final report

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Psyllid resistant leucaena to market

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Executive summary

The leucaena psyllid (*Heteropsylla cubana*) is a serious insect pest of commercial leucaena (*Leucaena leucocephala* ssp. *glabrata*) in Australia especially in areas with average annual rainfall > 800 mm. Availability of a psyllid-resistant variety would increase the range of adaptation of leucaena by 30%, from 4.4 M ha to 5.7 M ha.

An MLA-supported breeding program was initiated in 2002 to develop a psyllid-resistant variety developed from inter-specific hybrids between the susceptible species *L. leucocephala* and the resistant species *L. pallida*. Forty breeding lines of the psyllid-resistant leucaena were produced following three generations of mass selection, two generations of backcrossing to *L. leucocephala*, and two generations of self-pollination, progeny testing and selection among backcrossed breeding lines. Selection for psyllid resistance was carried out at each stage of the breeding program.

Four of these breeding lines were then selected for possible release to industry. The lines were chosen for their psyllid resistance, moderate seed production and high *in vitro* digestibility comparable to that of the existing commercial cultivars. To move to commercialisation, it was necessary to gain Plant Breeders Rights (PBR) for these varieties, bulk up seed, and conduct a final assessment of psyllid resistance and forage yield, and test palatability to animals.

This project involved fieldwork required to achieve PBR, and selection of one or more lines to be commercially released based on a final comparison of psyllid resistance, forage yield and forage quality. The field trial gathered data to prove the distinctness, uniformity and stability of the new variety. Part 1 documentation for QPBR was obtained giving provisional protection for two lines (#12 and #39) in 2014.

In parallel, additional work in conjunction with QDAF, a grazing preference trial was established at Whitewater Station in north Queensland to compare the grazing preference of the 4 breeding lines with commercial cultivars *L. leucocephala* cvv Cunningham and Wondergraze. Overall, there were no major differences in preference among the breeding lines. Although animals displayed a preference for commercial cultivars under light grazing when not psyllid damaged, all entries were well eaten with approximately 10% of leaf remaining at the end of the grazing period. Psyllid damage reduced the palatability of the commercial cultivars compared to the psyllid resistant breeding lines.

Breeding line #12 was ultimately selected for advancement to Stage 2 of the PBR application and has now been approved by IP Australia (reference 2014/112) (28/9/2017) and given the name cultivar Redlands.

Prior to final selection of #12 for release, seed orchards of each of the four selected lines were established at 3 locations in order to obtain breeder's seed for distribution to the commercial companies chosen to multiply and market the new variety. Seed of all of the non-selected breeding lines has been retained and placed into cold storage at the University of Queensland. Field plots of non-selected breeding lines have been destroyed, or are in the process of being destroyed.

About 40 kg of breeding line #12 was provided to Leuc Seeds PTY LTD as the first successful licensee to grow and distribute the new psyllid-resistant leucaena. In November 2015, 5 kg of seed was given to the second licensee, Bandana Station Carnarvon Pastoral with an additional 35 kg supplied in June 2016.

Commercial seed of cv. Redlands has now been harvested and is available for purchase by graziers.

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1. Background

The leucaena psyllid (*Heteropsylla cubana*) is a serious insect pest of commercial leucaena (*Leucaena leucocephala* ssp. *glabrata*) in Australia especially in areas with average annual rainfall > 800 mm. Availability of a psyllid-resistant variety would increase the range of adaptation of leucaena by 30%, from 4.4 M ha to 5.7 M ha (unpublished GIS data).

An MLA-supported breeding program was initiated in 2002 to develop a psyllid-resistant variety developed from inter-specific hybrids between the susceptible species *L. leucocephala* and the resistant species *L. pallida*. Forty breeding lines of the psyllid-resistant leucaena were produced following three generations of mass selection, two generations of backcrossing to *L. leucocephala*, and two generations of self-pollination, progeny testing and selection among backcrossed breeding lines. Selection for psyllid resistance was carried out at each stage of the breeding program.

Four of these breeding lines were then selected for possible release to industry. The lines were chosen for their psyllid resistance, moderate seed production (if seed production is too poor then seed will be too expensive, if too seedy than it will pose a greater weed risk) and high *in vitro* digestibility comparable to that of the existing commercial cultivars. To move to commercialisation, it was necessary to gain Plant Breeders Rights (PBR) for these varieties, bulk up seed, and conduct a final assessment of psyllid resistance, forage yield, forage quality and test palatability to animals.

This project involved fieldwork required to achieve PBR, and selection of one or more lines to be commercially released based on a final comparison of psyllid resistance, forage yield and forage quality. The project also established small seed orchards of the four breeding lines in order to obtain sufficient breeders seed to make available to the commercial seed producers chosen to market the new variety.

In parallel, additional work in conjunction with DAF north Queensland from 2014 to 2016, the four breeding lines were compared with the commercial cultivars Cunningham and Wondergraze for palatability and animal preference.

2. Project objectives

1. To achieve Plant Breeder's Rights (PBR) for up to three elite lines (Note: one was ultimately chosen).
2. Conduct a concurrent trial with DAF in north Queensland with the objective of comparing cattle preference of selected breeding lines with existing commercial cultivars.
3. To select and multiply seed of elite lines, and to select the line(s) to be released commercially.
4. Supply breeders seed and assist commercial companies chosen by MLA to grow and market the new variety.

3. Methodology

3.1 PBR trial

Four breeding lines were selected for comparison with the four currently used leucaena cultivars (Peru, Cunningham, Tarramba and Wondergraze).

Seed of the selected elite breeding lines, including current and previous generations of these lines, and the four commercial varieties, were planted in grow tubes in a glasshouse. Approximately 2500 seedlings were established in the week 19–25 August 2013.

When the seedlings reached approximately 30–40 cm in height, they were taken to the DAF Redlands Research Station at Cleveland for hardening and subsequent transplanting into the field on 21 November 2014 (Plate 1a–e and Plate 2a-c).

There were four replications of each treatment (12 varieties) with rows of cv. Peru between each replication. Each plot was 5 m with 10 seedlings per plot spaced 50 cm apart. Rows were spaced 4m apart (Plate 3). Additional plants of the psyllid susceptible cultivar cv. Peru were planted as border rows to ensure even psyllid challenge across the trial site.

