MEAT & LIVESTOCK AUSTRALIA

On farm

Managing Native Pastures and Stylo

Project number NAP3.221

Report prepared for MLA by:
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ABSTRACT

A field experiment in semi-arid north Queensland using combinations of stocking rates, wet-season spelling, fire, and seeding with exotic grasses evaluated management options to restore stable grass-legume pasture systems previously dominated by the stylo component. In addition, 19 commercial stylo-based pastures in the Einasleigh and Burdekin regions were monitored to document the extent and dynamics of the stylo component.

At light stocking rates only spelling was required to restore native 3P grass (perennial, productive, palatable) yields to natural levels (1200 – 1500 kg DM/ha), but they comprised only 10% of total yield. Such a light stocking regime is impractical in commercial situations. At medium stocking rates, burning was necessary to restore the native 3P grass component and there was a further significant response to spelling. Stable native grass-stylo systems with a grass component of 30% to 50% of total yield were achieved. At heavy stocking rates spelling was ineffective in restoring native 3P grasses. All systems were initially resistant to change and there was little response until seasonal rainfall events were in the average range or above.

Established exotic grasses (predominantly Indian couch and *Urochloa*) reached >30% of total yield across all treatments after 2 years. The *Urochloa* component declined and the Indian couch component increased with time. After 8 years, only the burn-spell treatment at medium stocking rate maintained a sown grass component near 50% of total yield.

The mean stylo component of commercial stylo augmented pastures increased from 4% to 31% over 5 years in pastures <10 years old whereas in pastures >10 years old there was no change over 3 years with a mean stylo component of 61%.

EXECUTIVE SUMMARY

Background

Legumes from the genus *Stylosanthes* have been successfully sown into at least 600,000 ha of northern Australian pasture lands and a further 60,000ha is sown annually. Native pasture yields on light textured, largely phosphorus deficient soils across north Queensland are approximately 1000–2000 kg DM/ha depending on amount and distribution of seasonal rainfall. Stylos are less affected than native grass to the seasonal conditions and, under usual grazing conditions can add a further 1000-2000 kg DM/ha of forage. The grass component of grazed, stable stylo-native grass pastures then should yield >1000 kg DM/ha and represent 30% to 50% of total pasture yield.

The long-term stability of native pastures oversown with stylo is in question after observations of stylo dominating pastures to the exclusion of perennial native grasses. This potentially increases the risk of weed invasion, accelerated soil erosion, increased variability in animal production, and soil acidification.

We established a field experiment to compare the relative effectiveness of combinations of burning (burn, no burn), wet season spelling (no spell, spell) and stocking rate (5.25, 3.5 and 1.75 ha/head) for restoring the 3P grass (perennial, productive, palatable) component in an existing stylo-dominant pasture. An additional combination evaluated the effects of cultivation, fertilisation and establishment of introduced improved grasses. The composition and vigour of a wide sample of commercial stylo pastures were also monitored to survey the dynamics of the pasture components over time.

Achievements

We have shown that the 3P grass component of degraded stylo-augmented native pasture systems can be restored using a combination of burning and spelling even though seed reserves were very low. There was, however, little response until seasonal rainfall events were in the average or above range.

At light stocking rates (5.25 ha/head but 3.5 ha/head for year 2000) only a spelling program was needed to rehabilitate the 3P grass yield to natural levels (although only 10% of total DM yield) even though yields of stylo in the pasture reached very high levels. Burning without spelling was largely ineffective in restoring the 3P grass component although the total grass component improved as a result of higher yields of increaser grasses (unpalatable species whose composition increases as grazing pressure increases). We showed that, at medium stocking rates (3.5 ha/head but 2.3 ha/head for year 2000), burning to reduce stylo competition resulted in a significant improvement in yields of 3P grasses and that there was a further improvement from spelling. There was no improvement in 3P or total grass yield at the heavy stocking rate (1.75 ha/head but 1.2 ha/head for 2000) despite annual spelling for 8 years.

Burning effectively reduced the yield of stylo with the major effect being on the seca rather than the verano component. Yields of stylo in unburnt paddocks reached 8200 kg DM/ha at the end of the 1999 growing season compared with 3600 kg DM/ha in burnt paddocks. If a grass component of 30% to 50% is the aim for stable and productive native grass-stylo systems then this can only be achieved with a burning program to reduce stylo competition regardless of stocking rate.

We have shown that sowing introduced improved pastures is also a technically available option for restoring a stable grass/legume balance. Again burning and spelling were necessary to gain and maintain a stable grass/legume balance. It is possible, though, that an ongoing fertiliser program may be necessary to retain the suite of species sown here. On the other hand the proportion of Indian couch increased with time and it eventually would have dominated the grass component without additional fertiliser.

The stylo component of commercial pastures sown less than 10 years old increased with time up to 31% whereas those sown 10 to 20 years previously were generally stable over the survey period at approximately 61%. These pastures experienced the usual range of grazing practices for the area.

Industry benefits

Grazing land managers already recognise the inherent instability of stylo dominant pastures or those in which the yield of the native grass component has been reduced to a minimal level. Managers, however, are reluctant to impose management variation in the absence of clear demonstration of the effectiveness of those variations to achieve the desired results in pasture restoration. We have demonstrated the effectiveness of burning and spelling as management tools available to rehabilitate degraded pastures by either restoring the 3P grass component or by replacing the native grass component with introduced improved grasses.

It is apparent that little restoration occurs in years of below average rainfall and this opens the prospect of planning spelling and burning options around periods when the Southern Oscillation Index suggests that average or above average wet seasons are more probable.

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BACKGROUND

Legumes from the genus *Stylosanthes* have been successfully sown into at least 600,000ha of northern Australian pasture lands and a further 60,000ha is sown annually (Miller *et al* 1997). Beef cattle grazing native pastures augmented with stylos (mainly *Stylosanthes scabra* cv. Seca and *S hamata* cv. Verano) produce higher annual weight gains, improved weaner and heifer nutrition and have reduced drought risk compared to animals grazing native pastures alone (Gillard and Winter 1984, Coates *et al* 1997).

There is, however, concern over the long-term stability of native pastures oversown with stylo, due mainly to observations of stylo dominating pastures to the exclusion of perennial native grasses (Jones *et al* 1997). This in turn increases the risk of weed invasion, accelerated soil erosion, increased variability in animal production, and soil acidification.

Native perennial grasses are displaced by stylo because of (1) increased grazing pressure on grasses during the growing season reducing their ability to seed and (2) competition from stylo plants. Varying the overall grazing pressure and wet-season spelling are two options for restoring native grasses. Fire kills at least some stylo plants and intermittent burning therefore offers a potentially potent way of managing the balance of native grass and stylo. Orr *et al* (1991) demonstrated successful rehabilitation of black speargrass pastures (a 3P grass) degraded by invasion of wiregrass (an increaser grass) using a combination of burning and spelling. Paddock spelling over summer strengthens individual grass tussocks and allows a heavier seed set. As well, new grass seedlings have an opportunity to establish. An alternative strategy is replacement of the grass component with introduced grass species that may compete and persist better under current management.

A field experiment was established to compare the relative effectiveness of combinations of these options for restoring the grass component in an existing stylo-dominant pasture. The composition and vigour of a wide sample of commercial stylo pastures were also monitored to survey the dynamics of stylo/grass pastures.

OBJECTIVES

Identify and communicate practical methods of maintaining a balance of grass and legumes in oversown native pastures by:

- Developing management systems (including fire, grazing and spelling) for maintaining native perennial grasses in pasture.
- Developing methods for introducing and managing sown grasses into stylo-dominant pastures.
- Assessing the economic benefits of different production systems.
- Communicating and promoting management practices encouraging stability and productivity of oversown pastures such that: a) all agency staff, agribusiness personnel and livestock producers are aware by the year 2000, and b) ‘best bet’ management practices are adopted by stylo users by the year 2001.

METHODS

The field experiment commenced in 1993 on the property of Mr Neil Davis on Eureka Creek, west of Dimbulah (17°11'S, 145°01'E, elevation 480m). The soil is predominately a greyish-brown sandy loam grading to yellowish-brown sandy light clay with metamorphosed rock at 75cm. The 15ha area is part of a native pasture paddock sown to seca and verano in 1982. By 1993, the pasture was dominated by the stylos with little grass remaining.

The vegetation was dominated by box (*Eucalyptus leptophleba*), tea tree (*Melaleuca stenostachya*) and bloodwood (*Eucalyptus clarksoniana*) which were chain pulled in 1988 but not stick raked until immediately prior to the commencement of the trial in 1993. Soil disturbance from the raking appeared minimal. Regrowth was spot sprayed in 1996 with further minor sprayings in 1997 and 1998.

Treatments consisted of combinations of 3 stocking rates (light, medium, heavy), 2 fire regimes (unburnt, burnt annually) and 2 spelling treatments (unspelled, spelled) applied to the existing standing pasture (called native pasture) and to sown pasture established after cultivation, fertiliser and seeding (called sown pasture). To maximise treatment numbers on the limited area, sown grasses were established into 10% of each of the native pasture paddocks.

Some combinations were excluded as unrealistic. In the light stocking rate array, the burn-no spell treatment was omitted on the basis that speargrass would flower and seed each year in any event and fuel for a fire would not be a problem. Similarly, the no burn-spell treatment was omitted because there would be excessive fuel and wildfires would be a problem. Similarly, in the heavy stocking rate array the burning combinations were omitted because there would never be sufficient fuel for an effective fire and the no burn-no spell combination was omitted as being unrealistically destructive. The full treatment list is shown in Table 1. Paddock layout and size are shown in Figure 1. There were 2 replicates of each treatment.

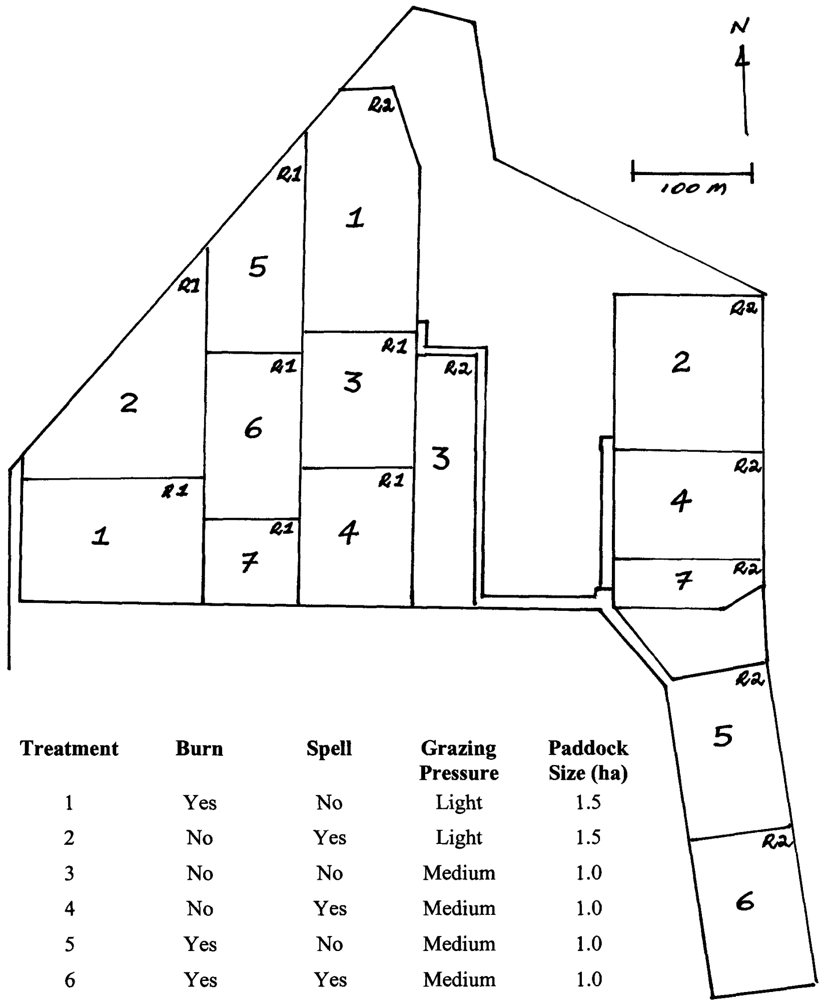
Table 1. Grazing, burning and spelling treatments imposed at the experimental site.

Treatment	Stocking Rate (ha/head)	Early Wet Season Burn	Wet Season Spell
1	5.25 and 3.5* (light)	Burn	No spell
2	5.25 and 3.5* (light)	No burn	Spell
3	3.5 and 2.3* (Medium)	No burn	No spell
4	3.5 and 2.3* (Medium)	No burn	Spell
5	3.5 and 2.3* (Medium)	Burn	No spell
6	3.5 and 2.3* (Medium)	Burn	Spell
7	1.75 and 1.2* (Heavy)	No burn	Spell

* Original stocking rate treatments were increased by 50% on 20 December 1999 for the - 2000 grazing period but the original stocking rates were reapplied on 29 January 2001 for the final grazing period.

Paddock size for each combination was reduced to fit the number of treatments into the area and grazing time compressed to 1 day/week with 2 animals/cell. Grazing for each week was completed over 3 days after which the animals were removed to adjacent common grazing. A new draft of Brahman cross animals was introduced each year. Mean starting liveweight was c.200kg (0.44 adult equivalent). In December 1999 all stocking treatments were increased by 50% by introducing 3 animals per grazing period to increase the pasture utilisation rate but the original stocking rates (2 animals per cell) were re-established for the 2000 – 2001 grazing period. The experiment closed at the end of May 2001.

Figure 1. Paddock layout and treatments at the Eureka Creek site.



Treatment	Burn	Spell	Grazing Pressure	Paddock Size (ha)
1	Yes	No	Light	1.5
2	No	Yes	Light	1.5
3	No	No	Medium	1.0
4	No	Yes	Medium	1.0
5	Yes	No	Medium	1.0
6	Yes	Yes	Medium	1.0
7	No	Yes	Heavy	0.5

In each paddock, 10% of the area was cultivated, using tandem discs, to provide a rough but reasonable seedbed. The cultivated area was fertilised with a commercial fertiliser (containing 17.3% P, 9.5% S, 14.3% Ca) at 7.5kg P/ha. Seed of the introduced grasses *Urochloa mosambicensis* cv. Nixon (Sabi grass), *Bothriochloa pertusa* (Indian couch) and *Cenchrus ciliaris* (US buffel) were sown at 10kg pelleted seed/ha, 3kg seed/ha and 6kg pelleted seed/ha respectively on 17 December, 1993. The heavy seed rates and fertiliser were meant to promote rapid and successful pasture establishment. However, initial establishment failed and half of each original sown area was recultivated and resown on 15-16 December, 1994 with unpelleted seed at 3 kg/ha, 2 kg/ha and 3 kg/ha for *Urochloa*, Indian couch and US buffel respectively. As well, a further 10kg P/ha was applied as superphosphate (9% P, 10% S, 20% Ca) to the recultivated area. The combined plantings successfully established.

