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LEUCAENA LEUCOCEPHALA PRODUCTION IN SUBCOASTAL, SOUTH-EAST QUEENSLAND

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ABSTRACT

The productivity of leucaena, grown as a winter supplement to native pastures, was assessed over 6 growing seasons on a range of adjacent soil and topographic sites in subcoastal, south-east Queensland.

Mean edible leucaena yield measured at the end of autumn reached a maximum of 800 kg dm/ha after 3 growing seasons and did not change substantially over the following 3 seasons. Leucaena plant height increased progressively each year to a mean of 190 cm after 6 seasons.

Highest yields were obtained on the alluvial and colluvial soils with potential rooting depths of 110-120 cm. Frosting was severe on these soils, but the leucaena still produced twice the edible yield of the leucaena on shallow basaltic and andesitic soils where frosts were absent or infrequent.

Leaf fall of leucaena during the summer/autumn growing seasons was equivalent to 30 to 40% of the annual production. Most of the remaining leaf was lost during winter if frosts occurred, or if winter rainfall was below average in the absence of frosting.

These results indicate that rooting depth, incidence of frost and winter rainfall strongly influence the productivity of leucaena grown as a winter grazing supplement in south-east Queensland. It is recommended that, where possible, leucaena should be planted on deep, fertile soils in frost free locations.

INTRODUCTION

Leucaena leucocephala (leucaena) is a legume adapted to and widely distributed throughout the tropics and sub-tropics (Oakes 1968; Hill 1971). It is a valuable protein supplement for beef cattle grazing native pasture (Addison 1970; Addison *et al.* 1984) and as a pasture forage (Jones and Jones 1982) in the subcoastal regions of south-east Queensland. Ambient temperature, annual rainfall, and soil characteristics are the major factors influencing leucaena production (Hutton and Gray 1959; Maclaurin 1981).

An extensive system for beef cattle production, using leucaena as a protein supplement to native pastures and which is applicable to large areas of grazing land in south-east Queensland (Cooksley 1984), has been developed in Gayndah. This paper reports the effect of some climatic and edaphic variables on the development of leucaena during the 6 years following planting, particularly in relation to the amount of edible material available for cattle grazing in south-east Queensland.

MATERIALS AND METHODS

Location

Leucaena growth was monitored at Brian Pastures Research Station, Gayndah (25°39′S, 151°45′E; altitude 130 m) which has an average annual rainfall of 733 mm (Table 1) and a mean monthly temperature range of 32°C (January maximum) to 6°C

(July minimum). The soils, predominantly derived from basalt and andesite with some occurring as alluvium and colluvium, included uniform fine-textured soils with self-mulching to hard setting surfaces and median-textured, duplex soils (Reid *et al.* 1986).

TABLE 1

Seasonal rainfall from 1976 to 1983 and 30-year average for Brian Pastures Research Station, Gayndah

Season	Year							
	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	(30-year)
				(mm)				
Winter	44	9	203	54	28	124	25	97
Spring	368	115	196	241	98	117	74	167
Summer	219	222	267	220	456	347	164	320
Autumn	176	99	117	154	164	103	439	149
Total	807	445	783	669	746	691	702	733

Leucaena management

Treated seed (Cooksley 1975) of *Leucaena leucocephala* cv. Peru was sown in December-January 1976/77 into a finely cultivated seedbed in 3 m rows at 4 kg/ha. The area was interrow cultivated in March-April 1977. Twenty areas of leucaena (5 × 1.0 ha blocks in each of 2 weaner paddocks and 5 × 2.0 ha blocks in each of 2 yearling paddocks) were established. Weaner or yearling cattle rotationally grazed the leucaena within each paddock during winter-spring from 1978 to 1983. Each leucaena block was grazed once during winter and again during spring. Frost incidence and severity varied within and among blocks according to topography.

Site selection

Leucaena was sampled at 56 sites, from 6 edaphic groupings, within the overall arrangement of the 20 leucaena blocks. These sites were positioned in representative areas of leucaena to cover the range of biological, topographical and edaphic variability. Two of these edaphic groupings were on soils derived from basalt, 2 on soils derived from andesite, 1 on a soil derived from alluvium, and 1 on soil based on a colluvium of andesite and basalt.