The experimental area was fertilised on 21 November 2013 with legume mix at 30kg/rep and fully cultivated prior to planting. Developing seedlings were initially sprayed with Confidor at 20mL/3L of water to control psyllids and irrigated as necessary to ensure strong early growth. Weeds were controlled with Starane or Atrazine as a pre-emergent, and (periodically between rows) Roundup at 14ml/L.

Due to the very dry growing season, there was minimal psyllid challenge. Accordingly, measurements were delayed until the 2014/2015 growing season when a high level of psyllid attack occurred.

Measurements were made of psyllid damage rating (PDR) (using the objective 1-9 psyllid damage rating system of Wheeler (1988) (where 1=no damage observed; 2=slight curling of leaves; 3=tips and leaves curling and yellow; 4=tips and leaves badly curled, yellowish and covered in sap; 5=Loss of up to 25% of young leaves; 6=loss of up to 50% of young leaves; 7=loss of up to 75% of young leaves; 8=100% loss of leaves and blackening of lower leaves; 9=blackened stem with total leaf loss).

Measurements were also made of plant height, number of primary branches and diameter at ground level, and flowering score (1=fully vegetative; 2= budding stage; 3= flowering stage; 4=green pod stage; to 5= brown pod stage). Yield was expressed in two ways. In Fig. 2, yield was expressed as a score of 1-10 allocated according to relative yield compared to all other lines. In Fig. 5, yield was calculated using the regression relationship of yield versus height x diameter^2. These data were collected for BL's #12, 24, 34 and 39 (and their parents 25, 74, 135 and 188, respectively) and commercial cultivars Cunningham, Peru, Tarramba and Wondergraze.

A preliminary (Part 1) application for plant breeder's rights was submitted by our appointed Qualified Person (QP) Mr Matthew Roche, Australian Sports Turf Consultants (ASTIC). A report was prepared by ASTIC for the PBR Office outlining pedigree and characteristics for two of the lines (#12 and #39). When the application was accepted, the breeding lines were provisionally protected until the field trials verified the characteristics of the new variety. The PBR office granted a minimum of 12 months to submit a Part 2 application which was subsequently submitted and PBR granted to the new psyllid resistant cultivar 'Redlands'.

3.2. Preference trial

The trial site was located on Whitewater Station (18^{o}S, 144^{o}E, 628 m asl). Treatments were 6 leucaena genotypes with seedlings planted in 15 m rows (50cm between plants), 10 m apart, with 4 replications containing two samples. Seedlings were planted in February 2014 and the entire area fertilized with sulphur at 30 kg/ha and Gran-Am at 50 kg/ha; while gypsum at 150 kg/ha was applied at the base of the trees. Some dripper irrigation was used as needed, especially in the dry season, and weeds were controlled mechanically.

Trial 1. In the first trial, conducted in December 2014, approximately 30 Brahman weaner steers were used, plus an additional 9 Brahman cows over the last 2 days. Initially, 6 weaners were grazed per plot

to gauge preference at very low stocking rate (first day), and then the larger mob was introduced to measure preference at higher grazing pressure.

During that time (a) 2300 separate observations on cattle behavior were made (from 0600 to 1800); (b) the forage yield pre- and post-grazing was measured on 480 trees i.e., 960 measurements; (c) pre-grazing yield estimations were conducted by making approx. 2200 non-destructive measurements of branch diameter and length; and (d) the reproductive status of 240 trees were determined.

Trial 2. Prior to the second trial, psyllids had caused significant damage to the commercial varieties in early April 2016. The trial was grazed in mid-May 2016 by 15–24 steers and cows (400–500 kg); yield of leaf before/after grazing was measured. Grazing behaviors were observed using a 180^{o} day/night time-lapse camera mounted on a pole.

Plate 1. Preparation of seedlings in glasshouse ready for transplanting into the field at DAF Redlands Research Station in 2013.

(a) Selected elite breeding lines grown in glasshouse (18 October 2013)

(b) Selected elite breeding lines grown in glasshouse (11 November 2013)

(c) Redlands field being prepared for PBR trial and seed orchards

(d) Seedlings transferred to Redlands for 'hardening'

(e) Seedlings transplanted into field at Redlands (21 November 2013)

Plate 2. Transplanted seedlings and established trees at the field at DAF Redlands Research Station in 2013–2014.

a. Transplanting seedlings into field at Redlands (21 November 2013)

b. Seedlings transplanted into field at Redlands ready for first irrigation (21 November 2013)

c. Seed pods forming on seed orchard at Redland Research Station (11 April 2014)

4. Results

4.1 PBR trial

Extensive data sets were obtained for all entries included in the PBR trial grown at Redlands Research Station. Psyllid damage rating (PDR), yield, height, number of primary branches and diameter at ground level were determined for BL's #12, 24, 34 and 39 (and their parents 25, 74, 135 and 188, respectively) and commercial cultivars Cunningham, Peru, Tarramba and Wondergraze. The data were collected during a time of severe psyllid infestation which accentuated the differences in all growth characteristics. The data showed clear differences ($P<0.05$) between the psyllid resistant breeding lines and the commercial cultivars for psyllid damage rating (Fig. 1 and 3), yield (Fig. 2 and 5), height (Fig. 6), number of primary branches (Fig. 7), and diameter at ground level (Fig. 8). There were no differences in flowering score in the November 201 (Fig. 4), but later measurements during the preference trial (Table 3) demonstrated that the commercial varieties were earlier flowering and potentially more seedy. Digestibility was not measured in this trial as previous measurements of digestibility showed little difference between the breeding lines and the commercial cultivars. Indeed, this was one of the main criteria for their selection for further testing.

Importantly, the psyllid resistant breeding lines were scored as highly resistant to psyllids and the commercial cultivars as highly susceptible (Table 1, Figs 1 and 3).

PBR registration proceeded with only one breeding line i.e. #12. The decision was made after the grazing preference trial was completed at Whitewater, Mt Surprise, in November 2014 based principally on the greater availability of seed of this line compared to #39. Breeding line # 34 had been rejected previously because of its *L. pallida* like appearance.