The whole trail area was spelled over the 1993/94 wet season and grazing commenced at the end of April 1994. Drought conditions forced the destocking of the trial from December 1994 until mid January 1995 during which period the cattle were fed hay.

Spelled paddocks were destocked from the break of the wet season until black speargrass plants began flowering. Designated paddocks were spelled from 3 January until 5 March, 1995 (9 weeks), from 28 November, 1995 until 19 February, 1996 (12 weeks), from 2 January until 10 March, 1997 (11 weeks), from 18 December, 1997 until 2 march, 1998 (10.5 weeks), from 9 November, 1998 until 11 January, 1999 (9 weeks), from November 10, 2000 until 29 January, 2001 (11 weeks). In the first week of September 1999 a hot, wildfire burnt out all paddocks and cattle were not reintroduced until 20 December 1999 (15.7 weeks spell for all). This wildfire occurred before the break in the season and was hotter than normal early wet season fires. It killed tree regrowth and seca plants to below ground level.

Rainfall measurements were collected on site usually daily but with up to 72 hours between recordings over weekends.

Pasture dry matter yields (kg DM/ha), species composition (% of total yield) and plant frequency (% occurrence in 0.5m X 0.5m quadrats) were calculated at the beginning of the wet season, the end of the spelling period and the end of the growing season using the Botanal technique (Campbell and Arnold, 1973). Pasture species were subdivided into 7 functional groups to reduce the complexity in understanding changes in pasture yields and composition. These groupings are shown in Table 2.

Table 2. The distribution of pasture species in groups according to their form and function in the pasture.

3P Grasses	Increaser Grasses	Other Grasses
Kangaroo Grass	Wire grasses	Cockatoo grasses
Black Speargrass	Native couch	Reed grass
Giant Speargrass	Native Rhodes	*Brachiaria* spp.
Forest Bluegrass	Button grasses	Citronella grass
Queensland Bluegrass	Bottlewasher grasses	Barbed wire grass
Golden Beard grass	Wanderrie grass	Summer grasses
Brown top	Love grass	Red Natal grass
	Barnyard grass	*Panicum* spp.
	Firegrass	Pigeon grasses
	Mnesthia formosa.	Native sorghum
	Comet grass	Grader grass
	Fairy grass	*Yakirra* sp.
		Whiteochloa sp.
		Other unidentified grasses

Stylo	Sown Grass	Native Legumes
Seca stylo	Indian Couch (Bowen)	*Flemingia* sp.
Verano Stylo	Nixon *Urochloa*	*Indigofera* sp.
Seca/Verano hybrid	US buffel	Other unidentified legumes

Forbs and Sedges
Spurges
Fimbristylis
Emu berry
Mitracarpus hirtus
Lilies
Pterocaulon sp
Sida spp.
Other unidentified forbs
Other unidentified sedges

Soil seed reserves were measured in the 0-5cm profile averaged over the trial area on 28 October 1993 and for individual treatments on 1 December 1994. In 1993, 100 cores, each 6.8cm diameter, were bulked before being divided and added to 150 pots. Soil seed was germinated and allowed to grow out for positive identification and then converted back to number of seeds per m^2. In 1994, soil samples from each paddock were added to 10 pots and seed allowed to grow out for identification.

Representative surface soil samples (0-10 cm) were collected across discrete areas of the trial site from uncultivated and unfertilised areas only in April 1994, February 1995 and November 1999 for nutrient analysis. Samples were analysed for pH, electrical conductivity, bicarbonate extractable phosphorus, calcium, magnesium and potassium.

Nineteen commercial, predominantly stylo-augmented pastures were sampled using the Botanal technique in 1995, 1998 and some in 2000 to survey species dynamics over that period.

RESULTS AND DISCUSSION

Soil chemical attributes

Soil P_b levels were lower than that required for near maximum stylo yields (8 mg/kg) (Shaw et al 1994). Moreover, the analyses in 1995 and 1999 (Table 3) suggest that the original analyses in 1994 (mean 6 mg/kg) were in error or that soil disturbance from stick raking could have mobilised organic P to that extent. At a nearby site Shaw et al (1994) found that established stylo growing where soil P_b levels of 2 mg/kg were capable of producing 40% of total potential yield. That level however, would be expected to severely reduce yield potential of sown grasses – particularly *Urochloa* and buffel which have high P requirements (McIvor 1984).

Soil pH and cation levels were within a range where they would not impact on stylo or grass production.

Although soil samples were not collected from sown areas, residual soil P_b levels can be predicted using models described by Gilbert (1989). Assuming that the starting soil P level was 3 mg/kg in undisturbed pasture then levels would have increased to 6.6 mg/kg after the 2nd fertiliser application (December 1994) before declining over time to 4.0 mg/kg at the conclusion of the experiment.

Table 3. Some chemical attributes of unfertilised surface soil (0-10 cm) meaned across the trial site on 3 occasions throughout the experimental period.

	11 March 1994	12 February 1995	30 November 1999
PH (1:5 H2O)	6.0	6.2	6.1
E.C. (mS/cm)	0.03	0.02	0.04
P_b (mg/kg)	6.8	3.3	2.8
Ca (me/100g)	2.08	2.43	2.03
Mg (me/100g)	0.43	0.36	0.43
K (me/100g)	0.20	0.19	0.29

Rainfall

Wet season rainfall (November to April) was 46%, 75%, 85%, and 67% of average for the years 1993/94 to 1996/97 but it was greater than average (107%, 138%, 119% and 112% for the years 1997/98 to 2000/01) for the remainder of the experiment (Figure 2).

Native pastures

Soil Seed Reserves

Germination of soil seed reserves prior to the commencement of the experiment (December, 1993) indicated there were 3 seeds/m^2 of black speargrass, 415 seeds/m^2 of verano stylo, 168 seeds/m^2 of seca stylo, 55 seeds/m^2 of increaser grasses and 43 seeds/m^2 of other grasses and a number of forbs and sedges (complete data not presented). The detailed assessment made in December 1994 failed to record any seed of 3P grasses while there were means across all treatments of 49 seeds/m^2 of verano stylo, 6 seeds/m^2 of seca stylo, 47 seeds/m^2 for increaser grasses and 41 seeds/m^2 for other grasses (complete data not presented). These data indicate the extremely low levels of seed reserves for 3P grasses (particularly black speargrass) at the beginning of the experiment. Orr and Paton (1997) recorded a mean of nearly 40 seedlings/m^2 of black speargrass over 2 years in a burn-no spell treatment in the south Burnett region of Queensland.

Figure 2(a). **Monthly rainfall at Eureka Creek (bars) and mean monthly rainfall for Dimbulah (line). The top boxes show annual rainfall (mm) from July to June compared to the Dimbulah mean (796mm). The second row of boxes show the percentage of rain falling in the wet season months (November - April inclusive) compared to the Dimbulah average for those months (734 mm).**

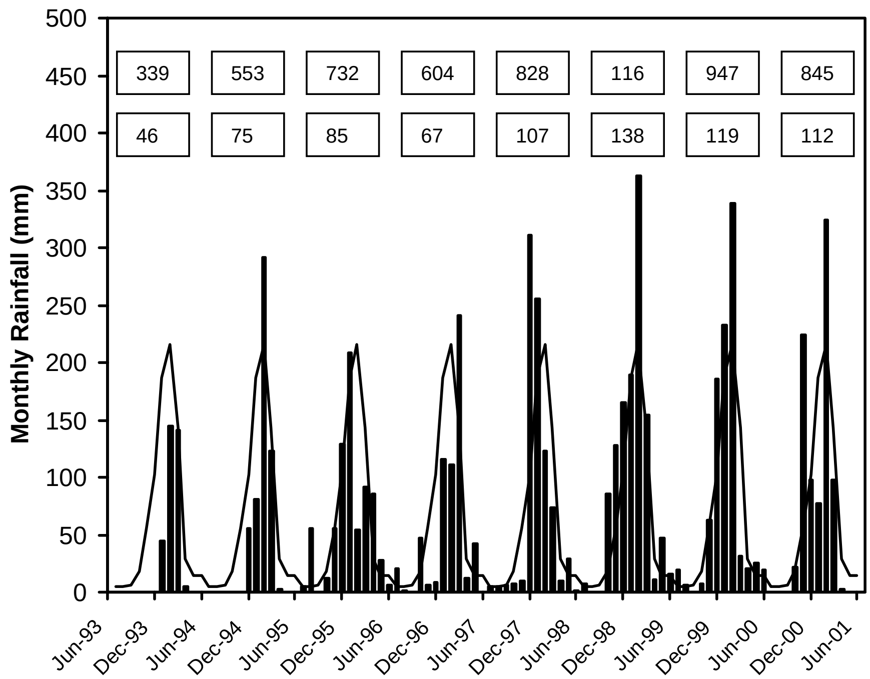
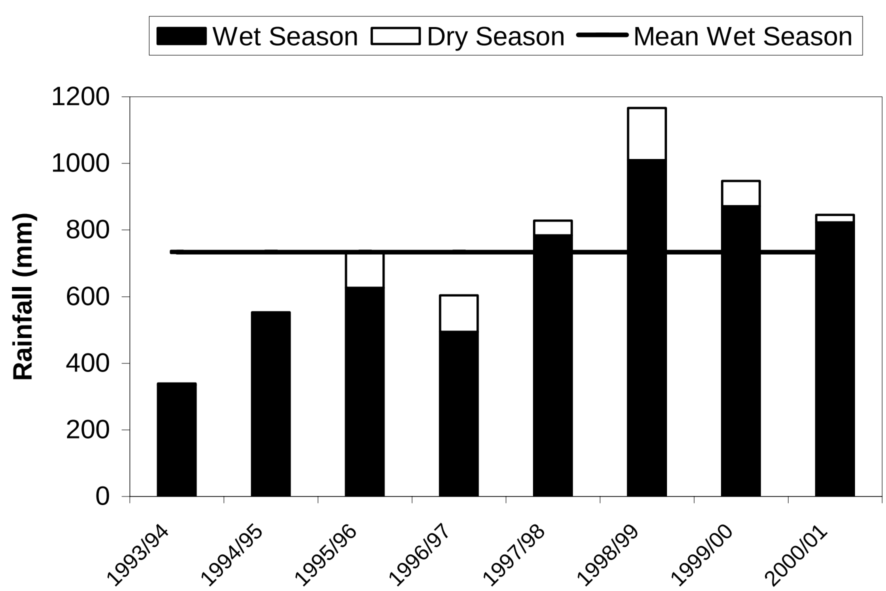


Figure 2(b). **Seasonal and mean wet season rainfall at Eureka Creek.**



Dry matter yield

Yields at end of growing season

Annual production of native pastures on sandy surfaced soils in semi-arid north Queensland is usually between 1000 and 2000 kg DM/ha of dry matter depending on season and is not affected by fertiliser application (for example Coates *et al* 1990, Gilbert *et al* 1987). Stylos on the other hand respond to both season and fertiliser (phosphorus) application and/or internal soil phosphorus up to 8 – 10 mg/kg P and successful establishment will produce additional forage over and above native pasture production that, at least in north Queensland, allows higher stocking rates (Coates *et al* 1990). Grazed pastures in apparent good condition may have 1500 kg DM/ha of native grass (predominantly 3P) and up to an additional 3000 kg DM/ha of stylo. Pastures in good condition then may comprise only 30% to 50% grass.

Dry matter yields of 3P grasses, increaser grasses, total grass and stylos at the end of the pasture growing season are shown by treatment in Figure 3 and in Table 4. In Tables 4 to 9, burning and spelling effects are shown for the medium stocking rate treatment only (since this was the only rate at which all combinations were included) and the stocking rate results are from the no burn-spell combination, again because these were the only treatments common to all stocking rates. Yields and composition by weight of the functional group “Other Grasses” were low and usually made up 2% - 5% of total yield apart from the growing season 1994/95 when they comprised 21% of total yield (range 15% - 27%) but there were no effects of treatment and that group has been ignored for the purposes of this report. The major component in 1994/95 was an annual *Panicum* sp. The functional groups of “Sown Pastures”, “Native Legumes” and “Forbs and Sedges” were always minor components of all treatments and have also been ignored in this section for the purposes of this report.

Yields of 3P grasses were increased by reduced stocking rates and by burning or wet season spelling. After 8 growing seasons under a light stocking rate regime, yields of 3P grasses in the no burn - spell treatment were 1862 kg DM/ha compared with only 400 kg DM/ha in the burn–no spell treatment. This represents 35 and 5 fold increases respectively in 3P grass yield over the experimental period (Table 4). In the no burn-spell treatment, yield of 3P and total grass increased to natural levels even as yield of stylo was increasing rapidly to very high levels (Figure 3 treatment 2). On the other hand the improvement in grass yields was not nearly so evident in the burn-no spell treatment even though stylo yields were significantly reduced by burning (Figure 3 Treatment 1).

At medium stocking rates yields of 3P grasses in the no burn-no spell treatment were low (281 kg DM/ha) even though the final yield represented a 10 fold increase over the 8 years. In the no burn-spell and burn-no spell treatments were 752 kg DM/ha and 780 kg DM/ha representing 21 and 16 fold increases respectively. In the burn-spell treatment, yield of 3P grasses was 1147 kg DM/ha after 8 growing seasons – a 31 fold increase.

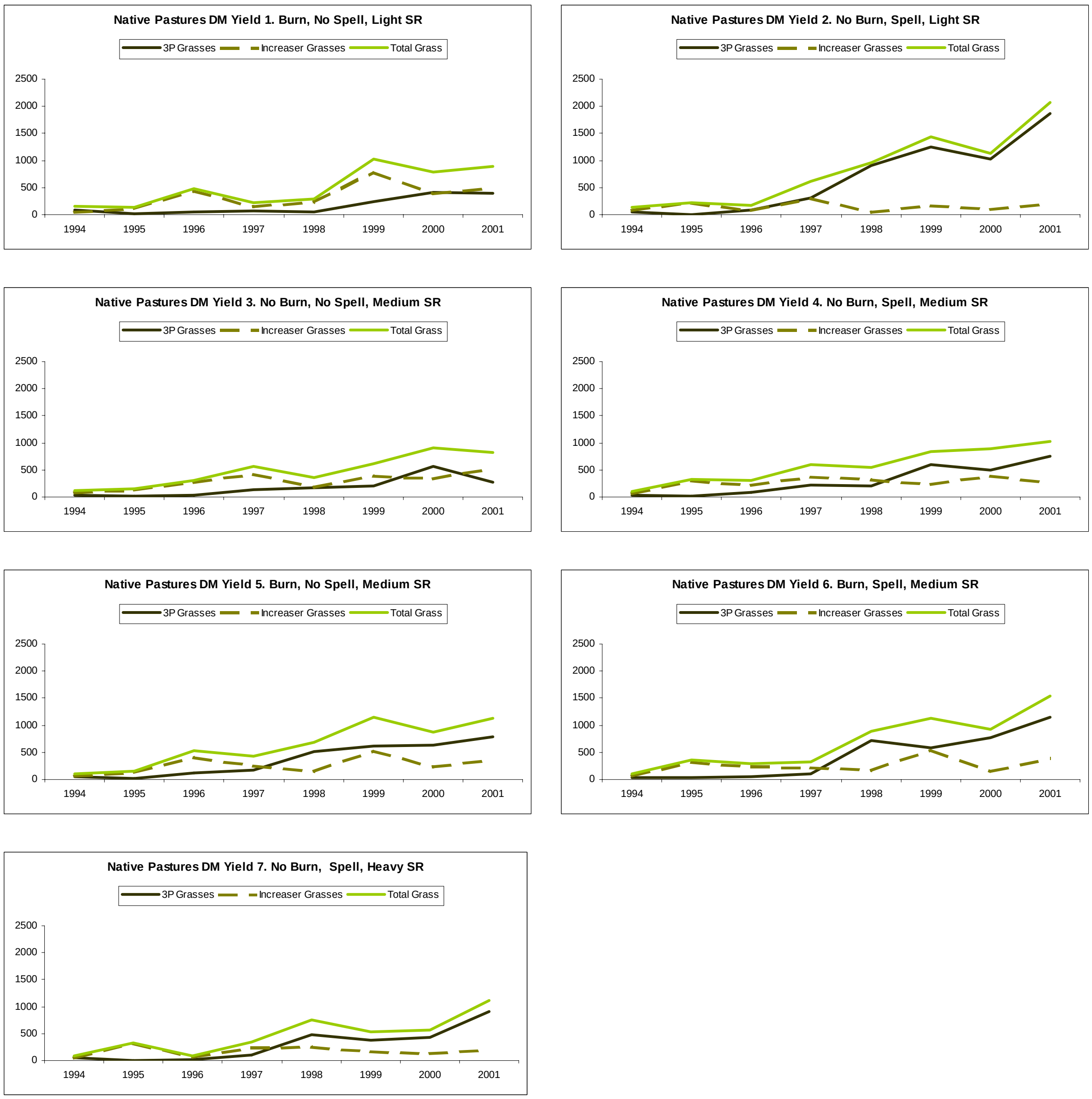
In the heavy stocked treatment (no burn–spell) 3P grass yield increased from 44 kg DM/ha in 1994 to 369 kg DM/ha in 1999 before the wild fire. In the 2 years following the fire 3P grass yield increased to 910 kg DM/ha – an improvement attributed to the effects of the fire reducing competition from the stylos. The overall reduced improvement in grass yields (both 3P and Total) in the no burn-spell treatments at medium and heavy stocking rates compared with the light stocking rate treatment demonstrate the effect of grazing pressure in holding back recovery of the grass component.

Increaser grass yields were generally unaffected by treatment except for perhaps a slight increase in the burn-no spell treatment at the light stocking rate.

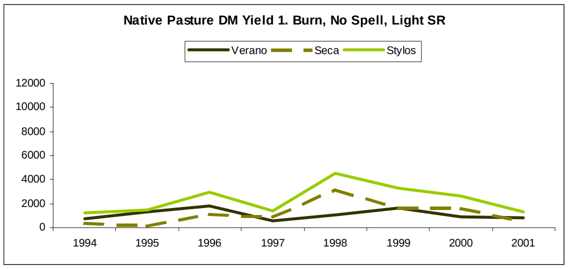
Burning had a major effect on stylo yields with yield of unburnt stylo averaging 8266 kg DM/ha in 1999 compared with an average of 3579 kg DM/ha in the burnt treatments. Yields of both seca and verano were reduced by fire but there was a much greater affect on seca. The hot, wild fire in September 1999 had a major impact on stylo (mainly seca) yield, particularly in previously unburnt treatments in 2000 and that reduction was still evident when the experiment ended in May 2001 (Figure 3, treatments 2, 3, 4, 7).

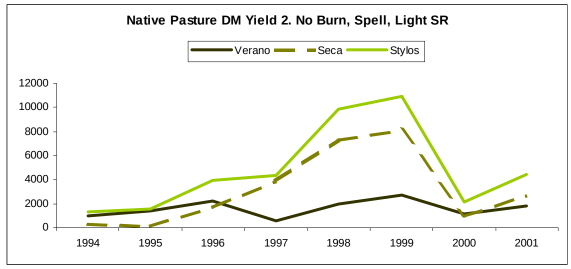
Figure 3. Mean dry matter yields of (a) native grass and (b) stylo components in individual treatments at Eureka Creek measured at the end of the summer growing season.

(a) Native Grass



(b) Stylo


Native Pasture DM Yield 1. Burn, No Spell, Light SR
Verano
Seca
Stylos
12000
10000
8000
6000
4000
2000
0
1994
1995
1996
1997
1998
1999
2000
2001


Native Pasture DM Yield 2. No Burn, Spell, Light SR
Verano
Seca
Stylos
12000
10000
8000
6000
4000
2000
0
1994
1995
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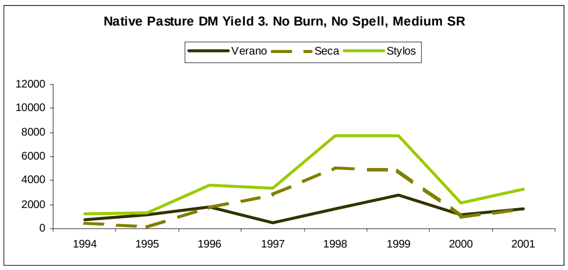
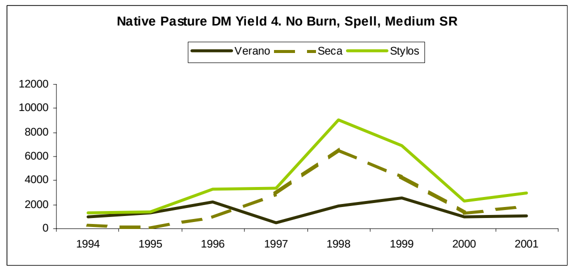
1997
1998
1999
2000
2001


Native Pasture DM Yield 3. No Burn, No Spell, Medium SR
Verano
Seca
Stylos
12000
10000
8000
6000
4000
2000
0
1994
1995
1996
1997
1998
1999
2000
2001


Native Pasture DM Yield 4. No Burn, Spell, Medium SR
Verano
Seca
Stylos
12000
10000
8000
6000
4000
2000
0
1994
1995
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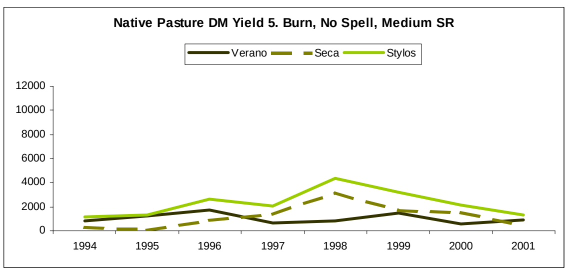
1999
2000
2001


Native Pasture DM Yield 5. Burn, No Spell, Medium SR
Verano
Seca
Stylos
12000
10000
8000
6000
4000
2000
0
1994
1995
1996
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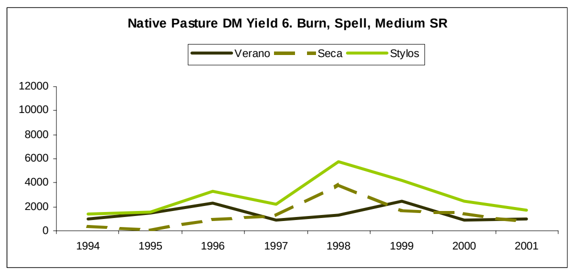
2000
2001


Native Pasture DM Yield 6. Burn, Spell, Medium SR
Verano
Seca
Stylos
12000
10000
8000
6000
4000
2000
0
1994
1995
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1997
1998
1999
2000
2001

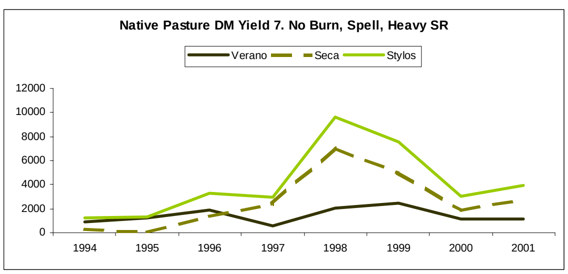

Native Pasture DM Yield 7. No Burn, Spell, Heavy SR
Verano
Seca
Stylos
12000
10000
8000
6000
4000
2000
0
1994
1995
1996
1997
1998
1999
2000
2001

Table 4. Pasture dry matter yield (kg DM/ha) at the end of the growing season as affected by spelling, burning and grazing pressure.

(a) Yield of 3P grasses

	No burn		Burn		Grazing Pressure [1]		
	No spell	Spell	No spell	Spell	Light	Medium	Heavy
1993/94	27	36	49	37	53	36	44
1994/95	18	20	13	32	4	20	7
1995/96	36	81	123	54	94	81	25
1996/97	139	218	177	101	301	218	97
1997/98	178	214	519	722	912	214	487
1998/99	209	609	620	583	1258	604	369
1999/00	568	494	634	767	1028	494	431
2000/01	281	752	780	1147	1862	752	910

[1] Grazing pressure data refer to the no Burn-spell treatment.

(b) Yield of total grass

	No burn		Burn		Grazing Pressure [1]		
	No spell	Spell	No spell	Spell	Light	Medium	Heavy
1993/94	118	98	110	105	138	98	88
1994/95	160	331	153	359	221	331	322
1995/96	310	308	528	291	178	308	91
1996/97	562	600	434	324	609	600	342
1997/98	361	545	681	894	960	545	749
1998/99	608	841	1155	1133	1435	841	539
1999/00	903	896	879	922	1131	896	565
2000/01	814	1035	1133	1538	2068	1035	1119

[1] Grazing pressure data refer to the no burn-spell treatment.

(c) Yield of Seca

	No burn		Burn		Grazing Pressure [1]		
	No spell	Spell	No spell	Spell	Light	Medium	Heavy
1993/94	488	339	342	410	345	339	328
1994/95	143	87	91	64	134	87	94
1995/96	1771	993	923	949	1760	993	1378
1996/97	2858	2843	1428	1290	3838	2843	2415
1997/98	5098	6573	3242	3894	7351	6573	7044
1998/99	4889	4330	1760	1752	8137	4330	5049
1999/00	950	1283	1554	1489	1015	1283	1859
2000/01	1650	1906	428	729	2685	1906	2808

[1] Grazing pressure data refer to the no burn-spell treatment.

(d) Yield of Verano

	No burn		Burn		Grazing Pressure [1]		
	No spell	Spell	No spell	Spell	Light	Medium	Heavy
1993/94	773	947	791	1003	961	947	940
1994/95	1150	1311	1243	1473	1413	1311	1227
1995/96	1826	2260	1717	2309	2203	2260	1890
1996/97	485	489	633	941	546	489	544
1997/98	1644	1890	830	1302	1976	1890	2055
1998/99	2774	2525	1446	2465	2742	2525	2428
1999/00	1152	1024	550	902	1133	1024	1154
2000/01	1649	1089	891	994	1789	1089	1124

[1] Grazing pressure data refer to the no burn-spell treatment.

(e) Yield of total stylo

	No burn		Burn		Grazing Pressure [1]		
	No spell	Spell	No spell	Spell	Light	Medium	Heavy
1993/94	1261	1285	1133	1413	1306	1285	1268
1994/95	1292	1397	1334	1537	1456	1397	1321
1995/96	3597	3255	2646	3258	3967	3255	3268
1996/97	3343	3332	2061	2231	4384	3332	2959
1997/98	7734	9069	4367	5731	9849	9069	9646
1998/99	7693	6877	3206	4230	10897	6877	7587
1999/00	2174	2310	2104	2430	2157	2310	3068
2000/01	3299	2995	1319	1722	4474	2995	3932

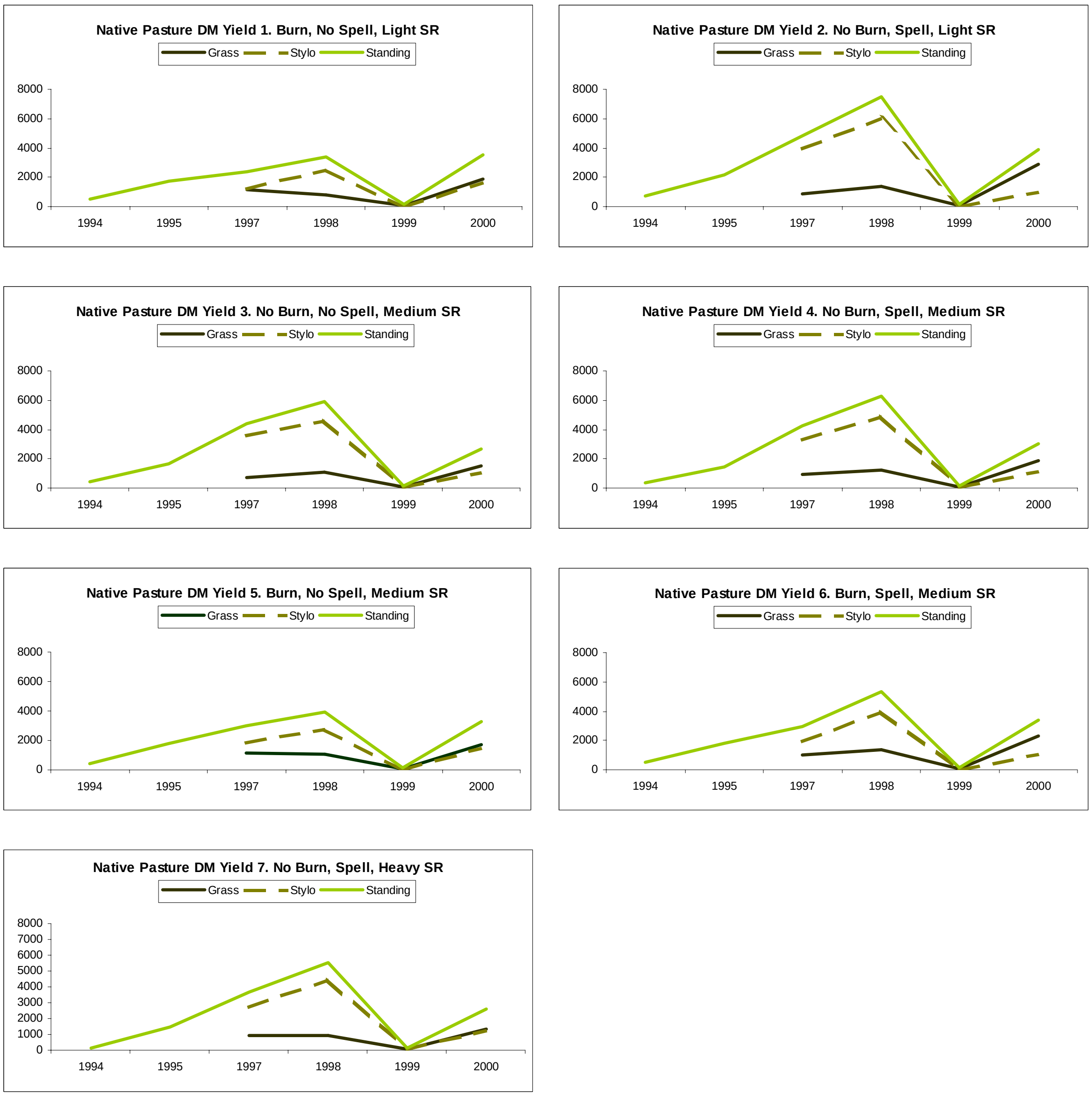
[1] Grazing pressure data refer to the no burn-spell treatment.