Pasture measurements

Plant number, height and dry matter (dm) yield available for grazing (edible leucaena) were determined from 10 m sections of row prior to cattle grazing the leucaena in winter. Edible leucaena was defined as leaf, flowers, seed, seed pods and stems to a thickness of 5 mm. Leucaena leaf fall was collected in 20 l drums (top opening 290 cm^2) placed within and between rows from December to the first winter grazing of the appropriate block at each site. Pasture yield (grass and its litter) in the interrow areas was estimated using the technique of Campbell and Arnold (1973).

RESULTS

Soils

Data extracted from Reid *et al.* (1986) showed that soils derived from basalt generally had higher values for pH, clay content, Cation Exchange Capacity (CEC), and available phosphate than soils derived from andesite (Table 2). Total nitrogen content was similar in all soils and was low. Soils derived from andesite and the alluvium/colluvium had maximum chloride levels deeper in the profile than in those derived from basalt, implying a greater potential depth of wetting and rooting in the former soil groups (McCown *et al.* 1976; Reid *et al.* 1979).

TABLE 2

Properties of 3 soil groups[1] used for leucaena production

	basalt	andesite	colluvium/ alluvium
pH[2]	6.5-7.9	6.1-6.5	8.0
CEC[2] (m. equiv./100 g soil)	46-65	27-32	52
Total nitrogen[2] (%)	0.13-0.19	0.12-0.19	0.16
Phosphorus[2] (ppm)			
Acid extraction	27-250	9-84	248
Bicarb extraction	39-147	15-155	9
Clay content[2] (%)	29-66	16-25	45
Depth (cm) to maximum Cl^- level	50-90	80-150	110-120
Maximum Chloride level (%)	0.002-0.055	0.084-0.167	0.070

[1] Adapted from Reid *et al.* (1986)
[2] Determined on surface 10 cm of soil

Leucaena

Plant establishment was unaffected by soil type and averaged 3.7 plants per metre of row.

The leucaena was characteristically slow to establish, yielding an average across all soils of only 195 kg/ha of edible material at the end of the first growing season (6 months after sowing) (Table 3). After a further 2 years, average edible yield stabilised at between 800 and 900 kg/ha. In contrast, leucaena height increased progressively to an average of 190 cm after 6 growing seasons.

TABLE 3

Development of leucaena and interrow pasture over a 6-year period after sowing (averaged over soil types)

	Age of leucaena (number of growing seasons)					
	1	2	3	4	5	6
Year of sampling	1977	1978	1979	1980	1981	1982
Yield of edible leucaena (kg/ha)	195	365	805	825	905	825
Leucaena height (cm)	45	90	125	130	185	190
Yield of leucaena leaf (kg/ha)	—	220	455	380	510	540
Leucaena leaf fall (Dec-May) (kg/ha)	—	130	430	325	590	565
Total growth (edible plus leaf fall) (kg/ha)	—	495	1235	1150	1495	1390
Yield of interrow grass (kg/ha)	—	—	2400	3300	4500	4500
Yield of interrow litter (kg/ha)	—	—	1000	800	700	900

After 2 years growth, leucaena yields of 1645 kg dm/ha were attained on the colluvium, compared with 400, 270-470 and 130-235 kg dm/ha for the alluvial, andesitic and basaltic soils respectively (Table 4). Leucaena yield had stabilised after 2 seasons on the colluvial soil, whilst it took an additional season for leucaena yields to stabilize on the other soil types and at a much lower dm yield/ha (Table 4).

TABLE 4

Edible yield, total growth, height and leaf yield of leucaena on 6 soil types. Standard errors in parenthesis.

	Year of Sampling	Alluvium Te[1]	Colluvium Ban/Nu	Soil Type Andesite Ban	Andesite Bro	Basalt Nu	Basalt Gr
Number of sites		5	4	19	7	17	4
Yield of edible leucaena (kg/ha)	1977	225 (100)	880 (140)	175 (40)	210 (79)	45 (11)	155 (78)
	1978	400 (115)	1645 (272)	270 (59)	470 (151)	130 (27)	235 (190)
	1979-82	1240 (100)	1600 (103)	775 (45)	835 (68)	695 (29)	575 (40)
Total growth (edible plus leaf fall) (kg/ha)	1978	490 (174)	2395 (324)	315 (77)	690 (222)	170 (35)	300 (256)
	1979-82	1515 (117)	2375 (163)	1215 (67)	1395 (96)	1145 (57)	970 (102)
Leucaena height (cm)	1977	100	150	40	60	15	30
	1978	150 (30)	190 (9)	80 (9)	100 (17)	55 (7)	65 (35)
	1979-82	165 (12)	235 (11)	155 (6)	165 (8)	145 (5)	130 (10)
Yield of leucaena leaf (kg/ha)	1978	260 (73)	985 (80)	175 (39)	265 (84)	85 (15)	135 (109)
	1979-82	690 (63)	915 (47)	460 (53)	425 (80)	375 (46)	425 (29)

