The need for legumes that are suitable for wet areas and can tolerate heavy grazing was highlighted by Cameron (1977). The same spread of *Vigna* as occurred in this experiment has been observed on other areas of Beerwah Research Station where it was first noticed in 1975. The source of this line of *Vigna parkeri* cannot be determined. Hence we cannot allocate the Beerwah line, now described as CQ1374, to any particular introduction of *Vigna parkeri*. However, recent studies (B. G. Cook, pers. comm.) suggest it is most likely to be CPI 25378. The results presented here and experience elsewhere (author's unpublished data; B. G. Cook, pers. comm.) suggests *Vigna parkeri* has the potential to be a useful legume in the wetter areas of the subtropics or the elevated tropics. CQ1374 was released, at the August 1984 meeting of Qd. Herbage Plant Liaison Committee, as cv Shaw.

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BREEDING *LEUCAENA* FOR LOW-MIMOSINE: FIELD EVALUATION OF SELECTIONS

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ABSTRACT

A breeding program to select low-mimosine lines of leucaena has been in progress since 1970. Selections were evaluated in two field trials at Lansdown. Although the low-mimosine selections did indeed have lower mimosine than the control cultivars, their dry matter yield was also inferior (about two-thirds of cv. Cunningham). Some possible reasons for this are discussed.

INTRODUCTION

The tree legume *Leucaena leucocephala* has considerable potential as a forage throughout the tropics in spite of some difficulties with establishment, management, and occasional toxicity in cattle from prolonged feeding (Hutton 1974, Jones 1979). The edible forage of *L. leucocephala* has a high content of mimosine, an amino-acid which is rapidly converted in the rumen to 3-hydroxy-4(1H)-pyridone (DHP), a goitrogen which upsets thyroid metabolism, thus causing loss of hair and weight and other side effects in cattle (Hegarty *et al.* 1976, Jones 1979). Even in the absence of clinical signs of toxicity, liveweight gain can be depressed, and this is associated with reduced serum thyroxine levels (Jones and Winter 1982). Elucidation of mimosine's primary role in the toxicity of *L. leucocephala* forage provides the rationale for breeding lines of this legume free from, or low in, mimosine.

Gonzalez *et al.* (1967) found variation in mimosine content among a number of leucaena species, although no species was found to be free of mimosine. They made crosses between high and low mimosine species and were able to select plants in the progenies with less than 30% of the normal mimosine values. Their investigation indicated the possibility of breeding leucaena lines combining low mimosine content with high yields of forage.

In 1970, one of us (EMH) began a breeding program to produce low mimosine lines of leucaena. Screening the then available material showed that the only sources of low mimosine were two introductions of *L. pulverulenta*, CPI's 22964 and 23145, both with a mimosine content of about 2% compared to about 5% in *L. leucocephala*. However, these accessions were low yielding, and did not appear to have potential as forage plants in their own right. Consequently, a breeding program was designed with the objective of producing types which yielded as well as the best *L. leucocephala* lines, but with a mimosine content close to that of *L. pulverulenta*. The program involved the hybridisation of *L. pulverulenta* (CPI 22964) with two lines of *L. leucocephala* (cv. Cunningham, and "line 5" (a Peru × Hawaii cross—see Hutton and Beattie 1976)). Following selection for low mimosine (weak plants having been discarded) backcrosses were made to the three parents. Details of the selections are given in Table 1. Apart from the F_1 material, all low mimosine selections were checked for mimosine content on more than one occasion.

Since the F_1 hybrids were self-sterile, and it was thought desirable to incorporate self-fertility, subsequent generations were continually monitored for this character. Among the 85 plants selected in the second backcross generation (Table 1) were 26 which proved to have some degree of self-fertility. The availability of seed from these plants (which were derived from *L. pulverulenta* × Cunningham × Cunningham × Cunningham) provided an opportunity to assess breeding progress in a field trial.

TABLE 1

Details of selection procedures in the low mimosine breeding program

Generation	No. of plants tested for low mimosine	Age when tested (weeks)	Number finally selected for low mimosine and good vigour
F_1	217	12	55
BC1	1190	12,20,40	59
BC2	909	6,12,18	85

EXPERIMENTAL DETAILS

Two cutting experiments were conducted at Lansdown Research Station, near Townsville. They were identical in all respects, except being situated on different soil types (Trial 1: Red podzolic soil, Gn 3.15 (Northcote 1971), pH 6.3; Trial 2: solodic soil, Dy 3.43 (Northcote 1971), pH 6.0). The sites were only 200 m apart. In 1974, both sites had received 250 kg/ha of Mo super, and 125 kg/ha of KCl. In 1978, they received a further 125 kg/ha of Mo super.

