Evaluation of Date Production in Central Australia

RIRDC Project DNT - 11A

Final Report

G. Kenna and J.G. Mansfield
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Project funded by:
Rural Industries Research Development Corporation (RIRDC)
Northern Territory Department of Primary Industry and Fisheries (NTDPIF)

ISBN: 0 7245 3038 X

September, 1997
PREFACE

It should be noted that one of the main driving forces behind the Northern Territory Department of Primary Industry and Fisheries date research program was Frank McEllister. Frank realised the potential of a Central Australian date industry while studying seedling date palms in the region. However, he was aware that the establishment of a successful date industry could not be based on seedling palms and therefore pursued the introduction of overseas cultivars. Frank was one of the people responsible for organising the funding and importation of the overseas cultivars now growing at the Arid Zone Research Institute. In addition, he went on a study tour to Israel and California in 1986 where he gathered information on date growing. He was able to use this knowledge to assist the development of the date industry. Unfortunately Frank was lost to illness in June 1992 when the date palms he helped introduce and the date industry he helped to promote were both still young.
SUMMARY

The date palm, *Phoenix dactylifera*, belongs to the family *Areceaceae*. This plant has perhaps been grown under cultivation for its fruit longer than any other plant. Dates are an important part of Islamic religious life and are in high demand for various ceremonies. At the present time there are 150 registered Islamic communities in Australia. In addition a number of South East Asian countries including Malaysia and Indonesia have a significant Islamic population. This is a large potential market for Australian produced dates. Also the consumer demand within Australia for dates is increasing due to the recognition of dates as a health food. In 1992 the total value of date imports into Australia was $7 million. Of this total $3 million were high quality dessert dates. Australia is credited with exporting dates to South East Asia (21 tonnes in 1992). However these dates are not grown in Australia and are fruit which were grown overseas, imported into Australia and then shipped out of Australia to South East Asia.

Date palms growing in the Northern Territory, South Australia, Western Australia and Queensland, both under cultivation and at abandoned sites, show that this plant is adapted to the arid climatic conditions experienced in Central Australia. Large areas of Queensland, Western Australia and the Northern Territory have been identified as having potential for commercial date production. Many of these areas have been disadvantaged by depressed animal production enterprises and are actively seeking alternative sources of income. Production of dates in these drier areas may provide employment opportunities as date production is labour intensive. There are also opportunities for value adding.

The commercial date industry in Australia at the present time is quite small. There are two commercial plantings in the Northern Territory, one in Western Australia and a number of small plantings in western Queensland. Apart from one Northern Territory planting and the Western Australian planting the majority of palms grown are seedlings or offshoots from seedlings. These produce an inferior quality fruit compared to the imported commercial selections. In addition, the commercial selections are recognised and well received in the international markets and this is not so for seedlings dates. Seedling palms also have additional management problems which affect their economic viability.

The Northern Territory government recognised the potential of the date industry in the early 1980's and commissioned a number of investigations into the production, economics and marketing of Australian dates. In addition to this they started importing commercial cultivars from overseas in September 1986. The first of these were planted in September 1989.
in the Dahlenburg Research Block at the Northern Territory Department of Primary Industry and Fisheries (NTDPIF) Arid Zone Research Institute (AZRI), Alice Springs. The importing and planting of date plant material has been ongoing since this initial consignment. The palms in this research block have been the basis of four major research projects.

A major factor limiting the expansion of the developing Australian date industry at this time is the availability of planting material of recognised commercial cultivars. At present commercial cultivars are propagated by using either offshoots or tissue culture. Offshoots are auxiliary buds which grow from the trunk of the parent palm. They have the same genetic characteristics as the parent palm from which they originate. Offshoot material of recognised commercial cultivars is difficult to obtain in Australia. It is also expensive to import and is subject to stringent quarantine requirements which involve treatment upon entry. The import of tissue culture palms in vitro has been found to be a viable alternative to the import of date palm offshoots. Tissue culture offers the possibility of importing material from countries where offshoot material cannot be obtained due to quarantine restrictions. In addition, tissue cultured plants are cheaper to import than offshoot material and as they are in a sterile medium they do not require fumigation on arrival. Another use of tissue culture in the future is that it offers a method of rapidly multiplying up planting material within Australia. At present, there are only two known commercial laboratories supplying tissue cultured material. One is in England and the other in the USA with the former only being accredited to supply material to Australia at this time.

There is some reservation about whether off-types may occur in tissue cultured date palms and that not all palms produced are “true to type”. To assess this an experiment was conducted at AZRI to compare tissue-cultured and off-shoot palms of the same cultivar for seven different cultivars. Depending on availability, tissue cultured palms produced by two different methods of propagation (callus multiplication and bud proliferation) were used. The offshoot material had been imported from California. The palms are still young and as yet little data has been collected on the fruit characteristics of each palm. Therefore, it is not yet possible to check if the palms are “true to type” by making comparisons within each cultivar of the fruit from palms of the various plant sources. However, at this stage it is possible to compare within each cultivar the production patterns of palms from the different sources. The offshoot palms tended to flower earlier than the tissue-cultured palms, most likely because they were larger and older when they were planted. They also tended to yield higher, possibly because they had more leaves and more food reserves. It is difficult to compare the
performance of the palms from the two different tissue-culture techniques due to differences in planting dates.

Throughout the world several thousand cultivars of dates have been recognised, but of these, those which have any commercial importance are limited to about 100 or so. Two projects have been conducted at the AZRI to assess the performance of international cultivars under Central Australian conditions and to determine their suitability as potential cultivars for commercial production in this region. However, many years are required to test thoroughly a new date cultivar because of varying climatic conditions and the effect that certain management and cultural techniques sometimes have on successful fruit production.

The first cultivar evaluation project studied the performance of palms of four cultivars (Barhee, Deglet Noor, Medjool and Thoory) planted in a statistical planting. The palms were planted in September 1989. The evaluation is still in the preliminary stages as date palms do not reach their maximum yield potential until ten to twelve years after planting. Some differences in the flowering and fruiting patterns and the fruit characteristics have been observed.

By the 1994/95 season, most palms of all cultivars had flowered. However, even by 1995/96 season, flowering patterns were still inconsistent as all the palms were not producing flowers every season. They may flower one season and not the next. This is particularly the case for the cultivar Thoory. In the case of all cultivars, except Thoory, the maximum number of flowers produced by a palm has steadily risen to reach a peak of 17 in the 1995/96 season. For Thoory the highest number produced by a palm was 19 in the 1994/95 season, while the highest in the 1995/96 season was 14. Because some palms failed to produce flowers or are only producing a few flowers, the average number of flowers per palm for the cultivars ranged from 7 to 9 in the 1995/96 season.

In general, Medjool was the earliest to produce fruit, normally followed by Barhee, while Deglet Noor and Thoory tended to begin fruiting later. The first two cultivars to begin fruiting, Medjool and Barhee usually finished fruiting before Deglet Noor and Thoory. However, the timing of when cultivars commenced and completed fruit production varied from season to season. Even six and a half years after planting the average yield of the palms is still low and erratic. When the average yield per palm is added together for the four seasons in which fruiting has been recorded since planting (1991/92 season not included), Deglet Noor has totaled 30 kg per palm compared to Barhee (20 kg), Thoory (19 kg) and Medjool (8.5 kg).
Medjool produced the heaviest fruit (around 16 g) which was also longer and wider than that of the other cultivars. While Barhee produced the next heaviest fruit (around 10 g). Barhee fruit were the shortest of the four cultivars, however, they were the second widest fruit after Medjool. Deglet Noor and Thoory seem to produce fruit of a similar weight (around 8 g) and similar dimensions.

The aim of the second cultivar evaluation project is to establish a collection of the world's best cultivars. At the AZRI is a planting consisting of eighteen female and three male cultivars. This collection includes palms planted specifically for observation purposes, but also includes the palms planted as part of two other experiments (the trial comparing the effect of plant source on palm performance and the statistical planting evaluating four cultivars). It is comprised of 239 palms with varying numbers of each cultivar. The palms come from various sources (offshoots from California and tissue-cultured palms from France and England) and were planted at a number of different planting dates. However, this collection can be used to make general observations on potential cultivars for the area. In addition, it acts as a source of offshoot material. In the future, it is envisaged that planting material from the collection in Alice Springs could be sent to other areas in the Northern Territory and Australia to establish plantings of these cultivars under different conditions.

The information obtained to date for each cultivar is presented in this report. From this information it is possible to see the variation in the characteristics from year to year, the effect of palm age on these characteristics including fruit size and the differences between the three harvest stages (khalal, rutab and tamar). For growth characteristics such as flowering, fruiting and offshoot production it is difficult to draw comparisons between cultivars due to the variation within and between cultivars in planting dates. However, for fruit characteristics such as length, diameter and individual fruit weight, which are not influenced as much by the age of the palm, some general comparisons between cultivars can be made.

The final research project conducted was to evaluate a range of material as bunch covers on four different cultivars. The occurrence of rain on date fruit as it nears maturity can cause considerable damage to the fruit. This can cause a downgrade in fruit quality or render the fruit unmarketable. However, cultivars vary in their susceptibility to rain damage with some being more sensitive than others. By planting cultivars resistant to rain damage, losses may be reduced. But these cultivars are still susceptible to damage by vertebrate and invertebrate pests.
The ideal bunch cover would be one possessing all the following attributes:

1. Waterproof during heavy rains
2. Allow free circulation of air throughout the bunch in periods of high humidity.
3. Allow easy entry for picking ripe fruit
4. Exclude vertebrate and invertebrate pests
5. Be economical to manufacture and fit to the bunch.

Unfortunately, the covers trialed here, did not have all these attributes. In the 1994/95 season, when the maturation period was very wet, covers made of shadecloth and nylon appeared to be most effective in preventing losses due to rain damage, as they allowed air circulation in and around the bunches. Although they will only keep light rain off the fruit, good air circulation appears to be more important in the prevention of mould growth following rain. Covers made of dense material (plastic banana bags and weedmat) appeared to be the least effective in preventing rain damage. This was probably due to heat, condensation build-up and lack of air circulation in and around the bunches, leading to excessive mould growth and fruit rots. It should, however, be noted that on these relatively young palms the fruit bunches hang quite close to the ground and the problem of condensation build-up in these covers may not be as prevalent in older palms with higher bunches. In contrast, in the drier season of 1995/96, the denser materials, particularly the plastic banana bags, tended to reduce losses due to vermin and bird damage.

In the 1994/95 season, when conditions were conducive to rain damage, the cultivars growing at AZRI showed similar responses to those reported overseas, except for Thoory. Medjool suffered the least damage and Deglet Noor the most damage, while Barhee suffered moderate losses. However, Thoory, which is considered very rain tolerant overseas, suffered more losses than Barhee and was only better than Deglet Noor.

The future research on date palms in Central Australia in the short term will involve less emphasis on comparing cultivars and more on adapting management techniques for the region. Selected palms will be monitored over the next five years for yield and fruit characteristic data. In another 5 years, when all the palms are reaching their productive peaks, more intensive research on cropping potential may begin. Though dates are grown commercially in Central Australia, there has been little research on refining management and production techniques necessary for high quality fruit production in this region. Further work will examine the nutrient and irrigation requirements of dates in the region.
For the development of a viable Australian date industry, all of the states need to work together rather than individually. It is important that a tissue culture protocol be developed and implemented to allow the developing date industry in Australia access to large volumes of superior genetic material as this is a major factor limiting expansion of the industry at this time.
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1 General introduction

1.1 Background information

The date palm has perhaps been grown under cultivation for its fruit longer than any other plant (Nixon and Carpenter, 1978). Its exact origin is unknown. It is thought to have grown wild in prehistoric times along the ravines bordering the desert regions of Mesopotamia (now Iraq) (Simon, 1978). The Lower Euphrates valley appears to have been the centre of ancient date cultivation, perhaps as long ago as 5 000 years (Simon 1978). Dates then spread across Arabia into North Africa along the trade routes of the old world (Nixon and Carpenter, 1978).

1.2 Botanical description

The date palm, *Phoenix dactylifera*, belongs to the family *Areceae*. It is in the same genus as ornamental palms such as *Phoenix canariensis* (Canary Island Palm) and *Phoenix sylvestris* (Sugar Palm). Its main distinguishing feature from these palms is that it produces offshoots, or suckers, and its tall columnar, relatively thick trunk (Nixon and Carpenter, 1978). The genus *Phoenix* is distinguished from other genera of pinnate-leaved palms by upward and lengthwise folding of the pinnae and the peculiarly furrowed seeds (Nixon and Carpenter, 1978).

The date palm characteristically consists of a single stem with a cluster of offshoots (suckers) at the base and a stiff crown of pinnate leaves at the top. If the offshoots are allowed to grow, the palms eventually becomes a large clump with a single base (Popenoe, 1920). Date palms have been known to live for 100 to 200 years although the commercial life of the palm may be much less depending upon factors such as climate, soils, quantity and quality of water etc (Petherbridge, 1980). The age of the tree may be approximately judged by its height (Petherbridge, 1980).

The date palm is a monocotyledon and has only has a single growing point. If this is removed the plant will usually die (Nixon and Carpenter, 1978, Petherbridge, 1980). Up to 25 leaves may be produced each year under good conditions and palms can carry up to 140 to 150 leaves (Petherbridge, 1980). With age the photosynthetic efficiency of the leaves gradually decreases and leaves normally have a functionally life of around four years (Nixon, 1957). Old leaves are not shed but gradually dry up and hang down. In cultivation these dead leaves are removed (Nixon and Carpenter, 1978). The root system of the date palm is usually extensive and roots may be 3 to 13 metres long and 1 to 2 cm in diameter (Petherbridge, 1980).
1.3 Historical, research and commercial date plantings in Australia

1.3.1 Northern Territory

The first planting of date palms in Australia was at the Hermannsburg Mission, 130 km west of Alice Springs. These palms were established from seeds which were sent in the early 1880's to the mission by Baron von Mueller, Director of the Botanic Gardens at Adelaide, in return for numerous specimens of native flora which the missionaries had collected for him (De Fontenay and De Fontenay, 1960). Many of these palms are still growing at the community although they are not producing fruit and many are in poor health.

The CSIRO planted palms at the Research Station at Katherine in 1952-53. These palms were grown from seeds which had been imported. Few survived transplanting and many remained in the nursery and were not planted out (De Fontenay and De Fontenay, 1960).

The first commercial date planting, “El Mirna”, was established at Alice Springs in 1952 by Mr and Mrs V J De Fontenay. Prior to establishing the planting, for two years they observed 32 palms (20 female and 12 male palms) growing in the Alice Springs and surrounding areas. These palms were growing in backyards, on vacant allotments and alongside old wells, springs and watercourses. Fifteen of these palms were selected for further trials. Eight of the palms were successfully transplanted to “El Mima”. Offshoots from all fifteen selected palms were also planted at “El Mima”. Between 1953-55 twelve off shoots of the cultivar “Deglet Noor” were given as a gift to De Fontenay's by a grower in California. Nine of these were established successfully at “El Mima”. In 1958, six offshoots were removed from one of the remaining palms at the old Cobdogla-Lake Bonney Irrigation Channel (now Barmera, SA) (see section 1.3.2.) and planted at “El Mima” (De Fontenay and De Fontenay, 1960). Unfortunately the date palm pest, parlatoria scale was introduced to Central Australia on these offshoots. Though these offshoots were removed and destroyed, the scale had spread to other palms and had became established (McColl, 1992). The “El Mima” planting is presently been run as a tourist attraction under new owners and with a new name “Mecca Date Gardens”.

In 1975 fifty offshoots were imported from America but only 12 survived. These offshoots plus other offshoots from the palms at Hermansburg Mission were planted in the Horticulture Block at the Arid Zone Research Institute (AZRI) in 1976. In addition 342 date seedlings were grown from imported American seed. These were planted at the Alice Springs Sewage Effluent Farm in October, 1976 and May, 1977. However around 80 died. The 265 palms at the Sewerage works were transplanted along the De Fontenay Drive of the AZRI in 1987/88. A majority of the female palms were removed in 1997. These seedling palms and
offshoots of seedling palms gave an indication of the potential of dates in the region and were responsible for initiating efforts to import the material of established cultivars from overseas which is now currently grown at AZRI (Plate 1).

Two commercial date plantings are currently established in the Northern Territory. One has been established at Deep Well, approximately 80 km south of Alice Springs. Approximately 1,500 palms are established there and consist of seedlings, offshoots from seedlings, commercial offshoots from California and tissue cultured palms (Kenna, 1993). The oldest palms, which are seedlings, are approximately 13 years of age. The other plantation is located approximately 60 km South East of Alice Springs. This area has only recently been developed as a date plantation. The planting consists of approximately 600 palms of named commercial varieties, either offshoots or tissue cultured. Further plantings are planned in the near future using tissue cultured palms which have recently been imported (Kenna, 1993).

