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Development of the North Queensland Tea Tree Industry

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by
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"Development of the North Queensland Tea Tree Industry"

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Foreword

Tea tree oil production is a relatively new industry in the Atherton Tablelands in North Queensland. For long term international competitiveness, the development of efficient growing and production techniques are essential.

While information is available from research carried out in NSW, due to differences in climate and soil types, this research must be adapted to North Queensland condition.

This report demonstrates ways in which the tea tree oil industry has already and can be further developed in North Queensland.

It is one of a series of publications produced by RIRDC relating to the tea tree oil industry under the auspices of the RIRDC/ATTIA Tea Tree Oil R&D Committee

Peter Core
Managing Director
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(II) NON TECHNICAL SUMMARY

Objectives

- Through participatory on-farm research, cooperation and collaboration with the New South Wales Department of Agriculture and the Australian Tea Tree Association, facilitate the rapid development of the knowledge base on the production of tea tree oil to enable the formation of an internationally competitive and sustainable essential oil industry in the Mareeba Dimbulah Irrigation Area.

- Develop guidelines for irrigation scheduling for maximising oil yield and quality.

- To establish a gene pool of selected superior plants.

Background

Tea tree oil production is a relatively new industry on the Atherton Tablelands in North Queensland. Interest in tea tree oil production was generated as an alternative crop for tobacco in the Mareeba Dimbulah Irrigation Area. For long term international competitiveness the development of efficient growing and production techniques are vital.

The production systems being used now are based on New South Wales information, plantations use high densities and all are irrigated. Initial production figures have been highly variable ranging from 50 to 400kg of oil/ha/year depending on production techniques, suggesting there is a large scope to improve production by improving management practices. Due to differences in climate and soil types it is essential to adapt the findings from New South Wales research work for North Queensland conditions. Environmental and management effects particularly irrigation look to have a major impact on oil yields.

Research

Information on tea tree production has been gathered from key researchers working with the New South Wales Department of Agriculture, CSIRO and numerous Universities, as well as from many growers in Northern New South Wales. Information has also been collected from field days, conferences and symposiums.

A soil moisture monitoring system (Environscan) has been used to investigate water use and water requirements of tea trees in North Queensland. Data has been collected on oil quality and quantity and the factors affecting it.

Several seedlines have been identified as having superior oil concentration and quality. Superior planting material has also been sourced from the tea tree breeding program and is being evaluated at two locations in the Mareeba Dimbulah Irrigation Area.

Outcomes

Information has been presented to growers via field days, newsletters, progress reports, presentations at growers' meetings and farm visits. The information has been put together in a tea tree production booklet which is available through the QDPI Information Centres. This information availability has led to a rapid increase in the knowledge base about tea tree oil production by the local growers and resulted in improved farming practices leading to higher yields.

Irrigation scheduling guidelines have been developed. Mature trees use 0.8-1.0 times the pan evaporation rate which is equivalent to a total water requirement of 10ML/ha/year or 7.5ML/ha/year when rainfall is subtracted.

Major factors influencing oil concentration, hence yields identified include: genotype, time of year, nutrition, irrigation, and seedling vs coppice growth.

Implications

This project has helped with the very successful development of the North Queensland tea tree oil industry. There has been a rapid expansion of the industry and yields and oil quality have been excellent. This project has shown the potential of tea tree oil production in other areas of Australia. There is likely to be substantial further expansion of the industry as production and marketing issues are further resolved.

(III) BACKGROUND

The Mareeba Dimbulah area is presently undergoing structural change due to large reductions in Tobacco quotas. Growers are looking for alternative cropping systems suitable for small farm sizes (20-50 ha). Tea tree oil production shows good prospects for economic farm diversification. The industry will be based on an irrigated plantation production system. An economic analysis has indicated that tea tree oil production is profitable with a 10 ha farm if good yields (200kg/ha) can be achieved.

A growers' association was formed in May 1993 with the aim of developing a economically viable tea tree oil industry based on cooperation and group marketing. The association currently has 60 members all of whom have or intend to plant tea tree. Growers have planted approximately 250 ha so far and substantial further growth (500 ha) is envisaged as production issues are resolved. For long term international competitiveness the development of efficient growing and production practices to maximise yields and minimise costs are vital. The growers' association has a strong commitment to research and development with a levy on oil sales collected for research.

Being a newly established industry on the Atherton Tablelands there is a lack of local knowledge on tea tree oil production. The industry has therefore relied upon the research results and experience from plantation production managers in Northern New South Wales. Because the tea tree oil industry has been largely confined to this area much of the information on tea tree production has been difficult to access especially by farmers. This project aims to facilitate in the transfer of technology and information between the New South Wales Department of Agriculture, the Australian Tea Tree Association and the local growers' association.

Current research has centred on the Northern New South Wales industry and therefore some of the findings are not relevant or need to be adapted and tested in the different climates and soil types in North Queensland. Because of the importance of irrigation in the Mareeba Dimbulah area and the lack of information on the irrigation requirements of tea tree, this project examines crop responses to irrigation particularly production patterns and changes in oil yields and oil quality. Research in New South Wales has shown oil recovery one day after irrigation was less than half of the recovery from the same crop four days after irrigation. Clarification of this effect as well as variation in yields throughout the year are key issues of concern.

Initial production figures have been highly variable (50-400kg oil/ha/year) and growth rates from 8-63 tonnes biomass/ha/year depending on production techniques, suggesting there is a large scope to improve production by improving management practices. Environmental and management effects will have a major impact on oil yields as has been demonstrated in New South Wales. The factors involved in influencing oil concentration in the plants has still not been resolved and are further examined in this project.

A major tea tree breeding project is under way in Northern New South Wales. Material from this project and other tea tree seedlines are being evaluated in North Queensland in this project. It is hoped this information will help in the understanding of the environmental by genotype interaction. In time the identified superior seedlines will be able to be used for seed production for the North Queensland industry.

(IV) OBJECTIVES

- Through participatory on-farm research, cooperation and collaboration with the New South Wales Department of Agriculture and the Australian Tea Tree Association, facilitate the rapid development of the knowledge base on the production of Tea Tree oil to enable the formation of an internationally competitive and sustainable essential oil industry in the Mareeba Dimbulah Irrigation Area.

- Develop guidelines for irrigation scheduling for maximising oil yield and quality.

- To establish a gene pool of selected superior plants.

(V) INTRODUCTION

Tea tree oil is produced by distilling the leaves of tea trees. Of the 150 or so tea tree species only three can be used to produce tea tree oil with the right chemical components in the oil, i.e. high in terpinen-4-ol, low in Cineole - these are *Melaleuca alternifolia*, *M.linarifolia* and *M.dissitifloria*.

The tea tree oil industry began as a cottage industry in Northern New South Wales where tea trees were collected from natural stands. The plantation Industry began in the 1980's to meet the increasing demand for tea tree oil. With the mechanisation and intensification of the industry there has been a need to develop management guidelines to maximise yields and minimise the costs of production. Being a new crop little information was known about the best farming practices and how to maximise production. A lot of work has been done in Northern New South Wales including research on weed control, planting density, insect control, irrigation, harvesting and distilling practices. However there are still many unanswered questions in regards to maximising oil production, factors affecting oil concentration and irrigation requirements.

Recently the plantation industry has expanded from being located almost entirely around Northern New South Wales to other areas of Australia with the potential for higher production, for example the Atherton Tablelands in North Queensland. In these areas tea trees are being grown in different climates and on different soil types. Little is known about the levels of production or how to manage the trees in these areas. Growers have used information from New South Wales to help establish plantations, however there is a real need for research work to adapt and alter this information and determine the factors which effect oil concentration and yields in these areas. This project aims to develop production technologies for North Queensland.

