TECHNICAL BULLETIN
NO. 242

# HORTICULTURE DIVISION TECHNICAL ANNUAL REPORT 1994 - 1995

$6.00

ISBN 0 7245 3006 1

DEPARTMENT OF PRIMARY INDUSTRY AND FISHERIES

# HORTICULTURE DIVISION

# TECHNICAL ANNUAL REPORT

# 1994 - 1995

APRIL 1996

# SUSTAINABLE AGRICULTURE

## THE DEPARTMENT OF PRIMARY INDUSTRY AND FISHERIES IS COMMITTED TO THE PRINCIPLES AND PRACTICES OF SUSTAINABLE AGRICULTURE

**Definition:**

Sustainable agriculture is the use of practices and systems which maintain or enhance:

- the economic viability of agricultural production:
- the natural resource base: and
- other ecosystems which are influenced by agricultural activities.

**Principles:**

1. Agricultural productivity is sustained or enhanced over the long term.
2. Adverse impacts on the natural resource base of agricultural and associated ecosystems are ameliorated, minimised or avoided.
3. Harmful residues resulting from the use of chemicals for agriculture are minimised.
4. The nett social benefit (in both dollar and non-dollar terms) derived from agriculture is maximised.
5. Agricultural systems are sufficiently flexible to manage risks associated with the vagaries of climate and markets.

SUSTAINABLE AGRICULTURE IN THE NORTHERN TERRITORY

# HORTICULTURE DIVISION GOAL AND STRATEGIES

Horticulture Division provides research, development and extension services to horticultural industries of the NT. Activities cover most fruit, vegetable and ornamental crops. The goal and strategies of the Division are as follows.

## GOAL

**To continue to assist in the development and promotion of a sustainable horticulture industry in the Northern Territory.**

## STRATEGIES

- **Provide appropriate genotypes of commercial species through varietal trials including annuals, perennials and ornamentals;**
- **Develop optimum production systems for selected crops, encompassing irrigation, nutrition and post harvest aspects;**
- **Support expansion with an orientation towards export through information services and participation in land use planning and infrastructure development.**

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## PREFACE

Structural changes, started within the Department last year, have all been formalised and procedures set in place. There are a number of planning processes in place to ensure discussion and consultation with the industry and various parts of the Department can address industry needs effectively.

The Department produced a "Future Directions" document to cover all aspects of rural and fishing industries development and incorporating functions of all NT Government instrumentalities. This is the first policy statement of the NT Government for the development of rural and fishing industries and it will provide guidance for future industry development in the NT. The document sets policy guidelines for the horticulture industry in the areas of sustainable development; pest, disease and weeds issues; resource and infrastructure development; value adding and market development; and improving the level of business management skills in the industry.

All Divisions now organise their activities on a program basis, with cross-divisional interaction and, for the first time Business Plans have been produced to streamline activities of the Department in assisting industry development. This planning process along with the flatter structure of the Department and more delegations to people with responsibilities will provide a greater ability to respond to the industry development needs in the future.

This report presents all the work done in the past year by Horticulture Division staff in the NT. For the first time the structure of the report will reflect the program structure of the Department's activities.

## MAJOR FRUITS PROGRAM

**Objective:** ***To improve the sustainability and expansion of existing commercial fruit production.***

| Sub-Program | Co-ordinator |
|---|---|
| Mango: | Dr V Kulkarni |
| Banana: | Mr K Blackburn |
| Table Grapes: | Mr G Kenna |

## DEVELOPING FRUITS PROGRAM

**Objective:** ***To increase the productivity and profitability of a number of new tropical and sub-tropical fruit crops.***

| Sub-Program | Co-ordinator |
|---|---|
| Tropical Exotics | Dr T K Lim |
| Dates | Mr G Kenna |
| Citrus | Mr M Hoult |
| Sub-Tropicals | Mr G Kenna |
| Cashew | Dr V Kulkarni |

## VEGETABLES PROGRAM

**Objective:** ***To enhance the profitability and sustainability of vegetables and other annual crops production in the horticulture industry.***

| Sub-Program | Co-ordinator |
|---|---|
| Annual Crops | Mr M Smith |
| Asparagus | Mr M Smith |

## ORNAMENTAL PROGRAM

**Objective:** *To increase productivity and sustainability of nursery and cut-flower industry.*

| Sub-Program | Co-ordinator |
|---|---|
| Tropicals | Mr J Powell |
| Australian Natives | Mr G Kenna |

The Division continues to operate the Post-Entry Quarantine facilities in Darwin. Most of the introductions were for the Department from Sarawak, Thailand and India. Several introductions, mostly ornamental plants, from Thailand were released to the industry this year.

Minor changes in staffing are listed in the attached details.

## INDUSTRY

Spread of melon thrips - ***Thrips palmi*** - to Queensland last year lifted quarantine regulations against NT produce, with the exception of WA and SA. Late in 1994, however a new insect whitefly (type B) - ***Bemisia tabaci*** - was identified for the first time in the NT. A national survey confirmed the presence of the insect in other states. In fact the insect came into Australia in other states first and then was shipped to the NT on some ornamental plants. Current melon thrips regulations also cover restrictions on NT produce into interstate markets.

The industry growth this year seems to be more buoyant than in previous years and seems to be linked to the economic activity. More enquiries were received this year, than in the last two years combined. The value of the industry increased by nearly $7.0M (21% over 1993).

The major improvement in the value of the industry came from the fruit crops, nearly 3000 tons and $5.0M more this year than last year. The bulk of improvement was recorded by mangoes where production increased to nearly 5,715 tons compared to 3,810 tons last year. The value of mango production increased nearly $2.1M over last year due to the volume of fruit rather than price, which fell to approximately $2.77 / kg. Most of the increased production of mangoes was recorded from more trees coming to production this year. This trend will continue for some years to come. This year only 265 tons of fruit were exported to Singapore and Hong Kong markets. This year also saw the beginning of export of vapour heat treated fruit to Japan, through Queensland. Initial comments from the Japanese market on the NT fruit were favourable.

**Table 1: Trends in production, value and price of mango, banana and table grapes in the past 5 years.**

| | 1990 | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|---|
| **MANGO** | | | | | |
| Production (Tons) | 1863 | 1984 | 3984 | 3810 | 5715 |
| Value ($M) | 6.87 | 6.15 | 10.92 | 13.73 | 15.83 |
| Average Price ($/Kg) | 3.69 | 3.10 | 2.75 | 3.61 | 2.77 |

| | 1990 | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|---|
| **BANANA** | | | | | |
| Production (Tons) | 1477 | 1790 | 2800 | 2381 | 3154 |
| Value ($M) | 1.41 | 2.22 | 3.47 | 2.62 | 3.56 |
| Average Price ($/Kg) | 0.95 | 1.24 | 1.24 | 1.10 | 1.13 |

| | 1990 | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|---|
| **TABLE GRAPES** | | | | | |
| Production (Tons) | 839 | 811 | 1310 | 1149 | 1130 |
| Value ($M) | 2.13 | 2.36 | 4.54 | 4.42 | 4.63 |
| Average Price ($/Kg) | 2.54 | 2.91 | 3.47 | 3.84 | 4.10 |

The value of banana production this year increased by nearly 36% to $3.56M. Production of banana was also higher this year, nearly 773 tons more than last year. The future for bananas in the NT looks promising with the release of land to two major banana growers, 100 ha each, to be planted over the next 3-4 years. A number of other banana producers from Queensland are also considering moving to the NT to complement their current production and to reduce the risk of losses through natural disasters like cyclones etc. This will essentially triple the land planted to bananas in the NT.

Table grapes is the next important fruit crop, with a similar value of production, volume and prices to that of last year. A number of new fruit crops are increasing in production and value.

Vegetable production this year remained at the same level as last year as illustrated in Table 2.

**Table 2: Production and value of fruit and vegetables for 1994.**

| | CROP | PRODUCTION (Tons) | VALUE ($M) |
|---|---|---|---|
| FRUITS | Mango | 5715 | 15.831 |
| | Melons | 2715 | 2.935 |
| | Table Grapes | 1130 | 4.625 |
| | Banana | 3154 | 3.562 |
| | Others | 447 | 2.088 |
| | Sub-Total | 13197 | 29.041 |
| VEGETABLES | Asian Vegetables | 251 | 0.525 |
| | Cucurbits | 1179 | 1.173 |
| | Others | 1209 | 1.988 |
| | Sub-Total | 2639 | 3.686 |
| TOTAL FRUIT & VEGETABLES | | 15836 | 32.727 |

The Asian vegetable industry is developing into a significant part of NT horticulture. The data presented in Table 2, 251 tons and $0.525M, is incomplete as most of the trade is vertically integrated and goes into southern retail markets, without going through traditional marketing chains. This presents a problem in obtaining all the relevant data. Vegetable crops are on the increase in the Katherine region and have a promising future.

The accurate value of cut-flowers and other nursery industry production is also difficult to obtain. There is a definite increase in this industry and an estimate of $8.0-$10.0M is provided for this sector this year, bringing the total value of NT horticulture industry to $40.7-$42.7M for the year.

## HIGHLIGHTS FOR THE YEAR

Following the formal signing of the "Bilateral Agreement" with Sarawak, a number of species and varieties of fruit trees were introduced . This list added to already successful introductions from Sarawak to date. A number of introductions from Sarawak and Thailand, mainly ornamental plants, were released to the industry this year. These introductions were essential for the continued operation of post entry quarantine facilities in Darwin, the only one operating for tropical Australia.

This year the Division initiated a new project to strengthen post-harvest research in mangoes. Skin browning in mangoes is increasing and adversely affecting the quality and price of NT mangoes. The incidence of browning is at a minor level but there is a need to address this issue now to avoid future problems. Collaborative efforts are being made with the Queensland DPI to address the skin browning problems with mangoes.

A national mango breeding project was initiated in collaboration with the Queensland DPI, WA Department of Agriculture and CSIRO Division of Horticulture. Some 70 hybrids were produced this year by the Division, out of total of 250 hybrids from all participating organisations. These hybrids will be tested in northern Queensland and Darwin sites.

The winged vertebrate pest project was pursued jointly with the NT Conservation Commission, who are responsible for the wildlife in the NT. The initial survey indicated that the bird and bat problems are concentrated in the Darwin rural areas, mainly in fruit crops. The intensity of the problem is low in other areas and other crops. A number of chemical, physical and biological control mechanisms were examined, with limited success. Successful control seems to rest with a combination of various methods rather than a single method.

The Division commissioned a consultancy to review the prospects for a citrus industry in the NT . Scholefield Robinson Horticultural Services Pty Ltd and Yandilla Park Ltd were appointed to conduct the study. This report will establish a framework for the development of a citrus industry in the NT.

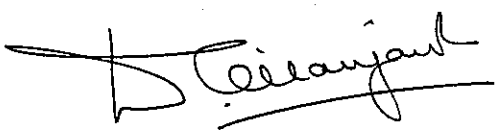
The Division also employed a consultant to liaise with the increasing number of Vietnamese growers, who have increased the extent and value of Asian vegetable production in the NT. One of the concerns was related to potential problems with the use of pesticides by the non-English speaking community. A pamphlet with details on the use of chemicals and pest identification, with colour photos, was produced and translated into Vietnamese and made available to some 25 growers. This assistance will continue in other areas identified through further discussion with the growers.

A number of research achievements were made this year, which will be discussed in the text of the projects reported here.

**ACKNOWLEDGMENTS**

Assistance provided by the Rural Industry Research & Development Corporation for three projects; Irrigation studies with Rambutan, Date Cultivar evaluation and Durian research is most appreciated.

We are most grateful for the assistance provided by a number of growers in all regions who allowed Divisional staff to conduct research and/or monitoring plant growth and related observations on their properties. This collaboration has enhanced the effectiveness of research conducted and optimised our resource utilisation.



Dr Niranjan R Dasari
Director, Horticulture Division

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## HORTICULTURE DIVISION

Horticulture Division has four Programs: Major Fruits, Developing Fruits, Vegetables and Ornamentals.

## MAJOR FRUITS

# Varietal Trials in Mango

V.J.Kulkarni, D.Hamilton

Although the mango industry has been almost entirely dominated by the cultivar Kensington Pride, cultivars such as Irwin, Nam Dok Mai, Glen and R2 E2, have been grown in the Top End on a small scale. R2 E2 is the latest addition from Queensland. Reaction from growers on the performance of these cultivars in the domestic market has been mixed. Some growers have been successful, whereas others have removed or have top worked their Irwin and Glen trees with Kensington Pride. One noticeable recent development in the industry has been the growing awareness about mango cultivars and the need for varietal research. This can be attributed to limitations such as erratic bearing habit, sap burn and poor storage life associated with Kensington Pride. In addition to this, export is emerging as a bright possibility for the future of the Australian mango industry, which necessitates looking at cultivars other than Kensington Pride in the potential markets. In the world market, there are several cultivars which have established themselves, on account of prolonged exposure to these cultivars and consumer preference. Our understanding of most of these cultivars is limited to single trees in the germ plasm collections. There is therefore a need to test these cultivars in various Australian growing conditions. This project aims at evaluating existing cultivars, introducing and evaluating cultivars with potential in domestic and foreign markets.

**Evaluation of cultivars in comparison to Kensington Pride:** One way of evaluating the success of a cultivar in the domestic market is to evaluate its performance (market price) in the market, when subjected to competition from Kensington Pride. After applying an estimated performance level to the cultivar based on its comparative performance against Kensington Pride, we can then estimate the performance level required by the cultivar and assess whether the cultivar would be capable of attaining these levels to compete with Kensington Pride. Using this approach, an attempt was made to evaluate the performance of cultivars Irwin, Glen, Nam Dok Mai and R2E2 in the domestic market over two years (1994 and 1995). Using the market prices throughout the season and taking Kensington Pride as the standard, a minimum performance level in relation to Kensington Pride was estimated. Market prices of these cultivars from 24 September to 10 December 1994, in comparison with Kensington Pride are summarised in Tables 1 and 2 .

As compared to the 1993 season, market prices were significantly low in all cultivars in the 1994 season. Some consistent differences were, however, evident among the four target cultivars. These are discussed below, along with their potential to meet the level of Kensington Pride.

The most striking observation was the performance of R2E2. Market prices of this cultivar were consistently much higher than Kensington Pride. In fact, R2E2 prices late in November were better than prices of Kensington Pride early in the season. As a result, the 'Tray equivalent' of R2E2 (number of trays required to equal Kensington Pride on the basis of price) was significantly low throughout (see Table 3). Its similarity to Kensington Pride and superior appearance have undoubtedly contributed to the success of this selection. There is a need to generate data on the long term performance of this cultivar and also a need to improve shoot density, which seems to be low. R2E2 has also been tipped as a cultivar with considerable export potential. Plantings of this cultivar have therefore increased substantially. During the year, we supplied bud wood to several growers from our research station. A large number has also been accessed from Queensland.

Market prices of Irwin were lower throughout the NT season, when compared to corresponding values for Kensington Pride and declined very sharply with the progress of the season. As a result of its market price, Irwin has always faced increased demands in respect of yield to compensate for the price. In spite of its regular bearing, two major limitations with Irwin are the self incompatibility-induced fruit deformities and its high susceptibility to humid and wet conditions. Irwin is a high yielding cultivar but it is clear that earliness is a crucial requirement for its success in the Top End.

The performance of Nam Dok Mai was better than that of Irwin. On two occasions, it commanded slightly better prices than Kensington Pride. However, we are yet to have a clear understanding about the long term performance of Nam Dok Mai. Observations have shown that it responds favourably to Cultar® as well as potassium nitrate. Other known aspects of this cultivar are its varying time of flowering and fruit maturity and its failure to set fruit in the absence of other cultivars in flowering, suggesting preference for other pollenisers. Its external appearance is limited by its green colour and oblong shape.

Glen is a cultivar with potential of earlier harvests than Kensington Pride. After some very attractive prices early in the season, its price declined sharply.Its profitability therefore seems to depend heavily on its early fruit maturity. Trials have shown that higher yields and earliness can be achieved with soil application of much lesser quantity of Cultar® than required by Kensington Pride. One limitation with Glen, however is reduction in fruit size with increased number of fruits.

On account of the smaller quantities of fruits of other cultivars available in the market, it can be argued that cultivars such as R2E2 may be successful by being speciality material. However, comparison with more established cultivars such as Irwin and Glen has clearly shown that cultivars with the required quality attributes can be successful in the market and can compete with established cultivars.

As mentioned earlier, there is a need to generate more information on cultivars which have potential. It is proposed to plant at least four trees of selected cultivars at CPRS to test their long term performance.

**Selections from monoembryonic cultivars :** S 113, a seedling from the Glen seedling progeny was selected in 1992 and has been planted on a small scale on a number of properties. S 113 fruit resembles Kensington Pride in most quality attributes. Positive points include a high percentage of fibreless flesh and attractive appearance, characters almost certainly inherited from Glen. The selection will be tested in further trials planned at CPRS and on growers' properties. Another selection made on a private property in Humpty Doo also looks promising with excellent taste attributes, fibreless flesh and very attractive external appearance. The fruit was subjected to preliminary evaluation by DPIF staff and also by QDPI staff working on mango. The fruit quality was unanimously approved. The selection was introduced at CPRS.

**Evaluation of cultivars for dried slices :** With a dramatic increase in production foreseen in the near future, value added products are going to be of considerable importance for the industry. There are several advantages of such value added products. Limitations such as costs of packing, cost and availability of transport, spoilage, wastage in culled out fruits, short post harvest life, limitations of available number of markets on account of quarantine issues are either avoided or reduced to a great extent. In the 1994 season, one grower used a considerable proportion of produce from his property for dried slices. Because of these advantages and a good market potential, more growers are looking at dried slices as an alternative for increased profitability. Some growers intend to use the lower grade fruit for this purpose. As in the case of fresh fruit, consistent good quality is required for the product to remain successful in the market. Some factors which can affect the quality of dried slices are cultivar, flesh consistency (absence of fibre), flavour and development of off flavour in the product, fruit maturity, and sugar content. The percentage of sliceable flesh and recovery of dried product from the raw material are important considerations from the point of economics.

In some preliminary trials, slices of Kensington Pride, Irwin, Nam Dok Mai and Glen were dried in the circular hot air drier at $55^0$ c for 16 to 18 hours. The slices were packed in plastic bags and stored at $20^0$c. Fibreless cultivars such as Glen seem to yield a very good quality product with smooth textured slices. Discolouration and off flavour were associated with Nam Dok Mai, perhaps on account of its high sugar content (TSS 19.5 %). Tasting of the dried slices at growers and staff meetings confirmed these findings. Dried slices of Kensington Pride and Glen were sent to Hong Kong. The product was received very well in Hong Kong supermarkets and food stores, where it was judged much superior in flavour and appearance in comparison with the Asian product. More systematic trials need to be conducted to look at the stage of fruit maturity of Kensington Pride on the quality of dried slices, recovery, packing and storage of the product.

**Table 3. Comparative market prices of mango cultivars for two seasons ($/tray)**

| Week ending | Irwin | | | Glen | | | Nam Dok Mai | | | R2E2 | | | Kensington Pride | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1993 | 1994 | Av | 1993 | 1994 | Av | 1993 | 1994 | Av | 1993 | 1994 | Av | 1993 | 1994 | Av |
| 24 Sept | | | | | | | n.a | 47.9 | 47.9 | | | | 43.3 | 47.2 | 45.2 |
| 1 Oct | | | | 51.7 | 35.0 | 43.3 | n.a | 34.6 | 34.6 | | | | 46.3 | 36.9 | 41.6 |
| 8 Oct | 25.7 | | 25.7 | 36.2 | 32.5 | 34.3 | 35.0 | 25.2 | 30.1 | | | | 36.9 | 27.6 | 32.2 |
| 15 Oct | 22.8 | 15.4 | 19.1 | 28.1 | 24.8 | 26.4 | 22.0 | 23.3 | 22.6 | | | | 28.7 | 23.3 | 26.0 |
| 22 Oct | 20.7 | 15.8 | 18.2 | 25.0 | 15.0 | 20.0 | 26.5 | 15.1 | 20.8 | | | | 24.8 | 20.6 | 22.7 |
| 29 Oct | 18.7 | 15.2 | 16.9 | | 13.0 | 13.0 | 21.6 | 17.9 | 19.7 | | | | 22.6 | 20.2 | 21.4 |
| 5 Nov | 17.7 | 12.5 | 15.1 | | | | n.a | 15.1 | 15.1 | | | | 21.5 | 17.9 | 19.7 |
| 12 Nov | 17.8 | 11.7 | 14.7 | 16.0 | | | n.a | 14.9 | 14.9 | 27.0 | | 27.0 | 20.4 | 12.7 | 16.5 |
| 19 Nov | 15.3 | 9.9 | 12.6 | | | | n.a | 12.0 | 12.0 | 21.0 | | 21.0 | 17.4 | 11.7 | 14.5 |
| 26 Nov | 13.1 | 10.0 | 11.5 | 10.3 | | | n.a | 10.3 | 10.3 | 20.0 | 20.5 | 20.2 | 14.3 | 10.7 | 12.5 |
| 3 Dec | 11.6 | 10.8 | 11.5 | | | | n.a | 8.7 | 8.7 | 17.6 | 19.9 | 18.7 | 13.1 | 10.0 | 11.8 |

**Table 4.** **Performance level (tray equivalent) of four mango cultivars using Kensington Pride as the standard.**

| | ( Tray Equivalent)* Number of trays of cultivar required to equal 100 trays of Kensington Pride in relation to market price | | | |
|---|---|---|---|---|
| **Week ending** | **Irwin** | **Glen** | **Nam Dok Mai** | **R2 E2** |
| 24 Sept | | | 95 | |
| 1 Oct | | 96 | 120 | |
| 8 Oct | 144* | 94 | 107 | |
| 15 Oct | 136 | 99 | 115 | |
| 22 Oct | 125 | 113 | 109 | |
| 29 Oct | 127 | 164 | 109 | |
| 5 Nov | 134 | | 119 | |
| 12 Nov | 122 | | 83 | 76* |
| 19 Nov | 87 | | 121 | 61 |
| 26 Nov | 121 | | 104 | 52 |
| 3 Dec | 97 | | 84 | 62 |
| 10 Dec | | | | 55 |

* It should be noted that additional harvesting, packing and transport and agent commission costs are not considered in this comparison. Positive or negative performance of cultivars will be magnified to a much greater extent if these are taken into account. Eg, if the extra costs for the 44 trays of Irwin are considered, the tray equivalent will be substantially higher. Similarly, the tray equivalent for R2E2 will be significantly reduced on account of the reduced harvesting and post harvest costs.

## Mango Cultivar/Rootstock Evaluation

M.W.Smith, J.D.Bright, M.D.Hoult, S.McAlister

In the last decade the Australian market has indicated a strong preference for Kensington Pride mangoes. This is despite considerable development work with other cultivars across northern Australia, and the availability of many of these different cultivars in commercial quantities. However, the opening up of the Japanese market in 1994 and the intractable problems of Kensington Pride (eg. sap-burn, scald susceptibility) have re-kindled interest in developing other cultivars. Furthermore, high prices for some cultivars, notably Delta R2E2, in recent years and the future desirability of increasing the length of the harvest season, have prompted greater commercial interest in a range of cultivars.

The major objective of this experiment is to assess the performance of different mango cultivars important in international trade, and to compare their performance with that of Kensington Pride. The experiment also serves to establish the consistency of rootstock response across a range of different scions. There are 6 cultivar treatments and 2 rootstock treatments arranged in a split plot design with 4 replicates and an experimental unit of 4 trees in a row.

**Table 5. Yield parameters for 6 mango scions on 2 different rootstocks, Katherine, 1994**

| Cultivar | Rootstock | Fruit Number (per tree) | Calc. Yield (kg/tree) |
|---|---|---|---|
| Glenn | ARC | 233 | 76.5 |
| | Sabre | 171 | 55.0 |
| Haden | ARC | 332 | 105.0 |
| | Sabre | 249 | 75.8 |
| Irwin | ARC | 375 | 107.8 |
| | Sabre | 271 | 81.6 |
| Kensington Pride | ARC | 200 | 76.6 |
| | Sabre | 110 | 40.0 |
| Kent | ARC | 177 | 46.0 |
| | Sabre | 171 | 48.0 |
| Tommy Atkins | ARC | 315 | 106.8 |
| | Sabre | 198 | 59.2 |
| Zill | ARC | 220 | 69.6 |
| | Sabre | 129 | 34.1 |

Kensington Pride performed poorly in 1994 with only marginal yield increases on the previous season. Yields of this cultivar on Sabre rootstock were only half of those on Adelaide River Common (ARC) rootstock. The poor performance of Sabre as a rootstock was evident across most of the other cultivars, and has been present in past seasons. It is clearly the case that Sabre is a poor rootstock for a wide range of cultivars under the climatic and edaphic conditions of this experiment and should be avoided in commercial plantings, until contrary information is obtained.

Tommy Atkins performed particularly well in the 1994 season, producing amongst the highest yields on ARC rootstock. This is in contrast to previous seasons when this cultivar has had very low yields (particularly given its large canopy area). Irwin on ARC also showed a dramatically increased yield in 1994, in contrast to combinations like Kent on Sabre and Kent on ARC which actually fell. These major shifts in performance over a short period of seasons are difficult to explain with information currently available, but they do re-emphasise the importance of assessing tree crops for an extended length of time.

## Regulation of Vegetative Growth Flowering and Fruiting in Mango.

V.J.Kulkarni, D.Hamilton

Two major limitations of mango growing are excessive tree vigour and unreliable flowering. These are perhaps the most important factors dictating the success of the mango industry, because they not only have a direct impact on tree productivity, but have a far reaching impact on orchard management, fruit quality, harvesting costs and thereby profitability of mango growing.

Flowering-related issues can be categorised as erratic flowering resulting in 'on and off' years, delayed flowering leading to delayed fruit maturity and staggered flowering, mainly responsible for variation in fruit maturity. These issues have a direct bearing on profitability of mango growing in the Top End.

There is sufficient evidence to support the view that flowering in mango occurs as a result of flowering factor(s) synthesised in the mature leaves in a cyclic way (floral cycle).

Leaves play a crucial dual role in flowering, in being the sites of synthesis of flower- promoting factors (FPF) as well as a flower-inhibitory role through the flower-inhibitory factors ( FIF )- almost certainly gibberellins- when they are in a vegetative mode. The ultimate result depends upon the strength of the factors. Bud activity at the apex, during the floral cycle plays an equally crucial role in flowering. If buds are dormant during the floral cycle, no flowering occurs. When bud activity resumes later in the vegetative mode, only vegetative flush emerges. The FPF thus seem to be very labile. These findings have provided the basis for our research in manipulation of flowering in mango.

Results achieved so far in the regulation of flowering are:

- Soil application of Cultar® resulted in a significant increase in the extent of flowering, early flowering and early fruit maturity in several cultivars including Kensington Pride. This seems to be mediated through the anti-gibberellin property of the growth regulator. Dosage requirement of Cultar® varies with cultivars, the Florida cultivars requiring a much lower dosage than Kensington Pride. As a result of the success in trials at CPRS and some private properties (see annual reports 1992-93 and 1993-94), several growers have adopted the technology. Our research and advice on the judicious use of Cultar® and potassium nitrate and follow up procedures have been of immense benefit to the industry.

- Early flowering induced by Cultar® treatment invariably resulted in early fruit maturity. Flowering in the first week of June resulted in fruit maturing in the first week of October, whereas flowering in the last week of July in the untreated trees resulted in fruits reaching maturity in the first week of November. While evaluating flowering vs fruit maturity, comparisons should be made for the same season and not between seasons.

- Potassium nitrate sprays have not been very effective in inducing synchrony.

- Pre-bloom vegetative flushing has been identified as a major counter-productive factor affecting flowering. Non-synchrony, resulting from of pre-bloom flushing could be overcome by pre-flower tip pruning the young flush. Trials involving the combined approach with a post harvest soil application of Cultar® and pre-flower tip pruning have been very successful in young trees. This has laid the foundation for the higher density planting trials being planned at CPRS and a few private properties. For the established older trees, removal of pre flower vegetative flush on shoots which can be easily accessed has provided another option and is being successfully practiced by growers.

- Cultar® treatment also causes significant reduction in shoot length of the new flush. This growth-retarding property of the growth regulator is also mediated through its anti gibberellin activity. This, together with precocious fruiting, will provide a very effective tool in controlling tree vigour, especially if used in conjunction with pre- flower tip pruning.

- These findings on flowering and vegetative growth have led us to take a combined approach towards tree vigour control and manipulation of flowering. Results from a trial are discussed below in Table 6.

- In 1994, the time of flowering seemed to have a significant impact on fruit set. Early flowering in June and early July set very well, but delayed flowering set very poorly, resulting in negligible fruit from the late panicles. Although it was difficult to attribute the failure to any particular reason, pollinator activity was generally low during anthesis of late-emerged panicles. Growers who had taken measures to attract pollinators (flies and bees) seemed to have benefited from the practice. It may be desirable to systematically investigate the usefulness of these practices.

**Table 6. Some positive and negative factors effecting flowering.**

| Factor | Positive/Negative | How it acts | What needs to be done |
|---|---|---|---|
| Monolepta, Thrips. | Negative | Defoliation encourages new veg.flush. | Pest management. |
| Potassium nitrate(KNo3) sprays at first signs of flowering. 2 to 3 sprays at weekly interval. | Positive | Promotion of bud burst. Effect not as dramatic in K.P. as in some other cultivars. | Up to 4 % Potassium nitrate can be sprayed. Higher dosages and more sprays can cause necrosis of leaf. |
| Very early and too many KNo3 sprays. | Negative | Bud burst before FBD*, pre-flower veg. flush. | Avoid Kno3 until `budburst'stage. 2 to 3 sprays are enough. |
| High Temperature during flower initiation. | Negative | Excessive veg.growth, interference with the flowering process.Leaf necrosis. | Tip pruning to mature wood during expected peak flowering time- an option. |
| Immature shoots and/or Vegetative flushing at flowering time. | Negative | Counteracts Flowering factors from mature leaves. | Removal of desired number of flushing/immature shoots at flowering - an option. |
| Cultar® | Positive | Counteracts action of gibberellins, vigour control. | Judicious use of the growth regulator. |
| Pruning | Positive | Better distribution of assimilates. Counteracts shoot immaturity. Tree size management. | Removal of unwanted branches (skirting) after harvest. Tip pruning before flowering depending on situation in combination with Cultar® |

* FBD : Flower Bud Differentiation

**Trials on Combined approach with Cultar® and pre flower tip pruning:** Based on the hypothesis of flower-promoting and flower-inhibiting factors, the positive effect of Cultar® on flowering and negative effect of pre flower vegetative flush, and after preliminary trials at CPRS and a private property in 1991, a trial was started in 1992 at Acacia Hills farm with trees planted at closer spacing. Treatments included an annual application of Cultar® in December-January after harvest and annual whole tree tip pruning at the beginning of June before flowering. Other treatments were pruning alone and control receiving no treatment. Observations on flowering and fruiting for the 1994 season were recorded and are summarised in Table 7.

As in previous years, maximum flowering and highest yield was recorded in the Cultar® + tip pruning treatment. Within a fortnight of pruning, activity was noticed in the sub apical buds. Up to six buds were activated. Flowering was early in Cultar® -treated trees, irrespective of the pruning treatment. Interestingly, tree aspect had a profound effect on flowering in the unpruned trees. Little flowering was noticed on the south western aspect. This pattern was also observed in the Cultar® treated trees, which had a considerable impact on the extent of flowering and yield in this treatment. Tip pruning seemed to have overcome this inhibitory effect of tree aspect. This was particularly evident in tip pruning + Cultar® treatment in which profuse flowering was observed on all aspects of the trees. Terminal buds on the non-flowering shoots on the western aspect of the unpruned trees remained dormant for a long time and on breaking dormancy late in August, sprouted as vegetative shoots. These findings strengthen the importance of synchronisation of bud activity in the flowering process with the flowering cycle.From the pale yellow colour of affected shoots on the south western aspect, it appears that the effect was mediated through radiation effect. It was interesting to note that this effect was restricted to the terminal shoot and once the terminal shoot was removed, the buds on the mature shoot below were activated and flowered within a few weeks. In control (unpruned) trees, the canopies had started to touch within the rows and there was no flowering on these aspects of the trees. Interestingly, tipping alone improved the yields over the control, but lagged far behind the best performance from the tip pruned + Cultar® treated trees.It appears that, while

Cultar® played a major role in tilting the balance in favour of FPF, tip pruning was crucial in overcoming any immediate inhibitory effect from the immature leaves.

The trials on tip pruning at Acacia Hills, CPRS and other preliminary trials at other private properties have not only substantiated our understanding of the crucial dual role of leaves ( by being the sites of synthesis of FPF and FIF) in flowering and that of bud activity in synchrony with the flowering cycle, but have also opened a new approach towards tree vigour control and higher density planting. A trial on high density planting being planned at CPRS is aimed at studying different aspects of this technique, which will include, besides long term performance, other related aspects such as tree physiological aspects, light penetration and assimilate partitioning.

