OBSERVATIONS ON THE TIME OF SOWING AND ESTABLISHMENT OF *LOTONONIS BAINESII* AND *DESMODIUM UNCINATUM* IN THE TAREE DISTRICT

D. R. KEMP*

ABSTRACT

Lotononis bainesii *and* Desmodium uncinatum *were sown near Taree (lat. 32°S) on sixteen occasions over three years from late September to March. Plant counts taken during the first winter after sowing indicated that the best establishment resulted from sowing during late September to early November, and, provided moisture was adequate, from sowing in late summer. Plant counts taken one to three years after sowing showed that many of the early effects had disappeared.* Lotononis *was slower to establish than* Desmodium. *Nitrogen and* Melinis minutiflora *tended to depress establishment of both legumes, though the effect was only significant in one year.*

INTRODUCTION

Tropical legumes have been sown in pastures on the mid-north coast of N.S.W. since the early 1960's. They have shown an ability to grow well and to have a place in pastures of the area (Kemp 1974). However, sowings frequently fail to establish and this has restricted the use of these species. Poor establishment of tropical legumes has also been reported by Murtagh (1970) on the far north coast of N.S.W. and Jones and Rees (1973) in south-east Queensland.

Examination of records of experimental areas on the mid-north coast, suggested that the time of sowing was an important factor in the successful establishment of tropical legume pastures. A series of observational experiments was then set down to examine the effect of time of sowing on legume establishment.

Establishment was defined as the number of legume plants that had germinated, grown and survived some frosting. The test species used were *Lotononis bainesii* cv. Miles and *Desmodium uncinatum* cv. Silverleaf. Within these experiments, the influence on legume establishment of competition from associated species, and of nitrogen fertilizer were also studied.

EXPERIMENTAL

Site and climate

The experiments were located 2 km from Krambach, which is situated 24 km SW of Taree (lat. 32°S, long. 152°E) on the crest of a ridge, on a shallow soil derived from shale (DY 4.51, Northcote). The area was dominated by *Themeda australis* and had never been cultivated or fertilized.

Annual rainfall at Taree is 1150 mm, with the period of most reliable rainfall being from late January to July. Rainfall at Krambach over the period of observations (1969-72) is shown in figure 1, together with the temperatures for Taree.

Design

Experiments were sown in three successive years on adjacent sites. No apparent differences in soil type or original vegetation were noted between sites. Each experiment involved a factorial arrangement of 2 replications × 4 to 6 sowing times × 2

*Department of Agriculture, Taree, N.S.W. 2430. Present address: Department of Agronomy, University of W.A., W.A. 6009.