[1] Soil groupings – see Reid *et al.* (1986)

After 2 years growth, leucaena plants on the colluvial soil were 190 cm tall compared with 55-65 cm on the basaltic soils (Table 4). Further growth occurred in subsequent years, the leucaena reaching 235, 165, 155-165 and 130-145 cm on the colluvial, alluvial, andesitic and basaltic soils respectively.

Leaf fall increased as the yield of edible leucaena increased and after 3 seasons, stabilised at between 300-600 kg dm/ha. This was equivalent to 30-40% of the summer/autumn production (Table 3).

Total growth stabilised after 3 seasons at between 1000 and 1500 kg dm/ha on most soils. However on the colluvial soil, it stabilised at a higher level (2400 kg dm/ha after 2 seasons) (Table 4).

Leucaena leaf presentation yields of ungrazed blocks during the period of winter grazing (Figure 1) varied considerably in response to frosting and rainfall. Leucaena leaf fall occurred in 1979, 1981 and 1982 and was associated with frost damage. Minimum screen temperatures recorded were −1.1, −0.7 and −3.3°C respectively. This damage varied from slight on the elevated sites, to severe on sites on the lower slopes. Substantial leaf fall occurred in all locations in 1979, 1980 and 1982 when the rainfall from June to August was low (Table 1). Consequently, a large proportion of the leucaena leaf was unavailable for winter grazing except in 1978 and 1981 in frost-free locations and in 1978 in the frost susceptible location.

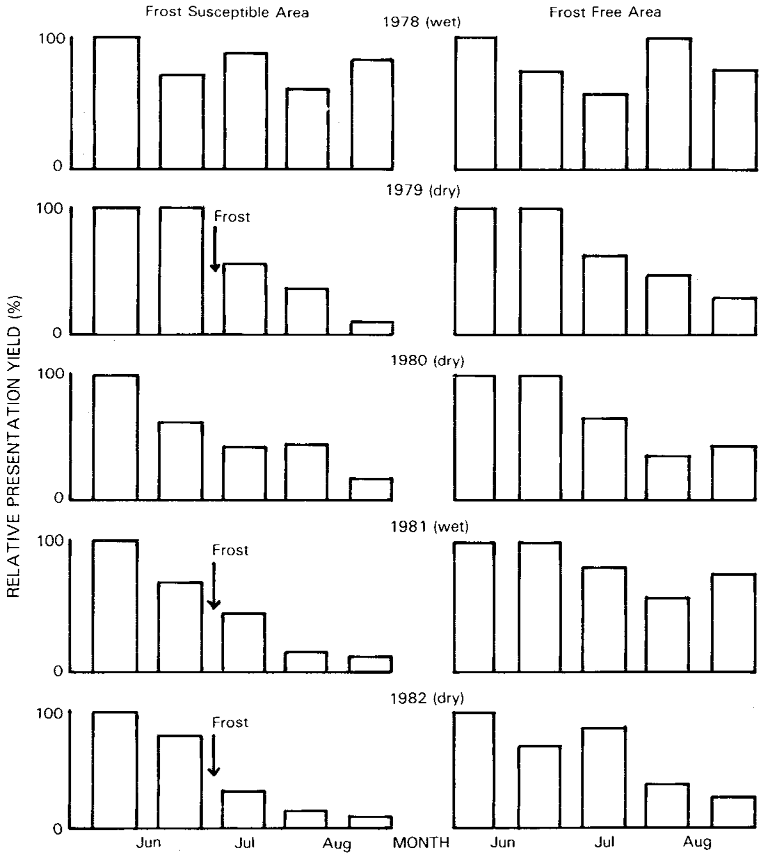

FIGURE 1

Trends in relative presentation yield (expressed as a % of yield at the commencement of winter) of leucaena in frost-susceptible and frost-free locations for the 5 years 1978-82

Leucaena did not produce many new shoots during winter, even during the wet, frost-free winter of 1978.