Yields at end of dry season

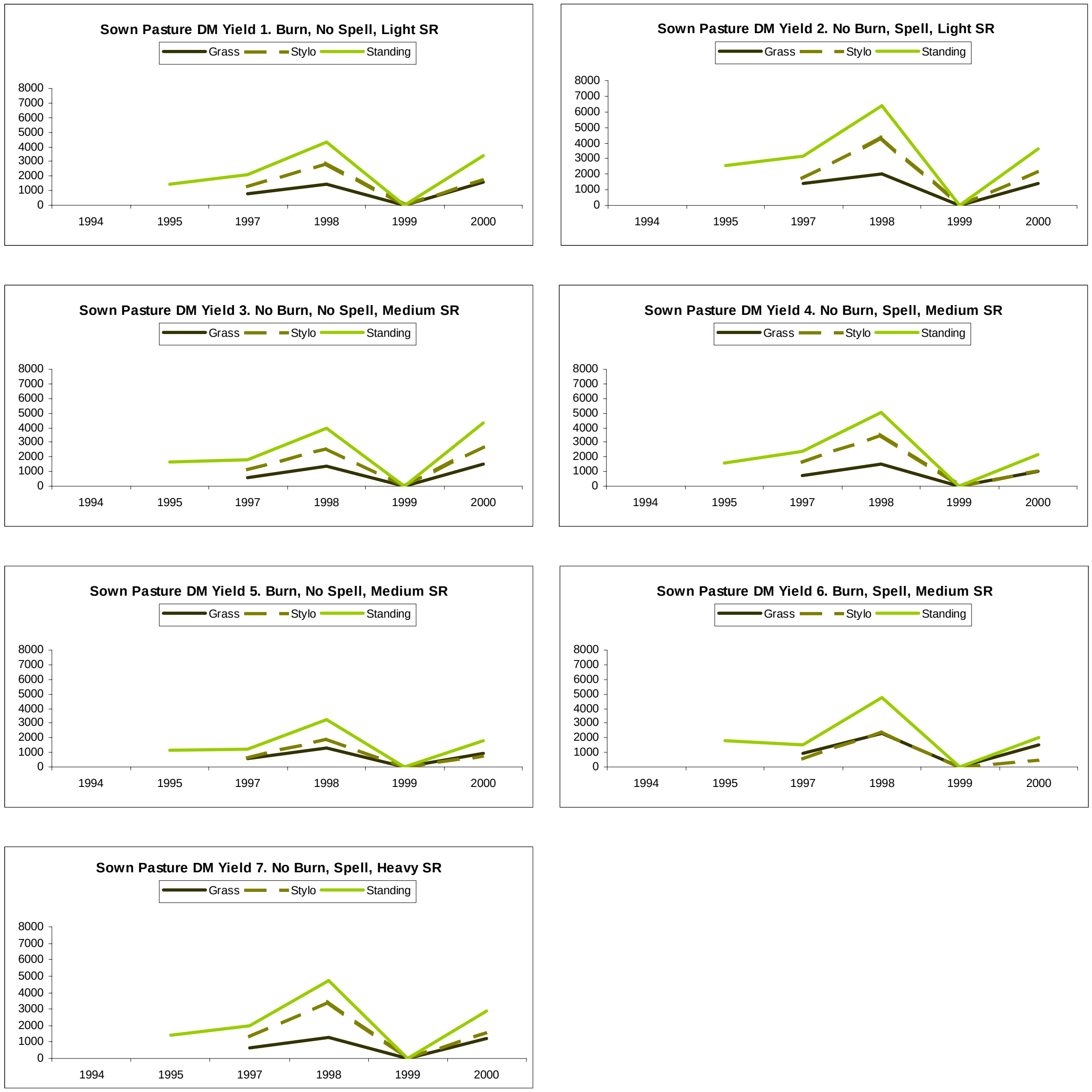
Pasture yield at the end of the dry season are shown in Figure 4. Native grass yields were always less than 1000 kg DM/ha with the major component of total pasture yield being seca stems from which leaf had almost completely detached. Average standing dry matter yield of unburnt treatments in 1998 were 6292 kg DM/ha compared with an average of 4209 kg DM/ha in the burnt treatments. In the first 2 years of the experiment burning was quite patchy because standing dry matter was low and dominated by stylo stems which would not carry a fire.

Figure 4. Mean dry matter yields of grass and stylo components in (a) native and (b) sown pastures in individual treatments at Eureka Creek measured at the end of the dry season.

(a) Native Pastures



(b) Sown Pastures



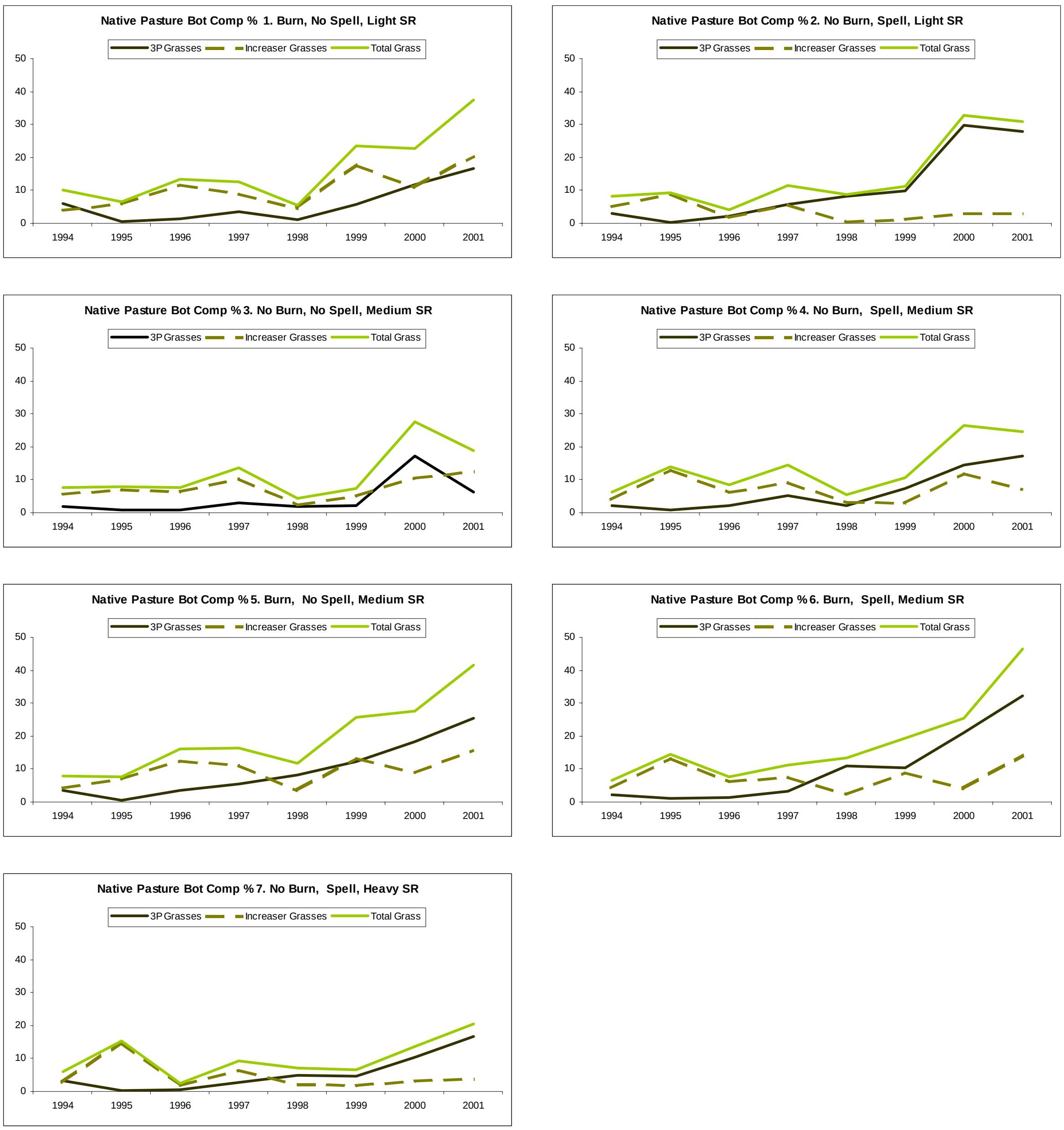
Species composition by weight

At the commencement of this experiment (summer 1993-94) the pasture comprised over 80% stylo, made up primarily of verano. Over the course of the experiment the stylo component became seca dominant across all treatments before switching to approximately even proportions of each (Figure 5 and Table 5). Table 5 refers only to the medium stocking rate treatment since it was the only complete combination of spelling and burning.

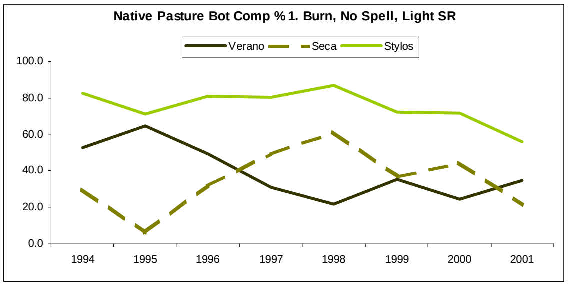
There was a large increase in both the 3P grass and total grass components as a result of annual burning at the break of the wet season (Figure 5 treatments 1, 5, 6). Total grass in the annual burn treatments improved consistently once wet season rainfall returned to average figures in 1997/98 and beyond and burns became more effective. Wet season spelling provided an additional response above burning such that the total grass component in the burn-spell treatment (medium stocking rate) was 47% of which 75% were 3P grasses (Figure 5). Spelling in the absence of burning (Figure 5 treatments 2, 4, 7) however, had no effect on the proportion of grass and, until the wildfire, remained low at approximately 10% of total yield. There was an apparent increase in the grass component of unburnt treatments in the final 2 years of the experiment (Figure 5 treatments 2, 3, 4, 7) but this response can be entirely attributed to the collapse in seca yield after the hot wildfire in September 1999.

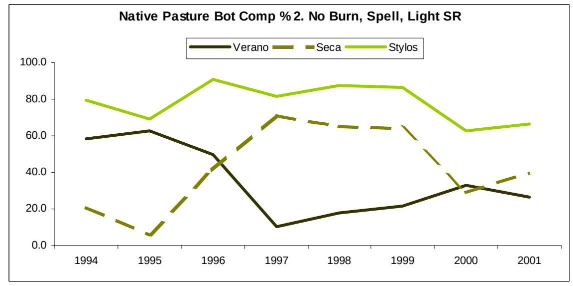
Figure 5. Pasture composition by weight of (a) native grass and (b) stylo components in individual treatments at Eureka Creek measured at the end of the summer growing season.

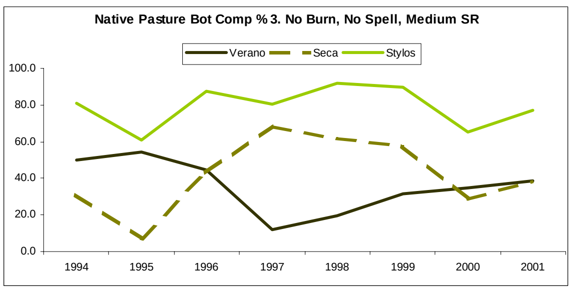
(a) Native Grass

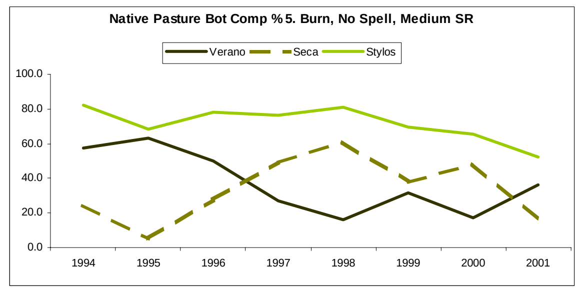


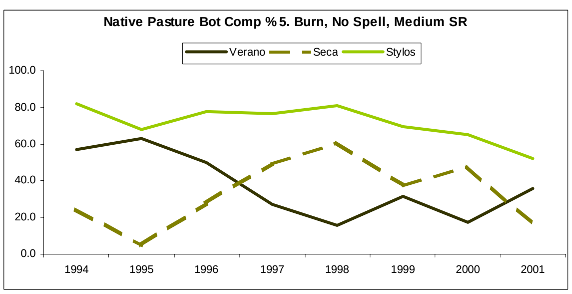
(b) Stylo

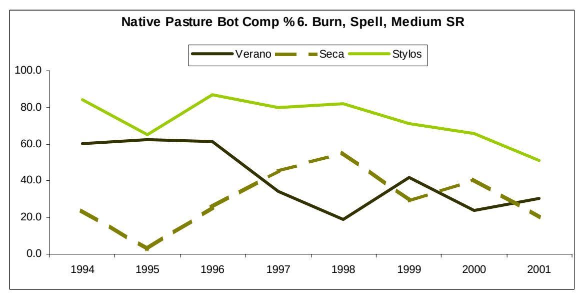


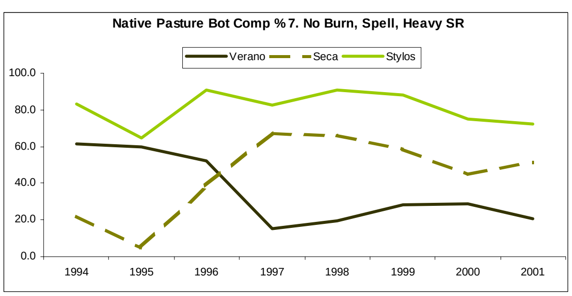












Under commercial conditions it is unlikely that a stocking rate equal to the light treatment used in this experiment would be employed over the time frame needed to rehabilitate a stylo dominant pasture. In any event this scenario would represent a waste of valuable feed. Much more likely is a scenario similar to the medium stocking rate used here that allows the rehabilitation of the grass component to natural levels and then stabilised at 30% to 50% of total pasture yield. It appears this can only be achieved with a burning program. The increase in the grass component in previously unburnt treatments (Figure 5, treatments 2, 3, 4, 5, 7) in the 2 seasons following the wildfire in September 1999 demonstrate, however, that grass composition can increase rapidly after an effective fire to set back the stylo component followed by reasonable growing seasons.