Five leucaena populations were tested:

(a) *L. leucocephala* cv. Cunningham.

(b) *L. leucocephala* cv. Peru.

(c) *L. pulverulenta*. Since this is an outcrossing species, and only three trees of CPI 22964 existed, progeny of a cross between CPI 22964 and CPI 23145 were used.

(d) A population made up of seed bulked from 25 of the 26 self-fertile plants referred to above ("bulk 25") and

(e) A population from the six "best" plants of the same 26 ("bulk 6"). These "best" plants were selected on the basis of plant vigour, growth habit, mimosine content, and seed production.

Seedlings were raised in peat pellets, inoculated with Rhizobium CB81, and transplanted to the field on January 8, 1978, at a spacing of 2.5 × 0.5 m. Each plot was two rows, each of 20 plants, with four replications at each site. All plants were cut back to 10 cm from ground level on September 6, 1978.

Four harvests were made (Table 2). Subsamples were separated into leaf plus edible stem (less than 5 mm diameter) and wood, to enable the production of edible dry matter (EDM) to be estimated. Green pods were included in EDM and mature pods were discarded.

At each harvest, samples of five "second fully expanded" leaves per plot were taken for mimosine analysis (Megarrity 1978). From the red podzolic soil, samples of leaf tissue were dried and ground for estimation of nitrogen and phosphorus content.

TABLE 2

Details of the four harvests of the field evaluation trials

Harvest	Date	Number of plants per plot	Height of cutting	Comment
A	Feb. 13, 1979	16	0.1m	growth from Sept 6, 1978
B	May 31, 1979	16	0.1m	regrowth from harvest A
C	May 31, 1979	16	0.1m	growth from Sept 6, 1978
D	Feb. 2, 1980	32	1.0m	regrowth from harvests A and B

RESULTS

After 6 months in the field survival of *L. pulverulenta* was only 45% on the red podzolic soil and 30% on the solodic, compared to nearly 100% for the other lines. Plants of *L. pulverulenta* were approximately one-tenth the size of those of cv. Cunningham. No further data on *L. pulverulenta* are presented.

In general growth habit, the low-mimosine selections were quite similar to Cunningham, displaying the same late flowering and branching characteristics.

Yield data from the two trials are presented in Table 3. Peru and Cunningham were always higher yielding than the other two lines, significantly so in most cases. At no harvest was Peru different from Cunningham, nor "bulk 6" from "bulk 25". The average yield of the low-mimosine lines was about two-thirds that of the control cultivars, and yield in the solodic soil ranged from one-quarter to one-fifteenth of the yield on the red podzolic.

Mimosine concentrations are shown in Table 4. The low mimosine selections clearly have less mimosine than Peru and Cunningham. Where the average mimosine contents were greater than 3% (harvests A and D, both sites) the differences between Cunningham and Peru and the low-mimosine lines were statistically significant. At harvests B and C, when the leucaena was growing less actively, mimosine levels in all lines were lower than at times of more rapid growth.

There were no apparent major differences in nitrogen and phosphorus content between lines. Mean values over all harvests (for N and P respectively) were: Cunningham 3.0% and 0.19%; Peru 2.9% and 0.19%; "bulk 6" 2.1% and 0.20%; "bulk 25" 2.9% and 0.18%.

DISCUSSION

The poor performance of *L. pulverulenta* in this experiment confirms that initial accessions of this species have limited potential as a forage species in north Queensland. The lack of vigour in the population tested should not have been due to inbreeding depression, as the material tested was a deliberate cross between accessions. Other observations in subsequent experiments (Bray, unpublished data) have confirmed the generally poor performance of early *L. pulverulenta* accessions. However, some later introductions are much more vigorous than CPI 22964 and CPI 23145, and have flourished under nursery conditions.