The Part 2 application was based on evidence from the field trial for distinctiveness (clearly different from other leucaena varieties), uniformity (relevant characteristics that present on propagation) and stability (relevant characteristics that remain unchanged on repeated propagations). Data were submitted to IP Australia for approval as part of the PBR application. It was accepted, and one of the varieties selected (#12) and a detailed description of the variety was published in the Official Journal of Plant Breeder's Rights for six months. As there was no opposition to the application, PBR was granted.

Field plots of all non-selected breeding lines have been destroyed, or are in the process of being destroyed.

Metres	Metres	2.5	5	5	5	5	5	5	5	5	5	5	5	5	2.5
	2	P	P	P	P	P	P	P	P	P	P	P	P	P	P
	2	P	12	188	P	C	135	39	T	74	24	25	34	W	P
	2	P	74	12	W	135	T	34	C	25	P	24	188	39	P
14	2	P	P	P	P	P	P	P	P	P	P	P	P	P	P
	2	P	P	135	74	C	24	25	W	39	12	T	34	188	P
	2	P	39	25	W	188	24	P	34	74	C	12	T	135	P
	2	P	P	P	P	P	P	P	P	P	P	P	P	P	P
4	4														
	2	BL #12													
	2	BL #12													
	2	BL #12													
	2	BL #12													
	4														
	2	Bl #24													
	2	Bl #24													
	2	Bl #24													
	2	Bl #24													
44	4														
	2	BL #34													
	2	BL #34													
	2	BL #34													
	2	BL #34													
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	44														

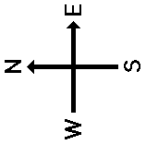

Plate 3. Layout of PBR trial and seed orchards at DAF Redlands Research Station.

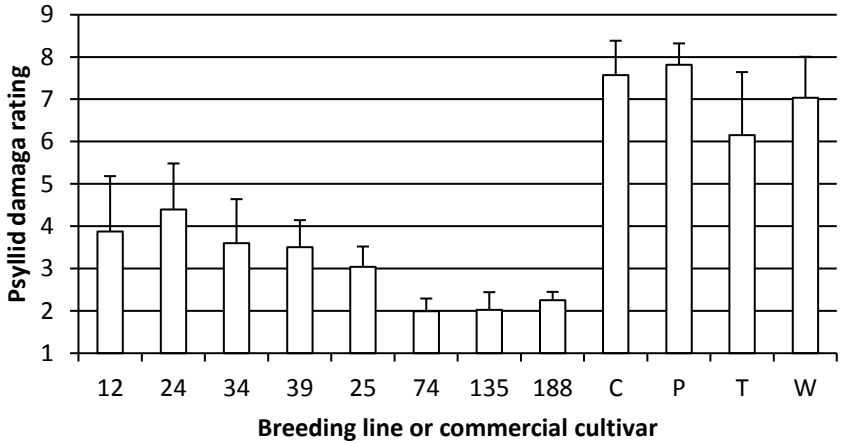

Figure 1. Psyllid damage ratings (± SD) (Wheeler 1988) (21 October 2014) (0= no damage, 9= death of growing tips)

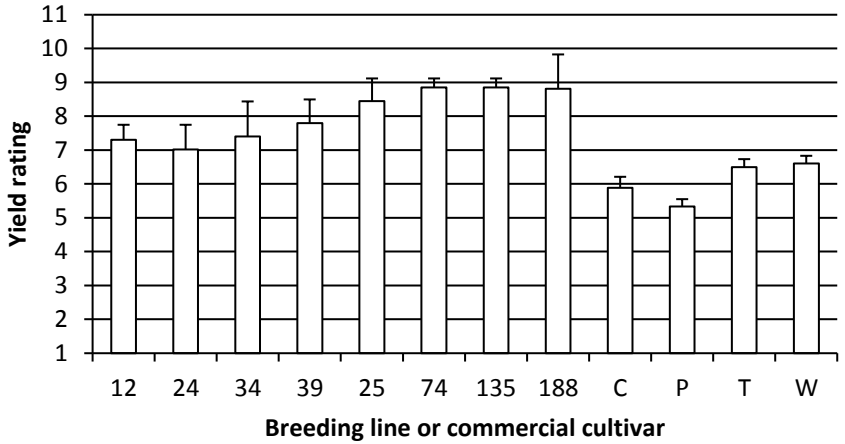

Figure 2. Yield ratings (± SD) (21 October 2014) (10= highest yield relative to other lines; 1= lowest yield relative to other lines)

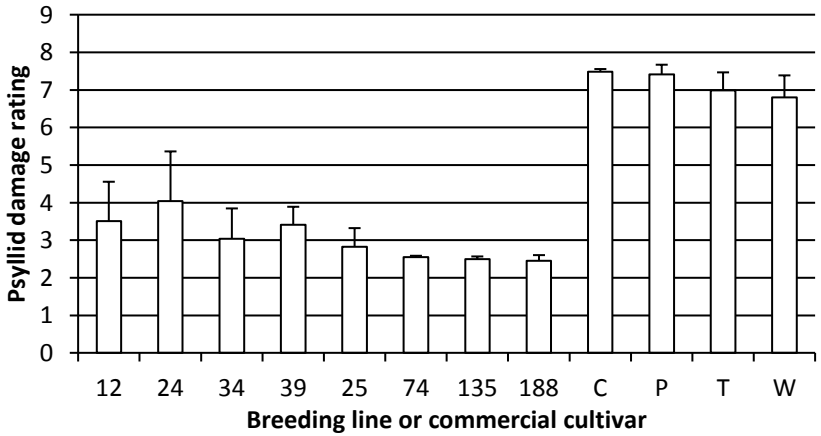

Figure 3. Psyllid damage rating (± SD) (5–6 November 2014)
(0= no damage, 9= death of growing tips)