Stocking rate had no effect on composition by weight of total stylo or the individual cultivars. Total stylo comprised more than 80% of total yield across stocking rates except following the wildfire in September 1999 and the reduction in stylo (particularly in seca) in the following 2 seasons.

Table 5. Native pasture species composition (% of total yield) at the end of the growing season as affected by spelling, burning and grazing pressure.

(a) Species composition of 3P grasses

	No burn		Burn		Grazing Pressure [1]		
	No spell	Spell	No spell	Spell	Light	Medium	Heavy
1993/94	2	2	4	2	3	2	3
1994/95	1	1	1	1	0	1	0
1995/96	1	2	3	1	2	2	1
1996/97	3	5	5	3	6	5	3
1997/98	2	2	8	11	8	2	5
1998/99	2	7	12	10	10	7	5
1999/00	17	15	18	21	30	15	10
2000/01	6	17	25	32	28	17	17

[1] Grazing pressure data refer to the no burn-spell treatment.

(b) Species composition of total grass

	No burn		Burn		Grazing Pressure [1]		
	No spell	Spell	No spell	Spell	Light	Medium	Heavy
1993/94	8	6	8	7	8	6	6
1994/95	8	14	8	15	9	14	15
1995/96	8	9	16	8	4	9	3
1996/97	14	14	17	11	12	14	9
1997/98	4	5	12	13	9	5	7
1998/99	8	11	26	19	11	11	7
1999/00	28	27	28	25	33	27	14
2000/01	19	25	42	47	31	25	20

[1] Grazing pressure data refer to the no burn-spell treatment.

(c) Species composition of Seca

	No burn		Burn		Grazing Pressure [1]		
	No spell	Spell	No spell	Spell	Light	Medium	Heavy
1993/94	31	22	25	24	21	22	22
1994/95	7	4	5	3	6	4	5
1995/96	43	27	28	25	41	27	38
1996/97	69	68	49	45	71	68	67
1997/98	62	66	61	56	66	66	66
1998/99	58	55	38	29	64	55	59
1999/00	29	38	48	41	29	38	45
2000/01	39	46	16	20	40	46	52

[1] Grazing pressure data refer to the no burn-spell treatment.

(d) Species composition of Verano

	No burn		Burn		Grazing Pressure [1]		
	No spell	Spell	No spell	Spell	Light	Medium	Heavy
1993/94	50	60	57	60	58	60	61
1994/95	54	58	63	62	63	58	60
1995/96	45	60	50	61	50	60	52
1996/97	12	12	27	34	10	12	15
1997/98	20	19	16	19	18	19	18
1998/99	32	32	32	42	22	32	28
1999/00	35	31	17	24	33	31	29
2000/01	38	27	36	31	26	27	21

[1] Grazing pressure data refer to the no burn-spell treatment.

(e) Species composition of total stylo

	No burn		Burn		Grazing Pressure [1]		
	No spell	**Spell**	**No spell**	**Spell**	**Light**	**Medium**	**Heavy**
1993/94	81	82	82	84	80	82	83
1994/95	61	62	68	65	69	62	65
1995/96	87	87	78	87	91	87	91
1996/97	80	80	77	80	81	80	83
1997/98	92	91	81	82	88	91	91
1998/99	90	87	69	72	86	87	88
1999/00	65	69	65	66	63	69	75
2000/01	77	73	52	51	66	73	72

[1] Grazing pressure data refer to the no burn-spell treatment.

Frequency occurrence

The frequency occurrence of black speargrass in 0.5 m X 0.5 m quadrats was used as a surrogate for the presence of all 3P grasses and the results at the end of the growing season are shown in Figure 6 and Table 6. At the beginning of the experiment the occurrence of black speargrass was generally less than 10%.

After 4 growing seasons (1996/97) there was still no change in frequency of black speargrass with mean value across the experiment of 9.5%. After the improvement in seasonal conditions in 1997/98, treatment effects rapidly became evident. Burning had a much greater positive impact on black speargrass frequency than spelling although the burn-spell gave an additional advantage before the wildfire tended to even out the responses. After the 1998/99 growing season, mean black speargrass frequencies for the no burn and burn treatments (medium stocking rate) were 18% and 40% respectively. This compares with 45% and 62% at the final sampling of those treatments in 2001. Frequencies in the unspelled and spelled treatments after the 1998/99 growing season were 24% and 34% respectively compared with 45% and 61% at the end of the experimental period.

The frequency of black speargrass plants was increased at the light stocking rate compared to the medium and heavy stocking rates which were similar. After the 1998/99 growing season (before the wildfire) the results showed a frequency of 48% at the light stocking rate compared with 23% and 22% for the medium and heavy stocking rates respectively. At the end of the experimental period the frequencies were 73%, 54% and 50% for the light, medium and heavy stocking rates respectively (Table 6).

Figure 6. Frequency occurrence (%) of pasture species measured in 0.5m x 0.5m quadrats of grass and stylo components in native pasture treatments at Eureka Creek measured at the end of the summer growing season.

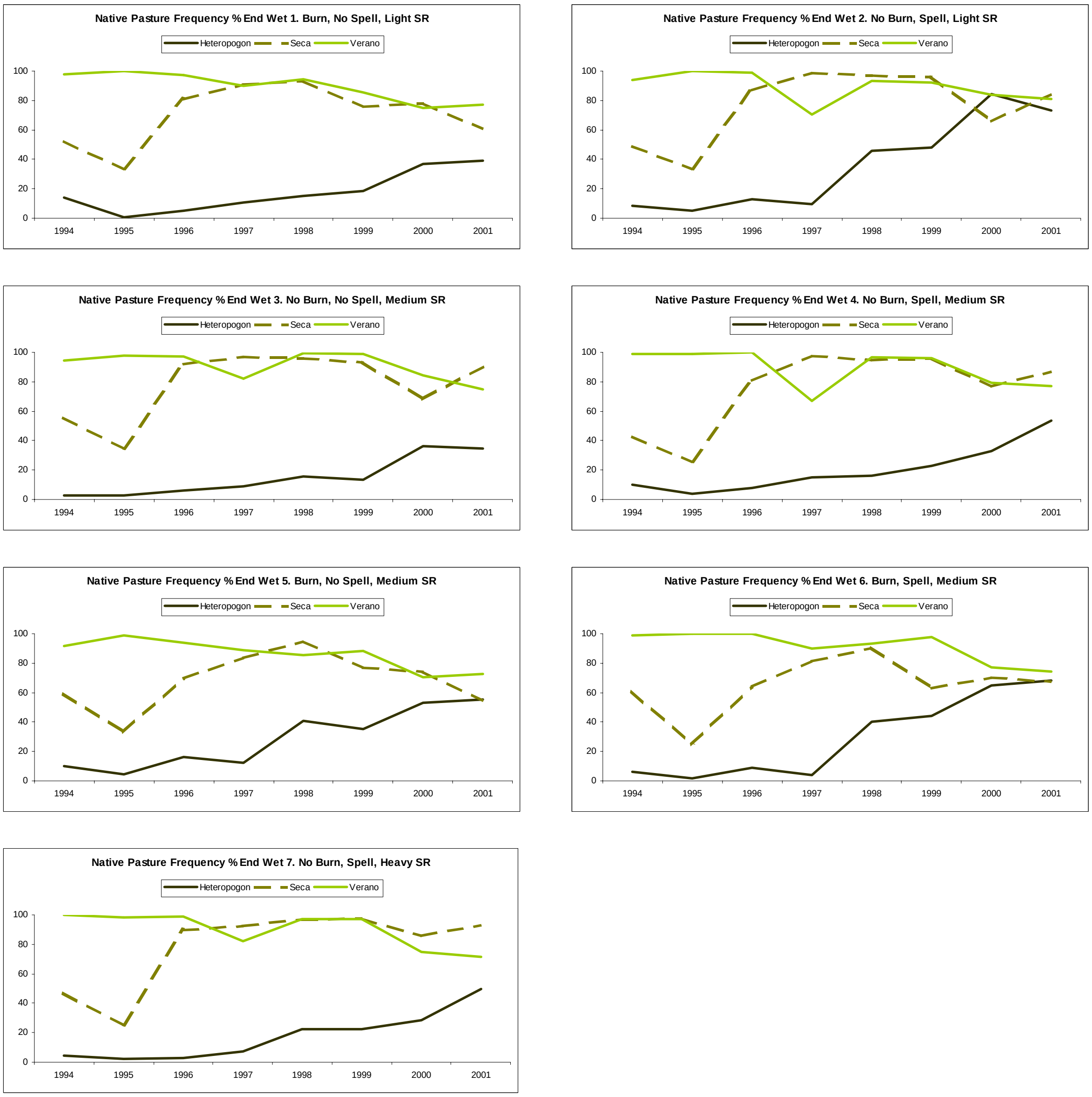


Table 6. Native pasture species frequency (% presence in quadrats) at the end of the growing season as affected by spelling, burning and grazing pressure.

(a) Frequency of Heteropogon

	No burn		Burn		Grazing Pressure [1]		
	No spell	**Spell**	**No spell**	**Spell**	**Light**	**Medium**	**Heavy**
1993/94	3	10	10	6	9	10	4
1994/95	3	4	4	2	5	4	2
1995/96	6	8	16	9	13	8	3
1996/97	9	15	12	4	9	15	7
1997/98	16	16	41	40	46	16	22
1998/99	13	23	35	44	48	23	22
1999/00	36	33	53	65	85	33	28
2000/01	35	54	55	68	73	54	50

[1] Grazing pressure data refer to the no burn-spell treatment.

(b) Frequency of Seca

	No burn		Burn		Grazing Pressure [1]		
	No spell	**Spell**	**No spell**	**Spell**	**Light**	**Medium**	**Heavy**
1993/94	56	43	59	61	49	43	47
1994/95	35	26	33	25	33	26	25
1995/96	92	81	70	64	87	81	90
1996/97	97	98	84	81	99	98	93
1997/98	96	95	95	90	97	95	97
1998/99	93	96	77	63	96	96	98
1999/00	68	77	74	70	66	77	86
2000/01	90	87	55	68	84	87	93

[1] Grazing pressure data refer to the no burn-spell treatment.

(c) Frequency of Verano

	No burn		Burn		Grazing Pressure [1]		
	No spell	**Spell**	**No spell**	**Spell**	**Light**	**Medium**	**Heavy**
1993/94	95	99	92	99	94	99	100
1994/95	98	99	99	100	100	99	98
1995/96	97	100	94	100	99	100	99
1996/97	82	67	89	90	71	67	82
1997/98	99	96	86	93	94	96	97
1998/99	99	96	88	98	92	96	97
1999/00	85	79	71	77	84	79	75
2000/01	75	77	73	74	81	77	71

[1] Grazing pressure data refer to the no burn-spell treatment.

Sown pastures

Dry matter yields and composition by weight

Soil disturbance is necessary for effective grass establishment (Cook and Dolby 1981, McIvor and Gardner 1981). Even so grass establishment was poor in the first year (1993/94). Satisfactory establishment was achieved by the end of the second growing season (1994/95) after recultivating half the area and resowing the whole area early in that growing season. Dry matter yields at the end of the growing seasons are shown in Figure 7 and Table 7. Species composition by weight for the same period are shown in Figure 8 and Table 8.

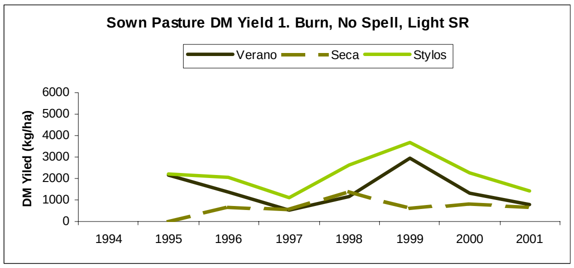
The pre-sowing cultivation dramatically reduced stylo yield compared with uncultivated areas at that time but verano recovered quickly such that it was the dominant pasture species (43% -70% of yield) by the end of the 1994-95 season. Seca, by comparison, contributed less than 2% - 4% of yield at that time but it had recovered to 45% (no burn-spell) and 12% (burn-spell) by 1998/99. The wild fire suppressed stylo in the previously unburnt pasture from 81% to 73%, but stylo also declined by a similar percentage in the annually burnt pasture from 67% to 58%.

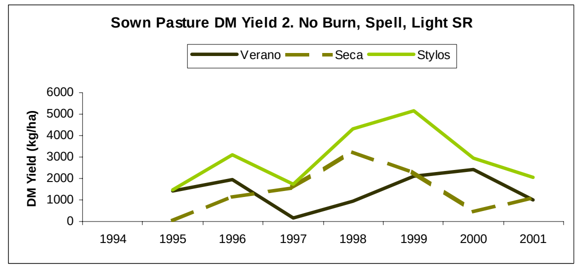
At the medium stocking rate there was a small advantage in total sown grass yield to the burn treatments immediately before the wildfire (823 kg DM/ha) compared to the unburnt treatments (1161 kg DM/ha) whereas there was a large advantage to spelling. Mean yields were 1302 kg DM/ha and 682 kg DM/ha for spell and no spell treatments respectively (Table 7a).

