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THE EFFECT OF STOCKING RATE ON THE POPULATION DYNAMICS OF SIRATRO IN SIRATRO *(MACROPTILIUM ATROPURPUREUM)*/ SETARIA *(SETARIA SPHACELATA)* PASTURES IN SOUTH EAST QUEENSLAND. III. EFFECTS OF SPELLING ON RESTORATION OF SIRATRO IN OVERGRAZED PASTURES

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ABSTRACT

Two experiments in coastal south-east Queensland examined the effect of spelling on Siratro (Macroptilium atropurpureum) *in Siratro/setaria* (Setaria sphacelata) *pastures where yield and density of Siratro were declining. Both experiments involved the use of small exclosures in established, continuously-grazed and set-stocked pastures. In an overgrazed pasture where Siratro and setaria were still the dominant species, both the legume and grass regained full productivity with 1 year's spelling. As overgrazing continued and the pasture degraded further, a longer rest period was required to restore productivity. In the final set of exclosures, the pasture did not fully recover even after 4 years of spelling.*

The second study compared the effects of spelling (a) over the full growing season, (b) the second half of the growing season and (c) the first half of the growing season on a continuously grazed pasture that still had adequate but declining Siratro density. Spelling for the whole growing season increased seed set of Siratro by factors of 14, 5 and 79 in 3 successive years, while spelling for the second half of the growing season increased it by factors of 8, 4 and 25. Spelling also increased the presentation yield of Siratro. The implications of such increases are considered and it is suggested that spelling may be a practical method of maintaining Siratro in pastures.

INTRODUCTION

In previous papers, Jones and Bunch (1988 a,b) described the persistence mechanisms of the tropical legume Siratro (*Macroptilium atropurpureum*) in Siratro/setaria (*Setaria sphacelata*) pastures in coastal south-east Queensland. These studies showed that Siratro can be eliminated from pastures by sustained heavy grazing and that a continued input of new plants to replace dying plants is essential for long-term persistence of the legume. At commercially acceptable stocking rates, this depends on seed being set under grazing and on the successful regeneration of Siratro from reserves of seed in the soil.

Consequently spelling may be a way of restoring declining Siratro pastures. Spelling, while there is still an adequate plant density, should increase legume yield, leading to increased nitrogen input and grass growth and subsequently, to reduced grazing pressure on the legume. Spelling should also increase seed set and could lead to a restoration of legume density, where this had declined below a critical level.

This paper reports the results of 2 experiments which used exclosures within a long term grazing trial. The first study examined the effect, on pasture composition, of spelling for up to 4 years. The second examined the effect of shorter term seasonal spelling on yield and seed set of Siratro.

METHODS AND RESULTS

Experiment 1—Methods

The grazing trial was sown at Samford Research station in south-east Queensland (27°22′S, 152°53′E, AAR 1100 mm) in 1968 and grazing commenced in 1969; further details are given by Jones and Bunch (1988 a). This study was carried out on a continuously grazed pasture, set stocked at 3 heifers/ha from 1969 to 1973 and at 2 heifers/ha thereafter. Three exclosures of 1.5 × 1.5 m were erected in autumn (May) 1973. A quadrat of 1 × 0.5 m was cut to 2 cm above ground level adjacent to each cage and sorted into green Siratro, setaria, blue couch (*Digitaria didactyla*) and other species, and dead material of all species. In May of each of the next 4 years, accumulated growth over the 12-month period and botanical composition within the exclosure was measured by cutting, to 2 cm, growth within a centrally placed 1 × 0.5 m quadrat. Adjacent quadrats were cut outside in the grazed pastures. After 4 growing seasons the cages were removed. Further sets of 3 exclosures were placed out every second year after May 1973 until 1983. Hence at any one time after 1975 there were areas that had been exclosed for either 1 and 3 years, or for 2 and 4 years. Yield and botanical composition inside and outside the cages were compared to gauge the pasture response to spelling.

Experiment 1—Results

The presentation yields and the Siratro density of the grazed pasture are given in Table 1. From 1973 to 1976, Setaria outyielded blue couch and other species, but thereafter its yields were negligible. Siratro density progressively declined from 3.2 plants/m^2 (1975) to zero (1985). The higher yields in the grazed pasture in 1982 and 1983 were primarily composed of blue couch and followed above average summer rainfall in 1981 and 1982, compared with below average rainfall from 1977 to 1980 and from 1983 to 1985 (Jones and Bunch 1988 a).

TABLE 1

*Presentation yields in autumn (May) of components of an overgrazed pasture, initially sown to Siratro and setaria in 1969. Also presented is the density of Siratro plants within the grazed pasture.**

Year	Yields						Siratro density
	Litter	Siratro	Setaria	Couch	Other species	Total	
	(kg DM/ha)						(plants/m^2)
1973	816	16	524	118	26	1500	1.7
1975	8	0	7	0	6	21	3.2
1976	124	13	269	98	39	544	2.6
1977	282	0	99	361	43	785	1.1
1978	4	0	0	4	2	10	0.9
1979	0	1	0	31	141	173	1.5
1980	180	0	0	80	287	587	0.4
1981	82	0	0	300	321	703	0.2
1982	1790	8	9	1655	814	4276	0.1
1983	1678	0	0	1491	634	3803	0.0
1984	998	0	0	548	610	2156	0.0
1985	222	0	0	94	217	533	0.0

* Siratro density as measured in November of that calendar year (Jones and Bunch 1988 a).
No yield data collected in 1974.

TABLE 2

Annual yields (kg DM/ha) in autumn of green Siratro, setaria, blue couch and other weeds in caged exclosures. A new set of cages was placed out in autumn (May) every 2 years and left for 4 years

Cage erected	Year when yield was measured											
	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	(kg DM/ha)											
Siratro												
1973	NM	1717	1820	2000	—	—	—	—	—	—	—	—
1975			1367	1547	2287	2448	—	—	—	—	—	—
1977				∅	855	829	1215	2020	—	—	—	—
1979						*	260	1013	1610	1445	—	—
1981									117	81	240	280
1983									∅	*	13	0
Setaria												
1973	NM	2346	3467	2868	—	—	—	—	—	—	—	—
1975			3040	2202	2625	2606	—	—	—	—	—	—
1977					289	1053	1683	3999	—	—	—	—
1979					*		41	1022	2331	3521	—	—
1981							*	*	293	191	1450	1357
1983									*	*	28	72
Blue couch												
1973	NM	0	0	0	—	—	—	—	—	—	—	—
1975			913	298	35	0	—	—	—	—	—	—
1977			**		880	673	633	57	—	—	—	—
1979					*	**	833	1286	957	194	—	—
1981								*	2870	1543	1676	522
1983									∅		2207	1600
Other species												
1973	NM	0	0	0	—	—	—	—	—	—	—	—
1975			0	0	0	0	—	—	—	—	—	—
1977					49	20	10	0	—	—	—	—
1979							644	150	43	13	—	—
1981							**	**	1224	417	482	241
1983									**	*	1592	1351

NM – not measured.
∅ * ** – difference between 1 and 3 or between 2 and 4 year caged areas significant to $P < 0.1$, 0.05 and 0.01 on 1 harvest date.
— cages were removed after 4 years

The yields of the main species within the exclosures are given in Table 2. Although yields were accumulated over a 12-month period (May to May), most growth occurred between October and May. In the exclosures placed out in 1973 and 1975, setaria and Siratro recovered within 1 year. In the 1975 exclosures there was some blue couch remaining after 2 years, but this had virtually disappeared by 3 years. In the 1977 and 1979 exclosures, blue couch was still dominant, or nearly so, after 1 year's spelling; Siratro and setaria slowly recovered to be the dominant species in the third and fourth year although blue couch was still present. In the cages placed out in 1981 Siratro yields marginally improved but were always low, and setaria only regained dominance over blue couch in the fourth year. The main species in the 'other species' component, averaging over the inside and outside of exclosures, were *Axonopus affinis* (68%), *Desmodium triflorum* (13%) and *Paspalum notatum* (9%).

Experiment 2—Methods

This study was carried out between 1980 and 1983 within the same grazing experiment in an established continuously grazed pasture, set-stocked at 1.7 heifers/ha. Siratro density declined over this period (Jones and Bunch 1988 a) although the pasture was relatively weed free.

Yields and seed set of Siratro in the continuously grazed (control) pasture were compared with those resulting from:

(a) Spelling within exclosures for the full growing season (beginning of September to end of May).
(b) Paddock grazing in the first half of the growing season (beginning of September to mid January), followed by spelling to the end of May.
(c) Spelling for the first half of the growing season, followed by grazing.

In the control, fixed quadrats of 1 m^2 were marked by short 5 × 5 cm pegs driven to ground level. The same size quadrats were used in treatments (a), (b) and (c) except that the quadrat was protected as appropriate by a wire exclosure. There were 4 replicates of each treatment. The experiment was repeated for 3 years, using different sites in each year.

Yields were measured at the beginning of June, (except for treatment (c) which was sampled in January) by cutting to 2 cm above ground level and sorting into Siratro (green and dead), setaria (green and dead), blue couch, other dicots and other monocots. Yield of the grazed pasture was also measured in January, using randomly sited quadrats. Whenever Siratro was seeding, the quadrats were inspected every 2 or 3 days. Ripe pods were removed and allowed to dehisce in paper bags to measure total seed production. At the same time ripe pods were also removed from a border around the fixed quadrats under grazing to prevent Siratro stems bearing pods being dragged into the fixed quadrat by grazing cattle.

Experiment 2—Results

In January the yield of Siratro in the grazed pasture was always lower than that spelled from September to January. The respective Siratro yields were 121 and 525 kg/ha (1981), 455 and 747 kg/ha (1982) and 100 and 892 kg/ha (1983).

Yields of both Siratro and setaria at the end of the growing season were increased by spelling from January to May and further increased by the longer spelling from September to May (Table 3). The yield of Siratro in the grazed pasture was much lower in 1983 than in 1981 or 1982. The percentage of dead material in the total Siratro yield was higher with the 9 months exclosure (average of 30% over 3 years) than with late season (19%) or no spelling (18%). During this study the density of Siratro crowns on the grazed pasture, as measured in November, fell from 12.8 (1981) to 7.7 (1982) and 4.3 plants/m^2 (1983) (Jones and Bunch 1988 a). The yields of 'other species' were always low, with a peak of 8% during 1983 in treatment (c).

TABLE 3

Effect of spelling on end of season presentation yield (kg DM/ha) of Siratro and setaria (green and dead) in a set-stocked (1.7 heifers/ha) and continuously grazed Siratro-setaria pasture at Samford (1981–3).

Species and year	Sept-Jan: Jan-May:	Treatments Grazed Grazed	Grazed Spelled	Spelled Spelled	LSD (P = 0.05)
		(kg DM/ha)			
Siratro					
1981		485	1241	1494	518
1982		1337	2336	3523	1218
1983		103	560	1396	691
Setaria					
1981		2865	5092	8401	1364
1982		4347	5677	9255	2616
1983		2717	5267	10334	3203

Seed set in spring and early summer was negligible in the treatments grazed during this period (Table 4). More seed was set during spring with spelling, but even then no seed was set in 1982. Seed set in autumn was much higher than in spring on both grazed and spelled areas. Compared with seed set under grazing, 12 times as much was set by pastures rested for the latter half of the growing season and 33 times as much by pastures rested for the whole year. The greatest effect of the season-long spelling occurred in 1983; corresponding factors for the mean of 1981 and 1982 are 5.6 (January to May) and 9.1 (September to May).

TABLE 4

Effect of spelling on seed set of Siratro in a set-stocked (1.7 heifers/ha) and continuously grazed Siratro-setaria pasture at Samford.

Treatment: Sept to Jan	Jan to May	Seed set during: Early season (Sept-Jan)	Late season (Jan-May)	Full season (Sept-May)
			(seeds/m^2)	
1981				
Grazed	grazed	0	56 (1.73)Ø	56 (1.73)
Grazed	spelled	0	427 (2.60)	427 (2.60)
Spelled	spelled	178	613 (2.70)	791 (2.86)
LSD (P = 0.05)			(0.30)	(0.34)
1982				
Grazed	grazed	0	70 (1.66)	70 (1.66)
Grazed	spelled	0	249 (2.39)	249 (2.39)
Spelled	spelled	0	338 (2.44)	338 (2.44)
LSD (P = 0.05)			(0.62)	(0.62)
1983				
Grazed	grazed	2	0 (0.00)	2 (0.24)
Grazed	spelled	2	48 (0.79)	50 (0.79)
Spelled	spelled	52	107 (1.60)	159 (2.18)
LSD (P = 0.05)			(1.24)	(1.17)

Ø Log transformations given in parentheses.

DISCUSSION

The results show that, provided sufficient plants are present, spelling of Siratro and setaria can allow these plants to regain dominance in a formerly overgrazed pasture. This is in accord with previous experience with Siratro (Jones 1979) and with *Neonotonia wightii* cv. Tinaroo (Davison and Brown 1985), a legume with a similar growth habit to Siratro. When overgrazing severely reduced the density and vigour of the sown species, and prostrate species such as blue couch have invaded, the pasture needed to be spelled for more than 1 year to regain its productivity and botanical composition. Such long-term spelling of more than 1 growing season would not be acceptable to graziers. With continued overgrazing pastures eventually reach a point where the sown species cannot be restored as there would be an insufficient density of plants and soil seed reserves.

No measurements were made of the effect of spelling on individual plants in these experiments. However other studies suggest that reduction or cessation of defoliation could enhance the survival of established plants (Jones and Bunch 1988 a) and improve plant density following increased seeding (Jones and Bunch 1988 b).