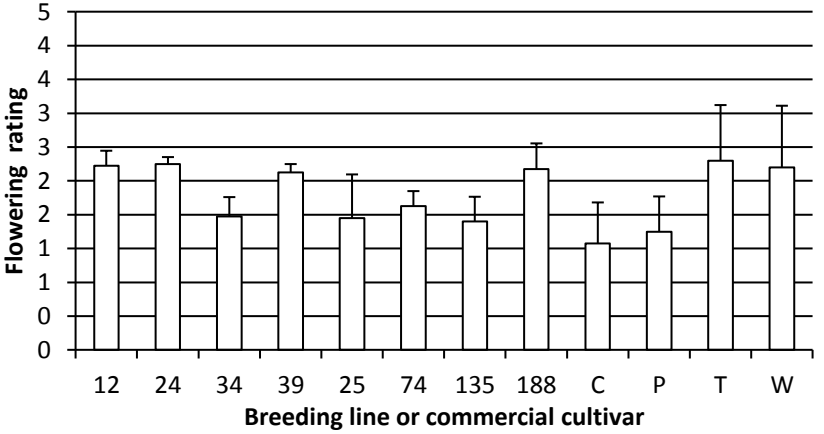

Figure 4. Flowering rating (± SD) (5–6 November 2014)
(1= vegetative; 2=budding; 3=flowering; 4=green pods; 5= brown pods)

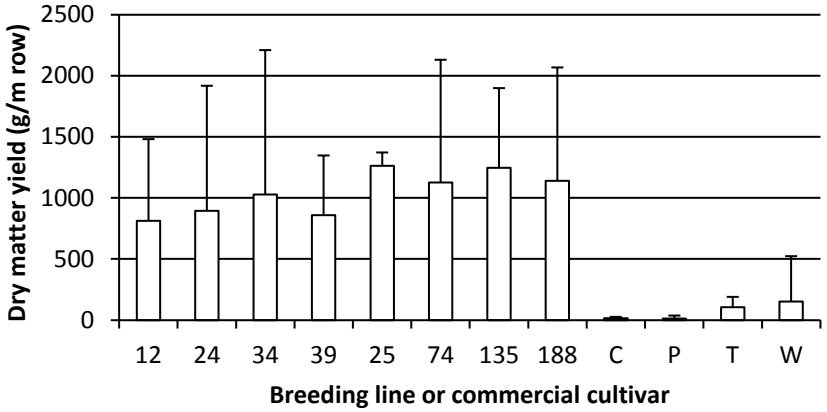

Figure 5. Dry matter yield (± StDev) (27–28 November 2014)

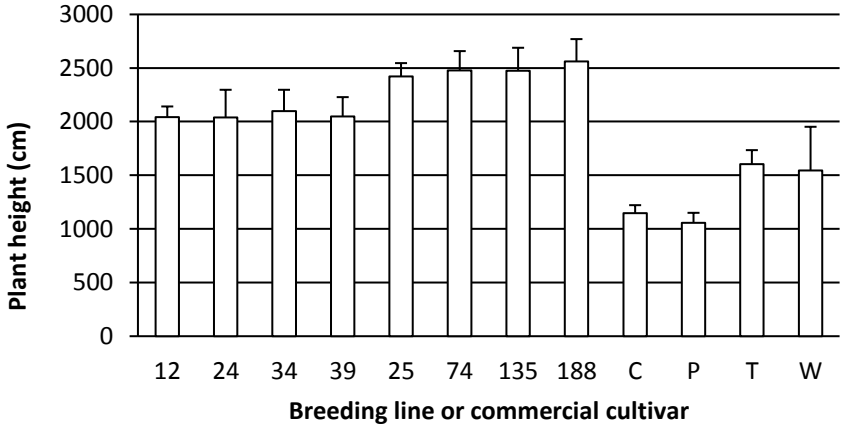

Figure 6. Plant height (± StDev) (27–28 November 2014)

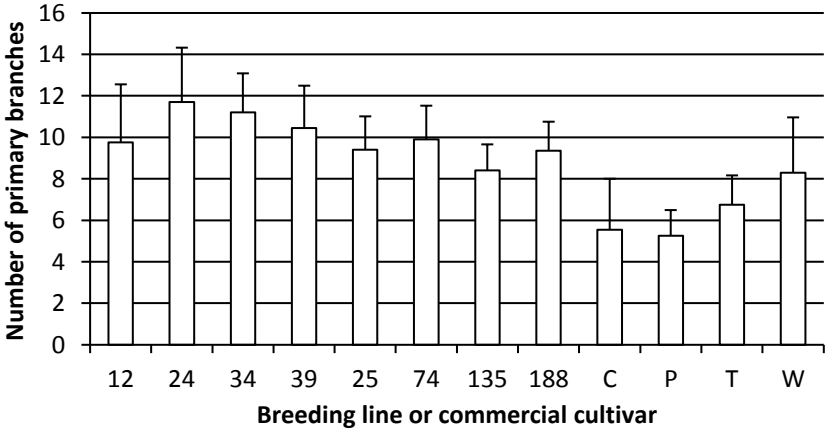

Figure 7. Number of primary (branches from main stem) branches (± StDev) (27–28 November 2014)

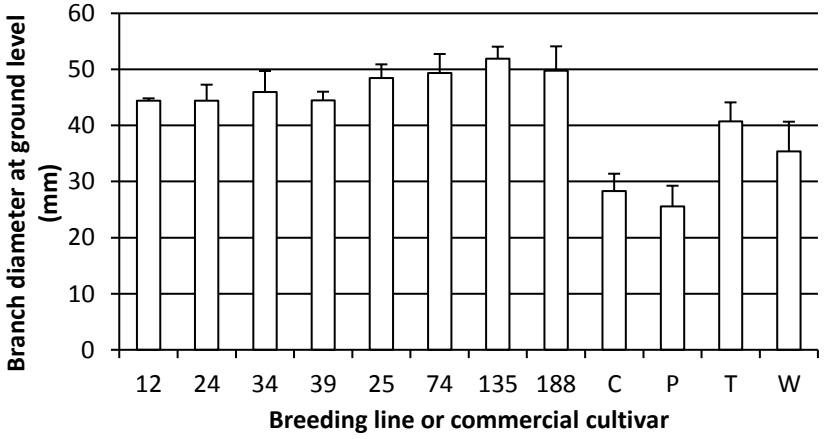

Figure 8. Branch diameter at ground level (± StDev) (27–28 November 2014)

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Table 1 Variety description and distinctness of candidate variety 'BL#12' and comparator varieties trailed. Characteristics which distinguish the candidate from one or more of the comparators are marked with a cross (x). A total of 8 out of 10 morphological-agronomic characteristics were identified as being distinct, uniform and stable (DUS) between the candidate variety and comparator varieties during testing.