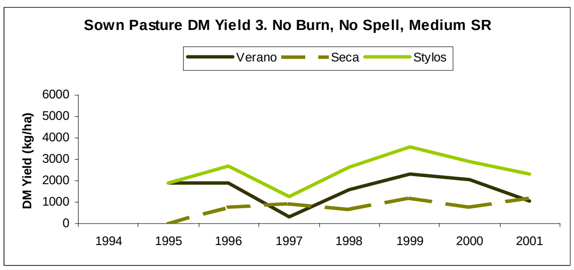
In the first year of the experiment there was a significant difference in total sown grass yield to stocking rate but this disappeared in the second year (Table 7). In the following years there was a clear advantage to the light stocking rate but there was no difference between in total sown grass yield between the medium and heavy stocking rate treatments.

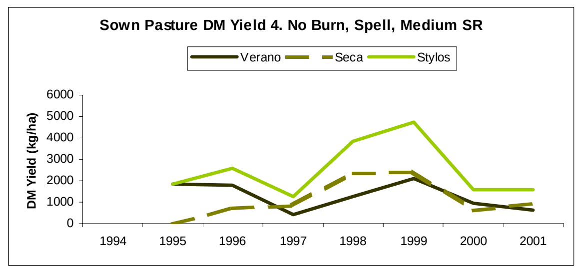
Figure 7. Mean dry matter yields of (a) sown grass and (b) stylo components in individual treatments at Eureka Creek measured at the end of the summer growing season.

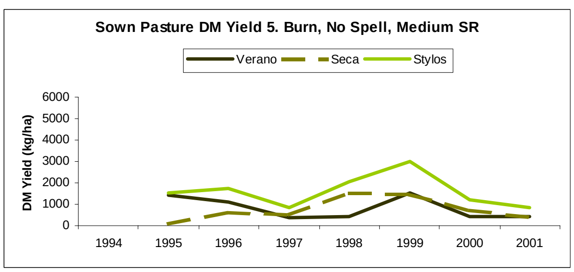
(a) Sown Grass

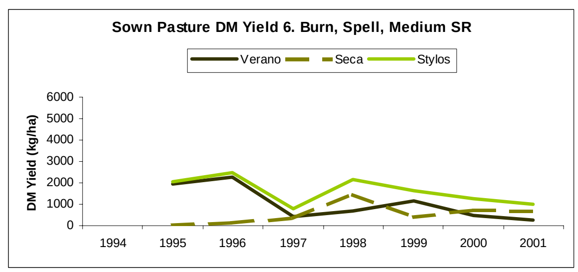


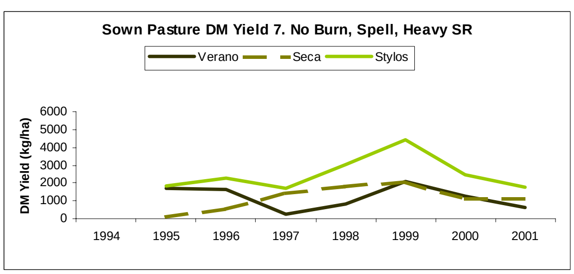




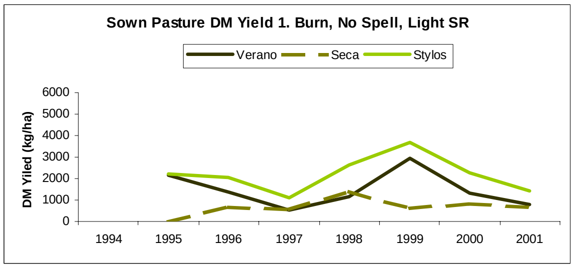


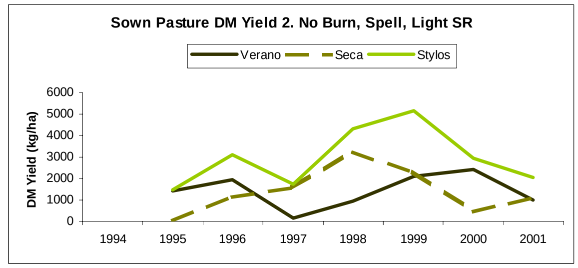


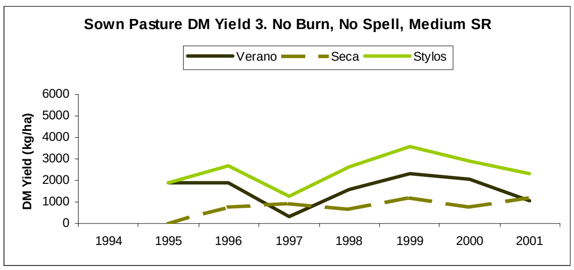


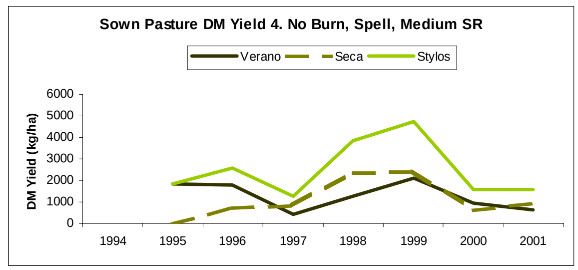


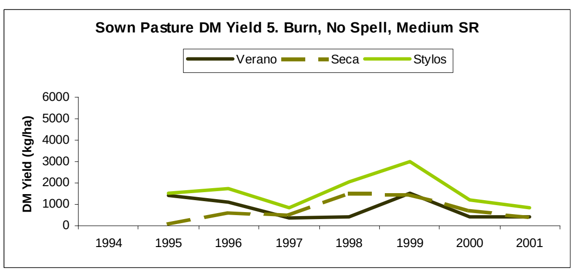
(b) Stylo

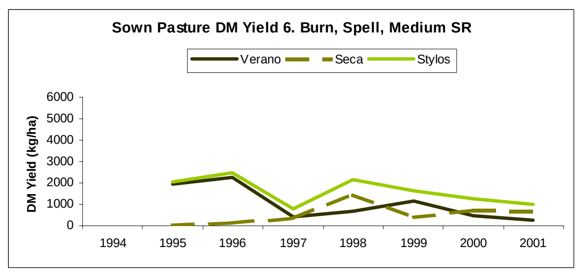


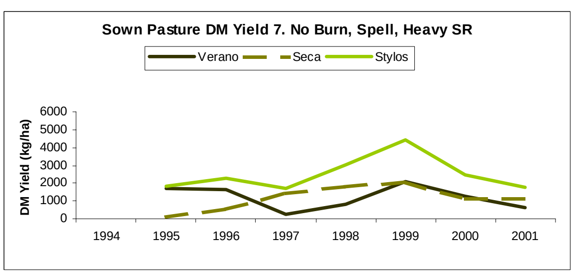












The burn–spell treatment at the medium stocking rate produced a stable grass-legume combination over the duration of the experiment. Mean composition of sown grass over the period was 47% of total yield (range 32% to 57%). The mean composition of sown grass in the other combinations at medium stocking rate were <30% with the no burn–no spell treatment the least effective throughout at 22% of total yield (Table 8). The mean composition of total sown grasses over the experimental period were 36%, 29% and 25% for the light, medium and heavy stocking rate treatments respectively.

Table 7. Sown pasture dry matter yield (kg DM/ha) at the end of the growing season as affected by spelling, burning and grazing pressure.

(a) Yield of sown grasses

	No burn		Burn		Grazing Pressure [1]		
	No spell	**Spell**	**No spell**	**Spell**	**Light**	**Medium**	**Heavy**
1994/95	406	1244	577	1263	1431	1244	849
1995/96	978	1815	993	1865	1779	1815	1829
1996/97	417	771	346	1091	1521	771	723
1997/98	1004	1186	868	2119	2082	1186	1048
1998/99	750	896	613	1709	1431	896	686
1999/00	488	582	709	1402	1078	582	597
2000/01	1021	685	392	1113	883	685	561

[1] Grazing pressure data refer to the no burn-spell treatment.

(b) Yield of grass in sown grass treatments at end of 2000 – 2001 growing season

	No burn		Burn		Grazing Pressure [1]		
	No spell	**Spell**	**No spell**	**Spell**	**Light**	**Medium**	**Heavy**
Urochloa	13	123	55	170	314	123	148
Buffel	0	13	0	104	229	13	2
Indian couch	1008	550	338	840	340	550	411
Native grass	77	202	401	275	58	202	197
Total grass	1098	888	794	1389	941	888	758

[1] Grazing pressure data refer to the no burn-spell treatment.

(c) Yield of Seca

	No burn		Burn		Grazing Pressure [1]		
	No spell	**Spell**	**No spell**	**Spell**	**Light**	**Medium**	**Heavy**
1994/95	6	14	110	72	57	14	108
1995/96	771	760	622	173	1143	760	597
1996/97	947	859	503	386	1562	859	1451
1997/98	706	2350	1534	1464	3260	2350	1859
1998/99	1234	244	1451	434	2301	2440	2115
1999/00	815	623	739	747	490	623	1125
2000/01	1234	941	446	687	1086	941	1146

[1] Grazing pressure data refer to the no burn-spell treatment.

(d) Yield of Verano

	No burn		Burn		Grazing Pressure [1]		
	No spell	**Spell**	**No spell**	**Spell**	**Light**	**Medium**	**Heavy**
1994/95	1909	1838	1439	1968	1439	1838	1735
1995/96	1892	1812	1127	2275	1952	1812	1668
1996/97	326	422	348	411	169	422	263
1997/98	1559	1285	422	692	923	1285	840
1998/99	2318	2129	1517	1180	2095	2129	2058
1999/002	2046	947	444	448	2404	947	1252
2000/01	1069	650	416	289	978	650	607

[1] Grazing pressure data refer to the no burn-spell treatment.

(e) Yield of total stylo

	No burn		Burn		Grazing Pressure [1]		
	No spell	**Spell**	**No spell**	**Spell**	**Light**	**Medium**	**Heavy**
1994/95	1915	1852	1548	2039	1496	1852	1843
1995/96	2663	2571	1749	2448	3094	2571	2265
1996/97	1272	1281	851	797	1731	1281	1713
1997/98	2627	3848	2063	2156	4337	3848	3060
1998/99	3603	4756	2992	1617	5149	4756	4446
1999/00	2913	1596	1204	1284	2952	1596	2447
2000/01	2338	1591	862	976	2064	2338	1753

[1] Grazing pressure data refer to the no burn-spell treatment.

Urochloa was the dominant sown grass species in the first years of the experiment. However, yields declined over time such that in the final growing season (2000/01) mean dry matter yield across the experiment was 139 kg DM/ha (range 13 kg DM/ha to 314 kg DM/ha) compared with a mean yield in 1995/96 of 1200 kg DM/ha (range 633 kg DM/ha to 1673 kg DM/ha).

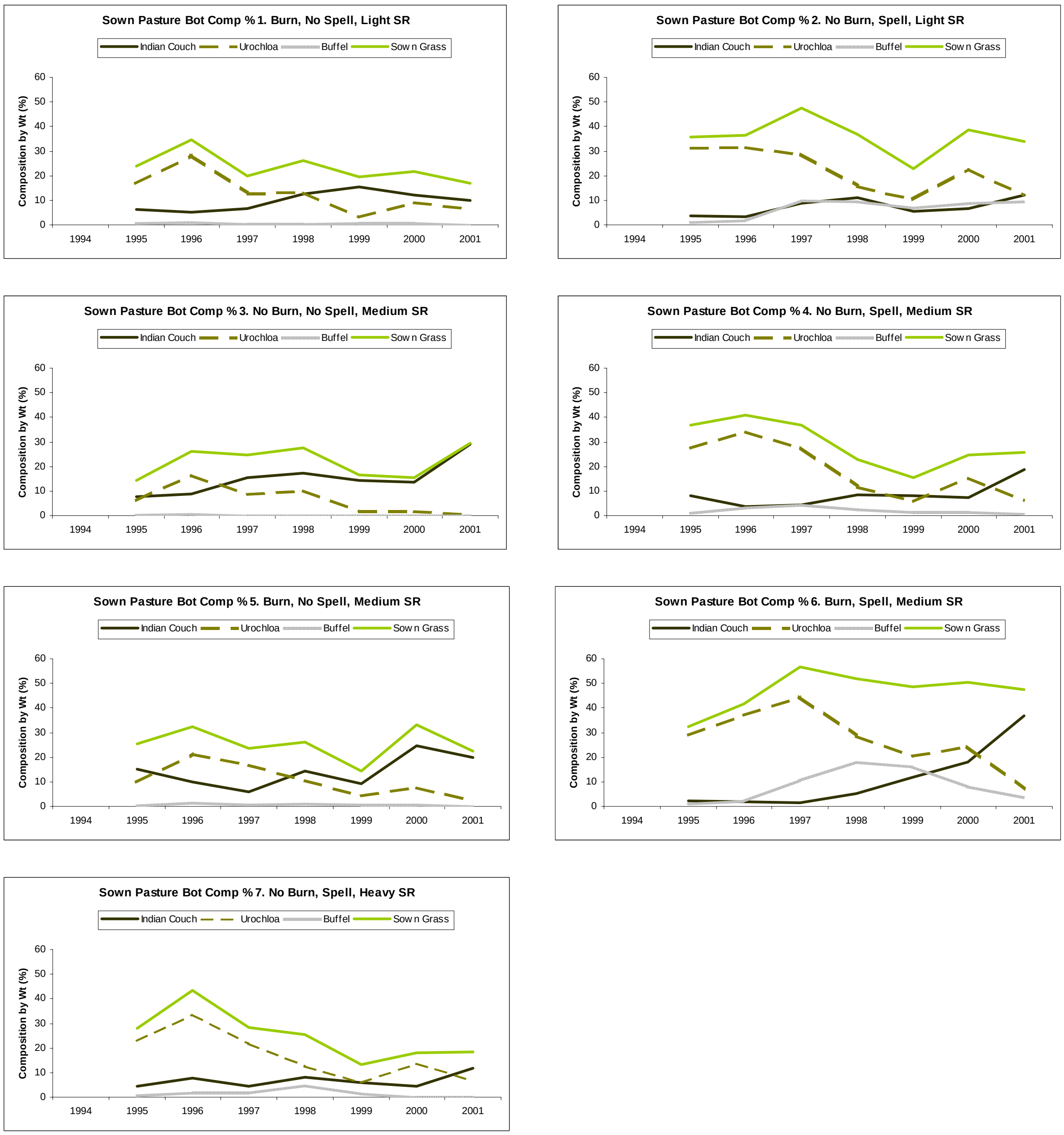
Yields of buffel grass were generally low throughout and it was a significant contributor to total sown grass yield only in no burn–spell treatment at the light stocking rate (mean of 7% of total yield over the period) and burn–spell treatment at the medium stocking rate (mean of 9% over the period). Buffel yield was only stable in the no burn–spell treatment at the light stocking rate treatment and declined to low levels (0% to 4% of total yield) in all other treatments.