Interrow grass

Grass growth between the rows of leucaena was suppressed by cultivation in the first year. Average interrow yield was 2400 kg dm/ha after 3 growing seasons, increasing to 4500 kg dm/ha after 6 seasons (Table 3). Yields of interrow grass litter did not vary over the final 4 years of the experiment and averaged 900 kg dm/ha. By the end of the experiment, the pasture contained a substantial component of *Rhynchelytrum repens* and *Panicum maximum* var. *trichoglume.*

DISCUSSION

This study demonstrated that leucaena growth can be markedly influenced by edaphic factors, especially potential depth of wetting and rooting. Furthermore, leucaena leaf fall in winter was markedly influenced by frosting and by lack of winter rainfall. These factors would appear to be major limitations to the use of leucaena as a winter supplement for grazing cattle in parts of south-east Queensland.

The average edible yield of leucaena 6 months after sowing was intermediate between those reported for weedy and weed-free stands by Shaw (1965) and Cooksley (1974). Although the edible leucaena yield stabilised at between 800 and 900 kg dm/ha after 3 growing seasons, this is significantly lower than the 3290 kg leaf dm/ha (growing period from December to June) reported for the Ord River area by Blunt and Jones (1977) and 3700 kg dm/ha at Gayndah by Addison *et al.* (1984). However, the leucaena in the Ord River was irrigated. We cannot explain the much higher values obtained by Addison *et al.* (1984), even allowing for the sequence of generally wetter years (average 846 mm) associated with their studies. Also, the growth period of this experiment was in spring/summer, which could account for a lower yield of leaf fall.

Leucaena height in the slowest growing stands progressively increased over the period of our experiment, but edible leucaena yields stabilised after 3 growing seasons. This suggests that, under grazed conditions, stable yields of edible leucaena will be reached soon after the establishment phase. It also shows that leucaena sown in 3 m rows can reach a height approaching 2 m despite annual grazing.

The wide range in leucaena edible yield, height, and growth rate recorded at the different sites is most likely due to the potential depth of wetting and rooting, and fertility of the soils, and to the incidence and severity of frost damage. Highest production was achieved on alluvial and colluvial soils, despite their position on frost susceptible slopes, suggesting that in such situations, the advantages of a deep and fertile soil will outweigh the disadvantage of frosting. The variation in the development of leucaena between other soils was smaller, even though these were derived from contrasting parent materials. The varying combinations of soil depth and soil fertility could explain these differences, since the andesitic soils were generally deeper, but also less fertile, than the basaltic soils.

The amount of leaf which fell during the summer/autumn growing period was similar to that available for grazing at the beginning of winter. Additional losses also occurred in winter before the plants were grazed. In ungrazed situations, 80% of the leaf remained at the end of winter after the 2 wet, frost-free winters, but only about 20% remained when stands were frosted or when winter rainfall was low in the absence of frosting. Therefore only a small proportion of the total annual leaf growth is available for consumption by cattle in winter. Nevertheless, this amount has proven effective in increasing animal weight gains (Cooksley, unpublished results).

Although these leaf losses restrict the amount of leucaena available for grazing in some winters, the leaf nitrogen is not totally lost from the grazing system. The increasing frequency of *Rhynchelytrum repens* and *Panicum maximum* var. *trichoglume* in the interrow pasture suggests an associated increase in available soil nitrogen similar to that reported by Ichinki *et al.* (1982).

CONCLUSIONS

Our data have highlighted some of the variability of leucaena sowings, both in the rate of development over a range of environments, and in the edible yield available for use by cattle in winter. The value of leucaena as an animal supplement is likely to be enhanced if plantings are made on deep (> 50 cm in depth), well-drained, fertile soils, preferably in frost-free locations. Its direct contribution to the diet of animals in winter will vary even on a single soil type, depending on the amount of leaf fall. Finally, leucaena can be expected to reach 2 m in height, even at reasonably high plant populations, when sown on soils to which it is well adapted.

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