buildings present that also require wind shelter.
(iii) Legal planting restrictions, especially near telegraph and power lines and roadsides.
(iv) Waterways, rivers, streams and native reserves determining boundaries.
(v) Varying topography, e.g. to avoid frost pockets.
(vi) Siting in relation to main races, gateways, etc.
(vii) Economic use of land.
(viii) Avoiding shading problems.
(ix) Siting away from areas of field and main drains (especially important with *Salix* spp. and *Populus* spp.).
(x) Existing fencing to give protection to shelterbelts and consideration of future fencing proposals.
(xi) The crop being grown - whether closer spacing or internal shelter rows is necessary for better wind protection

A Bay of Plenty Kiwifruit Orchard

It must be stressed that the following notes only pertain to establishing a plant shelterbelt in the Bay of Plenty. It is used for an example BUT should not be used for a basis of a final decision.

In the Bay of Plenty, the wind direction blows from the S.W. with the less common north easterly winds. Shelterbelt orientation is generally near north-south for two reasons:-

(i) To present a compromise of least shading possible - Orientation to N.S. results in minimal shading although N.W. suits the best wind protection.
(ii) To obtain the best wind control of shelter available - Where possible, a skewing to the S.W. is preferred to N.W.

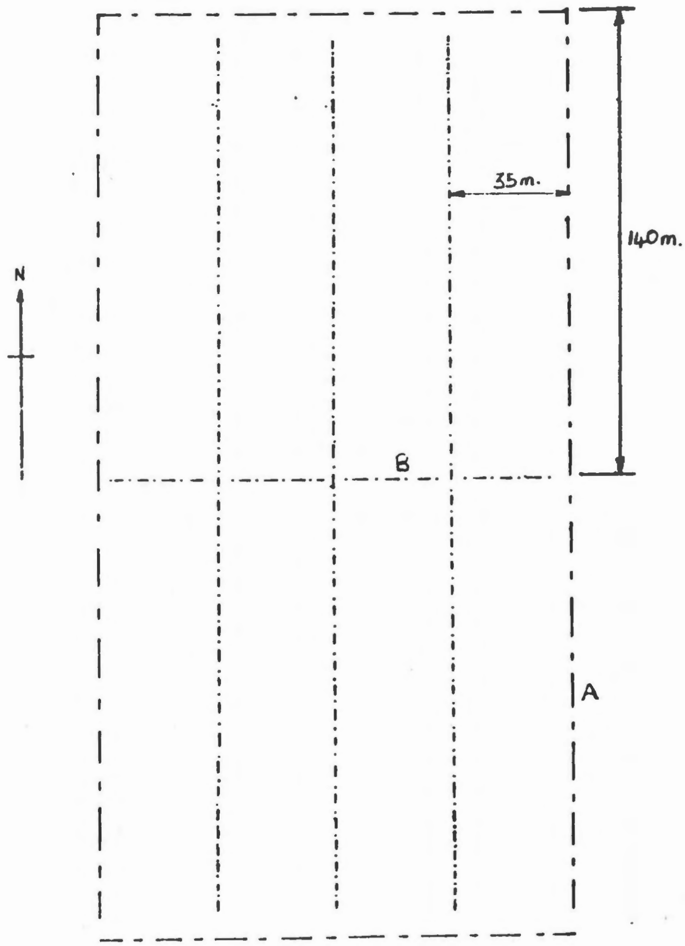

Figure 1: An example of kiwifruit orchard shelter layout in the Bay of Plenty.

Key A - —— - —— *Populus* X *euramericana* 'Flevo' & *Cryptomeria japonica*
B - · — — *Salix matsudana*

The typical shape of any shelterbelt is long and narrow, to reduce the shading problems, when orientated north-south.

Concepts of a Bay of Plenty Kiwifruit orchard layout

Generally speaking, the best layout is to have tall perimeter shelter on the east, west and south sides of a given kiwifruit orchard, orientated N.S., with lower growing or trimmed shelter plant species on the north end.

The basic concept of such planning is to reduce velocity of winds coming from the prevailing southerly direction and to create a wind 'draw' to the northern end (Fig. 1). If tall shelter is used on all boundaries, the stagnation of air will possibly cause frost damage.

Such a layout could be modified for subtropical fruit such as avacados, where greater wind protection is necessary. This would result in closer and greater numbers of internal shelterbelts.

Shelter Problems

In planning, especially in areas of subsequent management, the shelterbelt 'disadvantages' may be minimised or overcome.

(a) Shading effects - These are overcome by four methods:-

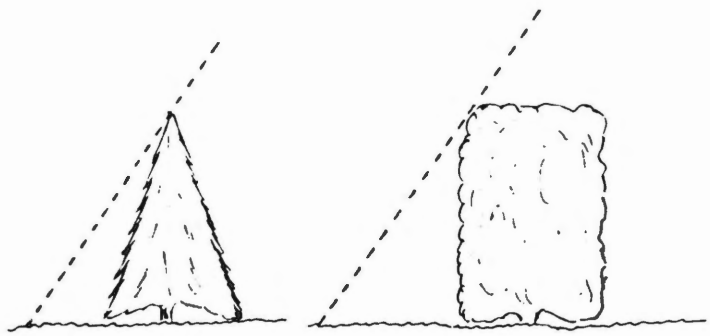

Figure 2: The shade effect, produced by shelterbelt profile (Yeates, 1942).

Figure 3: Typical Kiwifruit shelter layout. <u>Location</u> - Walker East Road, hill top, Katikati, Bay of Plenty.
In foreground *Eucalyptus fraxinoides*, background internal shelter *Salix matsudana*, with X *Cupressocyparis leylandii* clone 'Leighton Green' in the central field depression. Note the long rectangular fields divided by internal shelter.