1.3.2 South Australia

In the 1890's plantings were made at Hergott Springs (now Marree) and Lake Harry, approximately 30 km north of Hergott Springs. These palms were both seedlings and offshoots. Some offshoots originated from India. In 1894, around 100 Deglet Noor offshoots from Algeria were donated by the French Government and freighted to Australia. Around fifty of these were planted in New South Wales (see section 1.3.3). The other fifty two were planted at Lake Harry. These plantings were cropped successfully for more than twenty years and the dates produced were sold locally and in the Adelaide markets. During the peak of development 279 palms were planted at Hergott Springs (1896-97) and 3,300 at Lake Harry (1901-1902). These numbers gradually declined each succeeding year. The decline was due to death of palms, culling of seedlings, burying of the palms by sand storms, lessening of bore water flow and degradation of water and soil quality. In 1994 40 palms (mostly Deglet Noors) were transplanted to the Berri Irrigation Farm on the Murray River. Another 26 Deglet Noor palms were moved in 1915 to the Cobdogla-Lake Bonney Irrigation Channel (Barmera). Most of these palms had been removed when the sites were visited in 1958 but six offshoots were taken from one palm for planting on a Northern Territory property (see section 1.3.1) (De Fontenay and De Fontenay, 1960).

Date palms were planted at Dalhousie pastoral lease from seed sent in the late 1800's by Baron von Mueller. Some of these or descendants of them are still growing at the Dalhousie homestead ruins near a spring and in a creek bed and on mound springs in the vicinity of the ruins (Carpenter, 1988).
Offshoots and seedlings from imported Californian seed were planted at the Ernabella community in 1976. Although the palms were cared for and thrived for a few years, they are now abandoned and a large number of the palms have died (Carpenter, 1988).

1.3.3 New South Wales

In 1894 some Deglet Noor date palm offshoots were imported into NSW. These were supplied by the French Government and originated in Algeria and were part of the shipment which also went to South Australia (see section 1.3.2). In 1895, thirty-two offshoots were planted at Pera Bore and sixteen at Wollongbar. Though they were meant to be all of the one cultivar several different cultivars were actually present (Allen, 1910). They proved unsuccessful in the Wollongbar district, and at Pera Bore only one of the cultivars proved to be of commercial value. This palm did not sucker, so at the time it was not possible to reproduce it (Anon, 1966). Seedling palms grown from seed imported from the Middle East were planted in 1936 at Lake Curlew near Lake Cargelligo, in NSW and by 1962 several had borne fruit. However, the fruit failed to ripen evenly although some selections carried good bunches of large dates (Petherbridge, 1980; Sweedman, 1985). More importations were made from the USA in 1941 but most of the material failed to survive (Anon, 1966).

1.3.4 Queensland

From 1866 until the late 1890's the Queensland Acclimatisation Society distributed dates palms to individuals throughout the State. These were a mixture comprised of offshoots from locally grown palms and imported offshoots. In 1895 six palms imported from Bombay were donated to the society and also a consignment of 110 female and 20 male offshoots were received from the Persian Gulf. Unfortunately, the Society's records and maps were lost (Skerman, 1978a).

In 1935, a Date Experimental Plot was established in Barcaldine using offshoots obtained from the Rockhampton Botanical gardens and from locally grown palms. Some additions were made in the following years. The planting was never really successful and was abandoned in 1943 because the fruit were of inferior quality, water was limited and it was difficult to find labour and material to maintain the plot because of World War II (Skerman, 1978b).

In 1937, seeds of nine Californian cultivars were collected in the USA and the seedlings were planted at the Callide Cotton Research Station, Biloela and Queensland Acclimatisation Garden at Lawnton. The seedlings from Biloela were later transplanted to a number of western districts. One relatively large planting was at Rayford Park near Condamine in South East
Queensland and in the 1940's other palms were distributed to properties in the Charleville area (Skerman, 1978c). The performance of the seedling palms of six cultivars at Rayford park was documented for ten years to assess their potential in the region. The main problem encountered at Rayford Park was wet weather when the fruit was maturing on the palm (Richardson, 1952).

Commercial plantings of dates have been established in the Cunnamulla - Eulo area. There are approximately 7,000 palms planted in the area. The majority are seedling selections or offshoots from seedling selections. The plantings started around 1982.

1.3.5 Western Australia

At the Gascoyne Research Station Carnarvon, various plantings have been made since 1940 with offshoots and seedlings derived from the USA. Offshoots of ten named cultivars were obtained from California in 1952. In 1984, the only surviving named cultivars were Khadrawy, Halawy, Thoory and Zahidi. Except for Khadrawy, these palms were too old to produce offshoots. In addition, numerous seedlings of named cultivars were observed for their potential as possible new cultivars. Experimental work on dates ceased in 1973 when it was considered that the priority rating for research on this crop was low. However, the existing plantings were kept (Burt, 1990). These palms have been neglected in the last few years and although still growing were in a poor condition when inspected in 1993 (Kenna, 1993).

A small planting of palms has been established at Gascoyne Junction - approximately 200 km east of Carnarvon. The palms were imported as offshoots from California and are all commercial cultivars. They were planted in the field in 1991 (Zekulich, 1993).

1.4 Agronomic and management requirements

1.4.1 Soils

Dates will grow on a wide range of soil types from sands to deep clays, provided sufficient water is available, and soils are deep enough to allow root penetration (Petherbridge p41, 43). However sandy loams which have adequate moisture holding capacity and are free draining are considered as being some of the best types of soils (Nixon and Carpenter, 1978). Ideally soil pH should be around 7 and the salt levels low. Although date palms will grow in salty and sodic soils and are able to cope with water with higher TDS levels than most crops, plant growth and cropping levels can be reduced significantly (Nixon and Carpenter, 1978).

1.4.2 Climate

For proper fruit maturation, the date requires prolonged summer heat without rain or high humidity during the ripening period (Nixon and Carpenter, 1978). A long hot growing season is essential if the true potential for date production is to be realised in terms of palm
growth, yield and fruit quality. A method used to determine the suitability of a potential date
growing area is to add degrees Celsius above 18 degrees for each daily maximum temperature
for the six months from flowering to fruit maturation, (mid September to mid March in the
southern hemisphere). A total of 2 000 units is considered to be the minimum with only early
maturing varieties suitable for cultivation. Over 3 000 heat units is considered preferable. Alice
Springs has a an average of 2 843 heat units and local experience has shown that many cultivars
will ripen in Central Australia but difficulty with ripening of some late maturing cultivars (such
as Deglet Noor) can be experienced in some seasons (McEllister and Tamblyn, 1991).

The incidence of rain during the fruit maturation period can severely affect fruit quality
in some seasons (McEllister and Tamblyn, 1991). Splitting, checking and other disorders can
result. If rain persists for a prolonged period fungal growth on fruit may also occur. This topic is
covered in greater detail in section 6.

Early maturing varieties may be more suitable for planting in areas where there is a high
incidence of summer rain. Also cultivars which can be harvested at the khalal stage by removing
the whole bunch may have advantages in these localities. The use of materials to cover the fruit
bunches may help reduce fruit damage. This topic is covered in greater detail in section 6.

1.4.3 Planting distances

Palms are usually planted at a spacing of 9 metres between rows and 9 metres within
rows. This gives a total of 123 palms per hectare (McEllister and Tamblyn, 1991). One male
palm should also be planted for every 30 females. These male palms should be planted
separately from the females for ease of management.

1.4.4 Planting material

The majority of early commercial plantings of dates were established using palms grown
from seed. Palms grown from seed do not produce fruit true to type to that of the parent palm. In
most instances fruit quality and yields are variable and inferior in all aspects to that of the
recognised commercial cultivars. Also as date palms are dioecious it is difficult, if not
impossible, to reliably determine the sex of the seedling palms until they flower. This usually
does not occur until the palm is at least 4 years old. As there is at least a 50% chance that the
plant may be a male palm there may be a very high percentage of male palms in the planting if
seedlings are grown as a commercial crop. Most of these male palms have to be removed and
another palm planted. Also as consumer preference for high quality dates increases the demand
for seedling dates for the dessert market is expected to decline. This may limit the market for
this type of date to the lower value processing industry if a market is available at all.
A major factor limiting the expansion of the developing Australian date industry at this time is the availability of planting material of recognised commercial cultivars. There are several methods used to obtain date palms of known cultivars - offshoots and tissue culture. Offshoots are auxiliary buds which grow from the trunk of the parent palm (Plate 2). Most buds occur at the base of the trunk however a palm may also produce some aerial offshoots. Offshoots have the same genetic characteristics as the parent palm from which they originate. Parent palms will produce offshoots for the first 12 years of the plants life. The number of offshoots produced varies depending upon the variety. When these offshoots reach approximately 20 cm in diameter at their base they are removed from the parent palm. This is labour intensive and requires some expertise with the use of a jackhammer (Plate 3).

Offshoot material of recognised commercial cultivars is difficult to obtain in Australia due to the low number of palms of commercial cultivars previously imported into the country. Imports have been made in the past in an effort to introduce high value commercial cultivars. However, stringent quarantine requirements, including fumigation, have to be met before importing palm material. These quarantine requirements can result in the death of offshoots and also limits the countries from which plant material can be obtained. In addition, the high cost of airfreight has raised serious doubts as to the economic viability of importing offshoot material.

The import of tissue culture palms *in vitro* has been found to be a viable alternative to the import of date palm offshoots. Tissue culture offers the possibility of introducing material from countries where offshoot material cannot be obtained due to quarantine restrictions. In addition, tissue cultured plants are cheaper to import than offshoot material and as they are in a sterile medium they do not require fumigation on arrival. Another use of tissue culture, besides being a means of importing plants, is that in the future it will offer a method of rapidly multiplying planting material within Australia. At present, there are only two known commercial laboratories supplying tissue cultured material. One is in England and the other in the USA with the former only being accredited to supply material to Australia at this time. With tissue culture, palms losses can occur during the weaning process, however once they have been weaned into pots and grown on, they can usually be planted out 20 months later (Plate 4).

**1.4.5 Nutrition**

There has been little research on refining management and production techniques necessary for high quality fruit production in Central Australia. As yet no attempt has been undertaken to assess if the present rates and timings of nutrient applications are the optimum for date yield and quality in Central Australia. The schedules currently used are based on
overseas recommendations. Our knowledge of whether deficiencies or toxicities of nutrients may be limiting production and growth in Central Australia is limited. The information presently obtained is discussed in section 2.3.4.

1.4.6 Irrigation

As the date palm is best suited to the hotter climatic areas of Australia where evaporation rates are high and rainfall low, adequate supplies of irrigation water are essential if viable commercial crops of high quality fruit are to be produced. In their native habitat, date palms grow around oases and have their roots permeating the underground water table. In commercial plantations, the lack of a water table near the soil surface can be compensated for by using irrigation. However, good quality irrigation water is a valuable and limited resource in Central Australia and needs to be conserved where possible. Micro-irrigation techniques are used in this region with drip irrigation being the most efficient means of applying water.

The main date production areas in this country rely on bores to supply the irrigation requirements. This bore water varies considerably in salt content. It is preferable to use water below 1000 mg/l T.D.S. Water up to 2,500 mg/l T.D.S. could be used if suitable irrigation application and scheduling techniques are applied, without serious damage to palms or loss of production. Water up to 5000 mg/l T.D.S will not kill a date palm but would cause poor growth and serious loss of production (McEllister and Tamblyn, 1991).

The present irrigation schedules are based on overseas recommendations with some local adaptation. These schedules could be adding more water than is necessary and at the wrong time. The annual water requirement for date palms is considerable and increases with age. The irrigation scheduling of dates is discussed in greater detail in section 2.3.5.

1.4.7 Pruning

Pruning of date palms enables management practices to be implemented more efficiently and effectively. It allows better access to the palm for practices such as pollination, bunch management and fruit harvest. In dates there are three stages to pruning:

a) Dethroning

b) Frond removal

c) Removal of floral and fruiting remnants

Dethorning leaf stems consists of removing the thorns which grow along the leaf stems of the fronds. This is an important operation as if the thorns remain they will restrict access to the palm and may cause serious injury to workers. The removal of the thorns consists of running a sharp knife just under the thorn below the first leaf and cutting
Plate 1 Date palms growing in the Dahlenburg Research Block at the Northern Territory Department of Primary Industry and Fisheries’ Arid Zone Research Institute (1994).

Plate 2 Offshoots trimmed and tied ready for removal.
Plate 3 Removal of date offshoots with a jackhammer.
downwards towards the base of the leaf. If the cut is shallow all of the thorns on one side of
the leaf can be removed in a single cut and the strength of the leaf will not be affected. A
knife designed for cutting lino flooring material is suitable for the job. Heavy gloves should
also be worn to protect against thorns on other fronds.

Fronds are removed when they are of no further use to the plant, have turned brown
and are bent towards the ground. They should be removed as they make management difficult
and will encourage pests and disease. Healthy green fronds should not be removed unless
absolutely necessary as they are a functioning part of the plant. Some outer fronds on
offshoots may need to be removed to gain access to the palm or to prepare the offshoot for
removal from the parent palm. Fronds are removed by using secateurs, a pruning saw,
pneumatic secateurs or hydraulic secateurs on large established plants.

After flowering, the male and female flowers which have not been used for pollination
or have not been pollinated are removed. In addition, the remnants of the bunch stalk after
harvest are also removed.

1.4.8 Pests and their control

Date palm production in Central Australia has been relatively free of pests causing
economic damage to the plants and fruit. However, as plantings continue to develop there is a
possibility of native insects inhabiting vegetation in the vicinity of the date plantings
becoming a problem. These insects could move from their native hosts to the date palms and
cause damage to the plant or fruit. Already damage caused by a native borer tunnelling into
fruit has been recorded.

*Parlatoria* scale (*Parlatoria blanchardi*) is a major insect pest of date palms in many
parts of Australia and overseas countries (Carpenter and Elmer, 1978). The scale originates
from Middle Eastern countries where dates are grown. Besides infesting date palms it can also
infest the Canary Island palm (*Phoenix canariensis*), the California fan palm (*Washingtonia
filifera*), the pygmy date palm (*Phoenix roebellini*) and the doum palm (*Hyphaena thebaica*)
(Boyden, 1941). It is thought the scale was introduced to Australia on offshoot material in the
early 1900’s. It is a major pest of date palms in commercial and ornamental plantings in
Central Australia. The scale is a proclaimed pest under the Northern Territory Plant Pest and
Diseases Act.

Scale infests the leaves, leaf stalks and fruit (Plate 5 and Plate 6). It favours the white
succulent tissues at the base of the leaf stalk where it is protected by the fibrous material on the
trunk. As the population increases the scales move up onto the leaf surface and onto fruit. It can
increase in numbers rapidly though it is not favoured by very hot or very cold weather. Although in many instances it will not kill the plant it will cause it to become unthrifty and yield may be decreased. The presence of scale on fruit causes it to be decreased in price and may even make it unsaleable (McEllister and Tamblyn, 1991).

The life cycle of the insect consists of the adult female laying eggs which hatch and emerge from under her protective scale. The young crawlers settle not very far from where they hatch. The female scale, which has a dark spot in the centre with a grey/white border, is only mobile in the crawler stage whereas the male, which is white in colour, is mobile as an adult. Because of the lack of mobility of the insect they can form encrustations by forming layers of new scale on the remains of older insects while other parts of the plant may remain relatively clean. The female lays eggs throughout the year although the number of generations appears to increase in the warmer months.

Control of this insect is difficult. If the date industry is to reach its full potential in Australia it is important that this insect be quarantined from the commercial date growing areas. Good quarantine practices which ensure that no infested material is introduced onto properties is the most effective means of ensuring that the scale does not affect commercial production.

Foliar applications of the insecticide Maldison® in combination with white oil has been effective in significantly reducing scale populations when applied at three weekly intervals over a number of years. However, if the treatment is discontinued scale numbers can increase dramatically. This is due to young crawlers emerging from scale protected by the leaf axils or the fibrous material on the trunk of the palm. It is not easy to detect the presence of these scale.

Biocontrol organisms are also being trialed for their effectiveness in controlling scale. Red chilocorus lady bird (Chilocorus circumdatus) and blue chilocorus lady bird (Chilocorus baileyi) have been released onto palms heavily infested with scale to evaluate their ability to reduce scale populations in situations where control using insecticides is undesirable.

1.4.9 Diseases and their control

The incidence of disease in date palms in the Alice Springs region has been minimal due mainly to the hot, dry climate. Stringent quarantine regulations concerning where date palm material can be sourced for import to Australia has also probably assisted this. It is expected that diseases will continue to remain at a low level due to the use of mainly tissue cultured material rather than offshoots for future plantings.
Plate 4 Tissue culture palms being grown on in a glasshouse prior to field planting.
Plate 5 Parlatoria scale on date leaves.