In North Queensland all plantations are irrigated and in the absence of better information, growers have mostly adopted an irrigation regime similar to that used in tobacco. At this rate irrigation is a major cost and as such there is a need to tailor water use to the needs of the crop, develop irrigation guidelines and determine how irrigation influences oil production. This work has not been done - although it is recognised that irrigation and plant moisture levels can influence oil concentrations. It has also been observed that environmental factors and cultural factors can influence oil concentrations. There is a need to determine how these factors influence oil concentration in this area given the different seedlines, climates and soil types.

The yield and quality of oil from seedling tea trees has found to be highly variable indicating large scope to improve yields by selection and breeding. Because of the importance of genotype in determining oil concentration and the high heritability of oil concentration a large amount of work is being conducted on tea tree breeding. An important part of this breeding project is to assess selected lines in different environments. In this project selected lines from the breeding project and the seedlings already planted on the Tablelands are being evaluated.

(VI) METHODOLOGY

Technology Transfer

The project team and a grower representative travelled to Northern New South Wales to collect relevant information to aid the establishment of a North Queensland industry. This involved visiting tea tree plantations and talking with growers and plantation managers, inspecting tea tree trial work being conducted by the New South Wales Department of Agriculture and Sydney University and discussions with key researchers in the industry. Key industry representatives and researchers have also been invited to North Queensland to visit growers' plantations and present latest research findings at growers' meetings.

Information has also been gathered from attending field days, conferences and symposiums and made available to growers.

Irrigation/Oil Concentration

Project work has been conducted on growers' properties in the Mareeba Dimbulah Irrigation Area (16.6°S; 400m elevation). The plantations have used overhead irrigation, mostly single rows 0.9 - 1.2m apart with a density of 20-30 000 plants/ha and grown on sandy to sandy loam soils of granitic origin. Average annual rainfall is 1 000mm the majority of which falls between November and March. Average daily maximum temperatures vary from 31.2°C in November to 24.4°C in July. Minimum temperatures vary from 21.3°C in January to 14.3°C in July. The general climate is best described as dry tropical.

For the irrigation work a soil moisture monitoring system (Environscan) was installed on a grower's property. The property was selected because it is representative (soil type and agronomic management practices) of most tea tree farms in the area. Four access tubes were installed, two in a mature stand of trees and two in a new planting. Sensors were located at 10-80cm depth. The system was monitored regularly to determine plant water use and irrigation requirements of mature trees, coppice regrowth and seedling growth.

Oil concentrations were calculated using 300g lab stills (labglass - essential oil estimator). Samples of twig were collected from over 20-30 plants which were then bulked and two sub samples taken. Samples were then placed in plastic bags and sealed and then kept in a cool room until distillation (1-5 days). It was observed that if samples dried out before distillation, distillation was delayed and often incomplete. Samples were distilled for 2hrs to ensure full extraction of the oil. Oil concentrations were calculated on a dry leaf basis by adjusting for moisture content and the proportion of leaf in the twig sample. Oil concentration is given as the volume of oil per unit dry weight of leaf expressed as a percentage (% ml/g). Trial work at the start of the project indicated oil concentration determinations were accurate to within ± 0.25% ml/g using this technique.

Samples of oil distilled were stored for quality determination. These were conducted by the chemistry laboratory at Central Queensland University at Rockhampton.

Samples for oil concentration and oil quality were collected at regular intervals throughout the project from growers' properties to assess the variation in oil quality and quantity between seedlines, irrigation levels, nutrition levels, insect pressure (mites and psyllids), different times of the year, age of growth, type of growth and time of day.

Breeding/Selection

Over the course of this project over 50 seedlines have been evaluated for oil concentration. These seedlines have been collected from various sources in New South Wales.

Nine seedlines from the tea tree breeding project have been established from seed and planted out on two growers' properties. These are being assessed for growth and oil concentration.

(VII) RESULTS

Technology Transfer

As a result of this project a growers' booklet and information sheet on growing tea tree in North Queensland was written and widely distributed to growers and perspective growers (see Appendix). In these information sources basic guidelines for growing tea tree are presented, they have assisted with the establishment of plantations with the most up to date information. Information was also presented at a 1 day seminar held in Mareeba. Issues addressed in the booklet and at the seminar were agronomy, irrigation systems, economic analysis, marketing analysis, harvesting and distilling.

A very good cooperative relationship between New South Wales researchers and industry and the Queensland DPI and industry has been developed. This has been achieved through regular contact through meetings, study trips and conferences. There has been a good flow of information to and from North Queensland.

Information has been presented to growers via field days, newsletters, project progress reports, presentation at growers' meetings, and farm visits. Information has also been made available through the library and information centres.

Irrigation

Soil moisture levels have been monitored on a grower's property using an Environscan. The soil is a class I tobacco soil (see attached description) and is representative of much of the soil around Dimbulah on which tea tree is grown.

a) Mature Plants

Roots of tea trees were spread form 10 to 80cm soil depth and all were actively using water. However by far the greatest number of roots, and the most active, were in the top 40cm of soil - these roots used 3 times as much water as the roots at depth. Therefore, irrigation should be confined to the top 40cm of soil. Irrigating to water below 40cm is a waste because it requires a lot more irrigation to water to this depth and these roots are fairly inactive. Results also indicate that the roots at depth only become active when surface roots begin to dry out.

Results indicate that mature tea trees (1.5-2.0m tall) use between 2 and 9mm of water/day depending on the evaporation rate. This equates to about 0.8 to 1.0 times the evaporation rate. The measurements of soil moisture indicates that in the soils in the Dimbulah area there are about 25mm of plant available moisture in the top 40cm of soil. Therefore depending on the evaporation rate it is expected that the soil moisture would last for between 3 and 8 days.

With the Environscan it was determined that in a moist soil 12-15mm of irrigation reaches a depth of 40cm while 26mm reaches 80cm. In a dry soil it takes 23mm of irrigation to reach 40cm depth and 40mm to reach 80cm depth. Under normal irrigation therefore it is recommended to use 15mm of irrigation every 2 to 7 days depending on evaporation rates. Applying more than 15mm of irrigation at one time will result in water moving below 40cm depth.

Soil Type: Dimbulah **Site No:** MDI 528

Australian Soil Class.: Haplic, Mesotrophic, Red, Chromosol
Great Soil Group: No suitable group (affinities with Red Earth)
Principal Profile Form: Dr4.52

Substrate Material: Granite

Landform Element Type: Hillslope
Landform Pattern Type: Gently undulating rises 9-30m 1-3%
Morphological Type: Simple Slope **Slope:** Very gently inclined (1.0 %)

Vegetation: No vegetation, adjacent to Tea Tree plantation

Surface Coarse Fragments: No coarse fragments
Microrelief: Zero or none
Erosion: Active minor wind erosion
Rock Outcrop: No rock Outcrop

Condition Of Surface Soil When Dry: Recently cultivated

Wetness Class: Well drained, moderately permeable

Site Disturbance: Cultivation. Irrigated, past or present

Profile Morphology:

Horizon	Depth	Description
A11	0 to .12 m	Dark greyish-brown (2.5Y4/2) moist; no mottles; loamy sand; no coarse fragments: massive; moderately moist; no segregations; gradual to-
A12	.12 to .33 m	Greyish-brown (2.5Y5/2) moist; no mottles; loamy sand; no coarse fragments; massive; moderately moist; no segregations; sharp to-
A3	.33 to .50 m	Strong brown (7.5YR4/6) moist; no mottles; sandy loam; no coarse fragments; massive; moderately moist; no segregations; diffuse to-
B1	.50 to .65 m	Yellowish-red (5YR4/6) moist; no mottles; sandy clay loam; few (2-10%) small pebbles (2-6mm), angular quartz; massive; moderately moist; no segregations; diffuse to-
B2	.65 to 1.65 m	Reddish-brown (5YR5/4) moist; no mottles; clay loam, sandy; common (10-20%) small pebbles (2-6mm), angular quartz; massive; moderately moist; no segregations.
B3	1.65 m+	Reddiish-yellow (7.5YR6/6) moist; no mottles; massive; no segregations.

b) Coppice Growth

Following harvest the water use of the trees falls to 0. It takes about 3 weeks for stumps to reshoot. From 3 to 8 weeks of age the trees use about a ¼ of the evaporation rate. During this stage of regrowth most of the water is used from the top 20cm of soil, therefore irrigations should be reduced to 10mm at a time. At 8 weeks trees are usually about 30-40cm in height and extract water from the soil down to 40cm. So irrigations should be extended to apply 12-15mm of water at a time.