	'12'	'24'	'25'	'34'	'39'	'74'	'135'	'188'	'C'	'P'	'T'	'W'
☒ PLANT: BRANCH NUMBER AT 75 cm												
mean	9.75	11.70	9.40	11.20	10.45	9.90	8.40	9.35	5.55	5.25	6.75	8.30
std deviation	4.41	4.32	2.14	3.09	3.35	2.38	2.52	2.18	3.25	2.27	2.29	3.50
LSD/sig	3.36	ns	ns	ns	ns	ns	ns	ns	P≤0.01	P≤0.01	ns	ns
☒ PLANT: HEIGHT (mm)												
mean	2041.25	2039.65	2419.80	2099.00	2047.60	2476.30	2473.00	2559.85	1147.25	1056.40	1604.80	1545.95
std deviation	203.59	359.39	272.05	269.28	257.72	282.58	340.17	278.73	101.83	159.84	191.63	388.06
LSD/sig	393.7	ns	ns	ns	ns	P≤0.01	P≤0.01	P≤0.01	P≤0.01	P≤0.01	P≤0.01	P≤0.01
☒ YIELD: FRESH WEIGHT (g/m row)												
mean	5040.0	5417.5	7365.0	6270.0	6237.5	8170.0	9715.0	9985.0	250.0	183.8	1550.0	2175.0
std deviation	1094.5	2092.6	690.2	2748.5	1285.8	2688.2	2236.9	2800.7	56.0	138.3	489.5	2117.2
LSD/sig	3623.7	ns	ns	ns	ns	ns	P≤0.01	P≤0.01	P≤0.01	P≤0.01	ns	ns
☒ YIELD: DRY WEIGHT (g/m row)												
mean	2030.2	2233.6	3155.8	2568.7	2147.8	2812.9	3117.9	2849.2	41.6	33.4	265.2	380.1
std deviation	669.3	1024.5	108.8	1181.0	489.1	1004.5	652.0	928.1	9.3	25.1	83.7	370.0
LSD/sig	1357.3	ns	ns	ns	ns	ns	ns	ns	P≤0.01	P≤0.01	P≤0.01	P≤0.01
☒ RESISTANCE: PYSLID DAMAGE RATING 21 OCT 2014 (1 to 9 rating)												
mean	3.86	4.46	2.91	3.79	3.51	2.30	2.01	2.13	7.54	7.83	7.00	7.04
std deviation	1.57	1.61	0.79	1.61	1.11	0.79	0.58	0.57	0.98	0.93	0.64	1.13
LSD/sig	1.34	ns	ns	ns	ns	P≤0.01	P≤0.01	P≤0.01	P≤0.01	P≤0.01	P≤0.01	P≤0.01

4.2 Preference trial 1

Before grazing commenced, there was more leaf on the breeding lines than on the commercial lines (see Fig. 9). However, there was an additional 20% of edible green pods on the commercial cultivars with almost no pods on the breeding lines. None of the 6 lines were psyllid damaged at the time of this first preference trial.

Initial grazing by 6 weaners indicated that Cunningham and Wondergraze were clearly preferred to the breeding lines when offered at very low stocking rates. Weaners were able to freely select according to preference (see Table 2). This difference in preference although expected was stronger than anticipated given that the breeding lines are >90% genetically similar to *L. leucocephala* based on DNA markers. Given normal variability, we conclude that the apparent differences in preference among the breeding lines was not significant.

Both commercial cultivars had abundant green pods (Table 2) which were clearly preferred by the cattle and this factor may have influenced preference ratings. The commercial cultivars were shorter in stature due to damage by psyllids during the previous autumn. This was reflected in the lower leaf yield at the beginning of the trial (Fig. 9). The breeding lines, which were not affected by the psyllids, were consequently taller with more edible material above browsing height. Mature cows were introduced into the plots in the second half of the week to overcome the browse line effect. However, in hindsight this may not have been necessary as the weaners ultimately learned to bend trees over, allowing the others to feed.

When the larger group of weaners (n=22), and cows (n=9), were introduced, all plots were almost completely eaten (see Fig. 10 and 11, and Plate 4). An average of 80% of all leaf of the breeding lines was removed with little difference among them, while 85-90% of the leaf of Cunningham and Wondergraze was removed over the total grazing period (see Fig. 11). The median percentage removed was approximately 90% for all varieties (Fig. 11).

Table 2. Reproductive status of all lines and percentage of total grazing time (6 weaners) spent consuming each of the breeding lines and commercial cultivars.

Line	Time spent eating leucaena	Reproductive status*
12	7%	2.1
24	10%	2.7
34	7%	2.0
39	12%	1.7
C	34%	3.7
W	31%	3.6
Total	100%	

Legend: 1=vegetative; 2=budding; 3=flowering; 4=green pods; 5= brown pods

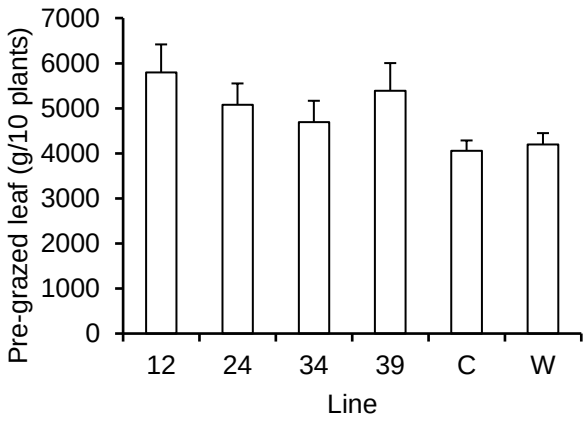


Figure 9. Leucaena leaf on trees prior to grazing.

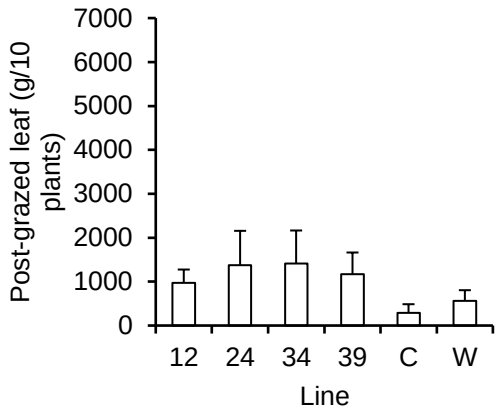


Figure 10. Leucaena leaf remaining on trees after grazing by the larger mob of cattle.

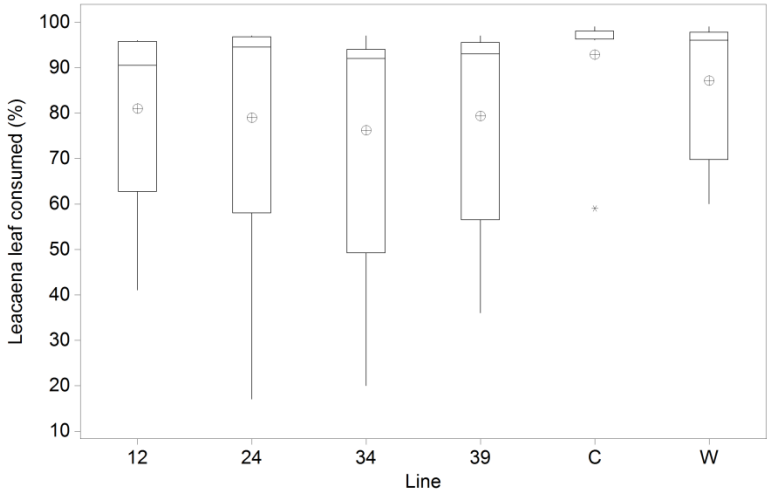


Figure 11. Box and whisker plot showing the percentage of leaf of breeding lines and commercial cultivars consumed by the larger group of cattle (22 weaners plus 9 cows) (Ɵ = average value; ── = median value).

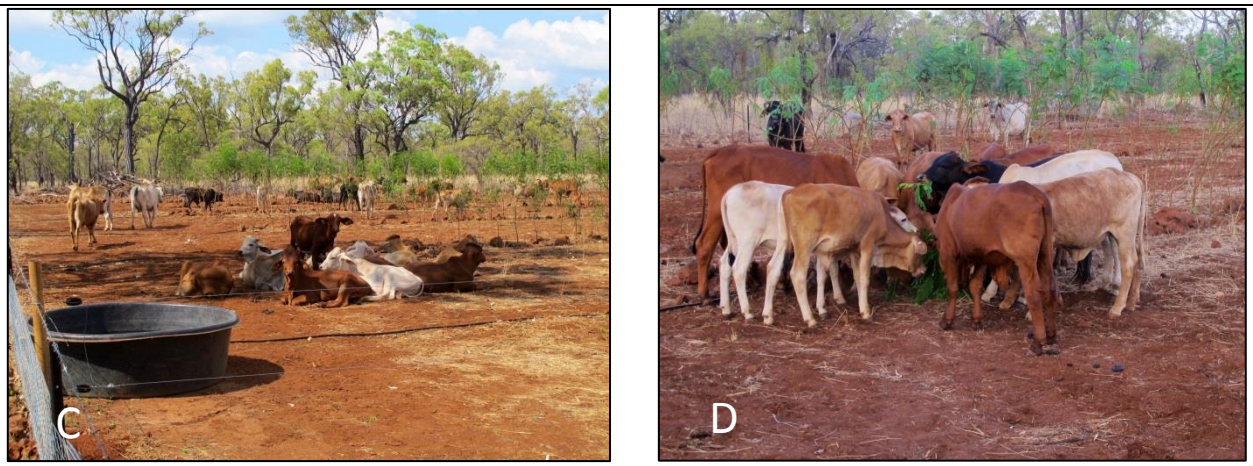


Plate 4. Initial preference was for the commercial cultivars (A), although cv Redlands consumed (B); however, the larger mob of cattle consumed almost all leaf of all breeding lines and commercial cultivars (C and D).

4.3 Preference trial 2

At the time of this second trial, the commercial varieties were psyllid damaged, while the breeding lines were not. Overall, there were no major differences in preference among the varieties following the second trial. All were well eaten with approximately 10% of leaf remaining at the end of grazing period (Fig. 12). Given that there was more leaf on the breeding lines at the beginning of the trial (due to the psyllid damage to the commercial lines), the cattle spent more time grazing these lines (Fig. 13). Grazing time was longer in the first half compared to the second half of each grazing period when there was less leaf available. However, relative grazing preference did not change from the first to the second half of grazing (Fig. 13). A video of grazing behaviour can be accessed (Plate 5).