Plate 6 Parlatoria scale on fruit.
While incidence of diseases on field grown plants in the Alice Springs region is minimal some diseases have been observed on dates in other parts of Australia. Young dates grown in nursery situations have been affected by *Fusarium* sp. While *Graphiola* leaf spot (*Graphiola phoenicis*) has been reported on date palms in the northern part of the Northern Territory. It is prevalent under humid conditions and is the most widespread of the date palm diseases. Leaves can be severely damaged and this can reduce yields. Heavily infested leaves die prematurely. No occurrence of *Graphiola* leaf spot has been reported in Central Australia and because of the low humidity in this region it is felt that the disease will not become a major problem if it did occur (McEllister and Tamblyn, 1991).

1.4.10 Weeds and their control

Weed control in date plantings consists of a combination of the use of herbicides and mechanical methods. The environment which is best suited to the production of dates has a low incidence of rain therefore weed control is usually limited to the control of weeds which grow as a result of the application of irrigation water to the palms.

The method of control is related to the age of the palms. Weed control in the first few years after planting is usually by hand hoeing or using a whipper snipper immediately around the base of the young palm. The remaining area between the plants and in the rows is either slashed or weeds are controlled using a covered Controlled Droplet Applicator (CDA) such as an Environmist®. Buffel Grass (*Cenchrus ciliaris*) tends to be a persistent weed which regrows after a rainfall event. This is best controlled by spot spraying with glyphosate.

As the palms grow and new fronds develop from the top of the palm, the lower fronds yellow and die. These dead fronds are progressively removed from the base of the plant and the trunk becomes covered by a thick matting of fibrous material and remnants of the leaves which protects and insulates the plant. Therefore, when plants reach this growth stage it is possible to use either herbicides which are desiccants or systemic glyphosate based. These are applied by hand directed nozzle around the base of the palms and by CDA down the tree row and between the rows. plants which originated as offshoots. Herbicides can be used on weeds close to plants which originated as offshoots a lot sooner after planting than on palms propagated using the tissue culture methods. This is because tissue cultured palms have fronds at their base that remain active for a number of years after planting out and it is not safe to use herbicide on these.
Weed growth can also be controlled by slashing particularly between the rows of palms. The main disadvantage with this method of weed control is that regrowth may occur and that often it is not possible to slash close enough to the palms because of the fronds.

1.4.11 Flowering and pollination

Date palms are dioecious, having separate male and female plants (McEllister and Tamblyn, 1991). The flowers of the male palm are waxy, cream coloured and are somewhat larger, more attractive, and more numerous than the whitish, globular, widely spaced female flowers. The flowers are produced on long slender strands, and emerge from the palm inside a woody protective covering (spathe) which opens to release the flowers (Simon, 1978) (Plate 7). In their natural environment, date palms are fertilised by wind and insect, but this is a haphazard affair, and does not always result in good fruit set (Simon 1978). However, because the date palm also produces suckers from its base (offshoots) then fruit production is not as important for its proliferation as in some other types of plants. (Simon, 1978).

To overcome the poor results of natural pollination, in a commercial production situation the female flowers must be hand pollinated. The male flowers are cut from the palm as they emerge from the spathe. The flowers are then dried and the pollen removed by shaking and then sieved to removed any debris. The spathe is cut from the female flower as it begins to open. The strands are thinned (see section 1.4.12) and the pollen from the male flowers are then blown onto the female flower parts using an applicator. After pollination, the flower strands are tied together, with sufficient twine to allow for expansion as the fruit begins to grow (Plate 8). It is important that the male palms selected have a range of flowering times so that pollen is available for early, mid and late season flowering females.

1.4.12 Bunch maintenance

The bunches are thinned to reduce the number of fruit on the bunch. Thinning is undertaken because if too much fruit is retained in one season on a palm it can reduce the yield in the next season resulting in biennial bearing (a good season followed by a poor season) of the palm. Thinning can also increase individual fruit size and quality as well as reducing the weight of individual bunches. Overweight bunches can cause the stem to bend or break resulting in the loss of the whole bunch. Reducing the number of fruit in the bunch also allows better airflow around individual fruit which helps prevent fruit losses under conditions of high humidity. At the same time fruit on individual bunches should not be thinned excessively as this may result in physiological problems which will affect fruit quality.
Plate 7 Bees working a male flower which is emerging from its spathe.

Plate 8 Female flowers which have been trimmed, tied and hand pollinated.
Thinning starts at the time of pollination with the removal of the top quarter to a third of the flower stalk. This tends to trim the bunch up and also reduces the number of fruit that develop. Once it is certain, which bunches were successfully pollinated, the number of bunches carried by the palms are regulated according to the size of the palm, and any excess bunches are removed. The rationale that a vigorous tree can carry about one moderately thinned bunch of fruit for every eight to nine leaves is used to determine the number of bunches retained on a palm (McEllister and Tamblyn, 1991).

Normally, six weeks after pollination, entire strands from the centre of the bunches are removed to open up the bunch and in some cases individual strands are thinned to reduce the fruit number per bunch. About 30% of the strands are removed in long-strand bunches and up to 50% in short-strand bunches. This operation is only carried out after any natural thinning of the fruit in the bunch had been completed.

Once the bunches had developed sufficiently, they are pulled down through the leaves and the fruit stalks tied to a petiole of one of the leaves. This is done to support the bunch as it develops, to prevent bending or breakage of the fruit stalk, to avoid the bunch tangling with emerging fronds and to prevent scarring of the fruit by rubbing. In pulling down the bunches care must be taken to avoid breaking the fruit stalks. In addition, tying down is left until the stalk is long enough to ensure that some of the stress is spread along the stalk and not all of it is exerted on the base.

The date bunches are normally covered in the “kimri” (green/unripe) stage of development just before the “khalal” stage (early ripening) to prevent damage to the fruit. In some cultivars, such as Medjool, spreader rings are used to open up the centre of the bunches to allow aeration and to help prevent rots.

1.4.13 Harvesting

The fruit on a bunch does not ripen all at once and therefore it is common to make several pickings from each bunch. This is especially so if the dates are being used to supply the fresh fruit market. This makes harvesting time consuming and costly. With dry and semi-dry dates, the bunches are left until all the fruit is ripe and then the whole bunch is removed. When palms are young they can be picked from the ground and as they get bigger, ladders and hydraulic picking platforms are used to harvest the bunches (McEllister and Tamblyn, 1991).

After harvesting, dates are normally cleaned to remove dust by placing them in a mechanical shaker and using compressed air or water spray to dislodge dust and dirt. They are
then graded to remove unsaleable fruit and to separate fruit into different class depending on size and ripeness (McEllister and Tamblyn, 1991).

1.4.14 Yields

Palms begin to produce crops of fruit 5 years after being planted in the field if growth rates have been satisfactory. They usually reach their peak production at around 11 to 12 years of age. Average yields range from 5 kg/palm (615 kg/ha) at year 6, to 100 kg/palm (12,300 kg/ha) at year 12 (Kenna, 1993).

1.4.15 Storage

Dates with a high moisture content (over 35%) must be consumed quickly or held under cool storage. Storage temperatures vary with the type of date. Soft dates with a high moisture content need a lower temperature than a semi-dry date with a moderate moisture content. Soft dates may be stored for a short while at -2 to 0 °C but need lower temperature if they are to be stored for a long period. Semi-dry dates can be stored for 5 to 10 months at 0°C. Humidity must be controlled to avoid moisture loss or gain of the fruit. At 0°C a humidity of 83 to 87% is required to maintain a 25% moisture content of the fruit (McEllister and Tamblyn, 1991).

If cool storage is not available then some soft dates may need to be dehydrated. This can be done in any well aired dry room or outside if protection is given from insects. The fruit is usually put on mesh trays and stacked to allow free air movement. If necessary the fruit can be hydrated at a later time by placing them in a room with high humidity or steaming the dates. Hydration is used mainly for soft dates as semi-dry dates become sticky and syrupy using this method (McEllister and Tamblyn, 1991).

1.5 Date consumption in Australia

Dates for fresh consumption are gaining in popularity which is reflected in increased imports into Australia. Increased consumer awareness of the eating qualities and health benefits of high quality fruit has led to imports of fruit with a high unit value. Dates play an important part in the religious life of the Islamic community. This has also contributed to an increased demand for the product (Kefina, 1993).

1.5.1 Imports

The consumer demand for dates in Australia relies almost entirely upon the import of fruit from various countries. The estimated Australian production in 1994 of 5 tonnes is insignificant in meeting the Australian domestic demand at the present time. In 1990-91 date imports (fresh and dried) into Australia were valued at $A6.1 million (3.8 million kilograms).
This increased to $A7.22 million in 1991-92 (3.8 million kilograms) 14% increase in value (Tables 1). Major importing countries included Iran, Pakistan and the USA with countries such as China, Lebanon, Israel and Mexico also supplying significant quantities (Kenna, 1993).

**Table 1** Annual Imports of dates (fresh and dried) to Australia 1982 - 92 (Source - Australian Bureau of Statistics)

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<th>Volume (million kilograms)</th>
<th>Value ($M)</th>
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</table>

1.5.2 Exports

Demand is high for dates in South East Asian countries such as Malaysia and Indonesia which have predominantly Islamic populations. Exports of dates from Australia have occurred since 1990. Exports in 1992/93 totalled 21.7 tonnes, with 94% of these being exported from Western Australia. Singapore and Indonesia were the main importing countries. These dates were imported into Australia mainly from the USA and re-exported (Kenna, 1993).

1.6 Conclusion

Date palms growing in the Northern Territory, South Australia, Western Australia and Queensland, both under cultivation and at abandoned sites, show that this plant is adapted to climatic conditions experienced in Central Australia. Large areas of Queensland, Western Australia and the Northern Territory have been identified as having potential for commercial date production. Many of these areas have been disadvantaged by depressed animal production enterprises and are actively seeking alternative sources of income.
2 General materials and method

2.1 Site

The projects described in this report were conducted on the date plantings in the Dahlenburg Research Block at the Northern Territory Department of Primary Industry and Fisheries (NTDPIF) Arid Zone Research Institute (AZRI).

2.1.1 Climate

Alice Springs has a generally dry, hot climate due primarily to its geographical position in the centre of Australia. It has a long term mean annual rainfall of 285 mm, 65% of which falls between the months of November and March. A large proportion of annual rainfall is often derived from just a few significant rainfall events. For example, 65% of the yearly rainfall is received in three falls of greater than 25 mm and 25% of rain occurs in heavy falls exceeding 75 mm. Annual evaporation is about 3 000 mm, which is over ten times the average annual rainfall (Roeger, 1996). The annual and monthly rainfall totals for the period from 1991 to June, 1996 for Alice Springs are presented in Figure 1. The rainfall up until the 1 January, 1994 was taken at the Alice Springs airport while the rainfall after that was recorded at AZRI.

Temperatures in Alice Springs are high throughout the year with an average daily maximum of about 28° C and an average daily minimum of 13° C. On average there are 13 days with maxima above 40° C each year. The diurnal temperature range is high as a direct result of the extreme radiation condition: low humidity and little cloud cover to interfere with either incoming or outgoing radiation. During winter, with clear night skies and little or no wind in the early mornings, frosts can occur for several consecutive days. They can occur between May and September with a incidence of 4 days in May, 10 days in June, 14 days in July, 9 days in August, and 3 days in September (Roeger, 1996). The monthly average maximum and minimum for temperatures for the period from 1991 to June, 1996 at the Arid Zone Research Institute are presented in Figure 2.

2.1.2 Soils

The AZRI site is situated on the Todd Land System (Perry et al., 1962). This land system has formed on the flood plains of the Todd River and its tributaries and the soils are sandy alluvials, some red clayey sands and silty fine sands and layered alluvial soils. The natural vegetation is sparse low trees over short grass. The soil type for the date block is a sandy clay loam. The irrigation water at AZRI which is pumped from part of the “Farm Aquifer” is around 800 to 900 ppm total dissolved salts (TDS) with sodium the dominant
Figure 1 The annual and monthly rainfall totals (mm) at Alice Springs for the period from 1991 to June, 1996.
Figure 2 The average maximum and minimum temperature for each month at the Arid Zone Research Institute for the period from 1991 to June, 1996.
cation and bicarbonate and chloride the main anions. Virgin soils are neutral to slightly acid, but rapidly increases to a pH of 8.5 to 9.0 when irrigated.

### 2.2 Source of planting material

In 1986, the Reserve Bank, through the Rural Credits Development Fund Grants, supplied funding to import 1 050 tissue-cultured date palms from Date Palm Developments Laboratories, England. The original intention was to establish a replicated trial of seven of the worlds best date varieties (Barhee, Deglet Noor, Halawi, Khadrawy, Maktoom, Medjool, and Zahidi) at the AZRI. The objective was to do detailed varietal assessment and management trials, and for the planting to simulate commercial conditions. The palms were to be planted in blocks of 25 (5 by 5) with the inner-most nine palms (3 by 3) being used as the datum palms. Blocks were to be replicated four times and randomised. Although 700 palms were required, the intention was to order an additional 50% to allow for anticipated losses in the weaning process. Instead, a varying number of a large range of varieties were eventually imported. This was due to a variety of reasons including considerable plant losses with an initial trial shipment, lack of knowledge of the requirements for deflasking and growing on tissue cultured palms, staff changes within the Department and cultivar availability from the supplier.

The plantlets were imported in three separate shipments from September 1986 to April 1987. They were weaned by a nursery in central coastal Queensland, however losses were severe. The weaned plants were delivered to the NTDPIF, Alice Springs in February 1988 where they were potted up and grown in a shadehouse for a further 19 months prior to planting out in September 1989. Some further losses occurred during this growing on period. The number of palms of each cultivar imported in these shipments and eventual survival rates are shown in Table 2. The surviving palms were planted in various trials at the AZRI (see sections 3.2, 4.2 and 5.2). Any plants excess to requirements were allocated to two private growers for planting in the Deep Well area.

On the 15 July 1988, 50 tissue cultured palms were imported from the Group of French Research on Date Palm (G.R.F.P.) laboratory, France. This laboratory used a bud proliferation method whereas Date Palm Developments, England, used a callus multiplication technique. These plants were quarantined for 2 years because though they were produced by tissue culture they had already been deflasked and potted up in France. All palms imported survived and were released. This consignment consisted of five palms each of the cultivars Bou Feggous, Bou Skri, Bou Sthammi, Medjool, Thoory and Fard No 4; and
ten palms of Khadrawy and Zahidi. From this consignment four palms of Fard No 4; three palms of Bou Feggous, Bou Skri and Bou Sthammi; and two palms of Khadrawy, Medjool Thoory and Zahidi were planted at the AZRI in either a trial studying the influence of the plant source on palm performance (section 3.2) or a germplasm collection (section 5.2). The remaining plants from this shipment were distributed amongst the local growers.

Table 2 The number of each cultivar imported as tissue-cultured palms from England and the number and percentage which survived deflasking and growing on.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Imported</th>
<th>Number surviving</th>
<th>Percentage surviving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abu Ma'an</td>
<td>20</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Barhee</td>
<td>160</td>
<td>39</td>
<td>24%</td>
</tr>
<tr>
<td>Deglet Noor</td>
<td>190</td>
<td>39</td>
<td>21%</td>
</tr>
<tr>
<td>Halawi</td>
<td>30</td>
<td>2</td>
<td>7%</td>
</tr>
<tr>
<td>Hayany</td>
<td>45</td>
<td>5</td>
<td>11%</td>
</tr>
<tr>
<td>Haziz</td>
<td>55</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Hilali</td>
<td>50</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Medjool</td>
<td>155</td>
<td>41</td>
<td>26%</td>
</tr>
<tr>
<td>Thoory</td>
<td>190</td>
<td>28</td>
<td>15%</td>
</tr>
<tr>
<td>Zahidi</td>
<td>30</td>
<td>14</td>
<td>47%</td>
</tr>
<tr>
<td>Boyer No 11 (Male)</td>
<td>30</td>
<td>1</td>
<td>3%</td>
</tr>
<tr>
<td>Fard No 4 (Male)</td>
<td>30</td>
<td>10</td>
<td>33%</td>
</tr>
<tr>
<td>Jarvis No 1 (Male)</td>
<td>30</td>
<td>1</td>
<td>3%</td>
</tr>
</tbody>
</table>

In December 1988 a shipment of date off-shoots were imported from California by air freight in a palletised bulk bin. Of the 24 palms imported, 19 survived and were released from quarantine in September and December, 1989. The original shipment consisted of 8 different cultivars with three palms of each of the following cultivars; Barhee, Dayri, Deglet Noor, Halawi, Khadrawy, Medjool, Thoory and Zahidi. For the cultivars Barhee, Halawi and Zahidi all three palms of each cultivar survived, but for the other five cultivars only two palms of each survived. These palms were planted at the AZRI in either a trial studying the influence of the plant source on palm performance (section 3.2) or a germplasm collection (section 5.2).