**Table 7. Effect of Pre Flower Pruning and Cultar® on Flowering and Fruiting in Young Kensington Pride Mango Trees.**

| Treatment | Flowering | | Yield | | |
|---|---|---|---|---|---|
| | Percentage | Days to flower* | Number/ tree | Wt/tree (kg) | Av fruit wt (g) |
| Cultar® alone | 64.3 (53.4) | 48.2 | 65.2 | 40.6 | 624.5 |
| Tip pruning + Cultar® | 91.8 (77.3) | 42.5 | 80.1 | 50.0 | 630.3 |
| Tip pruning alone | 49.3 (44.2) | 54.7 | 50.1 | 30.1 | 609.9 |
| Control | 41.8 (40.2) | 59.7 | 33.7 | 20.1 | 588.7 |
| L.S.D. | (6.8) | 2.6 | 10.9 | 6.4 | 23.5 |

Number of trees /treatment: 8

- Flowering data are mean values from 20 randomly tagged shoots/tree and 8 trees per treatment.
- Date of Cultar® treatment : 6 January 1994
- Date of tip pruning : 24 May 1994.
- Days to flower from 1 June 1994.
- Values in parentheses represent angular transformations of percentages.

**Other approaches towards tree vigour control :** These include the use of marcots as rootstocks, seedling rootstocks and interstocks known for their vigour-controlling property and root pruning. In 1994, a simple and effective technique for marcotting (airlayering) was evolved and standardised. Using the basic principles of the method, it involves the use of polystyrene cups (stubby holders and tea cups) as containers and polypropylene discs for sealing the marcot. The rooting medium consisted of 3 parts of moss and 1 part of fine sand by volume. IBA 8000 ppm was used in a gel form. Profuse rooting was obtained within 45 days during the wet season (December-January),which seems to be the ideal time. Root development was visibly reduced in marcots prepared later in March- April. Survival of the rooted marcots was excellent. These preliminary trials have clearly shown that the climatic conditions of the Top End are ideal for adventitious rooting of mango shoots. It is proposed to include these as treatments in the rootstock / interstock trials planned at CPRS.

## Mango Cultivar Observation Ti Tree

G. Kenna, K. Young, A. Mullins, N. Isgro.

The objective of this project is to evaluate a range of mango cultivars in the southern region of the Territory, to assess their potential for fruit production on late season domestic markets.

Twelve cultivars consisting of two tree plots were planted in a north-south row. Five cultivars were planted in high density plantings in an east-west direction. Harvest period, number of marketable fruit, total weight of marketable fruit and average weight per marketable fruit have been assessed for each cultivar. Results for the 1995 harvest are shown in Table 8.

**Table 8. Results for the 1995 harvest**

| Variety | Harvest Period | No. Market Fruit | Total FruitWeight (gm) | Av. Fruit Wt (gm) |
|---|---|---|---|---|
| R2 E2 | 20/1-7/2 | 20 | 13,994 | 700 |
| Isis | 20/1- 7/2 | 10 | 6,216 | 622 |
| Irwin | 20/1-25/1 | 2 | 415 | 208 |
| Lippens | 20/1-6/3 | 61 | 12,572 | 206 |
| Edwards | 20/1 | 4 | 429 | 107 |
| Davis Haden | 20/1-3/3 | 9 | 6,309 | 701 |
| Naomi | 20/1-20/2 | 3 | 1,221 | 407 |
| Kent | 25/1-9/3 | 49 | 20,048 | 409 |
| Sensation | 25/1-27/2 | 12 | 2,337 | 195 |
| Palmer | 20/2-24/2 | 3 | 1,052 | 350 |
| Keitt | 24/2-9/3 | 11 | 4,247 | 386 |

**Table 9. Yields - High Density Planting**

| Variety | Harvest Period | No. Market Fruit | Total Fruit Wt (gm) | Av. Fruit Wt (gm) |
|---|---|---|---|---|
| Kent | 8/2-13/3 | 51 | 24,776 | 486 |
| Palmer | 24/2-6/3 | 21 | 7,665 | 365 |
| Keitt | 23/2-3/4 | 196 | 94,387 | 482 |
| Springfels | 7/2 | 1 | 371 | 371 |

## Mango Breeding

V. J. Kulkarni, D. Hamilton

While there is a need from an export point of view to diversify into other cultivars, Kensington Pride will continue to rule the domestic market in spite of its limitations such as erratic bearing, excessive tree vigour, susceptibility to sap burn, stem end cavity, poor shelf life and lack of attractive colour on the fruit. Although some of these limitations can be managed by appropriate practices in the field and packing shed, introducing favourable traits from other potential donor cultivars into the commercial cultivar by genetic means i.e., by crossing, is yet another way of achieving the goals. It is with this background, that systematic hybridisation was initiated in the year 1994, mainly to improve Kensington Pride. This is a collaborative project involving DPIF, QDPI, CSIRO and WADA. All the crossing work in respect of the DPIF program was undertaken at CPRS. With Kensington Pride being a polyembryonic cultivar, crosses with other cultivars had to be undertaken, using Kensington Pride as the male parent. In two crosses, Nam Dok Mai and R2E2 (also polyembryonic cultivars), were used as male parents. Procedures involved emasculation, hand pollination of the female cultivar with the male parent and prevention of natural self and cross pollination. A total of 70 successful crosses were obtained in different combinations involving cultivars Lippens, Van Dyke, Keitt, Kent, Palmer, Haden, Alphonso, Julie, Glen and Irwin as female parents. The numbers are listed in Table 10.

**Table 10. Successful Crosses in Mango Hybridisation Program- 1994 Season.**

| Female parent | Male parent | No.of successful crosses |
|---|---|---|
| Lippens | Kensington Pride | 25 |
| Van Dyke | " | 13 |
| Keitt | " | 9 |
| Kent | " | 4 |
| Palmer | " | 3 |
| Haden | " | 3 |
| Alphonso | " | 5 |
| Julie | " | 1 |
| Glen | " | 1 |
| Irwin | " | 1 |
| Irwin | Nam Dok Mai | 1 |
| Irwin | R2 E2 | 4 |

Seedlings of the progeny were raised at BARC for grafting on Kensington Pride rootstock.

Crosses in various combinations were also undertaken by QDPI, CSIRO and WADA. It is proposed to continue the crossing work for three seasons. Two sites, one in Queensland and one in Darwin (CPRS) have been selected for preliminary screening of the crossed progeny. All crossed progeny evolved by different participating organisations will be tested at these sites.

The following schedule of activities has been planned:

Year 1 to 3: Crossing and raising of seedlings of successful crosses.

Year 2 to 4: Grafting of the seedling material on Kensington Pride rootstock and planting in field at 7 *5 m. Supply of budwood to other centres.

Year 3: Observations on growth and precocity of the progeny commence. Comparison of characters with parents.

Year 4 to 7: Phase 1 of evaluation of the fruit characteristics of the progeny. Phase 2 commences for phase 1 selections from early hybrids.

## Long-term Cultar®Effects

M.W.Smith, A.Lyon

Responses of mango to Cultar® (a.i. paclobutrazol) application have been under evaluation in the Northern Territory for almost a decade and yet its medium to long term effects on tree performance have not been examined. Experiments conducted at Katherine between 1988 and 1992 showed that Cultar® induced early flowering and earlier crop harvest, particularly in the first year after application, high yields on young trees if high rates were used, and more profuse flowering. However, it was consistently found that the improved flowering induced by Cultar® application was not translated into increased yield at final harvest. Consequently, work with Cultar® was terminated in 1992 on the basis that further work could only be "...justified if significant breakthroughs occur in fruit retention techniques." (Thompson 1990). This termination of the Cultar® project also enabled the research emphasis to be moved more in line with the sustainability objectives of DPIF.

Cultar® use is now a widespread practice in the NT mango industry. Because this practice is relatively new, concerns were raised about its long term effects, particularly given that researchers had generally not examined responses for more than 1 or 2 years after treatment.

Consequently in the 1993 and 1994 seasons, fruit counts were made on an old Cultar® experiment that had been established in early 1988. In this experiment, trees were treated at 5 different rates (0 to 40 ml/tree) in 1988 and then half of these trees (2 trees/treatment) were again treated in 1989 using the same rates. Linear regression models were developed to explain variations in fruit numbers per tree in terms of: the amount of Cultar applied in 1988; the amount of Cultar® applied in 1989 and; the total amount applied in 1988 and 1989.

A number of significant relationships were established in which fruit numbers per tree were found to be lower the more Cultar® that had been applied (Table 11). This effect was particularly strong in 1993, possibly because Cultar® was re-applied to the entire planting prior to the 1994 season. Worthy of particular note was that 3 experienced mango workers independently examined the trees in 1993 and could not observe any treatment differences. The differences only became obvious when the fruit was counted manually. This illustrates the importance of collecting reliable data on this phenomenum rather than relying on casual observations.

**Table 11. Fruit Numbers per tree in 1993 and 1994 following Cultar® Treatment in 1988 and 1989**

| Cultar® Treatment | Fruit Count 1993 | | Fruit Count 1994 | |
|---|---|---|---|---|
| | Mean | Std. | Mean | Std. |
| None | 130 | 43 | 130 | 18 |
| 5ml in '88 & '89 | 138 | 23 | 129 | 24 |
| 5ml in '88 | 99 | 25 | 111 | 1 |
| 10ml in '88 & '89 | 134 | 23 | 101 | 10 |
| 10ml in '88 | 51 | 8 | 130 | 22 |
| 20ml in '88 & '89 | 21 | 1 | 112 | 5 |
| 20ml in '88 | 66 | 17 | 108 | 9 |

No. of trees/treatment = 2, except for the "None" treatment which had 4 trees/treatment

Although intended only as a preliminary assessment and severely limited by tree numbers in each treatment, the data does indicate a need to examine long term Cultar® effects in more detail, and as a matter of urgency, given its widespread use in the industry . More specifically, there appears to be a detrimental effect on fruit numbers almost 7 years after treatment stopped, despite the trees receiving a high standard of management in terms of nutrition and irrigation inputs over that period. Although rates used in the experiment were high by today's "standards" and the trees were very young, the data collected in 1993 and 1994 indicates a need to examine the commercial sustainability of current management practices.

Thompson, R.P. (1990). The influence of Cultar®on Kensington mango production in the semi-arid region of the Northern Territory. *In* NT Primary Industry and Fisheries, Horticulture Branch Technical Annual Report 1989-1990. Technical Bulletin No.174.

## Rootstocks for Kensington Pride Mangoes

M.W.Smith, M.D.Hoult, J.D.Bright, S.McAlister, S.J.Martin

Commercial interest in mango rootstocks continues to increase, in response to results emerging from experiments underway at Katherine. The realisation that variations in fruit quality between orchards are probably not due to different Kensington selections has also shifted the focus toward possible rootstock effects.

Nine polyembryonic mango cultivars are being examined at the Manbulloo Orchard (near Katherine), with single tree plots in 6 replicates. Trees were planted in 1985 at a spacing of 13.5 m by 5 m in a sandy loam red earth soil. Results

for the 1994 season are shown in Table 12 and again indicate the significant impact of rootstocks on Kensington Pride performance.

**Table 12. Rootstock effects on the performance of 9 year old Kensington Pride Trees, Katherine, 1994**

| Rootstock | Yield (kg/tree) | Average Fruit Weight (g) | Trunk Circumference at Union (m) | Appearance* | |
|---|---|---|---|---|---|
| | | | | Low Fruit | High Fruit |
| SG Siput | 174 | 425 | 1.11 | 3.4 | 3.2 |
| J. Common | 156 | 441 | 1.02 | 3.2 | 3.5 |
| Pineapple | 153 | 430 | 0.96 | 3.5 | 3.3 |
| Teluk Anson | 143 | 411 | 0.99 | 3.4 | 3.3 |
| Strawberry | 120 | 442 | 0.91 | 3.4 | 2.8 |
| Kensington | 117 | 422 | 0.84 | 3.3 | 3.4 |
| Lemon D2 | 114 | 456 | 0.88 | 3.2 | 3.2 |
| Memph. Telur | 104 | 411 | 0.95 | 3.1 | 3.2 |
| Sabre | 97 | 425 | 1.02 | 3.0 | 2.9 |
| Sig. Level (p=....) | 0.03 | 0.15 | 0.01 | 0.28 | 0.006 |

*Rated on a scale from 1 (very poor) to 5 (excellent) by 6 assessors.

Fruit quality differences were not as pronounced in the 1994 season, although significant differences were still detected for the fruit picked from the tops of trees. Interestingly, the fruit quality from 'J. Common' rated the highest in 1994 and yet it had been one of the poorest the previous season. This reinforces the need to assess these parameters across a number of seasons in order to identify superior rootstocks. Trunk circumference for some rootstocks exceeded 1 m for the first time in 1994, with variations in this parameter reasonably consistent with visual observations of canopy size. Larger trees continue to produce the highest yields, often with the highest quality fruit, and yet with no sacrifice in terms of harvest rate per kilogram of fruit. With this in mind, it is difficult to appreciate why there continues to be such a strong desire for 'dwarf' trees.

Yields from some rootstocks were particularly high for Kensington Pride. This was, in part, due to harvesting larger fruit at a higher maturity level than had been the case in previous seasons (the commercial grower involved decides when harvesting should commence each year). However, even aside from this, the yield and quality figures indicate the opportunities that rootstock selection offers for productivity improvements in the Australian mango industry.

## Responses of Kensington Pride Mango to Zinc Application

M.W.Smith, L.P.deSouza, S.J.Martin, S.McAllister

The need for zinc application on mangoes is well recognised in the Northern Territory and is a common practice amongst commercial growers. Deficient trees show stunted terminal growth with small distorted leaves. In severe cases, young trees have died back from the tips. In most instances, such symptoms have been overcome with the application of zinc (particularly as a foliar application). More recently, a number of growers have reported severe limb die back in mature trees (> 10 years old) and intensive investigations have failed to identify the cause. Zinc deficiency was suggested as a possible cause, and in response a small experiment was initiated in November 1993 in a severely affected orchard (planted in 1984) on the banks of the Katherine River.

Each tree in the orchard of 39 grafted Kensington Pride trees was inspected by 2 assessors and ranked according to the severity of branch death using a 4 point scale (1= no branch death, 2=slight branch death, 3=some branch death, 4=severe branch death). A random sample of 10 trees from each of the middle 2 categories were identified for use in the zinc experiment. Five trees from each category were selected randomly to be treated with zinc, while the remaining 10 trees acted as controls. Trees in the zinc treatment each received 50 g/tree zinc sulfate heptahydrate dissolved in water and applied in a 200 mm wide band, 1.5 m out from the trunk of the tree. In addition, each of these trees received 2 litres of a solution (containing 2g/l zinc sulfate heptahydrate and 0.5 g/l low biuret urea) applied with an air blast nozzle to the leaves of the tree. These treatments occurred on 8 December 1993, taking care not to contaminate adjacent trees. Leaf samples were collected from individual trees in August 1994 and used to determine physical and chemical properties. Fruit counts per tree and trunk circumference measurements were taken in late October 1994. A new outbreak of branch die-back occurred in October 1994 and in response, each tree was again rated using the 4 point scale described above. With this second rating, only newly desiccated branches were considered when classifying the trees. Table 13 below shows the effects of zinc application on the parameters measured. It also indicates the different levels of these parameters between the two severities of branch die-back (slight and some).

**Table 13. Physical and Chemical parameters of Mango trees following zinc application, and with different severities of branch die-back**

| Parameter | Zn Treatment | | | Die-back Severity | | |
|---|---|---|---|---|---|---|
| | Applied | Control | *sig.p=* | Slight(2) | Some(3) | *sig.p=* |
| Leaf Area($mm^3$/leaf) | 6998 | 6632 | *0.200* | 6489 | 7141 | *0.030* |
| Leaf Weight(g/leaf) | 1.01 | 0.96 | *0.165* | 0.933 | 1.04 | *0.008* |
| Fruit Count(/tree) | 81.8 | 81.3 | *0.977* | 101.0 | 62.1 | *0.036* |
| New Die-back(1 to 4) | 1.9 | 2.0 | *0.779* | 1.3 | 2.6 | *0.002* |
| Trunk Circum.(m) | 0.97 | 1.00 | *0.509* | 0.99 | 0.98 | *0.740* |
| N(%) | 1.08 | 1.07 | *0.872* | 0.99 | 1.16 | *0.003* |
| P(%) | 0.101 | 0.102 | *0.839* | 0.103 | 0.100 | *0.545* |
| K(%) | 0.811 | 0.784 | *0.416* | 0.729 | 0.866 | *0.001* |
| Ca(%) | 2.00 | 1.93 | *0.655* | 2.08 | 1.86 | *0.160* |
| Mg(%) | 0.401 | 0.375 | *0.135* | 0.379 | 0.397 | *0.292* |
| S(ppm) | 1012 | 962 | *0.120* | 940 | 1034 | *0.007* |
| Zn(ppm) | 16.79 | 14.99 | *0.230* | 17.74 | 14.04 | *0.020* |
| Fe(ppm) | 59.6 | 57.8 | *0.724* | 62.7 | 54.7 | *0.129* |
| Mn(ppm) | 583 | 522 | *0.389* | 594 | 511 | *0.251* |
| Cu(ppm) | 4.63 | 5.27 | *0.265* | 5.71 | 4.19 | *0.014* |
| B(ppm) | 40.0 | 30.4 | *0.034* | 34.64 | 35.78 | *0.788* |
| Na(ppm) | 69.0 | 62.8 | *0.415* | 68.7 | 63.1 | *0.461* |

If we consider treatment differences, with a less than 20% probability of being due to chance, then it can be seen that zinc application leads to the development of larger and heavier leaves, and higher concentrations of magnesium, sulfur and boron. The effect on leaf zinc levels was significant at the p=0.23 level. Effects on fruit numbers and the severity of the new die-back outbreak were not significant. While these results do not rule out zinc deficiency as the cause of limb die-back, they suggest that the cause may be more complex. It is of particular interest that zinc application had a limited impact on leaf zinc levels, while at the same time, it had quite a marked effect on some other parameters. Although zinc concentrations were low, even in treated trees, it may be that leaf analysis is inadequate as a means of identifying zinc deficiencies in mango orchards.

What is perhaps surprising, is the number and extent of differences within parameters between the 2 levels of die-back severity. These 2 levels represented the middle categories on a 4 point scale and it was envisaged that they would be relatively similar. However the data clearly shows that trees with more severe symptoms had larger and heavier leaves, lower yields and lower leaf concentrations of calcium, zinc, iron and copper. Trees with less die-back had lower nitrogen, potassium and sulfur contents. These conditions are similar to those described by Kadman and Gazit (1984) for iron deficient mango orchards in Israel, and further support the notion that limb die-back problems at Katherine are due to factors more complex than a simple zinc deficiency.

The fact that trunk circumferences were very similar between the 2 severity categories suggests that the current problem is only a relatively recent occurrence. It would be reasonable to hypothesise that with the low fertiliser inputs applied to this orchard, naturally occurring supplies of nutrients have been exhausted over a 10 year period of tree growth and mango removal and that this is causing or aggravating the branch die-back problem.

Kadman, A., and Gazit, S. (1984). The problem of iron deficiency in mango trees and experiments to cure it in Israel. *Journal of Plant Nutrition* 7:283-290.

## Performance of Irwin Mango on Sabre and Brodie Common Rootstocks

S.J.Martin, M.W.Smith, S McAlister, M.R.A.Joseph, J.D.Bright, M.D.Hoult

Rootstock research, as with other areas of long term horticultural research, presents a considerable dilemma with regard to resource allocation and optimisation. Obvious problems occur when deciding how many trees each experimental unit should contain, whether these experimental units should be guarded, when assessments of treatment responses should commence, and for how many years this assessment process should continue. In order to examine some of these questions and to develop an efficient methodology for mango rootstock research, an experiment was planted within a commercial orchard at Katherine in October 1990. This experiment also sought to confirm rootstock responses that had been obtained from an earlier experiment on a different soil type.

Thirty six trees, (half on Sabre rootstock and the other half on Brodie Common rootstock), were arranged in 3 tree plots with 6 blocks within 3 rows of the orchard. The experimental area was guarded by Irwin on Brodie Common trees on all sides, which were planted at the same time. This design enables comparison of neighbour effects (eg comparison of Sabre adjacent to Sabre, with Sabre adjacent to Brodie Common), as well as the impact of using only data from the middle tree of each plot compared with using the mean of all 3 trees in the plot. Table 14 below indicates some preliminary results from this experiment, with more in-depth analysis of design implications to be undertaken when more data becomes available. Values presented are from an analysis involving all 3 trees in each plot.

**Table 14. Effect of rootstock on Irwin performance in the first 2 years of cropping**

| **Season** | **1993** | | | **1994** | | |
|---|---|---|---|---|---|---|
| **Rootstock** | **Sabre** | **Common** | ***Sig.p=*** | **Sabre** | **Common** | ***Sig.p=*** |
| FruitNo.(/tree) | 55.2 | 58.2 | *0.775* | 143.2 | 150.9 | *0.625* |
| FruitWgt(kg/tree) | 14.5 | 16.1 | *0.509* | 43.3 | 46.4 | *0.510* |
| FruitSize(g/fr./tree) | 271 | 276 | *0.451* | 308 | 312 | *0.625* |
| LeafArea($mm^3$/leaf) | not assessed | | | 1886 | 1723 | *0.288* |
| LeafWgt(g/leaf) | not assessed | | | 0.755 | 0.775 | *0.467* |
| %OverMature | not assessed | | | 19.0 | 28.5 | *0.027* |
| TrunkCirc.(mm) | | | | | | |
| 50mmAboveUnion | 295 | 307 | *0.392* | 343 | 361 | *0.317* |
| AtUnion | 335 | 321 | *0.280* | 395 | 380 | *0.250* |
| 50mmBelowUnion | 326 | 281 | *0.004* | 380 | 323 | *0.002* |

It can be seen that the commercially important parameters such as yield and fruit size, have not as yet become significantly different between the 2 rootstocks. However, differences in trunk morphology were present from a very

early age. Trunks of Irwin on Sabre swell below the graft union, while those on Brodie Common tend to swell above the graft union. An analysis of changes in trunk circumference (data not presented) showed that the rate of increase below the graft union for Sabre was also higher than the rate of increase for Brodie Common. Trees on Brodie Common had a greater percentage of over-ripe (fallen) fruit in the 1994 season than did trees on Sabre. This may suggest that Irwin on Brodie Common has an earlier maturity time than Irwin on Sabre, and is the first known indication of a possible rootstock effect on mango maturity time. Regression analysis was used to examine the relationship between the yield of individual trees in 1993 and 1994 for each of the rootstocks. Trees that yielded well in 1993 tended to do the same in 1994 and visa versa. From an examination of the slopes of each of the regression lines, it appears that trees on Brodie Common have a greater rate of yield increase than those on Sabre. If this is indeed the case, then it suggests that the yield differences between the 2 rootstocks will become more pronounced in future seasons as Brodie Common outperforms Sabre. Such a technique for identifying superior rootstocks before rootstock differences become statistically significant could have considerable application, provided future seasons' data support the above assertions.

## Observations on Mango Seed Weevil Incidence

M.D.Hoult, J.D.Bright, S.McAllister, S.J.Martin, M.W.Smith

Freedom from mango seed weevil (MSW), *Cryptorhynchus mangiferae* (F.) (Coleoptera: Curculionidae) remains a high priority in regions where this pest does not occur. With increasing interest in mango rootstocks, ease of de-husking could be a valuable trait for a stock, given other desirable horticultural parameters are met. De-husking of mango seed is recommended, as this ensures uniform seedlings with non- distorted tap roots. The opportunity arose to assess the incidence of MSW from two contaminated mango arboreta in Darwin, when seed of several polyembryonic cultivars were inspected to ensure freedom from MSW. Seed was required for a future mango rootstock trial in the Katherine region, a MSW free area. A total of 30 kernels from each of 31 polyembryonic cultivars were assessed. The number of kernels with MSW infestation was noted. For a given cultivar, ease of de-husking seed was ranked by two assessors (1 = easy to 5 = hard). Linear regression on transformed data was performed to identify any relationship between ease of de-husking and percentage MSW infestation. Some comparison with historical data (collected in 1989 from the same orchard) for 5 cultivars was also possible. The percentage weevil infestation and ease of de-husking for the 31 cultivars is presented in Table 15. Figure 1 shows the levels of infestation for 5 cultivars for 1989 and 1994.

For the 30 seeds of each cultivar evaluated, a strong relationship ($p=0.0001$; $r^2 = 0.752$) existed between the ease of de-husking and percentage weevil infestation for a given cultivar at CPRS. However this relationship did not hold for BARC, or when data from both sites were pooled. MSW was first detected at BARC around 1987-88 and at CPRS about 1993 (E.S.C. Smith, *pers. comm.*). Whilst the CPRS data suggests that MSW infestation is correlated with cultivar ease of de-husking, a lower population density at CPRS and non-infestation of some trees could be influencing the observed phenomena. That is, at lower population pressure, MSW may exhibit preference for particular cultivars. Hansen (1993) suggests mechanisms for resistance to MSW infestation may exist in cultivars that form seeds early, have a hard testa or an insect-toxic covering of the kernel. However, he does concede that most of the Hawaiian cultivars studied appear equally susceptible, with some exceptions such as 'Itamaraca'. Our study did not address the biodynamics of MSW, notably female oviposition relative to cultivar, specific time of flowering and fruit development. When data for 5 cultivars were compared between 1989 and 1994 for the same site, there was a trend to increasing levels of infestation over the 5 year period for all but the 'Orange' cultivar. This suggests that the size of the MSW population for infested orchards increases rapidly with time, to the point where very high numbers of seeds may be infested, irrespective of cultivar.

For cultivars with easier de-husking, the husks were papery and less rigid, which allowed for easy separation from seed along the suture of the husk. This could be a valuable trait for selected rootstock types, as it would allow for easier propagation. For areas that are free of MSW, the monitoring of those cultivars which have greater ease of de-husking may be a means of early detection of MSW. However, the most practical approach to maintaining MSW freedom is the rigorous control of the movement of non-infested fruit, seed or potted plants into areas known to be free of MSW.

Hansen, J.D. (1993). Dynamics and control of the mango seed weevil. *Acta Horticulturae* 341:415.

**Table 15. Ease of de-husking and Percentage MSW infestation for 31 polyembryonic mango cultivars.**

| Cultivar | Site[1] | Tree no. | Ease of de-Husking | % MSW infestation |
|---|---|---|---|---|
| A | BARC-4 | R8T4 | 1.0 | 93.1 |
| Ah toy long | CPRS | R13T3 | 1.0 | 43.3 |
| B | BARC-4 | R8T3 | 2.0 | 100.0 |
| Banana callo | CPRS | R9T3 | 2.0 | 16.7 |
| Bappakkai | BARC-1 | R7T1 | 3.75 | 0.0 |
| Batavia | BARC-4 | R9T3 | 1.5 | 87.5 |
| Black jamaican | BARC-3 | R2T5 | 4.5 | 86.7 |
| Carabao | CPRS | R4T1 | 2.5 | 0.0 |
| Cathamia | CPRS | R4T4 | 5.0 | 0.0 |
| Chandrakaran | BARC-1 | R8T1 | 5.0 | 0.0 |
| Early gold | CPRS | R14T2 | 1.5 | 10.0 |
| Late maturing ex Cairns | BARC-3 | R4T8 | 3.0 | 0.0 |
| Florigon | CPRS | R11T4 | 4.0 | 0.0 |
| Golden tropic | CPRS | R3T3 | 3.25 | 0.0 |
| Julie common ? | BARC-1 | R3T3 | de-formed husk | 0.0 |
| Kurukan | BARC-1 | R3T1 | 4.5 | 43.3 |
| Lemon | CPRS | R12T4 | 2.75 | 0.0 |
| Lemon | BARC-3 | R2T10 | 2.0 | 80.0 |
| Manzano | BARC-1 | R4T5 | 3.0 | 83.3 |
| Nam doc mai | CPRS | R8T3 | 1.0 | 33.3 |
| Ok rong | CPRS | R12T1 | 1.5 | 3.3 |
| Olour | BARC-1 | R1T4 | 3.75 | 0.0 |
| Orange | CPRS | R4T3 | 2.0 | 23.3 |
| Phoenix | BARC-1 | R6T3 | 1.5 | 0.0 |
| Pico | BARC-3 | R4T3 | 1.0 | 13.3 |
| Pineapple | BARC-3 | R6T2 | 4.25 | 66.7 |
| R2E2 | CPRS | mixed trees | 2.0 | 3.3 |
| Rapa | BARC-1 | R1T2 | 3.0 | 16.7 |
| Rosa | BARC-3 | R4T7 | 4.0 | 100.0 |
| Sabre | CPRS | R7T4 | 2.25 | 3.3 |
| Saigon | CPRS | R10T2 | 3.0 | 0.0 |
| Starch | BARC-1 | R6T2 | 3.0 | 0.0 |

[1]Note: the BARC site consists of 4 mango cultivar blocks all within a 200 metre radius.

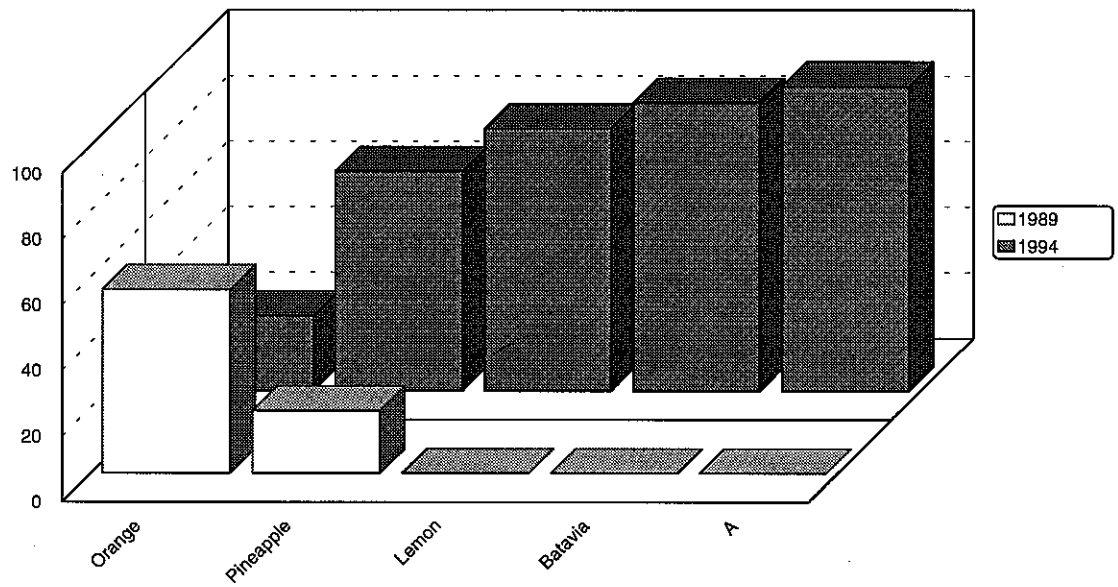



**Figure 1. Percentage mango seed weevil infestation for 5 cultivars - 1989 & 1994, BARC**

## Mango Irrigation Research

Y.Diczbalis, C.Wicks, G.McMahon

Mango water requirements and the response of the tree to irrigation management are still little understood, despite the fact that mangoes have been grown commercially in the Top End for over ten years. Work conducted by the irrigation section in

1992 and 1993 concentrated on examining water requirements during fruit development and the effect of irrigation management on fruit dry matter development and fruit maturity.

Another aspect of our work has been to monitor mango tree phenology (time of flushing, flowering, fruit set and harvest) in relation to rainfall, irrigation inputs, soil moisture, and weekly maximum and minimum temperature on a number of mango orchards over the last three seasons. With 3 seasons data it is now possible for us to make some assumptions on water requirements, and to examine some of the environmental variables which influence flowering and time from flowering to harvest.

In late 1991, 3 trees (var. Kensington Pride) in 3 Top End orchards were selected for weekly monitoring. Soil moisture measurements included total soil moisture from 0 to 1.2 metres (using the Neutron Moisture Probe) and soil tension (tensiometers 20, 40 and 80 cm depth). Irrigation inputs were monitored by installing a water meter on one of the lateral lines. Maximum and minimum temperatures were monitored using a simple max/min thermometer, hung from an internal branch of a tree, while rainfall was monitored using a rain gauge. All phenological and environmental variables were recorded once per week. Phenological recordings included flushing activity, first flower development, peak flowering, fruit set, early harvest and end of harvest.

Irrigation occurred only from flowering through to harvest although in some years, irrigation continued after final harvest until the onset of rains.

For this report we have chosen to present data from only 1 commercial farm. The soil moisture and irrigation data is presented for 1993 (Fig 2) and the temperature and phenology data is presented for the three years (Fig 3). The response on this farm was typical of that which occurred at the 3 sites.