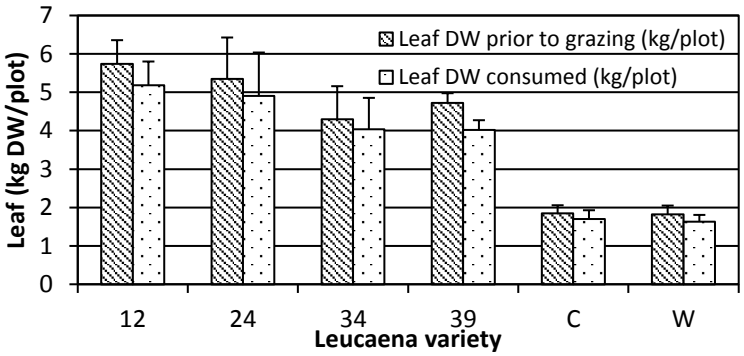
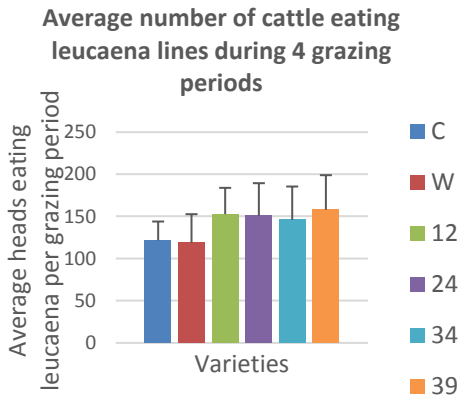
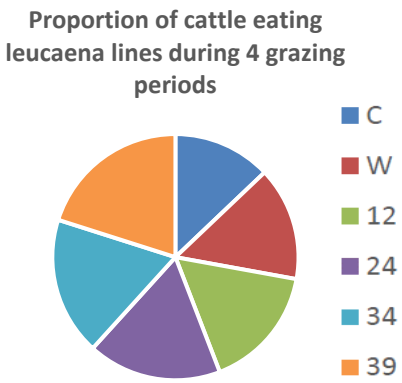
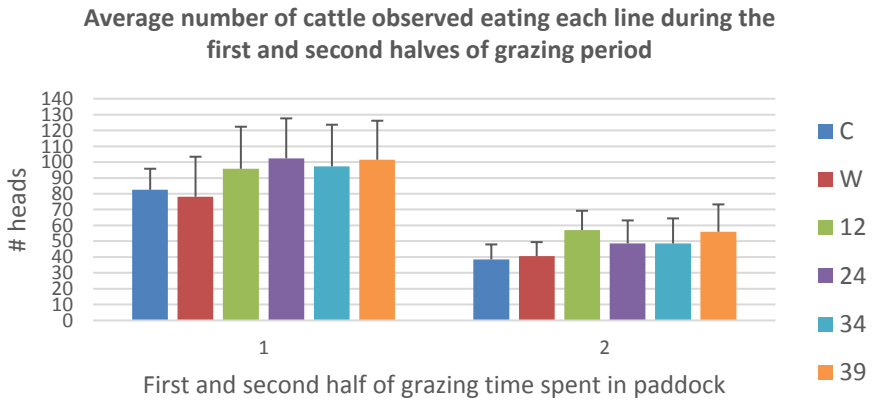


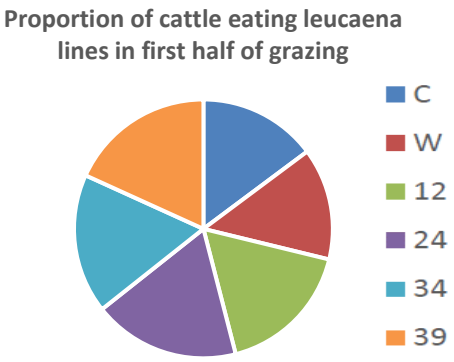
Figure 12. Dry weight of leaf/plot prior to grazing consumed during grazing.

Plate 5. QR code-grazing video.









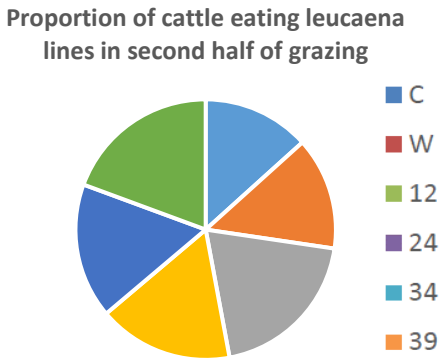


Figure 13. Cattle grazing data from Whitewater Station leucaena preference trial.

5. Discussion

5.1 PBR trial and preference trials

The PBR trial, and previous work in project B.NBP.0610, had showed that all four breeding lines were superior in psyllid resistance to the commercial cultivars. Under psyllid challenge, they were also higher in branch number and yield when compared to the commercial cultivars. Previous work had demonstrated that they were not significantly different in digestibility to the commercial cultivars.

The PBR trial successfully addressed the criteria of distinctness, uniformity and stability to comply with the rules for granting PBR, and breeding lines #12 and #39 were provisionally selected as having superior characteristics to lines #24 and #34.

The Whitewater grazing preference trial suggested that the breeding lines (#12, #24, #34, #39) were slightly less preferred than Cunningham or Wondergraze at very low stocking pressure; however, at higher stocking rate, the percentage of edible forage consumed for all 6 varieties was similar, and the amount remaining after grazing was also similar. This difference was more apparent in the first preference trial when there was no psyllid damage, and was less apparent in the second preference trial when the commercial varieties were psyllid damaged. This is in accord with grazier observations that psyllid damaged leucaena is less palatable to cattle due to the sticky exudate left by the psyllids, and the black mould that often develops on the sticky surface of the leaves.

All breeding lines were readily and almost completely eaten demonstrating that there was no special palatability problem. There were no appreciable differences in yield of #12, #24 and #39 at Whitewater before grazing. Earlier data collected from Redlands Research Station also indicated no significant differences in yield, digestibility, and psyllid damage rating between them, and none was particularly seedy. Cunningham and Wondergraze were far the seedier then the breeding lines with just minor differences among the lines.

Apart from #34, which had the blue/gray appearance and smaller leaflets resembling *L. pallida*, there was little difference between breeding lines #12, #24, and #39. On balance, #12 and #39 appeared the better varieties based on slightly better yields or grazing preferences, but these differences were not statistically significant.

Therefore, the amount of seed on hand was the only major point of difference and since there were adequate supplies of #12, choosing #12 ensured a shorter time to commercial availability. A table of differences between all breeding lines, their respective parent lines, and current commercial cultivars is provided Table 1. The decision was made known to the PBR office and a survey of interested parties resulted in the name ‘Redlands’ being chosen.

This has important practical implications for industry as there is now a leucaena cultivar available which can be planted in high psyllid challenge regions along coastal Queensland in the monsoon zone of north Queensland.

5.2 Seed increase and delivery of seed to successful tender applicants

For seed increase, three separate seed orchards had previously been established each containing the four elite lines. These were maintained free of weeds, and irrigated as necessary in order to increase seed stocks for commercial scale seed production. Seed was collected as, and when, it matured. The sites, and their current status, were as follows:

a. QDAF Redlands Research Station Cleveland (280 Seedlings of each line). Current status: All breeding lines apart from Redlands have now been removed. The majority of cv. Redlands orchard will also be removed soon although some trees will be retained for the sterile leucaena project to be used in breeding.

b. UQ Gatton Research Station (100 Seedlings of each line). Current status: All breeding lines including cv. Redlands are about to be destroyed other than some shy seeding or potentially sterile plants that may have value in the sterile leucaena breeding program.

c. DAF Walkamin Research Station (300 Seedlings of each line). All breeding lines have been destroyed.

d. Whitewater Station. All breeding lines apart from cv. Redlands have been destroyed

The first planted orchards (transplanted 21 November 2013) were 2–3m in height by April 2014 and in full flower and pod formation (see Plate 2). Seed was collected from the first maturing trees ready for larger scale plantings by commercial companies that were granted seed increase licences in the spring of 2014. By December 2014, approximately 45 kg of high quality breeders' seed of #12 was collected from the seed orchard at Redlands Research Station. Seed of all breeding lines was collected and placed in long-term cold storage at the University of Queensland. Further seed was collected at Gatton. All seed was cleaned, dried and then frozen for 1–3 days to kill bruchid beetles.