Another shipment of off-shoots were imported from California in October, 1989. These were transported by ship in a refrigerated container, and took 41 days to travel from California to Darwin. A total of 410 palms were imported but only 170 palms survived. The majority of these palms were for two local growers, but 9 palms (three palms of Fard No 4, two of Khalas and one each of Deglet Noor, Khadrawy, Medjool and Thoory) were planted in a germplasm collection (section 5.2) at the AZRI at the end of April 1991.
2.3 Management of palms and collection of data

2.3.1 Pruning

The dates at AZRI were dethorned, had dead fronds removed and had flowering and fruiting remnants removed as per the standard industry practice described in section 1.4.7.

2.3.2 Pest and disease control

Date palms in the Dahlenburg Research Block at AZRI have been relatively free of pests and disease causing economic damage to the plants and fruit. The only exception to this is the periodical appearance of Parlatoria scale on palms (see section 1.4.8). Foliar applications of the insecticide Maldison® in combination with white oil has been regularly applied at three weekly intervals and has significantly reduced scale populations. However if the treatment is stopped to undertake management practices and harvesting, populations can build up again due to scale residing in the leaf axils and re-emerging. No disease control measures have had to be implemented.

2.3.3 Weed control

Weed control in date plantings at AZRI consisted of a combination of herbicides and mechanical methods as per section 1.4.10. Common weeds requiring control in plantings include Buffel Grass (Cenchrus ciliata), Couch Grass (Cynodon dactylon) and Sida (Sida spp.).

2.3.4 Plant nutrition

Nutritional management of date plantings in Central Australia consists of ongoing monitoring of the nutritional status of palms grown under various fertiliser management regimes. Early nutrition management in the AZRI research planting consisted of weekly fertigation using potassium nitrate, urea and phosphoric acid for the first 5 years after the planting was established. No fertiliser was applied to the planting for the following two years during which time palm growth and fruit quality was satisfactory. A regular palm nutrition monitoring program is to be implemented in 1997 and fertiliser applications will be made in conjunction with these.

Two surveys of nutrient levels have been undertaken of palms at the AZRI and palms in the region. In June 1988 samples were taken from six Deglet Noor seedlings and six Medjool seedlings growing at AZRI. In February 1993, samples were taken from 4 date farms in the Alice Springs region. Eleven samples were taken from palms at AZRI with the palms being of both sexes, of varying ages and from different sources of the original planting material (offshoots from California, tissue cultured palms from England and tissue...
cultured palms from France). Four samples were taken from two farms (site 1 and site 2) and three samples were taken from the other site (site 3). The combined results from both surveys and all farms is presented in Table 3. Table 3 also includes results published on surveys of date palms in California. The individual results for each of the sites examined in the two surveys conducted in the Alice Springs region are presented in Table 4.

Table 3 The average and range of nutrient levels recorded in date leaves in Alice Springs and in California.

<table>
<thead>
<tr>
<th>Element</th>
<th>Alice Springs Region</th>
<th>California*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen (N%)</td>
<td>1.27</td>
<td>0.81</td>
</tr>
<tr>
<td>Phosphorus (P%)</td>
<td>0.11</td>
<td>0.06</td>
</tr>
<tr>
<td>Potassium (K%)</td>
<td>1.24</td>
<td>0.36</td>
</tr>
<tr>
<td>Calcium (Ca%)</td>
<td>0.56</td>
<td>0.29</td>
</tr>
<tr>
<td>Magnesium (Mg%)</td>
<td>0.18</td>
<td>0.08</td>
</tr>
<tr>
<td>Sulphur (S%)</td>
<td>0.25</td>
<td>0.19</td>
</tr>
<tr>
<td>Sodium (Na%)</td>
<td>&lt;0.01</td>
<td>0.06</td>
</tr>
<tr>
<td>Chloride (Cl%)</td>
<td>0.9</td>
<td>0.4</td>
</tr>
<tr>
<td>Zinc (Zn - mg/kg)</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>Manganese (Mn - mg/kg)</td>
<td>49</td>
<td>17</td>
</tr>
<tr>
<td>Iron (Fe - mg/kg)</td>
<td>148</td>
<td>31</td>
</tr>
<tr>
<td>Copper (Cu - mg/kg)</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Boron (B - mg/kg)</td>
<td>26</td>
<td>12</td>
</tr>
</tbody>
</table>

*From Labanauskas and Nixon (1962)

2.3.5 Irrigation

Irrigation schedules varied depending upon the time of year, weather conditions and the stage of crop growth. Irrigation requirements were estimated using tensiometers. A bank of tensiometers was situated in the date block with a tensiometer at soil depths of 30 cm, 60 cm and 90 cm. The average weekly tensiometer readings at each depth in relation to weekly inputs of rainfall and irrigation are presented for 1994 (Figure 3), 1995 (Figure 4) and up till 30 June, 1996 (Figure 5). During the summer months and the fruit developmental stage, the palms required an increase in water compared to the winter months when they were only growing slowly and not carrying a crop. However, the present summer irrigation may need to be increased, particularly as the palms get older and cropping potential increases, as there are beginning to be more regular periods of high tensiometer readings during summer. Even if the summer irrigation schedule was increased to stabilise tensiometer readings, the irrigation inputs into the date planting at AZRI is much less than that reported by McEllister and Tamblyn (1991) (Figure 6).
Table 4 The average and range of macronutrient levels (A) and micronutrient levels (B) recorded in date leaves taken in two surveys: in 1988 taken from Deglet Noor and Medjool seedlings growing at AZRI and in 1993, samples from 4 date farms in the Alice Springs region (AZRI, site 1, site 2 and site 3).

### A) Macronutrients

| Site                        | N% |  |  | P% |  |  | K% |  |  | Ca% |  |  | Mg% |  |  | S% |  |  |
|-----------------------------|----|--|--|--|----|--|--|----|--|--|----|--|--|----|--|--|----|--|--|
|                             | Av | Min | Max | Av | Min | Max | Av | Min | Max | Av | Min | Max | Av | Min | Max | Av | Min | Max |
| Deglet Noor (1988)          | 1.10 | 1.00 | 1.20 | 0.13 | 0.12 | 0.14 | 1.80 | 1.70 | 1.90 | 0.34 | 0.29 | 0.37 | 0.17 | 0.15 | 0.19 | - | - | - |
| Medjool (1988)              | 1.38 | 1.20 | 1.60 | 0.11 | 0.09 | 0.12 | 0.89 | 0.86 | 1.20 | 0.43 | 0.33 | 0.56 | 0.14 | 0.08 | 0.20 | - | - | - |
| (1993)                      | 1.24 | 0.87 | 1.51 | 0.12 | 0.06 | 0.18 | 1.10 | 0.48 | 1.47 | 0.76 | 0.57 | 0.87 | 0.21 | 0.17 | 0.27 | 0.29 | 0.19 | 0.46 |
| Site 1 (1993)               | 1.57 | 1.47 | 1.86 | 0.12 | 0.10 | 0.14 | 1.66 | 1.24 | 1.88 | 0.47 | 0.39 | 0.54 | 0.18 | 0.16 | 0.20 | 0.24 | 0.21 | 0.31 |
| Site 2 (1993)               | 1.29 | 1.10 | 1.50 | 0.10 | 0.08 | 0.12 | 1.30 | 0.69 | 1.74 | 0.49 | 0.40 | 0.63 | 0.19 | 0.15 | 0.24 | 0.21 | 0.2 | 0.24 |
| Site 3 (1993)               | 1.17 | 0.81 | 1.60 | 0.09 | 0.07 | 0.13 | 0.75 | 0.37 | 1.10 | 0.65 | 0.35 | 0.88 | 0.19 | 0.17 | 0.21 | 0.19 | 0.19 | 0.20 |

### B) Micronutrients

<table>
<thead>
<tr>
<th>Site</th>
<th>Na%</th>
<th></th>
<th></th>
<th>Cl%</th>
<th></th>
<th></th>
<th>Zn (mg/kg)</th>
<th></th>
<th></th>
<th>Mn (mg/kg)</th>
<th></th>
<th></th>
<th>Fe (mg/kg)</th>
<th></th>
<th></th>
<th>Cu (mg/kg)</th>
<th></th>
<th></th>
<th>B (mg/kg)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Av</td>
<td>Min</td>
<td>Max</td>
<td>Av</td>
<td>Min</td>
<td>Max</td>
<td>Av</td>
<td>Min</td>
<td>Max</td>
<td>Av</td>
<td>Min</td>
<td>Max</td>
<td>Av</td>
<td>Min</td>
<td>Max</td>
<td>Av</td>
<td>Min</td>
<td>Max</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deglet Noor (1988)</td>
<td>0.03</td>
<td>0.01</td>
<td>0.06</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>9</td>
<td>11</td>
<td>25</td>
<td>17</td>
<td>35</td>
<td>194</td>
<td>77</td>
<td>630</td>
<td>5</td>
<td>4</td>
<td>7</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Medjool (1988)</td>
<td>0.01</td>
<td>0.01</td>
<td>0.02</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>6</td>
<td>14</td>
<td>76</td>
<td>43</td>
<td>130</td>
<td>121</td>
<td>63</td>
<td>210</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>(1993)</td>
<td>&lt;0.01</td>
<td>0.85</td>
<td>1.16</td>
<td>11</td>
<td>1</td>
<td>16</td>
<td>52</td>
<td>34</td>
<td>81</td>
<td>209</td>
<td>120</td>
<td>340</td>
<td>28</td>
<td>13</td>
<td>50</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site 1 (1993)</td>
<td>&lt;0.01</td>
<td>1.02</td>
<td>1.12</td>
<td>11</td>
<td>10</td>
<td>11</td>
<td>39</td>
<td>27</td>
<td>52</td>
<td>43</td>
<td>31</td>
<td>56</td>
<td>43</td>
<td>31</td>
<td>56</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Site 2 (1993)</td>
<td>&lt;0.01</td>
<td>0.96</td>
<td>1.17</td>
<td>12</td>
<td>10</td>
<td>13</td>
<td>56</td>
<td>25</td>
<td>74</td>
<td>43</td>
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<td>24</td>
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<td>34</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Site 3 (1993)</td>
<td>&lt;0.01</td>
<td>0.65</td>
<td>0.82</td>
<td>11</td>
<td>8</td>
<td>15</td>
<td>52</td>
<td>40</td>
<td>64</td>
<td>124</td>
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<td>8</td>
<td>34</td>
<td>27</td>
<td>39</td>
<td>-</td>
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<td></td>
</tr>
</tbody>
</table>
Figure 3 The average weekly tensiometer readings at each depth (30, 60 and 90 cm) in relation to weekly inputs of rainfall and irrigation for 1994 for the date palms at the Arid Zone Research Institute.
Figure 4 The average weekly tensiometer readings at each depth (30, 60 and 90 cm) in relation to weekly inputs of rainfall and irrigation for 1995 for the date palms at the Arid Zone Research Institute.
Figure 5 The average weekly tensiometer readings at each depth (30, 60 and 90 cm) in relation to weekly inputs of rainfall and irrigation up till June 1996 for the date palms at the Arid Zone Research Institute.
Figure 6 The yearly water requirements (expressed on a per palm and per hectare basis) for date palms planted in 1989 at AZRI compared to that suggested by McEllister and Tamblyn (1991). (No information was recorded at AZRI for year 1 or year 2).
2.3.6 Removal of offshoots

Offshoots were removed during the time period of January to April. They were removed from the parent palms when it was certain that they were of sufficient size and maturity that they could survive away from the parent. Once the leaves on the offshoot have been trimmed and tied up, a jackhammer driven by a portable generator was used to cut through the connection between the offshoot and its parent palm and the offshoot was then removed. The base of the removed offshoots were placed in trenches in nursery rows and the trench was then backfilled. The offshoots were left in these trenches until they have begun to grow new fronds and their root system had recovered and was regrowing.

2.3.7 Pollination and flower removal

The process of hand pollination was carried out during August to October each year. Flowers were pollinated as per the method described in section 1.4.11. Each pollinated bunch was tagged and numbered and this along with the date of pollination was recorded. Some flowers were removed prior to pollination while others were removed after pollination. Flowers were removed prior to pollination if they were deformed or if they were produced in autumn or winter and pollination was not possible due to the unavailability of pollen or because temperatures were too low for successful pollination. Flowers which set very little or no fruit due to lack of pollination were also removed. The date and palm from which flowers were removed was recorded. For all seasons, except the 1991/92 season, it was possible to calculate the total number of flowers on each palm and the percentage of these which produced mature fruit. For the 1991/92 season while the total number of flowers produced by each palm was known no record was kept on how many of these went on to produce mature fruit.

2.3.8 Bunch maintenance

The bunches were maintained as per the accepted industry practice described in section 1.4.12. The date bunches were covered in the “kimri” (green/unripe) stage of development just before the “khalal” stage (early ripening). This process was usually carried out in December-January of each season. Covers used were made from a range of materials including weedmat, shadecloth, nylon, banana bags, muslin and Tyvek® (disposable overall material). Bunches were covered to protect the fruit from light rain, birds, insects and other pests.
2.3.9 Harvesting

There was no record kept of harvest details for the 1991/92 season, though only a few palms flowered. In the 1992/93 and the 1993/94 seasons the total yield for each palm was recorded but not individual bunch weights. The procedure for these seasons was as follows. At an interval of every couple of days the bunches on the palms were inspected and the ripe dates were collected and the date of harvest and the palm number was recorded. The dates collected from each palm were then weighed to get total weight for that palm for that day of harvest. The dates were sorted into two categories: marketable dates and culls and the two groups were weighed. The culls were then disposed of. The marketable dates were then divided into three ripeness categories: khalal, rutab and tamar and weights of each of these categories were recorded. If there was a reasonable number of dates of a particular stage present, then a sub-sample was taken. Measurements of the length and breadth of each individual fruit in this sub-sample were taken using a micrometer. This sub-sample usually consisted of ten fruit. Depending on the amount of fruit of each stage it was possible that several sub-samples of ten fruit were measured for each palm during the harvest period. At the completion of the harvest for each palm it was possible to calculate the total yield and the percentage of the total weight which was attributable to culls, as well as the earliest and latest recorded harvest times.

In the 1994/95 and the 1995/96 seasons individual bunch weights were recorded so that the performance of each palm and each bunch on that palm could be determined. The following procedure was used. Most of the dates were harvested in the tamar stage. Every day or second day each bunch was checked and the dates that were mature or were damaged were removed. The dates from each bunch were kept separate and the bunch number, palm number, bunch cover type and date of harvest was recorded each time. The dates collected from each bunch were then weighed to get total weight for that bunch for that day of harvest. The dates were then sorted into two categories: marketable dates and culls and the two groups were weighed. The culls were then disposed of. In these seasons the marketable fruit was not divided into their ripeness categories. For each palm, all the marketable dates were grouped together and placed in polystyrene boxes and kept in a cold store (5°C). At the completion of the harvest, for each palm and each bunch on that palm, it was possible to calculate the total yield and the percentage of the total weight which was attributable to culls, as well as the earliest and latest recorded harvest times. As the pollination date of each bunch was recorded
it was also possible to determine the time from pollination to harvest (maturation time) for the dates on each bunch.

In the 1994/95 and 1995/96 seasons, at the completion of the harvest, measurements were taken of the marketable dates which had been kept in cold storage. While it was possible to determine from which palm these came from it was now no longer possible to determine from which bunch or on what day they were picked. In the 1994/95 season, for each palm a sub-sample of 50 fruit was taken when possible, but less if insufficient fruit were present. In the 1995/96 season for each palm a sub-sample of 30 fruit was taken when possible. For each sub-sample, the total weight of the fruit was determined and this was divided by the number of fruit in the sample to get the average fruit weight for that palm. Then measurements of the length and breadth of each individual fruit in this sub-sample was taken using a micrometer.
3 Project 1 - Comparison of tissue cultured dates and offshoots

3.1 Introduction

There is some reservation within the industry as to whether off-types may occur in tissue cultured date palms and that not all palms produced are "true to type". Offshoots, suckers produced by the parent palm, are the standard method of propagation. However, tissue culture offers the possibility of introducing material which cannot be imported as offshoots due to quarantine restrictions. Tissue cultured plants are cheaper to import than offshoot material. As they are in a sterile medium they do not require fumigation on arrival and are subject to significantly less airfreight costs. Another use of tissue culture, besides being a means of importing plants, is that in the future it will offer a method of rapidly multiplying planting material within Australia.

This experiment compared tissue-cultured and off-shoot palms of the same cultivar. Depending on availability, tissue cultured palms produced by two different methods of propagation were used - those from Date Palm Developments, England, produced by a callus multiplication method and those from G.R.F.P., France which were produced using a bud proliferation technique.