TABLE 3

Edible dry matter yields (g/plant) for four leucaena lines at Lansdown.
(Within a column, means followed by the same letter are not significantly different at P = 0.05)

Line	Harvests A	B	C	D
(a) Red podzolic soil				
Cunningham	138a	266a	612a	434a
Peru	121a	227a	524a	373a
Bulk 6	89b	130b	249b	267b
Bulk 25	81b	178b	288b	268b
(b) Solodic soil				
Cunningham	27ab	34ab	37a	78a
Peru	45a	51a	38a	81a
Bulk 6	13b	17b	16a	25b
Bulk 25	16b	19b	18a	32b

TABLE 4

Mimosine content (%) of four leucaena lines at Lansdown.
(Within a column, means followed by the same letter are not significantly different at P = 0.05)

Line	Harvests A	B	C	D
(a) Red podzolic soil				
Cunningham	4.6a	2.8a	2.3a	5.6a
Peru	4.1a	3.1a	1.8a	5.8a
Bulk 6	3.0b	2.1a	1.9a	4.8ab
Bulk 25	3.3b	2.7a	1.4a	3.7b
(b) Solodic soil				
Cunningham	3.7a	2.0a	2.0a	5.8a
Peru	3.8a	2.6a	2.2a	6.0a
Bulk 6	2.2b	2.4a	2.4a	3.8b
Bulk 25	2.5b	2.4a	1.6a	4.4b

It is clear that the breeding program has produced lines with a lower mimosine content than Cunningham or Peru. However, the yields of edible dry matter obtained from these selections are obviously also less than those of existing cultivars. (The poor yield has been confirmed by Dr R. J. Jones and Dr W. H. Winter (pers. comm.) in grazing trials at the Kimberley Research Station in Western Australia). Although graziers might be willing to accept some decrease in yield as a trade-off for low mimosine, it is thought that the levels of production in the current material are too low to warrant commercial release. However, considering the poor performance of *L. pulverulenta*, the low mimosine selections represent a substantial advance in yield compared to that parent. Further backcrosses to *L. leucocephala* would be needed to increase yield to a more acceptable level.

Since *L. pulverulenta* and *L. leucocephala* differ in chromosome number (56 and 104 respectively—Gonzalez *et al.* 1967) the backcross and selfed derivatives would have incomplete chromosome complements. Not only would this disrupt fertility, but could be responsible for some of the lack of vigour. Further backcrossing followed by selection among selfed progenies could produce higher yielding lines with mimosine contents lower than those reported for the selections in the present experiments.

The relationship between mimosine content and yielding ability is not clear. Observations on another population of seedlings of progenies of individual low-mimosine trees has demonstrated a genetic correlation of 0.6 between seedling weight and mimosine content (Bray, unpublished data). This implies that selection based on low-mimosine content would tend to produce lower yielding plants. It does not imply that high yielding, low mimosine plants cannot be produced—the F_1 hybrid between *L. pulverulenta* and *L. leucocephala* is one example, with yields up to 150% of Cunningham and only 80% of the mimosine being readily achievable (Bray, unpublished data).

Another possible explanation for the present result is that growth of young plants (used for assessing plant vigour in selection generations) may not correlate well with field results from mature plants. Some evidence for this is available from the previously mentioned seedling study, where some progenies outyielded Cunningham at 12 weeks of age, but proved to be inferior later in the field. This suggests that future selections should be made only on older plants.

The results of this trial serve to emphasize the large differences in performance of leucaena on different soil types. Production during the experimental period on the poorly drained solodic soil averaged only about 10% that on the podzolic, and this difference has been subsequently maintained. In spite of some of the extravagant claims made for the performance of leucaena, it is clear that some discretion must be exercised in the selection of sites for its usage. High yields will only be obtained in favourable soils.

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EFFECT OF REINFORCEMENT OF NATIVE GRAZING WITH SILVERLEAF DESMODIUM (*DESMODIUM UNCINATUM*) ON DRY SEASON PERFORMANCE OF BEEF STEERS IN ZIMBABWE

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ABSTRACT

Silverleaf desmodium (Desmodium uncinatum) *was seeded into* Hyparrhenia *grassland on a sandy clay soil using disced strips which covered 0, 1/3, 2/3 and the whole area. After the Silverleaf desmodium had established, the plots were used for carrying weaner beef steers, at two stocking rates, through the dry season over a period of five years.*

Reinforcement with Silverleaf desmodium increased herbage yields at pregrazing samplings and resulted in marked botanical changes, with taller-growing Hyparrhenia *spp. displacing* H. filipendula *and* Sporobolus pyramidalis. *Lodging and death of these* Hyparrhenia *spp. then led to invasion by broad-leafed weeds. Steers in all treatments lost*