Yields and composition by weight of Indian couch were low for the first 3 years of the experiment but thereafter made a significant and stable contribution to total sown grasses in all treatments. Yields were highest in the no burn–no spell and burn-spell treatments at the medium stocking rate in the final year of the experiment (1008 kg DM/ha (29% of total yield) and 840 kg DM/ha (48% of total yield) respectively).

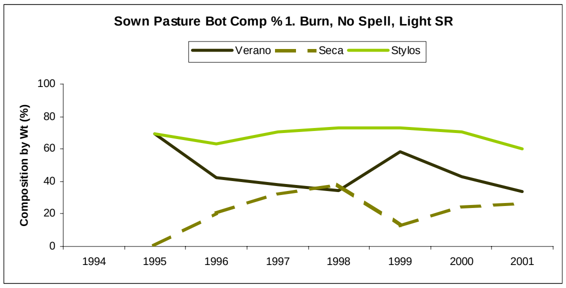
Both *Urochloa* and buffel grasses respond to applications of N and P whereas Indian couch is adapted to soils of variable nutrient status and textures. It is probable that *Urochloa* responded to the improved availability of nutrients from applied fertiliser and mobilisation of soil nutrients after cultivation but later declined as these ran down. Both McIvor (1984) and Coates *et al* (1990) have shown that *Urochloa*/stylo plots which received superphosphate became grass dominant whereas those receiving nil superphosphate became stylo dominant. However, the subsequent decline in yield and composition of *Urochloa* in our experiment is in contrast to the results of Coates *et al* (1990) who showed that even 5 years after an application of only 10 kg/ha of fertiliser P, *Urochloa* continued to respond positively in yield and composition. As well as the nutrient limitations, buffel grass is also limited on this soil by texture and low pH although it will establish well on low pH soils after cultivation (Humphreys 1967).

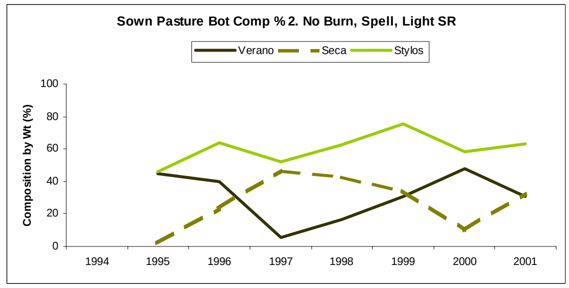
Figure 8. Pasture composition by weight of (a) sown grass and (b) stylo components in individual treatments at Eureka Creek measured at the end of the summer growing season.

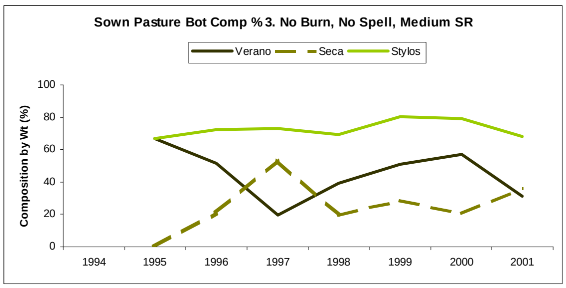
(a) Sown Grass

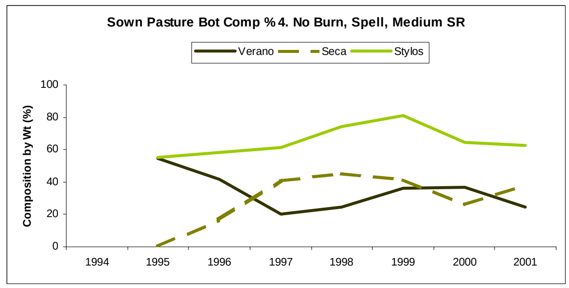


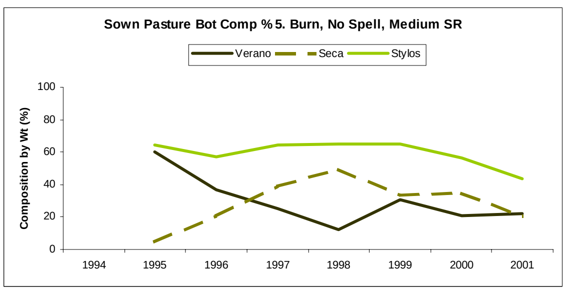
(b) Stylo

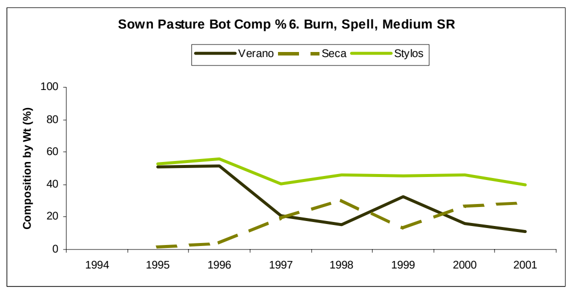

Sown Pasture Bot Comp % 1. Burn, No Spell, Light SR
Verano
Seca
Stylos
Composition by Wt (%)
0
20
40
60
80
100
1994
1995
1996
1997
1998
1999
2000
2001


Sown Pasture Bot Comp % 2. No Burn, Spell, Light SR
Verano
Seca
Stylos
Composition by Wt (%)
0
20
40
60
80
100
1994
1995
1996
1997
1998
1999
2000
2001


Sown Pasture Bot Comp % 3. No Burn, No Spell, Medium SR
Verano
Seca
Stylos
Composition by Wt (%)
0
20
40
60
80
100
1994
1995
1996
1997
1998
1999
2000
2001


Sown Pasture Bot Comp % 4. No Burn, Spell, Medium SR
Verano
Seca
Stylos
Composition by Wt (%)
0
20
40
60
80
100
1994
1995
1996
1997
1998
1999
2000
2001


Sown Pasture Bot Comp % 5. Burn, No Spell, Medium SR
Verano
Seca
Stylos
Composition by Wt (%)
0
20
40
60
80
100
1994
1995
1996
1997
1998
1999
2000
2001


Sown Pasture Bot Comp % 6. Burn, Spell, Medium SR
Verano
Seca
Stylos
Composition by Wt (%)
0
20
40
60
80
100
1994
1995
1996
1997
1998
1999
2000
2001

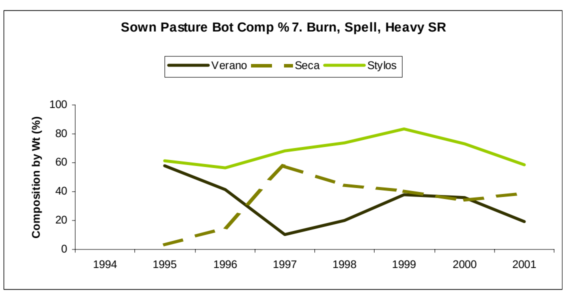

Sown Pasture Bot Comp % 7. Burn, Spell, Heavy SR
Verano
Seca
Stylos
Composition by Wt (%)
0
20
40
60
80
100
1994
1995
1996
1997
1998
1999
2000
2001

Table 8. Sown pasture species composition (% of total yield) at the end of the growing season as affected by spelling, burning and grazing pressure.

(a) % Sown grasses

	No burn		Burn		Grazing Pressure[1]		
	No spell	Spell	No spell	Spell	Light	Medium	Heavy
1994/95	14	37	25	32	36	37	28
1995/96	26	41	33	42	36	41	43
1996/97	25	37	24	57	48	37	28
1997/98	28	23	26	52	37	23	25
1998/99	17	15	14	49	23	15	13
1999/00	16	25	33	50	39	25	18
2000/01	29	26	23	48	34	26	18

[1] Grazing pressure data refer to the no burn-spell treatment.

(b) % Seca

	No burn		Burn		Grazing Pressure[1]		
	No spell	Spell	No spell	Spell	Light	Medium	Heavy
1994/95	0	0	5	2	2	0	4
1995/96	21	17	21	4	24	17	15
1996/97	53	41	39	19	46	41	58
1997/98	20	45	50	31	43	45	45
1998/99	29	42	34	13	34	42	41
1999/00	21	26	35	27	10	26	35
2000/01	36	38	21	29	33	38	39

[1] Grazing pressure data refer to the no burn-spell treatment.

(c) % Verano

	No burn		Burn		Grazing Pressure [1]		
	No spell	**Spell**	**No spell**	**Spell**	**Light**	**Medium**	**Heavy**
1994/95	67	55	60	51	45	55	58
1995/96	51	41	37	52	40	41	42
1996/97	20	20	25	21	6	20	10
1997/98	39	25	12	15	17	25	20
1998/99	51	36	31	32	31	36	38
1999/00	57	37	21	16	48	37	36
2000/01	31	25	22	11	31	25	20

[1] Grazing pressure data refer to the no burn-spell treatment.

(d) % grass in sown grass treatments at end of 2000 – 01 growing season

	No burn		Burn		Grazing Pressure [1]		
	No spell	**Spell**	**No spell**	**Spell**	**Light**	**Medium**	**Heavy**
Urochloa	0	6	3	7	12	6	6
Buffel	0	1	0	4	10	1	0
Indian couch	29	19	20	37	12	19	12
Native grass	2	8	29	11	2	8	6
Total grass	31	34	52	59	36	34	24

[1] Grazing pressure data refer to the no burn-spell treatment.

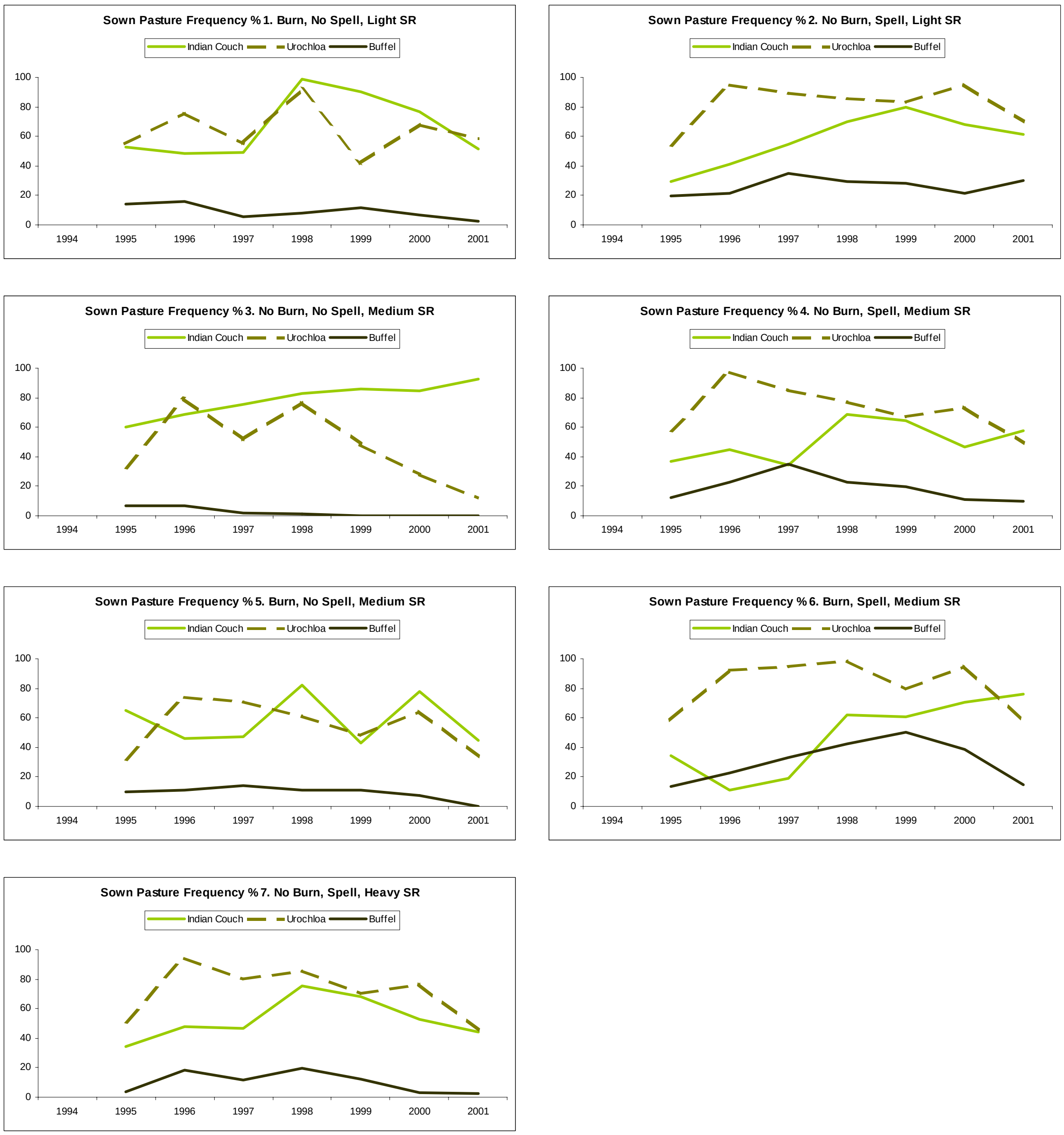
Burning treatments also resulted in an increase in the native grass yields and composition (combination of 3P and increaser grasses). In the final year of the experiment, mean yield and composition of burn treatments were 338 kg DM/ha and 20% respectively compared with means of 140kg DM/ha and 5% for the no burn treatments (Table 7b).

Frequency occurrence

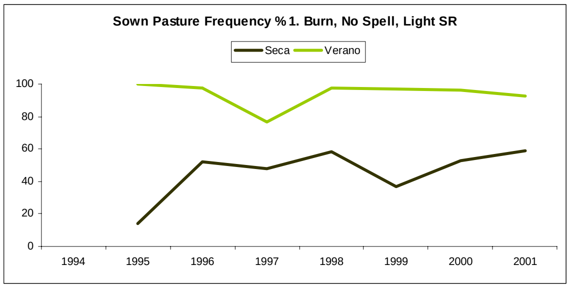
The frequency of occurrence of buffel plants was low throughout. The highest recording was in the burn-spell treatment at medium stocking rate in 1999 (45%) but by 2001 even in that treatment it had declined to 15% occurrence (Figure 9).