(i) When planting around a building whether an implement shed or glasshouses, follow guideline distances from structures of at least 2 h on the south side with 4-5 h from the other sides. Base these measurements on eventual mature shelter plant height.

(ii) North-south orientation where possible.

(iii) Use of deciduous shelter plants on dominant on shade producing sides.

(iv) The shape of shelterplant profile (whether trimmed or natural shape). See Fig. 2.

(b) Sloping topography

(i) Frost - On sloping topography the greatest problem associated with crop production, is the promotion of frost 'pockets'. This is caused by trapped downhill air flows, predominantly associated with very dense evergreen shelterbelts, firstly on the windward side of the hill, with subsequent shelterbelts, running parallel to shelterbelt contour. The use of deciduous shelter on the lower end will eliminate the problem of stagnant air. Possibly access into the block, is best obtained at lower ends to increase downward air flow 'draw'. However, it must be understood that all frost damage does not solely pertain to stagnant air, commonly caused by shelterbelts or sloping topography. Radiation frost damage is common to both sheltered and unsheltered fields. In such a situation, shelter does not directly promote this. The effect of colder chilled soil temperatures, will result in bolting of some field crops.

(ii) Inadequate shelterbelt on sloping topography - Total shelterbelt benefits can only be expected when the tree shelter is correctly orientated. Shelter is always planted on the windward side for both stability and wind control. Where shelter is planted on the leeward side of a hill, this will only create air turbulance.

(c) Land Use in comparison with artificial shelter. It is obvious that tree shelter takes up more land. The amount of land loss is directly related to the subdivision size (see Fig. 4).

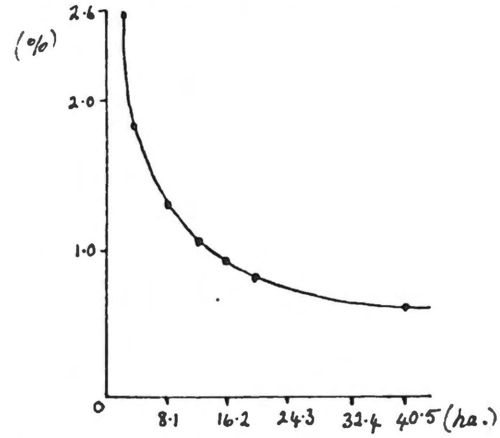

Figure 4: The relationship between land loss (%) in regard to field size (ha) with a 2 m wide shelter-belt. (After Edwards, 1970)

As illustrated, the larger the area, the less land loss occurs. Good management can aim at decreasing some land loss by regular shelterbelt trimming and choice of planting system (e.g. single or double row).

(d) Transference of fertility

To avoid transference of fertility, annual trimming of overhanging branches will prevent livestock congregating under the canopy.

CHOICE OF PLANTING SYSTEM

The most common form of perimeter planting of shelterbelts in the Waikato and Bay of Plenty are double row systems. The exception here would be that of past plantings of shelterplants such as *Cupressus macrocarpa*, *Pinus radiata* and *Chamaecyparis lawsoniana*, in single row shelterbelts so common to the Waikato Districts. The following sections are to investigate the advantages or failings of different planting systems.

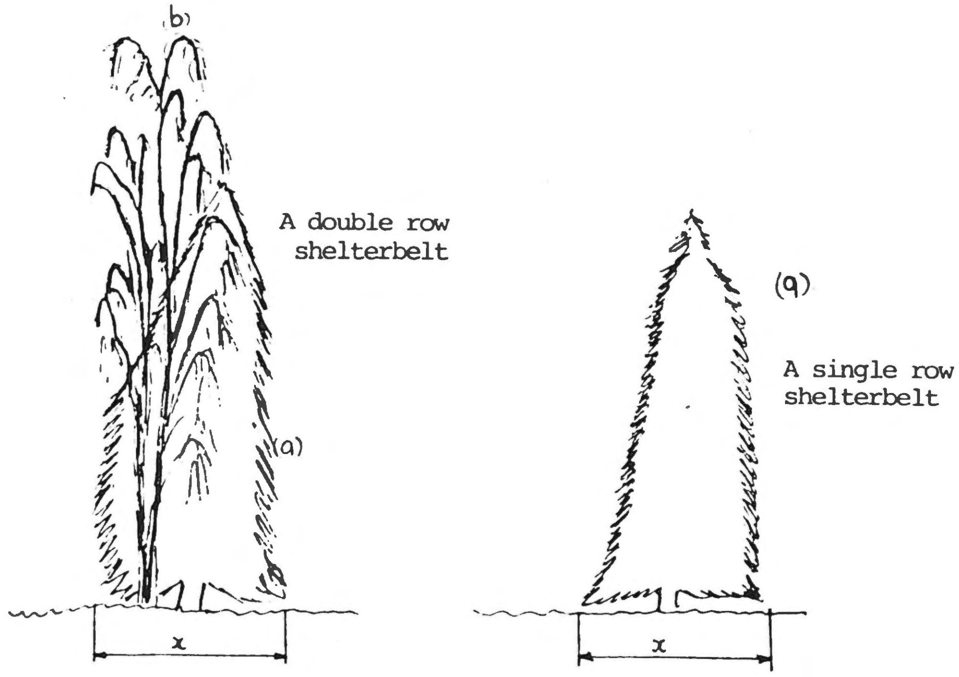

Figure 5: The effects in land usage when pruning single and double row shelterbelts.

Shelterplant (a) *Cupressocyparis leylandii* clone 'Leighton Green'
(b) *Salix matsudana* X *alba* N.Z. '1002'

Single row planting

This system of planting can be used for both perimeter and internal shelter:-

Perimeter shelter - when used as single rows in this situation, the tree species must be windhardy. Examples of such sheltertrees are Leyland cypress (X *Cupressocyparis leylandii* clones); poplars (*Populus* spp.) and Japanese cedar (*Cryptomeria japonica*). However, failure to use sheltertree species suited to single row perimeter shelter may produce disastrous results.