From 8 to 12 weeks of age the trees used about ½ of the evaporation rate, this increased to ¾ of the evaporation rate after 12 weeks of age and then 0.8 to 1.0 times the evaporation rate from 16 weeks of age - equivalent to the water use of mature trees. Using mulch on the soil surface reduce water losses from the soil by 2-4mm/week in mature trees, but is likely to be much more beneficial on young trees before a full canopy cover is established.

c) Seedlings

Seedling tea trees use very little water in the first 6 weeks however it is very important to keep the top 15-20cm of soil moist. This will require 5-8mm of irrigation every 3 to 5 days. After 10 weeks of growth tea tree roots are active down to 20cm. After 12-16 weeks (30-50cm tall) roots grow down to 40cm depth and irrigation should increase to 15mm per irrigation. At this stage plants are using 2-4mm/day.

The soil moisture observations indicated some variation in the level of watering at different positions in the field. This progressively deteriorated as the trees increased in size. It is recommended to harvest the trees before they interfere with the water distribution of the overhead sprinklers (1.8m).

Oil Concentrations

Oil concentration on plants grown in north Queensland have ranged from 3.0 to 11.0%. The oil concentration is heavily influenced by genetic factors (seed source) and by environmental factors.

The main factors found to influence oil concentrations in this project were:

Genetics. Genetic factors (seed source) would appear to have the single biggest influence on the leaf oil concentration. Of the 50 seedlines tested for oil concentration in north Queensland 4 have been identified as having significantly superior oil concentrations. These trees have averaged an oil concentration of 9.0% compared to 6% of the other seedlines. Oil concentration determination between plants within a seedline indicated a variation in oil concentration of $\approx \pm 1\%$. The highest oil concentrations have not always led to the highest yields/ha however. This is thought to be due to differences in management factors effecting growth rates hence biomass yield rather than slower growth rates of the highest oil concentration plants although growth rates were not studied in this present project. It was noticed that the lowest oil concentration plants never produced high yield/ha.

A small amount of *M.linarifolia* and *M.dissitiflora* is also grown on the Atherton Tablelands. The oil concentration of these plants has average around 6-8% and is therefore similar to the better alternifolia seedlines. Because of concerns over oil quality and total yields/ha similar to alternifolia all new plantings are based on alternifolia.

Irrigation. Irrigation as well as influencing growth rates seems to affect the leaf oil concentration and therefore has a dramatic affect on yields/ha. Prolonged periods of water stress (1-3months) reduce oil concentrations by around 3% from a high of 6% prior to water stress to 3% following water stress. Short term periods of water stress 1-2 weeks has had no effect on oil concentration. Oil concentrations have been highest on plantations and soils where the soil has been kept continuously moist but not wet. This has occurred with very regular irrigation (daily with drip irrigation) on heavy soils with shallow water tables and by using heavy mulch layers. Continuously moist soils also produce fast growth rates although no measurements of growth rates were done in this project.

Nutrition. Trees growing quickly which are dark green and lush always have better oil concentrations than trees which are nutrient deficient. Leaf analysis data collected from growers' properties throughout this project indicate the following optimum leaf nutrient levels.

TABLE 1. Approximate optimum leaf nutrient levels.

Nutrient	Optimum Range
N	1.8-2.0%
P	0.1%
K	1.5%
Ca	0.7%
Mg	0.1%
S	0.2%
Na	0.4%
Cl	0.3%
Cu	10ppm
Zn	40ppm
Mn	100-500ppm
Fe	30-100ppm
B	40-80ppm

These levels have been best achieved by applying small amounts of fertiliser very regularly through the whole growing season. The trees require quite large amounts of Nitrogen and Potassium ≈ 150-200kg/ha and smaller amounts of Phosphorus 20kg/ha.

The trees also appear to have a high demand for Iron, Zinc and Copper. Leaf oil concentrations have always suffered when any of these elements have been deficient. Oil concentrations have been 1.5-2.5% lower on nutrient deficient plants compared with healthy plants. It is recommended to apply a complete fertiliser with additional nitrogen, potassium, iron and zinc.

Coppice Growth. Coppice regrowth has 2-3% higher oil concentrations then seedlings at the same time of the year. However it does take 3-5 months for oil concentrations in the coppice growth to build up to normal levels. The good oil concentrations seem to be related to the faster growth rates and lush growth of coppice regrowth.

Age of Growth. Very new flush material and young (<2 month) coppice growth has low oil concentrations (2-3% lower than mature leaf material). Also oil concentrations tend to fall as trees age (>12 months), become less vigorous and growth slows down. This drop in oil concentration (1-2%) is aggravated if trees get water or nutrient stressed. This often occurs with large mature trees because it is difficult to keep up with the demands of the trees.

Time of Year. Oil concentrations have been monitored at three monthly intervals on numerous growers' properties (see Figure 1). The seedlines studied include high and low oil concentration plants. As can be seen from figure 1 the time of year plays an important role in determining oil concentration. Oil concentration follows similar patterns to that observed in New South Wales - highest in summer and lowest in winter although the yearly variation in North Queensland seems to be smaller. The highest oil concentrations seem to be related to hot, humid, wet conditions such as during and just following the wet season January-March.

The wet weather and high humidity rather than temperature seem to be key factors in the increase in oil concentration. Although temperatures are high in October-December oil concentrations are never as high as observed in March when temperatures, if anything, are cooler. This may be because of the drier weather and lower humidities during October-December. The year to year variation is around 1-2% in low yielding trees and 2-3.5% in high yielding trees (see Figure 1).

Insects. Plants badly effected by psyllids, mites or sooty mould have lower oil concentrations (≈2%) than unaffected trees. This could be related to the slower growth rates of these trees.

Flowering/Fruiting. No significant changes (<0.5%) in oil concentration have been observed in association with flowering or fruiting.

Time of Day. Significant short term changes in oil concentration have not been observed in North Queensland either through laboratory distillations or during growers' normal harvesting and distilling operations. There maybe small changes in oil concentrations but they are too small to accurately measure with the equipment used in this project.

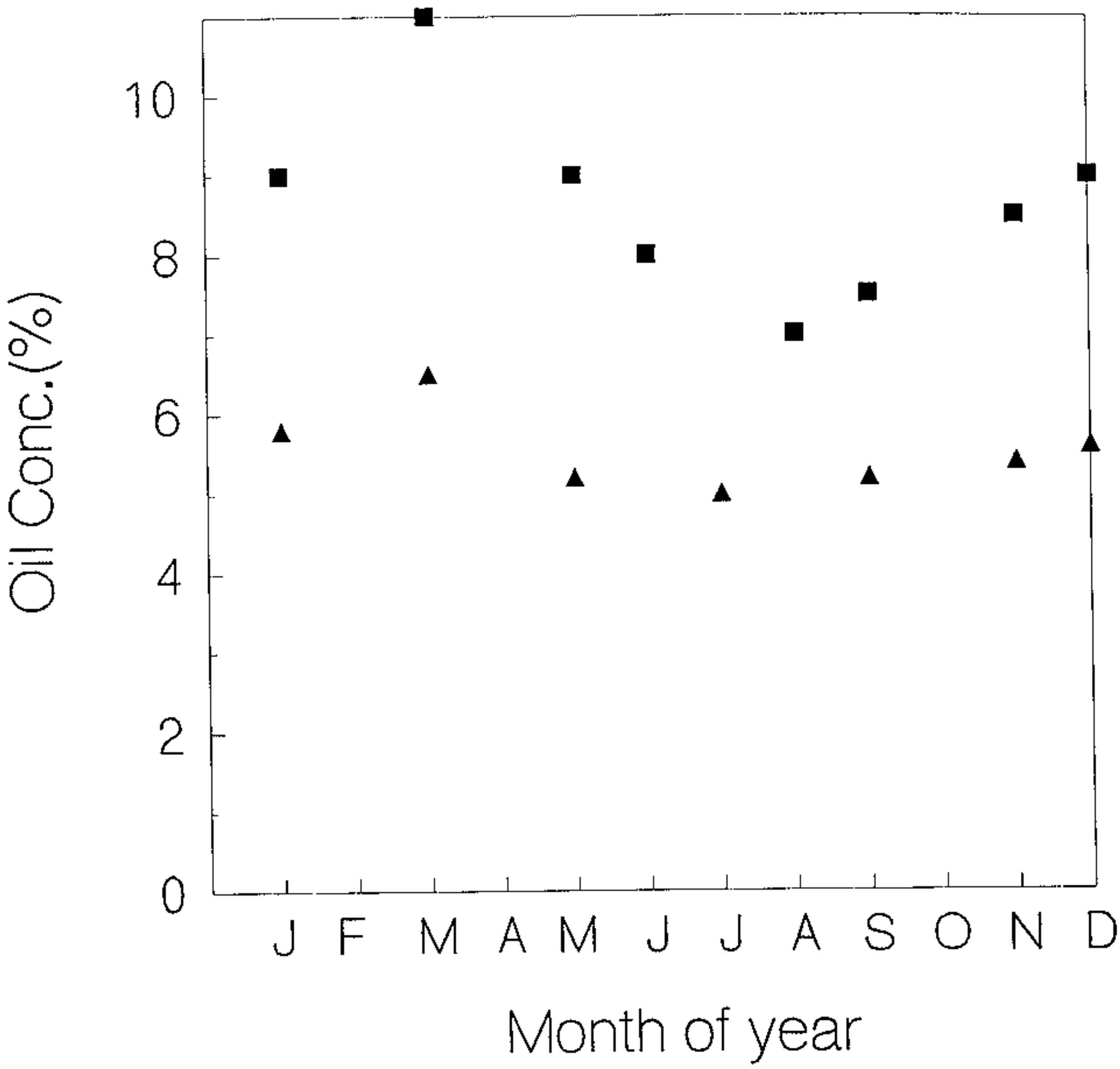

Figure 1. **The seasonal trend in oil concentration of a high oil yielding seedline (■) and a low oil yielding seedline (▲).**

Oil Quality

Samples of oil from the oil concentration determinations were collected and sent to the Rockhampton University chemistry lab for oil quality determinations.

In general oil quality from trees grown in the tropical climate of North Queensland has been excellent, with cineole levels around 2-4% and terpinen-4-ol levels around 40%. General findings from the study have been:

- Cineole levels tended to be quite consistent for each seedline with the terpinen-4-ol levels varying more.
- Very young new growth has higher cineole levels (1-2%) and lower (2-5%) terpinen-4-ol levels than mature growth.
- Old growth (1-2 years) from old trees have high terpinen-4-ol levels and low cineole levels.
- Flowering, nutrient levels and the time of year had no consistent significant effect on oil quality.
- Mild water stressed trees had higher terpinen-4-ol levels and lower cineole levels than well watered trees.
- Linarifolia seedlines always had higher cineole levels (4-5%) and lower terpinen-4-ol levels than alternifolia seedlines.
- In all seedlines there is a general inverse relationship between terpinen-4-ol levels and cineole levels.
- There seems to be a relationship between oil concentration and oil quality, with high oil concentrations leading to high oil quality.

Breeding/Selection

Assessment of oil concentrations on growers' properties has indicated a strong genetic influence on oil concentration in North Queensland. Of the 50 seedlines evaluated only 4 have been identified as having significantly above average oil concentrations. Average oil concentrations have ranged from 5% during winter to 7% during summer. This compares to 7.5% during winter to 10.5% during summer of the superior seedlines. Some stands of these superior trees have been left for seed production and some have been successfully vegetatively propagated using cuttings in 50% peat, 50% sand mix. The vegetatively propagated plants have been successfully machine harvested and oil concentrations have been comparable with the parent material. Estimates for the cost of cuttings range from 40-80¢ each and are therefore probably uneconomic.

From the tea tree breeding project in New South Wales, nine seedlots have been selected to assess productivity in North Queensland. These seedlots have been selected on the basis of oil concentration, biomass production and oil quality (see Table 2). The seedlings have been raised and planted on two representative growers' properties in the Mareeba Dimbulah Irrigation Area. The plants are about 5 months old and growing well. The plants are still too young to assess for biomass production and oil concentration, when collected this information will provide an understanding of the genetic x environment interaction.

TABLE 2. Seedlines chosen to evaluate in North Queensland.

	Oil Concentration		
Growth	High	Medium	Low
High	131	3	63
Medium	151	81	65
Low	191	113	31

(VIII) DISCUSSION

The information gathered by this project from New South Wales and project research has been enthusiastically adopted by the North Queensland tea tree industry. There has been a rapid expansion of the industry during the last 3 years as growers have become more knowledgeable about tea tree production. As growers' techniques have improved so have yields. The growth rates in North Queensland look to be about 50% greater than in New South Wales with the interval between harvests averaging 6-9 months. The faster growth rates reflect the response to warmer temperatures, higher solar radiation levels, plentiful irrigation and the lack of a winter dormant period. The best yields achieved so far have been 300kg/ha from 8-9 month old coppice regrowth, equivalent to 400kg/ha/year.

Information on growing techniques and farming practices have been freely exchanged between growers through the growers' association meetings and at field days.

The quality of oil produced in North Queensland has been excellent thanks to careful seed selection, and has found a ready market. The association has put in place a quality assurance program and the future prospects of the industry look excellent.

The growers' association has developed a good information base on tea tree production which is readily available to growers through their library and association office.

This project has highlighted the high water requirement of tea trees growing in North Queensland. From the rates of water use at the different stages of growth, total water requirements are estimated at 10ML/ha/year, i.e.

Total Water Use			
Weeks from Harvest	**Rate of Water Use (pan evaporation)**	**Water Requirement**	**TOTAL**
0-3	0	3 x 38 mm/week x 0 =	0
3-8	¼	5 x 38 mm/week x ¼ =	48
8-12	½	4 x 38 mm/week x ½ =	76
12-16	¾	4 x 38 mm/week x ¾ =	114
16-24	1	8 x 38 mm/week x 1 =	304
			540 mm

So the trees use approximately 540mm/6 months crop or 1 000mm/year or 10ML/ha/year. 38mm is the average weekly evaporation rate for Dimbulah. Total water requirement is reduced to 7.5ML/ha/year if there is sufficient rainfall to replace 3 months irrigation as is the case in the Mareeba Dimbulah Area. At this rate irrigation remains one of the major costs in the production of tea tree oil in North Queensland.

Oil concentration determinations indicate that it is important to schedule irrigation to maintain the top 40cm of soil in a continuously moist state, but not wet. This can be achieved with regular irrigation (3-4 times/week) and it will also be aided by selecting heavy textured soils high in organic matter with a shallow water table and using mulch. Periods of water stress should be avoided at any time as it results in slower growth rates, leaf loss and lower oil concentrations. As trees become tall the distribution of water becomes uneven from overhead sprinklers and care must be taken not to underwater trees.

As well as irrigation, tree nutrition has a major influence on oil production by influencing growth rates and oil concentration. Fertiliser should be applied to the trees in small amounts at regular intervals to encourage continuous growth. Trees with abundant fertiliser especially nitrogen and potassium have had the best oil concentrations. Total fertiliser requirement is estimated at around 150 - 200 kg/ha of nitrogen and potassium per crop. As with many Australian native plants the trees have a high requirement for Iron and Zinc.

Another factor found to play a role in determining oil concentration is the time of year of harvest (as has also been found in New South Wales). Growers should aim to harvest the trees during the warmer months of the year from December to April. Oil concentrations decline during the cooler drier months. The other factors to consider in determining the best time of year to harvest are the timing of the wet season, the trafficability of the land, the harvest interval and the rate of regrowth. When all things are considered the optimum harvest times would appear to be just before and after the onset of the wet season. Harvesting during wet weather has led to disease problems and plant deaths and thus should be avoided.

The quality of oil from a seedline is difficult to influence with management practices and is largely determined by genetic factors. Seed selection is therefore critical. Oil quality can be reduced if trees are harvested too frequently and growth is very young.

This project has highlighted the importance of selecting good quality seed from which to established a plantation. Seed must be selected from parent trees which have both good quality and quantity of oil. Although oil concentrations can be improved by good management practices (fertiliser and irrigation) and harvesting at the correct time of the year, yields will never be as good from genetically low oil yielding plants as in high oil yielding plants. Oil concentration determinations indicate some variation within a seedline, however this was small ($\pm$ 1%) compared with the variation between seedlines ($\pm$ 3%). Success has been achieved in propagating plants vegetatively which would ensure identical high yielding plants, however the cost of propagating plants vegetatively looks too expensive for the high planting density used.

(IX) IMPLICATIONS AND RECOMMENDATIONS

The results of this research work has important implications for the way in which tea trees are managed for maximum production. In order to achieve high yields it is essential superior seedlines are used by selecting seed from known good parents. Then the trees must be intensively managed with regular irrigation and fertiliser. Finally trees should be harvested either just before the wet season (December) or just after the wet season (April). Growers in the Mareeba Dimbulah Irrigation Area have been able to use this information to change their farming practices and increase yields. This has helped with the rapid and successful development of the North Queensland tea tree industry. This project has shown the potential for tea tree oil production in other areas of Australia outside of Northern New South Wales. There is likely to be substantial further expansion of the industry as production and marketing issues are further resolved. There is a need for more research on fertiliser requirements to maximise growth rates and on weed and pest control.

(X) INTELLECTUAL PROPERTY

Nil

(XI) EXTENSION STRATEGY

Research results have been regularly reported to the industry via field days, progress reports, farm visits and presentations at growers' meetings. Information has been made available through the Department's Information Centres and libraries and in the growers' association office. Information has also been presented at the Australian Tea Tree Growers' Symposium in New South Wales.

(XII) TECHNICAL SUMMARY

Tea tree oil production is a relatively new industry on the Atherton Tablelands. The production systems being used are based on New South Wales information. Plantations use high densities and all are irrigated. Initial production figures have been highly variable depending on production techniques suggesting there is a large scope to improve production by improving management practices.

This project has found that environmental, management and genetic factors all influence oil concentration in the plants hence oil yields. Assessment of oil concentrations on growers' properties has indicated a strong genetic influence on oil concentration in North Queensland. There are some seedlines with low oil concentrations and others with high leaf oil concentrations - the range has been from 3 to 11%. The variation within a seedline has been low compared with variation between seedlines. Some success has been achieved with vegetative propagation of the superior seedlines - these have been successfully harvested.

As well as the underlying genetic influence on oil concentration several other factors have been found to influence oil concentration. These include irrigation, plant nutrition, type of growth (coppice vs seedling), age of growth and time of year. In general anything which promotes healthy vigorous growth for example, plentiful irrigation and fertiliser and freedom from pests and diseases tends to increase leaf oil concentrations as well as plant growth. Oil concentrations were highest in the summer months and lowest in the winter months which seemed to correlate with the timing of the wet season. The decline in oil concentration was greatest in the highest yielding seedlines. Flowering and fruiting and the time of day did not significantly alter oil concentrations.

Oil quality was relatively unaffected by environmental and management factors although very young growth tended to have higher cineole levels and lower terpinen-4-ol levels while old growth (1-2 years) had high terpinen-4-ol levels and low cineole levels.

This project has highlighted the high water requirement of tea trees growing in the Mareeba Dimbulah Irrigation Area. The trees have a total water requirement of 10.0ML/ha/year which can be reduced to 7.5ML/ha/year when average annual rainfall is taken into account. The roots of tea trees extend down to 80cm however the majority are in the top 40cm of soil and it is recommended to only irrigate down to this level. This will require about 15mm of irrigation in the sandy soils of the Mareeba Dimbulah area. The best oil concentrations were achieved where the soil was maintained in a continuously moist state, which could be achieved with very regular irrigation.

From this project a growers' booklet and information sheet on growing tea tree for maximum production have been written and widely distributed (see Appendix). A good cooperative relationship has been developed between New South Wales researchers and industry and the Queensland researchers and industry.

APPENDIX

REPORT ON A TRIP TO NORTHERN NEW SOUTH WALES TO INSPECT THE TEA TREE INDUSTRY.

James Drinnan, Chris Norris, Irene Kernot and Judy Petrusa

Aim:

The purpose of the trip was to visit Tea Tree plantations, growers and researchers to assess the current knowledge on plantation agronomy, harvest and distillation systems and quality assurance. By visiting current research and production areas develop networks to facilitate the transfer of knowledge to North Queensland and coordinate research effort into Tea Tree.

During the course of a 5 day tour of Tea Tree growing areas the authors spoke with a large number of people and visited a number of plantations. The information has been summarised under sectional headings.

Seed Selection:

Current plantation practise is to collect seed from bush plants. There is no guarantee of breeding and due to the variability inherent in the species, seed populations are likely to show large variations in pedigree (cross pollinated). However reputable collectors gather their seed from plants of known quality to maximise the quality of the resulting seedlings. There tends to be low and high cineole types. It is generally agreed that the composition of oil in Tea Tree is genetically determined. The total concentration of oil in the leaf is also determined by the genetic potential of the plant. Heritability studies have shown oil concentrations to be highly heritable (0.7). Oil concentration is also affected by environmental factors. (Murtagh, Baker, Southwell, Williams pers comm)

Other factors such as growth rates, coppicing ability and leaf/stem ratio are also likely to have a genetic basis and can be selected for in a Tea Tree improvement program. The heritability of these factors appears to be around 0.2-0.3.

A breeding program has been initiated in NSW by the NSW Dept. of Ag and CSIRO (funded by RIRDC). This claims that very large gains are possible by improving selection methods. The breeding program is using a population selected from as wide an area as possible to establish seed populations. By selection these individuals are culled to obtain a seed population of high quality individuals.

Site Selection:

The main criterion used in NSW is that there is an accessible water table. This is seen as critical to the success of Tea Tree production. Occassional flooding is not seen as a problem. One of the "best" plantations is on a peat based soil with very high organic matter, good "all-round" soil- grows sugar cane well.(Chapman;)

Land Preparation:

Land preparation is seen as critical for the production of Tea Tree.

Chapman:	Cultivates several times before planting including laser levelling and a "touch up" if it rains before planting. Chapman will grow up to 3 green manure crops before planting. High organic matter is considered an advantage.

Stotter:	Main Camp Plantation is on sandy flats, moderate elevation >100m and in a valley floor. A chain of lagoons throughout the property has been restructured to supply irrigation. The area is laser levelled before planting, for flood irrigation. Ripped to 700mm and cultivated using deep offset ploughs. A pass with a rotary hoe and a bed former completes the seedling beds.

Planting:

A wide range of row spacings have been and still are being used throughout the Industry. This includes row widths up to 3m and beds with 2 and 3 rows. The Industry was beginning to move towards an 80cm row spacing with plant spacing of 40cm to give at least 30,000 plants/ha. Populations of 36,000 were believed to give optimal production.