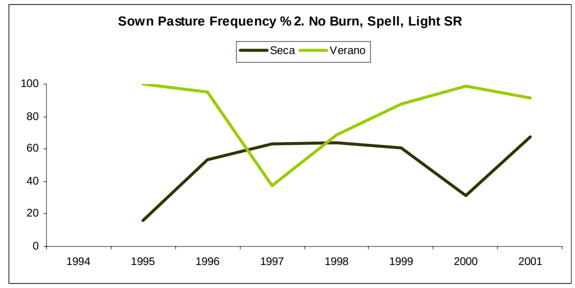
Figure 9. Frequency occurrence (%) of pasture species measured in 0.5m x 0.5m quadrats of (a) sown grass and (b) stylo components in sown pasture treatments at Eureka Creek measured at the end of the summer growing season.

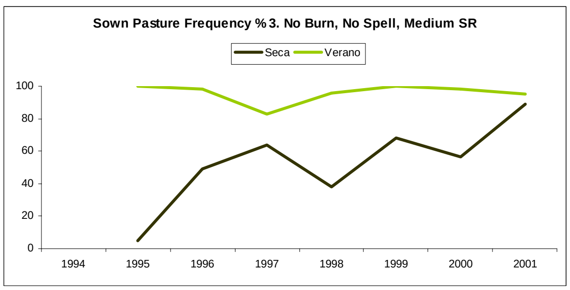
(a) Sown Grass

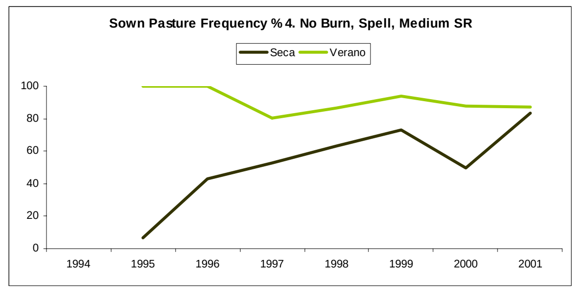


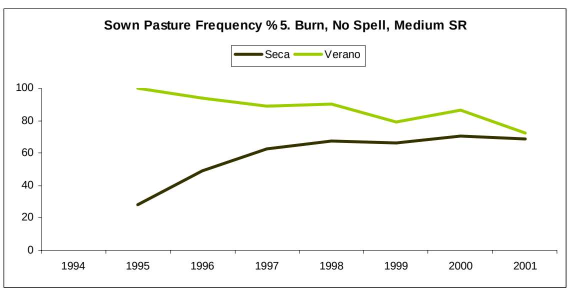
(b) Stylo

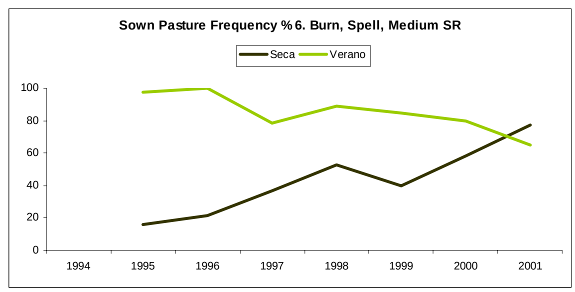


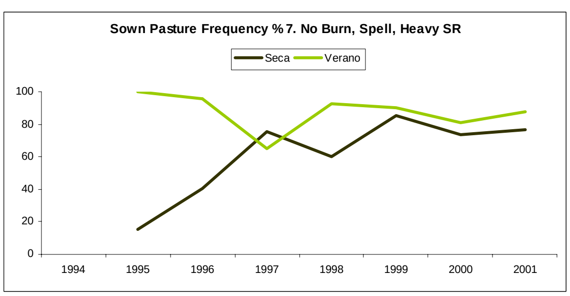












Urochloa and buffel were favoured by spelling (Table 9) whereas Indian couch occurred more frequently in unspelled treatments. Mean Indian couch frequency over all years in unspelled treatments was 68% compared with 49% for spelled treatments. There was no apparent effect of stocking rate on presence of sown grass.

There was no effect of treatment or stocking rate on frequency occurrence of seca although it generally increased with time from <20% in 1994/95 to c.80% in 2000/01. The frequency occurrence of verano was high throughout and there was no effect of treatment or stocking rate. Mean occurrence over all years was 90%.

Sowing introduced grasses to achieve a healthy grass-stylo balance in stylo dominant pastures may be a more attractive option for some producers than trying to maintain native species. There are a limited number of grasses available that are adapted both climatically and to soil physical conditions. As well, an ongoing fertilisation program will be needed on low phosphorus soils to maintain a heterogeneous mix of grass species. In this experiment a 50/50 grass-stylo mixture was obtained and maintained after two seasons in the sown pasture being spelled and burnt, while only a 30% grass proportion was achieved in the native pasture after seven seasons. The increment in grass yield in the native pasture was due to the yield increase of black speargrass. By 1999/00, the sown grass yield was 1505 kg DM/ha compared to 1126 kg DM/ha of native pasture in burnt and spelled treatments.

Table 9. Sown pasture species frequency (% occurrence) at the end of the growing season as affected by spelling, burning and grazing pressure.

(a) % frequency of Urochloa

	No burn		Burn		Grazing Pressure [1]		
	No spell	Spell	No spell	Spell	Light	Medium	Heavy
1994/95	33	58	32	58	54	58	51
1995/96	79	98	74	92	95	98	95
1996/97	51	86	71	95	90	86	80
1997/98	77	78	62	99	86	78	86
1998/99	48	67	49	80	83	67	71
1999/00	28	73	64	95	95	73	77
2000/01	13	49	34	58	70	49	45

[1] Grazing pressure data refer to the no burn-Spell treatment.

(b) % frequency of Indian couch

	No burn		Burn		Grazing Pressure [1]		
	No spell	Spell	No spell	Spell	Light	Medium	Heavy
1994/95	60	37	65	34	29	37	34
1995/96	69	45	46	11	41	45	48
1996/97	75	35	47	19	55	35	46
1997/98	83	69	82	62	70	69	75
1998/99	86	64	43	61	80	64	68
1999/00	85	48	78	71	68	47	53
2000/01	93	57	45	76	61	57	44

[1] Grazing pressure data refer to the no burn-spell treatment.

(c) % frequency of Buffel

	No burn		Burn		Grazing Pressure [1]		
	No spell	Spell	No spell	Spell	Light	Medium	Heavy
1994/95	7	12	10	14	20	12	3
1995/96	7	23	11	23	21	23	19
1996/97	2	35	14	33	35	35	12
1997/98	1	23	11	42	30	23	20
1998/99	0	20	11	50	28	20	12
1999/00	0	11	7	39	22	11	3
2000/01	0	10	0	15	30	10	2

[1] Grazing pressure data refer to the no burn-spell treatment.

(d) % frequency of Seca

	No burn		Burn		Grazing Pressure [1]		
	No spell	Spell	No spell	Spell	Light	Medium	Heavy
1994/95	5	7	28	16	16	7	15
1995/96	49	43	49	22	53	43	40
1996/97	64	53	63	37	64	53	76
1997/98	38	64	67	53	64	64	60
1998/99	68	73	66	40	61	73	85
1999/00	56	50	70	58	31	50	74
2000/01	89	84	69	78	68	84	77

[1] Grazing pressure data refer to the no burn-spell treatment.

(e) % frequency of Verano

	No burn		Burn		Grazing Pressure [1]		
	No spell	Spell	No spell	Spell	Light	Medium	Heavy
1994/95	100	100	100	98	100	100	100
1995/96	98	100	94	100	95	100	96
1996/97	83	81	89	79	38	81	65
1997/98	96	86	90	89	69	86	93
1998/99	100	94	79	85	87	94	90
1999/00	98	88	87	80	99	88	81
2000/01	95	87	73	65	91	87	88

[1] Grazing pressure data refer to the no burn-spell treatment.

Grass-stylo balance in commercial pastures

The sown legume-grass balance in 19 commercial pastures were measured in 1995, 1998 and 2000 (Mareeba, Mt Garnet and Georgetown districts) and in 1995 and 1998 (Charters Towers district) (Table 10). Sowing dates range from 1982 to 1993 and all included at least some sown grass seed. At the final observation the mean sown legume composition was 61% (range 39% to 89%) for pastures >10 year old and 31% (range 6% to 54%) for pastures <10 year old. Sown legume content in pastures <10 year old generally increased at each of the 3 observations (mean variation between first and last observation +27%) whereas, in older pastures, sown legume content was more stable (mean variation -0.5%) but usually after only 2 observations. Sown legume variation between the 1995 and 1998 observations (common to all commercial pastures) were +14 for pastures <10 years old and +0.6 for pastures >10 years old.

Table 10. Yield and composition of pasture components in commercial pastures oversown to predominantly stylo and including sown grass.

Property	Site	Date Sown	Date Measured	Total Yield	% Sown Legume	% Sown Grass	% Native Grass
1	a	Dec, 91	1995 1998 2000	592 1129 1791	1 39 51	2 6 9	74 46 33
2	a	Dec, 92	1995 1998 2000	5647 6774 3971	1 2 7	91 88 76	1 2 2
3	a	Feb, 92	1995 1998 2000	1190 1686 1144	5 33 42	1 5 3	70 57 42

Property	Site	Date Sown	Date Measured	Total Yield	% Sown Legume	% Sown Grass	% Native Grass
4	a	Dec, 91	1995 1998 2000	1931 2293 3705	3 17 54	3 23 16	68 50 22
	b	Dec, 91	1995 1998 2000	1203 1222 1817	2 14 6	2 10 32	81 60 49
	c	Dec, 91	1995 1998 2000	2137 1919 2403	2 3 9	69 82 77	23 9 9
5	a	Feb, 94	1995 1998 2000	1910 1932 1741	16 20 28	12 23 18	69 55 61
	b	Jan, 93	1995 1998 2000	3380 1160 1754	2 5 27	67 64 64	24 26 6
	c	Jan, 93	1995 1998 2000	2134 2171 2105	1 27 51	26 52 37	66 19 12
6	a	Jan, 86	1995 1998 2000	2020 3253 2997	51 70 59	1 1 0	41 26 30
7	a	1982	1998 2000	1802 2810	67 55	1 1	27 42
8	a	1983/84	1995 1998	6000 3317	64 47	33 35	1 3
	b	1983/84	1995 1998	5500 2570	68 50	24 33	2 10
	c	1983/84	1995 1998	6500 2673	51 39	42 33	4 2
9	a	1985	1995 1998	3000 2013	69 50	4 12	22 24
10	a	1985/86	1995 1998	6000 6026	64 89	26 2	2 8
11	a	1983	1995 1998	6500 9125	74 88	0 0	20 11
	b	1983	1995 1998	5500 7087	71 85	0 0	27 14
12	a	1985/87	1995 1998	700 918	40 52	1 7	41 39

Economic modelling

Economic models were developed to allow comparisons to be made between different stylo and grass (native and sown) compositions. Assumptions made were that the property (10000 ha) carried 1000 Adult Equivalents (AE) before sowing stylo and carried 2000 AE with 50/50 grass-stylo after ten years. The pasture could then be allowed to degrade to stylo dominance or be managed to remain at the 50/50 mix through the use of pasture spelling, burning or establishing sown grasses. The gross margin for the property was improved by stylo sowing but lowered when intervention occurred to keep the 50/50 mixture. The difficulty in interpreting stylo dominant pastures is how to value (or devalue) potential problems such as lost productivity through weed invasion, erosion or soil acidification. Sown perennial grasses are able to tolerate heavier grazing pressures than native perennial grasses and hence their higher gross margin (Table 11).

Table 11. Annual gross margins for a modelled property under a range of pasture development scenarios.

Pasture type	Gross margin
Native pasture, 1000 AE	$45 072
50/50 native grass-stylo, 2000 AE	$187 120
50/50 native grass-stylo spelled and burnt, 1600 AE	$149 696
Over 90% stylo, 2000 AE	$197 842
50/50 sown grass-stylo, 2000 AE	$205 550

Success in achieving objectives

This project clearly demonstrated that native pastures dominated by stylo could be rehabilitated by combinations of burning and spelling together with manipulating grazing pressure or by replacing the native perennial grass component with grazing resilient exotic grasses. These results were communicated through a variety of media from regular peer review, on-site field days and a number of occasional publications.

Economic analyses show that pastures maintained at an acceptable balance of grass and stylo are almost equivalent to stylo dominant pastures but the gap is much wider through reduced productivity taking into account paddock spelling and burning. These analyses highlight the need to proactively manage to prevent stylo dominance rather than be forced into a rehabilitation program. On the plus side, observations of commercial pastures suggest that stylo dominance, while a risk, may be less of a problem that originally thought.

CONCLUSIONS

Rehabilitating native pastures

In this environment >800mm rainfall in a growing season was necessary before any changes became apparent regardless of treatment.

At light stocking rates only spelling was required to return 3P grass yields to natural levels even though stylo yields reached high levels and grasses composed only 10% of total pasture.

At medium stocking rates, burning to reduce stylo competition produced a significant improvement in 3P grasses and there was a further significant improvement with the burn-spell combination. Only the combination of burning and spelling produced a balanced pasture where native grasses, dominated by 3P species, made up 30% to 50% of total yield.

At heavy stocking rates there was no rehabilitation of the stylo dominant pasture to spelling.

Replacing the native grasses with sown improved grasses

Cultivation drastically reduced stylo competition and effective sown grass establishment occurred regardless of stocking rate.

At light stocking rates a spelling period produced and maintained effective sown grass-stylo yields and balance.

At medium stocking rates the combination of burning and spelling produced high yields and good balance of sown grass and stylo.

At the heavy stocking rate the sown grass declined over time and became a minor component of the pasture.

Urochloa dominated the sown grass component in the first 3 years but later declined probably as soil P declined and an ongoing fertiliser program will be needed to retain it on phosphorus deficient soils.

Indian couch was slow to establish but it increased with time and would have gone on to dominate the sown grass component. It appears adapted to the low fertility status of these soils.

Impact on meat and livestock industry

The industry can be confident that, at moderate stocking rates, combinations of pasture spelling and burning are able to successfully rehabilitate pastures dominated by oversown stylo. The issue of stylo dominance remains a risk but is not currently a widespread problem.

Vigilance (call it pasture monitoring) is the current best practice to ensure that the 3P pasture grass component remains strong and this can be managed by periodically easing grazing pressure over the wet season to ensure seed set. However, spelling and burning practices are now relatively novel in the northern grazing industry after being common practice until the late 1970's. Interest in these practices is growing, however, as a means of controlling increasing tree density in semi-arid woodlands and in 5 to 10 years may, in fact, be common practice on some cyclical basis.

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