The impact of fire on population density and canopy area of currant bush (*Carissa ovata*) in central Queensland and its implications for grazed woodland management

P.V. BACK
Sustainable Grazing Systems, Animal Science, Department of Primary Industries and Fisheries, Rockhampton, Queensland, Australia

Abstract

Currant bush (*Carissa ovata*), where present in central Queensland beef cattle pastures, poses a severe constraint on the availability of herbage to domestic grazing animals and reduces the stock carrying capacity of the pasture. The impact of fire on population density and canopy cover of currant bush was investigated over 7 years. Seven burning treatments were imposed on plots heavily infested with currant bush and compared with an unburnt control. The treatments were: burnt once, burnt twice (12 months apart), burnt twice (20 months apart), burnt twice (24 months apart), burnt twice (32 months apart), burnt 3 times (20 months then 12 months apart) and burnt 3 times (32 months then 36 months apart).

Few existing currant bush plants died as a result of burning; however, fragmentation of the original plants increased plant numbers by an average of 22%. By greatly reducing the canopy of currant bush, fire gave cattle access to the pasture in those areas formerly occupied by currant bush. Measurements of canopy regrowth rates following burning indicate that regular burning, at least every 5 years, would contain the spread of currant bush without needing to attempt eradication of this native plant.

Introduction

Currant bush (*Carissa ovata*) is an erect or spreading, intricately branched shrub, 1–2 m tall, rarely semi-climbing up to 4.5 m tall, glabrous or scabrous with opposite axillary spines (Stanley and Ross 1986). In Queensland, it is found from the New South Wales border to southern Cape York. Its habitat ranges from seaside scrubs to softwood and brigalow (*Acacia harpophylla*) scrubs and semi-arid eucalypt woodlands. Currant bush spreads by seed and vegetatively by layering (prostrate stems up to 3 m long that root wherever they rest on the ground) and forms dense clumps that can cover over 100 m^2. Clumps can coalesce to cover large areas that significantly reduce pasture production (Dyer *et al*. 1997). Currant bush occurs most frequently where annual rainfall is 500–650 mm and is also known as 'baroom bush' (Anderson 1993), blackberry, 'burrum bush' and conkberry (NRM 2001).

In 1947, an investigation into the incidence of currant bush was carried out following complaints from landholders in the Emerald area (Mann 1947). