ASSESSMENT OF THE PEST STATUS OF LEUCAENA PSYLLID

in

Central Queensland

Project Leader: R.J. Elder

FINAL REPORT FOR PROJECT DAQ 066
to the
MEAT RESEARCH CORPORATION

DPI QUEENSLAND

FINAL REPORT

to the

MEAT RESEARCH CORPORATION

FINAL REPORT TO MEAT RESEARCH CORPORATION

ASSESSMENT OF THE PEST STATUS OF LEUCAENA PSYLLID IN CENTRAL QUEENSLAND

PART 2 - EXECUTIVE SUMMARY

(i) Background and industry context

The origin, distribution, life cycle, host range, pest status, control measures, associated pests, natural enemies and attempts at biological control of the leucaena psyllid (*Heteropsylla cubana* Crawford) have been reviewed by Waterhouse and Norris (1987) and Napompeth (1989). The psyllid which originated in Central America has spread rapidly throughout the Pacific since April 1985. Widely distributed areas including Hawaii, the Philippines and Indonesia had reported damaging populations of the pest by February 1986. This rapid spread was probably by wind movement. The insect commonly causes complete defoliation of *Leucaena* spp. and if this continues for a lengthy period, death of the plant may occur.

The psyllid was first recorded in Australia 28 April 1986 at Bowen (148.2°E 20°S) (Donaldson 1986). Within 6 weeks it was recorded at Rockhampton (150.5°E 23.5°S) 450 km to the south-east. It spread within 3 months throughout the leucaena growing areas of Queensland causing complete loss of foliage in many districts. By January 1987 it had been recorded from all leucaena growing areas of Australia.

Annual production from existing stands of leucaena has been estimated at $945 000. Annual production from potential Australian wide plantings has been estimated at $14m (Wildin J.H. personal communication). These figures do not include returns from soil conservation effects. Production losses due to psyllid damage based on measurements in areas of very high rainfall (greater than 3000 mm per annum) could exceed 50% (Palmer et al 1989). Severe infestations have deterred potential plantings in Queensland.

Leucaena as a pasture plant has been promoted for use on deeper, well drained soils. In these situations it has a higher food quality and yield than the other legumes available. It also has the unique ability (because of deep rooting) to provide a store of high quality green growth during dry periods when other shallow rooted pasture plants have dried off (Wildin 1986).

(ii) Project objectives

To measure the seasonal abundance and damaging effect of leucaena psyllid (*Heteropsylla cubana* Crawford) in a range of four environments in central Queensland. These environments to cover the near coast with an average annual rainfall of 900 mm and inland environments with rainfall as low as 600 mm.

A similar project was undertaken by CSIRO with 4 sites in southern and 3 in northern districts of Queensland.

(iii) Brief methodology

Four sites were selected across the average annual rainfall isohyets in Central Queensland to give a range of environments from near coastal (Kabra) to inland (Blackwater). At each site leucaena rows in plots were either sprayed weekly with 0.03% dimethoate to remove psyllids or left unsprayed. Weekly counts of psyllid numbers on untreated plots were undertaken and plots were rated for psyllid numbers. The rows were hedged at 1 m and, monthly, any material above this height was harvested to obtain oven dry weights. Various measurements were taken to obtain information on plant growth.

(iv) Main results and conclusions, including likely impact on the industry

The field work for the 2.75 year project was completed in December 1992. Yield loss due to psyllids varied from 8 to 49% (average 28%) over the period April to August when psyllids were present even under severe drought conditions. Losses as high as 75% were recorded in spring. The estimated annual losses due to psyllids based on an estimated 30 000 ha currently planted ranged from $0.6M to $2.2M with the annual value of leucaena to industry being $2.6M to $5.1M. If 500 000 ha were to be planted in the next 10 years or 8.3% of the suitable land, losses would range from $10.5 to $34.0M for an industry value of $43.8 to $85.2M.

Annual dry matter yields at 4 sites over the 2.75 years of the study were 454 (Dingo), 728 (Kabra), 1496 (Banana) and 491 kg/ha/yr (Blackwater). This was much lower than expected even under drought conditions. Growth was mainly restricted to periods of rain in the January to April period each year. In spite of these low yields all 4 property owners claimed that cattle growth on leucaena/grass compared with buffel grass alone was up to 4 times higher. They intend making further plantings of leucaena once suitable seasons resume.

The psyllid counts undertaken for this work and during a previous study indicate that psyllids are more prevalent in coastal districts of Central Queensland and population increases are most likely to occur with the milder weather of spring and autumn. Psyllids numbers were extremely low in the January to March (inclusive) period in 7 years out of 8.

Data obtained by CSIRO through a complementary project with sites in southern and northern Queensland indicated losses at their 7 sites due to psyllids of between 3 and 75% (average 36%) over the life of the project (Room *et al* 1993). Their results were for the entire period of their study as they were not as badly affected by drought.

CONTENTS

FINAL REPORT TO MEAT RESEARCH CORPORATION

PART 1 - PROJECT SUMMARY

Project Title	Assessment of the pest status of leucaena psyllid in central Queensland
Project No	DAQ. 066
Research Organisation/s	Queensland Department of Primary Industries
Commencement	1 January 1990
Completion	31 December 1992
Project Investigator	R.J. Elder
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Objective

To measure the seasonal abundance and damaging effect of leucaena psyllid (*Heteropsylla cubana* Crawford) in a range of four environments in central Queensland. These environments to cover the coast with an average annual rainfall of 900 mm and inland environments with rainfall as low as 600 mm.

A similar project is being undertaken by CSIRO with 4 sites in southern and 3 in northern districts of Queensland.

Summary

Four commercial sites across the range of environments in central Queensland were selected. The leucaena rows cut back to 1 m in height. Meteorological stations were established. Leucaena dry matter yield was obtained by harvesting all material above 1 m at 4 weekly intervals. Psyllid populations were controlled on half the plots by weekly insecticide spraying with 0.03% dimethoate. Psyllid numbers were counted on the remaining plots. An additional 2 sites at Rockhampton and Rannes were monitored for psyllid populations.

Data on yield loss due to psyllids was restricted to the April to August period due to drought conditions over the whole period of the study. Average loss over this restricted period was 28% which compares with average annual loss of 36% obtained by CSIRO at their 7 southern and northern Queensland sites.

The estimated annual losses due to psyllids based on an estimated 30 000 ha currently planted ranged from $0.6M to

$2.2M with the annual value of leucaena to industry being $2.6M to $5.1M. If 500 000 ha were to be planted in the next 10 years or 8.3% of the suitable land, losses would range from $10.5 to $34.0M for an industry value of $43.8 to $85.2M. The 2.75 years of field work for the project was completed in December 1992.

Useful data on leucaena DM yield under drought conditions and psyllid population dynamics were obtained. Annual edible dry matter yields at 4 sites over the 2.75 years of the study were 454 (Dingo), 728 (Kabra), 1496 (Banana) and 491 kg/ha (Blackwater). This was much lower than expected. The psyllid counts undertaken for this work and during a previous study indicate that psyllids are more prevalent in coastal districts of Central Queensland and population increases are most likely to occur with the milder weather of spring and autumn.

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PART 3 - FINAL REPORT

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(iii) Methodology

(a) *Sites*

Four sites were selected for yield and psyllid population assessment in the Central Queensland Region on an east-west transect from near Rockhampton to include sites with decreasing rainfall from about 900 mm to about 600 mm. The sites selected were:

Jeff Hume's	on a 5% slope near Kabra
Peter Larsen's	on a slight slope 14 k south of Banana
Paul Donovan's	on a slight slope 25 k north of Dingo
Scott McGhie's	on a level site 20 k north of Blackwater

Two additional sites were selected for population assessment only:

QDPI	on a slight slope at Parkhurst on the northern outskirts of Rockhampton
David Nobb's	on level country at Kokotungo near Rannes

Soil analyses and descriptions were undertaken.

(b) *Site layout*

Each of the 4 yield sites consisted of an area of at least 40 m x 50 m (at least 8 rows) of well established Peru or Cunningham leucaena fenced to exclude cattle. Sites had three blocks with two plots, each plot comprising two rows 10 m long and with a 5 m buffer area.

The central 5 m portion of each plot was marked with pegs and plastic tape and used for detailed observations. Five main stems per plot were chosen semi-randomly by moving 0.8 m along a row and counting every fifth stem along. These stems were then marked permanently with acryllic paint and a numbered tag.

(c) *Treatments*

Three of the six plots at each site were sprayed with 0.03% dimethoate each week to remove psyllids. Sprayed plots were randomly selected with the provision that each block had a sprayed and an unsprayed plot and with the restriction that all three sprayed plots were not on the same side of the central buffer rows. Therefore there were five alternatives:

1.	sprayed	unsprayed	2.	sprayed	unsprayed
	sprayed	unsprayed		unsprayed	sprayed
	unsprayed	sprayed		unsprayed	sprayed
3.	sprayed	unsprayed	4.	unsprayed	sprayed
	unsprayed	sprayed		unsprayed	sprayed
	sprayed	unsprayed		sprayed	unsprayed

5. unsprayed sprayed
   sprayed unsprayed
   unsprayed sprayed

(d) *Observations*

Row spacing was measured at each site at the beginning of the study to allow results to be expressed per unit area.

Observations were taken on the central 5 m portion of the 2 rows in each plot as follows:

Bulk soil samples to 10 cm were taken in each plot and 1 or 2 per trial site to base material and the appropriate nutrient analyses undertaken. The samples were taken in mid 1991 when time permitted.

(e) *Psyllid abundance and damage*

Each week the abundance of psyllids was determined on 5 terminals per plot and descriptive estimates of abundance (e.g. none, few and many), and the damage to plants rated on the oldest unfolding leaf of each terminal: 0 = no damage; 1 = slight puckering of pinnules; 2 = yellowing of pinnules and loss of up to 25% of pinnules; 3 = more than 25% of pinnules lost; 4 = all pinnules missing; 5 = all pinnules missing plus blackening of younger leaves and growing points; 6 = all pinnules missing plus collapse of growing points. A terminal was defined as the section a the branch from the growing point to and including the first fully expanded leaf.

An additional 5 destructive samples of terminals were taken from each unsprayed plot but outside the 5 m observation section and psyllid numbers estimated after washing psyllids from samples by shaking in alcohol (Elder and Mayer 1990). This method gives a much more accurate estimate of psyllid numbers than does the rating system.

(f) *Coppicing*

At intervals of four weeks, after weekly observations had been made, all leucaena plants inside the fence at each site were coppiced at 1.0 m removing only plant material above 1.0 m. The plant material from the 2, permanently located, 5 m of row in each plot was kept.

Coppicing was carried out in the following order:

First: the plant material coppiced from each of the marked stems was collected separately, bagged and tagged with date, block, treatment and stem number.

Second: all coppiced material from the remaining stems in the 2 * 5 m observation area was collected per plot, bagged and tagged with date, block and treatment.

Third: all remaining plants inside the fence were coppiced and the material discarded.

(g) *Site photographs*

Photographs were taken from set locations immediately before and after coppicing. Photographs were aimed at showing growth differences between treatments.

(h) *Growth measurements*

After coppicing, all main stems per plot were counted.
Five main stems per plot, chosen semi-randomly by moving 0.5 m along a row and then counting to the 5th stem along, were marked permanently with acrylic paint and a numbered tag attached. A main stem was a stem that went from ground level up to coppice height. The plant material removed from each of the marked stems was collected separately during coppicing (see above), bagged and tagged with date, block, treatment and stem number. The number of terminals, length of terminal stem and the number of fully expanded leaves bearing at least some pinnules was counted in the laboratory before the material was dried and weighed and data recorded for each numbered stem. A terminal was defined to include the first fully open leaf and all material that was younger on the same stem.

(i) *Data processing*

All data was recorded on an IBM compatible computer using the spread sheet program 'Excel' to facilitate analysis.

(j) *Weather stations*

Automatic weather stations recorded half hourly screen temperature, relative humidity, and rainfall.

(iv) Results and discussion

(a) *Soil analyses*

The soil phosphorous levels (bicarbonate extraction method) were much lower (4 - 8 ppm) than expected (> 12 ppm) based on the quality of the leucaena growing at each site. These levels were lower than the accepted level for growing of leucaena (Wildin pers. comm.) and at the lower end of the range for these types of grazing lands (Shields and Anderson 1989). At each site the area selected was the best and most even stand of well grown and established (at least 3 years old) leucaena out of a large area (> 50 ha). Total P levels were however average (0.03%) for Australia (Baker 1991) in the first 10 cm of soil; 0.039, 0.033, 0.037 and 0.060%. Uptake of soil P may have been increased by the presence of vesicular-arbuscular mycorrhizae in the soil (Thompson 1988).

For a full soil description for each site see Appendix 1.

PSYLLID DAMAGE TO A LEUCAENA TERMINAL.

ADULT LEUCAENA PSYLLID.

PSYLLID DAMAGE TO UNPROTECTED (LEFT) AND PROTECTED (RIGHT) LEUCAENA.

HEDGEING BUFFER ROWS OF LEUCAENA TO 1 M HEIGHT.

(b) *Weather records*

Rainfall is shown for all sites in Figure 1. The weather stations proved difficult to maintain in an operational condition. Some data had to be obtained from nearby coal mines at Blackwater and Banana and from the Meteorological Bureau at Rockhampton for Kabra.

Analysis of psyllid numbers vs temperature, relative humidity percent (RH%), rainfall and growth, with and without lag periods, for the whole period of the study gave no significant relationships. This was surprising in that there was a body of circumstantial evidence that temperature and/or RH% are important in affecting psyllid numbers e.g.

i) Psyllid populations very low in wide spaced rows where the height has been kept below 3 m compared with high populations under the canopy of leucaena 5 m in height which had overgrown the 5 m inter row space.

ii) Higher populations for much of the year in central Queensland near coastal districts or southern Queensland districts where as in inland districts, high populations are more common in the milder weather of autumn and spring.

iii) Leucaena psyllid eggs have a reduced stem attachment to the plant material indicating adaption to moderate temperature, high relative humidity environments (Taylor 1992).

iv) Psyllid fecundity drops markedly at temperatures of 30°C and above (Yasuda and Tsurumachi 1988).

This data will be further analysed in conjunction with the long term population data. It is intended to look at restricted periods when psyllids were present.

c) *Psyllid observations*

Estimated psyllid numbers and ratings of psyllid abundance and psyllid damage are shown in Figures 2 to 6. The x - axis scales are exactly the same for these and the weather figures.

(d) *Leucaena growth*

Increases in dry weight in the protected and unprotected plots are shown in Figures 2 to 3 again with the same x - axis scales as above.

Leucaena growth (Figures 2 to 3) was mainly restricted to periods of heavy rain in the December to April (inclusive) period in 1990-91 and 1991-2. Otherwise drought conditions prevailed and there was minimal growth. Psyllids attack and damage only the expanding leaves (Elder and Mayer 1990). Psyllid populations are normally low in the December to April period in Central Queensland (Elder, unpub. data) and the period from 1990 to 1992 was no exception (Figures 2 to 3).

Any differences between the treatments during the periods of rain were therefore more likely due to the effect of the insecticide treatment on insects other than psyllids or in the case of the Kabra site due to inherent plot differences (Tables 1 and 2). Psyllid abundance was abnormal over the period of the study in that activity was restricted to the late April to August period whereas in years with higher rainfall psyllids are often present from April to late December and occasionally also in the January to April period (Elder unpublished data). The data for the period late April to mid August when psyllid populations were relatively high (Figures 2 and 3) indicated dry matter losses of between 8 and 49% , average 28% (Table 3). Data for Kabra was excluded because of inherent plot differences between the treated and untreated plots, not obvious when the site was established, and for 1991 at Blackwater because of extremely low yields of 26 kg for the 16 week period.

While the Central Queensland data were obtained under conditions of extremely low yield they are similar to values obtained at the CSIRO sites; 3 to 75%, average 36% (Room *et al* 1993). The CSIRO data relates to the full period of their study and under much better growing conditions. Dry matter yield at their best protected site was 7270 kg/ha/y compared with our 1566kg/ha/y and 1004 kg/ha/y at their worst compared with our 487 kg/ha/y. Accordingly figures of 30, 40 and 50% loss (Appendix 2) was used in calculations of the potential damage due to psyllids in Central Queensland. The yield loss figure will of course vary with the size of the psyllid population. It is also extremely conservative in that the method of psyllid exclusion, weekly spraying with the insecticide dimethoate, was not efficient. Our technique involved spraying a very small area of leucaena which was mixed with and completely surrounded by a large psyllid affected area. This is a classic situation where control of any pest becomes difficult. Under these circumstances there was rapid and continuous reinfestation of the treated plots. Undoubtedly this reduced the differences between the two treatments, protected (sprayed) and unprotected (unsprayed) and caused an underestimation of loss due to psyllids.

The annual losses due to psyllids based on an estimated 30 000 ha currently planted ranged from $0.6M to $2.2M with the annual value of leucaena to industry being $2.6M to $5.1M. If 500 000 ha were to be planted in the next 10 years or 8.3% of the suitable land, losses would range from $10.5 to $34.0M for an industry value of $43.8 to $85.2M (Appendix 2)

A number of factors need to be taken into account when determining the importance of the losses due to psyllids.

i) The percentage of the material which would normally be consumed by stock.

In the case of the leaf and young stem leucaena component this percentage is probably 70 to 90% as it constitutes the most palatable and easily obtained portion of the pasture. Cattle usually preferentially eat the leucaena as they graze through the pasture and little is trampled.

ii) The leucaena to beef conversion ratio

Not only is the conversion ratio of leucaena important but also the extremely high quality of the material facilitates the use and conversion of other much poorer pasture material.

iii) The effect of the 30 % loss on any carry over for later in the season or the loss of the most palatable and nutritious part of a pasture often at critical times of the year such as the dry spring when pasture is often limiting.

This aspect depends on the management of any particular property. Some owners feed off as the material grows or at times paddocks may be locked up as a store for use later in the season. A 30 % or greater loss at critical times becomes a risk factor which will, if managed correctly, reduce overall pasture productivity. Overall stocking rates need to be reduced to account for this risk factor.

iv) The effect of the loss of terminals on the nodulation and thereby the transfer of N to other components of the pasture.

v) The small size of psyllid populations in near coastal districts as compared with western districts (Compare Kabra Figure 3 and Blackwater Figure 2).

Long term records of psyllid populations in central Queensland and some for southern Queensland (Elder unpubl. data) and the data obtained in this study indicate that psyllid populations are lower in western districts when compared with coastal sites and that populations in central coastal and southern districts can occur over a much longer period of the year.

vi) Beef yields throughout the year of 0.8 kg/head/d have been recorded by Mr P. Larsen at Banana and 1.0 kg/head/d by Mr S. McGhie at Blackwater for 200 to 300 d/y. These yields are on the same properties as our trial sites, are perhaps up to 4 times the yield of buffel grass pasture (0.4 kg/head/d) when stocking rates are also taken into account. They indicate the importance of the leucaena component of the pastures. I compared leucaena with 'run down' grass pasture because there is consensus that grass (e.g. buffel) pastures run down over a 10 to 20 y period without a legume component.

(v) Success in achieving objectives

The objectives of the study were fully achieved with enlightening information on loss due to psyllids and psyllid temporal distribution for Central Queensland being obtained. These results have been obtained in spite of extreme drought conditions over the 3 year life of the study.

(vi) A description of any Intellectual Property (Project Technology) arising from the project

No saleable intellectual property was produced.

(vii) Progress in, or recommendations for, commercial exploitation of the results of the project

Producers and QDPI Extension Officers in Central Queensland have been made aware of the importance of psyllids through news releases, direct contact and field days. Producers have been advised and are managing their properties accordingly. This process is continuing. It is expected that Central Queensland producers will resume plantings of leucaena once the drought breaks. Growers in the southern part of the region, where more rain has fallen, have already been planting. There is considerable interest in leucaena as evidenced by the number of questions and interest in leucaena at a field day at 'Serocold' near Rolleston on 5 July 1993 and querys to DPI research and extension on other occasions.

Further analyses of the results in conjunction with the long term population data should be undertaken to further define risk due to psyllids and to determine economic thresholds. These results would provide better guidelines on leucaena based pasture management.

(viii) Impact on meat and livestock industry - present and within 5 years

Leucaena planting in Central Queensland coastal districts should be regarded as high risk with the potential for severe damage for 40 weeks out of 52 and throughout the year once in perhaps 10 years. Preference should be given to other legumes on the coast. The extremely high food value of leucaena would make planting and occasional spraying with dimethoate ($3/ha cost of material, $15 application cost) economic, particularly if the leucaena was grown as a monoculture in close rows to reduce area and hence aerial application costs.

Leucaena plantings in more western (west of Westwood) districts will be greatly accelerated. Property owners will need to take into account the risk associated with regular psyllid outbreaks. In spite of 2.5 years of drought in the region there is already evidence that leucaena plantings are accelerating and it is possible that within 5 years that leucaena plantings will increase from 30 000 ha to 150 000 ha and to 500 000 ha within 10 years.

(ix) Total funding and MRC contribution

QDPI contribution	$216 000
MRC contribution	$149 961
Total cost	$365 961

(x) Conclusions and recommendations

Nature of the project

The project was well designed and provided the required information.

Recommendations for further work

i) Further economic analysis of the long term population data (held by DPI, Elder 1987) in conjunction with the psyllid yield loss data to provide a psyllid risk assessment for leucaena production. A further loss assessment study in more normal rainfall years would be helpful in making this assessment for Queenslands major potential leucaena growing area, Central Queensland. Economic thresholds for control should be determined and action levels and sampling methods then provided for grower use.

ii) Investigation of the soil analysis results which indicated that soil bicarbonate P levels were low (total P levels were average to high). Leucaena has been regarded as a high P demand plant unsuitable for soils with low bicarbonate P levels. This study indicated that other methods of assessing soil P levels should be studied and that leucaena may be more adaptable than previously thought. **(Currently being undertaken at QDPI expense)**.

iii) Life table studies of leucaena psyllid should be undertaken to elucidate the factors which determine size of populations.

iv) Leucaena psyllid resistance should be sought.

v) A watching brief should be kept on potential parasites and predator studies outside Australia and imports made if and when they become available.

vi) The cost/benefit of importing known broad host range parasites should be investigated as the area of leucaena increases as against the loss/benefit of putting at risk control of the psyllid used for control of giant sensitive weed.

vii) Investigate grazing management techniques to minimise losses due to psyllids.

vii) Leucaena productivity should be investigated. There is only circumstantial evidence as to the high productivity of the plant. Grower measurements are confounded by a very large range of management systems currently being used.

viii) Continuous year round grazing at reduced stocking rates should be compared with higher stocking rates for 200 to 300 d.

Recommendations for producers

There are still major gains to be made with better understanding of psyllid population dynamics and control. Leucaena plantings, particularly in the more central district away from the coast, should proceed. Even with psyllids, leucaena gives major economic advantages over grass only pastures. Leucaena is the only suitable legume on good soils in these districts.

Growers should be aware that in some seasons psyllid damage could reach as high as 75%. In these cases insecticide control should prove economic.

The results obtained were under dryland conditions. Under irrigated conditions of much higher productivity, insecticide control should be even more economic.

(xi) Media coverage

The effect of psyllids on leucaena has been subject to coverage by radio and at one field day. Drought conditions prevented use of the site for demonstration. Results will be released to press and radio when the drought breaks.

(xii) Publications

Elder, R.J. and Mayer, D.G. (1990) - An improved sampling method for *Heteropsylla cubana* Crawford (Hemiptera: Psyllidae) on *Leucaena leucocephala*. *J. Aust. ent. Soc.* **29**: 131-137.

Publications on the project results are in preparation.

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Acknowledgment

The project could not have been undertaken without the cooperation of Jeff Hume, Peter Larsen, Paul Donovan, Scott McGhie and David Nobbs and their respective families. They generously donated assistance and area on their properties where the trial sites were located.

TABLE 1. GROWTH OF LEUCAENA PROTECTED (P) AND UNPROTECTED (U) FROM PSYLLID: TOTALS OVER ALL GROWTH PERIODS OF 4 WEEKS EACH

	No. growth periods		No. terminals /terminal	No. leaves/ terminal	Length terminals cm/term.	Dry weight g/m row	Dry weight kg/ha
Dingo	33	P:	142.73	72.40	4587.4	4547	1262
		U:	139.07	80.25	4486.5	4442	1233
Kabra	37	P:	132.67	72.69	3397.2	2111	1760
		U:	92.07	73.05	2142.9	2688	2241
Banana	38	P:	126.20	74.46	6078.3	5495	4579
		U:	131.93	83.25	7369.2	4380	3650
Blackwater	35	P:	91.27	61.64	3207.3	3373	1406
		U:	124.27	62.40	4068.9	3103	1293

TABLE 2. PERCENT LOSS IN LEUCAENA PRODUCTION CAUSED BY LEUCAENA PSYLLID OVER ALL GROWTH PERIODS OF 4 WEEKS EACH

	No. growth periods	No. terminals /terminal	No. leaves/ terminal	Length terminals cm/term.	Dry weight kg/ha
Dingo	33	3	-11	2	2
Kabra	37	31	-1	37	-27
Banana	38	-5	-12	-21	20
Blackwater	35	-36	-1	-27	8

TABLE 3. LOSS IN LEUCAENA PRODUCTION UNDER DROUGHT CONDITIONS DURING PERIODS (16 WEEKS) WHEN PSYLLIDS POPULATIONS WERE RELATIVELY HIGH

Location	Starting date	Finishing date	Total production (kg/ha)	Loss (kg/ha) due to Psyllids	Loss (%) due to Psyllids
Dingo	3 May 1990	22 Aug 1990	76.23	8.90	11.68
	11 Apl 1991	31 July 1991	77.82	32.00	41.12
	8 Apl 1992	29 July 1992	79.46	6.72	8.45
Kabra	9 Apl 1990	29 July 1990	101.67	-47.82	-47.03
	15 Apl 1991	5 Aug 1991	83.58	-6.00	-7.18
	13 Apl 1992	3 Aug 1992	161.06	48.07	29.85
Banana	17 Apl 1990	6 Aug 1990	154.57	66.92	43.29
	23 Apl 1991	12 Aug 1991	92.13	25.76	27.96
	21 Apl 1992	10 Aug 1992	135.99	67.34	49.52
Blackwater	24 Apl 1990	15 Aug 1990	182.91	26.08	14.26
	29 Apl 1991	20 Aug 1991	26.27	-2.11	-8.05
	29 Apl 1992	20 Aug 1992	77.14	22.54	29.22

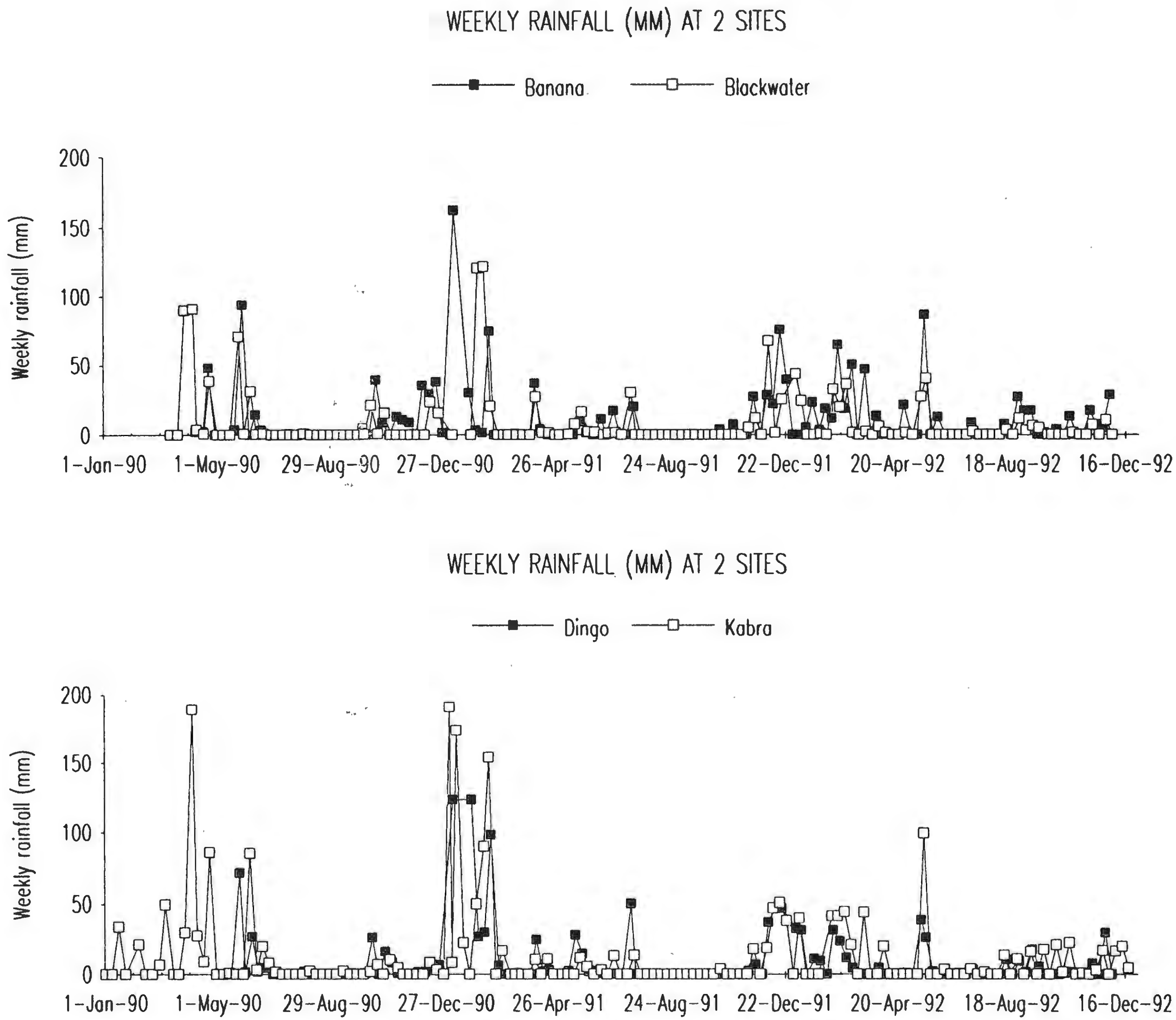
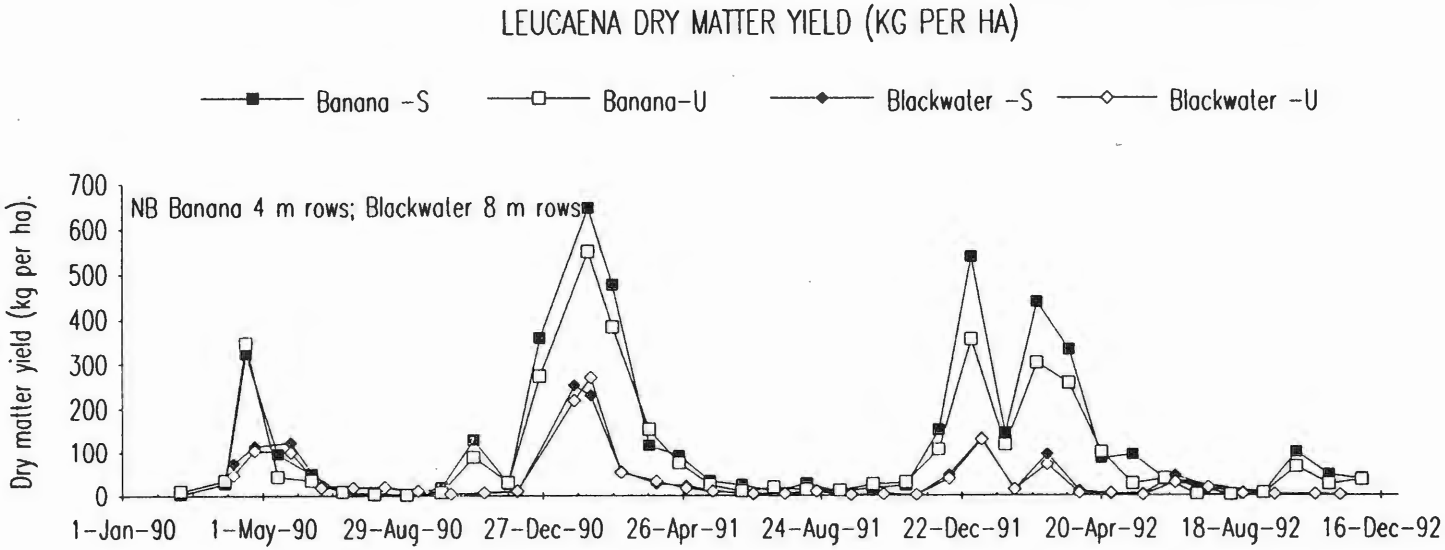