Internal shelter - Pekin willow (*Salix matsudana*) makes up a large proportion of internal single row shelterbelts in established Bay of Plenty orchards.
As the initial force of the wind is broken up by the perimeter shelter, those species that are sometimes less suitable for single row perimeter shelter, may be used internally.
The use of Pekin willow internally is popular due to its ability to be trimmed hard and often into a compact and narrow hedge. The height and width of these shelterbelts can be easily controlled with annual trimming.

Double row shelterbelts
Advantages of double row systems using two sheltertree genera

(i) Failure of a sheltertree species
Often bad management brought about by the choice of the wrong sheltertree species for the prevailing climate may result in either death or lack of vigour in that tree species. Two points are obvious here:-
(a) Choice of correct species initially is important for successful shelter establishment.
(b) When the result leads to death of one of the two species of shelterbelt trees, the other species is responsible until the mistake is rectified. In single row shelter, with an unsuitable species, total shelter may be lost.

(ii) Safeguard against pathogen attack
This could be no better illustrated

A comparison between two tree species in single row plantings.

Figure 6 (a): Single row shelterbelt of *Cryptomeria japonica* (Japanese Cedar) showing it to be perfectly windhardy in its planting situation.

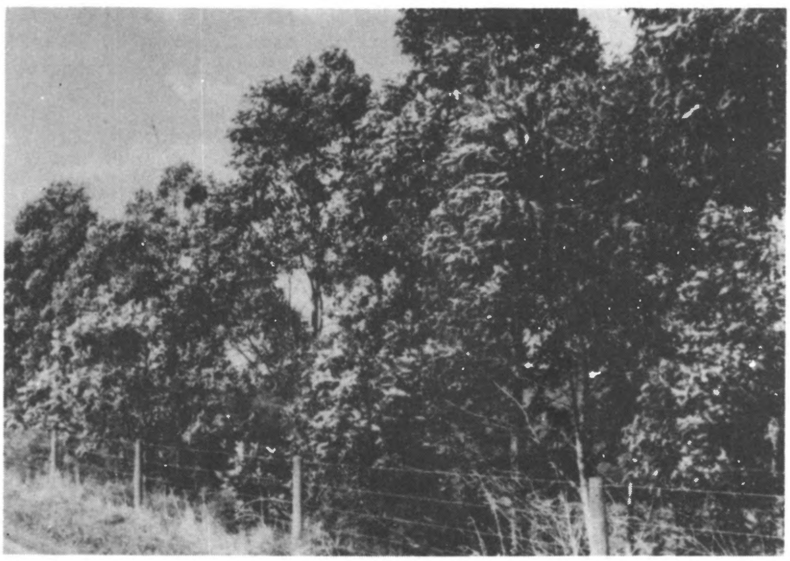

Figure 6 (b): *Eucalyptus saligna* showing wind effects. A species most definitely requiring the assitance of another shelter tree genera.

than the large destruction of Lombardy poplar, (*Populus nigra* 'Italica') by poplar rust (*Melampsora* spp.) in the Bay of Plenty and Waikato shelterbelts (1974). Where this tree was used alone in single row plantings, the orchards were left either partially or totally naked of shelter. It is only in such situations that the full potential of using two shelterplant genera in double row planting is evident.

(iii) The use of some tree species for single row planting

Certain tree species will not produce ideal shelter. This is particularly true of *Eucalyptus* spp. which have the tendency to defoliate at the base naturally. These are likely to suffer from wind damage in all but the most sheltered position. The comparison between two shelterplant genera is shown in photo 6 (a) and 6 (b).

(iv) Provision of shelter in the shortest possible time

In planting schemes of the double row shelter - they usually comprise of a deciduous and evergreen genus. The benefits of these plantings are that the deciduous tree is the quicker growing, hence providing two important advantages:-

(a) Initially providing taller shelter, in a shorter time than that of evergreen shelter;
(b) Protection from wind velocity for the slower growing evergreen sheltertree.

This is one feature not available to single row planting, but however, it must be noted that where two rows of the same evergreen species are planted, the benefits of (a) and (b) are not available.

(v) Wind permeability

The use of two genera in double row plantings will reduce wind velocity to a greater extent. The combination of both evergreen and deciduous species aids permeability by avoiding excessive density. Defoliation of the deciduous species during winter months is helpful. At this time of the year total shelter may not be required overall due to absence of flowers and fruit on most crops.

(vi) Perimeter shelter

Dependent on the shelterplant used, often the use of double rows is necessary to provide perimeter shelter. Once the primary shelter is established, it may allow the use of single rows of shelter on the interior shelterbelts. In coastal conditions, the use of salt resistant genera is necessary for the outer rows of double row planting to give primary shelter to the interior shelterbelts.

(vii) Protection among both shelterbelt rows

The outside row has the ability to break up the initial wind force, prior to reaching the second belt. This can be used to advantage for those genera that are prone to windthrow in the initial stages of growth.

Arguments raised against double row plantings

As with any concept of planting, there are always good and bad points raised. It would be unacceptable if these failings were not investigated by this thesis.

Upon looking into the matter, areas of concern include:-

(i) Use of land
(ii) Extra costs
(iii) Potential of pathogen attack
(iv) Removal of one plant genera at a later date
(v) Interplant competition

(i) Use of land

This is often the most important area of concern. However, the amount of extra land used for double row shelterbelts is often overestimated. Land wastage is minimised by trimming under correct shelterbelt management, as shown in Fig. 6.
Where less fastigiate tree forms are used, such as Chinese poplars (*Populus yunnanensis*), extra width is not occupied at ground level but usually in the skyline.

In general, one can definitely support the theory of excessive land use but only in conditions where the shelterbelt is untrimmed, which defeats the purpose of correct shelterplant management. Trimming of any shelterbelt, whether single or double row, is imperative to cut down on land wastage and increase permeability factors of given shelter. It cannot be stressed too strongly that all shelterbelt plantings are best where they are trimmed at least once a year.

(ii) Extra costs

In general, a combination of evergreen and deciduous sheltertrees are used. In double row shelterbelts, the extra costs of deciduous sheltertrees can be measured in the benefits obtained.

(iii) Potential of pathogen attack

One should never overlook the potential of pathogen attack to a sheltertree on a national scale. Such an example was the poplar rust epidemic.
Diseases in the past have lead to the downfall of many useful hedges such as hawthorn (*Crataegus monogyna*) and Lawson's cypress (*Chamaecyparis lawsoniana*) to name two. Similar problems could prove disastrous in single row plantings where one species is used. This point shows the advantage of double row shelterbelts.

(vi) Removal of plant genera at a later date

This is a very debatable point and a question often raised is - is removal warranted?
Removal of a species will make the vulnerability of one genera to pathogen attack greater.

(v) Interplant competition

This is not a real problem in most double row shelterbelts. Willows and poplars withstand close competition as do most evergreen sheltertrees, e.g. Japanese cedars, Leyland cypress.
There is possibly one notable exception and that is Sheoke (*Casuarina* spp.) which does not appreciate competition over a long period of time.

Triple and other multiple row shelterbelts

The use of triple and further increased multiple shelterbelt plantings is totally unwarranted in the Bay of Plenty and Waikato. These are generally only used in the colder climates to obtain better protection against adverse weather conditions (e.g. snow).

Although used in the past in certain areas, they are now not recommended because:-

(i) Excessive land use, especially on intensive orcharding blocks;
(ii) Climatic conditions prevailing here don't require them;
(iii) The same shelter effect can be obtained by choosing suitable shelterplant genera, and/or use of double row shelterbelts;
(iv) Where timber is likely to be required from say *Pinus radiata* or *Eucalyptus* spp. plantations elsewhere on the farm will produce far superior quality timber to that produced from shelterbelts.

Examples of such planting abortions are found in the Bay of Plenty. What objectives are trying to be obtained here?

Shelterbelt rows consist of - inside to outside:-

Salix matsudana
Casuarina cunninghamiana
Eucalyptus saligna
Feijoa sellowiana
+ artificial windbreak materials.

With correct management, *Salix matsudana* and *Casuarina cunninghamiana* could have been used in conjunction, providing far superior shelter. Problems could arise here with possible removal of some genera, pruning problems, incorrect permeability, plant competition and pesticide spraying of the shelterbelt.

The most important disadvantages are excessive capital expenditure into unnecessary shelter, as well as valuable land wastage.

Planting orientation of shelterbelts using two plant genera

A common question asked is what is the arrangement of planting design when using two shelterplant genera?

The two layouts that are available are:-

(i) Planting the evergreen species at

alternate planting stations in the single row shelterbelt.

(ii) Planting the evergreen sheltertree at the leeward side, at alternate stations to the deciduous species.

ESTABLISHMENT PRINCIPLES

Before planting any shelter, good pre-planting practices are of importance. The first consideration is that of weed control and then cultivation. It is not until this is done that planting can proceed. In all situations, fencing must be erected before planting.

Choice of herbicide

With the advent of contact, systemic and residual herbicides on the market, a large amount of manual labour is now eliminated. For proper establishment of shelter, weedkilling followed by cultivating of the planting strip is necessary. The best planting season for shelterplants is from June - September. Therefore, weedkilling prior to this period is essential. Before beginning this section, it is best to clarify what is meant by contact, systemic and residual herbicides.

(i) Contact and systemic herbicide

Contact (desicant) sprays are those which only kill the weed foliage to which they are applied. Their main effect is to burn off the aerial foliage of plants with the chemical not being translocated internally.
Systemic spray such as 'Round up' is translocatable being able to be absorbed by the plant foliage, killing the entire plant.
Existing weedgrowth will determine the first and final choice of herbicides. Where the predominant weedgrowth at the initial spraying time is annual weeds, contact herbicides are adequate. This is because spraying annual weedgrowth with such sprays kills annual weeds by loss of aerial foliage.
As contact sprays only permit regrowth of deep rooted perennials, underground rhizomes or roots, systemic sprays are necessary for the initial spraying of planting strips or spots where perennial weedgrowth rules.

(ii) Residual herbicides

These are the least used, being the most fatal to trees when used incorrectly. The two commonly used residual herbicides are 'Simazine' (for broadleaf weeds) and 'Propachlor' (for grasses). Remember that too heavy application rates for herbicides can be dangerous - likewise too weak rates may give poor results. In general, follow the application instruction rates carefully.

Remember - always read the herbicide label and wear protective clothing when spraying.

Herbicide Application

Preplanting spraying of weedgrowth is carried out in two ways:-

(i) Spot spraying

This is generally carried out where cultivation by rotary hoeing cannot be achieved, i.e. sloping topography, or where weed competition is very marginal. Spot spraying as the term suggests, aims at spraying, where the planting stations occur, in a circle generaly 1½-2 times the diameter of the plant foliage width.

(ii) Band spraying

This is the most commonly used method, and is the only effective means of preventing further weed regrowth following cultivation when systemic herbicides are used. It has the advantage over the former in that planting stations do not have to be known at the time of spraying. Where double rows of planting are being used it is best not to spray the two individual bands. Spray the whole area including that area between the two rows. This will make maintenance a lot easier in the long term.

Polythene Mulches

The use of polythene for control of weed problems is frowned on by some planters and can create havoc when laid at the wrong time of the year, and under bad planting management.

It is totally inadvisable to lay polythene mulches during summer to control weeds, the reasons being explained shortly. For successful establishment of sheltertrees under polythene it is imperative that the underlying soil is moist. Late autumn, i.e. May - early June, is generally the most acceptable time for best results.

After herbicide spraying and cultivation, the siting of the shelterbelt polythene bed can be determined by measuring out from the boundaries with the use of occasional markers. Along the siting of the line of markers, the fertilizer can now be applied, and then cultivated in lightly. Efforts will be wasted by trying to conserve fertilizer by placing at proximities of planting stations. This is because under cultivation, the fertilizer used will be displaced through the entire length of the strip. This results in ⅓ - ½ of total fertilizer at planting stations being displaced. If applied along the total length of the planting zone, even distribution through the entire area occurs.

Where possible, laying of the polythene is best suited to periods after light rain occurs but not following torrential rains. Working in conditions too wet cause vehicular compaction of soil by tractor polythene laying machine as well as poor cultivation to mix in fertilizers.

Another method of laying polythene that is inadvisable, is laying polythene after planting of shelter trees. This has the major drawbacks of time consumption on larger plantings, waste of polythene and reintroduction of weeds above the polythene.

Autumn pre-planting procedure

In general, most people tend to spray off weed growth and cultivate 3-4 weeks prior to planting. In autumn, such planting techniques are often not ideal, especially during periods of rain. Autumn preparation prior to planting should most definitely aim at using systemic herbicides to kill deep rooted perennial weeds unaffected by contact sprays. The earlier in autumn the weed killing is done the better. Due to the large amount of rain sometimes encountered in the following 4-5 months cultivation is often hopeless, leading to damage of the soil structure.

Late summer pre-planting practices

To avoid the difficulties of applying herbicides and cultivating in wet weather, pre-planting preparation can begin in late summer. The advantage of this method is better soil preparation due to drier weather conditions. More thorough soil preparation will definitely lead to better subsequent plant growth. Initially, contact sprays can be used to kill off existing weedgrowth, with consequent cultivation of weed control. A weed clean up using a systemic spray in autumn is advisable. Of course, this method depends on the scale of planting and available labour and machinery resources.

'Zero Tillage'

This planting method involves the use of weedkillers for band spraying without any cultivation prior to planting. Two advantages are reduction in erosion problems on loose soil structures and reduced weed growth by not disturbing the soil stimulating conditions for weed seed growth.

Cultivation

When cultivating the shelterbelts soil, it is best to rotary hoe to a shallow depth first to scim off vegetation and break up the sod on top before burying it. It must be stressed that cultivation will not give control of perennial weedgrowth. Herbicide spraying before cultivation is considered advisable in most situations. Subsequent cultivation should aim at maximum hoeing depth and promotion of a suitable soil tilth.

Before the final 2-3 cultivations, shortly before planting shelterplants, the appropriate fertilizers should be added and mixed in.

It must be stressed that no two soils are similar and that soil tests are advisable to determine the fertilizer quantities to be used.

Fencing

This is one of the important features of good management before, not after, planting of the shelter.

It is important to provide good fencing to prevent livestock damage to the valuable tree stock in farm situations. The use of double fencing is the best method of livestock control. The most common mistake in shelter farming is the placement of stock fences too close to the sheltertrees.

The spacing of double fencing is best based on the sheltertrees' mature dimensions. Niggardly use of fencing material leads to defaciation of the sheltertree as well as destruction of the shelterbelt design. Other methods in recent years are the use of a single wire off the ground, of which is being used successfully in Nelson (N.Z. Journal of Agriculture, Sept. 1981).

Yeats (1942) suggests some ways in which to reduce fencing costs are:

a) On road boundaries, plant hedges on the roadside of the fence. In some cases, ditches will prevent fencing on the other side of the shelterbelt.
b) Use of electric fences which reduce both labour and capital costs of conventional fencing.

PLANTING

In this area of the country, the best planting time is early June to mid-August for best results. The pla ing season is by no means strictly limite to within this period, but two factors influencing earlier and later plantings are:-

(a) Wrenching or open ground sheltertree stock

Not being done till May, facilitating 2-3 weeks after wrenching prior to being despatched. (In this area, the amount of rainfall received is sometimes a governing agent, controlling the time of the wrenching operation.)

(b) Drier planting conditions

The period of time from mid-August onwards is often climatically drier with the onset of Spring approaching. In September, this will definitely not allow lifting of O/G evergreen shelter trees (i.e. *Cryptomeria japonica*) and deciduous genera. It will also influence establishment of containerised stock. The disadvantages of later plantings are clearly seen both in plant growth and extra financial expenses in terms of trickle irrigation and replacements of plant losses in the next growing season. Therefore, management is best aimed at planting within this time with the winter rains used to advantage to establish shelter assisting also in fertilizer release. However, spring planting can be used to advantage with frost tender shelter plant (e.g. *Eucalyptus* spp.).

Fertilizers

Unless the fertilizer has already been added to the soil (e.g. where polythene mulches have been used), it is best to apply the fertilizer into the planting holes.

Since the shelterbelt is permanent, a long term fertilizer is advisable. The use of a slow-release fertilizer such as 'Osmocote' is highly recommended. This has the ability to feed the plant over the next 8-9 months.

Avoid the use of high nitrogenous fertilizers, e.g. 'Urea', as these will often produce shelterplant mortalities when applied at heavy rates. Also, they are only short term sources of food.

One point worth of mention is that *Eucalyptus* spp. are sensitive to fertilizer applications and advice should be sought from the supplier at purchase time.

Planting Procedure

It cannot be stressed enough how the planting practice of any sheltertree will affect its ultimate growth. Care at planting time is necessary but on the other hand, time is important. The planting of any shelterbelt should aim at the quickest and most efficient method possible.

Of course, this is where the choice of plant selection (i.e. cutting, 'pole', one-year plant) will effect the time taken in planting.