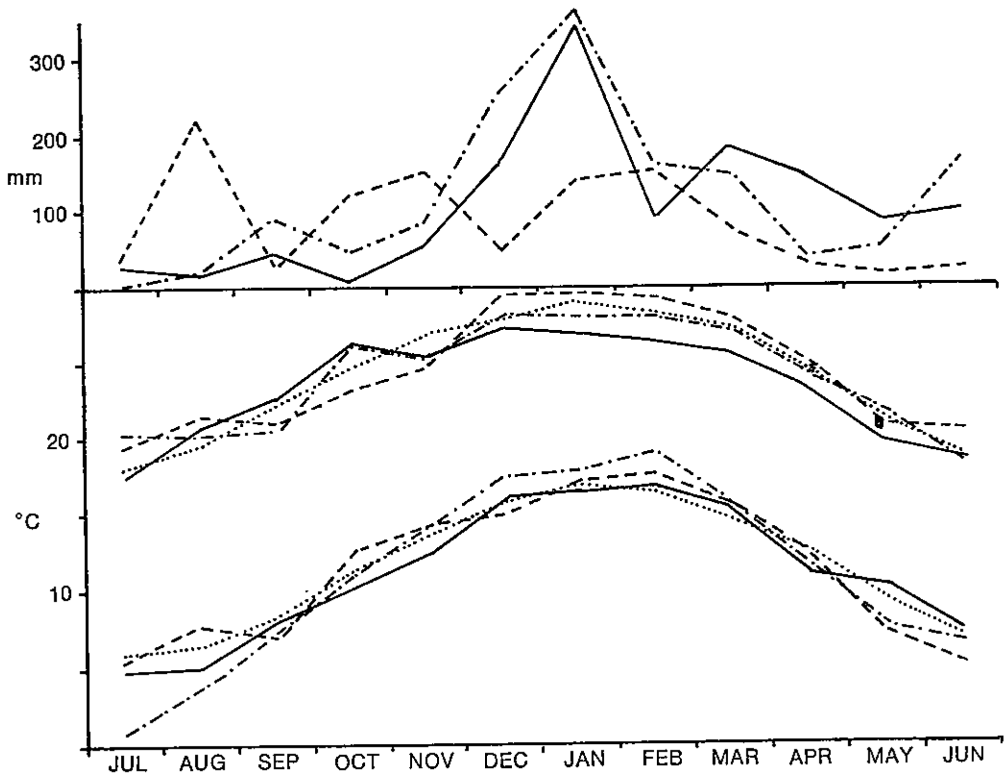

FIGURE 1

Mean daily temperature at Taree and total monthly rainfall at Krambach, July 1969 to June 1972: (- - -) 1969-70; (- · -) 1970-71; (——) 1971-72; (. . . .) 29 year average.

species × 3 to 5 associated factors. The species were *Lotononis* and *Desmodium*. The sowing times in each year are listed below.

Sowing time	*Experiment* 1	*Experiment* 2	*Experiment* 3
1	3 x 1969	24 ix 1970	21 ix 1971
2	6 xi 1969	22 x 1970	21 x 1971
3	5 xii 1969	24 xi 1970	25 xi 1971
4	16 i 1970	22 xii 1970	22 xii 1971
5	12 ii 1970		8 ii 1972
6	20 iii 1970		28 ii 1972

It was not possible to complete all planned sowings in experiment 2 due to restricted access to the site as a result of wet conditions.

The associated factors and sowing rates for molasses grass (*Melinis minutiflora*) are listed below.

Experiment 1	*Experiment* 2	*Experiment* 3
1. nil	1. nil	1. nil
2. molasses grass (11 kg ha^{-1})	2. †nil	2. †nil
3. †molasses grass (11 kg ha^{-1})	3. †molasses grass (0.6 kg ha^{-1})	3. †molasses grass (2.8 kg ha^{-1})
4. *Lablab purpureus* (34 kg ha^{-1})	4. †molasses grass (2.8 kg ha^{-1})	
	5. †molasses grass (5.6 kg ha^{-1})	

† Nitrogen was applied to these treatments at 34 kg N ha^{-1} in a single dressing at sowing as ammonium nitrate.

The experimental design was a split plot arranged in randomized blocks with sowing times as main plots and species × associated factors as sub plots. The sub plot size in experiment 1 was 2.75 m × 6.25 m; in experiment 2, 2.1 m × 4.3 m; and in experiment 3, 1.8 m × 3.0 m.

Procedures

A seed bed was prepared by rotary hoeing six months prior to the start of each experiment and again one to two weeks before each sowing time. Seed and fertilizer were broadcast separately and then lightly raked into the soil. *Lotononis* was sown at 4 kg ha^{-1} and *Desmodium* at 13 kg ha^{-1}. These high sowing rates were used as experience from commercial sowings suggested that the recommended sowing rates of 1.2 kg ha^{-1} for *Lotononis* (Betts 1972) and 4.8 kg ha^{-1} for *Desmodium* (Mears, Murtagh and Wilson 1965) were too low. Seed was obtained from commercial sources and was unscarified. The legumes were inoculated. All plots received a basal fertilizer application of 450 kg Mo superphosphate ha^{-1} and 110 kg potassium chloride ha^{-1} at sowing and an annual topdressing of 225 kg superphosphate ha^{-1} each winter.

Sampling and Analysis

For each experiment plant counts were taken using 3 random 30 cm × 30 cm quadrats per plot, after mowing plots back to 5 cm, during the July or September following sowing, and then each experiment was opened for general grazing by cattle. The number of legume plants established at the end of the first winter was chosen as the prime criterion for evaluation. Grazing of these plots depended primarily on when the farmer had animals grazing in the paddock—though generally the legumes were grazed when 60 cm high and grazed to 5 to 10 cm. Stocking rates were low, at approximately 1 cow ha^{-1}. Plots were open for grazing for most of the year. All plots within each experiment were then counted in June 1973.

Plant counts were also taken approximately four weeks after the sowing of the first three sowings in 1970-71 (experiment 2). Plant counts were analysed using standard analysis of variance techniques. To achieve normality the plant count data was transformed to $\sqrt{x + 1}$

RESULTS

Primary plant counts

For each of the three years the relation between sowing time and the plant populations of *Lotononis* and *Desmodium* at the end of the first winter is shown in figure 2. Also shown is the weekly rainfall at Krambach during the sowing period.

