The effect of seedbed and sowing time on establishment of Siratro and Gatton panic into native pasture

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Summary

The effect of seedbed preparation, sowing time and the inclusion of a grass component on the establishment and subsequent production of native pastures oversown with siratro (*Macroptilium atropurpureum* cv. Siratro) were investigated over 4 years in sub-coastal, south-east Queensland.

It was concluded that environmental conditions following sowing, no matter what seedbed preparation was employed or what time of the year the sowing occurred, had a major influence on the success of sowings of Siratro into a native pasture sward. Reliable establishment of the legume component was only achieved by severe pasture renovation which reduced the original basal cover by at least 75 percent. Spring sowings were the most reliable but good establishment of Siratro was also achieved from mid-summer sowings. The grass component never established well (usually < 1 plant/m^2), no matter what the seedbed preparation. However, small initial populations were sufficient to contribute significantly to pasture yield in subsequent years.

Increasing the severity of renovation reduced subsequent pasture yields; reduction of the initial population by at least 75 percent by rotary hoeing increased the sown pasture component in pasture yields but decreased the native pasture component, particularly when the renovation occurred in summer or autumn. Severe renovation increased the yield of broadleaved weeds.

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Resumen

*El efecto de la preparación de la cama, fecha de siembra ye la inclusión del componente gramínea sobre el establecimiento y subsecuente producción de las pasturas nativas sembradas con siratro (*Macroptilium atropurpureum *cv. Siratro) fue investigado durante 4 años en la región sub-costera al sur-este de Queensland.*

Se concluyó que las condiciones medio ambientales posteriores a la siembra ejercieron una gran influencia en el éxito del establecimiento del siratro en pasturas nativas, sin importar el tipo de preparación de la cama empleado o la época del año en la que se realizó la siembra. Se logró un establecimiento confiable de la leguminosa únicamente con una renovación severa de la pastura en la cual la cobertura basal se redujo cuando menos 75%. Las siembras de primavera fueron las más confiables pero también se obtuvo un buen establecimiento del siratro en las siembras relizadas a mediados del verano. Sin importar el tipo de preparación de la cama, el componente gramínea nunca se estableció bién. Sin embargo, las pequeñas poblaciones iniciales fueron suficientes para contribuir significantemente al rendimiento de la pastura en los años sub-siguientes.

El aumento en la severidad de renovación redujo los rendimientos de la pastura en los años subsiguientes; la reducción de al menos 75% de la población inicial mediante una escardodora rotatoria incrementó el componente de pastura sembrada en el rendimiento de la pastura pero redujó el componente de pastura nativa, particularmente cuando la renovación fue realizada en el verano o en el otoño. La renovación severa incrementó el rendimiento de las malezas de hoja ancha.

Introduction

Establishment of tropical species into existing stands of native pasture in southern Queensland has become a popular method of improving pasture production at a relatively moderate cost (Bisset and Marlow 1974; Lowe 1972; Lowe *et al.* 1977). However the reliability of such establishment methods is somewhat doubtful (Cook and Lowe 1977). This is especially true of the small-seeded tropical grasses, and their inclusion in this type of sowing has not been recommended for commercial operators (Lambert and Steentsma 1979).

Tropical pastures can be sown from September to March in south-eastern Queensland (Lowe 1973; Ostrowski 1969, 1978) but greater reliability of establishment has been obtained during December and January using cultivated seedbeds, particularly in the sub-coastal areas (Lowe 1973). However, for oversowing of tropical species into established native pasture swards, there is no information on the best time to sow, the reliability of methods of introducing species into existing native pasture swards, nor whether there is any benefit in introducing a grass.

The objective was, firstly, to assess the influence of seedbed preparation and sowing time on establishment of the legume Siratro (*Macroptilium atropurpureum* cv. Siratro), and on the subsequent production of the pasture obtained, and secondly, to assess the value of including a grass component in the seed mixture sown into native pasture. The experiment was repeated over 4 consecutive years to assess the reliability of these establishment techniques with seasonal variation.

Materials and methods

Site

The experiment was located in cleared forest country on the upper terrace of Cressbrook Creek, near Toogoolawah, south-east Queensland. The soil was a solodic with a gravelly loam A horizon overlying a brown clay sub-soil (Db 2.43; Northcote 1971). It had the following fertility characteristics:—

pH	6.3
Extractable P (acid extraction)	14 ppm
Extractable Potassium	0.45 meq/100 g
Chloride	66 ppm
Total Soluble Salts	0.039%

Existing vegetation

The native pasture in the experimental area was basically a blue couch (*Digitaria didactyla*), pitted blue grass (*Bothriochloa decipiens*) community with a minor component of black spear grass (*Heterpogon contortus*) (Table 1). There were only minor variations in the botanical composition over the 4 separate experimental sowings. The botanical composition presented in Table 1 was measured using the wheel-point-quadrat technique previously described by Lowe *et al.* (1977).

Table 1. Botanical composition of the native pasture community into which the Siratro and Gatton panic seed was sown (as measured by the basal area of component species)

Species present	Mean botanical composition (% of basal area)	
	Year 1 and 2 Sowings	Year 3 and 4 sowings
Bare ground	24.0	32.1
Aristida benthanii (three awned grass)	0.0	1.4
Bothrichloa decipiens (pitted blue grass)	7.4	4.3
Chloris ventricosa	5.0	4.3
Dicanthium tenue	0.0	0.7
Digitaria didactyla (blue couch)	37.2	37.9
Erichloa procera (early spring grass)	0.0	0.7
Fimbristylis dyphala	4.1	5.7
Glycine tabacina	0.8	1.4
Heteropogon contortus (black spear grass)	5.0	2.9
Panicum effusum	0.0	0.7
Paspalidium distans	1.7	0.7
Paspalidium caespitosum	4.1	2.9
Sporobolus creber	4.1	5.0
Herbaceous species (small)	6.6	2.1

Design and treatments

Experiments were randomised blocks of 30 treatments with 3 replicates. Treatments included 5 seedbed preparation methods, 3 sowing times and 2 sowing mixtures in factorial combination:

Seedbed method	*Sowing time*	*Sowing mixture*
Mowing, no soil disturbance	Spring	Siratro
Burning	Summer	Siratro, Gatton panic
Ripping	Autumn (late)	
Sod-seeding		
Rotary hoeing		

Plot size was 6 m x 4 m. The first year's sowings were unfenced and were grazed openly by the co-operator's cattle. Subsequent sowings were fenced and ungrazed. All treatments were defoliated to 5 cm and the cut material (ranging from 500 to 1500 kg/ha of dry matter depending on the prevailing conditions experienced in the previous season) was removed from all except the 'burning' treatments before seed was broadcast on to the surface. On the 'burning' treatments, the cut material was allowed to dry for a week, and then set alight. Seed was sown into the cool ash. Because of the drought situation which existed at the site for the majority of the experimental period, only the first series of sowings (in 1976/77) contained a full set of burning treatments. The remaining 'burning' treatments in other years were, in fact, duplicates of the 'mowing, no disturbance' treatments.

Both the 'ripping' and 'sod-seeding' treatments were performed by the use of a single tine ripper mounted on a small-plot rotary hoe except in the first year of sowings when this operation was performed by a tractor-mounted ripper unit (2 m wide). Ripped rows were approximately 30 cm apart and 6-10 cm deep when the single-row implement was used and 20 cm apart and 15 cm deep for the tractor-mounted implement. The only difference between 'ripping' and 'sod seeding' treatments was that the 'ripping' treatments had the seed broadcast over the plot, while the 'sod-seeded' treatment had the seed deposited within the rows of soil disturbance.

The 'rotary hoed' treatments were prepared by two passes 1 week apart, using a small-plot rotary hoe. This was generally conducted when the soil was dry; the rotors did not penetrate more than 5 cm and only about 50% of the existing vegetation was removed with each pass (*i.e.* 25% of vegetation remained at sowing). Seed was broadcast onto the surface and raked for coverage.

Technique

The experiment was conducted from 1976 to 1981. Spring is from September to November, Summer-December to February and Autumn from March to May. Actual sowing dates for treatments are presented in Table 2. Spring sowings were made after the first useful falls of rain in the spring. Summer plantings were designed for sowing on good falls in mid-summer. However, in practice it was found that the seasons generally had below average rainfall and sowings had to be conducted prior to the end of the particular season even if effective rainfall had not been received. Autumn sowings were designed to be sown late in the season so that temperatures were too low for active germination. As winter rainfall was generally very low in this environment, it was expected that this seed would sit undamaged in situ until the first spring rains. It was postulated that this seed could establish on unpredictable early, spring storms. Generally, these sowings took place in early to mid-winter (Table 2).

Siratro (*Macroptilium atropurpureum* cv. Siratro) was sown at 2 kg/ha of commercial seed (approximately 11% hard seed) and Gatton panic (*Panicum maximum* cv. Gatton) at 5 kg/ha. In

Table 2. Actual sowing dates in 4 consecutive years at Toogoolawah

Sowing time	Actual sowing date			
	1976/77	1977/78	1978/79	1979/80
Spring	22.11.76	17.11.77	19.10.78	1.11.79
Summer	7.3.77	15.2.78	20.12.78	10.1.80
Autumn/Winter	16.4.77	6.7.78	13.7.79	9.7.80

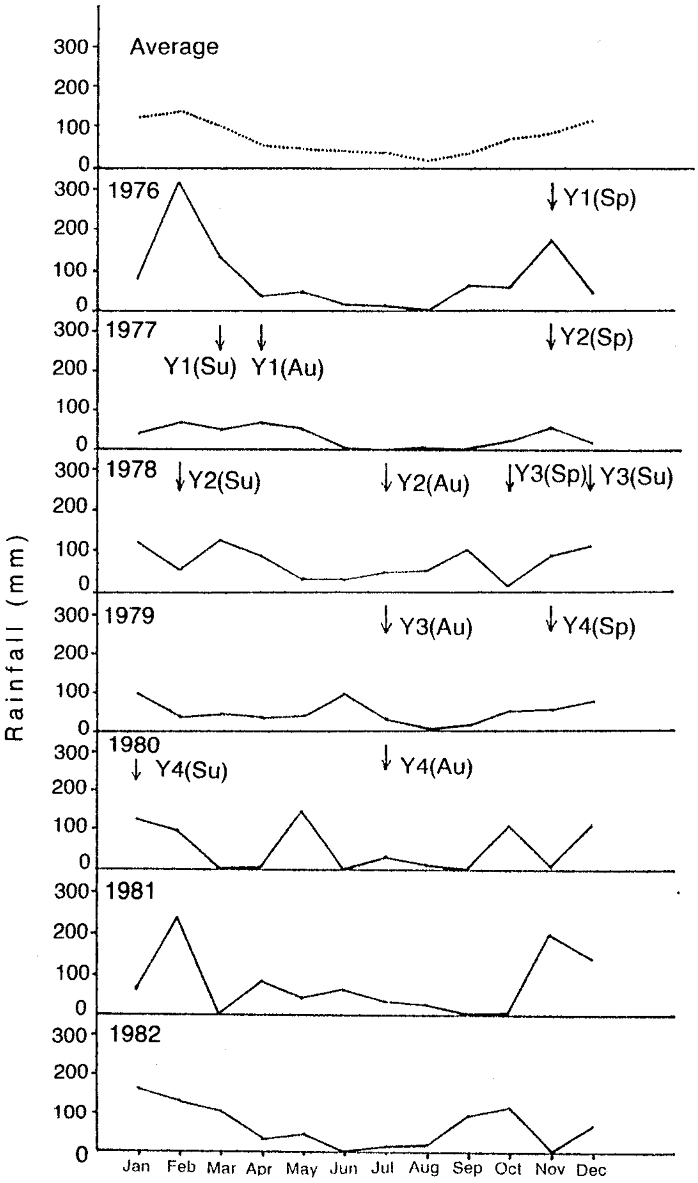

Figure 1. Rainfall for the 7 years 1976-1982 and the 72-year average, received at Toogoolawah, approximately 5 km from the experimental site. The arrows indicate sowing dates for the different years (Y) and seasons (Sp-spring, Su-summer, Au-autumn).

the 'sod-seeding' treatment, the same quantity of seed was concentrated within the disturbed rows, thereby substantially increasing the effective seeding rate. Mo-superphosphate (9% P, 0.02% Mo) was applied at 250 kg/ha at sowing; this was repeated in the spring following establishment and annually thereafter.

Measurements

Establishment plant counts were taken 4 and 12 weeks after sowing for spring and summer sowings, and 4 and 12 weeks after germinating falls of rain in the following spring for the autumn sowings. In subsequent years, a mid-summer plant count of all sowings was taken to determine population change with pasture age. Ten 0.2 m^2, randomly placed quadrats were counted per treatment to determine plant populations.

Dry matter yields were recorded by cutting two 0.9 m x 2.4 m quadrats at 5 cm from each treatment twice a year, once in mid-summer and once in early autumn. After sampling, the areas were defoliated to 5 cm and the excess material removed. Cut material was sorted into native grass, sown Gatton panic, Siratro, other legumes and broadleaved weeds, dried at 80 °C and weighed. Because of the different sowing times, the first harvest from all treatments was determined over different growth periods (Figure 1). Spring sowings had a growth period of 12 to 17 months, summer sowings had a growth period of 11-14 months while autumn sowings had only grown for 6 to 8 months. Subsequent growth periods from any year of sowings were directly comparable.