Today, planting is done manually or with the use of mechanical post-hole diggers on larger planting projects, reducing both time and labour.

Where post-hole borers are used, the wall of the hole should be broken down with a spade and the hole squared off to encourage root growth.

The management objectives of all planting selections are:-

(i) Thorough watering of all planting stock prior to planting.
(ii) Planting in favourable weather.
(iii) Avoid structural plant damage

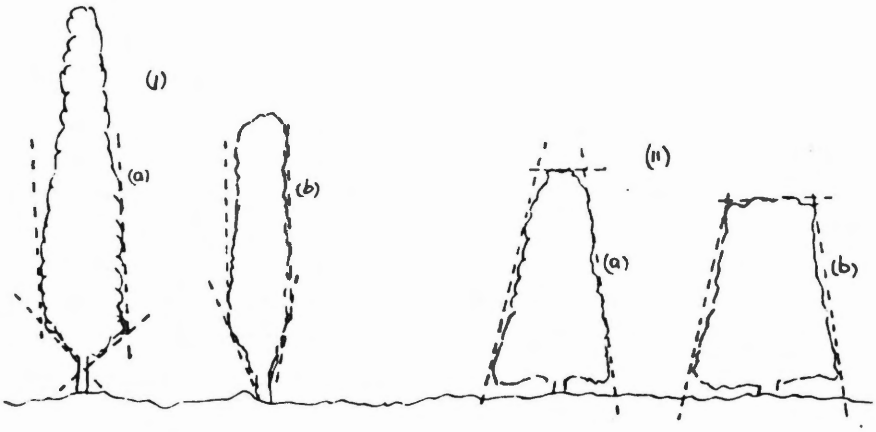

Figure 7: Bad trimming examples (i)a and (i)b. The best profiles possible are (ii)a and (ii)b. Note foliage to ground level.

especially to plant roots and foliage.

(iv) Avoid drying of roots on all O/G bare root planting stocks.
(v) Correct sized planting holes.
(vi) Planting at the correct depth in the soil.
(vii) Firm planting.

Planting Cuttings

To avoid minimal weed problems in establishment of cutting stock, it is strongly advisable to use a polythene planting mulch.

Once the polythene (see Section 3(a)) is laid, the next steps are as follows:

(i) Spiking of the polythene mulch at planting stations. Make the hole in the polythene slightly smaller than the cutting diameter. This results in minimal weed growth around the cutting.

(ii) Planting of cuttings - here two points need considering:-
  (a) Polarity of cutting - Mistakes in inserting cuttings upside-down can be avoided by cutting the basal end square and the proximal end diagonal.
  (b) Depth of planting - Successful establishment is best achieved when the cutting is inserted to at least 2/3-3/4 of its depth. Here optimum moisture requirements are met leading to successful establishment.
  Only on tighter soils and erodible slopes where cultivation is limited, planting conditions may be difficult. Insertion can be aided with the use of a rubber-headed hammer.
  If the top end becomes shattered, it can be pruned off cleanly down to the next bud.

Planting of both container and O/G shelterplant stock

(a) Container stock planting involves

(i) Preparation and the addition of fertilizer to the planting hole.
(ii) Removal of the container and 'loosening' of the rootball if necessary. The acceptable practice here is two or more verticle spade cuts down the rootball and teasing out of the lower roots. Care should be taken not to disturb the roots too much as a severe check may be made thus increasing the changes of plant collapse.
(iii) Firm planting to the correct depth.

Peat pots

Shelterplants are best left in these containers but 'pinch' out the base of the pot. Also removal of the 'lip' is important to avoid excessive moisture loss if this is planted above ground level.

(b) Planting of O/G deciduous and evergreen sheltertree

Where the roots of these plants are dry due to being too long in transit or for some other reason, the old practice of 'puddling' of roots, is worthwhile at planting. As the name suggests, slurry of mud and water is mixed to a 'porridge' consistency. The roots are then immersed in this prior to planting. It acts as:

(i) A barrier against roots drying out.
(ii) A moist surface allowing new root growth in surrounding soils.
(iii) Provides a source of moisture when prevailing conditions are drier.

Planting through polythene mulches

The planting of O/G and container stock in polythene mulch, is done by making an opening or by cutting a '+' pattern in the mulch with a sharp knife.

The corners of the hole can be enveloped against the plant stem. The size of the '+' cut is dependent on rootball size and a single 'I' cut may only be necessary in certain situations (e.g. cuttings).

POST-PLANTING CARE

The planting of the shelterbelt does not terminate the job of sheltertree establishment. Good management does involve post-planting care in area of:-

(a) Weed control
(b) Irrigation
(c) Trimming
(d) Fertilizing
(e) Pest control

(a) Weed control

The presence of excessive weedgrowth is the first indication of poor post-planting management.

The two primary causes of weed invasion result from:-

(i) Inadequate pre-planting weed control.
(ii) Choice of a contact herbicide where a systemic spray was necessary to control perennial weed growth.
(iii) Failure to replace sheltertree losses in early stages allowing gaps for weedgrowth (as well as affecting shelterbelt efficiency).

Weed control during the period of sheltertree establishment is of utmost importance for reducing sheltertree/weed competition for nutrients and water.

(b) Irrigation

The use of irrigation is a great advantage in establishing the shelterbelt.

The most effective method is the use of trickle (or microtube) irrigation. Once the shelterbelt is established, the irrigation system can then be adapted for the crop, i.e. subtropical fruits. Ideal delivery rates of 5 l/3 days for each young shelter tree as recommended by the Department of Agriculture (1981). Always bear in mind that over-application of water is detrimental to plant growth. A clean water supply is necessary for such a system and correct sized irrigation pipes, and good advice for establishing such a system can be obtained from the local M.A.F.