WEEKLY RAINFALL (MM) AT 2 SITES
Banana
Blackwater
Weekly rainfall (mm)
200
150
100
50
0
1-Jan-90 1-May-90 29-Aug-90 27-Dec-90 26-Apr-91 24-Aug-91 22-Dec-91 20-Apr-92 18-Aug-92 16-Dec-92
WEEKLY RAINFALL (MM) AT 2 SITES
Dingo
Kabra
Weekly rainfall (mm)
200
150
100
50
0
1-Jan-90 1-May-90 29-Aug-90 27-Dec-90 26-Apr-91 24-Aug-91 22-Dec-91 20-Apr-92 18-Aug-92 16-Dec-92

Figure 1.


LEUCAENA DRY MATTER YIELD (KG PER HA)
Banana -S
Banana-U
Blackwater -S
Blackwater -U
NB Banana 4 m rows; Blackwater 8 m rows
Dry matter yield (kg per ha).
700
600
500
400
300
200
100
0
1-Jan-90
1-May-90
29-Aug-90
27-Dec-90
26-Apr-91
24-Aug-91
22-Dec-91
20-Apr-92
18-Aug-92
16-Dec-92

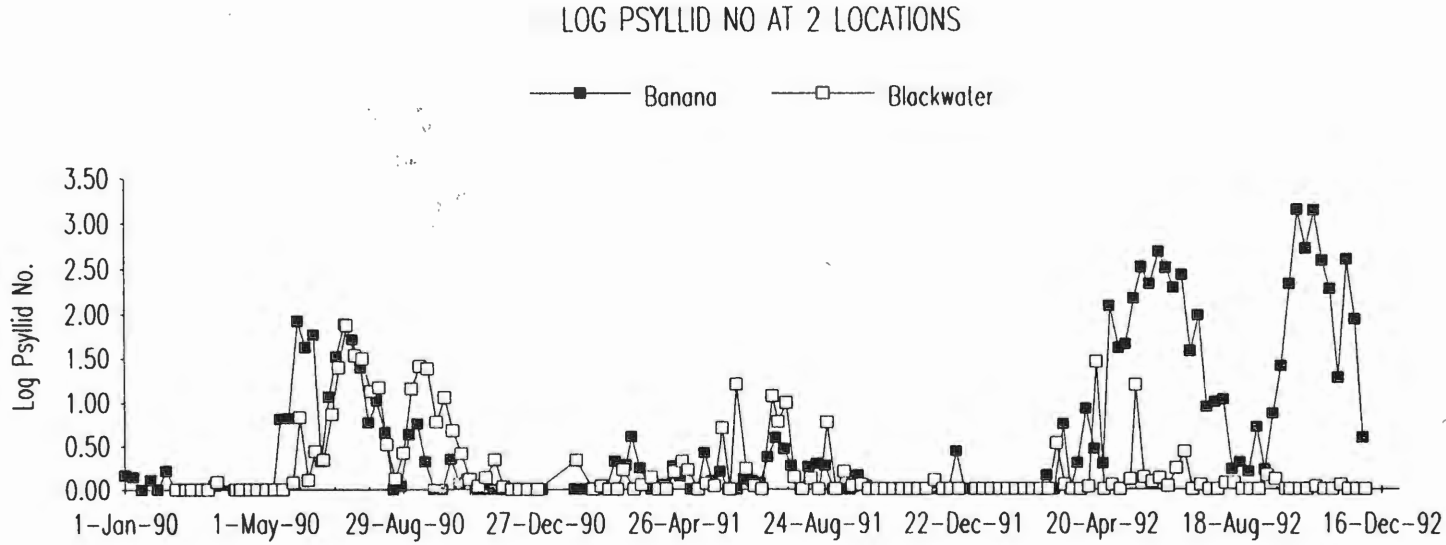

LOG PSYLLID NO AT 2 LOCATIONS
Banana
Blackwater
Log Psyllid No.
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1-Jan-90
1-May-90
29-Aug-90
27-Dec-90
26-Apr-91
24-Aug-91
22-Dec-91
20-Apr-92
18-Aug-92
16-Dec-92

Figure 2.

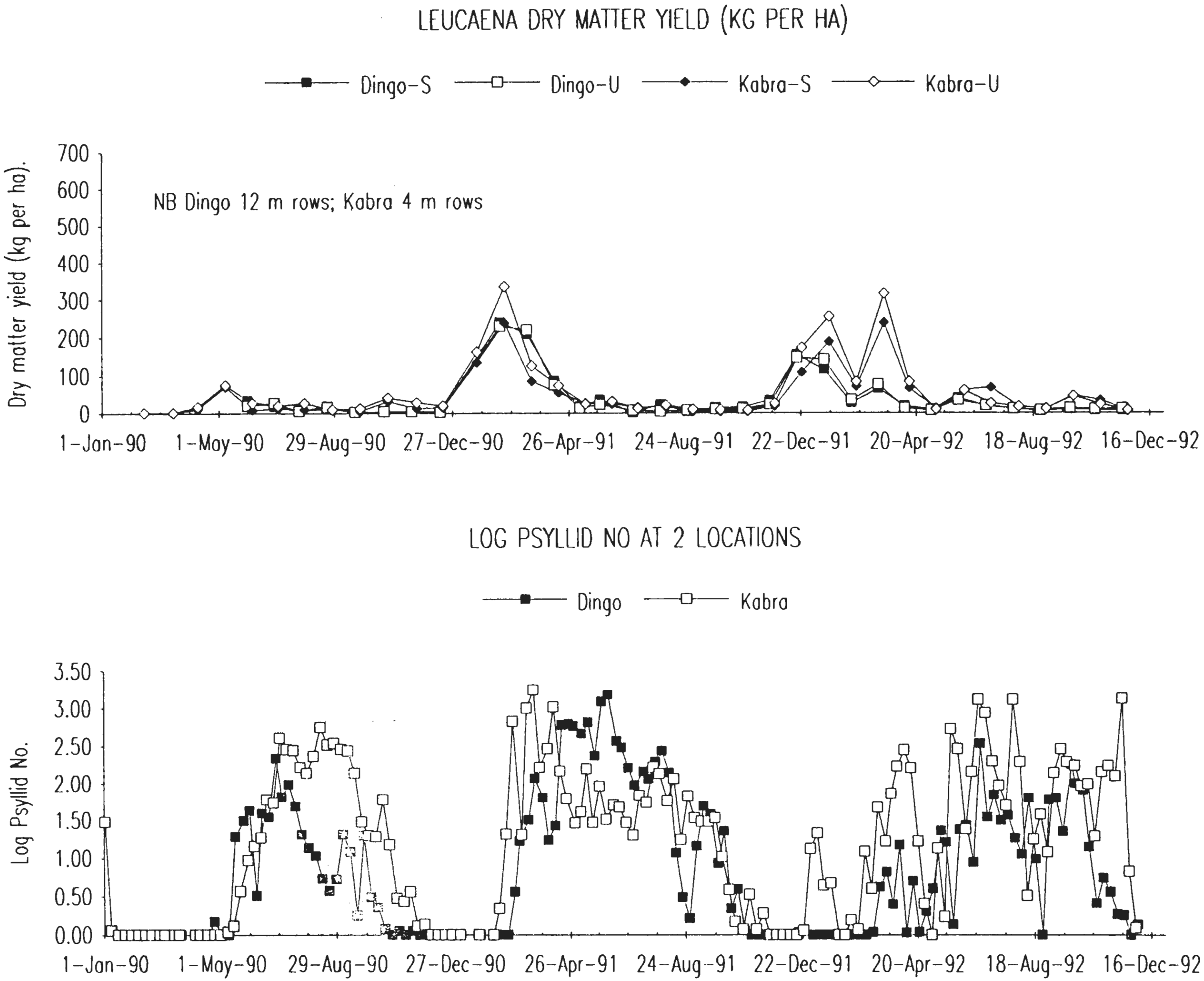
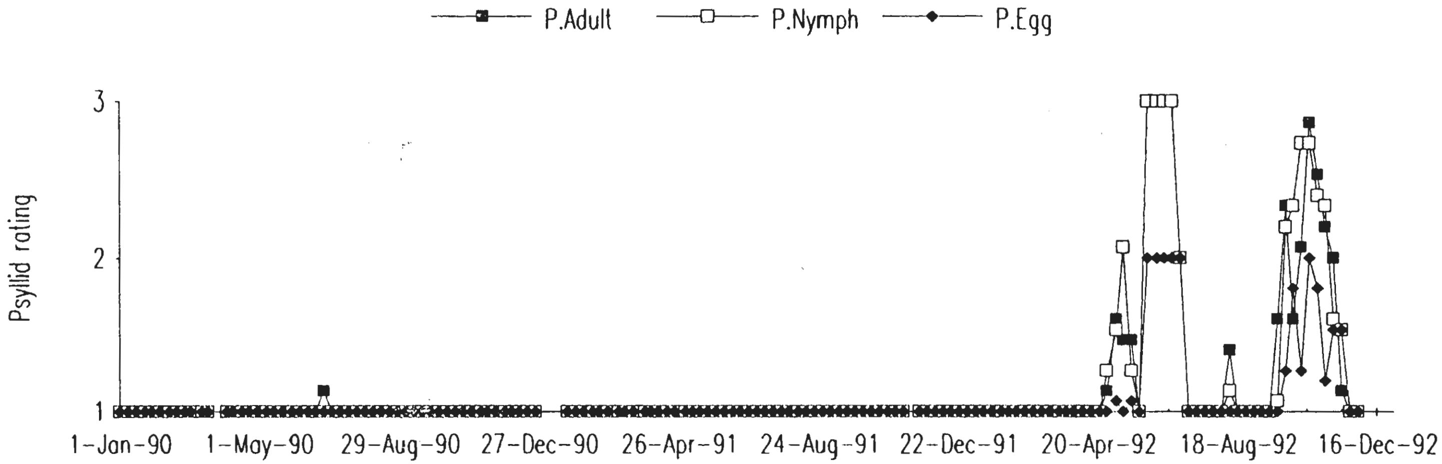