Soil moisture levels were dependent on rainfall levels during the wet season and irrigation inputs during the dry season. Soil moisture falls and tensions rise soon after the last rains for the wet season. The maximum soil tensions at the 3 depths are reached within 8 weeks of the last rain. The bulk of the available soil moisture in the top 1.2 metres is used within 4 weeks following the last rain. Soil moisture increases rapidly following the onset of irrigation when flowering begins. Some growers choose to begin irrigating at bud swelling, while others wait until over 50 % of the tree is in flower.

Irrigation inputs during fruit development are generally higher than required, with 2 of the 3 orchards putting on the equivalent of 100 mm per week (4.0 inches/week). We suggest that 50 mm per week is more than ample. A simple guide to irrigation requirements for trees, in litres/tree/week, is to multiply the average tree canopy area by 50 mm. For example a tree with a canopy area of 20 $m^2$ would require 50 x 20 = 1000 litres/tree/week. This method will tend to over-irrigate the trees. A more exact guide to irrigation requirements can be obtained from AgNote 587.

The onset of flowering in mango is traditionally thought to be linked to the date of the last major vegetative flush and early flowering is thought to increase the profitability of the crop. Low night temperatures have also been recognised as playing a role in promoting flowering. Our data suggests that the flowering date is more closely related to the degree hours at or below $18^0$C, than to the date of the last vegetative flush (Table 16). Early flowering does not necessarily result in equivalent time advantage at harvest, because the rate at which the fruit develop is dependent on the mean temperature. The base growing temperature for mango is thought to be $12^0$C. At or below the base temperature growth and development ceases.

The mean growing temperature, minus the base temperature, multiplied by the number of days for a particular event to occur is called a heat sum. Our data suggests that the fruit development period can be defined by the heat sum technique. We believe that the relationships could be improved if daily temperature data is collected and some account is taken of the level of soil moisture. These relationships could be used to predict flowering date and more importantly maturity date for mangoes.

**Table 16. Days for various phenological events and associated temperature heat sum relationships.**

| Year | Days from last flush to flower. | Degree hours# at or below $18^0$C | Days from flowering to harvest | Heat Sum Degree hours above $12^0$C |
|---|---|---|---|---|
| 1992 | 77 | 3052 | 105 | 41706 |
| 1993 | 119 | 3444 | 84 | 36834 |
| 1994 | 70 | 3486 | 126 | 38976 |

# - Assumption; minimum for the week x 7 days x 4 hrs/day.

Mango growth, flowering and fruit development are highly dependent on temperature. The importance of moisture stress prior to flowering, for the initiation of flowering, is still not well understood. We feel that more effort should be expended on understanding the relationship between temperature, soil moisture status and flower initiation, as well as the relationship between temperature and time to maturity.

We have started a trial this season, in collaboration with a leading grower, to investigate some of these issues, with emphasis on fruit set relative to pre-flowering soil moisture status. We wish to take this opportunity to thank growers who have allowed us to monitor their trees.

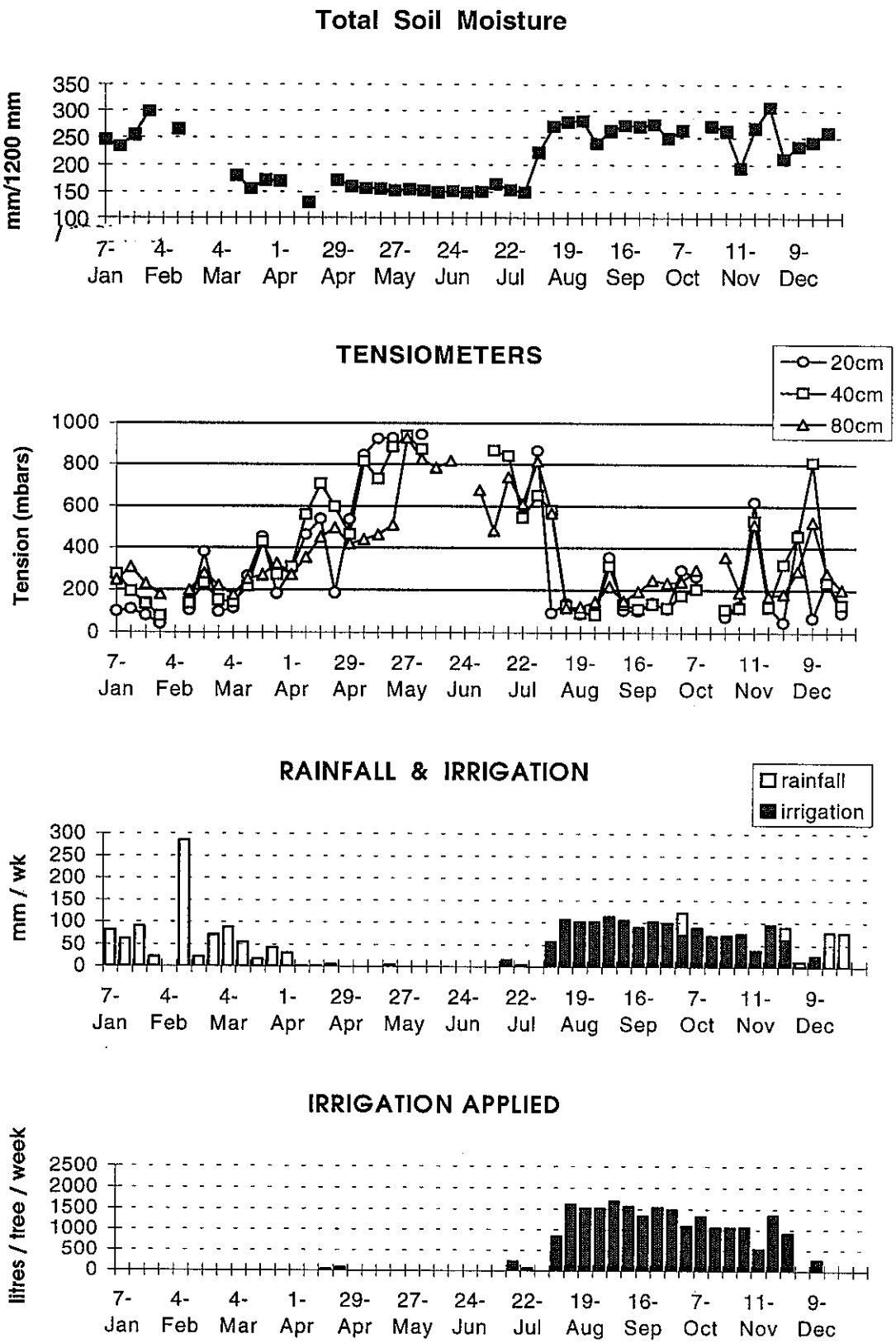



**Figure 2: Weekly total soil moisture, soil tension, rainfall and irrigation inputs expressed as mm and irrigation inputs expressed in litres/tree for a commercial mango orchard in 1993.**

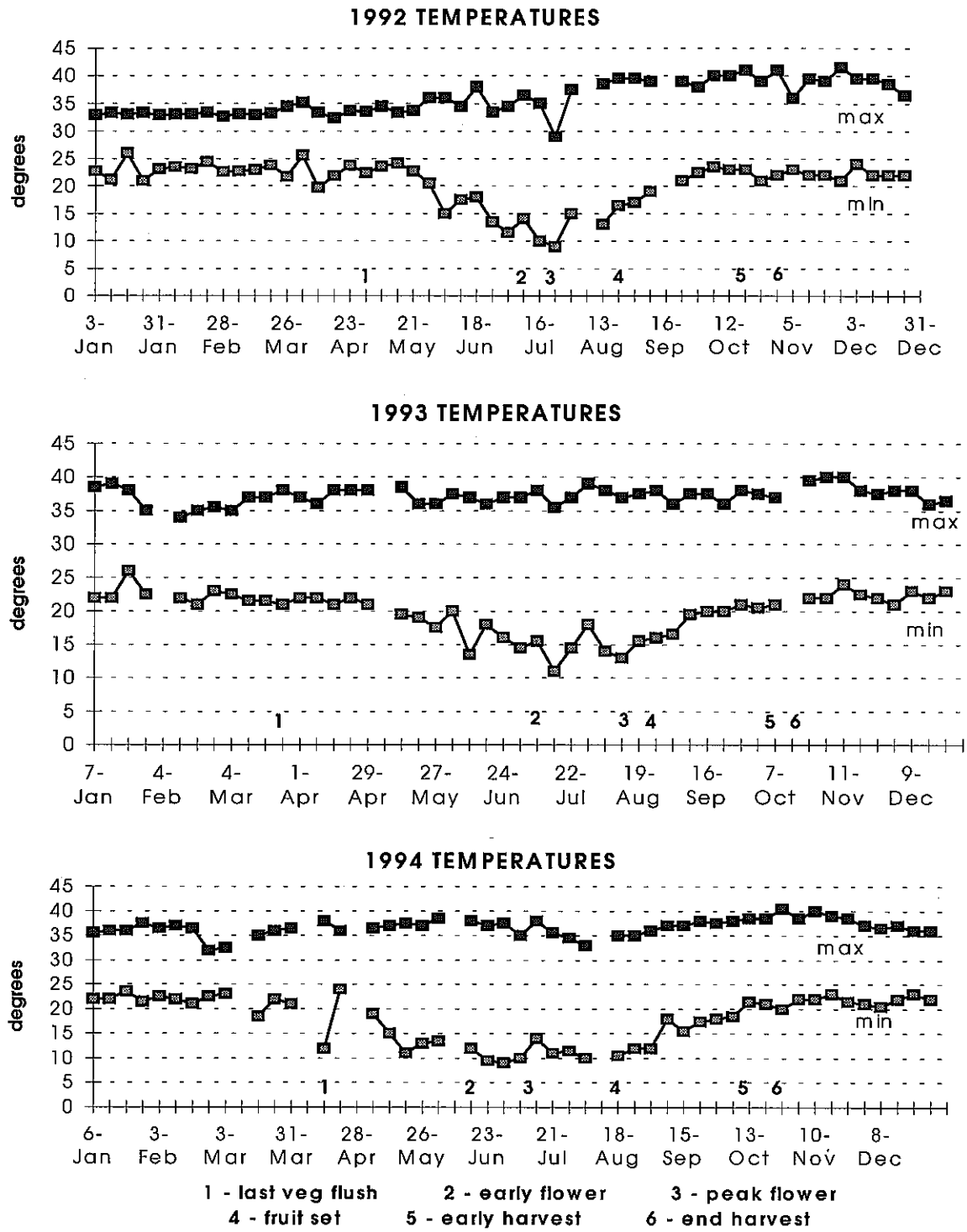



**Figure 3: Weekly maximum and minimum temperatures and phenological events on a commercial mango orchard over three years, 1992, 1993 and 1994.**

## Mango Postharvest Research 1994

M.Landrigan, T.K.Lim, M.Poffley, L.Luders, G.Ramsay, J.Carter, P.Hopkinson

**DISCLAIMER:** Naming of proprietary products in this review does not imply endorsement by DPIF. Postharvest chemical usage is currently controlled by strict government legislation. It is illegal to use any chemical product for which specific registration does not exist.

Mango is gaining commercial importance in Northern Australia, being the largest tropical fruit crop in the NT. Estimates of production for the 1994 season were 5700 tonnes, worth $15.8 million. Approximately 98 % of this production was exported, mostly to the southern markets. Because of our necessity to send to distant markets, it is more important than ever to restrict deterioration of produce as much as possible between harvest and consumption, by good postharvest practice.

In the 1994 season three postharvest activities were examined. These were: 1) mango ripening and postharvest dips, 2) skin browning monitoring, and 3) hot water dip and sapburn ameliorants.

**Mango Ripening and Postharvest Dips**: Feedback from the markets suggested Northern Territory mangoes arrive south in various stages of ripeness. It is well known that the use of ethylene gas, a naturally occurring fruit hormone, can induce and promote uniform ripening. Ethylene treatment by gassing requires specialised equipment, whereas the use of the chemical Ethrel® (Rhone Poulec Rural Industries Pty Ltd) requires no special facilities. Ethrel® contains the chemical ethephon which liberates ethylene gas when mixed with water. There is a wide range of approved uses of ethephon in horticulture, but it is currently not registered for postharvest dipping of mangoes in the NT. Preliminary trials on improving ripening of mangoes were conducted in 1993 and in the 1994 season it was decided to further investigate the use of ethylene as a ripening agent, in combination with other postharvest treatments currently used.

The first experiment used early season fruit (11 October 1994) with a non-recirculating spray containing dimethoate, prochloraz (recommended non-recirculating spray 16 L/hr) and ethephon. Two flow rates were used; a high (12 L/min) and a low (0.4 L/min) rate and 3 different desapping procedures; desapping on the rack, mango wash solution (5g/L) and a DCTron spray (0.4 mL/L).

Once treated, all fruit were stored at 22 °C and 65 %RH. To assess whether fruit were ripe, we used a firmness rate scale of 1 being hard to 5 being oversoft. Fruit were judged edible ripe with a score of 4. Fruit were also rated for colour and total soluble solids.

Ethephon increased the rate at which fruit ripened. All treated fruit were fully soft in 6 days, control fruit were not ripe until day 12. The action of ethephon was not affected by the addition of the postharvest insecticide and fungicide chemicals. There was no obvious difference between the high and low flow rates using this concentration of ethephon. However, with lower ethephon concentrations there may be problems. There was also no difference between the desapping solutions used (at these concentrations) and the ability of the fruit to ripen with ethephon.

In mid-season (26 October 1994), a second experiment looked at the postharvest treatments of dimethoate, prochloraz and ethephon applied as a spray (0.4 L/min) compared to a dip (1 min). The desapping solutions included Bioshield®, as well as desapping on the rack, mango wash solution and a DCTron spray.

As before, the ethephon fruit ripened by day 6, whether a spray or dip was used. The desapping solutions did not affect the ability of ethephon to ripen fruit.

Finally, late season fruit (15 November 1994) were treated in the same way as the mid-season fruit. Once again, spray or dip or desapping solution did not influence the result, but treated fruit were ripe in about 5 days compared with 10 days for untreated fruit.

Also ethephon dipping was trialed on two other cultivars; Irwin and Nam Dok. Irwin responded favourably to ethephon dipping, ripening in 5 days, whilst control fruit took 9 days. In contrast there was no noticeable effect on Nam Dok Mai, either with the ability of the fruit to colour or soften. It is important to note that not all mango cultivars respond in the same way to ethylene treatment.

Ethephon dipping is a useful tool to promote ripening, as an alternative in areas where the cost of constructing gas chambers may be prohibitive. However, the effectiveness in achieving faster and more uniform ripening depends on the cultivar of fruit been treated as well as; maturity, temperature and relative humidity of ripening room, ethylene concentration and time of exposure. Work on efficacy and stripping rates is still required.

**Skin Browning Monitoring**: Skin browning is an important problem in mango fruit quality and can result from a range of pre- and postharvest factors. The benefits of identifying and reducing skin browning will be to improve the fruit quality at the retail level and give growers more confidence in their harvesting and postharvest handling of fruit. Preliminary monitoring was carried out in the NT. Fruit from 6 growers were monitored to assess which harvesting and postharvest handling systems contribute to good fruit quality and shelf life.

Fruit was assessed from 7 sheds, using either manual picking or the mango harvesting aid, in combination with detergents or oil desapping agents and fungicide and insecticide dips/sprays.

Our study showed that most fruit took 8-10 days to ripen at 20°C and 65%RH. All fruit were of good quality, even though some lines were highly coloured and others were not.

Overall, the incidence of browning was low, however, browning did increase as fruit ripened. There were no noticeable differences between the quality of fruit from the different postharvest systems. Quality appeared to be grower-linked.

**Hot Water Dip and Sapburn Ameliorants**: Research work on hot water dip (HWD) treatment commenced 6 years ago. The Entomology section has studied in depth how the protocol affects fruit fly disinfestation, postharvest rots, fruit quality and the probable causes of fruit scalding. The standard HWD treatment of heating fruit to 46°C core temperature and holding at that temperature for 10 minutes before cooling for 15 minutes in 13°C, has been accepted as a quarantine treatment in 3 states (Victoria, Tasmania and South Australia).

Heat scalding from the HWD treatment is still an intermittent problem. It appears different desapping solutions can increase the probability of scald with HWD. The oil treatments (DCTron® and Bioshield®; 0.04 mL/L) increased scalding. Also, the longer fruit were left in all desapping solutions the greater the likelihood of injury.

Also this season, a means of predicting damage prior to treatment, was investigated. The amount of sap exuded per kg fruit per hour was measured, immediately after harvest. Firstly, to look at the effect of rain, Kensington fruit, from 3 trees were harvested immediately after rain and on days 3, 7 and 21. The amount of sap decreased with time after rain, as did heat injury. The second experiment combined irrigation cut-offs prior to harvest and rain. Irrigation was cut-off at 0,1, 2, and 3 weeks prior to harvest. There was a difference between fruit irrigated right up to harvest and those where irrigation had been cut-off. But once rain occurred there was no difference between fruit from any irrigation treatments.

In conclusion, further work is required in this area to fully address this problem. The sap work was carried out at CPRS, it would be necessary to collect fruit from a range of localities and over a few seasons to clarify results.

## Table Grape Evaluation in a Tropical Environment

M..D.Hoult, J,D. Bright, S.McAllister

Tropical table grape production is well established throughout the world. Production levels are high, however pest and disease incidence can be severe, especially in high rainfall regions.

Preliminary evaluation of a number of table grape cultivars at the NT Rural College, Katherine indicated the potential for possible commercial production of the crop in the Katherine region. From this investigation, the management of a number of aspects of vine phenology and agronomy need further clarification, notably excessive vegetative vigour, cultivar specific pruning methods, erratic and extended budbreak and disease control. Proposed marketing of table grapes is targeted towards the months of August, September and October when Australian domestic production is at its lowest. The impact of future imports on this market niche will need to be closely monitored.

The project incorporates a number of sub-projects. The rootstock evaluation proposes to determine whether stocks will reduce excessive vegetative vigour whilst maintaining good yields and berry quality. Adaptability to alkaline edaphic conditions will also be evaluated. The cultivar evaluation incorporates a number of cultivars, predominantly seedless, in 2 vines per cultivar, single, observational plots. Redglobe is rapidly becoming a major table grape cultivar for both the domestic and Asian market. Management of Redglobe under the tropical environment of Katherine is the major thrust of the final sub-project.

As most vines are < 2 years old, no substantial data has been collected. Some observations on bud-fruitfulness for Red globe, pruned to 4 bud spurs, was collected. Fruitfulness was < 30% for all buds studied, clearly unsatisfactory. This may have been a reflection of the young age of the vines. Disease incidence was distinctly seasonal, with 3 diseases being prominent, notably powdery mildew, downy mildew and anthracnose (black spot). Powdery mildew is prevalent from around April/May until Oct/Nov. Downy mildew and anthracnose are most active during the monsoon period around December to March/April.

## Preliminary Evaluation of the Effect of Combine® On Bunch Quality In Tablegrapes. Southern Region.

G.Kenna, K.Young, C.Ellis

Gibberellic Acid (GA) has been used for many years by tablegrape growers to improve the berry size and quality of seedless tablegrapes There are a number of problems associated with the use of this chemical such as accurate timing of spray applications and the effectiveness of the sprays in achieving the desired results. While increased berry size may be achieved, the effectiveness of the spray application to achieve berry thinning or bunch stretching, which is necessary to offset the increase in berry size, is not always possible.

While on a visit to research establishments in India, the Director Horticulture DPIF, was made aware of a new generation plant growth regulator which is being researched in that country. The substance, which is sold commercially as Combine®, is a naturally occurring brassinosteroid. It will increase berry size in tablegrapes independently of GA, yet is claimed to have a synergistic effect when used with that product. Research work in India recommends that a small amount of GA be used in combination with Combine®. The product can be used on seedless and seeded varieties.

Preliminary work to assess the potential of Combine® for the Central Australian tablegrape industry was carried out on the 4 main varieties grown in the region. The assessment was carried out at Territory Grapes on the varieties Flame Seedless, Menindee Seedless, Sultana and Red Globe.

Menindee Seedless is usually not treated with GA. If this chemical is applied, cropping can be reduced by up to 100% the following season. The effect of Combine® on this variety was also assessed.

The application of the GA/Combine® solution was made using two methods. The recommended method of application is by dipping each bunch in the solution by hand. This is considered uneconomic under Australian tablegrape production conditions. The more efficient method of applying the solution, by spray application, to each bunch was also evaluated. In this instance the spray was applied by hand.

Flame Seedless, Menindee Seedless and Red Globe were treated by dipping bunches on 2 panels consisting of 1.5 vines per panel in the solution. Bunches on 2 panels of 1.5 vines per panel were sprayed with the solution. Bunches on 2 panels of 1.5 vines per panel were used as a control.

The variety sultana was subjected to the following treatments:

A panel of 1.5 vines was treated with the regular GA applications and 2 applications of Combine® and GA by dipping.

No regular GA treatment but 2 applications of Combine® and GA applied by dipping.

Regular applications of GA and 2 applications of Combine® and GA by spraying.

No regular applications of GA but 2 applications of Combine® and GA by spraying.

The timing of the applications of Combine® and GA were as per the recommendations;

1st application: Berry diameter 3-5 mm for seeded grapes
Berry diameter 2-3 mm for seedless grapes

2nd application 10 days after first treatment.

**Table 17.** **Results: Flame Seedless:** Harvest Date: 24 November 1994

| **Treatment** | **Bunch No.** | **Total Bunch Wt (gr)** | **Av. Bunch Wt (gm)** | **Culls Wt (gm)** | **Berry Wt - 20 berries - (gm)** |
|---|---|---|---|---|---|
| Dip | 115 | 42,912 | 373 | 5,855 | 359 |
| Spray | 75 | 21,671 | 289 | 7,221 | 342 |
| Control | 102 | 32,431 | 318 | 5,134 | 350 |

**Table 18.** **Menindee Seedless:** Harvest Date: 1 December 1994

| Treatment | Bunch No. | Total Bunch Wt (gm) | Av. Bunch Wt (gm) | Cull Wt (gm) | Berry Wt 20 berries (gm) |
|---|---|---|---|---|---|
| Dip | 99 | 39,875 | 403 | 3,612 | 803 |
| Spray | 115 | 47,248 | 411 | 4,785 | 785 |
| Control | 98 | 39,786 | 406 | 5,412 | 778 |

**Table 19.** **Sultana:** Harvest Date: 20 December 1994

| Treatment | Bunch No. | Total Bunch Wt (gm) | Av. Bunch Wt (gr) | Cull Wt (gm) | Berry Wt 20 berries (gm) |
|---|---|---|---|---|---|
| Dip @ GA | 34 | 16,370 | 482 | 216 | 92 |
| Dip no GA | 37 | 8,530 | 231 | 525 | 81 |
| Spray @ GA | 41 | 17,909 | 437 | 599 | 371 |
| Spray @ No GA | 42 | 16,603 | 395 | 835 | 325 |

**Table 20.** **Red Globe:** Harvest Date: 29 December 1994

| Treatment | Bunch No. | Total Bunch Wt (gm) | Av. Bunch Wt (gm) | Cull Wt (gm) | Berry Wt - 20 berries (gm) |
|---|---|---|---|---|---|
| Dip | 114 | 31,407 | 276 | 2,422 | 480 |
| Spray | 120 | 29,041 | 242 | 2,124 | 450 |
| Control * | | | | | |

* Control vines were harvested prior to assessment.

Results from the preliminary work conducted indicate that the use of this chemical has the potential to improve tablegrape bunch quality in all varieties.

Generally the dip treatments on all varieties produced the highest average bunch weights. Berry size for dip treatments was also higher than the spray treatments or controls. These are only preliminary indications of the potential of this chemical and further research is required in the 1995-96 season under more controlled conditions which include:

- More replicates for each treatment.
- Regulating the number of bunches on each replicate by removing excess bunches.
- A more efficient method of spray application of the Combine®/GA solution to bunches as this is considered to be the most efficient method of applying the chemical in a commercial situation.
- The affect on bunch quality by spray application of the Combine®/GA solution to the vine including the foliage.

## Banana Research 1994

K.J.Blackburn, M.M.Traynor

Banana research and development in the Darwin area was formally initiated in late 1993 when all growers attended a Banana Workshop where Research and Development priorities were agreed upon. A Banana Industry Working Group was formed which meets 3 times a year to discuss Research and Development projects and to advise DPIF on relevant industry issues.

**Table 21. Industry Status 1994**

| No. of Growers | Approx. Total Area (ha) | Total Production (kg) | Value of Industry ($) | Marketing (%) | |
|---|---|---|---|---|---|
| | | | | Local | Interstate |
| 8 | 140 | 3, 154, 214 | 3, 561, 748 | 43 | 57 |

The current industry comprises 5 growers in Darwin and 3 small growers at Katherine, with 2 new growers entering the industry in 1995.

**Nutrient Monitoring:** A banana nutrition monitoring program commenced in March 1994 consisting of bi-monthly leaf and soil analyses to be correlated with grower fertiliser practices, over a 3 year period, to optimise banana nutrition. Initially the project set out to establish what the present situation was, in regard to nutritional status of the plants and the frequency, amounts and type of fertilisers applied.

Results in the first year (1994) over 5 sampling dates showed some interesting trends. The 5 growers applied fertiliser on a monthly basis generally, but this could be highly irregular with crops receiving no fertiliser for up to 2 to 3 months at a time. The rates of application varied from 100 kg/ha/month up to nearly 400 kg/ha/month, with an average of about 200 kg/ha/month which would correspond to an annual rate of 330 N, 72 P, 720 K. Based on North Queensland observations these levels should be adequate for reasonable production, but irregular application of fertiliser results in much less being applied. One grower, (Farm 4 in Figures 1,2,3), has been able to maintain good soil and leaf levels of nutrients, although his application rate is lower than the average, by fertilising at regular monthly intervals. One of the main problem areas is in the wet season when access to the crop is restricted by water-logged conditions and regular fertiliser programs cannot be maintained by ground application. At such times it would be beneficial to apply soluble fertiliser through the irrigation system rather than induce a nutrient stress situation that would affect production later in the year.

Figures 4, 5 and 6 show both leaf and soil levels for nitrogen on 6 farm sites and 5 sampling periods throughout 1994. The two horizontal bars represent the range of adequate levels of nutrients for leaf analysis, while the single horizontal bar in the soil analysis is considered to be an optimum level. These adequate or optimum levels are based on work conducted in South-east Queensland and may not represent ideal levels for a tropical environment, however, they will be used as indicative levels until more work is carried out. It is generally considered that nitrogen leaf levels could be 0.5 to 1.0% lower in a hot climate and potassium levels could be a little lower as well. Leaf levels of nitrogen and potassium in Figure 4 on all farm sites could be improved by additional fertiliser applications. Leaf potassium levels have been adversely affected by high soil and leaf levels of magnesium (Figure 5), which has altered the cation balance and restricted potassium uptake. The high magnesium levels has also affected leaf calcium levels, although soil calcium levels are considered adequate. Although soil potassium levels generally are less than adequate on most farms, small, regular applications of potassium are considered necessary to maintain adequate leaf levels with 2 or 3 major applications at seasonal intervals. The maintenance of adequate leaf zinc levels is an industry wide problem and will have to be addressed (Figure 6) . High zinc soil levels on Farm 4 (Figure 6) has not resulted in adequate leaf levels, although regular foliar application of zinc is applied.

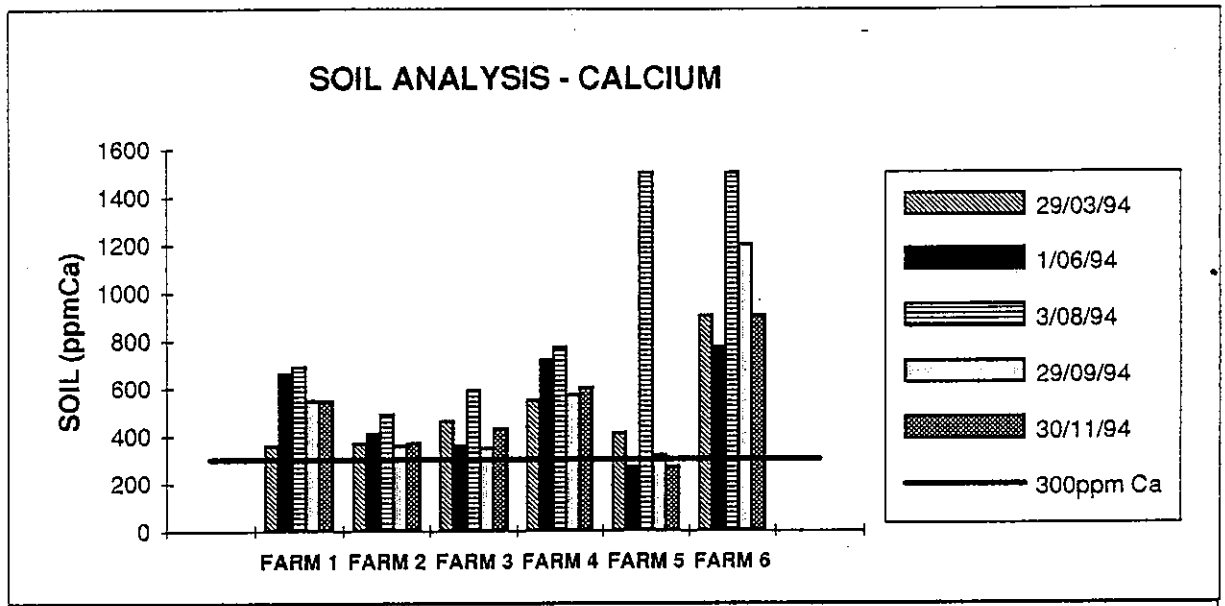
The present nutrition situation with regard to the Darwin banana industry could possibly be improved, at this early monitoring stage, by making growers aware of a number of issues.

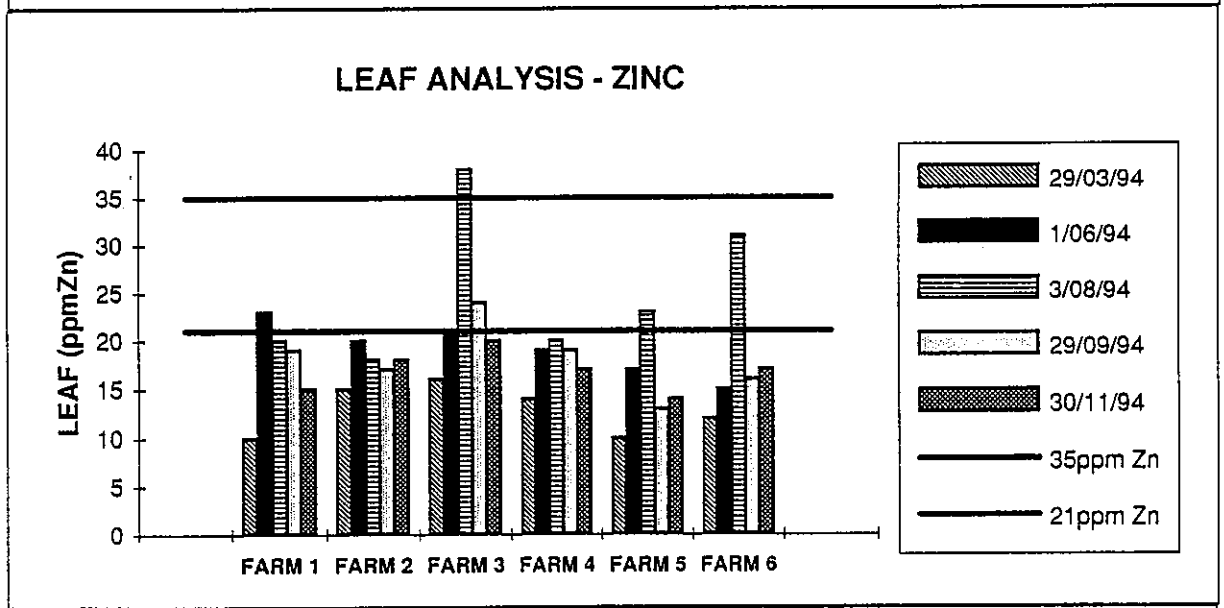
- Regular monthly applications of nutrients should be strictly carried out to maintain a constant supply to the growing crop. It is anticipated that, as the phenology of the crop is better understood, critical times for additional fertiliser applications will be determined. For example, additional potassium could be required in March/April before the onset of cool dry season conditions.

- The importance of precise irrigation scheduling in bananas under local conditions cannot be over-emphasised. Unless this is achieved, the response from an improved nutrition program will not be obtained. Current irrigation scheduling is generally variable and water is insufficient during Sept./Oct./Nov.when climatic conditions are harsh and banana crops are under undue stress. New plantings on existing farms, as well as 2 very large banana projects just commencing operations, are using undertree sprinkler irrigation systems, rather than the traditional overhead method, and will be injecting fertiliser through the irrigation system at regular intervals. It is considered that this system will be more efficient in supplying the irrigation requirements and the nutrient demands of the banana crop under Darwin climatic conditions.

- Strategies for improving both zinc and potassium nutrition to ensure constant and adequate levels in the soil and plant will have to be developed. The high magnesium content in the irrigation water from bores is a concern and the effect on potassium availability may only be partially overcome by small, frequent applications of potassium fertilisers. Maintaining adequate zinc levels in the soil and leaf is an industry-wide problem and both ground and foliar application will need to be employed to overcome deficiencies.