(c) Aims and Benefits of Pruning

One of the most important post-planting practices is trimming of shelter on an annual or regular basis. Trimming differs from 'pruning' in that each outward branch is cut uniformly.

Summary of trimming objectives

(i) To increase shelterbelt efficiency by increasing branch and leaf area.
(ii) To keep the shelterbelt to the required dimensions.
(iii) Increase possible land area for cropping.
(iv) Reduce soil moisture and nutrients required especially in areas of drought.
(v) To produce a uniform sheltertree width avoiding overhanging higher branches.
(vi) Promotion of stronger branches from old growth.
(vii) To prevent the spread of noxious weeds (see Appendix for Provisions of Noxious Weed Act, 1928).

The promotion of stronger growth is possibly the prime objective of pruning. This factor determines the 'suitability' of sheltertrees to trimming. Coniferous shelterbelts are commonly ruined by severe trimming. It must be remembered that this group of trees will not regrow from older wood thus making it necessary to do regular trimming.

Certain vigorous sheltertrees need and will withstand harsh pruning, *Salix* and *Populus* spp. (willows and poplars).

These sheltertrees have the ability to reshoot from bare stems where leaves were previously absent.

Shelterbelt Profile

The shape of the shelterbelt profile is the common area in which most trimming errors are made. Even in the domestic New Zealand home garden, the average person will trim the hedge in either of the profiles shown in Figure 7.

With the finished trimmed profile in (i)b, retention of the lower leaves is impossible. This is due to the fact that the sun will not reach the lower leaves due to its angle. Loss of sunlight results in defoliation because photosynthesis (briefly, the plant's production of food by leaves in the presence of sunlight) cannot be carried out. This in turn leads to the opening of the shelterbelt at the base thus reducing its efficiency. Often the profile (*i*)b is produced by stock grazing the plant foliage when inadequate fencing is present. The profiles of (ii) illustrate the best possible trimmed shelterbelt. For (ii)a, a slight slope backwards to the top is also acceptable. (ii)b typically illustrates the profile of a coniferous shelterbelt.

(d) Fertilizing

Shelterplants will respond to the benefits of fertilizer sidedressing. The best time to apply this would be from July - September. Where trickle irrigation is being used on young shelterbelts, fertilizer may be transferred through the water supply.

Fertilizers should be applied on the basis of the soil tests which should have been done earlier. This may avoid an over-supply of any of the major elements N.P.K. If in doubt, it would be advisable to contact the horticultural adviser with the M.A.F.

(e) Pest Control

Opossums, hares and rabbits are three associated pests of farm shelter planting. The most common damage is the removal of young growing tips of plant and structural plant damage. It is not a very easy problem to control. Plant damage may be reduced by any of the following:

(i) Spraying stocks of trees with 'Zineb' fungicide. A commercial 'sticker' will increase the longevity of the spray adherence.

(ii) Organising opossum hunts to reduce the populations.

(iii) Contacting the local pest destruction board for assistance.

(iv) The use of trees in preference to cuttings.

(v) Spot spray in preference to band spraying. Hares are less likely to run through wet rank grass compared with completely sprayed areas (Stringer, 1977).

Horticultural Education at Massey University

by

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With approximately 365 students involved over the four years of the Bachelor of Horticultural Science degree (135 in the current first year), and 160 students in the one year specialist undergraduate Diploma Courses, Massey University can, with justification, claim to be one of the major centres, if not the major centre, for Horticultural Education in the Southern Hemisphere.

Horticultural training at Massey University began in 1945 with the introduction of a two-year Diploma course, and two years later - with a single student - the introduction of a four year Degree course in Horticulture. Training at the post graduate level - post graduate Diploma, Masterate and Doctorate - began in the mid 60's.

The increase in student numbers, which has occurred particularly over the past 10 years, is a far cry from the 50's and 60's when horticulture was the Cinderella of the Faculty of Agricultural and Horticultural Sciences with only 7% of the students; now approximately 40% of the Faculty's students are studying for horticultural qualifications.

This growth in student numbers has resulted in an increase in the number of academic staff teaching in the Department of Horticulture and Plant Health to 23, while lecturers with major horticultural interests are located in other departments of the Faculty, and include three Horticultural Management lecturers, and horticultural specialists in soil, horticultural mechanisation, plant breeding and horticultural engineering.

Massey University is a multi-faculty University, and this allows degree students the opportunity to specialise outside the Faculty in their final year of the degree in, for example, specialised areas such as biochemistry, (in the Faculty of Science) or horticultural marketing (in the Faculty of Business Studies).

THE UNDERGRADUATE HORTICULTURAL DIPLOMAS

Currently Massey University offers four specialist horticultural Diplomas, viz:

- Diploma in Amenity Horticulture
- Diploma in Nursery Management
- Diploma in Orchard Management
- Diploma in Vegetable Production

The Diploma in Nursery Management offers a major in either Nursery Production or in Cut Flower Production.

All four Diplomas have common courses in Horticultural Botany, Soils and Fertilizers, Horticultural Engineering, Plant Health (2 papers), Horticultural Management and Horticultural Mechanisation, but differ in their specialist areas, with two papers and a practical in either Fruit Production, or Amenity Horticulture, or Vegetable Production, or Nursery/Cut Flower Production. Although the course is academic there is a strong practical horticultural component, with a 3-hour horticultural practical every week, and a pre-entry minimum requirement of 48 weeks practical horticulture relevant to the particular Diploma. Entrants must be at least 18 and have an acceptable school education, preferably involving a minimum of four years at secondary school. The course runs from late February to mid-October.

BACHELOR DEGREES IN HORTICULTURE

Entry into a Bachelor Degree in Horticulture is a minimum of University Entrance in New Zealand or Australia. New Zealand students are generally well advised to take a further year at secondary school after obtaining University Entrance in their fourth year.