Chapman:	-chain type transplanter, suitable for speedlings or open root plants -currently 4 row-6500 plants/day -building 6 row-10000/day -1m x 30 cm spacings (33 000/ha)

Stotter:	-6 row planter, cartridge/cone feed, for speedlings. -50 ml water/plant, at planting -80cm x 45cm (28 000/ha) -seedlings from many suppliers -mostly single seedling/speedling

Stretton:	-3m rows to allow grass sward inter-row thus allowing trafficability under wet conditions -30 cm spacing along row (10 000/ha)

Thursday Plantation:	-1.5m x 25cm to suit forage harvester -too wide-incomplete row cover even when ready to harvest -have tried filling in (75cm) with little success

Agronomic Factors:

Many of the observations regarding growth rates and yields were not documented or objectively measured.

Growth after coppicing:

Ther was general agreement that interrow cultivation was beneficial for Tea Trees. Growth was stimulated after cultivation.(Murtagh,Chapman,Thursday) The manager at Thursday plantation advocated regular ripping along the rows as well as cultivation.

The value of a cleanly cut stump was not as clear. Some believed that damge to the bark and the stump assisted in more rapid regrowth by promoting a heavier bud burst. Typically only 2-6 main stems dominate despite the formation of very large numbers of shoots initially.(Murtagh). Craig Chapman has tried to reduce stump damage by using a better quality forage harvester.

Any factor which increases the growth rate or biomass yield of Tea Tree was beneficial as Oil yield was tied to the total biomass yield and does not vary with the factors that increase yield. (Murtagh)

Best to harvest when trees will grow back quickly causing less death of roots and stumps.

Weed Control:

Weed control is generally seen as critical for successful Tea Tree production. Tea Tree does not compete well with weeds (non competitive root system). Research projects investigating weed control options (weed mat, mowing low frequency, mowing high frequency, shallow cultivation (50mm), deep cultivation (150mm) and "over the top" herbicide), and the effect of weed competition on growth and oil yields was inspected. John Virtue concluded that the best weed control gave the best yields (this was achieved with herbicides). Weed matting was not successful due to the heat according to Virtue. Virtue puts the reduction in yield from weed competition down to a combination of competition for light and nutrients particularly when the plants were young.

A mixture of chemical and non chemical weed controls are practised by the industry. The most innovative is the use of sheep to graze the interrrows and reduce weed competition. Simazine is no good on light, dry soils. A summary of the weed control measures used in the plantations visited:

Chapman:	-pre-emerge with Simazine & spray-seed -plant -Sheep + two cultivations -No spraying of plots after harvest.

Stotter:	-fully mechanical weed control -all equipment 6 row -2-4 rotary hoe -cultivate & hill-smother weeds

Stretton:	-wide rows (3m)- row kept weed free by contact herbicide, at expense of bottom 30 cm of bush

Thursday Plantation:	-pre-emergent-spray-seed -surflan -sheep used and viable -apply herbicide with mister because only equipment available.

Insects:

NSW Depaartment of Agriculture entomologist Neil Treverow presented a talk on the range of pest problems experienced in Tea Tree.

At this stage the Pergo beetle (*pergoides trygyna*) is the only pest which is considered to have an economic impact on Tea Tree. The beetle and the larvae feed on young growth. Egg laying occurs continuously. Pergo betle can lay dormant as adults and pupae, this gives it the ability to re-establish itself very quickly when good growth conditions occur. One prospect for biological control is a fungus which has been recorded in field infestations.

Minor pests:

Gall fly (*dasyneura*)
Leaf psyllid (*trioza*)
Sawfly (*pterigoferus*)

Pest Control Measures:

Endosulfan sprays have shown residues in oil and are therefore not able to be used. Lannate is suitable for plantations and in some cases is used as often as weekly. Decis/chlorpyrifos are suitable for pest control on seedlings.

Chapman:	-use lannate by cropduster

Thursday Plantation:	-Cotton insecticide used (Bulldock)

Nutrition:

There is a general belief that high levels of nutrition are not required for Tea Tree production. Dept of Agriculture recommendations for a basal fertiliser application are given because of the range of soil types in which Tea Tree could be grown. Trials have not shown a significant response to fertiliser in the peat based soils in which much of the Tea Tree is grown.(Murtagh,Chapman)

Main Camp management believes that the lack of response to soil fertiliser applications is due to poor uptake by Tea Tree root systems. They will use foliar fertiliser applications. They claim that oil content can be raised by the application of a "special " fertiliser mix. (trade secret!)
Thursday plantation believes that fertiliser is needed but is not yet using it.

Irrigation:

NSW Department trials do not show a signifacant response to irrigation, although the data given indicated some response. Murtagh believes tha lack of response is due to the accessibility of the watertable in many of the plantations in NSW. Most growers do not irrigate Tea Tree after establishment so could not comment on response to irrigation. Graham Merry did see definite irrigation responses in a situation where Tea Tree was receiving seepage from a nearby dam. Graham thought that the cost of providing the irrigation would not justify the increased growth that could be obtained. Some newer plantations are being designed for flood irrigation.

Biomass Yield:

Tea Tree is able to grow throughout the year and given good conditions grows very quickly. Yield can be affected by leaf drop. Murtagh reports that in plantation the total yield reached a maximum level and any incerase in growth after that is accompanied by a corresponding leaf drop from the bottom of the plant. Thus leaf starts dropping at physiological maturity. Nutrution weed control and water stress can also play a part in this leaf drop.

Chapman:	-Massive leaf drop at Ord.

Stotter: -	-impressive growth -2m at 12 months, dense foliage.

Oil Content:

Everybody agrees that there is considerable variation in oil yield throughout the year. Trials have noted that this variation is even noticable on a daily basis. Research results have recorded a 30% change in oil concentration over a day, a 37% change over 2 days and a 62% change between months. The reasons behind this variation are unknown. Temperature changes, particularly night temperatures are thought to be implicated (low oil concentration after high night temperatures have been recorded). Murtagh believes that catabolism of the oil during the night may cause some of the variation. Only a small percentage of oil is lost through volatilisation during the day. Murtagh has estimated this to be around .07%/day. Oil concentration in the leaf varies from 3% to 9% (Vol oil/dry wt of leaf). Oil quality would appear to be less variable with good oil quality type plants and bad oil quality type plants.

Chapman:	-agreed with the seasonal variation in oil content but had seen no evidence of daily variation in oil content.

Harvest:

Numerous prototypes have been built, however the industry has now accepted conventional heavy duty forage harvesters as the most viable option.

Chapman:	-harvested once/year -uses KEMPER (German forage harvester) $170000 inc tractor) -1 ha/day theoretical capacity -seldom over 0.5 ha/ day -fine cut gives dense fill of bins

Stotter:	-Kemper harvester

Merry:	-one harvest/year -use "New Holland" chopper unit with severing discs i.e. gives clean cut. -single row, inadequate capacity.

Thursday Plantation:	-one harvest/year -"New Holland" heavy duty flail forage harvester -more stump splitting (seen as desirable) -concerns as to it's suitability in sandy soil -coarse fill

Stretton:	-harvesting trees after only 6 months of regrowth -"New Holland" flail/chopper unit -relatively fine cut -bust stumps- good regrowth from shattered stumps.

Materials handling:

Southwell:	-Time between harvest and extraction not important -only problems fungal contamination -drying OK for storage as long as below 60°C. -no losses shifting containers

Murtagh:	-Trial with harvested material comparing -spread in open, - spread in shed, -in bags in open -in bags in a cool room no loss of oil after 2-3 weeks

Conclusion - that storage had no effect on oil loss, only problems are when the mass starts heating up and fermentation occurs.
Uses drying temperatures of up to 60°C although on odd occasions there was some unexplained loss of oil

Stotter:	-round bins, 6cu m. (1.8m high). 20 off -bins will rotate while filling to avoid "tracking" by steam and obviate the need for packing

Merry:	-standard "2 tonne" tipping bin (6.8 cu m approx) -has block near house which is used to fill bins after settling during transport.