**Figure 6.** Zinc leaf and soil analysis and calcium soil analysis over 6 farm sites 1994



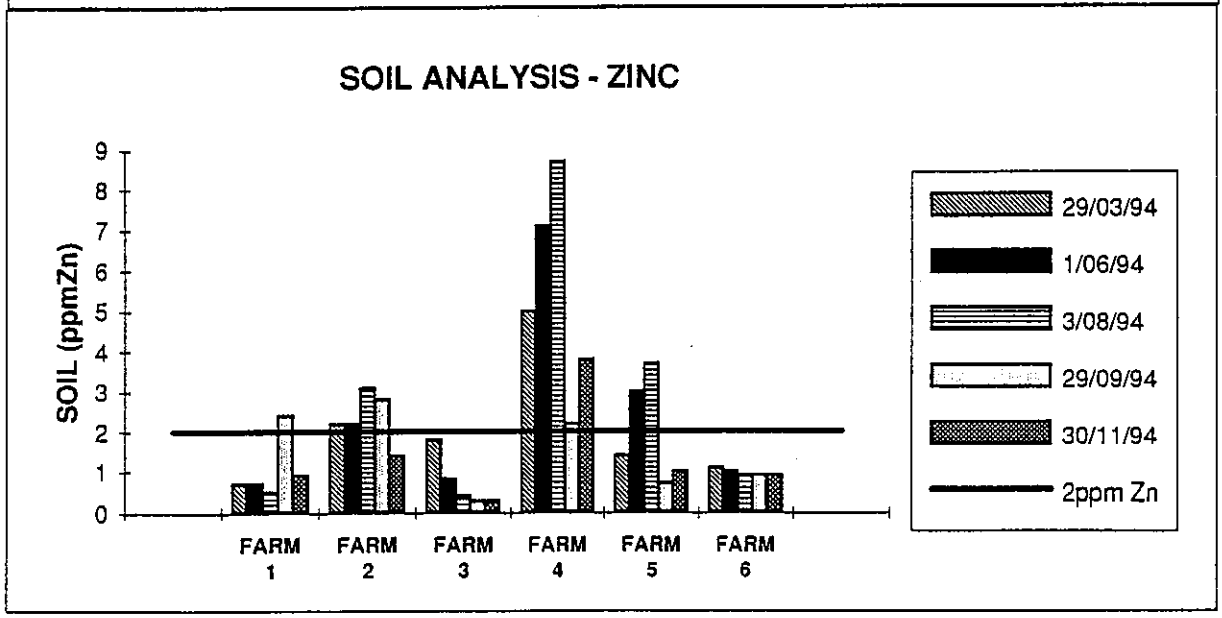



**Figure 5.** Magnesium leaf and soil analysis and calcium leaf analysis over 6 farm sites 1994

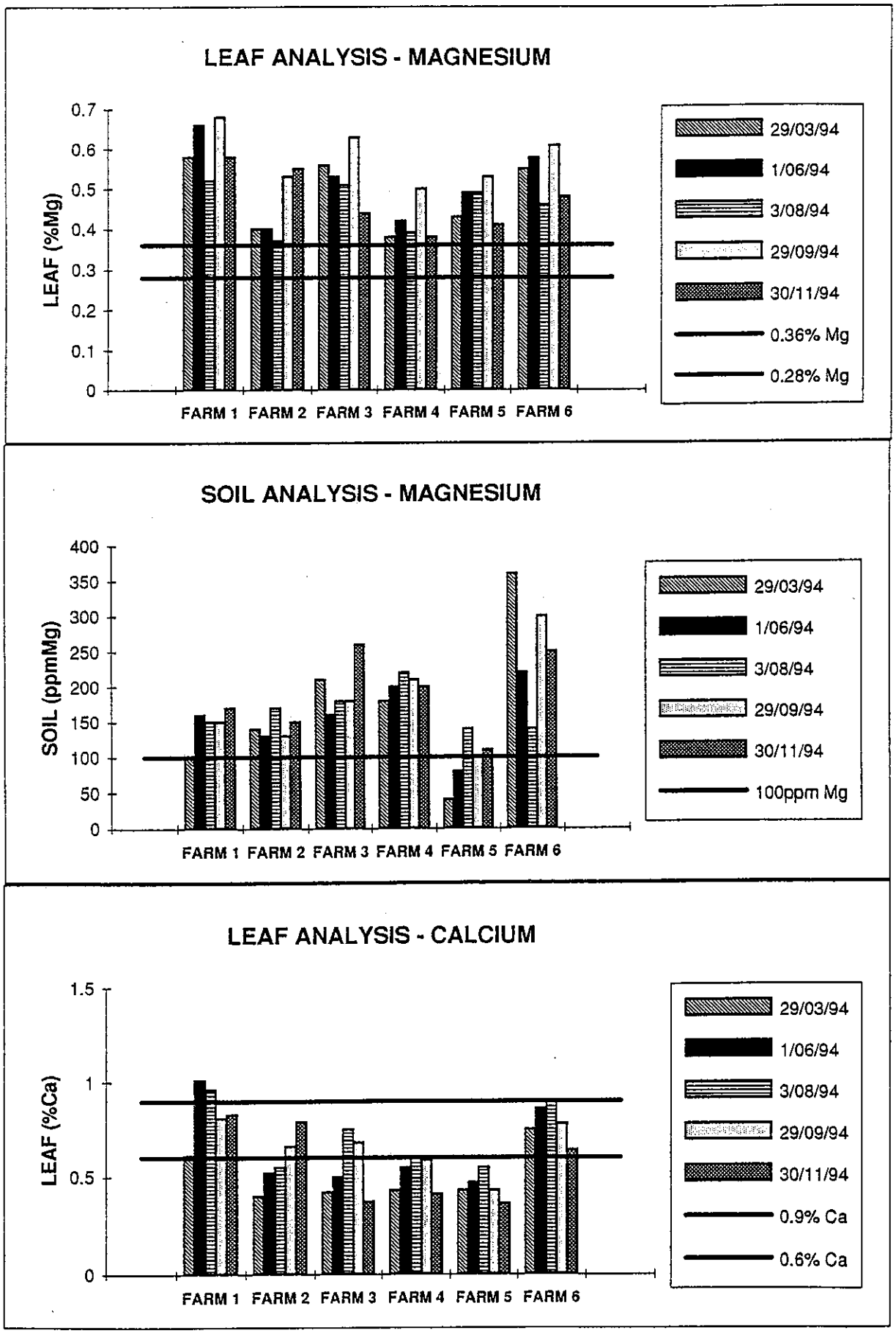
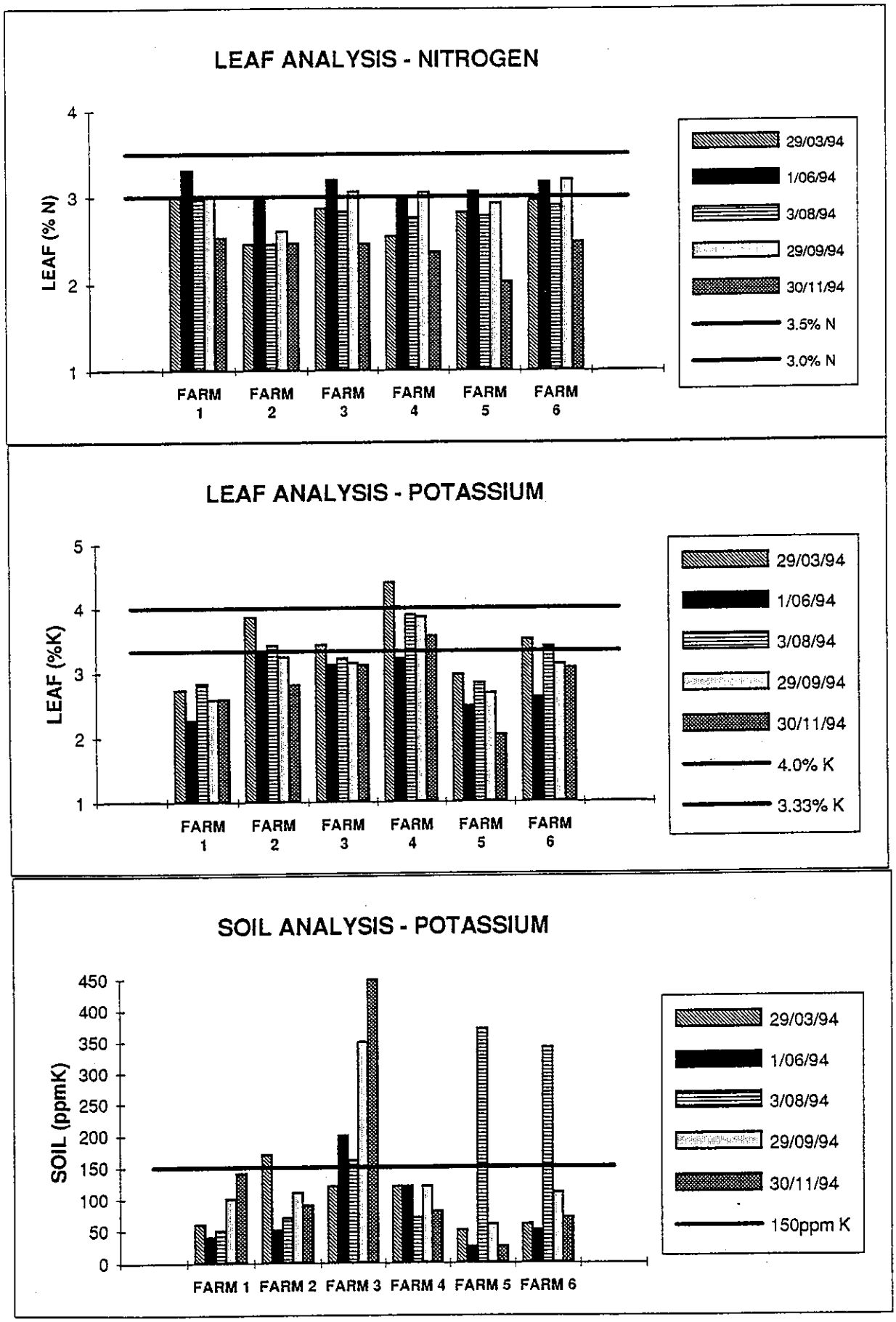


**Figure 4.** Nitrogen leaf analysis and potassium leaf and soil analysis over 6 farm sites 1994



## Banana Cultivar Assessment

K.J.Blackburn

One of the recommendations of the 1993 Banana Workshop was that a collection of relevant banana cultivars be established at CPRS for assessment under local conditions. The Banana Industry Working Group, with advice and co-operation from QDPI, decided that the collection should contain cultivars that are popular with the major ethnic groups that have settled in the NT. It was considered that there would be less inclination to illegally bring in these cultivars if they were locally available and so reduce the threat of disease importation from countries in the South East Asian area. As well, some new introductions and QDPI selections were included for assessment. These included Goldfinger, a new breeding line from Honduras, which has some excellent agronomic characteristics.
The original introductions arrived in early 1994 as "in vitro" tissue culture plantlets, but due to the varying number of plants recovered after growing on, these were planted in a temporary museum block. These were field planted on 27 June into an undertree irrigation system. Two cultivars, Goldfinger and Santa Catarina Prata, were delayed due to legal and licence requirements and were field planted on 13 December 1994. In 1995, a larger banana arboretum block will be planted out with an increased number of plants of each cultivar for assessment and, eventually for distribution to interested parties. The cultivar collection is listed in Table 22.

**Table 22. Banana cultivar collection**

| Lab. Code | Q Ban Reg. No. | Cultivar |
|---|---|---|
| 29 | M450 | Sucrier |
| 92 | C398 | J.D. Special |
| 99 | C405 | J.D. Dwarf |
| 117 | M421 | Lakatan |
| 229 | M438 | Pisang Rajah |
| 248 | M320 | Pisang Gajih Merah |
| 259 | M259 | Ducasse |
| 324 | M511 | Pacific Plantain |
| 362 | C543 | Dwarf French Plantain |
| 383 | C550 | Williams |
| 401 | C582 | Grande Naine |
| 404 | M559 | Sugar |
| 411 | M566 | Horn Plantain |
| 412 | M567 | Improved Lady Finger |
| 321 | M508 | Santa Catarina Prata |
| 360 | C541 | Goldfinger |

## Banana Cultivar Evaluation in the Katherine Region.

J D Bright, S McAllister, S J Martin, G S Foord, M W Smith

This experiment aims to: identify banana cultivars that are suited to the climatic conditions of the Katherine region, as well as satisfying different consumer tastes (ie. cultural niche, market niche); have available plant material which local growers can source; discourage illegal plant importation and; develop a database on the performance of different cultivars in this environment.

Although the cultivar 'Williams' performs well in the Katherine environment, there may be alternative cultivars which are better suited to the conditions, particularly regarding dry season production. It is proposed that observations of several cultivars including 'Williams' be undertaken, looking at each cultivar's ability to grow in the cooler winter months and to handle moisture/heat stress during the 'build-up' (October/November).

Alternative cultivars may also provide other advantages to the grower including: reduced pesticide use (i.e. some cultivars can be grown without pesticide usage, giving reduced costs and a 'pesticide free' product); better wind resistance than Ladyfinger (eg. Santa Catarina Prata); better prices when Cavendish fruit is in a glut ; easier management for some cultivars via tougher peel ( giving less damage to fruit ) and lighter bunches (making harvesting easier ) and; greater chance for export as direct competition from countries with cheap labour is avoided.

The trial was established on the 24 January 1995 at KRS, from tissue cultured plantlets. The trial consists of 4 rows having 4 m between rows and 2.5 m between plants. Table 23 shows the cultivars that have been established.

**Table 23. Banana cultivars currently under evaluation at Katherine Research Station**

| Cultivar | Comments |
|---|---|
| Gold Finger | Dessert type<br>Resistant to Panama (R1 and R4) ,<br>Resistant to Leaf Spot<br>Tolerant to Nematode |
| Santa Catarina Prata (Dwarf Ladyfinger) | Dessert type<br>Better wind resistance than Ladyfinger<br>Popular in Hawaii<br>Resistant to Panama disease R2 |
| Pacific Plantain | Dessert/ cooking type<br>Resistant to Panama disease R2 |
| Lakatan | Dessert type<br>Resistant to Panama disease R1 |
| Ducasse | Dessert type<br>Common N.Q. backyards<br>Resistant to leaf spot<br>Resistant to Panama disease R2 |
| J.D. Dwarf | Dessert type<br>Good wind resistance<br>Robust pseudostem |
| J.D.Special | Dessert type<br>Off-type of Mons Mari |
| Grand Naine | Dessert type<br>Most popular export banana in world |
| Horn Plantain | Cooking type<br>Resistant to leaf spot<br>Resistant to Panama disease R1 and 2 |
| Sugar | Dessert type<br>Resistant to Panama disease R2<br>Resistant to leaf spot |
| Sucrier | Dessert type<br>Resistant to Panama disease R1, 2 and 4 |
| Pisang Gajih Merah | Cooking type<br>Resistant to leaf spot |
| Simoi | Ornamental |
| Wain | Ornamental |

Parent bunches will be assessed for weight of bunch, number of fingers per bunch, size of fingers (i.e. diameter of fingers using middle three fingers of the outer whorl of the 3rd hand from the proximal end), average finger length of middle 3 fingers of outer whorl of each hand (as per Daniells *et al* 1986). Observations will also be made on cold damage to different cultivars as well as cycling times. Ratoon bunches will be measured using the same parameters as for parent bunch measuring. Consumer acceptability and grower reaction will be gauged for the different cultivars.

Daniells, J.W., O'Farrell, P.J., and Campbell, S.J. (1986). The response of bananas to plant spacing in double rows in North Queensland. *Queensland Journal of Agriculture and Animal Science* 42:45-51.

## Timing of Banana Sucker Selection.

J.D.Bright, S.McAllister, S.J.Martin, G.S.Foord, M.W.Smith

It is believed by some banana growers that the timing of sucker/follower selection is crucial in determining harvest time for that follower's bunch. Early sucker selection is thought to lead to shorter cycle times. However, work conducted in a range of different environments has indicated that the time of sucker selection has little or no influence on harvest time. Indeed, Robinson (1990) concluded that early sucker selection did not lead to shorter cycle times and that bunch weight was increased by later sucker selection. This experiment will determine the effects of time of follower selection on time to harvest of the follower.

The trial was established within a commercial planting of Williams banana (Mr R.Lawrie, Kimtanya, Katherine). Suckers had been planted in August 1993. The soil type was an alluvial red earth. Seventy seven stools were selected from within the planting after satisfying the following criteria:

- true-to-type Williams,
- parent pseudostem between 1.5 and 2.0 m tall, un-bunched,
- 2 suckers less than 0.75 m tall.

Parent pseudostems were cut-off 50 mm above ground level and treated with 2 ml of diesel. Two suckers (less than 0.75 m tall) were left on each stool. All others were cut at ground level and treated with diesel. Selected stools were randomly allocated to the 7 treatments shown below. Each treatment was replicated 10 times (individual plant plots) within a completely randomised block design .

Treatments were as follows:

| | | |
|---|---|---|
| Jan | Month 1 | Select 77 stools so that parent suckers are 0.75 m tall |
| Feb | Month 2 | of 77 stools select 11 stools and de-sucker rest |
| March | Month 3 | of 66 stools select 11 stools and de-sucker rest |
| April | Month 4 | of 55 stools select 11 stools and de-sucker rest |
| May | Month 5 | of 44 stools select 11 stools and de-sucker rest |
| June | Month 6 | of 33 stools select 11 stools and de-sucker rest |
| July | Month 7 | of 22 stools select 11 stools and de-sucker rest |
| August | Month 8 | of 11 keep remaining 11 stools |

Crop management, with the exception of sucker removal, was as per standard commercial management for the farm. The trial was affected by a windstorm in mid November, where 60% of datum plants were blown over.

The most obvious trend from this trial was that the parent had the corm dominance and it was not until the parent had flowered that the suckers showed any significant, active growth (Figure 7).

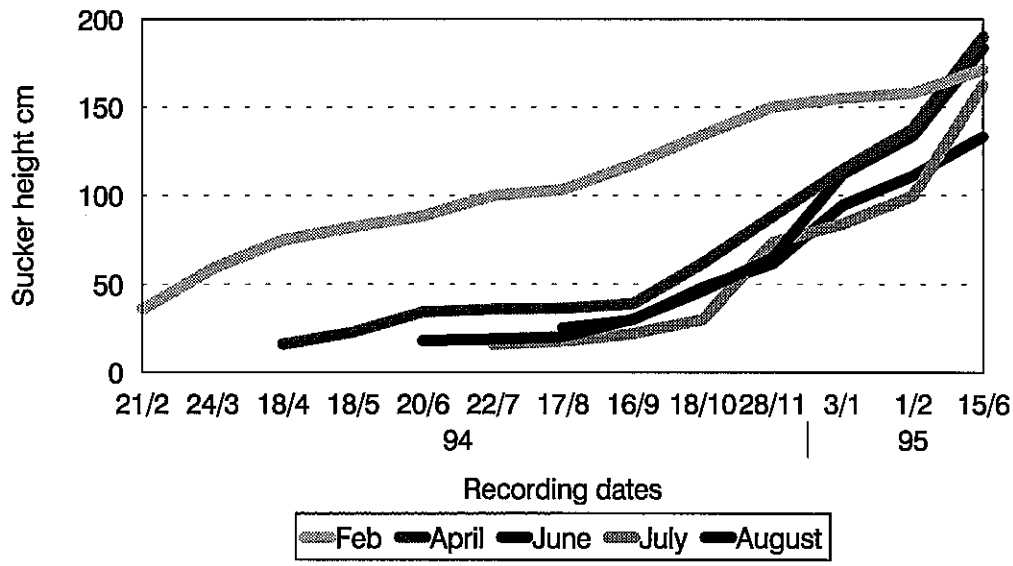



**Figure 7. Growth of suckers selected at different times**

Selection time of followers does not appear to affect their time of flowering (Table 24).

**Table 24. Percentage of followers that had flowered by 15 June 1995**

| Selection Date | Percent Flowered |
|---|---|
| February | 50% |
| April | 75% |
| June | 30% |
| July | 55% |

This trial will be carried out again at KRS, with nurse sucker management added as another parameter. When performed in conjunction with each other, it is anticipated that differences in flowering times (and other production values, eg. bunch weight) may occur.

Robinson, J.C. (1985). Parent To Sucker Competition Within A Banana Mat. *Information Bulletin Citrus & Subtropical Fruit Research Institute of South Africa* 157:11-13.

## Nurse Sucker and Sucker Selection Influence on Banana Production.

J.D.Bright, G.S.Foord, S.McAllister, S.J.Martin, M.W.Smith, M.D.Hoult

The 'nurse sucker technique' is a widely employed method of manipulating banana production, so as to coincide with periods of better prices. The technique involves the foregoing of the parent crop to achieve a synchronisation of harvest and higher prices with the ratoon crop. The experiment was established in January 1995, using tissue cultured 'Williams' plants at 2 by 4 m spacing. A factorial treatment design is employed with 3 follower selection dates (31 May, 15 July and 20 September) and 2 nurse sucker treatments (parent pseudostem cut down on the 20 September and parent pseudostem left to carry a bunch). Plots consist of 4 stools in a row, with each of the 6 treatments replicated 4 times within a randomised complete block design. Measurements to be taken include time of flowering and bunch harvest, yield and quality parameters. Preliminary results will be available in late 1996.

## Banana Water Requirements and Irrigation Monitoring

Y. Diczbalis, C.Wicks, G.McMahon

The banana industry in the NT is rapidly expanding. Growers have requested information on water requirements and irrigation management to enable improved planning for new plantings and improved irrigation management of established and new plantings. Work carried out during the latter half of 1993 and throughout 1994 centred on determining the irrigation management status of current farms. Measurements made included soil moisture tensions at 20, 40 and 80 cm within a number of banana plantings. Established farms utilise overhead irrigation and a distribution test was carried out on one typical installation. Further irrigation monitoring work was carried out on a block set up to test the distribution patterns and reliability of 4 different under tree sprinklers.

Irrigation monitoring of established banana blocks shows clearly that growers are under irrigating their banana crops. In all cases, soil tensions at 20 and 40 cm depths exceed the maximum recommended tension of 30 kPa. Work carried out in NW Australia and overseas, shows that banana yield decline rapidly once soil tensions exceed 30 kPa. The high tensions are partly due to the unevenness of irrigation within the block. A sprinkler distribution test of a typical overhead irrigation block indicated that the coefficient of uniformity (CU) of the system was 72% . The minimum CU recommended is 84%. For the block measured, approximately 33% of the block was being under irrigated at each application.

In the under tree irrigation trial, measurements included water inputs, soil tension, weekly rainfall, evaporation rate and weekly maximum and minimum temperatures. The data showed that water requirements rose sharply from late August (Figure 8). This is related to the increase in day and night temperatures and evaporation rate. Water inputs of approximately 50 mm per week maintained soil tensions at 20 and 40 cm below 300 mbars (30 kPa) during this time.

Literature on banana irrigation and the above work suggests the following irrigation management strategies should be

employed in our environment.

- Soil tensions need to be maintained in the 10 to 25 kPa range.
- Even, well distributed irrigation is essential (favours use of under tree systems).
- Frequent irrigation is essential (daily).
- Wind breaks should be incorporated into the farm layout.
- Important to monitor irrigation inputs and soil tensions to allow quick response to changing conditions.

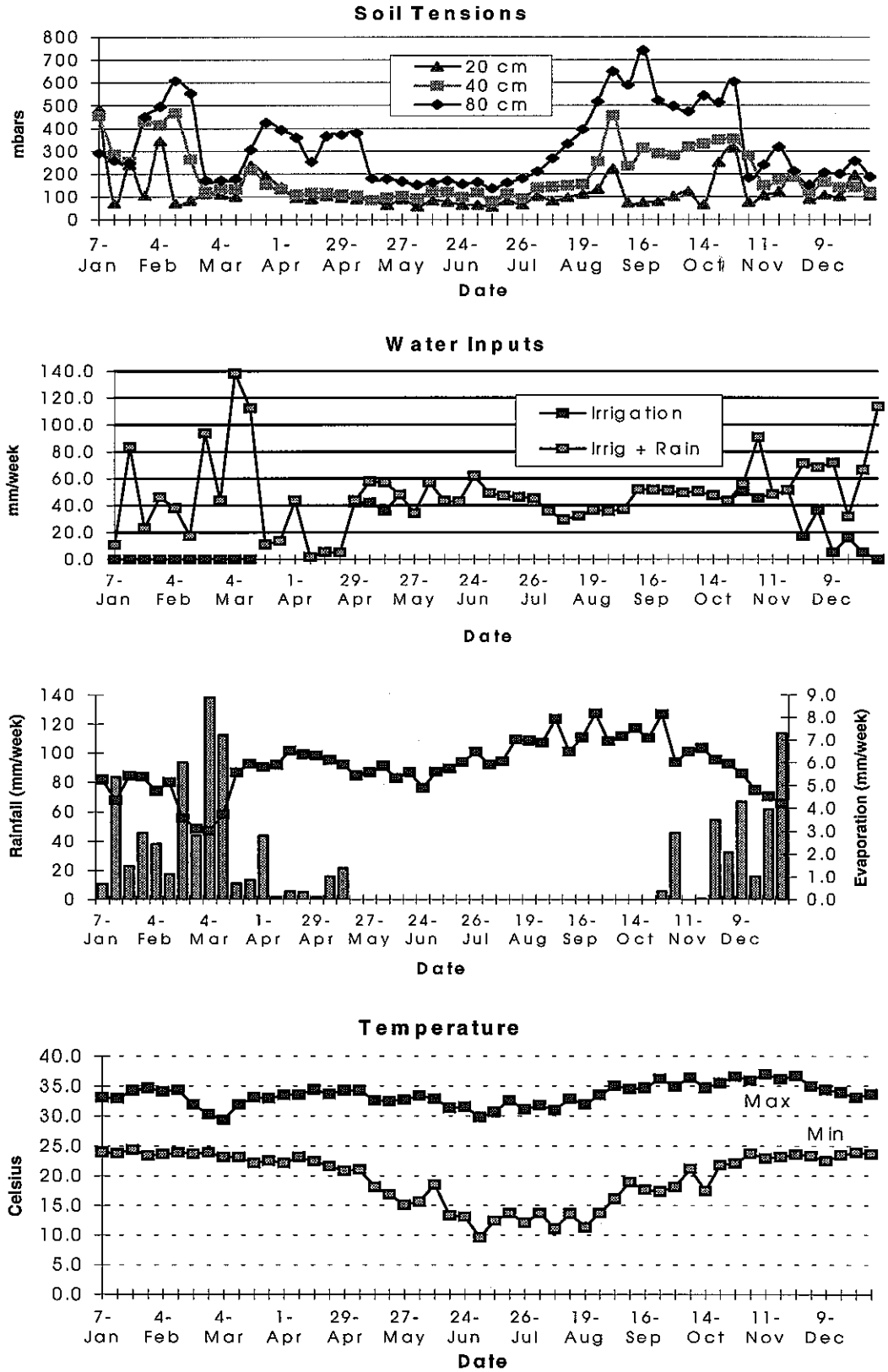



**Figure 8: Weekly soil tensions, water inputs, rainfall, evaporation and maximum and minimum temperatures for the banana irrigation monitoring site.**

# DEVELOPING FRUITS PROGRAM

## Introduction of Exotic Fruit Germplasm

T.K.Lim, L.Luders, V.Kulkarni, G.Ramsay

Since 1992-1995, germplasm of more than 100 species and varieties of new exotic fruit trees have been introduced from Asia, the Americas (mainly via Florida) and from north Queensland. A major portion came from East and West Malaysia. The fruit materials were introduced in the form of grafted seedlings, seedlings, seed and as budwood, which were subsequently grafted onto rootstocks in the plant quarantine screenhouse. Cultivars of durian registered the highest casualty rate. Also, large quantities of durian and mangosteen seeds were brought back for use as rootstock materials. Many of the introduced plants have been planted out and the surviving durian cultivars will be planted out towards the end of 1995. All these plants were brought in for field evaluation, to serve as genepool material for breeding and selection purposes, and for trials as rootstock materials, for existing and potential commercial fruits. Table 25 below lists the plants introduced under the various families.