LEUCAENA DRY MATTER YIELD (KG PER HA)
Dingo-S
Dingo-U
Kabra-S
Kabra-U
Dry matter yield (kg per ha).
NB Dingo 12 m rows; Kabra 4 m rows
700
600
500
400
300
200
100
0
1-Jan-90
1-May-90
29-Aug-90
27-Dec-90
26-Apr-91
24-Aug-91
22-Dec-91
20-Apr-92
18-Aug-92
16-Dec-92
LOG PSYLLID NO AT 2 LOCATIONS
Dingo
Kabra
Log Psyllid No.
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1-Jan-90
1-May-90
29-Aug-90
27-Dec-90
26-Apr-91
24-Aug-91
22-Dec-91
20-Apr-92
18-Aug-92
16-Dec-92

Figure 3.

PSYLLID RATING AT BANANA



PSYLLID RATING AT BLACKWATER

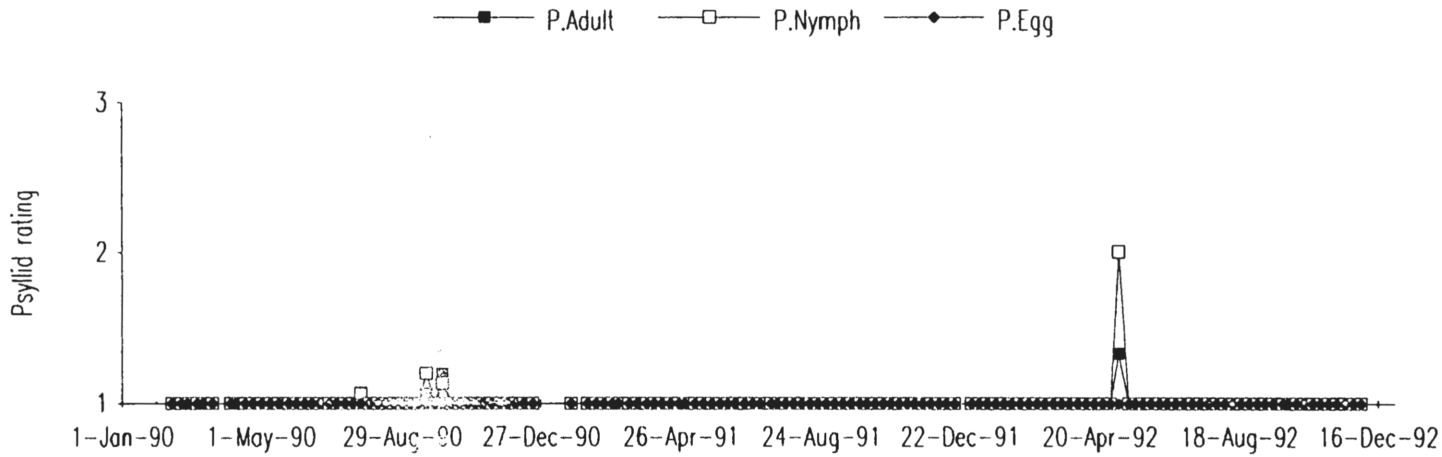
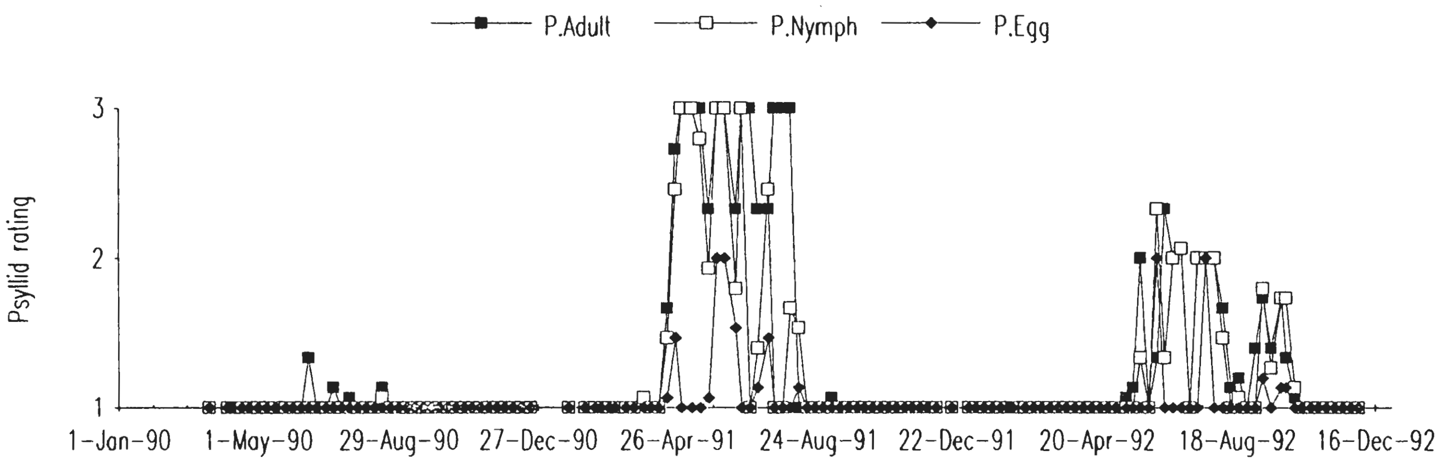


Figure 4.