Establishment of *Desmodium* in each of the three years followed a broadly similar pattern with the two earliest sowings producing the highest plant populations, despite varying rainfall patterns. These earlier sowings also had the most vigorous plants when plant counts were taken. *Desmodium* plants being greater than 1 m high from early sowings and *Lotononis* greater than 25 cm, compared with sparse and very small plants from late sowing. However in 1972 when more rain fell, the early February sowing resulted in plant numbers similar to those from the September and October sowings. This improvement was not sustained at the late February sowing when establishment declined significantly. This pattern of superior establishment from spring plantings was also found with *Lotononis* but with marked departures from the general trend in December 1970 and 1971 when establishment was equal or superior to the spring plantings.

Secondary Plant Counts

The results are shown in Table 1 for plant counts four weeks from sowing and at the end of the first growing season, for the first three sowings in 1970-71. The early

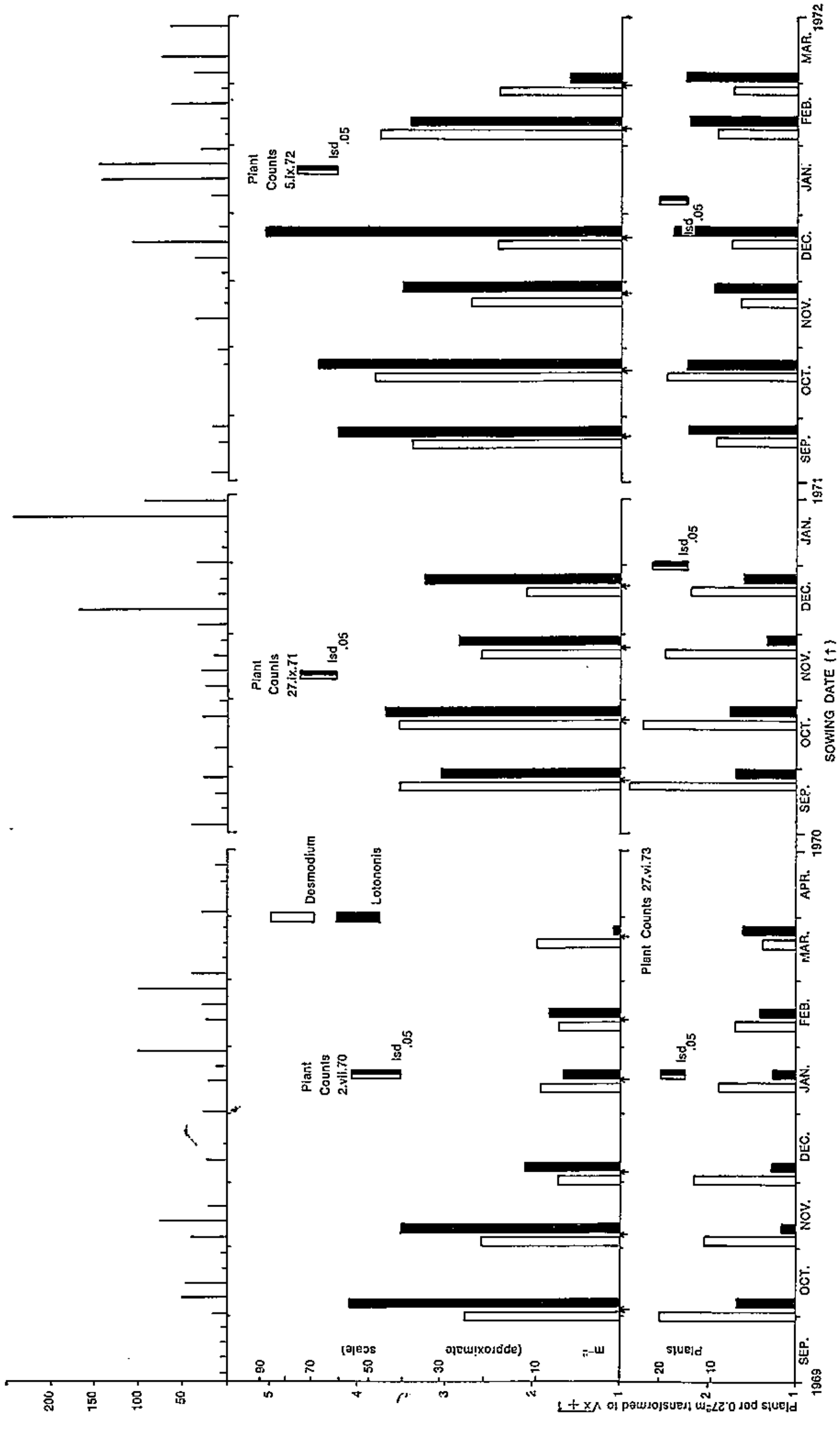

FIGURE 2

Time of sowing and plant population at the end of the first growing season and one to three years later for *Lotononis* and *Desmodium*, with weekly rainfall at Krambach during sowing period.

plant counts for *Lotononis* were less than at the end of the first growing season while for *Desmodium* they were greater.

Supplementary counts of the plots sown on October 22nd, 1970, 8 weeks after sowing showed that the plant population of *Lotononis* had increased to 15.9 plants m^{-2} and *Desmodium* had decreased to 51.7 plants m^{-2}.

TABLE 1

Plant populations of Lotononis *and* Desmodium *in 1970, four weeks from sowing and at the end of the growing season. Mean effects of treatments.*

Sowing date	*Lotononis* 4 weeks	*Lotononis* 27.ix.71	*Desmodium* 4 weeks	*Desmodium* 27.ix.71
		PLANTS m^{-2}		
24.ix.70	3.2 (2.1†) a	30.1 (5.6)b‡	56.5 (7.6)a	42.3 (6.6) a
22.x.70	1.6 (1.6) a	46.6 (6.9)a	64.3 (8.1)a	41.6 (6.5) a
24.xi.70	1.9 (1.7) a	26.6 (5.3)b	51.4 (7.2)a	20.8 (4.7) b

† $\sqrt{x + 1}$ transformed means
‡ Means in the same column not followed by the same letter differ at p = 0.05 by Duncans multiple range test.

The results of plant counts taken in June 1973 (Figure 2) showed that plant numbers of *Desmodium* had only declined slightly from the 1969-70 and 1970-71 sowing, but there was a larger decline from the 1971-72 plantings though the initial trends remained. The correlation between first year and 1973 counts was not significant for the 1969-70 sown plots but was highly significant for 1970-71 ($r^2 = 0.98$; $P < 0.01$) while in 1971-72 the correlation ($r^2 = 0.58$) was only significant at the 10% level. This suggests that some of the first year effects had remained in the same order.