Rainfall

Rainfall at Toogoolawah, 5 km from the experimental site is presented in Figure 1. The patterns show considerable variation from the 72-year average and between years. Severe moisture stress occurred during late summer and autumn in 1977 and again in spring and early summer 1979. By comparison the summers of 1980, 1981 and 1982 were wetter, allowing more satisfactory growth conditions. Very much higher than the expected rainfall was received in February 1976, May 1980 and February and November 1981.

Results

Plant establishment

The effect of sowing time. No one sowing time proved to be consistently more successful than another for the establishment of Siratro into an established sward of native pasture (Figure 2).

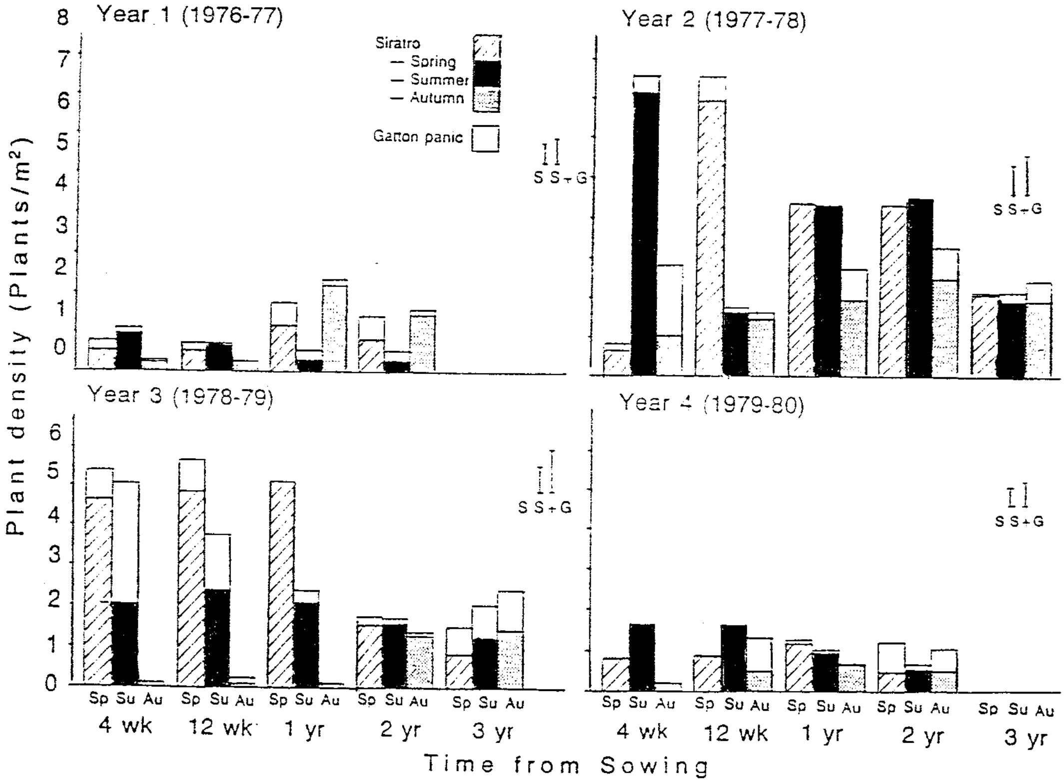

Figure 2. Siratro and Gatton panic plant numbers established at 3 sowing times (Spring, Sp; Summer, Su; Autumn, Au) in 4 consecutive years, and the subsequent plant density changes with time. Bars represent the LSD, P = 0.05, for Siratro (S) and Siratro + Gatton panic (S + G).