PSYLLID RATING AT DINGO



PSYLLID RATING AT KABRA

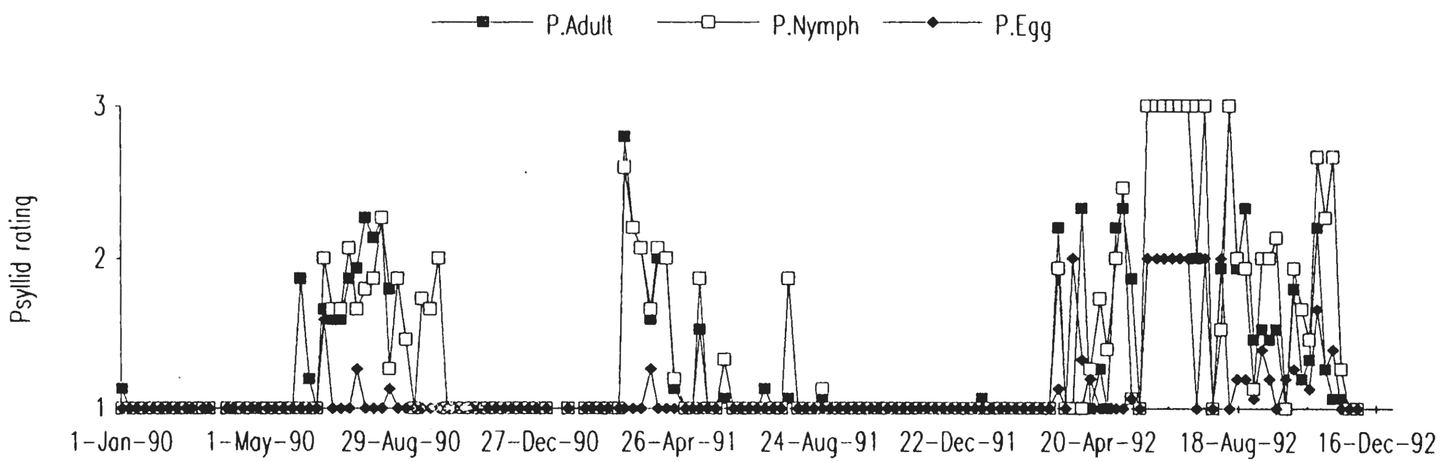


Figure 5.

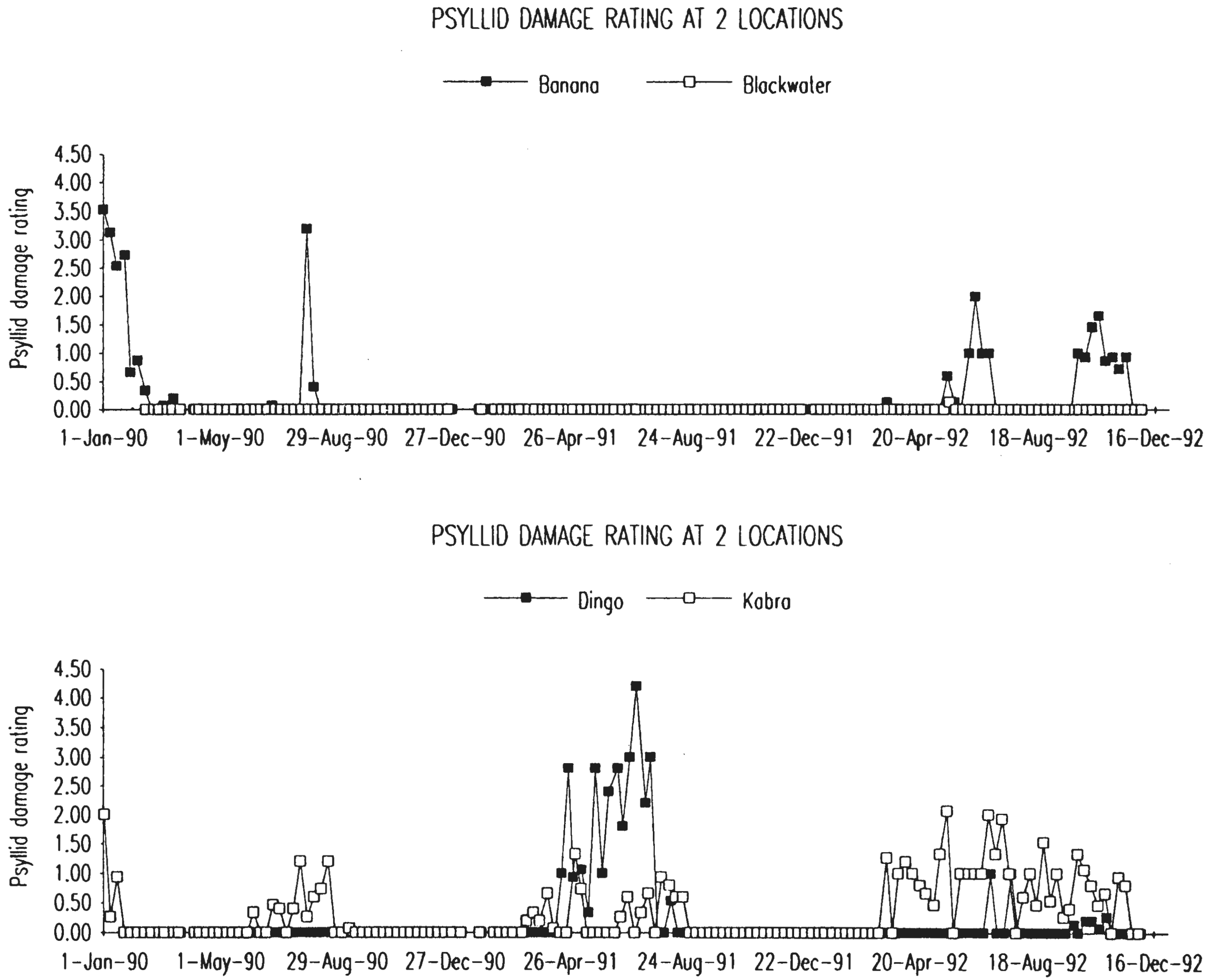

PSYLLID DAMAGE RATING AT 2 LOCATIONS
Banana
Blackwater
Psyllid damage rating
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1-Jan-90
1-May-90
29-Aug-90
27-Dec-90
26-Apr-91
24-Aug-91
22-Dec-91
20-Apr-92
18-Aug-92
16-Dec-92
PSYLLID DAMAGE RATING AT 2 LOCATIONS
Dingo
Kabra
Psyllid damage rating
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1-Jan-90
1-May-90
29-Aug-90
27-Dec-90
26-Apr-91
24-Aug-91
22-Dec-91
20-Apr-92
18-Aug-92
16-Dec-92

Figure 6.

APPENDIX 1

SOILS

The soils at the four trial sites were examined for variability within the site. Soil variability was low at each site. A representative soil was then described at each site. The surface and subsoil were sampled for laboratory analysis at the Kabra, Blackwater and Dingo sites. The soil at the Banana site was sampled at 100 mm increments. Bulk surface samples were collected and analysed from each of the six plots at each site. The soils were classified to Principal Profile Form, Great Soil Group and Australian Soils (Third Approximation).

BRIEF SOIL DESCRIPTIONS

A brief description of the representative soil at each site is provided below. A detailed description and classification is provided in the Appendix.

Kabra (Site 2)

A moderately deep, red duplex soil, with a massive sandy loam surface overlying a structured dark red, light clay subsoil, grading to weathered granite as 65 cm.

This soil has very low electrical conductivity and soluble salts and a high base status dominated by calcium. Bicarbonate P is low (4-7 ppm) in the surface, and very low (0.2 ppm) in the subsoil.

Blackwater (Site 4)

A deep, very dark greyish-brown cracking clay with a self-mulching surface over a very dark grey to dark greyish-brown medium-heavy clay subsoil.

This soil has moderate levels of soluble salt in the subsoil and a high base status dominated by magnesium and calcium. Bicarbonate P levels are low to moderate (6-17 ppm) in the surface, and very low in the subsoil (0.5-0.9 ppm).