**Table 25. List of introduced fruit species and varieties**

| Scientific Name | Common Name/Variety | Origin/Source |
|---|---|---|
| **Anacardiaceae** | | |
| *Anacardium occidentale* | Cashew (seeds) | Brazil |
| *Bouea macrophylla* | Maprang, Marian Plum | Sarawak |
| *Mangifera foetida* | Bachang, Horse Mango | Sarawak |
| *Mangifera griffithii* | Asam Raba, Raba | Sarawak |
| *Mangifera indica* | Mango cv. Chok Anan | Sarawak ex Thailand |
| | cv. Badani Model | India |
| | cv. Himayat Pasand | India |
| | cv. Kesar | India |
| | cv. Mahmuda Karabad | India |
| | cv. Manyeera | India |
| | cv. Navaneetam | India |
| | cv. Red Mulga | India |
| | cv. Royal Special | India |
| | cv. Suvernarekha | India |
| | cv. Vanaraj | India |
| *Mangifera laurina* | Depih | Sarawak |
| *Mangifera odorata* | Kuini | Sarawak |
| *Mangifera pajang* | Mawang | Sarawak |
| *Mangifera quadrifida* | Asam Kumbang | Sarawak |
| *Mangifera similis (M. torquenda)* | Lamatan | Sarawak |
| **Annonaceae** | | |
| *Annona muricata* | Yellow soursop | Kalimantan? |
| *Annona purpurea* | Soncoya (purple) | Queensland ex C. America |
| | Soncoya (yellow) | Queensland ex C. America |
| **Apocynaceae** | | |
| *Willughbeia* sp. | Buah Kubal | Sarawak |
| Bombacaceae | | |
| *Durio dulcis* | Tutong | Sarawak |
| *Durio graveolens* | Durian Umot, Durian Burung | Sarawak |
| *Durio kutejensis* | Durian Kuning | Sarawak |
| *Durio oxyleyanus* | Isu | Sarawak |
| *Durio testudinarum* | Durian kura-kura | Sarawak |
| *Durio zibethinus* | Durian cv. D2 | Malaysia |
| | cv. D10 | Malaysia |
| | cv. D24 | Malaysia |
| | cv. D96 | Malaysia |
| | cv. D98 | Malaysia |
| | cv. D99 | Malaysia |
| | cv. D123 | Malaysia |

| Scientific Name | Common Name/Variety | Origin/Source |
|---|---|---|
| | cv. Hew 1 | Malaysia |
| | cv. MD 79 | Malaysia |
| | cv. Monthong | Malaysia ex Thailand |
| | cv. Gaan yaow | Malaysia ex Thailand |
| | cv. Chompoosri | Queensland ex Thailand |
| | cv. Gaan Yaow | Queensland ex Thailand |
| | cv. Gob Yaow | Queensland ex Thailand |
| | cv. Hew 3 | Queensland ex Malaysia |
| | cv. KK 8 | Queensland ex Malaysia |
| | cv. Limberlost | Cairns ex Malaysia? |
| | cv. Luang | Queensland ex Thailand |
| | cv. Monthong | Queensland ex Thailand |
| | cv. Parung | Queensland ex Indonesia |
| | cv. Pomoho Monthong | Q. ex Hawaii ex Thailand |
| | cv. Sunan | Queensland ex Indonesia |
| *Matisia cordata* | Matisia | Queensland ex S. America |
| **Bromeliaceae** | | |
| *Ananas comosus* | Pineapple cv. Nenas Sarawak | Sarawak |
| | cv. Tainung | Malaysia ex Taiwan |
| Burseraceae | | |
| *Canarium odontophyllum* | Dabai | Sarawak |
| *Canarium ovatum* | Pili nut | PNG |
| *Dacryodes rostrata* | Kembayau, Keramoh | Sarawak |
| Caricaceae | | |
| *Carica papaya* | Paw-paw, Papaya cv. Eksotika | Malaysia |
| | cv. Subang | Malaysia |
| | cv. Paris | Malaysia |
| | cv. Sunrise Solo | Malaysia ex Hawaii |
| | Local Sarawak varieties | Sarawak |
| **Cactaceae** | | |
| *Cereus peruvianus* | | Florida ex C. America |
| *Hylocereus undatus* | Red Pitahaya (Dragon fruit) | Florida, Qsld ex C. America |
| *Selenicereus megalanthus* | Yellow Pitahaya | Queensland ex Colombia |
| Euphorbiaceae | | |
| *Baccaurea griffithii* | Tampoi Hutan | Sarawak |
| *Baccaurea lanceolata* | Empaong | Sarawak |
| *Baccaurea motleyana* | Rambai | Sarawak |
| *Baccaurea parvifolia* | Uchong, Bilimbing Hutan | Sarawak |
| *Baccaurea reticulata* | Tampoi | Sarawak |
| Flacourtiaceae | | |
| *Flacourtia rukam* | Rukam | Sarawak |
| *Pangium edule* | Kepayang | Sarawak |
| Gnetaceae | | |
| *Gnetum gnemon* | Meninjau | Sarawak |
| Guttiferae | | |
| *Garcinia artroviridis* | Assam Gelugor | Malaysia |
| *Garcinia dulcis* | Yellow Mangosteen | Malaysia |
| *Garcinia hombroniana* | Sea-shore Mangosteen | Malaysia |
| *Garcinia livingstonei* | Imbe | Florida ex C. America |
| *Garcinia parvifolia* | Kundong | Sarawak |
| *Garcinia prianiana* | Cerapu | Malaysia |
| *Mamea america* | Mamey Apple | Queensland ex S. America |
| *Rheedia madruno* | Madruno | Florida, Q. ex S. America |
| **Lauraceae** | | |
| *Litsea garciae* | Engkala putih (white) | Sarawak |
| | Engkala merah (red) | Sarawak |

| Scientific Name | Common Name/Variety | Origin/Source |
|---|---|---|
| **Lecythidaceae** | | |
| *Bertholettia excelsa* | Brazil Nut | Malaysia ex Brazil |
| **Leguminosae** | | |
| *Cynometra cauliflora* | Nam-nam | Sarawak |
| *Dialium maingayi* | Velvet Tamarind, Keranji | Sarawak |
| *Inga* sp. | Ice Cream Bean | Queensland ex S. America |
| *Pithecellobium lobatum* | Jiring | Sarawak |
| *Tamarindus indica* | Tamarind cv. Thai Sweet | Thailand |
| | cv. Jae Home | Queeensland ex Thailand |
| | cv. Muen Chong | Queensland ex Thailand |
| | cv. Niad Yad | Queensland ex Thailand |
| | cv. Red | Queensland ex Thailand |
| | cv. Sri Chompoo | Queensland ex Thailand |
| | cv. Sri Tong | Queensland ex Thailand |
| **Malpighiaceae** | | |
| *Malpighia glabra* | Acerola, Barbados Cherry | Queensland ex S. America |
| **Meliaceae** | | |
| *Lansium domesticum* | Langsat | Malaysia |
| | Langsat | Sarawak |
| | Longkong | Malaysia ex Thailand |
| | Duku Muar | Malaysia |
| | Duku Trengganu | Malaysia |
| *Sandoricum koetjape* | Sentul | Queensland ex Malaysia |
| **Moraceae** | | |
| *Artocarpus anisophyllus* | Entawa | Sarawak |
| *Artocarpus heterophyllus* | Jackfruit | Thailand |
| | Jackfruit cv. Isi Merah | Malaysia |
| | cv. NS 1 | Malaysia |
| *Artocarpus kemando* | Pudu, Pudua | Sarawak |
| *Artocarpus odoratissimus* | Terap, Marang | Sarawak |
| *Artocarpus rigidus* | Pala Munsoh | Sarawak |
| *Artocarpus sarawakensis* | Pingan | Sarawak |
| *Artocarpus sericicarpus* | Pedalai | Sarawak |
| **Myristicaceae** | | |
| *Myristica fragans* | Nutmeg | PNG, Sarawak |
| **Myrtaceae** | | |
| *Eugenia brasiliensis* | Grumichama | Queensland ex Brazil |
| *Eugenia uniflora* | Surinam Cherry | WA ex S. America |
| *Psidium guajava* | Guava cv. Crystal seedless | Malaysia |
| | cv. India seedless | India |
| | cv. Safed Jam | India |
| *Syzygium samarangense* | Water Apple green | Malaysia ex Thailand |
| | Water Apple maroon | Malaysia ex Thailand |
| **Olacaceae** | | |
| *Scorodocarpus borneensis* | Bawang Hutan | Sarawak |
| **Oxalidaceae** | | |
| *Averrhoa bilimbi* | Bilimbing Wuluh | Queensland ex Malaysia |
| *Averrhoa carambola* | Carambola cv. B 2 | Malaysia |
| | cv. B 10 | Malaysia |
| | cv. B 17 (Honey) | Malaysia |
| **Palmae** | | |
| *Areca catechu* | Betelnut | Sarawak |
| *Salacca zalacca* | Salak cv. Gula | Sarawak |
| | cv. Nangka | Sarawak |
| | cv. Bali | Indonesia |

| Scientific Name | Common Name/Variety | Origin/Source |
|---|---|---|
| **Passifloraceae** | | |
| *Passiflora edulis* f.sp. *edulis* | Passion fruit cv. Florida Red | Florida |
| | cv. Ruby Red | Queensland |
| | cv. Tinaroo | Queensland |
| **Piperaceae** | | |
| *Piper nigrum* | Pepper cv. Kuching | Sarawak |
| **Polygaceae** | | |
| *Xanthophyllum amoenum* | Langgir | Sarawak |
| **Punicaceae** | | |
| *Punica granatum* | Pomegranate cv. Ganesh | India |
| **Rutaceae** | | |
| *Limonia acidissima* | Woodapple | Malaysia |
| *Merrilia caloxylon* | Malay Lemon | Malaysia |
| **Sapindaceae** | | |
| *Dimocarpus longan* ssp. *longan* var. *longan* | Longan | Vietnam |
| *Dimocarpus longan* ssp. *malesianus* var. *malesianus* | Sau, Isau | Sarawak |
| *Dimocarpus longan* ssp. *malesianus* var. *malesianus* | Mata kuching cv. Seliong anak Ju | Malaysia, Sarawak |
| *Lepisanthes alata* | Engkili | Sarawak |
| *Nephelium maingayi* | Serait cv. mujau | Sarawak |
| *Nephelium rambutan-ake* | Pulasan | Sarawak |
| *Nephelium* sp. | Wild rambutan Kebuau | Sarawak |
| *Nephelium* sp. | Wild rambutan Mak | Sarawak |
| *Nephelium* sp. | Wild rambutan Nelayan | Sarawak |
| *Nephelium* sp. | Wild rambutan Sibau | Sarawak |
| *Nephelium* sp. | Wild rambutan Maong | Sarawak |
| *Pometia pinnata* | Dawa, Taun, Fijian Longan | PNG |
| **Sapotaceae** | | |
| *Manilkara hexandra* | | India |
| *Pouteria caimito* | Abiu cv. Alba Gold | Queensland ex S. America |
| *Pouteria caimito* | Abiu cv. Z 4 | Queensland ex S. America |
| *Pouteria campechiana* | Canistel | Qeensland ex S. America |
| *Pouteria obovata* | Lucmo | Queensland ex S. America |
| *Pouteria sapota* | Mamey sapote | Florida, Qsld. ex S. America |
| *Synsepalum dulcificum* | Miracle Fruit | West Africa |
| **Sterculiaceae** | | |
| *Sterculia monosperma* | Peanut tree | Queensland ex Thailand |
| *Theobroma cacao* | Cocoa | PNG |
| *Theobroma grandiflorum* | Cupuassu | Brazil |
| **Tiliaceae** | | |
| *Grewia asiatica subequinalis* | Phalsa | India |

## Rambutan Research 1994

TK Lim, L Luders

Two small scale field trials were carried out on rambutan, to determine: a) the effect of premature fruit abortion on yield in a grower's orchard at Colton Park, and b) the effect of a domestic bee pheromone on fruit set and yield at CPRS.

In the first trial , weed mats covering the canopy area were placed under 4 trees just before flower anthesis. Flower and fruit drop on the mats were monitored weekly, and floral biomass dropout was collected, categorised, weighed and counted from September to November. These 4 trees were not given any fertiliser from July to December, ie. during fruit development stages. The yields of these 4 non-fertilised trees with mats, were then compared with trees without the

mats and which received about 1 kg of a chloride free NPK fertiliser 11:8:12 split twice in August and October. The results indicated that fruit abortion was very heavy during the first 3 weeks after anthesis and petered off as the season advanced (Fig.9). Trees with more prolific flowering had more fruit drop but higher yields (Fig 10.). No fertiliser application during fruit development was detrimental - reducing yield by half (38 kg/tree), compared with fertilised trees with average yield of 58 kg/tree (Fig 11). A bigger randomised complete block design in factorial arrangement of this trial is being repeated this coming fruiting season at Colton Park. Similar trends were observed at CPRS where trees which received no fertilisers during flowering and fruit development in 1993 had markedly reduced yields compared to 1992 and 1994 when they were fertilised (Fig 12).

In the second trial, rambutan trees were sprayed with Beekeeper®, a domestic bee pheromone with specially formulated bee attractant, some with water from late July to September and some trees were not sprayed. Due to the protracted flowering of rambutan, ie flowering occurs in flushes, each tree received 8-9 sprays of Beekeeper® at the recommended rate of 5 ml/L, using a medium spray volume. The results indicated no added advantage of spraying with the bee pheromone as there were no significant differences among non-sprayed trees, water sprayed trees and pheromone sprayed trees. In fact, yield was depressed by the bee pheromone (Fig.13)

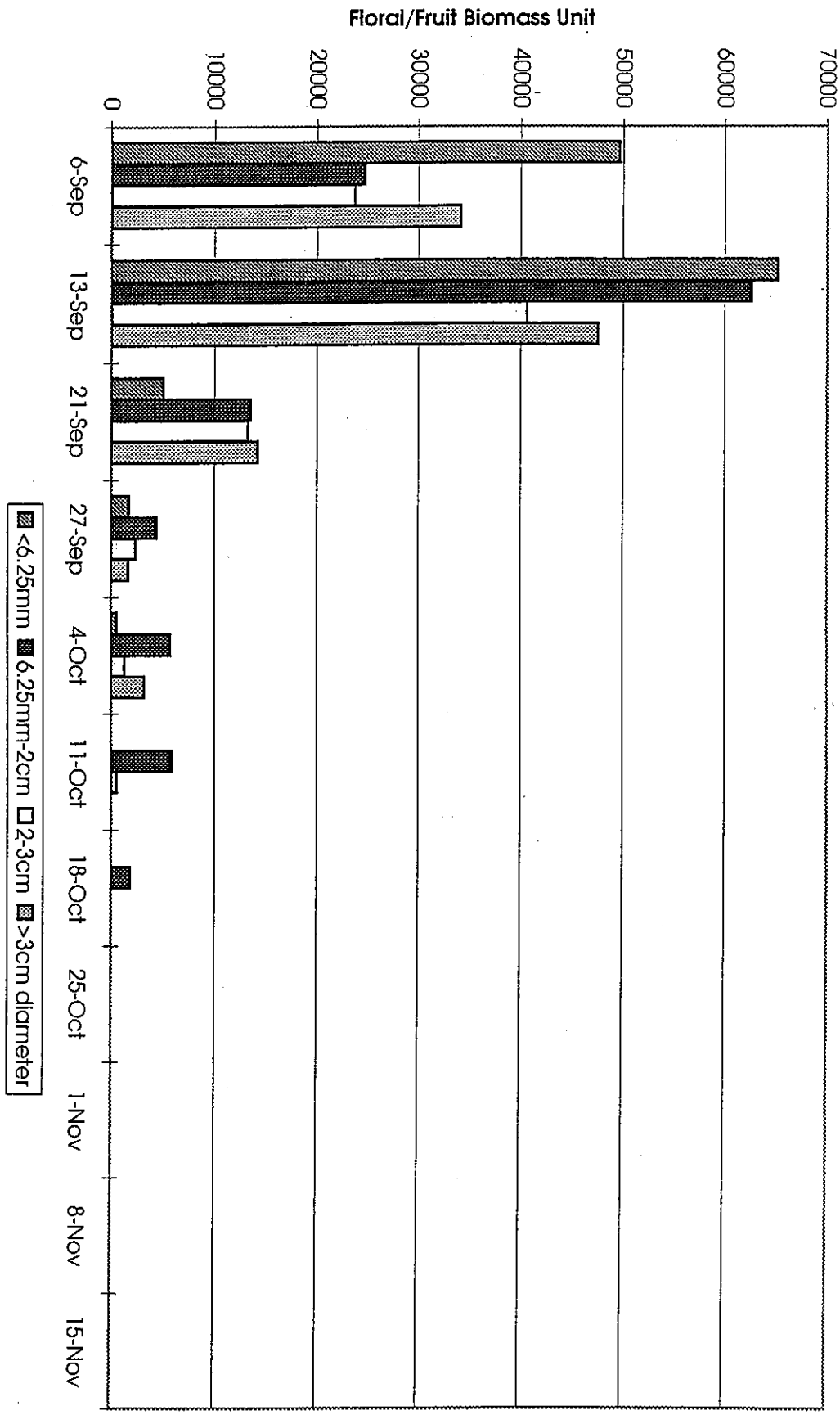



**Fig. 9 Rambutan Floral/Fruit Drop after Flower Anthesis**

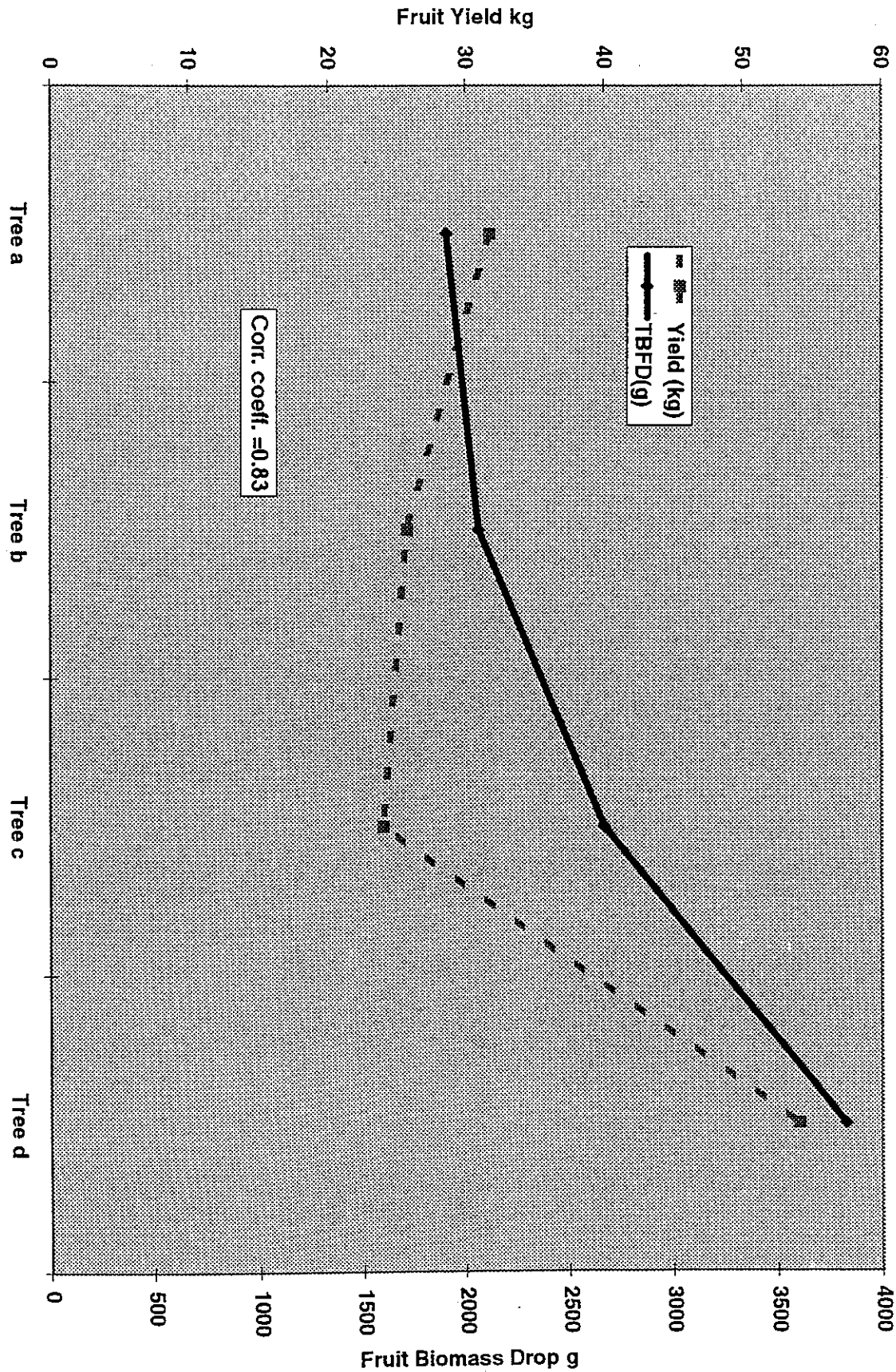



Fig. 10 Rambutan Fruit Yield and Fruit Drop

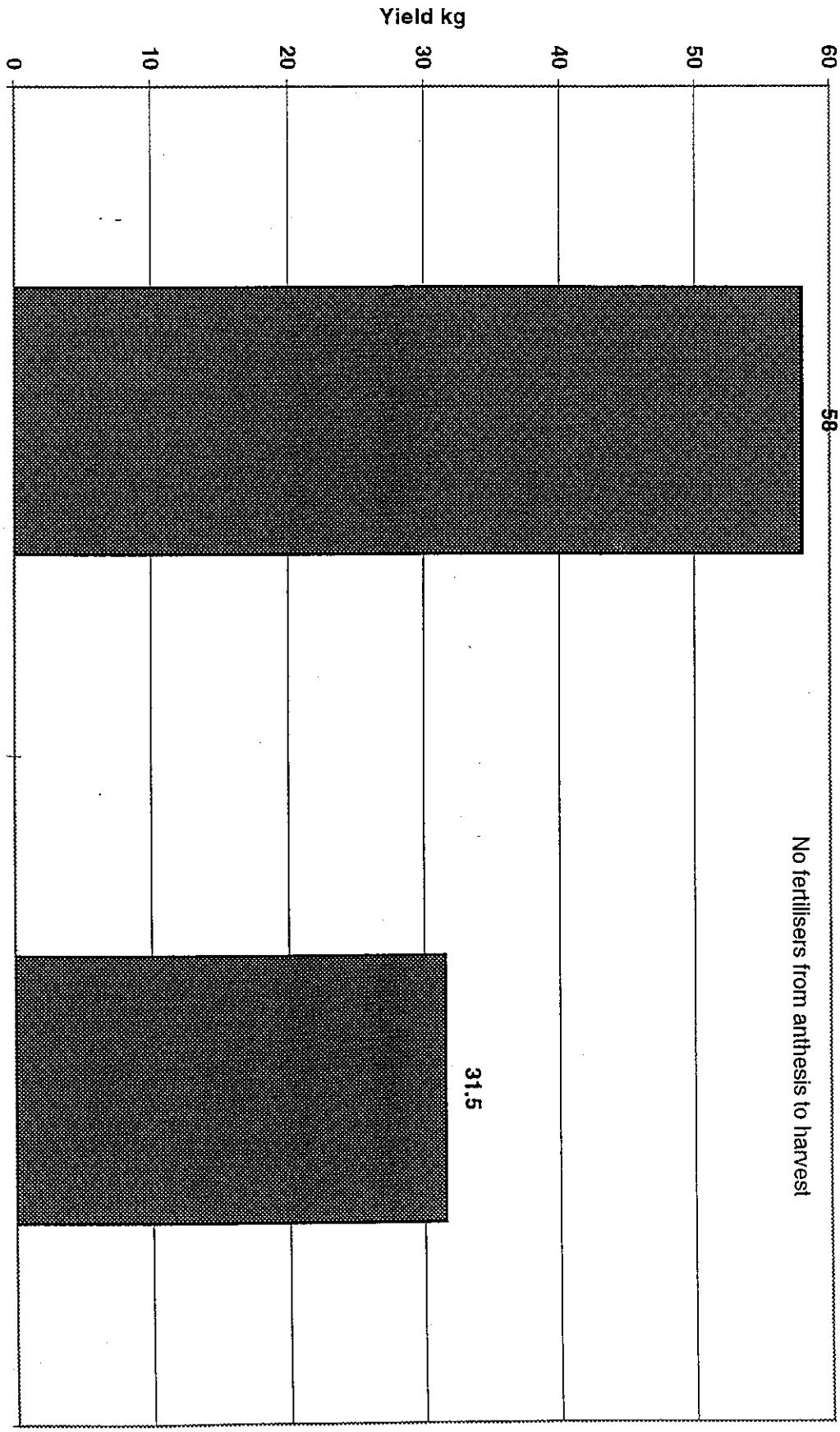



Fig. 11 Comparative Yields of Fertilised and Non-fertilised Rambutan

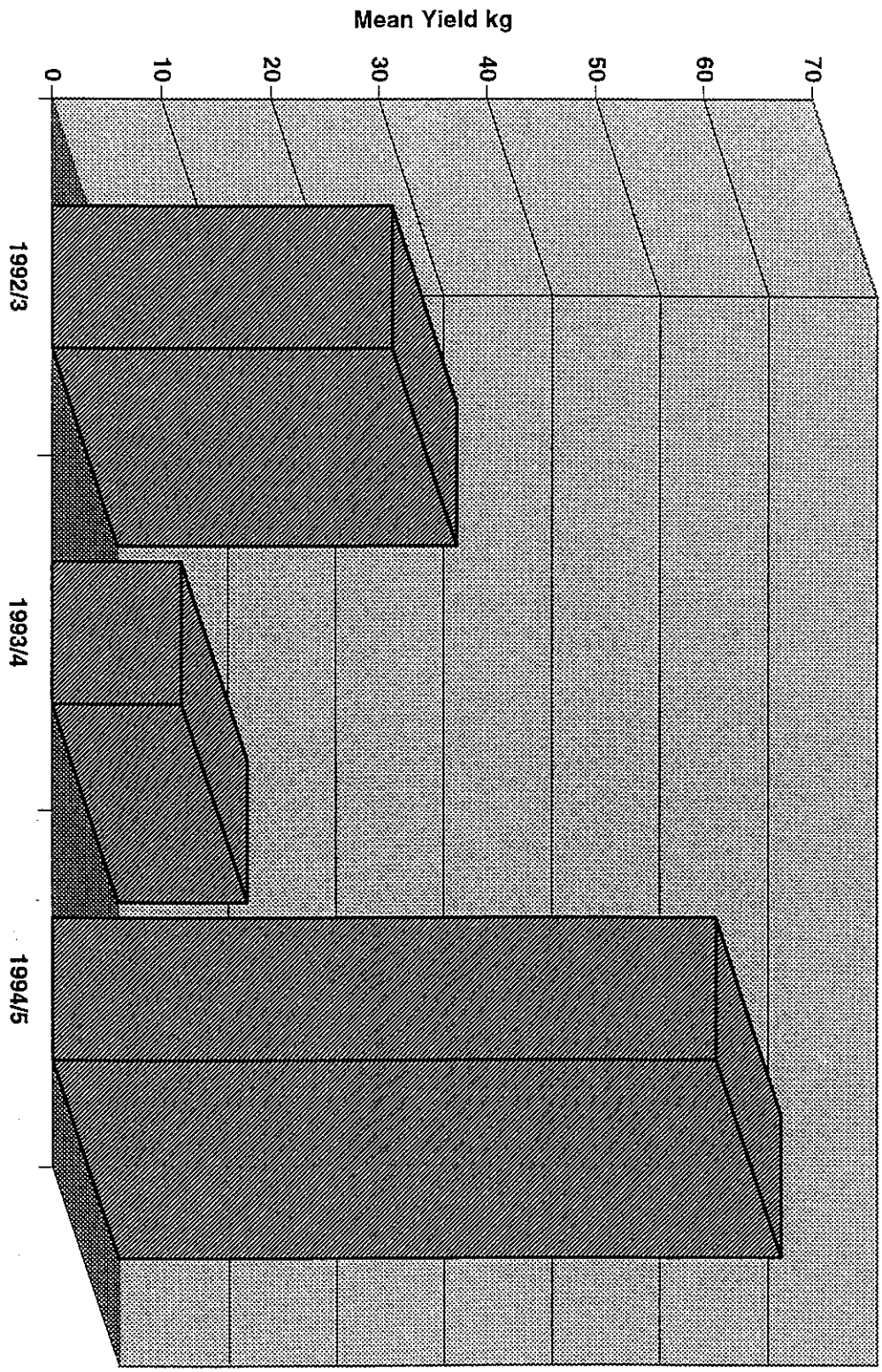



Fig. 12 Mean Yield of Selected Rambutan Clones CPRS 1992-1994/5

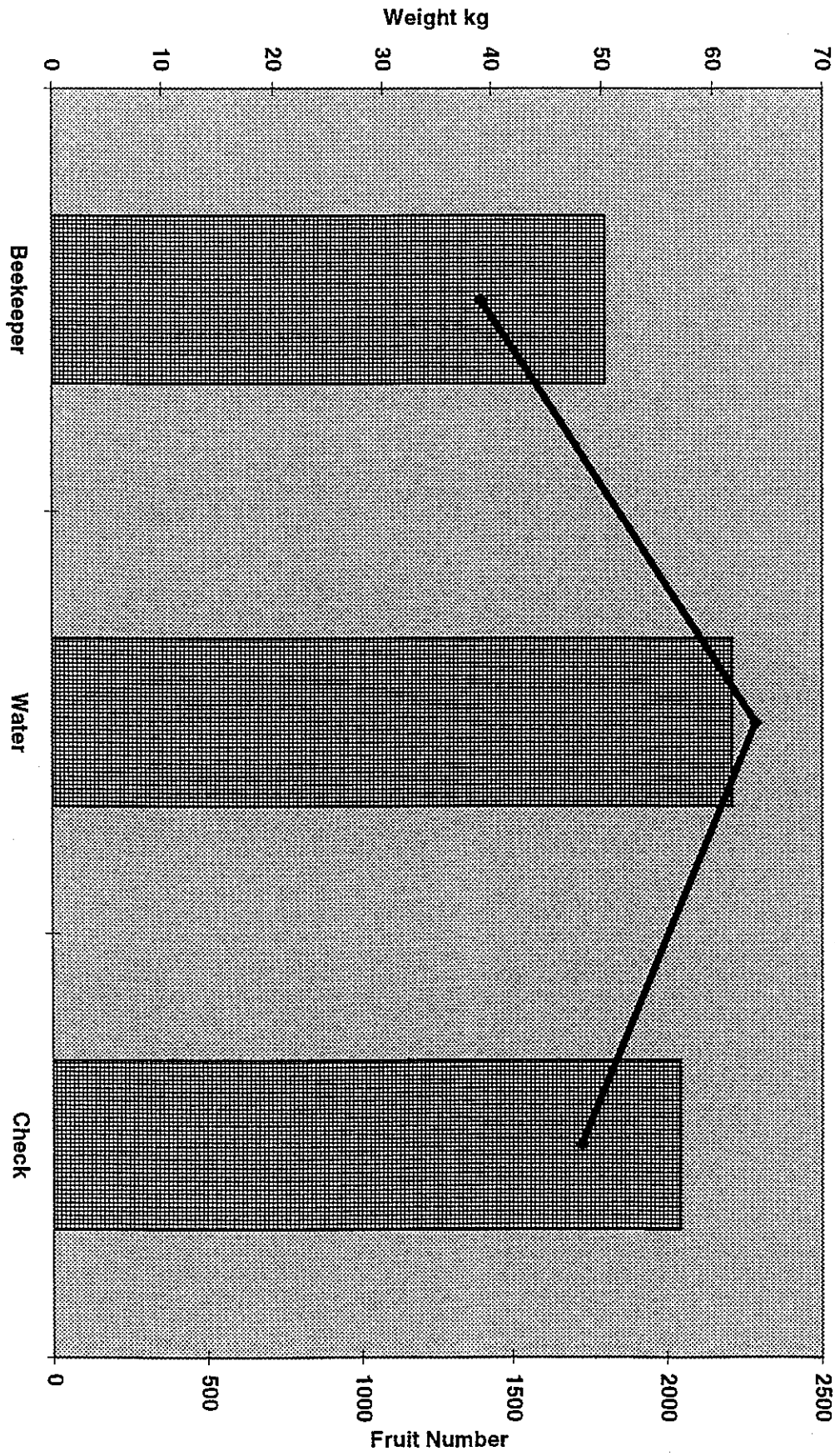



Fig.13 Effect of Beekeeper on Rambutan Yield

## Rambutan Photosynthesis and Irrigation

Y.Diczbalis, C.Wicks, G. McMahon

Irrigation management is crucial to the production of high yielding and high quality fruit.

Work conducted by DPIF has shown that rambutans are sensitive to water stress. This is due to the shallowness of their root system, with 80 % of the root system in the top 15 cm, as well as the inability of the plant to avoid or tolerate water stress.

An experiment was conducted during the early dry season of 1994 to test the photosynthesis response of mature (10 year old) trees to low soil water. This work was carried out to check previous work which had been undertaken on plants grown in large pots (200L). Photosynthesis is the term used to describe the process by which plants produce carbohydrates from sunlight, water and nutrients. If photosynthesis is low the plant's ability to grow and fill fruit is reduced.

Data from the trial (Figure 14) showed that within four days of no irrigation, photosynthesis was significantly lower than that which occurred in continuously irrigated trees. By day six photosynthesis was half of that in irrigated trees. At day nine, the last day of the experiment, the non irrigated tree was beginning to show signs of early wilt. Soil moisture was recorded during the experiment using a capacitance probe (EnviroScan®). The data shows that most of the available soil moisture was taken up in the top 20 cm of the soil profile with little extraction of moisture occurring in the deeper profiles.

In summary the experiment confirmed previous work carried out on plants grown in large pots and the shallow rooted nature of the trees. Soil moisture needs to be retained at a high level in the surface horizons for the plant to grow efficiently.

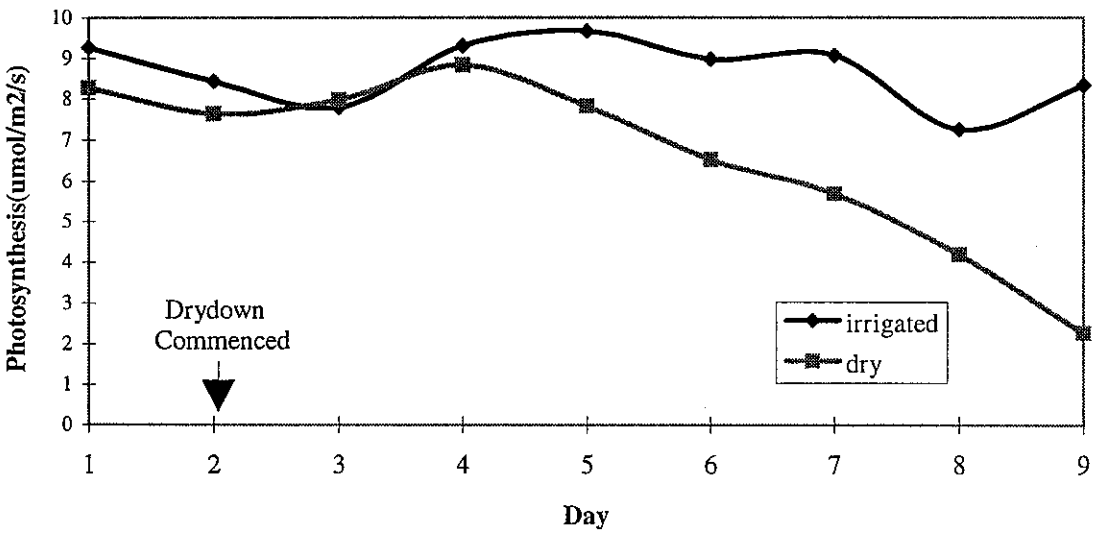



**Figure 14: Leaf photosynthesis rates of irrigated and non irrigated rambutan trees.**

## Rambutan Pre-flowering Water Stress

Y.Diczbalis, C.Wicks, G.McMahon

Rambutans are still a relatively new crop in the top-end of the NT. Most producing trees are less than six years of age and irrigation management has been ad-hoc and based on maintaining soil moisture through out the year. The growth patterns of the rambutan in the top-end suggest that low night temperatures in June and July are conducive to flowering in July to September. This results in fruit being ready for harvest from November to December, which have been low price periods,due to competition with other fruits available on the market at that time of the year. Market information (Landrigan pers com.1994) suggests that October and late January are more favourable harvest periods in terms of price.

Trials have been conducted on a commercial property over the last two years to assess the effect of pre-flowering irrigation management on time and synchrony of flowering in rambutan. Treatments in the 1st year, consisted of four levels of water inputs ranging from 122 % to 50 % evaporation replacement for an eight week period from late April to the commencement of first flower development (early July). Plants were irrigated daily except for the 89 % replacement second daily irrigation

treatment. Each treatment was imposed on eight plants. Plant growth and soil moisture were monitored twice weekly during this time. On the commencement of flowering all plants were watered at a high rate through to harvest.