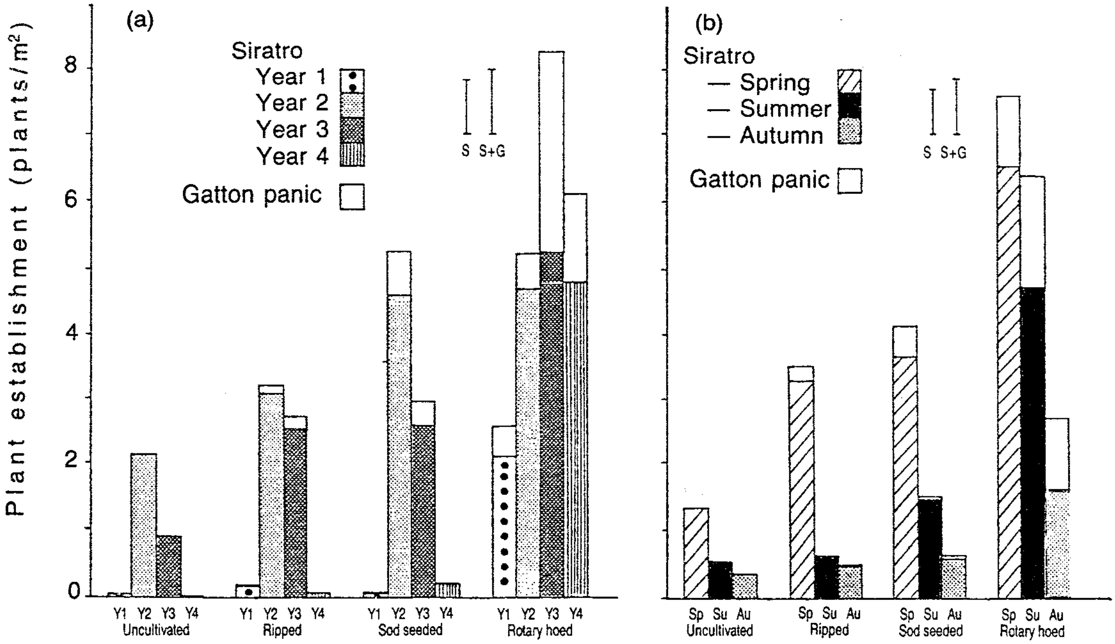

Figure 3. The effect of seedbed preparation and (a) sowing year (averaged for sowing time) or (b) sowing time (averaged over years) on Siratro and Gatton panic seedlings established 12 weeks after sowing for different establishment methods. Bars represent the LSD, P = 0.05, for Siratro (S) and Siratro + Gatton panic (S + G). panic (S + G).

Over the 4 years, establishment of Siratro was equal in spring and summer, with establishment in spring being greater in Year 3, summer being greater in Year 4 and with no difference in Year 1. Year 2 was unusual in that the number of Siratro seedlings increased from 4 to 12 weeks after sowing in spring but, in the summer sowings, counts were higher at 4 weeks. Environmental conditions severely stressed all pastures between 4 and 12 weeks after the summer sowing in that year. Sowing in late autumn always gave inferior plant establishment and, in all but one sowing, Year 2, and the densities achieved were very low (< 0.2 plants/m^2).

Establishment of Gatton panic was generally unacceptably low (< 0.5 plants/m^2). Best establishment occurred in Year 3 with 3 plants/m^2 from the summer sowing, 4 weeks after sowing (Figure 2). This high count was mainly associated with good establishment in the rotary hoed treatment. In Year 3, some establishment of grass occurred in all but the undisturbed (control) treatment (Figure 3). However, plant losses were also considerable; by 12 weeks, most sowings had lost over 50 percent of the originally established populations. In most sowings, there was a small but significant increase in grass plant numbers from the end of the sowing year until the end of the third year.

However, if all years are averaged (Figure 3), then the best establishment of Siratro was achieved in spring, 12 weeks after sowing. On the other hand, Gatton panic establishment was favoured by autumn sowings.

The effect of sowing method. There was no 'sowing method' by 'time of sowing' interaction. As 12 week plant counts gave the most reliable measurement of plant establishment, these data have been used to graphically present the effects of sowing method on establishment of Siratro and Gatton panic (Figure 3).

Rotary hoeing of the native pasture was the most reliable method of introducing Siratro into an existing pasture (Figure 3). In each of the 4 years, the establishment of Siratro was significantly higher from it than from the other methods. Sod seeding gave higher establishment (P < 0.05) than ripping and broadcasting seed in 1 of the 4 years, but in the other years, the 2 techniques produced similar results. Broadcasting seed onto the sward surface without soil disturbance gave similar results to 'ripping' and 'sod-seeding' treatments in 2 years, but in these years legume establishment in all treatments was very low (<0.2 plants/m^2).

Gatton panic was not established without some form of soil disturbance (Figure 3). Some grass was established, with all treatments where soil disturbance occurred, in Years 2 and 3; in Years 1 and 4, establishment of grass only occurred with rotary hoeing.