3.2 Material and methods

This experiment was conducted in the Dahlenburg Research Block at AZRI (described in 2.1). For each of the cultivars Fard No 4 (male), Medjool, Thoory and Zahidi, two palms of offshoots and two palms produced by each tissue culture method were planted (see section 2.2). For the cultivars Barhee and Deglet Noor, two offshoots were planted along with four palms from the tissue culture laboratory in England. For the cultivar Khadrawy two offshoot palms were planted with two palms obtained from the French tissue culture laboratory only. Each cultivar was planted in a single row at a spacing of fourteen metres. There was a spacing of 7 metres between each culture. The tissue cultured palms from England and all offshoots, except the two Fard No 4 offshoot palms, were planted in April 1990. The tissue cultured palms from France and the two Fard No 4 offshoot palms were planted in April 1991. The two offshoots for each cultivar were planted side-by-side at the northern end of the rows. When present, the French tissue cultured palms were planted side-by-side in the centre of the row. The palms were managed and harvested using the methods and techniques described in section 2.3.
3.3 Results

The palms are still young and as yet little data has been collected on the cropping and fruit characteristics of each palm. Therefore, it is not yet possible to check if the palms are “true to type” by making comparisons within each cultivar of the fruit from palms of the various plant sources. However, at this stage it is possible to compare within each cultivar the production patterns of palms from the different sources. From this it is possible to get some indication of the advantages and disadvantages of using palms from the different methods of producing propagating material.

3.3.1 Barhee

The offshoots appeared to develop a pattern of consistent flowering earlier than the tissue cultured palms from the English laboratory. For this cultivar, there were no tissue-cultured palms from France. Both offshoots flowered in the 1992/93 season though they then both failed to flower in the following season (1993/94) but both flowered again in 1994/95 and 1995/96 seasons. The tissue cultured palms didn’t flower until the 1993/94 season but then continued to flower each subsequent season after that. However, in each season only some of the palms flowered.

The average yields from the English tissue-cultured palms was low in the three seasons that some palms fruited (1993/94, 1994/95 and 1995/96). Though one palm in the 1994/95 season produced a reasonable yield for a young palm (22.5 kg). The offshoot palms first fruited in the 1992/93 season and in contrast to the tissue cultured palms when the yield for the first season of fruit production was low (average of 0.5 kg), the offshoots had a average yield of 16.4 kg. In the following season the offshoot palms failed to flower (or fruit) - indicating that they may have carried too heavy a crop the previous season. They then fruited again in the 1994/95 season when they produced an average yield of 23 kg per palm. They also flowered in the 1995/96 season though they failed to set fruit. It appears that these offshoots palms are showing some biennial bearing (a good season of production followed by a poor season of production).

3.3.2 Deglet Noor

Both the offshoots and the tissue cultured palms from England started flowering in the 1992/93 season. However, all the offshoot palms flowered whereas only one of the four tissue cultured palms flowered. For this cultivar, there was no tissue-cultured palms from France. In the following season (1993/94) none of the offshoots flowered whereas three of the four tissue cultured palms flowered. In subsequent seasons, all palms from both sources flowered.
All palms from both sources produced fruit every season that flowers were produced. However, the average yield was higher for the offshoots in all seasons except the 1993/94 season when the offshoot palms failed to flower.

3.3.3 Fard No 4 (Male)

For the male cultivar Fard No 4, the tissue-cultured palms from France and the offshoots from California were planted a year later than the tissue-cultured palms from England. No flowering was recorded in the tissue-cultured palms from England yet flowering occurred in palms from the other two sources. All the offshoot palms started flowering in the 1993/94 season and continued flowering every season after that. No flowering occurred in the palms from France until the 1995/96 season when one palm flowered.

3.3.4 Khadrawy

The offshoots appeared to get into a pattern of consistent flowering earlier than the tissue cultured palms from the French laboratory. For this cultivar, there was no tissue-cultured palms from England. One of the two offshoots flowered in the 1992/93 season though they both failed to flower in the following season (1993/94). Both flowered in the 1994/95 and 1995/96 seasons. The tissue cultured palms didn’t flower until the 1995/96 season. It should be noted that the tissue-cultured palms from France were planted a year later than the other palms.

The yield from all palms were low, regardless of plant source, and over all seasons no palm produced more than 4 kg.

3.3.5 Medjool

Palms from both tissue culture laboratories flowered before the offshoot palms, as one palm from each laboratory flowered in the 1991/92 season, whereas the offshoots didn’t flower until the 1992/93 season. Both tissue cultured palms from England have flowered in all subsequent seasons, except for the 1994/95 season when only one palm flowered. For the tissue cultured palms from France, flowering occurred in all seasons, though only one of the two palms flowered. After their initial flowering, the offshoots failed to flower in the 1993/94 season, but then both palms flowered in the subsequent seasons. Though the tissue-cultured palms from France started flowering in the same season as the palms from the English laboratory it should be noted that they were planted a year later than the other palms.

In all seasons that the tissue cultured palms from both sources fruited, the yields were low with the highest average being 7 kg and the highest yield for a palm being 14 kg. On the other hand, the offshoots averaged 7.5 kg in the first season they flowered (1992/93 season).
and 31 kg in the second season (1994/95). However in the 1995/96 season, the average yield for the offshoots was low (1 kg).

3.3.6 Thoory

All sources of palms for Thoory have been irregular in their flowering patterns. One offshoot palm produced a flower in the 1991/92 season. Then both offshoot palms flowered in the 1992/93 and 1994/95 season but neither flowered in the 1993/94 season and only one flowered in the 1995/96 season. The tissue-cultured palms from England produced their first flowers a year later than the offshoots. Both palms flowered in the 1992/93, 1993/94 and 1995/96 seasons but only one flowered in the 1994/95 season. Tissue-cultured palms from France, did not flower until the 1993/94 season when only one palm flowered. No palms flowered in the 1994/95 season, and both flowered in the 1995/96 season. It should be noted that the tissue-cultured palms from France were planted a year later than the other palms.

The offshoot palms tended to produce higher yields than the tissue cultured palms from both sources. In the 1992/93 and 1994/95 season the offshoots palms averaged 13.5 and 16 kg respectively, with one palm producing 24 kg in the 1994/95 season, while in the same seasons, the tissue cultured palms from England averaged 1.5 and 6.7 kg respectively with the highest yield on a palm of 13.3 kg in the 1994/95 season. In the 1993/94 season when both offshoots failed to flower, the averages for palms from both tissue culture sources were less than 2 kg. In the 1995/96 the averages for palms from all three sources were very low being less than 1 kg.

3.3.7 Zahidi

The palms from both tissue culture laboratories were slower than the offshoots in producing their first flowers. The tissue cultured palms didn’t flower until the 1995/96 season while the offshoots first flowered in the 1992/93 season. The offshoots failed to flower in the 1993/94 season but flowered again in 1994/95 and 1995/96 seasons. The number of flowers each palm produced in the 1995/96 season were fewer than the previous season. It should be noted that the tissue-cultured palms from France were planted a year later than the other palms.

The yield from all offshoots and tissue cultured palms, in the first flowering season was small or non-existent. The offshoot palms first fruited in the 1992/93 season and then fruited again in the 1994/95 season when they produced a reasonable yield for young palms (average of 14 kg per palm). They flowered again in the 1995/96 season but failed to fruit. It appears that these offshoot palms are showing some biennial bearing characteristics.
3.4 Discussion

The offshoot palms tended to flower and fruit earlier than the tissue-cultured palms, most likely because they were larger and older when they were planted. They also tended to yield higher, possibly because they had more leaves, more food reserves and became established faster. It is difficult to compare the performance of the tissue-cultured palm from the French laboratory against those from the English laboratory due to differences in planting dates.
4 Project 2 - Cultivar evaluation

4.1 Introduction

The aims of this project were to assess the performance of four international cultivars under Central Australian conditions and to determine their suitability as potential cultivars for commercial production in this region. Many years are required to thoroughly evaluate a new date cultivar because of varying climatic conditions, the effect that certain management and cultural techniques sometimes have on successful fruit production and the irregular cropping characteristics of young palms.

The four cultivars evaluated were Barhee, Deglet Noor, Medjool and Thoory. Barhee is a cultivar increasing in popularity overseas. The fruit is egg-shaped, quite soft and very sweet (Plate 9). It has excellent eating qualities at all stages of maturity. Deglet Noor is the leading commercial variety in the United States (Plate 10). It is a semi-dry date with sweet flesh and a nutty taste, however, it is susceptible to rain damage and has a long fruit maturation period. Medjool is one of the main cultivars grown internationally for the high value fresh fruit market. It produces a large, soft fruit with excellent eating qualities (Plate 11). Thoory is a dry date with an attractive appearance and a delicate flavour (Nixon & Carpenter, 1978) (Plate 12).

4.2 Materials and methods

In September, 1989 the palms were planted in the Dahlenburg Research Block at AZRI (see section 2.1). The palms were imported from England as tissue cultured palms (see section 2.2). Four cultivars (Barhee, Deglet Noor, Medjool and Thoory) were established in a statistical planting comprised of four blocks, with each block containing four randomly distributed single palm replicates of each cultivar. The palms were planted at a spacing of 7 m between rows and 14 m within rows. Planted around the planting, at the same time and using the same spacing, was a single guard row. The palms in this guard planting will be discussed in more detail under a separate project (section 5 - Project 4). The palms were managed and harvested using the methods and techniques described in section 2.3.

4.3 Results and discussion

4.3.1 Cultivar differences in flowering characteristics

4.3.1.1 Percentage and number of palms that flowered

Some palms of Deglet Noor and Thoory produced flowers in the 1991/92 season, while it was a year later (1992/93 season) before some palms of Barhee and Medjool flowered. By the 1994/95 season, most palms of all cultivars had flowered. However, even by
1995/96 season, flowering patterns were still irregular as all the palms were not producing flowers every season. A palm may flower one season and not the next. This was particularly the case for palms of the cultivar Thoory.

4.3.1.2 Number of flowers produced per palm

In their first season of flowering, the maximum number of flowers produced by a palm was 4 (a Barhee palm in the 1992/93 season). In the case of all cultivars, except Thoory, the maximum number of flowers produced by a palm has steadily rose to reach a peak of 17 in the 1995/96 season. For Thoory the highest number produced by a palm was 19 in the 1994/95 season, while the highest in the 1995/96 season was 14. Because some palms failed to produce flowers or are only producing a few flowers, the average number of flowers per palm for the cultivars ranged from 7 to 9.

4.3.1.3 Percentage of total flowers which were retained on palms to produce fruiting bunches

This parameter is of limited importance because bunch numbers are regulated in relation to palm size. Therefore a palm producing a lot of flowers will have a lower percentage than one producing a lower number of flowers. However this parameter does give an indication as to whether there were differences between seasons or cultivars in relation to flower production patterns or in the success of pollination.

In the 1992/93, 1993/94 and 1994/95 seasons, on average over half the flowers produced by the palms of all cultivars went on to fruit. However, in the 1995/96 season the percentage of flowers produced which went on to fruit was around 20% or less for Barhee, Medjool and Thoory. One of the main reasons for this, was that in this season flowering was erratic and occurred in autumn or winter. As explained previously (section 2.3.7) these flowers had to be removed as pollination was not possible due to the unavailability of pollen or because temperatures were too low for successful pollination.

4.3.2 Cultivar differences in fruiting characteristics

4.3.2.1 Harvest range

The overall trend seemed to be that Medjool was the earliest to produce fruit, normally followed by Barhee, while Deglet Noor and Thoory tended to begin fruiting later than the other two cultivars but they continued to produce mature fruit after the other cultivars had finished. However, the timing of when cultivars commenced and stopped producing fruit varied from season to season.
Plate 9 Fruit of the cultivar Barhee in tamar stage.

Plate 10 Fruit of the cultivar Deglet Noor in tamar stage.
Plate 11 Fruit of the cultivar Medjool in tamar stage.

Plate 12 Fruit of the cultivar Thoory in tamar stage.
The harvest information for the 1991/92 season was not recorded so no comments can be made.

The Medjool palms produced the earliest fruit in the 1992/93 season (9 March) being one week before the first Barhee fruit, nearly two weeks before the first Thoory fruit and over five weeks before the first Deglet Noor fruit. The last Medjool fruit was collected on the 13 May only one week earlier than for the other three cultivars (20 May). Both Medjool and Barhee had fruit available for the same length of time but the Medjool fruit was available one week earlier than the Barhee, while the Barhee fruit was available for one week later.

In the 1993/94 season, the fruit maturation period commenced earlier in all cultivars compared to the previous season but also finished earlier. Medjool fruit matured nearly one week before Barhee fruit (22 February compared to 28 February), and eleven days before the first fruits of both Deglet Noor and Thoory. In contrast to the previous season, the Barhee palms finished fruiting three weeks earlier than the Medjool palms. Deglet Noor and Thoory fruit were available for five days longer than the Medjool fruit (26 April compared to 21 April).

In the 1994/95 season, all cultivars commenced fruiting in early March, with Medjool again being the earliest (3 March), three days ahead of Thoory and 6 days head of the other two cultivars. This season finished the latest of all seasons for all cultivars except Medjool with these cultivars producing fruit up until the 26 May. Medjool finished over three weeks before the other cultivars (3 May).

In the 1995/96 season, the fruit maturation period commenced the earliest of all seasons for most cultivars, and all cultivars commenced at the same time (26 February). Medjool and Barhee palms stopped fruiting at the end of March (26 and 28 of March respectively) while the Deglet Noor and Thoory palms fruited for another three weeks (17 April).

4.3.2.2 Total recorded yield

Even six and half years after planting the average yield of the palms is still low. When the average yield per palm is added together for the four seasons in which fruiting has been recorded since planting (1991/92 season not included), Deglet Noor has totaled 30 kg per palm compared to Barhee (20 kg), Thoory (19 kg) and Medjool (8.5 kg).

In the 1992/93 season the first of the Barhee and Medjool palms fruited. Some Deglet Noor and Thoory palms fruited in the previous season but this was not recorded. The highest yields recorded in the first season of fruiting for the Barhee and Medjool palms was 2.8 kg
and 1.8 kg respectively and the averages for these cultivars were low, due to the fact that some of palms never flowered and those that did flower had low yields. The Deglet Noor and Thoory palms had a lot higher averages in this season mainly because some of the palms were carrying higher yields, 18 kg for one Thoory palm and 9 kg for a Deglet Noor palm.

All cultivars except Deglet Noor had very low averages in the 1993/94 seasons (less than 0.6 kg). The highest yield of a palm of these cultivars for this season was 2.5 kg. Deglet Noor averaged 3.6 kg per palm in this season and the highest yield on one of its palms was 14 kg.

In the 1994/95 season all cultivars had their highest averages. The highest of which was for Barhee which averaged 18.4 kg and one palm yielded 56 kg of fruit. Deglet Noor had the next highest average of 15 kg with the one palm producing 30 kg of fruit. Thoory and Medjool both had averages less than 10 kg (9.9 kg and 6.3 kg respectively) and the highest yielding palm for each cultivar produced around 20 kg of fruit.

In the 1995/96 season, all palms had very low averages compared to the previous season. All cultivars except Deglet Noor had averages of less than 1.5 kg. Deglet Noor averaged 6.6 kg per palm but the highest yield of a palm was almost half that of the previous season (16 kg).

### 4.3.2.3 Percentage culls

In the 1991/92 season the harvest information was not recorded so no comments can be made.

In the 1992/93 season, all cultivars had their lowest average amount of culls compared to the other seasons (all cultivars less than 40% culls per palm). However, Medjool averaged only 5% culls and highest culls on a palm was 8%. Barhee also had fairly low percentage culls (12%) while Thoory was next best with 22%. The worst cultivar was Deglet Noor with 36%.

In the following season (1993/94), for all cultivars a major proportion of the yield from a palm was unmarketable. All cultivars averaged more than 60% culls per palm and the lowest percentage culls recorded on a palm of any of the cultivars was 22%. Thoory had the lowest with an average of 60% per palm followed by Medjool (72%) and Deglet Noor (78%). Nearly all the fruit produced by the Barhee palms were unmarketable with an average of 98% culls and the lowest percentage on a palm of 97%.

In the 1994/95 season, the cultivar Medjool showed a major difference from the other cultivars. This cultivar averaged 26% culls per palm while the other cultivars had over 60%
culls. Of these other cultivars Barhee had the lowest with an average of 66%, followed by Thoory with 83% culls. Like Barhee the previous season, nearly all the fruit produced by the Deglet Noor palms were unmarketable with an average of 99% culls.

In the 1995/96 season, the cultivar Medjool again had the least amount of culls, but it was still half the crop produced on a palm. Barhee had the next least amount with 65% followed by Thoory (70%) and Deglet Noor (76%).

Excluding the 1993/94 season, Medjool had the least culls of all the cultivars while Deglet Noor had the most. The proportion of yield that was unmarketable for each cultivar varied from season to season. For example Medjool had an average of 5% culls per palm in the 1992/93 season but 72% culls in the 1993/94 season. The explanation for the variation between cultivars and between seasons will not be given here. This is covered in other sections of the report. The differences in the amount of culls between seasons due to differences in the rainfall distribution pattern is explained in section 6.3. Similarly, in section 6.4 cultivar differences due to the varying susceptibility of the cultivars to rain damage are explained. In those sections, information generated on a bunch basis is used, rather than on a palm basis as used in this section. However, the percentage culls per cultivar for each season are very similar between the two methods.