Lotononis showed a decline in plant numbers for all sowing dates from the first year to the 1973 counts except for the March 1970 and late February 1972 plantings. In these latter two a slight increase in plant density occurred with time. There were no significant correlations between first year and 1973 plant counts for *Lotononis* for any of the three sowing years, although significant differences remained between some sowing dates at the 1973 counts (Figure 2).

Associated Factors

The associated factors in experiment 1 had no significant effects on legume populations, though there was a tendency for molasses grass to reduce legume density. *Lablab purpureus* densities were low and had no effect upon legume plant numbers. No significant effects from associated factors were recorded in the second experiment. Molasses grass and nitrogen significantly depressed plant numbers in experiment 3 and these results are shown in Table 2.

TABLE 2

Associated factors and plant populations. Mean effects of six sowing times in 1971-72-plant counts September 5, 1972.

Treatment	*Lotononis*	*Desmodium*
	Plants m^{-2}	
nil	20.2 (4.6†) a	12.2 (3.6)c‡
Nitrogen	16.0 (4.1) b	8.0 (3.0)d
Molasses grass + Nitrogen	8.4 (3.1) d	7.5 (2.9)d

† $\sqrt{x + 1}$ transformed means
‡ Means not followed by the same letter differ at p = 0.05 by Duncan's multiple range test.

In no experiment did the associated factors show any tendency to increase legume populations. Overall molasses grass plants were small and lacking in vigour. This was probably due to the low nitrogen rates applied, and most plants had disappeared within a year or so of sowing. Weed growth on these plots was negligible over the course of observations.

DISCUSSION

The seed cost of tropical legumes is high and any technique that improves establishment or enables a reduction in sowing rates is justified. The initial observations indicate that spring sowings were consistently successful. Roberts (1974) had also found, in commercial situations, that October was the best month for sowing tropical legumes in N.E. New South Wales and S.E. Queensland, and October sowings on dry seed beds were successful. Spring sowing had the added advantage that forage was provided for grazing in the first year, whereas later sowing produced little forage before winter.