Plants receiving the least water during the pre-flowering period exhibited less vegetative growth prior to flowering and reached peak flowering approximately three weeks earlier than plants under the higher irrigation regimes. This difference in flowering was maintained at the peak harvest stage with the low and high irrigated plants reaching peak harvest on the 23 November and 18 December respectively. Total yield per tree was not affected by treatments with the average yield being approximately 30 kg per tree. Harvesting duration was less for the two low irrigation treatments suggesting that the treatments improved fruit synchrony. Soil moisture tensions, during the pre flowering period, in the lowest irrigation treatment at 20, 40 and 80 cm reached 88, 85 and 48 kPa respectively with no signs of physical stress to the tree. In the second year's work, only high and low irrigation inputs were used over a four week period from early April. Soil tensions at 20, 40 and 80 cm, in the low irrigation treatment, reached 65, 80 and 50 kPa respectively. There was no effect of moisture stress on earliness of flowering or harvest. This was attributed to the early start of low minimum temperatures which overrode the effect of water stress.

The results indicate that low water inputs pre-flowering can induce earlier flowering relative to wet treatments. Wet conditions may also be used to delay flowering, however, low temperatures early in the dry season will override the water stress treatments. More work needs to be done to confirm the outcome of the trials and to study the effects of water stress timing, intensity and duration on flower induction.

We would like to acknowledge the contribution of Mr. Roy Gubb to the trial. Without his willingness to make trees available for the work and his contribution to the collection of the yield data the trial would not have been possible. We thank RIRDC (Rural Industries Research and Development Corporation) and the DPIF for funding the trial.

## Rambutan Postharvest Research 1994/95 Season

M.Landrigan

1994/95 was a good year to be a rambutan grower, with good returns from a reasonably high yielding crop. However, with demand for high quality, and the rambutans unique ability to deteriorate rapidly after harvest, refinement of the postharvest handling chain is still required.

Rambutans go brown and shrivel because they begin to lose water immediately after harvest. Emphasis has been placed on postharvest handling procedures which primarily prevent or reduce this water loss.

The use of hydrocooling was considered. The use of cold water is an old and effective method used for quickly cooling a wide range of fruit and vegetables. Hydrocooling avoids water loss and may even add water to the commodity. With the red cultivar R4, no difference was found between quality and appearance of fruit that were hydrocooled or cooled in air in a high humidity coolroom, after storage at 10°C for 10 days. This begs the question, so why use hydrocooling if you have a high humidity coolroom?

Following on from results from last season, some promising waxes were applied to 3 red cultivars and stored under high and low humidity at 10 and 22°C. Waxes are applied to fruits for 2 purposes. First, to reduce the rate of water loss from the fruit, and second, to improve appearance to the consumer. All 3 cultivars performed similarly and the beneficial effect of the wax was only apparent at high temperature and low humidity (the equivalent of a supermarket display shelf).

This year an alternative box liner was tested and compared with those commonly used. This was a strong clear plastic bag with a predetermined breathing rate that is currently being used by the lychee industry. Fruit were of similar quality when stored in this bag, compared to the others.

Finally a hot water dip treatment was examined, since rambutan is considered a fruit fly host and treatment may be required for future worldwide export. A range of dipping temperatures and times were examined, but rambutan appeared to be highly susceptible to hot water damage, especially in combination with cold storage, that is essential to maintain quality.

Many questions about appropriate long term rambutan storage still remain unsolved. Next season, promotion work may be undertaken, depending on support from the industry, along with collecting data for a maturity index.

## Mangosteen Research Report 1994

T.K.Lim, L.Luders, M.Poffley

Crop phenological and nutrient monitoring studies of mangosteen since 1992 have revealed some interesting trends. Significant differences were observed in the macronutrient status of mangosteen grown under or among banana trees as shade and those not grown under banana shade.

Mangosteen trees grown in banana shade in Berry Springs (Jabiru Orchards) and in the northern suburbs of Darwin (NTU Horticulture Block) exhibited the following trends:

Nitrogen declined sharply during the Dry season from May/July, phosphorus declined from July/August and calcium and potassium from May/August to the end of the year. There was a slight increase in the magnesium level during the early Dry season and then a slight decline after September and October. Magnesium stayed more or less level, except in September in Berry Springs when it increased sharply, probably as a result of dolomite application during the previous months. Harvesting occurred in late December/January in 1993 and 1994.

Mangosteen trees grown in Lambells Lagoon near some big trees exhibited somewhat different nutrient trends. Nitrogen declined later in September 1992 and in July 1993 and 1994. Calcium and sulphur declined slowly during the early Dry season and then more sharply as the season progressed. Potassium increased gradually to a high in November/December, before decreasing. Potassium also increased from July to December, but the trend was reversed in 1994 - Potassium declined from July to November, most probably because of poor uptake of potassium, as well as other macronutrients during the prolonged cool and dry in 1994. Harvesting usually starts in late October and extends to late December. However, in 1994, because of the prolonged cool during flowering and fruit development, yield (size and fruit number) were reduced.

Insofar as the means of the nutrient levels for the years 1992-1994 (Table 26), mangosteen grown in banana shade had significantly higher potassium and calcium, and slightly higher nitrogen, but lower levels of phosphorus, calcium and sulphur than those not grown under banana shade. This could be attributed to the high rates and frequent applications of fertilisers particularly potassium and nitrogen in banana. Additionally, the monitoring results show that banana competes very fiercely with mangosteen for nutrients during the Dry season. The results also point out that mangosteen grown among bananas are protected from drastic changes of prevailing weather, especially cool nights and mornings during the prolonged cool in 1994, and were not as affected as mangosteen grown more or less in open situations.

**Table 26. Means of Macronutrient Levels in Mangosteen Leaves 1992-1994**

| Locality | N | P | K | Ca | Mg | S | Cl |
|---|---|---|---|---|---|---|---|
| **Lambells Lagoon** | 1.11 | 0.08 | 0.64 | 1.40 | 0.24 | 0.34 | 0.31 |
| **Berry Springs** | 1.14 | 0.05 | 0.94 | 1.01 | 0.27 | 0.28 | 0.47 |
| **Darwin** | 1.15 | 0.07 | 0.84 | 1.37 | 0.20 | 0.33 | 0.54 |

The implications here are that mangosteen grown under banana shade requires a different fertilisation program in terms of rates and schedules; what is optimum for bananas might not be so for mangosteen.

## Boosting of Durian Productivity

T.K.Lim, L.Luders, G.Ramsay

This project is partially funded by RIRDC as project DNT No. 13A and operated from July, 1993 to July 1996.

The objectives of the research are:

a) to increase productivity by introducing more adaptable, high yielding new durian clones and species.
b) to improve our understanding of the reproductive and vegetative phenology of durian with regard to pollination, so as to devise a practical means of assisting pollination.
c) to improve fruit yield by leaf, flower and fruit pollination and proper fertilisation based on regular soil and leaf nutrient monitoring, and
d) to reduce the juvenile period, using precocious rootstock-scion combinations and propagation techniques.

**Introduction of Durio Species and Durian clones, Germination and Seedling Establishment:** Among the *Durio* species brought back from Sarawak in January 1994, the following had established well from seeds: *Durio kutejensis* (durian kuning), *Durio graveolens, and Durio oxleyanus.* One batch of the seedlings planted out in the germplasm block at BARC is progressing well. Another batch will be planted out at CPRS.

The following durian (*Durio zibethinus*) cultivars established well in the post-entry quarantine screenhouse (D24, D96, D99, D123, and MD 79) and were released in late December, 1994. Two more Thai cultivars, viz. Monthong ex Malaysia and Gaan Yaow ex Malaysia were released from the Post Entry Quarantine Screenhouse in May 1995. Budwood of a dozen clones were brought back from Queensland in May and budded. The clones include Limberlost, Monthong ex Thailand, Gob Yaow, Gaan Yaow, Hew 3, Pomoho Monthong, Luang, Chompoosri, Parung, Sunan and KK 8.

Because of the mislabelling and misidentification of durian clones in the N.T. and Queensland, preliminary polygonal analysis studies of clonal durian morphometric leaf characteristics have just been initiated. These studies include leaf samples of over 40 durian clones in the NT and north Queensland.

**Crop Phenology, Flower Biology, Pollination, and Cultural Practices:** There were 3 pronounced flushes of growth, as measured by the new vegetative flush and terminal shoot extension from May 1993 to May 1994 (9 September to 6 October; 3 December to end December, and a longer period of 24 February to late April). From May to October 1994, the abnormal weather markedly affected the vegetative and flowering phenology of durian. In fact, several cold nights below 15°C in the second week of March caused 1 tree at BARC to flower at the end of April and produced several fruits which matured in late August, the earliest ever in the Top End.

In 1994, there were close to 4 months (May to September) of prolonged cool weather - cold night and early mornings of <15°C with some night temperatures in June and August going lower than 10°C, especially in the Lambells Lagoon area. This induced abundant floral protuberances on the branches with virtually no vegetative extension growth in June-July. Many flowers which developed and opened in July and August, failed to set fruit because of the cold and dry weather which affected flower formation, flower anthesis, pollination activities and perhaps growth of the pollen tube. Some fruits which were formed also aborted. This phenomenon was particularly rife in the Lambells Lagoon area. Consequently, there was profuse flower abortion and also many buds failed to open. In addition, there was severe, premature leaf defoliation, especially on the cultivar D 24. Owing to the severe leaf defoliation, many of the flower bud protuberances turned into vegetative leaves on the branches to compensate for the extreme leaf loss, thus producing vegetative flushes in mid August and mid September. The main flowering phase was delayed by the cold weather from the end of August until the end of September but flowering continued until the end of November. Vegetative flushing also occurred in December.

At BARC, fruits produced in 1994 were harvested (dropped when fully mature and ripe) in mid October, mid November and throughout December, while in the Lambells Lagoon area and Humpty Doo orchards very few durian fruits were obtained in January/February 1995.

Vegetative flushes occurred from January to May 1995. Floral protuberances and some clusters of flower buds were observed on trees at BARC and in Humpty Doo and Lambell's Lagoon durian orchards in late May and June 1995. This probably resulted from a few consecutive cool nights < 18°C in the last week of April. Generally the night temperatures in May and June are higher than previous years, excepting 2 consecutive nights of < 18°C in late April and 2 incidences of 3 nights <16°C from 21-23 May and 5 nights of <18°C in late May. From the amount of protuberances produced, a massive flowering is expected, which may lead to good fruit numbers if the cool, Dry season this year is not as cold and protracted as the previous year.

**Nutrient monitoring:** Based on mean nutrient levels and the modified DRIS indices obtained from bimonthly foliar and soil monitoring, interesting trends were observed on the fluctuations of the leaf nutrient levels since 1992 in one orchard and since 1993 in another orchard. Potassium and nitrogen were found to be the most significant nutrients influencing yield and growth over the years, although in 1994 calcium was found to be limiting. Generally, potassium tends to decline from July to September, which can be explained by mobilisation of potassium from leaves to the developing fruits (August to November). However, in 1994, potassium levels peaked in September and remained high in the 2 orchards. 1994 is a peculiar year as there was a prolonged cool season which extended from May to September and this affected fruit set and development, resulting in meagre to negligible fruit set. Thus there was no demand of potassium from the leaves. Similar trends were observed for nitrogen, decline in July - September; but in 1994, the nitrogen level plateaued at a high level because of the lack of demand, due to the very poor fruit set and development.

Another interesting trend was that of sulphur and the nitrogen:sulphur ratio. Sulphur is an important component of the sulphurous compound responsible for the odour of durian flowers and fruits. The levels of sulphur were found to slide during May- July (flower initials and flowering). In 1993, sulphur declined further in September during fruit set and development. However in 1994, there was a sharp rise in the sulphur level in the leaves in September. This is again

understandable, as fruit set and development was extremely low and there was no demand for sulphur. Sulphur levels range from 0.14-0.22% in durian leaves. Generally, the nitrogen:sulphur ratio decreases as the tree gets older. The nitrogen:sulphur ratio fluctuates, depending on the phenological development of the tree, it usually peaks in July and declines to lower levels after July, September and November due to mobilisation of both elements from leaves to flowers and fruits.

**Pollination and pollen germination:** Assisted self and cross pollination with various clones carried out in July and August resulted in very poor fruit set, especially in the Lambells Lagoon area because of the prolonged cold and dry weather which affected flower and fruit development. Pollination studies carried out from the end of August to mid October resulted in better fruit set. As was observed in earlier crossings, crossed-pollinated fruits were more well-formed and produced 6-10 viable seeds; in contrast selfed fruits produced misshapened fruits with nil to 1-2 small seeds. Also the flesh recovery ratio was very much lower in selfed fruits.

Generally, mature durian pollen grains are large, round and tricolpate, ranging from 13.8- 15.7 by 14-16 um. Fresh pollen grains were more viable, as indicated by cotton-blue lactophenol stain and germinated better than pollens stored for several days. Nectar liquid from opened durian flowers were collected in the morning and sent away for analyses. Results revealed the flower nectar to contain sugars:- sucrose 6.4%, fructose 5.4 % and glucose 3.4%. Preliminary pollen germination studies revealed that the pollens germinated better in 10% sucrose solution than in 5% or 25% solution and the agar plate method was better than the slide cavity solution technique. The studies also showed that pollen germination ranged from 50% to over 90% and that pollens from a dwarf seedling fared better than pollens from cv. Luang or Gumpun. Most pollen showed tricolpate germination, with germ tube lengths ranging from 60- 120 um.

**Reduction of Juvenile Period:** Stakes and irrigation lines had been established in the field for the trial and *Gliricidia* and *Inga* (ice-cream bean) shade trees had been planted out. In addition a bana grass windbreak was planted out around the Durian Block.
The abnormally prolonged cool weather in 1994 also caused some grafted seedlings to dieback as such new grafts on double and single rootstock were prepared in December. Planting of these seedlings in the Wet season in January - April 1995 was thwarted by the wettest Wet season on record, which made field operations unsuitable for planting.

## Evaluation of Miscellaneous Exotic Fruits - Katherine

S.McAllister, M.W.Smith, M.D.Hoult

This project seeks to identify adapted fruit tree species and cultivars, for which distinct market niches are present. The following species are under investigation: avocado, figs, atemoya, passionfruit, lychee, pomegranate, guava, carambola, sapodilla, *Artocarpus* sp., caimito and other Annonaceae and Sapindaceae species. The project has a very simple philosophy : identify species where market opportunities exist; identify suitable cultivars of these species, suited to the Katherine region; screen these cultivars for their ability to produce economic yields during the specific market niches and assess methods such as de-foliation and moisture stress, to manipulate harvest periods, so as to coincide with specific market niches. This project attempts to develop a broader base to the fruit tree industry in the region, in an attempt to bring greater diversity for horticultural producers. Much of the impetus for this project comes from an increasing availability of new genetic material. For example, several commercial avocado cultivars, better adapted to tropical climates were introduced by CSIRO. Some of these cultivars appear promising at Kununurra (P. Johnston, *pers. comm.*), which has a similar climate to Katherine. A number of these cultivars have been propagated for planting at KRS, so as to find whether any will be adapted to the region and have a very early harvest season (vis. January to early March).

Some of the more" tropical" cultivars are currently growing at BARC and carried fruit in the 1994/1995 season. A taste evaluation of these was undertaken using the popular, late season cultivar 'Reed' as a standard. 'Hall' and 'Booth' were preferred over 'Reed'.

**Table 27. Taste evaluation of several avocado cultivars ex BARC, 1995**

| Cultivar | Taste rating [1] | Most liked | Most disliked |
|---|---|---|---|
| Hall | 3.6 | 57 % | 0 % |
| Booth | 3.0 | 0 % | 14 % |
| Reed [2] | 2.9 | 14 % | 29 % |
| McMillan | 2.6 | 14 % | 14 % |
| AV 107 | 2.2 | 14 % | 43 % |

[1] - average rating assessed by 7 assessors rating taste as 6 = excellent to 1= very poor .
[2] - purchased from local supermarket.

## Comparison of Imported Tissue Cultured and Offshoot Date Palms

G.Kenna, K.Young, N.Isgro, S.Freeman, C.Ellis

Importation of offshoots from California has proved to be expensive and has met with mixed results. An alternative is the importation of plantlets produced from tissue culture laboratories in England and France.

There are doubts as to whether tissue culture palms grow and produce fruit true to type to the parent palm. The experiment consists of 6 cultivars (Medjool, Thoory, Deglet Noor, Barhee, Zahidi and Khadrawy), both tissue cultured and offshoots, and was established in 1989 to assess palm growth, yield and fruit quality and to assess whether there is a risk in using tissue cultured palms for commercial date production.

The objective of the project is to assess the performance of internationally recognised date cultivars under Central Australian conditions, with regard to potential for commercial development, including the comparison of the performance of tissue cultured palms from England and France with offshoots of the same cultivars from California.

The total number of palms in this evaluation is 34. Twenty-one palms flowered in 1994 and 20 palms carried a crop through to harvest in 1995. Palms from all cultivars in the evaluation cropped in the 1994/95 season, with 12 of the palms being offshoots, 7 tissue culture from England and 1 tissue culture from France.

Flowering results and total yield for each palm and the source of the planting material are listed in Tables 28 and 29.

There were no outstanding differences in growth habit or fruit quality between the various planting materials.

**Table 28. Flowering Comparison - Tissue Culture versus Offshoots.**

| Variety | Type and Origin of Planting Material | Total Palm Number | Number of Palms Flowered in 1994 | Percent of Total number Flowered in 1994 |
|---|---|---|---|---|
| Deglet Noor | Offshoot<br>TC England | 2<br>4 | 2<br>4 | 100%<br>100% |
| Barhee | Offshoot<br>TC England | 2<br>4 | 2<br>2 | 100%<br>50% |
| Medjool | Offshoot<br>TC England<br>TC France | 2<br>2<br>2 | 2<br>1<br>1 | 100%<br>50%<br>50% |
| Thoory | Offshoot<br>TC England<br>TC France | 2<br>2<br>2 | 2<br>1<br>0 | 100%<br>50%<br>0% |
| Zahidi | Offshoot<br>TC England<br>TC France | 2<br>2<br>2 | 2<br>0<br>0 | 100%<br>0%<br>0% |
| Khadrawy | Offshoots<br>TC France | 2<br>2 | 2<br>0 | 100%<br>0% |

**Table 29. Yield Comparison - Tissue Culture versus Offshoots.**

| Variety | Type and Origin of Planting Material | No of Palms Cropped in 1994/1995 | Total Yield (kg) | Weight of Culls (kg) | Average Yield/Palm (kg) |
|---|---|---|---|---|---|
| Deglet Noor | Offshoot<br>TC England | 2<br>3 | 58.49<br>56.86 | 58.00<br>56.86 | 29.25<br>18.95 |
| Barhee | Offshoot<br>TC England | 2<br>2 | 45.38<br>23.94 | 21.36<br>12.67 | 22.69<br>11.97 |
| Medjool | Offshoot<br>TC England<br>TC France | 2<br>1<br>1 | 61.52<br>9.27<br>13.89 | 7.64<br>1.05<br>1.81 | 30.76<br>9.27<br>13.89 |
| Thoory | Offshoot<br>TC England | 2<br>1 | 31.62<br>13.33 | 25.03<br>6.30 | 15.81<br>13.33 |
| Zahidi | Offshoot | 2 | 28.38 | 20.31 | 14.19 |
| Khadrawy | Offshoot | 2 | 7.78 | 1.79 | 3.89 |
| **Totals** | | **20** | **350.46** | **212.82** | |

## Germplasm Collection at Arid Zone Research Institute

G.Kenna, K.Young, N. Isgro, S.Freeman, C.Ellis

There are 19 female and 4 male selections of *Phoenix dactylifera* included in the germplasm collection at AZR. Additional varieties with potential for commercial production in this region are planted, as material is sourced and introduced from overseas.

The objective of this project is to assess the performance of internationally recognised date cultivars under Central Australian conditions, with regard to potential for commercial development.

The total number of palms in this evaluation is 49. Of the 19 female and 4 male selections, the total number of female palms is 30 and total number of male palms is 19.

A total number of 23 palms flowered in 1994 and of this number, 5 were male (Fard No.4, Jarius No.1, Boyer) and 18 were female (Deglet Noor, Thoory, Barhee, Dayri, Khalasa, Bou Skri, Halawi, Zahidi, Bou Feggous, Hayany). Only 1 female palm, which flowered in 1994, did not carry a crop.

Flowering results and fruit yield and quality results are listed in Tables 30 and 31.

**Table 30. Date Cultivar Observation - Cultivars and Flowers.**

| Variety | Type and Origin of Planting Material | Total Palm Number | Number of Palms Flowered in 1994 | Percent of Total number Flowered in 1994 |
|---|---|---|---|---|
| Fard No. 4 | Offshoot | 17 | 3 | 18% |
| Jarius No.1 | TC England | 1 | 1 | 100% |
| Boyer | TC England | 1 | 1 | 100% |
| Dayri | Offshoot | 2 | 2 | 100% |
| Khalasa | Offshoot | 2 | 2 | 100% |
| Halawi | Offshoot<br>TC England | 3<br>2 | 3<br>1 | 100%<br>50% |
| Hayany | TC England | 5 | 2 | 40% |
| Bou Skri | TC France | 3 | 3 | 100% |
| Zahidi | Offshoot | 1 | 1 | 100% |
| Bou Feggous | TC France | 3 | 1 | 33% |
| Thoory | Offshoot | 1 | 1 | 100% |
| Deglet Noor | Offshoot | 1 | 1 | 100% |
| Barhee | Offshoot | 1 | 1 | 100% |

**Table 31. Date Cultivar Observation - Cultivars and Yields.**

| Variety | Type and Origin of Planting Material | Number of Palms Cropped in 1994/1995 | Total Yield (kg) | Culls (kg) | Average Yield/Palm (kg) |
|---|---|---|---|---|---|
| Khalasa | Offshoot | 2 | 11.72 | 3.11 | 5.86 |
| Halawi | Offshoot<br>TC England | 3<br>1 | 36.56<br>4.94 | 16.49<br>0.29 | 12.19<br>4.94 |
| Bou Feggous | TC France | 1 | 13.61 | 5.03 | 13.61 |
| Bou Skri | TC France | 2 | 21.06 | 7.34 | 10.53 |
| Zahidi | Offshoot | 1 | 2.76 | 1.17 | 2.76 |
| Deglet Noor | Offshoot | 1 | 26.94 | 26.94 | 26.94 |
| Thoory | Offshoot | 1 | 3.06 | 1.38 | 3.06 |
| Dayri | Offshoot | 2 | 15.48 | 12.56 | 7.74 |
| Barhee | Offshoot | 1 | 5.10 | 4.82 | 5.10 |
| Hayany | TC England | 2 | 10.55 | 1.50 | 5.28 |
| **Totals** | | **17** | **151.78** | **80.63** | **98.01** |

## Parlatoria Scale Eradication

G.Kenna, K.Young, N.Isgro, S.Freeman, C.Ellis, D.Kennedy, T.Micklem, R.Mills, M.Reid

Parlatoria scale is a pest of date palms in the Alice Springs area. The insect threatens the future viability of the industry, as it causes palms to be unthrifty and downgrades or renders date fruit unmarketable. It was introduced into the area on infested material approximately 40 years ago. It is established in a commercial planting of palms at Mecca Date Gardens and Arid Gold Farm and in plantings at AZRI There are large numbers of infested palms in the Alice Springs town area, with infested palms spread throughout the region. In most instances, these palms have been brought as infested plant material from the town area.

A serious attempt to eradicate the scale from these commercial plantings was begun in April 1991. The program involves;

1. Foliar application of insecticides at 3 weekly intervals, where the size of the plant enables efficient application.
2. Trunk injections of monocrotophos at 3 and 6 weekly intervals.
3. Combination of foliar application and trunk injections of insecticides.
4. Removal of dead and unthrifty leaves.
5. Removal of excess offshoots to increase the effectiveness of insecticide applications.
6. Leaf samples taken at regular intervals to assess the effectiveness of the program, by counting the number of dead and live scale, including immature insects.

The effectiveness of the program in eradicating scale from palm plantings is related to the size of the palm and the degree of scale infestation.

The number of live scale on palms at AZRI continues to decline. Only a few of these palms have detectable scale at present and a process of burning the foliage of these palms is being considered as a means of eradicating the pest from these palms. The scale is almost eradicated from the Dahlenburg research block . Only 1 palm has been detected with low scale numbers in the past 10 months.

Scale numbers on a planting of seedling palms which have been regularly trunk injected and received foliar sprays are also low. Larger seedling palms, which can only be trunk injected with insecticide, are having scale numbers reduced. Numbers of scale, however, are reducing at a slower rate using this treatment.

Assistance from DPIF is available to commercial growers, in the form of the issue of insecticide for the eradication of the pest.

## Evaluation of a Range of Bunch Covers to Reduce Rain Damage in Dates

G.Kenna, K.Young, N.Isgro, S.Freeman, C.Ellis.

Rain on date fruit, as it nears maturity, can cause considerable damage. The skin of the fruit can split or check and in some instances, rots may also develop. This can cause fruit quality to be downgraded and may render it unmarketable.

A number of materials have been used to manufacture bags to cover date fruit. These bags are applied over the bunches as the fruit nears maturity. Materials used include shadecloth, banana bags, disposable overall material (Tyvek), muslin, weedmat and nylon.

During the fruit maturation period of the 1994/1995 season, an above average amount of rain fell at AZRI. In January - 195mm, in February - 8 mm, in March - 26mm, in April - 1mm and in May - 46.75mm. In total, throughout the 6 month fruit maturation period, 282.5 mm of rain fell, which is well above the yearly average of 250 mm for the Alice Springs area. All rain falling during the above months caused minor to severe damage to the crop, which was in various stages of development and maturity.

Not all data had been collated and assessed, however observations can be made on the effectiveness of various materials used as date bunch covers, during periods of high rainfall at the time of fruit maturation.

Covers made of shadecloth and nylon appear to be the most effective for this purpose, as they allow air circulation in and around the bunches. Although they will only keep light rain off the fruit, good air circulation is more important in the prevention of mould growth following rain.

Covers made of plastic (banana bags and weedmat) appear the most ineffective for this purpose, due to condensation build-up and lack of air circulation in and around the bunches, leading to excessive mould growth and fruit rots. It should also be noted that, on these relatively young palms, the fruit bunches hang quite close to the ground and the problem of condensation build-up and lack of air circulation cannot be totally contributed to plastic bunch covers. The more permeable covers, which allow better air circulation in and around the bunches, appear more appropriate at the present time.

## Date Cultivar Evaluation

G.Kenna, K.Young, N. Isgro, S. Freeman, C.Ellis.

To assess the performance of 4 internationally recognised date cultivars under Central Australian conditions, with regard to their potential commercial production, Barhee, Deglet Noor, Medjool and Thoory were planted in a random block design at the AZRI in September 1989. The trial consists of 1 datum palm per plot, with 4 varieties in 16 replications. The block is bordered by a total of 44 palms (consisting of 18 Barhee, 14 Deglet Noor, 10 Thoory and 2 Zahidi).

During the 1994 season, 59 palms from a total of 64 in this evaluation flowered (92%) and 56 of the 59 which flowered, actually carried a crop through to the 1995 harvest.

Flowering and harvest results are listed in Tables 32 and 33.

**Table 32. Flower Comparison - Date Cultivar Evaluation**

| Variety | Type and Origin of Planting Material | Total Palm Number | Number of Palms Flowered in 1994 | Percent of Total number Flowered in 1994 |
|---|---|---|---|---|
| Deglet Noor | TC England | 16 | 15 | 94% |
| Barhee | TC England | 16 | 15 | 94% |
| Thoory | TC England | 16 | 15 | 94% |
| Medjool | TC England | 16 | 14 | 88% |

**Table 33. Date Cultivar Evaluation - Cultivars and Yields**

| **Variety** | **Type and Origin of Planting Material** | **Number of Palms Cropped in 1994/1995** | **Total Yield (kg)** | **Culls (kg)** | **Average Yield/Palm (kg)** |
|---|---|---|---|---|---|
| Barhee | TC England | 16 | 264 | 152 | 16.5 |
| Medjool | TC England | 12 | 100 | 176 | 8.33 |
| Thoory | TC England | 14 | 224 | 222 | 16 |
| Deglet Noor | TC England | 13 | 142 | 117 | 10.9 |

## Citrus Cultivar and Rootstock Evaluation in a Tropical Environment

M.D.Hoult, S.McAllister

Maturity time for fruit grown around Katherine is very early, compared to fruit produced in southern Australian production areas. Quality of certain citrus types, notably grapefruit, is excellent. Major pests of citrus fruits, the fruit piercing moths (FPM) and citrus leafminer (CLM) are at their peak during the wet season (ie December to April). This period is also the time of fruit maturation for many citrus types. Consequently, FPM could be of major importance with respect to the commercial cultivation of the crop. Certain citrus types are less prone to attack than others, such as grapefruit comparative to mandarin types. Management strategies for CLM are currently being developed. Warm temperatures at Katherine inhibit

full, natural rind colour development and consequently, effective post-harvest "de-greening" techniques, using ethylene gas and/or cold temperature storage, will need to be developed for the various citrus cultivars. Preliminary investigations using current de-greening technology suggest that this will be achievable.

Currently the bulk of Australian grapefruit production occurs in southern states. Several citrus authorities concede that climatically, these areas have insufficient heat for the production of high quality grapefruit. The more tropical climate of northern Australia results in grapefruit of low acidity, reduced levels of bitter components, high sugar and excellent colour development. Internationally, "super-red" grapefruit cultivars are increasing in importance. Many of these new, red cultivars have recently been introduced into Australia and have been included in a HRDC funded national evaluation. Katherine is one of the major sites for this evaluation and this trial was planted in May 1995. There is virtually no Australian production of mandarin/tangor types for the months of January, February and March. Early maturing cultivars at Katherine, could be harvested in February and March. Whilst this very early maturity of the Katherine district is encouraging, some aspects of mandarin/tangor phenology need addressing, notably the erratic and poor flowering of several cultivars. Cultivar screening is underway at Katherine. The impact of imports on this current domestic market niche needs to be monitored in the future. Australian lemon production has a shortfall in supply for the months of January to March. Investigation into cropping patterns and manipulation of harvest period (ie: "Verdellii" or "moisture stress" induced flowering) for lemons is proceeding. Five cultivars are currently being screened for their suitability for summer production in the Katherine region.

Over the past 3 years, a number of cultivars of the different citrus types, with potential for commercial production have been introduced and established at KRS. As all trees are less than 3 years old, no fruiting has occurred to date. The exceptions were : 'Henderson' red grapefruit - very small number of fruit produced exhibited superior internal colour and external blush, comparative to locally grown 'Ruby' grapefruit; 'Marisol' clementine mandarin - colour break early February, bland flavour; 'Turner Murcott' tangor - very poor fruit, no juice.

Reduced CLM levels have been achieved on >3 year old grapefruit trees by managing vegetative flushing with the strategic use of nitrogen. Nitrogen application was restricted to one, split application in late June (to coincide with bud-break) and then early August (to coincide with flowering). This application was to encourage a single, mixed vegetative and floral flush. Enhanced productivity may also result from reducing unnecessary vegetative flushing during the "Wet" season.

## Cashew Germplasm Assessment

G.S.Foord, M.W.Smith, J.D.Bright

The objective is to identify superior genetic selections, producing a high yield of good quality nuts. Two germplasm collections at separate locations are under assessment.

The first is a collection of hybrids planted at King Producers' Venn block, 20 kilometres south of Katherine. In excess of 800 trees, of which there are about 350 different cashew hybrids, were planted in November 1992. Many of these trees have displayed good vigour and the potential for high yields. King Producers are very keen to develop a commercial cashew operation on their property. However "...for the project to be commercially attractive, i.e., the IRR to be higher than 10% in real terms, a cashew yield of more than 4 t/ha nut-in-shell and a c.i.f. price of over US$1.00/kg are required," (Oliver, Ngo and Kuppelweiser, 1992). Therefore, yields in excess of 20 kg per tree nut-in-shell are required.
As yet, no yield results are available, although a few management problems have occurred and are being addressed. This planting presents an opportunity to observe and address potential problems that may have significant impact in the Katherine region. The most pressing problem is the control of *Mastotermes darwiniensis*. Over 25% of trees have been lost, mostly due to attacks from this insect. Katherine staff and the Joint Termite Group in Darwin are working on a management strategy to control *Mastotermes darwiniensis* in cashew orchards. Management of other insect pests is also a concern. Chemical control of Mango Tip Borer (MTB) proved impractical before flowering. This pest may have been of benefit, by encouraging the development of auxillary growth capable of producing flowers. The management of MTB by delaying the use of chemical control until early in May will be investigated in future years.

The second genetic source to be trialed at Katherine is material selected from 800 Brazilian seedlings at CPRS. In addition to the extensive data collection carried out by Darwin staff in 1992/93, a visual assessment was performed by Katherine staff in February 1995. The number and size of nuts under each tree were visually assessed to identify trees that yielded well in 1994. Although this assessment method has limitations, 3 of the trees identified were also selected from 1992/93 data. This shows a degree of consistency from those trees, (Table 34).