The effect of seedbed disturbance interacted with season: there was more chance of establishing Siratro with lower soil disturbance (*i.e.* sod seeding or ripping compared to rotary hoeing) in spring than in summer or late autumn. A late autumn sowing gave similar results ($P<0.05$) to summer only if a rotary hoed seedbed was used. Gatton panic was more likely to establish (albeit at very low levels, <0.5 plants/m^2) from a spring sowing than at other times, except for autumn sowings with the rotary hoed seedbed. This latter treatment gave significantly higher Gatton panic establishment than all others except the same seedbed treatment sown in spring.

Persistence

Two years after sowing, Siratro numbers had fallen to below 2 plants/m^2 from all except Year 2 (Figure 2). In most sowings this meant a decrease from the plant density achieved in the establishment year. On the other hand Gatton panic numbers generally increased or remained static over the same period.

Sowing season and method of sowing had no effect on persistence of grass or legume. In the two sowings where data was recorded into the fourth year (i.e. 3 years after the sowing year), Siratro plant numbers continued to fall.

Yield

Establishment period. Because of the different sowing times, a yield comparison between the different sowing time treatments during the

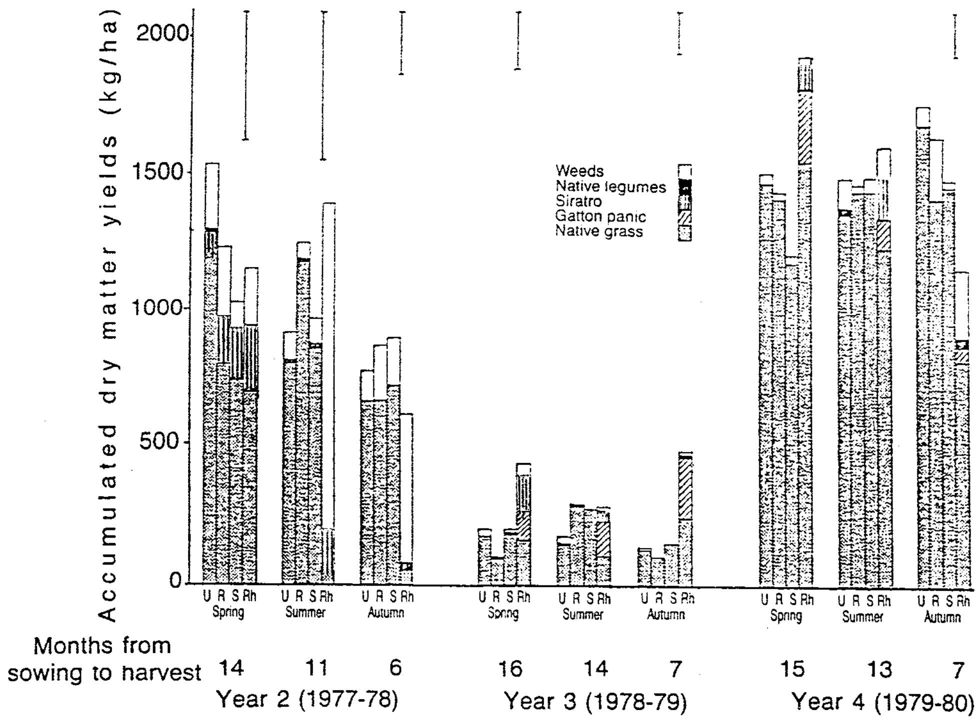

Figure 4. The effect of seedbed preparation and sowing time on the establishment yields of a native pasture oversown with Siratro and Gatton panic for different years of establishment. Seedbed preparation — Uncultivated (U), Ripped (R), Sod seeded (S) and Rotary hoed (Rh). Bars represent the LSD, P = 0.05, for total dry matter yields.