4.3.3 Cultivar differences in fruit characteristics

4.3.3.1 Individual fruit weight

No information on the weight of individual fruit was collected for the 1991/92, 1992/93 or 1993/94 seasons. However, in the 1994/95 and 1995/96 seasons, Medjool produced the heaviest fruit in both seasons (16 g and 15.5 g respectively), while Barhee produced the next heaviest fruit in both seasons (10g and 9 g respectively). Deglet Noor and Thoory seem to produce fruit of a similar weight. In both seasons, fruit for both cultivars weighed between 7 g and 8 g.

4.3.3.2 Fruit length and diameter

For both fruit length and diameter, the differences between the cultivars for all the various harvest stages within each season was small, with the biggest difference being 3 mm. In addition, for all fruit maturity stages, the average of both of these for each cultivar stayed fairly consistent between seasons, with the biggest difference being 5 mm.

The cultivars showed some genetic difference in dimensions. The cultivar with the longest and widest fruit of these four cultivars was Medjool. Over all seasons and harvest stages this cultivar average length ranged between 44 mm and 49 mm with the shortest length
recorded being 31 mm and the longest one recorded being 61 mm. While the average diameter ranged between 25 mm and 28 mm with the narrowest diameter recorded being 20 mm and the widest one recorded being 32 mm.

The cultivar with the shortest fruit of the four cultivars tended to be Barhee, however it was the second widest fruit after Medjool. It’s average length ranged between 31 mm and 33 mm with the shortest length recorded being 21 mm and the longest recorded length being 39 mm. It’s average diameter ranged between 23 mm and 26 mm with the narrowest diameter recorded being 18 mm and the widest being 31 mm.

Deglet Noor and Thoory were very similar in fruit length and diameter. Over all seasons and harvest stages the average length of Deglet Noor fruit ranged between 36 mm and 37 mm with the shortest length recorded being 26 mm and the longest one recorded being 47 mm. While Thoory had an average length ranging between 32 mm and 38 mm with the shortest length recorded being 26 mm and the longest being 44 mm. The diameter of the Deglet Noor had an average ranging between 18 mm and 20 mm with the narrowest diameter recorded being 15 mm and the widest being 23 mm. Thoory showed a very similar pattern with an average fruit diameter ranging between 19 mm and 20 mm with the narrowest diameter recorded being 13 mm and the widest being 26 mm.
5 Project 3 - Cultivar observation

5.1 Introduction

Throughout the world several thousand cultivars of dates have been recognised, but of these, those which have any commercial importance are limited to about 100 or so (Popenoe, 1920). Some cultivars are unique to a particular country but others, such as the top cultivars now grown in the United States, are grown fairly extensively around the world (Micklem, 1990).

Cultivars of dates are generally divided into three groups according to whether the flesh of the fruit, as it ripens under normal conditions in a favourable climate, is soft, semi-dry or dry. These divisions are somewhat arbitrary, as consistency of the flesh is affected by climatic conditions and methods of handling, but the classification is convenient and widely used (Nixon and Carpenter, 1978). The moisture content of soft dates is normally around 20% and the total sugar content is 60%. While semi-dry dates tend to have a lower moisture content than the soft dates and between 60 and 65% total sugar content. Dry dates (also known as bread dates) have very low moisture content and between 65 and 70% sugar content (Petherbridge, 1980). In addition, sucrose (cane sugar) makes up a high proportion of the total sugar content of immature dates of all cultivars. As ripening progresses, the sucrose is converted to glucose or fructose (invert or reducing sugars), but the amount of conversion is related to the date texture. Soft cultivars, when fully ripe, contain little or no sucrose, while the dry and semi-dry cultivars have a higher proportion of sucrose (Nixon and Carpenter, 1978).

Traditionally, the dry dates were used by the Arabs as a convenient food, especially when travelling because they kept their shape well, didn’t spoil easily, were easy to pack and provided satisfying nourishment. Although the Arabs also ate soft dates, they would pound most of them into a cohesive mass, or “cake” from which pieces were cut off as required. They would occasionally eat soft dates whole but usually only on special occasions (Simon, 1978). In western countries, dates are considered a confectionary or a dessert rather than a staple food. Consequently, consumers have a preference for fresh, dessert type dates and this has determined that the main cultivars grown here in Australia, and in most western countries, should be large in size, soft with a reasonable moisture content.

Careful attention needs to be given to the selection of cultivars likely to succeed in a particular location. The suitability of the cultivar to the climatic condition of that particular area (heat sum units, rainfall pattern) are of primary importance but other considerations
include the adaptability of the cultivar to the soil conditions and management techniques, the amount of high quality dates produced, and the present and future markets (Nixon and Carpenter, 1978).

The aim of this project is to establish a collection of the world’s best cultivars. From this general observations can be made on potential cultivars for the area. In addition, it acts as a source of offshoot material. In the future, it is envisaged that planting material from the collection in Alice Springs could be sent to other areas to establish plantings of these cultivars under different conditions.

5.2 Materials and methods

This project includes all palms planted in the Dahlenburg Research Block at the AZRI (described in 2.1). It includes palms planted in the comparison of tissue cultured dates and offshoots trial (section 3 - project 1), the date cultivar evaluation trial (section 4 - project 2). In addition it includes the palms planted as guard palms around the date cultivar evaluation trial described in section 4 - project 2 as well as palms planted as a germplasm collection.

The guard palms were planted in September 1989 at a spacing of 7 metres between rows and 14 metres with in rows. The planting was made using a mixture of cultivars of tissue cultured palms from England and consisted of 15 Barhee, 10 Thoory, 14 Deglet Noor and 2 Zahidi palms. In addition, three palms originally planted as Barhee were later found not to be this cultivar. Two were female palms of unknown origin and one was a male palm of unknown origin. These palms of unknown origin are not included in the results.

The germplasm collection is made up of a number of male and female cultivars from various sources. The planting of the trial started in April 1990 and additions have been made as material has become available (Table 5). Besides the 94 palms in the germplasm collection discussed in the results section (5.3) there is also four female palms of unknown origin planted in the collection.

Information was collected on the flowering and fruiting patterns of the palms, their fruit characteristics and the number of offshoots they produced. The palms were managed and harvested using the methods and techniques described in section 2.3.
Table 5 The number, source of planting material and planting date for the various cultivars grown in the germplasm collection.

<table>
<thead>
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<th>No of palms</th>
<th>Cultivar</th>
<th>Plant Source</th>
<th>Planting Date</th>
</tr>
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<tr>
<td>1</td>
<td>Barhee</td>
<td>Offshoot California</td>
<td>August 1995</td>
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<tr>
<td>2</td>
<td>Barhee</td>
<td>Offshoot - AZRI</td>
<td>December 1995</td>
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<tr>
<td>18</td>
<td>Barhee</td>
<td>Offshoot - AZRI</td>
<td>April 1996</td>
</tr>
<tr>
<td>3</td>
<td>Bou Feggous</td>
<td>Tissue culture - France</td>
<td>April 1991</td>
</tr>
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<td>3</td>
<td>Bou Skri</td>
<td>Tissue culture - France</td>
<td>April 1991</td>
</tr>
<tr>
<td>3</td>
<td>Bou Sthammi</td>
<td>Tissue culture - France</td>
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5.3 Results

5.3.1 Female cultivars

5.3.1.1 Abu Naringa

Four palms of this cultivar were only recently planted and they are yet to flower, fruit or produce offshoots. This cultivar produces fruit of excellent flavour in other date producing countries (Anon, 1993).

5.3.1.2 Barhee

5.3.1.2.1 Flowering

Thirty-one palms were planted in September 1989, seven in April 1990, one in August 1995, two in December 1995 and 18 in April 1996. For both the September, 1989 planting date and the April, 1990, some palms started flowering in the third season after planting (1991/92 and 1992/93 respectively) and by the sixth season (1994/95 and 1995/96 respectively) most palms were flowering. The maximum number of flowers produced by a palm in a season was 17. In the 1995/96 season, the palms planted at both planting dates averaged around 7 flowers per palm. The palms planted in 1995 and 1996 were too young to flower.

5.3.1.2.2 Fruiting

The harvest range for this cultivar was from mid-March to mid-May in the 1992/93 season, early March to late April in the 1993/94 season, early-March to late-May in the 1994/95 season, and late-February to late-March in the 1995/96 season. The time taken from pollination to harvest was as short as 149 days (5 months) and as long as 270 days (9 months). In the 1994/95 season, the palms planted in September, 1989 and April, 1990 both had their highest average yields (18 kg and 11 kg per palm respectively). The highest yield recorded for a palm of this cultivar was 63 kg in the same season. In all other seasons the palms averaged 5 kg per palm or less. Over the 1994/95 and 1995/96 seasons, the average bunch weight for this cultivar was around 3 kg with the heaviest weight recorded being 11.4 kg.

5.3.1.2.3 Fruit description

The average fruit size has varied between 8 g and 10 g. Both fruit length and diameter were fairly consistent regardless of harvest stage, seasons or planting dates. The average fruit length varied between 29 and 34 mm while the average fruit diameter varied between 23 and 26 mm. These measurements are similar to those recorded overseas for this cultivar (Nixon, 1950).
5.3.1.2.4 Offshoot production

The average number of offshoots removed up until April, 1996 from the palms at AZRI (4) is slightly less than the average of 6 to 8 produced on palms overseas (Nixon, 1950), but these palms still have offshoots that will be removed when they reach a suitable size.

5.3.1.3 Bou Feggous

5.3.1.3.1 Flowering

Three palms were planted in April, 1991 and some started flowering in the third season after planting (1993/94) and by the fifth season (1995/96) all palms were flowering. The maximum number of flowers produced by a palm in a season was 7. The highest average number of flowers per palm was 3 in the 1995/96 season.

5.3.1.3.2 Fruiting

The harvest range for this cultivar was from early-March to early-April in the 1993/94 season and late-March to early-May in the 1994/95 season. Though the palms flowered in the 1995/96 season no fruit set. The time taken from pollination to harvest was as short as 178 days (around 6 months) and as long as 217 days (around 7 months). In the two seasons in which fruiting has occurred, the palms have averaged less than 5 kg per palm. The highest yield recorded for a palm of this cultivar was 13.6 kg in the 1994/95 season. Over the 1994/95 and 1995/96 seasons, the average bunch weight for this cultivar was 2.7 kg with the heaviest weight recorded being 4 kg.

5.3.1.3.3 Fruit description

The average fruit size was measured in only one season and was 7.8 g. Both fruit length and diameter were fairly consistent regardless of harvest stage, seasons or planting dates. The average fruit length varied between 31 and 33 mm while the average fruit diameter varied between 17 and 21 mm.

5.3.1.3.4 Offshoot production

The average number of offshoots removed up until April, 1996 from the palms at AZRI is 14.

5.3.1.4 Bou Skri

5.3.1.4.1 Flowering

Three palms were planted in April, 1991 and some started flowering in the second season after planting (1992/93) and by the fourth season (1994/95) all palms were flowering. The maximum number of flowers produced by a palm in a season was 7. In the three seasons...
when flowering has been recorded, the average number per palm has ranged between 2 and 4.3.

5.3.1.4.2 Fruiting

The harvest range for this cultivar was from late-March to mid-April in the 1992/93 season, late-February to late-April in the 1993/94 season and late-March to early-May in the 1994/95 season. Though the palms flowered in the 1995/96 season there was no fruiting. The time taken from pollination to harvest was as short as 168 days (around five and a half months) and as long as 219 days (around 7 months). The highest yield recorded for a palm of this cultivar was 15.4 kg in the 1994/95 season. The palms averaged 7 kg in this season but in the other two seasons they averaged less than 1 kg. Over the 1994/95 and 1995/96 seasons, the average bunch weight for this cultivar was 2.3 kg with the heaviest weight recorded being 5.6 kg.

5.3.1.4.3 Fruit description

The average fruit size was measured in only one season and was 6.3 g. Both fruit length and diameter were fairly consistent regardless of harvest stage, seasons or planting dates. The average fruit length varied between 32 and 35 mm while the average fruit diameter varied between 19 and 22 mm.

5.3.1.4.4 Offshoot production

The average number of offshoots removed up until April, 1996 from the palms at AZRI is 14.

5.3.1.5 Bou Sthammi

5.3.1.5.1 Flowering

Three palms were planted in April, 1991 and some flowered in the third season after planting (1993/94). The palms failed to flower in the fourth season (1994/95) and even by the fifth season (1995/96) not all palms were flowering. The maximum number of flowers produced by a palm in a season was 7. The highest average number of flowers per palm was 3.7 in the 1995/96 season.

5.3.1.5.2 Fruiting

Fruiting has only occurred in the 1995/96 season. The harvest range for this cultivar in this season was from late February to late March. Though some flowers were produced in the 1993/94 season, no fruiting occurred. The time taken from pollination to harvest was as short as 147 days (around 4 and half months) and as long as 175 days (around 5 and a half months). In the 1995/96 season, the palms averaged less than 0.3 kg per palm. The highest yield
recorded for a palm of this cultivar was 13.6 kg in the 1994/95 season. Over the 1994/95 and 1995/96 seasons, the average bunch weight for this cultivar was 0.4 kg with the heaviest weight recorded being 0.5 kg.

5.3.1.5.3 Fruit description

The average fruit size was measured in only one season and was 6.1 g. Fruit length and diameter were only recorded at the tamar stage in the 1995/96 season. The average fruit length was 29 mm while the average fruit diameter was 21 mm.

5.3.1.5.4 Offshoot production

The average number of offshoots removed up until April, 1996 from the palms at AZRI is 9.

5.3.1.6 Dayri

5.3.1.6.1 Flowering

Two palms were planted in April, 1990 and in the third season after planting (1992/93) both palms flowered, but in the following season only one palm flowered. However, in the subsequent seasons (1994/95 and 1995/96) both palms again flowered. The maximum number of flowers produced per palm in a season was 8. In the 1994/95 and 1995/96 seasons the palms have averaged around 6 flowers per palm.

5.3.1.6.2 Fruiting

The harvest range for this cultivar was from early-April to mid-May in the 1992/93 season, late-February to late March in the 1993/94 season and late-March to early-April in the 1994/95 season. Though the palms flowered in the 1995/96 season there was no frukting. The time taken from pollination to harvest was around 180 days (6 months). The highest yield recorded for a palm of this cultivar was 10.2 kg in the 1994/95 season. The palms averaged 7.7 kg in this season but in the other two seasons they averaged less than 0.5 kg. Over the 1994/95 and 1995/96 seasons, the average bunch weight for this cultivar was 2.2 kg with the heaviest weight recorded being 3.9 kg.

5.3.1.6.3 Fruit description

The average fruit size was measured in only one season and was 7.9 g. Fruit length and diameter were only recorded in the tamar stage and over the three seasons they were fairly consistent. The average fruit length varied between 41 and 43 mm while the average fruit diameter varied between 18 and 21 mm. These measurements are similar to those recorded overseas for this cultivar (Nixon, 1950).
5.3.1.6.4 Offshoot production

The average number of offshoots removed up until April, 1996 from the palms at AZRI (8) is less than the average of 15 to 20 produced on palms overseas (Nixon, 1950), but these palms still have offshoots that will be removed when they reach a suitable size.

5.3.1.7 Deglet Noor

5.3.1.7.1 Flowering

Thirty palms were planted in September 1989, six in April 1990 and one in April 1991. For both the September, 1989 and April, 1990, some palms started flowering in the third season after planting (1991/92 and 1992/93 respectively). By the fifth season from planting (1994/95) all the palms planted in April 1990 were flowering and they all flowered again in the following season. It was not until the seventh season from planting that all the palms planted in September, 1989 were flowering. The palm planted in April 1991 flowered in the second season following planting (1992/93) and continued flowering each season after that. The maximum number of flowers produced by a palm in a season was 17. Depending on the planting date and season, the palms averaged between 6 and 13 flowers per palm in the 1994/95 and 1995/96 seasons. Prior to that the palms averaged less than 4 flowers per palm except for the 1993/94 season when the palm planted in April 1991 had 7 flowers.

5.3.1.7.2 Fruiting

The harvest range for this cultivar was from mid-April to mid-May in the 1992/93 season, late-February to late April in the 1993/94 season, early-March to late-May in the 1994/95 season, and late-February to mid-May in the 1995/96 season. The time taken from pollination to harvest was as short as 147 days (around 5 months) and as long as 255 days (around 8 months). In the 1994/95 season, for all planting times the palms had their highest average yields (between 12.7 and 26.9 kg per palm). The highest yield recorded for a palm of this cultivar was 30 kg in the same season. In the 1992/93 and 1993/94 seasons the palms averaged less than 5 kg per palm. While in the 1995/96 season the palms averaged between 5 and 8.5 kg per palm depending on planting date. Over the 1994/95 and 1995/96 seasons, the average bunch weight for this cultivar was around 2.5 kg with the heaviest weight recorded being 8.4 kg.