Dingo (Site 6)

A shallow, dark reddish-brown, self-mulching cracking clay overlying weathered substrate at 38 cm.

This soil has very low soluble salt and a high base status dominated by calcium. Bicarbonate P levels are low (4-5 ppm) in the surface, and very low (2 ppm) in the subsoil.

Banana (Site 7)

A moderately deep, dark brown cracking clay soil with a self-mulching light-medium clay surface overlying a dark brown light-medium clay subsoil grading to a highly calcareous weathered substrate at 65 cm.

This soil has very low levels of soluble salts in the surface, increasing to low-moderate amounts in the deep subsoil. Base status is high and dominated by calcium. Bicarbonate P is low-moderate (6-8 ppm) in the surface.

CHEMICAL ANALYSIS OF BULK SURFACE SAMPLES

The chemical analysis for the representative soil at each site is shown in Table 1.

The data indicates that there is very little variability in surface soil parameters between the three control plots and the three treatment plots at each site.

The three cracking clay soils (Blackwater, Dingo and Banana) have an alkaline surface, in contrast to the acid surface of the duplex soil (Kabra). Soluble salts (chloride) are very low for each soil.

The surface soil at the Banana site has a higher fertility than the other sites, with higher organic Carbon, total N, bicarbonate extractable P and replaceable K.

PLANT AVAILABLE WATER CAPACITY (PAWC)

PAWC was calculated for the cracking clay soils at Blackwater, Dingo and Banana using the Shaw and Yule (1978) model for swelling clay soils. PAWC was calculated for the duplex soil at Kabra using data for rigid soils from Williams (1983).

The rooting depth of *Leucaena* was not measured in the field. No significant salt bulges, which would limit root penetration, are evident before 100 cm depth from the electrical conductivity and chloride data at any of the four sites. Rooting depth is assumed to be at least 100 cm in the deep clay at Blackwater. Determining rooting depth at the other sites is more difficult because of the thick weathering zone (ie. BC horizon) into which perennial tree roots are likely to penetrate. Accordingly, PAWC has been calculated for two depths in these soils, firstly, to the bottom of the soil profile (ie. B horizon) and secondly, to the bottom of the weathering horizon (ie. BC horizon), with a 100 cm maximum depth limit. PAWC data is presented in Table 2.

If *Leucaena* roots penetrate into weathering substrate, the Kabra and Banana soils have the highest PAWC. However, if rooting depth is considered to be to 100 cm or to the depth of the soil profile, then the Blackwater and Banana soils have the highest PAWC.

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Table 1. Mean Value for 0-10 cm Bulked Surface Samples

Location (Site No.)		Kabra (2)			Blackwater (4)			Dingo (6)			Banana (7)		
Parameter	Unit	control	treatment	site	control	treatment	site	control	treatment	site	control	treatment	site
pH		6.3	6.2	6.2	8.3	8.2	8.2	8.1	8.2	88.2	8.4	8.4	8.4
EC	mS/cm	.03	.02	.02	.07	.07	.07	.08	.09	.09	.13	.12	.13
Cl	%	.001	.001	.001	.001	.001	.001	.001	.001	.001	.002	.003	.003
Org C	%	.7	.7	.7	.8	1.2	1.0	1.4	1.4	1.4	2.3	2.6	2.4
Total N	%	.04	.04	.04	.07	.07	.07	.11	.12	.12	.19	.22	.2
Bicarbonate Extract. P	mg/kg	4.0	4.0	4.0	5.0	7.0	6.0	4.0	4.0	4.0	6.3	7.7	7.0
Replac. K	m. eq%	.33	.24	.28	.52	.62	.57	.59	.67	.63	.87	.92	.90
Fe	mg/kg	26	32	29	13	14	14	6	6	6	5.1	5.2	5.1
Mn	mg/kg	50	51	50	13	13	13	17	17	17	3.7	4.6	4.2
Cu	mg/kg	7.3	6.5	6.9	1.4	1.5	1.4	.7	.7	.7	.8	.8	.8
Zn	mg/kg	.8	.6	.7	.2	.2	.2	.2	.2	.2	.2	.3	.2

Table 2. Plant Available Water Capacity

Location (Site No.)	Kabra (2)	Blackwater (4)	Dingo (6)	Banana (7)
Rooting depth to bottom of soil profile, maximum 100 (cm)	65	100	38	65
PAWC (mm)	85	112	72	107
Rooting depth to bottom of weathering zone (BC), maximum 100 (cm)	100	-	70	100
PAWC (mm)	126	-	107	135

APPENDIX 2

ECONOMICS OF DRY MATTER LOSSES IN LEUCAENA DUE TO PSYLLIDS

The economic impact of dry matter (DM) losses in leucaena are quite difficult to calculate accurately for the following reasons:

i) DM yield is consumed in a grazing system and these vary widely for leucaena based pastures.

ii) The proportion of leucaena DM yield consumed in a grazing system is unknown but observation suggests that the proportion is much higher (80%) than the in a sward based pasture.

iii) The incidence of psyllids varies widely from month to month, year to year and from coastal to more western/inland districts.

iv) Losses due to psyllids are irrelevant when pasture is understocked as happens annually during the growing season.

These and other factors could not be considered in this report. There would need a more extensive study with consideration of historic long term population trends. DPI has collected this data for central Queensland.

The losses below were calculated on a yearly basis as CSIRO data averaged 36% loss for a full year as compared with the average 28% loss obtained in central Queensland for the April to August period.

IF

Leucaena based pastures = 0.7 beasts per ha at 0.7 kg/head/d
Grass based pastures = 0.25 beasts per ha at 0.4 kg/head/d

in 365 d

Leucaena produces	=	0.7 x 0.7 x 365 =	179 kg/ha/y
Grass produces	=	0.25 x 0.4 x 365 =	37 kg/ha/y
Difference	=		142 kg/ha/y

A loss of 30% to 50% of DM due to psyllids with 80% consumed by stock means loss in animal wt and $ loss (beef valued at $1.20/kg) =

142 x 0.3 x 0.8 = 34 kg = $41/ha/y
142 x 0.4 x 0.8 = 45 kg = $54/ha/y
142 x 0.5 x 0.8 = 57 kg = $68/ha/y

ie if grower has 1000 ha loss is $41 000, $54 000 and $64 000

OR Conservatively

Leucaena based pastures = 0.5 beasts per ha at 0.6 kg/head/d
Grass based pastures = 0.25 beasts per ha at 0.4 kg/head/d

in 365 d

Leucaena produces = 0.5 x 0.6 x 365 = 110 kg/ha/y
Grass produces = 0.25 x 0.4 x 365 = 37 kg/ha/y
Difference = 73 kg/ha/y

A loss of 30% to 50% of DM due to psyllids with 80% consumed by stock means loss in animal wt and $ loss (beef valued at $1.20/kg) =

73 x 0.3 x 0.8 = 18 kg = $21/ha/y
73 x 0.4 x 0.8 = 23 kg = $28/ha/y
73 x 0.5 x 0.8 = 29 kg = $35/ha/y

ie if grower has 1000 ha loss is $21 000, $28 000 and $35 000

Annual value to industry of leucaena over grass

Current
Minimum 73 kg/head/y x $1.20 x 30 000 ha = $2.6M
Maximum 142 kg/head/y x $1.20 x 30 000 ha = $5.1M

Potential
Minimum 73 kg/head/y x $1.20 x 500 000 ha = $43.8M
Maximum 142 kg/head/y x $1.20 x 500 000 ha = $85.2M

Annual current and potential loss to industry

Current loss:
minimum loss to industry = 30 000 ha x $21 = $630 000
and
maximum loss to industry = 30 000 ha x $68 = $2 204 000

Potential loss:
Estimated potential leucaena plantings in Central Queensland, the most suitable region in Queensland, are 500 000 ha in the next 10 years. This is 8.3% of the estimated 6M ha of suitable land.

minimum loss to industry = 500 000 ha x $21 = $10.5M
and
maximum loss to industry = 500 000 ha x $68 = $34.0M

Acknowledgment

The assistance of Mr A.W.D. Bourne (DPI Principal Agricultural Economist, Rockhampton) in undertaking this economic analysis is gratefully acknowledged.