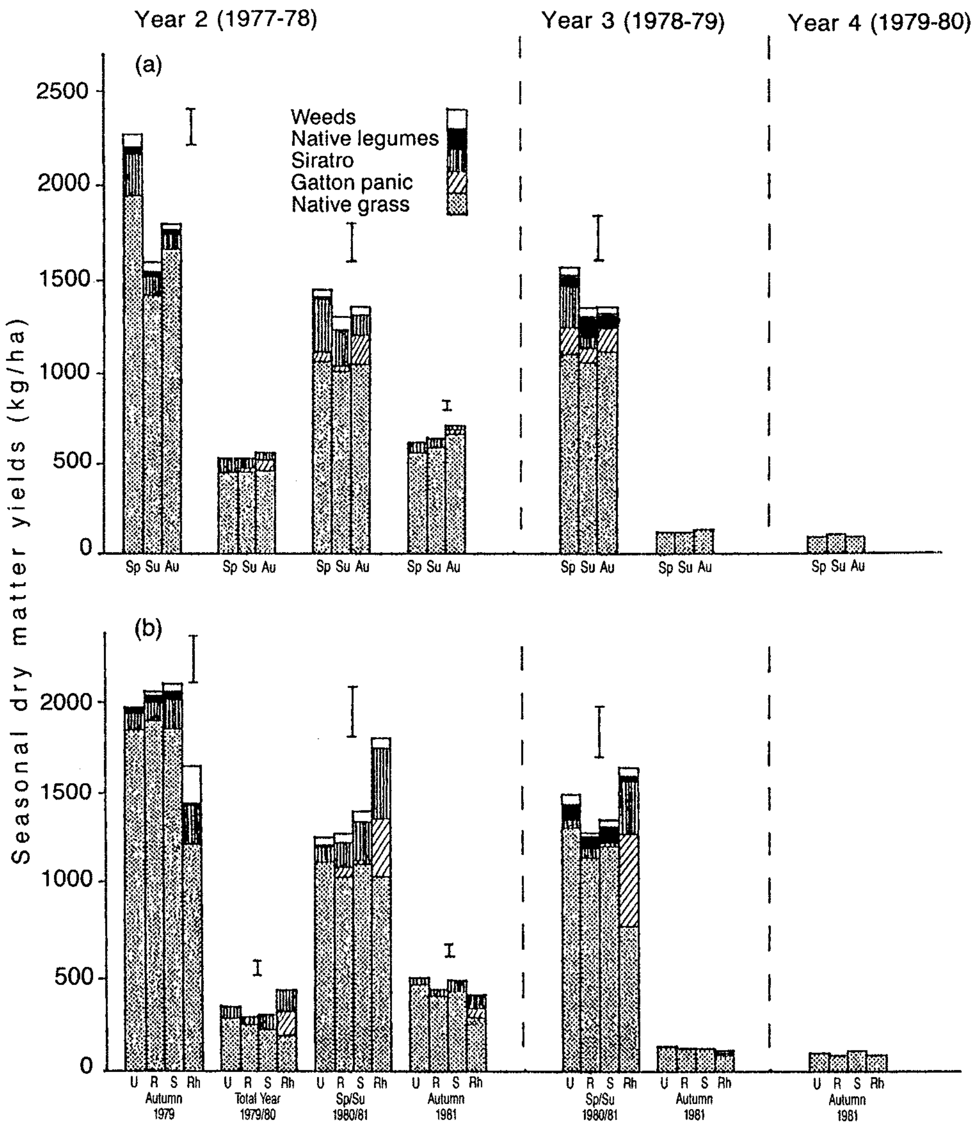

Figure 5. The effect of (a) sowing time and (b) seedbed preparation on subsequent yields (following the establishment period) of a native pasture oversown with Siratro and Gatton panic, for different years of establishment. Seedbed preparation — Uncultivated (U), Ripped (R), Sod seeded (S) and Rotary hoed (Rh). Bars represent the LSD, P = 0.05, for total dry matter yields.

establishment period was not possible. Subsequently, sampling was delayed until the middle of the next growing season in Years 2, 3 and 4 because of the poor growing conditions. Yields were not recorded for the sowings in Year 1 because pastures were open to regular grazing.

Total and native pasture production was unaffected by sowing method in any of the 3 spring sowings (Figure 4). In 2 of the 3 years, Siratro yields were significantly higher ($P < 0.05$) from the rotary hoed treatment compared with the other disturbance treatments. In Year 2, no Gatton panic yield was recorded in any treatment while in Years 3 and 4, it was only recorded in the rotary hoed treatment.

In summer sowings, yield of native pasture was significantly reduced by rotary hoeing in 1 of the 3 years, while in autumn, this reduction occurred in 2 of the 3 years. Siratro yields were significantly higher in the rotary hoed treatments in all 3 years.

Gatton panic again only produced a measurable yield from this cultivation treatment. Rotary hoeing also produced the greatest weed yields ($P < 0.05$) from summer and autumn sowings (Figure 4).

Second and third year production. Native pasture was the major component of all pastures in subsequent yields, although sown components yielded up to 50 percent of the total yield on the rotary hoed treatment on some occasions (Figure 5). The rotary hoed treatment did not begin to outyield the other treatments in Year 2 sowing until the 1979/80 season, 3 years after the pasture had originally been sown. The sown components in this treatment outyielded those from all other sowing method treatments from both the Year 2 and Year 3 sowings in the spring and summer of 1980/81.