**Table 34. Visual assessment of Brazilian cashew seedlings, CPRS, 1995**

| Row | Tree | Comments |
|---|---|---|
| 4 | 59 | largest nut size |
| 4 | 66 | highest yield, large nut size |
| 5 | 11 | high yield, small nut size |
| 5 | 18 | high yield, large nut size |
| 5 | 31 | high yield, good nut size |
| 5 | 40 | high yield, good nut size |
| 6 | 36 | high yield, good nut size |
| 7 | 45 | large nut size |
| 8 | 44 | high yield, large nut size |

Darwin cashew research staff are providing selected material for further assessment at Wildman River, Cashew Australia (Queensland), King Producers (Katherine), KRS and CPRS. Field planting will occur at the Katherine sites in 1995/96. Identification of superior lines will be established after data collection from 3 consecutive harvests, including data from 5 year old trees (when the trees are well established).

Oliver, M., Ngo, H., and Kuppelweiser, W. (1992). Cashew Production in the Northern Territory Top End, An Economic Evaluation. NT DPI&F, Technical Bulletin No. 198.

## Cashew Seedling Selection

V.J.Kulkarni, D.Hamilton

One of the most important prerequisites for establishing a successful cashew industry for the Top End is evolving the high yielding genotypes with the optimum nut and kernel size. One way of achieving promising cultivars is by selection from a heterozygous gene pool. With this objective, 800 seedling progeny from 25 parent lines were planted at CPRS in 1990. These were evaluated and screened, following a protocol of observations on vegetative, floral, nut characteristics and yield potential. Trees with high shoot density, profuse flowering and nut set and high yields were selected, whereas those with undesirable features were eliminated in successive evaluations. By 1994, 14 selections were made, of which 5 were considered as more promising. For further evaluation, it was decided to test the 14 selections in variuus growing conditions in Queensland and the NT. They were propagated and material was raised for planting at Cashew Australia (Dimbulah Queensland),Wildman River Plantations NT, Ian Curtis' Venn Block Katherine, KRS and CPRS.

These selections are listed below in Table 35.

**Table 35. Cultivars screened**

| Tree number | Parentage |
|---|---|
| CPRS 5/9 | A 2 |
| CPRS 5/11 | A 2 |
| CPRS 5/13 | A 2 |
| CPRS 5/18 | A 2 |
| CPRS 5/19 | A 2 |
| CPRS 5/21 | A 2 |
| CPRS 5/22 | A 2 |
| CPRS 5/23 | A 2 |
| CPRS 5/24 | A 2 |
| CPRS 5/30 | A 2 |
| CPRS 5/40 | A 2 |
| CPRS 3/28 | A 1 A2 |
| CPRS 4/59 | AC 20 |
| CPRS 4/66 | AC 20 |

It was interesting that most of the selections came from a single parentage i.e., A 2. Most trees from this line had ideal tree canopy, very dense shoot canopy and good yields. The performance of grafted trees of these selections will be assessed at the above sites.

## Amdro® for Field Control of Mastotermes.

G.S.Foord, M.W.Smith

The objective was to establish the suitability of AMDRO® (a.i. 7.3g/kg hydramethylnon) as a control measure in the management of *Mastotermes darwiniensis* in orchard situations.

*M.darwiniensis* are a major pest of tree crops in the NT where "...losses to mastotermes can be as high as 25-30% in the first year." (Miller 1994). Cashew hybrid selections planted at King Producers' Venn block (south of Katherine) have suffered heavy losses due to *M.darwiniensis*. The trees are to be assessed for future commercial planting and some genetic material has already been lost. Hydramethylnon was very effective in the control of the bigheaded ant, *Pheidole megacephala* on Protea in Hawaii (Hara and Hata 1991) and "...is used in the control of agricultural and household ants..." (Worthing 1987). The hydramethylnon formulation AMDRO® was "...effective in killing the termites over a five day period" in laboratory trials at Darwin (Chin and Smith 1994) . A quantity of AMDRO® was supplied by Cyanamid Australia for field testing on *M.darwiniensis* at Katherine, commencing in 1994.

On 29 February 1995, a total of 26 x 18 litre ration tins with holes cut in the bottom and filled with moist corrugated cardboard, were installed throughout the orchard. These were buried to a depth of 250mm where *M.darwiniensis* were, or had recently been active. Tins were monitored regularly and all new tree losses due to *M.darwiniensis* (row and site numbers) were recorded.

Six active tins were treated with 100g of AMDRO® on 22 March 1995. The AMDRO® became 'mouldy', the termites abandoned those tins and did not return during the monitoring period (Figure 15).

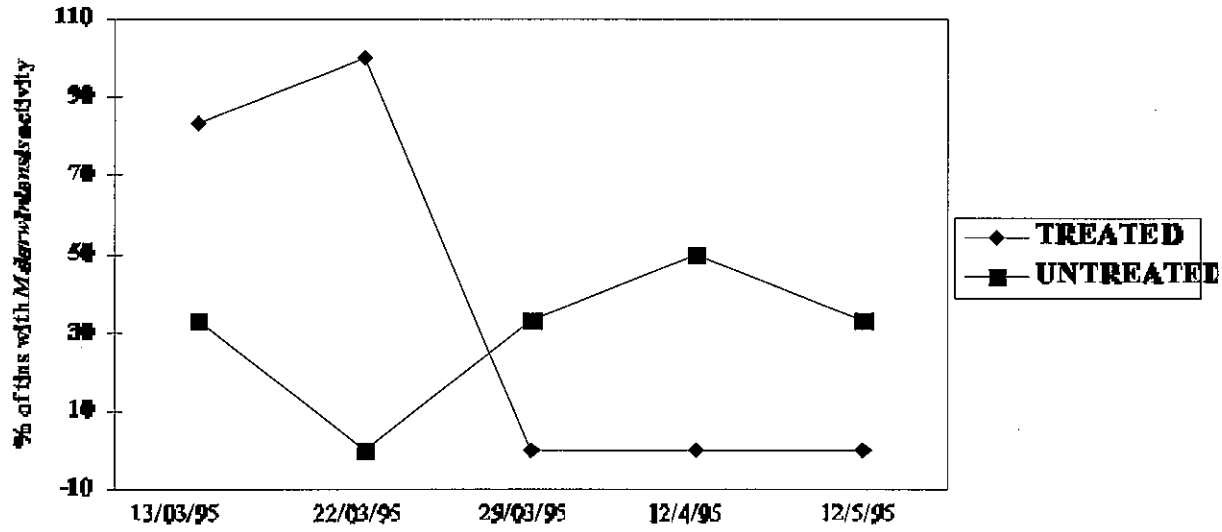



**Figure 15. Change in *M. darwiniensis* activity in aggregating tins following Amdro® treatment on 22 March 1995**

The formulation AMDRO® was not suitable for baiting *M.darwiniensis* in the field, using the moist cardboard aggregation technique, as it is susceptible to fungal infection and appears repellent to *M.darwiniensis* in that state. Further testing, using alternative field techniques or alternative hydramethylnon formulations may be warranted.

Chin, D., and Smith, E.S.C. (1994). Alternative toxicants for Mastotermes darwiniensis. *In* NT Primary Industry and Fisheries Technical Annual Report 1993-1994. Technical Bulletin No. 224.

Hara, A.H., and Hara, T.Y. (1992). Ant control on protea in Hawaii. *Scientia Horticulturae* 51:155-163.
Miller, L. (1994). Mastotermes in cashew. Seventh annual cashew research and development workshop. May 1994. pg. 87.

Worthing, C. R. (1987). The Pesticide Manual, 8th edition. The British Crop Protection Council. pg. 464.

## Bamboo Research 1994

K.J.Blackburn, M.M.Traynor

The bamboo research project is partially funded by RIRDC and is an Australian joint research investigation combining inputs from:

- The University of Central Queensland, Rockhampton (Principal Organisation).
- Bamboo Australia, Belli Park, Eumundi, Queensland (Commercial grower).
- Queensland DPI, Bundaberg Research Station.
- NT DPIF, Coastal Plains Research Station.

The objectives of the project, which was approved and funded in August 1994, are:

- To identify suitable species for the production of bamboo shoots under Top End conditions.

- To gain expertise in the cultivation of selected species and to develop cultural practises such as irrigation and fertiliser scheduling for optimum shoot production.

- To release trial quantities of fresh product to assess its market potential.

- To collate and extend information on species performance.

There is, effectively, no production of bamboo shoots within Australia. Canned bamboo shoots are currently imported from SE Asia with a retail price between $3 and $6 per kg. and an estimated Australian consumption of 1,357,000 kg. (value $6 M) per annum. A potential export market exists for fresh shoots into Asian markets, particularly Japan, where they represent the largest category of imported fresh vegetables into the country (44 - 85,000 tonnes p.a.).

Two project officers visited Belli Bamboo Farm from 18 - 23 November 1994 to attend the first RIRDC meeting on the project, as well as attending a Bamboo Workshop conducted by the grower participant, Mr. Durnford Dart. A visit was made to Bundaberg Research Station to discuss the co-operative project with researchers and to inspect the bamboo collection. On the return trip to Eumundi, a visit was made to Rollo Campbell's Tiaro Bamboo Nursery and varietal collection. The RIRDC meeting was attended by John Leonardi of UCQ, Peter Bindon of the Australian Bamboo Network (Perth), Mr. Dart and the NT officers. The RIRDC project was discussed at length and much valuable information was collected to support the NT part of the project. The most suitable bamboo species was selected and arrangements were made to have the plants prepared and grown on, for shipment to Darwin early in 1995 for trial establishment.

A varietal collection of over 25 cultivars has been collected by DPIF to examine cultivars that are used for timber, windbreaks, fences and ornamental types as well as edible bamboo.

- An older collection of 12 species of bamboo (single plants) gathered from around the Darwin area is now over 2 years old, but has only been managed well for the past year (Table 36).

**Table 36. Bamboo species being examined**

| |
|---|
| Bambusa arundinacea |
| Bambusa vulgaris var. vittata |
| Bambusa vulgaris var. wamin |
| Bambusa glaucescens |
| Bambusa vulgaris |
| Bambusa arnhemica |
| Bambusa sp. |
| Thyrostachys siamensis |
| Schizostachyzum brachycladum |
| Nastus elatus |
| Gigantochloa apus |
| Gigantochloa sp. Timor Giant Black |

- A new collection of bamboo (15 species) was purchased by DPIF from Belli Bamboo Farm with 2 plants of each species. This collection includes *Dendrocalamus asper, D. latiflorus* and *Bambusa oldhami,* the 3 preferred species for edible shoot production in the tropics (Table 37).

**Table 37.**

| |
|---|
| Bambusa eutuldoides |
| Bambusa textilis |
| Bambusa oldhami |
| Bambusa tuldoides |
| Bambusa multiplex var. riviereorum |
| Bambusa ventricosa |
| Bambusa multiplex |
| Bambusa polymorpha |
| Guadua angustifolia |
| Gigantochloa atter |
| Gigantochloa var. Malay dwarf varieg |
| Gigantochloa apus |
| Psuedosasa japonica |
| Dendrocalamus asper |
| Dendrocalamus latiflorus |

## The Level of Effectiveness of Various Control Methods to Reduce Bird Damage on Horticultural Crops

D.Marcsik, D.Clarke

The types of control methods used to repel birds can be described by their mode of action which are visual, audio/sound, barrier and chemical. These control methods either replicate something natural which birds find threatening or distressing, or give the bird an unexpected fright.

Visual methods used to repel birds are usually in the form of objects, shapes and colours. These include such things as scarecrows, models of birds of prey, shiny bright objects, coloured balloons and lights. Audio or sound repellents include sudden loud or unusual noises such as explosions, gunfire, loud piercing alarms, horns and the recorded sounds of birds in distress played over amplifiers. For both the visual and audio methods to be effective these need to be administered as soon as the birds start to become a problem.

Netting provides the only real barrier method to exclude and repel birds from crops. However, netting has some disadvantages as an acceptable control method particularly on fruit crops. The main disadvantages of netting has been the high cost of materials and the perceived difficulty of applying and removing the netting. The types of netting options available has overcome some of these problems and made it increasingly acceptable.

The use of chemical repellents is another control method but this has not been widely used on horticultural crops due to the amount needed to be applied to have an effect on all birds. Other disadvantages are the cost of the chemical and the problem of chemical residue left on the fruit.

The objective of this project is to investigate and assess the various bird control methods - visual, audio and barrier - for their level of effectiveness in relation to repellency and persistency.

These bird control methods were trialled under field conditions with no controls. Trials were assessed by observation and monitoring of the birds' behaviour and the response exhibited by the birds to each control method.

Balloons were used and placed in the rows between trees, above and in the trees. Large circular shapes were painted on variously coloured balloons to represent the threatening shapes found under the wings of some birds of prey. Balloons were either flown alone or with attachments such as tinsel, streamers and alfoil plates. Normal party and larger balloons were either blown-up manually or filled with helium gas. A number of these balloons were placed in an area of the orchard and observations were taken.

Plastic cut-out models of hawks were tested and these were flown at heights of 2.5 to 3 metres under balloons or PVC pipe which allowed the model to move in the wind. A model hawk was placed in a small area of the orchard and monitored. As well, a plastic model of an owl was tested in the orchard to see whether birds would respond to it.

Recordings were made of the distress calls of the rainbow lorikeet, as well as mixed recordings of these distress calls, together with the alarm calls of the butcher and yellow-throated miner birds. Another mixed recording was made of the same calls as mentioned above, with the addition of the alarm call of Sulphur-crested cockatoos, together with shotgun noises and human voices. These recordings were played when birds were present in the orchard.

Other audio methods investigated were the gas canon and bird frite. Each of these were operated in the orchard when scout birds were seen in the early morning and late afternoon. These methods were also tested together, when the numbers of birds started to increase in the orchard. The gas canon was moved on a regular basis throughout the orchard and the bird frite was fired as close as possible to the birds.

A sound device known as the "AVA Bird Gard System" was trialled in rambutan orchards for the entire fruiting season. The AV-alarm is a device which produces intermittent electronic sounds of bird distress and alarm calls that are broadcast through speaker units set up in the orchard. Two systems were tested together on the same orchard and run continuously all day for the whole season.

Bird netting of both the white and black knitted types, having a mesh hole size of 25 to 30mm were used to cover individual trees and row system designs over rambutan trees. Two different row system designs were investigated, one covered with the white netting and the other covered with the black. Bird damage to fruits was assessed for both types of netting options.

Each bird control method was assessed for it's level of effectiveness in relation to repellency and persistency. Repellency was rated between 1 and 10, and persistency was described as either short- (ST), medium- (MT) or long-term (LT).

Most of the visual methods trialled had a very low level of repellency and short-term persistency (see Table 38). In general, most species of birds observed did not take any notice of the balloons or the added bits and pieces attached to them. The same response was observed when the model hawks and owl were placed in the orchard.

The level of effectiveness of the different audio methods rated slightly higher and some showed medium-term persistency (see Table 39). For these methods to work, they need to be activated in the orchard when the first scout birds are seen in the orchard and continuously rotated about the orchard where the birds are seen feeding.

Netting proved to be the most effective control method, both in regard to repellency and persistency (see Table 40). The throw-over netting on trees did initially repel birds such as Rainbow lorikeets and Northern rosellas, however, these birds soon got under the nets, due to the gaps at the bottom of the tree, where the netting did not touch the ground. Also, it was observed that the lorikeets kept off the rambutan trees covered with the white netting for a period of time and went instead to peck at fruits on trees covered with the black netting.

**Table 38. The level of effectiveness of various visual methods on particular bird species damaging horticultural crops.**

| BIRD SPECIES | METHOD | CROP | EFFECT |
|---|---|---|---|
| Rainbow lorikeet | Balloons and/or attachments | Rambutan | 1 (ST) |
| | Model hawks | | 1 |
| Redwinged parrot | Balloons and/or attachments | Snakebean | 1 (ST) |
| Fig bird<br>Yellow oriole<br>Friar bird<br>BF Honeyeater<br>Bower bird<br>Cuckoo shrike | Balloons and/or attachments | Mixed fruit trees | 2 (ST) |
| | Model hawks on poles | | 2 |
| BF Honeyeater<br>Friar bird | Model owl | Mango flowers | 3 (ST) |

**Table 39. The level of effectiveness of various audio methods on particular bird species damaging horticultural crops.**

| BIRD SPECIES | METHOD | CROP | EFFECT |
|---|---|---|---|
| Redwinged parrot | Bird frite | Snakebean | 4 (ST) |
| Rainbow lorikeet | Bird frite<br>Alarm/distress calls | Rambutan | 4 (ST)<br>3 |
| Sulphur-crested cockatoo<br>Corella<br>Galah | Bird frite<br><br>Gas canon | Mixed fruit trees | 5 (MT)<br><br>4 (ST) |
| Magpie geese | Bird frite/<br>Gas canon | Mango & guava | 7 (MT) |
| Ground and foliage birds | Alarm/distress calls hawks calls birdfrite/gas canon | Mixed fruit trees | 2 (ST) |
| Sulphur-crested cockatoo | Bird frite | Mango & Banana plants | 5 (MT) |
| Magpie geese | Bird frite | Mango & Sweet potato | 7 (MT) |
| Rainbow lorikeet and Northern rosella | AVA Bird Gard System | Rambutan | 1 (ST) |

**Table 40. The level of effectiveness of various netting options.**

| BIRD SPECIES | METHOD | CROP | EFFECT |
|---|---|---|---|
| Rainbow lorikeet & Northern rosella | Black netting thrown over tree | Rambutan | 6 (MT) |
| Same as above | White netting thrown over tree | Rambutan | 8 (MT - LT) |
| Same as above | Black netting on row frame | Rambutan | 8 (LT) |
| Same as above | White netting on row frame | Rambutan | 8 (LT) |
| All species | Black netting of whole orchard | Rambutan & mixed fruit trees | 10 (LT) |

From the following trial work, most of the visual methods had a very low degree of effectiveness as a bird control measure to reduce damage on horticultural crops. Some of the audio methods showed a slightly higher degree of effectiveness in regards to repelling and deterring birds for a medium period of time in the orchard. However, netting showed a significant degree of effectiveness in repelling birds over the long-term.

# Preliminary Field Trial Assessment on Methiocarb + DC Tron® to Reduce Bird Damage in the Rambutan Orchard

Doris Marcsik

Previous chemical repellent studies found that methiocarb (4-methylthio-3, 5-xylyl N-methyl carbamate, Mesurol 750R) significantly repelled rainbow lorikeets in repeated feeding tests. Also, a petroleum-based compound DC-Tron® was found to significantly repel lorikeets from fruits. Methiocarb has been known for sometime for its bird repelling properties and causing birds to become sick (ie. postingestional illness) after they eat fruit treated with the chemical. In flight-pen studies conducted with DC-Tron® on rainbow lorikeets, it was found that the oily, sticky properties of this compound irritated the lorikeets when their tongue came into contact with it on the fruit.

In previous studies, both compounds have been mixed together and applied onto rambutans in controlled feeding tests on lorikeets. The result was a reduction in feeding of more than 50% after the second feeding test, when more than half the birds experienced postingestional illness and/or discomfort, after eating the treated fruits.

Therefore, the approach of this study was to conduct a preliminary spraying trial and assess the effectiveness of methiocarb + DC Tron® in a rambutan orchard.

The objective of the trial was to assess the timing and the number of sprayings required of methiocarb + DC Tron® in an orchard,to have an effect in reducing the level of bird damage on rambutans.

Twelve rambutan trees were randomly selected which had fruits that were 50% red and completely red in colour. Ten fruits from 4 different sections of the tree were selected and tagged. Each tree was assessed the day before spraying for any bird damage. The same procedure was done for 12 control trees.

Methiocarb at 1g/L, in the form of the wettable powder Mesurol 750R® (750g/kg a.i.) and DC Tron® at 1ml/L, were mixed together at a ratio of 1:1. A wetting agent, Top Wet, was added to the solution and agitated well in the spray tank before spraying. A generated spray tank with a hand operated spray-gun was used to apply the solution on the trees. Spraying was conducted in the morning and fruits were thoroughly sprayed until dripping. After spraying, monitoring was conducted for 60 minutes to note any birds entering or feeding on rambutans in the orchard. An assessment of bird damage on rambutans was done on the treated and control trees the next day and 3 days later.

Another spraying was done 4 weeks later due to most of the crop ripening during this time. The same procedure was conducted as outlined above and trees were assessed for bird damage 1 and 3 days after spraying.

The pre-spraying assessment of the selected rambutan trees for bird damage recorded very little fruit damage. Most of the crop was still immature (ie. the rambutan coat was still green) with only about 30% of the crop starting to ripen. Therefore, selecting bunches of fruit at the same stage for the spraying trial was limited.

Only 1 bird, a sulphur crested cockatoo, was observed in the orchard straight after spraying and it was perched on an untreated tree. Also, both fruit and foliage were monitored for symptoms of phytotoxicity and after 60 minutes, none was observed.

The level of bird damage 1 day after spraying was low for both the treated and control trees. Only 4 of the treated trees experienced significant bird damage of greater than 50%, due to having a lot more fruit that were red in colour and ripened. Some bird damage was also experienced on the control tree which had fruits at the same stage, but it was not significantly higher than the treated trees. In general, the level of bird damage to rambutans was quite low in the orchard, which was due to the very low bird activity during this time.

For the other spraying done 4 weeks later, most of the fruit in the orchard had turned red and were ripening. An assessment of the selected trees before spraying, for fresh damage, was low with only the already ripened fruits suffering damaged. An assessment of bird damage the day after spraying recorded little to no damage on both the treated and controlled trees. Overnight rain occurred on the day of the spraying and the following days. Bird damage 3 days after spraying for the treated trees was only 20% and very little bird damage was recorded for the controlled trees.

The field trial spraying of methiocarb + DC-Tron® was not very successful due to a number of factors which were (i) very low bird activity in the orchard, (ii) daily rainy periods, and (iii) the low degree of persistency of the solution.

The level of bird damage experienced on last season's rambutan crop was significantly low. Most growers harvested their main crop without losing much to bird damage. There was some bird damage experienced on early ripening fruits,

which was caused by small flocks of rainbow lorikeets before the field spraying trial. However, during the time of the first spraying trial bird activity in the orchard was extremely low and only about 30 to 40% of the crop was starting to ripen. In the second spraying trial, about 80% of the crop was at the ripening stage and the bird activity was still significantly low. Therefore, the immediate effect of lorikeets feeding on rambutans treated with methiocarb + DC-Tron® was not observed. The level of persistency of the methiocarb + DC-Tron® mixture is not very long, as was found in the controlled flight-pen studies. Birds need to eat the food soon after it has been treated for the methiocarb to have an effect. Therefore, bird damage needs to be actively occurring in the orchard when spraying, for a large number of birds to experience the unpleasantness of these chemicals.

Damage to fruits, 1 and 3 days after spraying in the orchard was low, and was not due to the effects of the methiocarb + DC-Tron® mixture but to the low bird activity. No repeated sprayings were done in the orchard for the first trial, due to the lack of bird activity. For the second spraying trial, repeated sprayings were not carried out due to the frequent rainy conditions occurring in the late afternoons, as wet conditions greatly reduce the presence and level of persistency of the methiocarb + DC-Tron® mixture applied to the rambutans. Also, very little bird activity was noticed in the orchard during this period.

**VEGETABLES**

## Cucurbit Yield Decline

S.McAlister, M.W.Smith, A.Lyons, J.D.Bright, J.D.Duff, R.N.Pitkethley

This experiment investigated the causes of yield decline on re-used plastic mulch. Yield decline is currently preventing growers from utilising plastic mulch for more than one crop, with obvious economic and environmental implications. In response to extensive canvassing of growers and researchers, it was decided to investigate the roles of adequate soil phosphorus, seed bed tilth and soil fungicide applications.

Three planting dates were used in order to enable comparison of treatment responses on beds that had been cropped once, twice and three times. A 3(crops) * 2(phosphorus) * 2(bed tilth) * 2(fungicide) factorial treatment design was employed within a split plot experimental design. Sub-plots consisted of 4 individual zucchini plants (cv. Regal Black) with all treatment combinations replicated 4 times.

Plantings occurred on the 17 March, 19 May and 3 August 1994, with a 4 week harvest period used for each planting. Responses were measured in terms of fruit fresh and dry weights, fruit numbers, leaf stem and root biomass, leaf number, photosynthetically active light interception, and soil compaction (measured with a penetrometer). The dilution plate technique was used to quantify soil microbial levels under the different treatment regimes. Three culturing media were used (Tryptic Soy Agar, Malt Extract Agar with Terramycin, and quarter strength Potato Dextrose Agar) with the dilutions $10^{-2}$ to $10^{-6}$ being plated and counted. Root samples were extracted and examined for plant pathogens.

All plantings received the same base fertiliser applications (105 kg/ha potassium nitrate and 16 kg/ha ammonium sulfate) and side dressings (50 kg/ha potassium nitrate at 21, 28 and 35 days after sowing and 50 kg/ha ammonium sulfate at 7, 14 and 21 days after sowing) injected through the drip tape, in order to negate any impact of changes in soil nutritional status with cropping intensity. Foliar applications of trace elements were also made at 10 and 20 days after sowing for each of the 3 plantings.

Plants sown into plastic mulch that had been used previously, showed dramatically reduced growth, vigour and production, compared to those sown into newly laid mulch (Figure 16). All measured parameters showed that this yield decline was a cumulative, rather than binary response. That is, the yield decline after 3 sowings on the same plastic mulch was more severe than that after 2 sowings. Perhaps surprisingly, this response to multiple cropping was evident from the time seedlings emerged, with quite distinct differences in the size of emerging cotyledons.

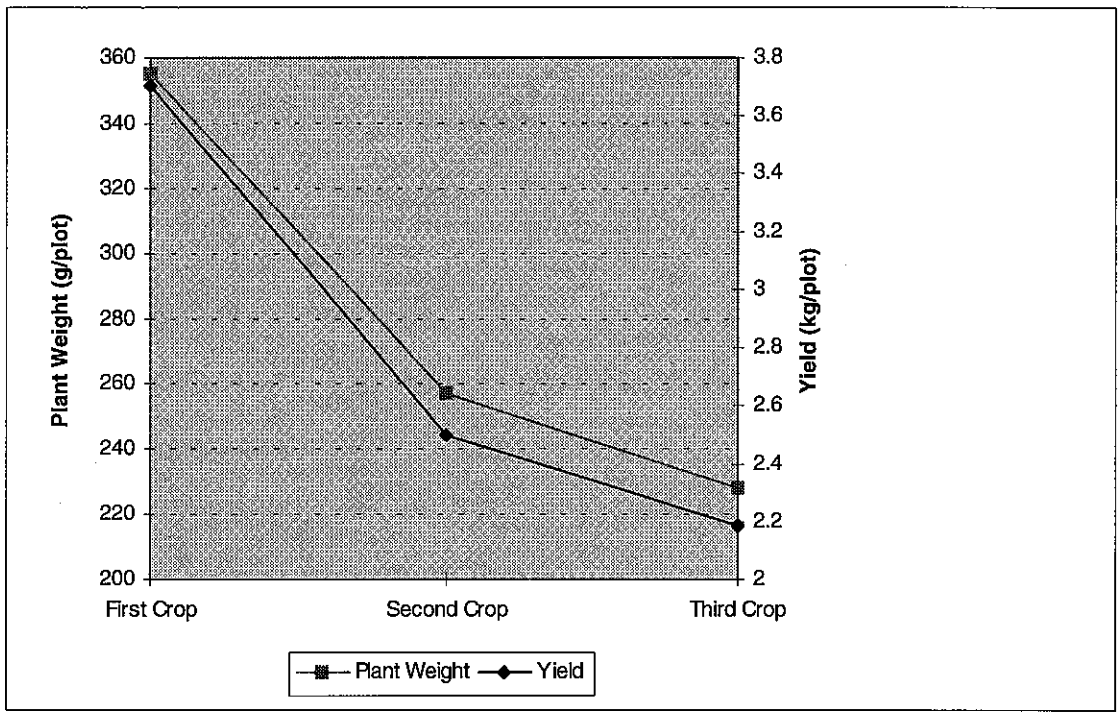



**Figure 16.** **Decline in Plant Weight and Yield with increased cropping intensity on the same plastic mulched beds.**

The treatments of additional superphosphate, seed bed cultivation, and the application of phosphoric acid, had no consistent effect in overcoming the yield decline. Nor were there any significant interactions between these factors. Multiple regression analysis using individual plot data, and yield as the independent variable, indicated that few of the measured parameters were closely correlated with yield (except above ground biomass). Results from the dilution plate technique were inconsistent, although there tended to be more *Trichoderma* sp. present from newly cropped plastic mulch treatments. Significantly, there were no *Pythium* sp. detected on any of the 120 plates produced, and likewise, these pathogens were not detected on any of the root samples examined.

The experiment was unsuccessful in finding a solution to cucurbit yield decline. However, it demonstrated that the phenomenum is cumulative and likely to be a complex interaction of factors. Importantly, *Pythium* sp. played no part in the observed yield decline, despite having been implicated in similar cucurbit problems in other parts of Australia. Soil microbial aspects warrant closer examination in future work aimed at enabling multiple cropping on plastic mulch.

## Productivity Responses of Asparagus to Droughting in a Tropical Environment

J.D.Bright, S.J.Martin, M.W.Smith, M.D.Hoult, S.McAllister, G.S.Foord, Y.Diczbalis, C.Wicks.

Asparagus (*Asparagus officinalis L.*) has traditionally been grown in temperate climates where cool winter temperatures cause plant dormancy. Asparagus spears are picked as these plants emerge from their dormancy period in spring. Dormancy by the cessation of irrigation prior to harvest is used, where possible, in tropical areas. The effects of such droughting are, in some cases, believed to be detrimental to the plant both in production and health. This project will quantify production in response to droughting, through assessment of spear quantity and quality. Different droughting intensities and durations will be examined for their effect on crop production. Both field and lysimetry experiments commenced in 1994 and the information below outlines the methodology employed. Data collection is due to commence in mid 1995.s.

Asparagus plants (120) were transplanted in 200 litre lysimeters with various treatments being imposed on various plants. Treatments were arranged as follows:-

| 4 Moisture stress levels (kPa) | 5 Droughting durations |
|---|---|
| 10 | 0 days |
| 50 | 10 days |
| 100 | 20 days |
| Dry | 40 days |
| | 80 days |

They were arranged in a 4 * 5 factorial treatment design (total 20 treatments) with 6 replications. The length of moisture deficit and associated commencement dates were as follows:

| | |
|---|---|
| 80 days | starts at 28/4/95 |
| 40 days | starts at 7/6/95 |
| 20 days | starts at 27/6/95 |
| 10 days | starts at 7/7/95 |
| continual watering. | |

Each lysimeter was weighed at field capacity (i.e. complete saturation followed by 12 hours drainage overnight). Once watering had ceased and the desired tension reached, the drums were reweighed and the difference in weight added as water. ( eg. a 50 kPa lysimeter weighed 369 kg at field capacity and then 350 kg when tension was 50 kPa, therefore, 19 litres of water needed to be added to the drum). Plants in the 50 kPa treatment took from 4 to 5 days to reach this tension, while those in the 100 kPa treatment required watering every 6 to 8 days.

Once the fern had been removed (on the 17/7/95) the crop was watered to maintain a matric potential at 400 mm of 10-20 kPa. Emerging spears were then harvested for 12 days. Harvested spears were categorised into 1st, 2nd, and reject classes, and then weighed and counted for each plot.

The field experiment (conducted within a commercial asparagus planting) involved the examination of 5 different droughting durations namely 80, 40, 20, 10 and 0 days without irrigation prior to harvest. The length of moisture deficit and commencement were as follows:

| | |
|---|---|
| 80 days | starts at 17/3/95 |
| 40 days | starts at 26/4/95 |
| 20 days | starts at 16/5/95 |
| 10 days | starts at 26/5/95 |
| continual watering. | |

Plots were 4 m long with 1.5 m guards at both ends. Plots were also guarded on each side. At the commencement of each treatment, a 13 mm tube (blank) replaced the T- tape for the 7 m of the plot. Monitoring of water availability was by neutron probes (in the 80 day cut off plots) and Enviroscan® in all treatments in 1 replicate . Gravimetric determinations were made to a depth of 2m in all plots at the cessation of droughting treatments. At slashing (using hand shears), fern was collected for biomass determination for each plot.

Harvesting commenced on the 12 June 1995. Evaluation of yield and spear quality is currently being undertaken.

Several sensory evaluations (consumer appeal) were performed, looking for variations in spear fibre in relation to duration of droughting. Comparisons were made on all 5 droughting treatments. Participants were asked to assess fibre content and taste preference. Assessment was by ranking on a 5 point scale. A Latin square design was employed, such that each participant (3 groups of 5) tasted each of the 5 samples in a different order.

ORNAMENTALS

## Hippeastrum Propagation to Flowering Trial

D.Neilsen, J.Carter, P.Albano

Hippeastrums are a popular bulb of home gardeners throughout the world, producing scapes of striking tubular flowers, in a range of colours.

Many varieties have been bred specifically for pot plant forcing and, to a limited extent, cut flower production. The original species used in the breeding of hybrids were native to tropical America and are classified as tropical perennial geophytes. The major natural factor controlling their flowering and dormancy is seasonal thermoperiodicity, ie: the change in mean temperature at various seasons and plant growth stages.