A strong background in the Sciences, in particular in Chemistry, Botany, Physics and Mathematics, is highly desirable. It is possible for students to provisionally enter the degree course without the equivalent of University Entrance, once over the age of 20 years.

The course follows the usual pattern of applied science degrees throughout the world:

Year 1 - Sciences:	Biology of Plants Cell Biology Cell Chemistry Chemical Principles Chemical Reactions Physics Mathematics Horticultural Plant Science I Horticulture I
Year 2 - Applied Sciences & Technology:	Biochemistry Horticultural Plant Science II Horticultural Engineering Horticultural Mechanisation Economics Horticulture II (2 papers covering Fruit/Vegetable, and Cut Flower/Amenity Horticulture)
Year 3 - Applied Sciences & Technology:	Horticultural Plant Science III Horticultural Economics Horticultural Management Plant Health Biometrics Soil Science Horticulture III (2 papers covering Fruit/ Vegetables, and Nursery Crops/Amenity Horticulture)

At the completion of the Third Examination students may graduate with a Bachelor of Horticulture Degree, but most students continue to Year 4 to obtain a Bachelor of Horticultural Science, or, for a few selected students the Bachelor of Horticultural Science with Honours.

YEAR 4 - SPECIALISATION

Students are able to select five subjects from a list of over 50 papers for study in the final year. Students selected for Honours in addition to the five subjects, also do a research project equivalent to one paper.

An essential part of the degree is the requirement to do 48 weeks practical horticultural work prior to graduation. This must be done on <u>at least</u> two different types of horticulture enterprise, and is usually undertaken in the summer vacations. For the practical experience to be credited, it is necessary to submit an acceptable report on the work.

POST GRADUATE STUDIES

A range of post graduate courses are avialable in Horticulture, including a post graduate Diploma, Masters and Doctor of Philosophy (Ph.D).

DIPLOMA IN HORTICULTURAL SCIENCE

This is a one calendar year course which involves the equivalent of five papers and may include research equivalent to one or two papers. It is currently being used primarily to give non-horticulturists with appropriate degree qualifications (e.g. Science or Agriculture) a background in horticultural science. It is also used to assess the potential of some students for masterate training, and to "retrain" horticultural degree holders.

MASTER OF HORTICULTURAL SCIENCE

Nominally of 12 months duration, but most students take between 18 and 24 months to complete this degree. Entry is only through a degree majoring in Horticultural Science, and the course involves three papres, and a research thesis equivalent to a further two papers. Students without the required horticultural background may study for the Master of Philosophy, which is precisely the same course, under a different name.

DOCTOR OF PHILOSOPHY

This is the highest supervised degree available from the University. Entry into the programme is through a satisfactory Masters degree or an upper class Bachelor Honours degree. Although some course work may be required in the early years, the degree is assessed on the research thesis produced by the students. Nominally of a minimum duration of two years, probably three to four years is a better estimate of the time required to complete a Ph.D.

One of the major strengths of the Horticultural programmes at Massey University is that both Degrees and Diplomas are taught within the same Institution. This means that there is available a larger pool of specialised lecturers, and better facilities than either programme could justify independently. The multi-faculty nature of Massey University is also particularly advantageous for the degree programmes.

Recently Presented N.Z. Theses and Dissertations of Interest to Horticulturists

N.D.H. THESES

MATTSON, L.T.W.	N.D.H. (Nursery Management) Fourth Schedule. "The Establishment of Effective Shelter for Sub-tropical Cropping in North Taranaki."
GRINTER, K.R.	N.D.H. (Nursery Management) Fourth Schedule. "An Assessment of the Suitability of Some Species of Tree for Planting in Te Mata Park."
GILLESPIE, R.J.	N.D.H. (Vegetable) Third Schedule. "An Analysis of the Importance of Ring Spot (*Marssonina panattoniana*) and other Diseases in Lettuces with Suggested Control Methods."
REECE, M.J.	N.D.H. First Schedule. "Plants Suitable for Wellington Rock Gardens."
ROSSITER, G.G.	N.D.H. First Schedule. "Management and Establishment Principles of Major Shelterplant Species in Bay of Plenty and Waikato Areas."
MILLS, J.	N.D.H. First Schedule. "The Establishment of Plant Material on Sanitary Landfills with Particular Reference to the 'Meola Reef'."
DANIELS, M.	N.D.H. First Schedule. "The Collection, Propagation and Growing of Native Ferns in the Canterbury Area."

THESES AND DISSERTATIONS PRESENTED AT UNIVERSITIES IN NEW ZEALAND

BASHAM, C.A.	Some factors which may influence root formation in conifer cuttings. M.Sc. (Massey)
FLOYD, R.M.	Growth studies with peas. M.Sc. (Massey)
GREEN, J.C.S.	Plant density and crop establishment studies with tomatoes for mechanical harvest. M.Sc. (Massey)
JACKSON, T.A.	A study of insect pests of Brussel Sprouts in Canterbury; their phenology and the resultant crop losses. Ph.D. (Lincoln)
KAINI, R.R.	Studies on shoot growth and flower initiation in apples. M.Hort.Sc. (Lincoln)

LALLU, N.	Studies on bud dormancy of woody species. Ph.D. (Canterbury)
LEONG, A.G.B.	Certain factors affecting the production of container grown ornamental peppers (*Capsicum annum*). M.Hort.Sc. (Lincoln)
LEWIS, I.R.	Towards the development of a management information system for glasshouse tomato growers. M.Hort.Sc. (Lincoln)
SPIERS, A.	Studies of *Marssonina* and *Drepanapeziza* species pathogenic to poplars. Ph.D. (Massey)
WAKEFORD, R.J.	Land use constraints to increasing horticultural production in the western Bay of Plenty. M.Sc. (Massey)

(N.B. N.D.H. theses are deposited in the Lincoln College Library and are available through the New Zealand Libraries Interloan Service.)