5.3.1.7.3 Fruit description

The average fruit size has varied between 7.3 g and 9.3 g. Both fruit length and diameter were fairly consistent regardless of harvest stage, seasons or planting dates. The average fruit length varied between 32 and 39 mm while the average fruit diameter varied
between 18 and 22 mm. These measurements are smaller than those recorded overseas for this cultivar (Nixon, 1950).

5.3.1.7.4 Offshoot production

The average number of offshoots removed up until April, 1996 from the palms planted in September 1989 at AZRI (7) is slightly less than the average of 8 to 12 produced on palms overseas (Nixon, 1950), but these palms still have offshoots that will be removed when they reach a suitable size.

5.3.1.8 Halawi

5.3.1.8.1 Flowering

Five palms were planted in April, 1990. In the third season after planting (1992/93) some flowering occurred but it was not recorded. In the following season (1993/94) one palm flowered. In the next season (1994/95) four palms flowered, however, in the 1995/96 season only one palm flowered. The maximum number of flowers produced by a palm in a season was 8. In the 1994/95 season the palms averaged 3.6 flowers but in the other seasons they averaged less than one flower per palm.

5.3.1.8.2 Fruiting

The harvest range for this cultivar was from early-March to mid-April in the 1992/93 season, late-February in the 1993/94 season and mid-March to early-May in the 1994/95 season. Though the palms flowered in the 1995/96 season there was no fruiting. The time taken from pollination to harvest was as short as 160 days (around 5 months) and as long as 200 days (around six and a half months). The highest yield recorded for a palm of this cultivar was 18.7 kg in the 1994/95 season. The palms averaged 8.3 kg in this season but in the other two seasons they averaged less than 1.5 kg. Over the 1994/95 and 1995/96 seasons, the average bunch weight for this cultivar was 3.6 kg with the heaviest weight recorded being 5.3 kg.

5.3.1.8.3 Fruit description

The average fruit size was measured in only one season and was 6.1 g. Both fruit length and diameter were fairly consistent regardless of harvest stage, seasons or planting dates. The average fruit length varied between 36 and 44 mm while the average fruit diameter varied between 20 and 24 mm. These measurements are similar to those recorded overseas for this cultivar (Nixon, 1950).
5.3.1.8.4 Offshoot production

The average number of offshoots removed up until April, 1996 from the palms at AZRI (12) is similar to the average of 10 to 15 produced on palms overseas (Nixon, 1950), but these palms still have offshoots that will be removed when they reach a suitable size.

5.3.1.9 Hayany

5.3.1.9.1 Flowering

Five palms were planted in April, 1990 and some started flowering in the fourth season after planting (1993/94) and by the sixth season (1995/96) all palms were flowering. The maximum number of flowers produced by a palm in a season was 11. In the 1995/96 season the palms averaged around six flowers but in the other seasons they averaged less than two flowers per palm.

5.3.1.9.2 Fruiting

The harvest range for this cultivar was from late-February to early-April in the 1993/94 season, mid-March to mid-April in the 1994/95 season and late-February to early-March in the 1995/96 season. The time taken from pollination to harvest was as short as 151 days (around 5 months) and as long as 190 days (around six months). The highest yield recorded for a palm of this cultivar was 6.6 kg in the 1994/95 season. In all seasons the palms have averaged less than 2.5 kg per palm. Over the 1994/95 and 1995/96 seasons, the average bunch weight for this cultivar was 2.1 kg with the heaviest weight recorded being 3.7 kg.

5.3.1.9.3 Fruit description

The average fruit size has varied between 8 g and 8.5 g. Fruit length and diameter were only recorded in the tamar stage. The average fruit length varied between 36 and 45 mm while the average fruit diameter varied between 22 and 23 mm. These measurements are consistent with the lower end of the range recorded overseas for this cultivar (Nixon, 1950; Popenoe, 1920).

5.3.1.9.4 Offshoot production

The average number of offshoots removed up until April, 1996 from the palms at AZRI (9) is low compared to an average of 40 which is frequently removed from palms of this cultivar overseas (Nixon, 1950). However these palms are still young and have offshoots that will be removed when they reach a suitable size.
5.3.1.10 Hilali

Though the palm of this cultivar was planted in April, 1990 it is yet to flower, fruit or produce offshoots. This cultivar has been recorded as producing fruit which is late to very late in ripening and with a mild delicate flavour overseas (Nixon, 1950).

5.3.1.11 Khadrawy

5.3.1.11.1 Flowering

One of the two palms planted in April 1990 flowered in the third season after planting (1992/93) but neither flowered in the following season (1993/94). Both flowered in 1994/95 and 1995/96. The three palms planted in April 1991 didn’t flower until the fifth season after planting (1995/96). The maximum number of flowers produced by a palm in a season was 7. Except for the 1992/93 season when the average number of flowers produced per palm was 0.5, when flowering has occurred the palms have averaged between 4 and 5 flowers per palm.

5.3.1.11.2 Fruiting

The harvest range for this cultivar was late-April in the 1992/93 season, early-March to mid-March in the 1994/95 season and late-February in the 1995/96 season. The time taken from pollination to harvest was as short as 150 days (around 5 months) and as long as 191 days (around six months). The highest yield recorded for a palm of this cultivar was 4 kg in the 1994/95 season. In the 1994/95 season the palms averaged 3.5 kg per palm. In all other season the palms averaged less than 0.25 kg per palm. Over the 1994/95 and 1995/96 seasons, the average bunch weight for this cultivar was 0.65 kg with the heaviest weight recorded being 2.3 kg.

5.3.1.11.3 Fruit description

The average fruit size has varied between 6.7 g and 10 g. Fruit length and diameter were only recorded in the tamar stage. The average fruit length varied between 34 and 37 mm while the average fruit diameter varied between 21 and 22 mm. These measurements are similar to those recorded overseas for this cultivar (Nixon, 1950; Popenoe, 1920).

5.3.1.11.4 Offshoot production

The average number of offshoots removed up until April, 1996 from the palms at AZRI (12) is slightly less than the average of 15 to 20 produced on palms overseas (Nixon, 1950), but these palms still have offshoots that will be removed when they reach a suitable size.
5.3.1.12 Khalas

5.3.1.12.1 Flowering

The two palms planted in April 1991 both flowered in the third season after planting (1993/94) and continued flowering in the following seasons. The maximum number of flowers produced by a palm in a season was 6. In the 1994/95 season the palms averaged 6 flowers per palm, however they have otherwise averaged less than 2.5 flowers per palm.

5.3.1.12.2 Fruiting

The harvest range for this cultivar was from late-February to early-April in the 1993/94 season and late-March to early-May in the 1994/95 season. Though the palms flowered in the 1995/96 season there was no fruiting. The time taken from pollination to harvest was as short as 160 days (around 5 months) and as long as 204 days (around six and a half months). The highest yield recorded for a palm of this cultivar was 7 kg in the 1994/95 season. The palms averaged 6 kg in this season but in the other season they averaged less than 0.5 kg. Over the 1994/95 and 1995/96 seasons, the average bunch weight for this cultivar was 3.3 kg with the heaviest weight recorded being 1.3 kg.

5.3.1.12.3 Fruit description

The average fruit size was measured in only one season and was 10.2 g. Fruit length and diameter were only recorded in the tamar stage. The average fruit length was 35 mm in the both seasons it was measured while the average fruit diameter varied between 23 and 24 mm. These measurements are similar to those recorded overseas for this cultivar (Nixon, 1950).

5.3.1.12.4 Offshoot production

The average number of offshoots removed up until April, 1996 from the palms at AZRI (5) is low compared to the 15 to 20 which is frequently removed from palms of this cultivar overseas (Nixon, 1950). However these palms are still young and have offshoots that will be removed when they reach a suitable size.

5.3.1.13 Khalas Oman

The two palms of this cultivar were only recently planted and are yet to flower, fruit or produce offshoots.

5.3.1.14 Kush Zabad

The two palms of this cultivar were only recently planted and are yet to flower, fruit or produce offshoots. It is considered overseas to produce fruit with a rich, buttery flavour (Nixon, 1950).
5.3.1.15 Medjool

5.3.1.15.1 Flowering

Sixteen palms were planted in September 1989, four in April 1990, three in April 1991 and 18 in April 1996. For the palms planted in September 1989 some flowered in the fourth season following planting (1992/93). All the palms flowered in the following season (1993/94) but in the subsequent seasons (1994/95 and 1995/96) a couple of palms failed to flower. For the palms planted in April 1990, one palm flowered in the second season following planting (1991/92). All the palms flowered in the following season (1992/93) but in the subsequent two seasons (1993/94 and 1994/95) a couple of palms failed to flower. However in the 1995/96 season, all palms flowered again. One of the palms planted in April 1991 flowered in the first season after planting (1991/92) but even by the 1995/96 season only two of the three palms were flowering. The maximum number of flowers produced by a palm in a season was 17. Depending on the planting date and season, the palms averaged between 5 and 9 flowers per palm in the 1995/96 season, and between 1.7 and 6.5 flowers per palm in the 1994/95 season. Prior to that the palms averaged less than 3 flowers per palm. The palms planted in 1996 were too young to flower.

5.3.1.15.2 Fruiting

The harvest range for this cultivar was from early-March to mid-May in the 1992/93 season, late-February to late April in the 1993/94 season, early-March to early-May in the 1994/95 season, and late-February to early-April in the 1995/96 season. The time taken from pollination to harvest was as short as 143 days (around four and half months) and as long as 222 days (around 7 months). In the 1994/95 season, for all planting dates the palms had their highest average yields (between 6 and 18 kg per palm). The highest yield recorded for a palm of this cultivar was 35 kg in the same season. In the other seasons, the palms averaged less than 5 kg per palm. Over the 1994/95 and 1995/96 seasons, the average bunch weight for this cultivar was around 2.2 kg with the heaviest weight recorded being 9 kg.

5.3.1.15.3 Fruit description

The average fruit size has varied between 15.4 g and 19.7 g. The average fruit length varied between 39 and 49 mm while the average fruit diameter varied between 26 and 30 mm. These measurements are consistent with the lower end of the range recorded overseas for this cultivar (Nixon, 1950).
5.3.1.15.4 Offshoot production

The average number of offshoots removed from planting up until April, 1996 from the palms at AZRI is 9 though some palms have had 18 offshoots removed. No information was found on the average number of offshoots produced by palms overseas.

5.3.1.16 Nabut Saif

The three palms of this cultivar were only recently planted and are yet to flower, fruit or produce offshoots. It is considered overseas to produce fruit with an excellent flavour (Bacha and Shaheen, 1986; Anon, 1993).

5.3.1.17 Thoory

5.3.1.17.1 Flowering

Twenty-six palms were planted in September 1989, four in April 1990 and three in April 1991. For the palms planted in September 1989 one flowered in the third season following planting (1991/92). In subsequent seasons the palms showed signs of biennial bearing. Over 80% of the palms flowered in the 1992/93 season but in the subsequent season (1993/94) only 35% of the palms flowered. However, this increased again to over 80% of the palms in 1994/95 but then dropped again to 65% of palms in 1995/96. For the palms planted in April 1990, one palm flowered in the second season following planting (1991/92). All the palms flowered in the following season (1992/93) but in subsequent seasons (1993/94, 1994/95 and 1995/96) a couple of palms failed to flower. One of the palms planted in April 1991 flowered in the second season after planting (1992/93) and by the 1995/96 season all three palms were flowering. The maximum number of flowers produced by a palm in a season was 19. Depending on the planting date and season, the palms averaged between 6 and 11 flowers per palm in the 1995/96 season and between 3 and 9 flowers per palm in the 1994/95 season. Prior to that the palms averaged around 4 or less flowers per palm.

5.3.1.17.2 Fruiting

The harvest range for this cultivar was from late-March to mid-May in the 1992/93 season, late-February to late April in the 1993/94 season, early-March to late-May in the 1994/95 season, and late-February to mid-April in the 1995/96 season. The time taken from pollination to harvest was as short as 153 days (around five months) and as long as 254 days (around 8 months). In 1992/93 season the palms planted in September 1989 and April 1990 averaged 5 and 7 kg per palm respectively but the palms planted in April 1991 averaged only 0.3 kg per palm. While in the 1994/95 season, the palms planted in September 1989 and April 1990 had their highest average yields (8 kg per palm and 11 kg per palm respectively) while
the palms planted in April 1991 only averaged 1 kg per palm. The highest yield recorded for a palm of this cultivar was 24 kg in the same season. In the 1993/94 and 1995/96 seasons, for all planting dates the average yields of the palms was less than 1 kg per palm. Over the 1994/95 and 1995/96 seasons, the average bunch weight for this cultivar was around 1.8 kg with the heaviest weight recorded being 8.8 kg.

5.3.1.17.3 Fruit description

The average fruit size has varied between 6.6 g and 8.0 g. The average fruit length varied between 32 and 40 mm while the average fruit diameter varied between 19 and 20 mm. These measurements are consistent with the lower end of the fruit range recorded overseas for this cultivar (Nixon, 1950).

5.3.1.17.4 Offshoot production

The average number of offshoots removed from planting up until April, 1996 from the palms at AZRI (7) is similar to the average of 6 to 8 produced on palms overseas (Nixon, 1950).

5.3.1.18 Zahidi

5.3.1.18.1 Flowering

Two palms were planted in September 1989, five in April 1990 and two in April 1991. Another palm was also planted recently. For the palms planted in September 1989 both flowered in the third season following planting (1991/92). In the following season (1992/93) only one of the two palms flowered and then in the 1993/94 seasons none of the palms flowered. In the subsequent seasons (1994/95 and 1995/96) both palms flowered. For the palms planted in April 1990, one of the five palms flowered in the third and fourth seasons following planting (1991/92 and 1993/94). This increased to three palms in the 1994/95 season and four palms in the 1995/96 season. Both palms planted in April 1991 did not flowered until the fifth season after planting (1995/96). The maximum number of flowers produced by a palm in a season was 15. The palms planted in September 1989 averaged between 5 and 14 flowers per palm while the palms planted in April 1990 averaged between 0.2 and 4.2. The palms planted in April 1991 averaged 5 flowers per palm when they flowered in the 1995/96 season.

5.3.1.18.2 Fruiting

The harvest range for this cultivar was from mid-March to mid-May in the 1992/93 season, early-April in the 1993/94 season, mid-March to late-May in the 1994/95 season, and late-February to mid-March in the 1995/96 season. The time taken from pollination to harvest
was as short as 154 days (around five months) and as long as 238 days (around seven and a half months). In the 1992/93 season the palms planted in September 1989 averaged 7 kg per palm but the palms planted in April 1990 averaged only 0.4 kg per palm. While in the 1994/95 season, the palms planted in September 1989 and April 1990 had their highest average yields (24.9 kg per palm and 6.2 kg per palm respectively). The highest yield recorded for a palm of this cultivar was 25 kg in the same season. In the 1993/94 and 1995/96 seasons, for all planting dates the average yields of the palms was less than 2.5 kg per palm. Over the 1994/95 and 1995/96 seasons, the average bunch weight for this cultivar was around 2.8 kg with the heaviest weight recorded being 7.6 kg.

5.3.1.18.3 Fruit description

The average fruit size has varied between 5.7 g and 8.8 g. The average fruit length varied between 28 and 34 mm while the average fruit diameter varied between 19 and 24 mm. The fruit are slightly shorter than the average recorded overseas but the diameter is similar (Nixon, 1950; Popenoe, 1920).

5.3.1.18.4 Offshoot production

The average number of offshoots removed up until April, 1996 from the palms at AZRI (3 for palms planted in September 1989 and 5 for palms planted in April 1990) is low compared to number of 15 to 25 which is frequently removed from palms of this cultivar overseas (Nixon, 1950). However these palms are still young and have offshoots that will be removed when they reach a suitable size.

5.3.2 Male cultivars

5.3.2.1 Boyer No 11

5.3.2.1.1 Flowering

A palm of this cultivar was planted in April 1990 and it flowered in the fifth season after planting (1994/95) and then flowered in the following season (1995/96). In the 1994/95 season it produced 16 flowers and in the following season it produced 27 flowers. In the 1994/95 season this cultivar commenced flowering on the 17 June 1994 and was completed by the 3 October 1994. This was 3 weeks earlier than for the male cultivar Jarvis No 1 and similar to the other male cultivar Fard No 4. Boyer No 11 is considered overseas to be an early flowering cultivar (Anon, 1993). It is still too early to assess performance of this cultivar here. In the 1995/96 season Boyer No 11 and the other two male cultivars started flowering in late-March, 1995. However, in this season the duration of the season was not recorded.
5.3.2.1.2 Offshoot production

Two offshoots have been removed in the time period from planting up until April, 1996 from the palm at AZRI.