Observations from a variety evaluation trial conducted in Darwin from 1993-1995 showed that hippeastrums produce rapid vegetative growth in Darwin's climatic conditions, but uniform flowering did not occur because of the relatively high night temperatures. A small storage treatment trial was then undertaken to break dormancy and induce flowering, which yielded positive results.

In areas elsewhere in Australia where hippeastrums are grown commercially, a 24-36 month growing period is required to produce a mature size bulb and retail bulb sales are generally limited to the July-November period.

An opportunity existed to develop a complete growing program for hippeastrums which would take advantage of Darwin's climatic conditions by achieving a higher turnover of bulb production due to reduced propagation, growth to maturity time. The main objective would be to force production and flowering of hippeastrums at specific times throughout the year to achieve the greatest commercial benefit.

The objectives of the trial were:

- To develop a complete growing schedule for hippeastrums from propagation through to flower production.
- To provide information to industry which gives a choice of producing hippeastrum bulbs for the retail bulb market, as cutflowers, potted colour lines or an amalgamation of all three.

**Propagation** - Ten cultivars of hippeastrum were propagated using the "twin-scaling" method. All bulbs used were of mature size and averaged 26 cm in circumference. Each bulb was cut into 8 equal portions. One "twin-scale" is equivalent to partitioning off 2 pieces of scale along with the adjoining section of root basal plate.

A total of 32 "twin-scales" was partitioned off one bulb for each cultivar and placed in trays containing 1 part perlite and 1 part german peat moss. The basal plate section was just covered by the media, approx 3 - 5 mm in height. All trays were drenched with 'Previcur' at the rate of 1.5 m per litre.

**Growing Phase** - The bulblets from the propagation trial remained in the tubes for a period of 1-2 months and were grown on under 80% shade, after which they were hardened off under 50% shade for a 1 week period.

Half of the bulblets were transplanted into 5 litre bags containing potting mix and the remainder were grown on in raised soil beds, both growing areas were covered with 50% shadecloth.

After an 11 month growing period, 20 bulbs of each cultivar were dug up, washed and the excess roots and leaves removed.

All individual bulbs were numbered and the following measurements were recorded for each bulb:

1. Fresh weight
2. Bulb circumference
3. Number of bulblets produced
4. Total weight of bulblets produced pre-bulb

**Storage Treatments** - Five cultivars (Tosto, Masai, Summertime, Apple Blossom and Desert Dawn) were selected for the storage treatment trial. Five bulbs of each of the 5 cultivars were placed into 4 different storage treatments (refer to Table 41). The main objective was to test the effect of the temperature and storage period to induce flowering.

**Table 41. Hippeastrum storage treatment trial 1994**

| Treatment No. | No of Bulbs per Treatment | Temperature and Length of Storage | |
|---|---|---|---|
| Tr 1 | 25 | 13°C(95% RH) | 4 weeks |
| Tr 2 | 25 | 13°C (95% RH) | 6 weeks |
| Tr 3 | 25 | 21°C(60% RH) | 4 weeks |
| Tr 4 | 25 | 21°C60% RH) | 6 weeks |

After each storage treatment the bulbs were potted into 7" pots and placed under 50% shade.
The results gained are as follows:

**Propagation** - Bulblets were visible in some cultivars at 21 days. Each bulblet was transplanted into 2" tubes when they were approximately 10 mm in circumference, 15 mm in height and had developed a root system (refer to Table 42). The method used and the number of bulblets produced per "twin-scale" confirmed the findings of Chih Wei Huang and Hiroshi Okubo (1990).

**Table 42. Hippeastrum Twin-scaling Propagation Trial.**

| Cultivar | No of Twin-Scales | Propagation Date | No of Bulblets produced | Mean No of Days from Propagation to Tubing |
|---|---|---|---|---|
| Desert Dawn | 32 | 19/1/93 | 45 | 80 |
| Apple Blossom | 32 | 19/1/93 | 52 | 98 |
| Summertime | 32 | 19/1/93 | 22 | 133 |
| Masai | 32 | 19/1/93 | 39 | 92 |
| Tosto | 32 | 19/1/93 | 25 | 128 |
| Wedding Dance | 32 | 19/1/93 | 33 | 111 |
| Zanzibar | 32 | 19/1/93 | 38 | 104 |
| Safari | 32 | 19/1/93 | 42 | 118 |
| Spring Time | 32 | 19/1/93 | 29 | 137 |
| Kalahari | 32 | 19/1/93 | 21 | 104 |

**Table 43. Comparison of Fresh Weight and Bulb Circumference of Hippeastrums Grown in two different media**

| Cultivar | Propagated to Tubed up | Grown on | Propagation to Dug up (for Storage) | Fresh Weight (gm) | | Bulb Circumference (cm) | |
|---|---|---|---|---|---|---|---|
| | Number of Days | | | Raised Soil Beds | 5 litre Bags - Potting Mix | Raised Soil Beds | 5 litre Bags Potting Mix |
| Desert Dawn | 80.25 | 411.25 | 491.5 | 198.2 | 314.2 | 22.6 | 26.3 |
| Apple Blossom | 96.75 | 394.75 | 491.5 | 178.7 | 215.8 | 22.4 | 25.1 |
| Summer Time | 184.25 | 307.25 | 491.5 | 105.1 | 163.3 | 17.0 | 21.3 |
| Masai | 96.5 | 395.0 | 491.5 | 131.4 | 247.8 | 20.1 | 25.4 |
| Tosto | 128.5 | 363.0 | 491.5 | 134.9 | 129.5 | 20.1 | 19.7 |

The mean bulb circumference for the cultivar "Apple Blossom" grown on in potting mix over a 16½ month period was higher than the findings of A. de Gelder (1990), who reported a mean bulb circumference of 24.0 cm for the cultivar "Apple Blossom" grown on for a 20½ month period.

**Table 44. Mean Values of bulbs for each treatment at initial time of storage**

| Treatment No | Propagation to Dug up No of Days | Fresh Weight (gm) | Bulb circumference (cm) | Total No of Bulblets | Total Weight of Bulblets (gm) |
|---|---|---|---|---|---|
| 1 | 499 | 217 | 23 | 2 | 33 |
| 2 | 484 | 165 | 21 | 1 | 15 |
| 3 | 499 | 237 | 24 | 2 | 33 |
| 4 | 484 | 143 | 20 | 1 | 10 |

**Table 45. Mean values of characteristics of flowering bulbs for each storage treatment**

| Treatment No. | 1st SCAPE | | | |
|---|---|---|---|---|
| | No of Leaves | Leaf Height | Total Stem Length (cm) | Width of 1st Flower Open (cm) |
| 1 | 3 | 18 | 39 | 16 |
| 2 | 4 | 16 | 38 | 15 |
| 3 | 2 | 10 | 34 | 16 |
| 4 | 2 | 8 | 33 | 15 |

**Table 46. Percentage of Flowering in Relation to Bulb Size and Treatment**

| Treatment No. | No of Bulbs per Treatment | Percentage of Flowering Bulbs | Percentage of Non-Flowering Bulb | Mean Circumference of Flowering Bulbs (cm) | Mean Circumference of Non-Flowering Bulbs (cm) |
|---|---|---|---|---|---|
| T 1 | 25 | 60% | 40% | 24.5 | 23.7 |
| T 2 | 25 | 48% | 52% | 22.5 | 20.2 |
| T 3 | 25 | 60% | 40% | 26.0 | 21.6 |
| T 4 | 25 | 40% | 60% | 23.3 | 18.0 |

**Table 47. Schedule of Hippeastrum Cultivation to Flowering (number of days)**

| Treatment No. | Propagation to Dug up for storage | Total days in storage to Potted-on | Propagation to Potted-on | Potted-on to 1st bud colour | 1st bud colour to flower No 1 opening | Propagation to flower No 1 opening |
|---|---|---|---|---|---|---|
| 1 | 499 | 29 | 528 | 67 | 4 | 599 |
| 2 | 484 | 43 | 527 | 66 | 3 | 596 |
| 3 | 499 | 29 | 528 | 73 | 4 | 605 |
| 4 | 484 | 44 | 528 | 67 | 4 | 599 |

No major differences were apparent between the treatments, in relation to temperature and length of time in storage having an effect on flowering, although a dormancy period is required to induce flowering. The main factor for flower production to occur appeared to be the size of the bulb, with bulb circumferences of 24 cm and over flowering in all treatments. Further work will be necessary, in association with bulb size and cultivar response, to substantiate the most effective temperature and length of storage time to induce uniform flowering.

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de Gelder, A. (1990). Variety Evaluation of Hippeastrum. *Acta Horticulturae* 266:273-275.

de Hertogh, Dr August, (1985). Amaryllis (Hippeastrum) - Potted plants. *Holland Bulb Forcer's Guide* 173-176.

## Ornamental Plant Introductions

J.Powell, D.Neilsen

In early 1994, Dr TK Lim - Principal Horticulturist, Garry Ramsay - Farm Manager CPRS, Colin Jettner - Farm Manager BARC and Jeremy Powell - Ornamental Horticulturist, went on a plant collecting trip to Sarawak, Malaysia. Although the primary focus of this trip was to exchange tropical fruit germplasm and to look at ways in which DPIF and the Sarawak Department of Agriculture could co-operate in Agricultural research, there were opportunities to observe and collect ornamental plants. After the Sarawak trip, Jeremy Powell and Colin Jettner visited the Botany Department of the University Kuala Lumpur and travelled through peninsula Malaysia and South Thailand and visited the Nong Nooch Tropical Garden.

Throughout the trip, ornamental plants were collected both from the jungle and from nurseries and gardens. Four separate shipments of plants were sent back to Darwin. Some of these were collectors items, others were planted with potential to be grown for cut-flower production or commercial nursery production.

After 3 months in the Quarantine Screenhouse, most of the plants were removed and grown on in shadehouses until they reached the stage where they could be propagated and released to industry. Potential cut-flower varieties were planted out in trial plots and the ornamental plants were planted in gardens at BARC and CPRS. Brief description of the plants which have been released to industry through the Nursery Industry Association of the NT are presented below, together with notes on cultivation and propagation.

1. *Ficus* sp. (Golden Ficus). This plant is used extensively in landscaping in South-East Asia because of its golden yellow leaves. In shaded situations, the young leaves are more of an emerald green colour, ageing to a darker green. It appears to be much smaller than most cultivars of Ficus benjamina which grow to large trees. It can be used in landscaping and possibly as an indoor plant - propagated readily from cuttings.

2. *Ixora* sp. - pale apricot flowers. This plant has paler leaves than most other Ixora cultivars. The flowers, which are about 4-5 cm in diameter, are a very pale apricot colour, almost white, and occur all year round. It is a bushy plant which seems to prefer some protection from full sun. At this stage it is unknown what size it grows to. Tip and second cutting 5 - 7.5 cm long propagate readily.

3. *Ixora* sp. - double red flowers. The main feature of this plant is the double flowers, uncommon in Ixoras, although the colour of the flowers and leaves are not very different from other Ixora cultivars. It propagates quite readily from cuttings but probably does not have as much potential as the previous cultivars.

4. *Ixora* sp. - with distorted stem-clasping leaves. Another unusual Ixora, the main feature is the shape of the leaves. These have no petisle, are rounded in shape and folded to form two crinkly wings. The flowers are red. Its detractions are that it is slow growing and has, so far, proved a little difficult to propagate. The soft green tips wilt easily and are susceptible to rots, greatest success has been achieved with second cutting up to 10 cm long.

5. *Calathea* sp. - lauceolate leaves. This would be a very attractive plant in a shady moist position in a garden, or as a potted plant. It is quite bushy and grows to 40 cm in height and eventually probably 1 metre or more wide. The lanceolate leaves are 15-20 cm long, about 2 cm wide, dark green on top and dark purple underneath. It readily propagates by division. When moved from a moist situation to a drier one, the leaves can sometimes stand up until they have adapted to the new conditions.

6. *Schefflera actinophylla* - dwarf variegated form. This plant is a more compact and smaller form than the one currently available from the nursery industry in Darwin. The leaves are smaller and the variegation is creamy yellow in colour, rather than bright yellow. It would make a good pot-plant or colourful foliage plant in a position in the garden with some protection from the sun. Tip cuttings were susceptible to rotting - older wood may be more successful.

7. *Etlingera hemispherica.* This species, which is closely related to the commonly cultivated Torch Ginger (Etlingera elatior), was found in the rainforest in South Thailand. The flowers are spectacular and look like a waxy red rose from above. It has potential for cut-flower production and as a garden plant. Its detractions as a cut-flower cultivar are that, it requires shade and humidity to grow and the flowers occur for only 2-3 months every year (October - December in Darwin) It propagates readily by rhizome division but can be difficult to maintain in a pot.

8. *Etlingera elatior* - white flowered form. The flower colour of the forms of Etlingera elatior currently in cultivation, range from pale pink to almost red. This almost white form should be a useful addition to the colours available in this hardy, easy to grow species. Propagation is by rhizome division.

9. *Zingiber otensii.* Similar in appearance to Zingiber spectabilis, this plant is slightly smaller and the flower colour is green/brown, ageing to red. Its main advantage is that it appears to be a high producer of flowers all year round. It would have potential as a cut-flower, a garden plant and for breeding with forms of *Zingiber spectabilis.*

10. *Alpinia mutica.* Cultivated from seed collected in Kalimantan, this species is closely related to the shell ginger ( Alpinia zerumbet). It has very attractive, narrow shiny leaves and grows to a maximum of 2m x 2m. Would need shade.

Other cultivars resulting from this trip which are yet to be released are listed in Table 48.

**Table 48.**

| Cultivar | Pot Plant | Garden Plant | Cut Flower | Cut Foliage |
|---|---|---|---|---|
| Cordyline 'China Boy' | ✓ | ✓ | | ✓ |
| Cordyline cultivar | ✓ | ✓ | | ✓ |
| *Pleomele* sp. Sth Thailand | ✓ | ✓ | | |
| *Calathea louisae* | ✓ | ✓ | | |
| *Calathea* sp. Lauceloate green leaves | ✓ | ✓ | | |
| *Shefflora* sp. Variegated (2) | ✓ | ✓ | | |
| *Zingiber spectabilis* apricot flowers | | ✓ | ✓ | |
| *Zingiber spectabilis* - lemon yellow flowers Sth Thailand | | ✓ | ✓ | |
| Scaphochlamys sp. (3) | ✓ | ✓ | | |
| *Aspelenium* sp. | ✓ | ✓ | | |
| *Dracaena sanderiana* cv | ✓ | ✓ | | |

Several plants obtained from other sources have also been distributed to industry. These include *Costus woodsoniana*, a prolific year round producer of egg-shaped waxy red flowers, which have a 2-3 week vaselife. It tolerates full shade to at least half sun and would make a good addition to the gingers and heliconias currently available from growers in Darwin. Two dwarf selections of *Melaleuca linarifolia* - 'Snowflake' and 'Claret tops' promise to be improvements on Melaleucas 'Snow Storm', which is currently available from nurseries, but ends up growing to about 4 metres, flowering in the dry season. 'Snow flake' has pale yellow/green flushes of new growth and 'Claret tops', as its name suggests, has dark red flushes. Both are reputed to grow to a maximum of 1.5 m x 1.5 m. *Melaleuca thymifolia* has very attractive mauve shaped flowers (and sometimes pink or white). Good forms will flower year round (somewhat sparsely) in Darwin. A recently discovered prostrate form - 'Little Beauty' was also introduced to industry. If it flowers as prolifically as it does in Southern Queensland, then it will be a welcome addition to nurseries in Darwin which, in general, are short on native ground-cover plants. All the melaleucas can be propagated by cuttings, but the mist propagating conditions should not be too wet.

## The Influence of Three Levels of Shade on Flowering of Dendrobium 'Sonia'

J.Powell, D.Neilsen

The objective of this trial was to determine the optimum commercially available black shadecloth for dendrobium orchid production in the Darwin area. The 3 shade treatments were 50%, 70% and 80% black shadecloth. Data from the 2 previous flowering seasons (1991/92 and 1992/93) indicated that 50% shadecloth produced a marginally higher yield than the other treatments, but that stem-length tended to increase with increasing shade. Table 49 below presents data from the 1993/94 flowering season. A marketable stem was defined as one with a stem-length $\geq$ 40 cm and bud-drop $\leq$ 1.

**Table 49. Effect of shading on flowering of Dendrobium 'Sonia' for the 1993/94 season.**

| Shade Treatment | Mean Stems/Plant | Mean Mark Stems/Plant | Mean Stem-length | Mean Fl. No. | Bud-drop |
|---|---|---|---|---|---|
| 80% | 3.6 | 3.2 | 50.7 | 9.2 | 0.15 |
| 70% | 4.5 | 3.9 | 48.8 | 9.0 | 0.2 |
| 50% | 5.1 | 4.5 | 52.9 | 10.1 | 0.25 |

This data largely agrees with data obtained in previous years and, therefore, also with data from the 3 flowering seasons combined, which is presented in Table 50 below.

**Table 50. Effect of shading on flowering of Dendrobium 'Sonia' from 1991 to 1994.**

| Shade Treatment | Mean Stems/Plant/Year | Mean Mark Stems/Plant/Year | Mean Stem-length | Mean Fl. No. | Mean Bud-drop |
|---|---|---|---|---|---|
| 80% | 3.4 | 3.1 | 53.5 | 9.7 | 0.17 |
| 70% | 4.1 | 3.6 | 50.4 | 9.4 | 0.19 |
| 50% | 4.6 | 4.0 | 51.7 | 9.9 | 0.21 |

Given that 60% black shadecloth is not an option, unless quantities justifying a special production run are ordered, growers' best options would be 70% shadecloth in an open area, with no wind protection and little or no tree cover and 50% shadecloth in protected situations with trees surrounding the shadehouse.

## Chipped Callitris Pine as a Potting Mix Ingredient

J.Powell, D.Neilsen

Of the available potting mix ingredients of organic origin used by nurseries in the Darwin area, pinebark is the most popular. The product is manufactured by hammer-milling bark from *Pinus radiata* plantations in southern Australia. As a result, the product can be expensive to transport to Darwin and sometimes there are problems with supply.

A potential alternative exists in the form of chipped wood from *Callitris intratropica* plantations in the Darwin area. Currently woodchips from these trees are being marketed as a termite-resistant garden mulch in Darwin. Potential disadvantages of these chips are: the product from the chipping machine has too many large particles and not enough fine particles (of equivalent size to sawdust or peat), like other ingredients of wood or bark origin, it would draw down nitrogen in a potting mix, and the highly aromatic oil in the wood may be toxic to some plants.

However, a radish seed germination test indicated that fresh, finely chipped *Callitris intratropica* was no more toxic to the germinating radish seedlings than German peat, a widely used ingredient of propagating media. The other potential problems could be overcome by the addition of a slow release source of nitrogen to the mix, sieving the larger particles out of the chips, putting the chips through a hammer-mill to bring the particle size down, and/or composting the chips.

It was therefore decided to conduct a trial comparing the performance of 2 mixes based on callitris chips, with 1 mix based on pinebark. A sample of the callitris chips was sieved to remove the particles larger than 1 cm in diameter. Half of the sieved chips were steamed at approximately 70°C for 8 hours, removing a large proportion of the oil. These chips and the pinebark were combined with other ingredients according to the proportions described in Table 51 below:

**Table 51. Potting mix ingredients**

| Bulk Ingredients | Mix 1 | Mix 2 | Mix 3 |
|---|---|---|---|
| Pinebark | 33% | | |
| Steamed chips | | 30% | |
| Unsteamed chips | | | 30% |
| German peat | 33% | | |
| Coco peat | | 30% | 30% |
| Mary River Sand | 33% | 30% | 30% |
| Fine Sand | | 10% | 10% |
| Fertilisers | | | |
| Osmocote 8-9 months | 5 g/l | 5 g/l | 5 g/l |
| IBDU | 0.5 g/l | 0.75 g/l | 0.75 g/l |
| Coated Iron | 0.5 g/l | 0.5 g/l | 0.5 g/l |
| Micromax | 0.5 g/l | 0.5 g/l | 0.5 g/l |
| Dolomite | 1.5 g/l | 1.5 g/l | 1.5 g/l |

Mix 1 is the recipe currently used by the DPIF ornamentals section and has proved to be successful in growing a wide range of plants over many years. For the mixes using callitris chips, it was decided to use cocopeat instead of German peat, as this is another relatively new potting mix ingredient which could be a cheaper substitute for the peat currently used. Also, the slow-release nitrogen was added at a higher rate because, in general, wood products (especially sawdust) have a higher rate of nitrogen draw down than bark products. The fine sand was added to compensate for the lack of fine particles in the callitris chips compared, to the pinebark.

Three species of plant were chosen for this trial - *Cuphea hyssopifolia*, a fast-growing small herbaceous shrub, *Eucalyptus foelcheana*, a medium sized tree and *Acalypha wilkinsiana*, a woody shrub. Ten plants of each of these species in 5 cm tubes were potted into 15 cm pots, containing each of the 3 potting mixes on 25 August 1994. As each of the species reached saleable size, the growth of the plants was measured in the following way: On 5 October 1994, the cupheas were assessed by taking 2 measurements of the diameter of the plants perpendicular to each other and then averaging the results; on 25 October 1994, the height of the *E. foelcheana* and the height and diameter (in the same way as the cupheas) of the acalyphas was measured. The results are presented in Table 52 below:

**Table 52. Growth of plants in three potting mixes**

| | Mix 1 | Mix 2 | Mix 3 |
|---|---|---|---|
| *Cuphea hyssopifolia* | | | |
| mean diameter (cm) | 28.5 | 25.2 | 22.8 |
| *Eucalyptus foelcheana* | | | |
| mean height (cm) | 33.3 | 36.2 | 33.0 |
| *Acalypha wilkinsiana* | | | |
| mean height (cm) | 19.2 | 19.0 | 18.4 |
| mean diameter (cm) | 17.2 | 16.9 | 16.4 |

As can be seen from these results, the differences in growth rate of the 3 species across the 3 media were very small. At the time of measurement of the eucalyptus and the acalypha, it was observed that the size of the cuphea plants had evened out, compared to the earlier measurements. These results show that callitris pine-chips can be successfully substituted for pinebark, provided the correct allowances are made for nitrogen draw down and the lack of fine particles compared to pinebark. Composted or aged chips would be preferable to fresh chips.

## Evaluation Of The Potential Of Centralian Native Species As Cutflowers

W.Tregea, G.Kenna

Central Australia is renowned for its diverse native flora. The number and types of flowers which grow in this area, when there are favourable seasonal conditions, are numerous. The potential of many of these plants for commercial cutflower production is largely unknown.

Funding has been obtained from the Rural Industry Research and Development Corporation to conduct a preliminary investigation into the potential of these plants for commercial cutflower production.

A literature review of past research and development work with Centralian native species, identifying their potential for cutflower production, has been completed.

Wildflowers identified as having potential will be collected in the field and assessed for the characteristics desirable for cutflowers, using the following parameters, including flower size, density, evenness and colour. Stem length is also an important factor in determining suitability for cutflower production, as is vase life.

Flowers with the desirable characteristics will be propagated and research plantings established under cultivation. Various treatments will be used to determine the most efficient methods of propagating these plants under commercial conditions.

Lack of rainfall, at the time best suited for wildflower growth, has delayed the availability of plants for field collection. It is anticipated that the field work stage of the project will be implemented during the late winter and early spring of 1995.

## Visitors To Horticultural Research Establishments

- July 1994

  - 20 Queensland growers (mango/rockmelon/sugarcane)
  - David Minnis, Chris Rigney, David Pullar, Michael Keenan, David Montgomery, Rip van Velsen, Andrew Combe, Trish Bell, Gerard McEvilly, Chris Rowley - HRDC
  - Sam Nucifora, Chairman, Mango Sub-committee, QFVG
  - Stuart Pettigrew, Integrated pest management consultant, SA

- August 1994

  - Dean Walkley, Director/Technical Manager, Moeco Pty Ltd
  - Professor Uwe Von Hentig, German,
  - Colin Symonds, Yankalilla Seeds
  - Kym James, Executive Officer, FECA
  - Brian Freeman, Managing Director, International Horticultural Marketing

- September 1994

  - Students from NT University
  - Governor of Nusa Tenggara, Indonesia and entourage (14)
  - WADA officers and mango growers from Kununurra
  - Andy Flower, Flower Lychee and fruit grower, Maroochydore Qld
  - Dean Lehman - Radiometer Pacific, South Australia
  - Trevor Pahl and Graeme Johnson, Hardi Spraying
  - Andrew Weigall, Vitor Pty Ltd
  - Alex Carolan, Fruit and Produce Exporters, Flemington
  - Bob Hughes, Co-Ordinator, NT Food Project
  - Paul Knuckey, Citrus growing in the NT
  - Joe Cremona, Agent Sydney Market
  - James Drinnan, QDPI

- October 1994

  - John De Luca and Nigel Gerrard, Chiquita Brands
  - Peter Finlayson and Karl Henggeler, Top Banana
  - High Commissioner, Bangladesh
  - Jeff Harrison, Spray Tech, Brisbane
  - Dr Ponsoonboon and Dr Choikattiyos, CSIRO/Thailand ACIAR Project
  - Keith Kroger and Mal Brown, Wingfields

- November 1994

  - Tony Alicastro, Olive grower
  - Ortosud Iacobini and Rovitti Francesco, Italy olive growers
  - Tony Shaw, Regional Manager, Primary Industry Bank, Brisbane
  - Paul Walker, State Manager, Primary Industry Bank, Townsville
  - Julian Cribb, Science writer for the Australian
  - His Excellency Mr George Busitill and his wife
  - Jimmy Budd, ATSIC and Mr John Costa, grower/buyer from Victoria
  - Jim Egan, Rainbow Reticulation
  - Richard Lim, MLA

- December 1994/January 1995

  - Group of visitors from Hainan, China
  - Mr Antony Possinger, Goat farmer

- February 1995

  Mr Durnford Dart, bamboo grower, consultant Qld
  - Peter Finlayson, Top Banana
  - N Robinson, Marketing Manger, Sentek (EnviroScan)
  - Ben Franklin, work experience, Waite SA
  - Barunga Women's Group
  - Shawn Hood and Tony Pintana, cashew growers
  - Sigi Rodshtein, date grower, Israel

- March 1995

  - Peter Gallasch , SADA, citrus research
  - Brian Stynes, Project Manger, and Rodney Field Director, RIRDC
  - Des Boxtell and Ross Lindsay, Sth Qld growers
  - Bob Hughes, Co-Ordinator, NT Food Project
  - Jimmy Budd, Chairperson, Nth Eastern Indigenous Council
  - Glen Stotter, Managing Director, Main Camp Tea Tree Oil Group
  - Mr Costa, tablegrape grower, Mildura Vic
  - Peter Bowler, pastoralist and tablegrape grower, Wiluna

- April 1995

  - Bob Williams, Horticulture Manger, N Qld, QDPI
  - Chris O'Brien, Regional Manager, N Qld, QDPI
  - Barry Thompson, Scientist, Police Forensic Branch
  - Jeff Harrison, Spray Tech, Qld
  - Des Turbidy, consultant DPIF Staff Attitude Survey
  - Paul Connolly, New World Seed
  - Stan Smyth, melon grower, Mildura/Merindee/Kununurra
  - Gerry Clancy, Ti Tape
  - Anthony Abbott, British Consulate General Perth and his wife, AZRI

- May 1995

  - 40 Cane farmers, Mackay
  - Amaroo family, melon growers from Griffith NSW
  - Representatives from Collins Radio
  - Peter Scholefield and Trevor Warren, Citrus study consultants
  - Jim Egan, Rainbow Reticulation
  - Nathan Miller, SA/NT Manager, Netafim Irrigation

- June 1995

  - Cameron McConchie, CSIRO Queensland
  - Peter Scholefield and Trevor Warren, Citrus Consultants
  - Indonesian Officials
  - Students and staff, Sydney University
  - Martin Walker, Marketing Consultant Queensland
  - Paul Nicholls, Biometrician NSW Department of Agriculture
  - Durnford Dart, Bamboo grower Queensland
  - New Zealand cattlemen
  - Tony Dick, Manager Total Flowers

## Organisation of Seminars, Workshops and Field Days

- July 1994
  - Organised Pest Management Workshop (conducted by Dan Papacek, Qld)
- August 1994
  - Coastal Plains Research Station Open Day - All Staff
  - Pre-Season Mango seminar, Darwin - Mike Poffley
  - Presentation to Rare Fruit Council on Malaysian visit - Yan Diczbalis
  - Presentation to Regional Outlook Conference - Niranjan Dasari
  - Presentation to NT Science Teachers Conference - Malcolm Smith
  - Organised Central Australia Cut Flower Growers meeting and tour of Ti Tree properties - Geoff Kenna/Wayne Tregea
- September 1994
  - Pre-Season Mango seminar, Katherine - Mike Poffley
- October 1994
  - Presentation to Rare Fruits Council on Mango future outlook - Vinod Kulkarni
- November 1994
  - Mango harvesting workshop - Katherine staff
  - Coastal Plains Research Station - working bee
- February 1995
  - Presentation to Rare Fruits Council on mango grafting - Mike Poffley
  - Organised Bamboo seminar, presented by consultant from Qld - Kevin Blackburn
- March 1995
  - Organised Mango R & D meeting - Hort staff
  - Organised Katherine Farm and Garden Day
  - Prepared Asparagus Droughting Poster for Sesame workshop - Katherine staff
- April 1995
  - Presentation to Rare Fruits Council on "A New Method of Marcottage of Mango - Vinod Kulkarni
  - Organised Exotic Crops R & D meeting - Hort staff
  - Organised Annual Research and Development Meeting - Geoff Kenna/Kylie Young
- May 1995
  - Organised mango pruning field day demonstration - Mike Poffley
  - Organised display at Orchid Show, Okoyama, Japan - Jeremy Powell
  - Organised Annual R & D Review, Darwin - Hort staff from all regions and staff from other Divisions
  - Organised research presentation to Katherine industry - Katherine staff

## Staff Visits

- September 1994
  - Wooliana Mango farm, Daly River, several Hort staff
  - Attendance at Melbourne Flower Show - Jeremy Powell
- October 1994
  - Attendance at Plant Industries Committee meeting, New Zealand - Niranjan Dasari
- November 1994
  - Attendance at Bamboo cultivation meeting, Eumundi, Qld - Kevin Blackburn, Mark Traynor
- April 1995
  - Visited Sarawak with a delegation of AIAS scientists - Niranjan Dasari

## Seminars/Workshops Attended/Presentations

- July 1994
  - 13th Australian Orchid Conference - Darwin
  - Pruning demonstration at Tangentyere Council - Alice Springs
- August 1994
  - Mango Export Seminar - Howard Springs
- October 1994
  - Cross Cultural Workshop - Darwin
- November 1994
  - Display of Territory Produce set up for the opening of Parliament House, Darwin - Hort staff from all regions
- December 1994/January 1995
  - "End of Season Mango Meeting" - Hort staff
  - Cultar workshop conducted by Crop Care (ICI) - Hort staff
- February 1995
  - Annual Research Presentation and Review - Frank Wise Institute in Kununurra - Katherine staff
- April 1995
  - Meeting on Mango Skin Browning, Townsville
- May 1995
  - Exotic Fruit Seminar, El Arish, Qld - Yan Diczbalis, Lana Luders and TK Lim
  - Banana Conference, Gold Coast - Kevin Blackburn, Yan Diczbalis

## Publications

Agnotes

- Poffley, M. Grafting Tomatoes for Bacterial Wilt Control. Agnote A8.
- Blackburn, K. and Poffley, M. Vegetable Varieties for Darwin. Agnote A9.
- Poffley, M. Vegetable Fertiliser Guide for Top End Growers. Agnote B31.
- Poffley, M. Mango Management - Flowering to Market. Agnote D9
- Poffley, M. Improving Soil Structure and pH Levels in Top End Horticulture Soils. Agnote D16.
- Kulkarni, V. and Hamilton, D. Flowering and Fruiting in Mango in the Top End with Paclobutrazol. Agnote D20.
- Tregea, W. Gypsophila Growing in Central Australia. Agnote D21.
- Tregea, W. Geraldton Wax Growing in Central Australia. Agnote D22.
- Tregea, W. Kangaroo Paw Growing in Central Australia. Agnote D23.
- Tregea, W. Flower Seed Sowing Calendar for Central Australia. Agnote D24.
- Powell, J. Home Garden Composting. Agnote D25.
- Powell, J. and Ngo, H. Dendrobium Orchid Production in the NT Top End - Costs and Returns. Agnote H9.
- Tregea, W. and Cann, B. Costs and Returns for Gypsophilia in Central Australia. Agnote H77.
- Tregea, W. and Cann, B. Costs and Returns for Geraldton Wax in Central Australia. Agnote H78.
- Tregea, W. and Cann, B. Costs and Returns for Kangaroo Paw in Central Australia. Agnote H79.
- Blackburn, K. and Traynor, M. Raised Beds for Home Vegetable Gardens. Agnote B33.
- Poffley, M. Fruit Tree Fertiliser Rates in the Top End. Agnote D10.
- Tregea, W. Wholesale Cut Flower Prices 1991-1994. Tech Bull 229.