Streeton:	-round bins, 4-5 cu m. winched off trailer and onto extraction stand.

Thursday:	-"industry standard" tipper bins, (2 tonne).

Steam Extraction:

Chapman:	-100hp gas fired boiler feeding two tipper bins, each 3.5 ton nominal -up to 14 bins/ha -7 to 14 bins/day x 3.5/4 tonne -side tipper bins with low slope (flat cone) -3m row spacing for stability while tipping -distils for 2.5 hrs -high steam flow rate until distillation commences, then reduced rate -purges bins with steam at end of run -wet leaf not a problem except for harvesting -170 hp not enough for 70ha (170 days) -condensers mounted on top of bin, but will move them to enhance ease of handling. -signs of darkening of charge at bottom of bin (after emptying) -loads weighed before extraction

Murtagh:	-time v's quality- relative unimportance of temperature. (partial pressures)

Stotter: -	-8 stand system -design based on Demnny system -250 hp steam generator

Stretton:	-10hp boiler. no electricity, diesel fired, engine driven fan. -signs of blackening of charge at bottom of bin (after emptying)

Thursday Plantation:	-130-150hp boiler -1.5hrs to 2hrs to distil if leaf wet. -condensers not mounted on top of bin for ease of handling. -high steam flow-reduced steam flow- no steam flow- to allow "self heating" -second blast to complete extraction. -operator has steam ticket. -separators run at 85°C. -oil weighed electronically and filtered (special filters because of solvent action of oil.

Merry:	-1hp=15.5kg steam/hr -24hp/tonne leaf=375 lb steam/hr=166 l/hr

Yield:

Chapman:	-achieved 300kg oil/ha -believes 400 should be possible with best husbandry, -that 1000 kg/ha theoretically possible (Ubergang)

Oil Quality:

Southwell:-	-gas chromatography units can give differing readings -high cineol levels not a problem (<15%) -Oil is a mixture of -teroinene 4 ol -cineol -hydrocarbons -steam distillation changes pre-cursors of Terpinene 4 ol and cineol to the final products. - solvent extracted product can therefore be quite different to steam extracted product. -time and severity of extraction determines the amount of other hydrocarbons extracted and thus the final % of terpinene 4 ol & cineol -2 to 3 hrs of extraction usually necessary. -high stability of products (unlike other essential oils) thus excessive temperature will not cause breakdown.

Williams:	-rapid extraction desirable to allow rapid turn around of bins etc -high stability of oil -should aim for high Terpinene-4-ol & low Cineole for advantage in marketplace.

Spent Charge disposal:

Stotter:	-dumped from extraction bin into forage spreader -spread on field.

Chapman:	-in high demand as mulch

Merry: -	in high demand as mulch

Thursday:	-in high demand as mulch

Hints for NQ:

Chapman:	-high growth- two cuts/year -central distillery-group ownership -transport needs systems-approach

Murtagh:	-at least 25 000/ha (maximise populations) -narrow rows <1m -ground preparation important -Pre-emergent herbicide essential.

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GROWING TEA TREE IN NORTH QUEENSLAND

Irene Kernot, Extension Horticulturist Mareeba

INTRODUCTION

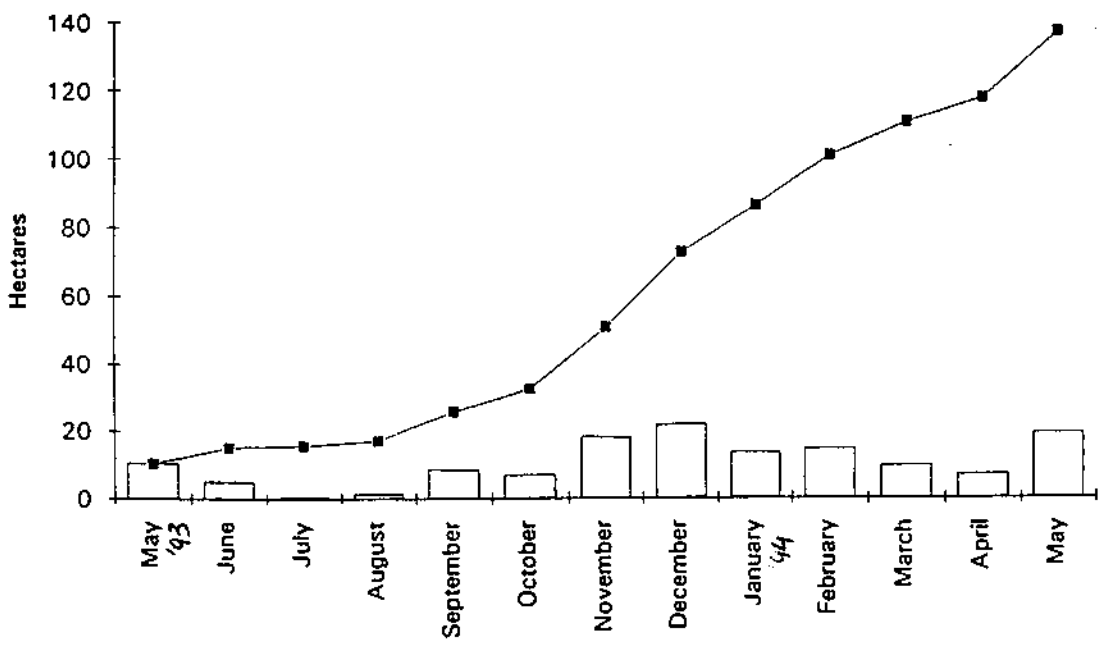
Tea Tree Oil is produced by steam extraction from the leaves of several species of *Melaleuca*. The main species used is *M alternifolia*, but two other species *M. dissitiflora* and *M. linariifolia* also produce oil of suitable quality.

The Tea Tree Industry began early this century as a bush industry which was harvesting natural stands of Tea Tree in northern New South Wales. During the 1970's an expanding demand resulted in a shortage of product and in the 1980's the plantation industry emerged in response to this increasing demand. Continuing increases in demand for oil has lead to relatively high prices for the oil. The prospect of attractive returns, has lead to increasing planting both in the Northern Rivers area and elsewhere throughout Australia.

The main production area is in northern New South Wales where there are around 35 growers. Information about Tea Tree production outside of this area is scarce, but apart from the local area there are only a few growers outside the Northern Rivers region. Production in Queensland is spread between Boonah and Cooktown.

The interest in Tea Tree production in North Queensland has only gained momentum in the last 12 months. Before this a few small trial blocks had been planted and some harvesting of natural stands of *Melaleuca linariifolia* was tried. Growth rates in trial plantations looked impressive. Projections of possible returns calculated using current prices multiplied with potential growth rates, looked attractive. As a result, an association was formed to assist tobacco growers to diversify into Tea Tree, and form a marketing group to supply the market with larger quantities of a branded quality oil than would have been possible if growers marketed the oil independently.

Tea Tree production areas - North Queensland



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IRRIGATION SYSTEMS

Jeff Benjamin, Water Resources, Mareeba

INTRODUCTION

Irrigation is utilised to alter the existing climate of a particular location by providing the full water requirements of the particular crop. Efficient irrigation along with correct crop nutrition will provide an increase in crop yield and allow the grower to maximise profit per hectare.

However it is important to understand some basic soil relationships before the practice of irrigation can be efficiently conducted. Soil consists of particles with the void spaces between the particles filled with either air or water or a combination of both. When rain (or irrigation) falls on the soil surface it moves through the soil profile under the force of gravity. Some of the water is held tightly by the soil particles while the remainder is either available for use by the crop, or drains down below the root zone where it is lost to the ground-water table.

When the soil profile is full (say a day or two after rain) it is said to be at field capacity.