Spring sown treatments gave higher yields ($P < 0.05$) than summer and autumn sown treatments in the third year following sowing of both the Year 2 and Year 3 sowings. These differences disappeared in the only experiment (Year 2) to be sampled 4 growing seasons after sowing.

Discussion

Spring was the most reliable time to oversow Siratro into established native pasture in the Brisbane Valley Region although acceptable levels of establishment were sometimes recorded at the other sowing times. Establishment populations of 4 to 8 plants/m^2 were achieved from these sowings. To reliably achieve these population levels, two passes with a rotary hoe were needed and this destroyed about 75 percent of the native grass population. Lower levels of soil disturbance (such as ripping) were less reliable but there was increased establishment from seed placement into the disturbed soil (sod seeding) compared to the seed being broadcast over a ripped sward.

Grass establishment was only successful with maximum soil and vegetation disturbance. All other seedbed methods produced either no establishment or variable results. Even with the best treatments, grass populations 12 weeks after sowing were usually less than 1 plant/m^2. There were indications that autumn sowings may give better grass establishment.

These results agree with those of Cook (1981; 1984) in the more open, black spear grass (*Heteropogon contortus*) dominant swards of the Burnett Region of southern Queensland. Despite different sward structures and soil types, both experiments indicate that weather conditions and seasonal rainfall patterns had an overriding effect on establishment. The establishment populations achieved were remarkably similar; surface broadcasting without soil disturbance achieved a population of 1-2 plants/m^2 by the end of the first growing season in both this experiment and those of Cook (1981; 1984).

The extremely variable weather conditions experienced during the 4-year period of our experiment were similar to those experienced by Cook (1984). He found that failure of seedlings to survive was the main problem encountered. It was this failure to survive which produced the unusual result in Year 2 sowings, where the best establishment at 4 weeks occurred from a summer sowing but at 12 weeks, the best establishment was from the spring sowing. Although there was some early establishment from the spring sowing, the same favourable weather conditions following the summer sowing established good populations in both the earlier spring and the summer sowings. However unfavourable conditions subsequently put added pressure on the overall younger population of the summer sowing.

As a result of the below-average rainfall conditions experienced during the 1980s, established populations were not maintained, and continued to fall up to the beginning of the fourth year. This casts some doubt on the predictions made by Cook and Lowe (1977) that an established population of 1 to 2 plants/m^2 of Siratro would probably be sufficient to achieve a satisfactory population later in the stand life. However, under conditions of above average rainfall conditions in the 1970s, populations were shown to increase (Lowe *et al.* 1977) so perhaps long term population changes are dependent on long term rainfall patterns.

Despite the extremely poor and variable establishment of Gatton panic, subsequent samplings showed increased quantities of Gatton panic in the overall pasture yield. No Gatton panic was measured in yields taken from Year 2 in autumn 1979 but in autumn 1980 (despite the extremely adverse conditions experienced), approximately one third of the total yield of the rotary hoed treatment came from Gatton panic. This is in keeping with the results of Cook (1981; 1984) which showed that grass survival was enhanced only if competition from the native pasture community were reduced by herbicides or defoliation. No grass improvement was demonstrated until our plots began to be regularly defoliated. (i.e. in Year 2, from autumn 1979 onwards).

Substantial soil disturbance had 2 adverse affects on pasture production. Firstly it reduced the vigour of the native pasture component. In the case of summer and autumn cultivations, this reduction was dramatic and long lasting except in Year 3 sowings where weather conditions restricted growth of all pastures. This reduction continued into subsequent seasons, resulting in up to a 3-year depression in yields. Sown pasture components were unable to compensate for this loss until at least the second season after establishment. Secondly, cultivation increased the broadleaf weed component of the pasture (considerably so in some years). The main weeds were balloon cotton bush (*Gomphocarpus physocarpus*), *Sida* spp. and some annual herbs. It took up to 3 years for this weed component to disappear.

Native legumes formed a measurable component in some sowings, particularly Years 2 and 3. These were obviously stimulated by the application of superphosphate to the area but were suppressed when the areas were rotary hoed. However, their contribution was generally small compared to that of Siratro.

Conclusions

Siratro can be reliably introduced into native pasture dominated by blue couch in the Brisbane Valley region of south east Queensland by vigorous renovation that destroys about three-quarters of the original vegetation. Spring sowings were most reliable but good establishment can also be achieved from mid-summer sowings. The inclusion of a grass such as Gatton panic will not always achieve an initially satisfactory population in the sward, but a higher component can be expected to develop in 2 or 3 years provided competition from the other components is reduced by controlled grazing.

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