When there was still good Siratro density, spelling for even the latter half of the growing season increased legume presentation yield and seed set of Siratro. The relative increase in seed set from Siratro resulting from spelling, compared to the continuously grazed pastures, was most marked when seed input in the grazed pasture was lowest. In a study at Narayen, in subcoastal south-east Queensland, Tessel (1983) found a 30–60 fold increase in the number of Siratro flowers and pods after 3 months spelling in late summer compared with a continuously grazed pasture having the same density of Siratro plants.

In a previous study, Jones (1981) found that only 35% of Siratro seed hand broadcast onto a short, overgrazed pasture at Samford was recovered as seedlings or as soil seed. This was attributed to predation, rotting of soft seed and losses during germination. While this result would not apply to all situations, it helps to show why the extra seed obtained from spelling could be an effective way of maintaining adequate soil seed reserves and, in turn, an adequate density of legume. From 1972 to 1978 approximately 2 new plants/m^2/year were required to maintain a stable legume density in the paddock stocked at 1.7 heifers/ha (Jones and Bunch 1988 a). This required the emergence of some 20 seedlings/m^2 during the previous year (Jones and Bunch 1988 b). Assuming the 65% loss referred to previously, this would require, as a long term average, a set of 60 seeds/m^2/year to maintain the Siratro stand. An even higher seed loss would be expected on a more leniently grazed pasture (Jones and Bunch 1988 b). Thus the seed set under grazing may have been marginally adequate in 1981 and 1982 (56 and 70 seed/m^2) but was grossly inadequate in 1983 (2 seeds/m^2). In contrast, the increases in seed set following spelling (Table 4) could increase seed reserves enough to improve Siratro plant density.

Siratro has rarely been sown over more than 25% of the relatively few properties where it has been widely sown. Therefore spelling pastures during autumn can be a practical proposition, as the quantity of feed on beef cattle properties in south-east Queensland is not usually limiting in this period. In contrast, feed is usually scarcest in spring and spelling at that time would be unacceptable; even apart from the fact that spelling during this period is of less benefit. Spelling would be most efficiently carried out in a year when rainfall was sufficient to give reasonable yields by late summer, with expectation of continued growth and good seed set. In such years there should be little problem of finding acceptable areas of alternative feed. The feasibility of spelling may also depend on the local farming system; spelling Siratro for seed set in Thailand fits in particularly well with the traditional alternative feed sources for cattle (Gutteridge 1985). One disadvantage of autumn spelling in south-east Queensland is that it could result in wastage of Siratro in terms of ingestion by cattle, as early frosting could result in shedding of leaves before the pasture had been grazed at the end of the spell. However the pasture would still benefit from the extra nitrogen fixation and organic matter return following spelling (Filet and Tothill 1984).

Spelling would not be necessary in every year. The frequency required would depend on such factors as the density of plants, soil seed reserves and the sequence of years with good or poor rainfall (Jones and Bunch 1988 a, b).

The problems of Siratro persistence in commercial pastures in southern Queensland have been documented by Brown (1983). Spelling may alleviate some of these problems, while cultivation treatments (Bishop *et al.* 1981) could be used to stimulate germination of the increased soil seed reserves following spelling. Partial destruction of the existing sward by cultivation would also aid survival of seedlings by reducing competition.

The studies on spelling were a logical outcome of the detailed studies on Siratro persistence (Jones and Bunch 1988 a, b) and the possibility of using demographic measurements to develop improved management strategies for pastures has been discussed in a wider context by Jones (1986). The use of small exclosures within grazed pastures proved to be an easy and effective way of investigating the immediate benefits of pasture spelling. However, it would be impossible to use such exclosures to measure the residual benefit of spelling once the exclosures are removed, as grazing on such areas is initially quite atypical of that of the remainder of the pasture.

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RESISTANCE OF SOME *LEUCAENA* SPECIES TO THE LEUCAENA PSYLLID

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ABSTRACT

Twenty lines representing 4 Leucaena *species* (L. leucocephala, L. diversifolia, L. collinsii, L. pallida) *were screened for resistance to the leucaena psyllid by placing potted seedlings in an infested field planting of* L. leucocephala. *Estimates of numbers of adult psyllids, egg numbers, nymph numbers, and plant damage were recorded. All 4* L. leucocephala *lines were susceptible.* L. collinsii *had least damage. All species were damaged to some extent, but there were differences between accessions within* L. diversifolia, L. collinsii, *and* L. pallida. *All estimates of psyllid susceptibility were well correlated.*