IRRIGATION SYSTEMS

Surface Irrigation

Surface irrigation is the oldest and probably the most widely used type of irrigation in the world. The method is generally restricted to heavier soils because water must advance over the surface of the soil with only a small amount infiltrating into it. It is necessary to have fairly flat, even slopes to reduce erosion from both irrigation flows and storm run-off. Also, adverse slopes must be eliminated in order to prevent waterlogging. In addition a good supply of water is required because surface irrigation requires flows greater than those for spray or localised irrigation schemes.

However it is often the cheapest form of irrigation because very little equipment is required and operating costs are also low.

Surface irrigation of tea-tree would be possible providing soil types were suitable. Systems would generally involve lay-flat type plastic fluming with cup outlets to supply each furrow or every second furrow. This type of system would cost less than $1,000/ha.

If surface irrigation is attempted on lighter, more porous soils large water losses will occur as a result of water passing below the root done at the higher end of the area, while the lower end is insufficiently irrigated.

Therefore a different irrigation method should be utilised.

Spray Irrigation

Spray irrigation utilises a network of pipes to supply impact type sprinklers to spray water over the particular irrigation block.

Spray systems can be divided into three types:

(a) Portable, ie all equipment can be moved (includes pump).

PRODUCING TEA TREE OIL IN THE MAREEBA - DIMBULAH IRRIGATION AREA - AN ECONOMIC PERSPECTIVE

Andrew Hinton, Economist, QDPI, Mareeba

Summary

The profitability of growing tea tree for the Mareeba - Dimbulah region was analysed using three 10 ha model or hypothetical farms. Each of these farms used a different harvesting and distilling regime. The first model farm used contract harvesting and contract distilling. A second farm actually purchased a harvester and on-farm distilling plant while the third farm, to reduce capital costs, joint purchased a harvester and on-farm distilling plant with another farm. It was assumed that tea tree was grown on a whole-farm basis and that land and most capital equipment were purchased new.

Based on the model farms the costs of establishment were $164,590, $246,590 and $188,090 for farms 1, 2 and 3 respectively. The peak overdrafts for these three farms, all occurring in year 1 were $192,322, $246,935 and $187,558 respectively. Project outlays were recovered by the end of years 9,7 and 5 for farms 1, 2 and 3.

Tea tree oil production, based on the three model farms, proved to be most profitable for the third farm scenario. The returns to capital and management were $10,261, $27,808 and $36,459 for farms 1, 2 and 3 respectively. On a per kilogram basis these returns are equivalent to $4.29, $11.62 and $15.23. The return to capital and management represents tea tree oil gross receipts less growing costs and fixed costs. This return was based on a yield of 175 kg oil per hectare (25 000 kg fresh leaf weight) for each harvest which is achieved from year 3 onwards. The price used was $50/kg with harvests conducted every 8 months starting from the end of year one. All the returns were positive indicating that growing the given area of tea tree for all the model farms was profitable.

A comparison between the farm scenarios reveals that the first farm had the lowest capital outlay requirements, therefore low risks attached, but also had the lowest returns to capital and management. The third farming option, using group harvesting and group distilling, had higher capital input requirements, therefore higher borrowing requirements and risks, but received the greatest returns to capital and management.

Prices of $46/kg, $38/kg and $34/kg were required to break-even to growing costs and fixed costs for the three model farms 1, 2 and 3 respectively. All of these prices were calculated based on the yield of 175kg oil/ha/harvest. The fresh matter yield required to break-even to these costs were 22,500 kg/ha, 20,000 kg/ha and 17,500 kg/ha for farms 1, 2 and 3 respectively. These yields were calculated based on the oil price of $50/kg.

Significant economies of size existed for the three model tea tree farms. Costs per kilogram tea tree oil produced were reduced for larger areas. Costs reduced by about half when shifting from a 5 ha farm to a 40 ha farm. The break-even areas required for farms 1, 2 and 3 were 9, 7 and 6 hectares respectively.

TEA TREE OIL
A MARKET ANALYSIS

Maurice Downing, Marketing, QDPI Mareeba

SUMMARY

The Australian tea tree oil industry is centred around northern New South Wales and currentl produces approximately 100 tonnes of oil per year, up from 20 tonnes in the mid 1980's. Th domestic market consumes 20 percent of this production while the remainder is exported, mainl to the USA. As a result of this increase further expansion is planned for southern and norther Queensland.

Tea tree oil has three main applications; as an antiseptic, a preservative and as a disinfectant, a within the health care market. Although pure tea tree oil is the largest single product in terms (sales volume, the highest selling value added products are shampoo, soap and antiseptic crean Prices for pure oil have been high in recent years and are currently above $50 per kilo althoug long term projections expect the price to stabilise at around $35 per kilo.

A major opportunity for further market growth lies in gaining registration with the Food and Dru Authority (FDA) in the USA. Should this be successful tea tree oil can legally be sold as therapeutic substance. Accreditation with the FDA is also recognised in other countries such th there is a consensus of opinion within the industry that this would see the world market for te tree oil expand to approximately 1500 tonnes.

At present tea tree oil, and its associated products, are predominantly sold through pharmacies an health food shops. They receive little or no promotional support. Supermarkets sales are limite by their preference for low margin, high turnover items and the relatively low product knowledg levels of their staff.

The New South Wales industry is characterised by the independence of individual growers. Ther is virtually no collaborative marketing in evidence which may constrict market development.

The long term success of the industry in the Mareeba/Dimbulah area will be enhanced if the grou is able to maintain its present solidarity. Production of pure oil is suggested in the initial stage with value adding activities being undertaken once the group gains sufficient experience in th production of the oil and its marketing environment.

INTRODUCTION

The traditional home of the tea tree industry is centred on the north eastern region of New Sout Wales. Prior to the mid 1980's oil was mostly produced from bush harvested leaf, however, sinc that time both demand and production have increased significantly. By 1989 a total production o 55 tonnes was valued at $3 million, up from a base value of $340 000 in 1987. Curren production stands at approximately 100 tonnes and is climbing towards 140 tonnes.

HARVESTING AND OIL EXTRACTION OF PLANTATION GROWN TEA-TREE

Chris Norris, Agricultural Engineer, Walkamin.

1.0 INTRODUCTION

The most common method of harvesting tea-tree in plantation production systems involves the removal of most of the above ground plant biomass and it's processing into a form suitable for extraction of the oil. This system can be described as "whole plant" harvesting. Industry development has been towards using forage harvesters to finely chop the harvested plants, and placing this material directly into trailer mounted distillation pots which have been taken into the field. The material is then taken to distillation facility where the oil is extracted. Much of the technology has been directly transferred from the mint and other essential oils industries.

Key decisions the grower will have to make include the specifications of his harvesting and oil extraction systems, and his harvesting interval, the actual management of the harvest, and post harvest plantation management. Unfortunately, there are no simple answers to these issues. In this discussion, key issues effecting decisions of when to harvest, and the specification of harvesting and extraction facilities will be addressed. The impact of management of the distillation facility on the quality of the oil extracted will also be discussed.

2.0 WHEN TO HARVEST

Ideally it would be desirable to be able to harvest throughout the year to minimise capital cost invested in distillation and harvesting equipment, provided it was also possible to maximise yield and oil recovery. Indications are however that this in not possible. To maximise total oil yield per hectare it is necessary to both maximise the total leaf production per hectare per year and maximise oil concentration of the material harvested. To maximise profit, it is essential to achieve this goal of high oil production at minimum cost.

An extremely important and relevant finding of the research being conducted by NSW Agriculture at Wollongbar is that there is no interaction between total biomass production and oil content. Thus the crop can be managed to maximise growth as both high yield and high oil content are possible. Conversely, there is no indication that poor growth will in any way be compensated for by higher oil content.

Profitable production therefore dictates management strategies aimed at both high oil content and high biomass production, in particular high leaf production.