The published evidence on sowing times for these species is scanty. In his original paper on *Lotononis*, Bryan (1961) does not mention sowing time, though in a subsequent paper (Bryan, Sharpe and Haydock 1971) it is noted that plots were sown in September and were well established by February. Jones (1975) compared tropical legume establishment at two sowing times, both in October, and found no difference, both producing well established swards. Whiteman and Lulham (1970) examined sowing times for *Desmodium* and concluded that December sowing was better than October, February or April, but their data only covered one year, the plots were irrigated and the October sown plots had a real infestation of weeds.

Recommendations as to appropriate sowing times appear to be based more on considerations of rainfall patterns than experimental comparisons; for example Betts (1972) recommends autumn sowing of *Lotononis* as that is the period of most reliable rainfall on the N.S.W. north coast. Yet the data in figure 2 show that autumn sowing of *Lotononis* produced very few plants in the first year, significantly fewer than the spring sowings. The counts taken in later years, on autumn sown plots, showed an increase in plant numbers. This suggests that few seeds germinated and established in the first year either through unsuitable environmental conditions or hardseededness. Bryan (1961) does not indicate that *Lotononis* has a hard seed content, in fact the reverse is suggested. The slower establishment rate of *Lotononis* (Table 1) may be due to some hard seed, but the general trend in plant numbers was a decrease over time for all sowings except the last in autumn 1970 and 1972. The role of hard seed in *Lotononis* establishment requires further study. Unfortunately it was not possible to determine the hard seed content of the seed samples used.

Lotononis seedlings were establishing over a longer period than *Desmodium* (Table 1). For *Desmodium* the climatic conditions close to sowing would then have a greater effect on plant population, than for *Lotononis*. This also suggests that to satisfactorily establish a *Lotononis* sward a sequence of favourable periods over a few months may be required. In such a situation weed control over a long time interval would be essential and this may be why establishment failures are common with *Lotononis* (Jones & Rees 1973).

High temperatures may have been responsible for poor legume germination and establishment in summer. High seed mortality and poor establishment of *Glycine wightii* at high temperatures (37°C) has been recorded by Murtagh (1970) and Souto and Dobereiner (1970). Cloonan and Vincent (1967) recorded poor nodulation of *Lablab purpureus* and *Vigna sinensis* from December sowings on the far north coast of N.S.W. and they attributed this to high soil temperatures. From field observations, Roberts (1974) had also concluded that summer temperatures are detrimental to tropical legume establishment.

Spring is traditionally a dry period on the N.S.W. north coast, but low spring rainfall appears to be less of a problem for tropical legume establishment than high summer temperatures. Further research is obviously needed to define the interaction between soil temperature and moisture on tropical legume emergence and establishment.

Secondary plant counts showed that the initial legume populations declined with time, suggesting that initial sowing rates were too high for the prevailing environmental conditions. Lower sowing rates may have resulted in the initial effects of sowing times persisting for longer. Another factor that would have reduced plant numbers with time was that grazing management on these plots was less than satisfactory. The effects of grazing could have overridden any initial effect of sowing time.

Jones (1973) found that established swards of *Desmodium intortum* were highly productive at a plant population of 9.5 plants m^{-2}, about one third that recorded for some spring plantings of *Desmodium uncinatum*. High initial plant populations are advisable to control weeds (Jones 1975) but may not need to be as great as recorded here. Further research is needed to assess the initial plant densities required for productive swards of these legumes.

The associated factors studied had only a minor effect on legume establishment except in 1971-72. Some paddock observations had suggested that a cover crop may assist establishment during hot weather, but no evidence was obtained to support this opinion. The vital importance of weed control has been well demonstrated by Jones (1975) and the sensitivity of *Lotononis* to competition from *Axonopus affinis* is well known (Bryan 1961; Betts 1972; Kemp 1974). Neither factor operated in these experiments. No firm conclusions can be drawn from these observations, suffice that *Lotononis* and *Desmodium* can both withstand some competition from molasses grass and that small amounts of ammonium nitrate impair establishment.

The observations reported here indicate that the time of sowing over the warmer months of the year can affect the establishment of *Lotononis* and *Desmodium* and suggest several lines of research that are necessary before these results can be fully understood. The main point emphasized by these observations is that a spring sowing with low rainfall in the Taree district of N.S.W. can be superior to summer or autumn sowing under better moisture conditions.

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