Selection of Commercial Seed Growers

Following instruction from MLA, after the first round Tender, 40kg was supplied to (Leucseeds Pty Ltd) at Banana in February 2015, keeping 5kg for contingencies. Since Leucseeds Pty Ltd had not been certain that they would be awarded the contract, they had not prepared land for planting to Redlands. On obtaining the contract, they began preparing land, originally a buffel grass paddock. As the paddock was originally grass, it required an extended period of cultivation before it was finally sown to cv. Redlands in the growing season of 2016. We visited Cedars Park on Tuesday 20 June 2017. At that time, Redlands leucaena about 3m high.

On completion of the second round Tender, 5kg of the original 45 kg of cv. Redlands, was sent to the Maynes on Bandana Station, Carnarvon Pastoral. Thus, the Bandana cv. Redlands seed orchard was planted with seed identical to the cv. Redlands seed planted at Banana by Leucseeds Pty Ltd. The 5kg was planted at Bandana Station in November 2015, and grew extremely well. Visits were made in early December 2015, and then again in July 2016, and May 2017.

The next lot of seed from UQ (about 30kg) and was delivered to Mr Bruce Mayne in June 2016. A further 5-10 kg was subsequently delivered. Thus the second planting of cv. Redlands at Calliope occurred using the second instalment of seed from Redlands Research Station.

6. Conclusions/recommendations/key messages

6.1 Conclusions and recommendations

- The leucaena grass pasture system is the most productive, sustainable and profitable 'grass-fed' grazing system available to the northern Australian beef industry. The availability of the new psyllid resistant cultivar *Redlands* addresses one of the principal issues restricting the use of leucaena in the wetter regions, and especially the basaltic uplands in the monsoon zone of north Queensland where psyllid challenge is greatest.
- Of four breeding lines chosen for possible release to industry, one (#12) was chosen and submitted for PBR protection. PBR was achieved for the new psyllid resistant variety and it was named cv. Redlands.
- The new cultivar *Redlands* has a high level of psyllid resistance (psyllid damage rating of <4 compared to rating of >7 for the commercial cultivars) (see definition of damage ratings on page 5). While there is some variability for this character, and for some other traits, including grazing preference, the differences were minor. In the case of grazing preference during high psyllid challenge, cattle preferred undamaged leucaena to the sticky mould covered psyllid damaged leaf of the commercial varieties.
- Seed orchards were planted, and breeders seed was supplied to two private seed producters (Leucseeds Pty Ltd and Bandana Station, Carnarvon Pastoral). They were selected through a tender process and both growers have successfully planted and harvested seed.
- The first seed is now available for commercial planting by producers.
- The principal unanswered question is that it is not yet known if the cattle weight gains that will accrue from grazing of this cultivar will match what is possible from existing cultivars for *L. leucocephala.* It was not possible within the scope of the project to conduct a grazing trial to ascertain the live weight gains in comparison with existing commercial cultivars. For this reason, the QDAF grazing trial in north Queensland is important as it presents the best opportunity to answer this question.
- It is recommended that specialised training course be made available to all graziers wishing to plant cv. Redland*s* leucaena as this cultivar has different characteristics compared to previous commercial leucaena releases. The additional significance of training regarding cv*. Redlands* relates to the fact that it will be planted in wetter zones including coastal areas where weedy invasion is a greater risk.

6.2 Key messages

- The new psyllid resistant variety 'Redlands' will increase the area potentially suitable for leucaena by 30% from 4.4 to 5.7 M ha (unpublished GIS data). This will have significant positive implications for the beef industry as it is widely acknowledged that leucaena plantings can double productivity and profitability.
- The use of 'Redlands' leucaena in the grazing lands of monsoonal Australia will have far-reaching positive benefits. Firstly, by providing much needed high quality protein during the dry season, and secondly, as a system for maintaining backgrounded cattle bound for the live export trade. The region has been invaded by Indian couch and is in need of a suitable legume to lift productivity. While Stylo remains an option, the much higher quality of leucaena pasture, and its ability to remain green well into the dry season, will substantially increase productive efficiency.
- It is important that tailored extension messages are prepared for graziers planning to utilize this cultivar. Firstly, if the proposed planting is not in a high psyllid challenge region, it may be better that one of the existing cultivars be used, as psyllid resistance will not be a priority. Secondly, for those who require a psyllid resistant cultivar, it is important that they receive training, not only on best practice for establishment and management of leucaena, but also specialised training on management to minimise seed set and the spread of seed into the environment where it is not desired.
- The level of weed risk is likely to be low in the volcanic uplands in the northern Australian monsoon zone. The weathered volcanic soils, while high in phosphorus, are very low in sulphur. Accordingly, any escaped

leucaena will lack vigour due to sulphur deficiency, and is highly likely to be consumed and eradicated by domestic and native animals, especially in the dry season when feed is scarce.

- Both phosphorus and sulphur are crucial nutrients for vigorous leucaena growth as they are vital to the nitrogen fixation process. Graziers who plant leucaena in the basaltic uplands will need to apply elemental sulphur to promote leucaena growth and protein content.

7. Bibliography

Dalzell SA, Robertson LM, Lambrides CJ, Brewbaker JL, Greenway D, Dieters M, Shelton HM (2013) *Tropical Grasslands – Forrajes Tropicales 1,* 66−68

Wheeler, RA. Leucaena psyllid trial at Waimanalo, Hawaii. Leucaena Research Reports 1988 Vol.9 pp.25-29.

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