5.3.2.2 Fard No 4

5.3.2.2.1 Flowering

Nine palms were planted in April, 1990 and 7 palms were planted in April, 1991. The palms planted in April, 1990 did not flower until the sixth season following (1995/96) and then only two of the nine palms flowered. Three of the palms planted in April, 1991 flowered in the third season (1993/94) and fourth season (1994/95) after planting. In the fifth season after planting (1995/96) six of the seven palms flowered. The maximum number of flowers produced by a palm in a season was 12. In the 1995/96 season the palms planted in April 1991 averaged 6 flowers per palm but in the other seasons have averaged around 3 or less. In the 1994/95 season this cultivar commenced flowering on the 17 June 1994 and stopped on the 10 October 1994. This was 3 weeks earlier than for the male cultivar Jarvis No 1 and similar to the other male cultivar Boyer No 11. Fard No 4 is considered overseas to be a mid to late season flowering cultivar (Anon, 1993). It is still too early to assess performance of this cultivar here. In the 1995/96 season Fard No 4 and the other two male cultivars started flowering in late-March, 1995. However, in this season the duration of the flowering was not recorded.

5.3.2.2.2 Offshoot production

The average number of offshoots produced on the palms planted in April 1990 is 6 while for those planted in April 1991 it is 8. However the maximum number produced by a palm is 18.

5.3.2.3 Jarvis No 1

5.3.2.3.1 Flowering

A palm of this cultivar was planted in April 1990 and it flowered in the fifth season after planting (1994/95) and then flowered in the following season (1995/96). In the 1994/95 season it produced 4 flowers and in the following season it produced 17 flowers. In the 1994/95 season this cultivar commenced flowering on the 8 July 1994 and stopped on the 10 October 1994. This was 3 weeks later than for the other two male cultivars (Boyer No 11 and Fard No 4). Jarvis No 1 is considered overseas to be a early to mid - season flowering cultivar (Anon, 1993). It is still too early to assess performance of this cultivar here. In the 1995/96
season Fard No 4 and the other two male cultivars started flowering in late-March, 1995. However, in this season the duration of the season was not recorded.

5.3.2.3.2 Offshoot production

Twelve offshoots have been removed in the time period from planting up until April, 1996 from the palm at AZRI. No information was found on the average number of offshoots produced by palms overseas.

5.4 Discussion

The results are complicated by the fact that within the cultivars and between the cultivars, palms have been planted at a number of different planting dates. This resulted because the palms were not all available at the same time. This was due to the tissue culture laboratories constantly releasing new cultivars and to the quarantining of palms on arrival in Australia. In addition, even when palms arrived in the same batch from overseas they were not all suitable for planting at the same time due to the differences in their growth rates. Some palms reached a suitable planting out size faster than others.

It is not possible to just consider the amount of time which has elapsed from planting, as the palms could have been of different sizes and ages when first planted. In addition a palm which was planted in one year and flowered and fruited two years after planting may not have done so, or the crop load may have varied, if it was planted a year later. This difference would be because of the differences in climatic conditions during its growing period.

A further complication is that as the palms are quite young, they are still maturing and palms of the same cultivar planted at the same time are showing big differences in their flowering and fruiting patterns. Once all palms are over twelve years of age then comparisons between cultivars should be able to be made as the palms should be in a consistent fruiting pattern and reaching maximum production potential.

From the information presented it is possible to see the variation in characteristics from year to year including the effect of palm age on plant growth and cropping, fruit size and the differences between the three harvest stages (khalal, rutab and tamar). For growth characteristics such as flowering, fruiting and offshoot production it is difficult to draw comparisons between cultivars due to the problems outlined previously. However, for fruit characteristics such as length, diameter and individual fruit weight, which are not influenced as much by the age of the palm, some general comparisons between cultivars can be made.
6 Project 4 - Evaluation of bunch covers in reducing rain damage

6.1 Introduction

The occurrence of rain on date fruit as it nears maturity can cause considerable damage to the fruit. It can cause a downgrade in fruit quality or render the fruit unmarketable. The primary damage caused by rain and humidity are:

1. Checking and blacknose - Checking results in small, transverse linear scars, chiefly near the apex. Although these ruptures tend to heal, the scars remain, and may downgrade fruit quality. Checking usually results if rain occurs just prior to the khalal stage. If checking is severe, particularly in the cultivar Deglet Noor, it can be followed by darkening and shrivelling of the tip, known as blacknose. If the fruit is badly affected it may be almost worthless.

2. Splitting and tearing - In the late khalal stage, the fruit is subject to severe splitting and tearing if exposed to direct contact with water.

3. Excessive hydration of the fruit - In some soft cultivars, contact with rain may cause sugar to concentrate on the fruit surface, producing a sticky skin, and a poor appearance.

Secondary damage to the fruit can result, usually in the late khalal stage, due to fruit rots caused by fungi which are active during prolonged periods of high humidity (Nixon, 1950). In addition, souring and fermentation of fruit can occur, usually in the rutab stage. It tends to occur in the centre of heavy bunches during periods of high humidity following rain.

However, cultivars vary in their susceptibility to rain damage. Some being more sensitive than others. By planting cultivars resistant to rain damage, losses can be reduced. But these cultivars are still susceptible to damage by vertebrate and invertebrate pests. Owners of commercial date plantings have tried various methods of covering the bunches to protect them. The problem has been to provide a moderately dry atmosphere and favourable temperatures around the bunch but at the same time adequately protect it from rain, birds, insects and other pests. This problem would be relatively simple if it were not for the water vapour constantly transpired from the fruit surfaces. Moisture from uncovered bunches is quickly dissipated into the surrounding air. In covered bunches, however, some of the moisture may become trapped and the resulting condition tends to promote water injury and fungal attack. The aim of this project was to evaluate the effectiveness of a range of materials when used as bunch covers on four different cultivars.
6.2 Material and methods

Bunches on palms planted in the Dahlenburg Research Block at the AZRI (described in 2.1) were covered in the Kimri (green/unripe) stage of development just before the Khalal stage (early ripening). This period was usually around January. The covers being tested were made from a range of materials including banana bags (plastic bags used for covering banana bunches) (Plate 13), muslin, nylon, shadecloth, Tyvek® (a spinbonded polyolefin material used to make disposable overalls) and weedmat. In each season, where possible the bunches on each palm were covered using different materials. Bunches on four different cultivars were used for the experiment (Barhee, Deglet Noor, Medjool and Thoory). Bunches were covered in the 1992/93, 1993/94, 1994/95 and 1995/96 seasons. In the first two seasons preliminary observations only were made as not many bunches were available. However in the 1994/95 and 1995/96 seasons individual bunch information was recorded. In these seasons, the differences between types of covers and between cultivars were determined by comparing average percentage of culls. The palms were managed and harvested using the methods and techniques described in section 2.3.

6.3 Results

6.3.1 1992/93 season

Rainfall was negligible during January, February and March, 1993 (13.2, 3.8 and 14 mm respectively) which made comparisons between the various bunch cover materials impossible.

6.3.2 1993/94 season

Rain was recorded at AZRI during the month of February. The amount of rain which fell over these days was significant. Rainfall was recorded on 7 days. The highest were 10 mm on the 10/2/94 and 15 mm on the 18/2/94. This rain had the effect of causing considerable crop losses due to fruit cracking, splitting and the development of mould and some bunch rots (Plate 14). It was the period of time over which the rain fell and the resulting high humidity, however rather than the amount of rain, which appeared to have had a significant effect on fruit quality.

6.3.3 1994/95 season

During the fruit maturation period an above average amount of rain fell at AZRI. In January 195 mm, February 8 mm, March 26 mm, April 1 mm and May 46.8 mm. In total, throughout the 6 month fruit maturation period, 282.5 mm of rain fell, which was well above the yearly average of 250 mm for the Alice Springs area. All rain falling during these months
Plate 13 Date bunches covered with plastic banana bag covers.

Plate 14 Fungi growing on fruit following rain.
caused minor to severe damage to the crop, which was in various stages of development and maturity. For Medjool, covers made of shadecloth, muslin and nylon appeared to be the most effective in preventing losses due to rain damage and covers made of dense material (plastic banana bag, Tyvek® and weedmat) appeared to be the least (Table 6). For the other cultivars it was difficult to see any obvious differences between cover types.

In this season, the least damage was suffered by the cultivar Medjool, where overall an average 20% of fruit collected from each palm was culled. The next best cultivar was Barhee where an average of 60% of fruit collected from a palm was culled, followed by Thoory with 83%. Nearly all the fruit collected from Deglet Noor palms where unmarketable (97% culls) (Table 6).

6.3.4 1995/96 season

In the 1995/96 season, very little rain fell during the fruit maturation period. Only 2.8 mm fell in January, 1.8 mm in February, 2 mm in March, 7 mm in April and no rain in May. Therefore very little loss occurred due to rain damage or rots. However, due to the dry conditions mice and birds were prevalent and caused considerable damage to some bunches. The denser materials, particularly the plastic banana bags, tended to reduce these losses. This was particularly apparent in the cultivar Medjool (Table 6).

In this season all cultivars averaged between 60 and 80% damage, with the percentage culls decreasing slightly from the previous season for Deglet and Thoory, increasing slightly for Barhee and significantly increasing for Medjool (Table 6).

6.4 Discussion

6.4.1 Bunch covers

The ideal bunch cover would be one possessing all the following attributes:
1. waterproof during heavy rains,
2. allow free circulation of air throughout the bunch in periods of high humidity,
3. allow easy entry for picking ripe fruit,
4. exclude vertebrate and invertebrate pests, and
5. be economical to manufacture and fit to the bunch.
(Bliss et al., 1949)

Unfortunately, the covers trialed here, did not have all these attributes. In the 1994/95 season, when rain fell regularly throughout the maturation period, covers made of shadecloth and nylon appeared to be most effective in preventing losses due to rain damage, as they allowed air circulation in and around the bunches. Although they will only keep light rain off
the fruit, good air circulation appears to be imperative in the prevention of mould growth following rain. Covers made of dense material (plastic banana bags and weedmat) appeared to be the least effective in preventing rain damage. This was probably 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, however, be noted that on these relatively young palms the fruit bunches hang quite close to the ground and the problem of condensation build-up in these covers may not be as prevalent in older palms where bunches are higher off the ground and better air circulation is possible. In contrast, in the drier season of 1995/96, the denser materials, particularly the plastic banana bags, tended to reduce losses due to vermin and bird damage.

In a bunch cover trial undertaken in California in the late 1940's, water-repellent muslin and untreated cotton marquisette netting excluded insects and caused little sunburn damage but were relatively expensive and were ineffective against fruit tearing and fungus infection. Paper covers were generally effective against tearing and fungi infection. However, brown covers increased the sunburning of fruitstrands, and in more severe cases, this injury was accompanied by shrivelling of the dates. Under white paper covers, where internal temperatures were lower, less sunburning occurred but this was still more than for the cloth covers. In addition, the paper covers caused a slight retardation in ripening, probably because of a reduction in the rate of dehydration of the fruit during the ripening process. The problem in this trial was that the white paper bags had less strength than the brown paper bags due to the bleaching process. With the advances made since this trial was conducted, paper covers with improved properties would probably be available (Bliss et al., 1949).

Using a bunch cover alone is not considered sufficient to ensure the maximum degree of protection. A combination of protective measures is considered necessary. In addition to using bunch covers to protect the fruit, the grower should also use wire spreaders to assist with bunch aeration. Spraying fungicide after rain to prevent fungi growth and using insecticides when necessary to control insect pests would also be desirable. However, the lack of registration of chemicals suitable for use on date palms could make this impractical at this stage. Lifting the skirts of the covers after storms, would be beneficial because the increased aeration would help to dissipate the moisture present around the bunch but this would be very time consuming as labour would be necessary to lift the covers and then pull them back down again.
6.4.2 Cultivar differences in susceptibility to rain damage

It has been reported in California, that the cultivar Deglet Noor is one of the most susceptible of all varieties to splitting and fruit spots, but sours less readily than many of the soft cultivars. While the cultivar Barhee is moderately damaged by checking, splitting and souring but not much by fruit rot. Thoory is considered to have a high tolerance to rain with occasional splitting, confined to small ruptures near the stem end, and very slight damage from fruit spots and souring (Nixon, 1933; Nixon, 1942). Medjool is considered very tolerant to rain damage and is only slightly damaged by occasional rains and high humidity (Nixon and Carpenter, 1978).

In the 1994/95 season, when conditions were conducive to rain damage, the cultivars growing at AZRI showed similar responses to this reported overseas, except for Thoory. Medjool suffered the least damage and Deglet Noor the most, while Barhee suffered moderate losses. However, Thoory, which is considered very rain tolerant overseas, suffered more losses than Barhee and was only better than Deglet Noor.
Table 6 The average percentage culls for four date cultivars for the seasons 1994/95 and 1995/96

<table>
<thead>
<tr>
<th>Cover Type</th>
<th>Barhee</th>
<th>Deglet Noor</th>
<th>Medjool</th>
<th>Thoory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana bag</td>
<td>64%</td>
<td>60%</td>
<td>97%</td>
<td>75%</td>
</tr>
<tr>
<td>Muslin</td>
<td>55%</td>
<td>84%</td>
<td>94%</td>
<td>83%</td>
</tr>
<tr>
<td>Nylon</td>
<td>54%</td>
<td>83%</td>
<td>95%</td>
<td>84%</td>
</tr>
<tr>
<td>Shadecloth</td>
<td>61%</td>
<td>70%</td>
<td>100%</td>
<td>71%</td>
</tr>
<tr>
<td>Tyvek®</td>
<td>57%</td>
<td>67%</td>
<td>100%</td>
<td>85%</td>
</tr>
<tr>
<td>Weedmat</td>
<td>62%</td>
<td>52%</td>
<td>95%</td>
<td>93%</td>
</tr>
<tr>
<td>Overall</td>
<td>61%</td>
<td>71%</td>
<td>97%</td>
<td>82%</td>
</tr>
</tbody>
</table>

Overall percentages for the seasons 1994/95 and 1995/96:
- Barhee: 61% and 71%
- Deglet Noor: 97% and 82%
- Medjool: 20% and 60%
- Thoory: 83% and 74%
7 Conclusion

The future research on date palms in Central Australia in the short term will involve less emphasis on comparing cultivars and more on adapting management techniques for the region. Selected palms on which there is limited data will be monitored over the next five years for yield and fruit characteristic data. In another 5 years, when all the palms are reaching their productive peaks, more intensive research on cropping potential may begin. At the present time comparison of palms is severely compromised by the palms being of different ages and from different plant sources (offshoots, tissue cultured palms from France and tissue cultured palms from England). Offshoots will be removed from these palms and will be used to assist in the development of the date industry.

Though dates are grown commercially in Central Australia, there has been little research on refining management and production techniques necessary for high quality fruit production in this region. As yet no attempt has been undertaken to assess if the rate and timing of nutrient applications are the optimum for date yield and quality in Central Australia. The schedules currently used are based on overseas recommendations and it is not known if deficiencies or toxicities of nutrients are limiting production and growth. Work will be conducted to monitor nutrient levels in the leaves of dates palms over time and relate these changes to timing of nutrient applications and growth patterns. The information generated by this project will be the most substantial database of leaf nutrient levels in Australian date palms. It will be subsequently built upon and used as a reference source for making comparisons if nutritional problems develop in the future.

In addition, the present irrigation schedules are based on overseas recommendations with some local adaptation and could be using more water than is necessary and at the wrong time. Research will also be conducted to develop an irrigation scheduling method based on evaporation rates and tensiometer readings so that date growers can maximise yield while at the same time conserving irrigation water. In addition, by accurately identifying the water requirements of date palms it will be possible to identify potential date growing areas in Central Australia.

For the development of a viable Australian date industry, all of the states need to work together rather than individually. It is important that a tissue culture protocol be developed and implemented to allow the developing date industry in Australia access to large volumes of superior genetic material as this is a major factor limiting expansion of the industry at this time.
8 Bibliography


Petherbridge, R. (1980) The ecologically favourable areas in Australia for potential cultivation of the date palm, (*Phoenix dactylifera*). Dissertation submitted in partial fulfilment of the requirements for the Degree of Bachelor of Science (Honours), University of Sydney.


9 Acknowledgments

Firstly, thanks must be given for the efforts of the horticulture staff, in particular Kylie Young, Nic Isgro, Carolyn Ellis and Shirley Freeman, in conducting all the work required to maintain the date palms and collect the yield and fruit quality data. Also the assistance of the staff from the AZRI farm section over the years should also be recognised.

The effort of Susan Byrne in proof reading the drafts cannot be overlooked. In addition, the contribution of Stuart Smith and the staff in the Entomology Section, Rex Pithkethley and Barry Condé in the Plant Pathology Section and Vlad Kavaljenko and staff in the Chemistry Section of the Department of Primary Industry and Fisheries in relation to the identification of pests and diseases and analysis of plant and soil samples is greatly appreciated.

The work of Frank McEllister is obtaining the date plant material currently growing in the research block at the Arid Zone Research Institute has previously been recognised in the preface at the front of this book.

Finally, thanks must be given to the Rural Industries Research Development Corporation (RIRDC) and the Northern Territory Department of Primary Industry and Fisheries (NTDPIF) for their financial support towards this project.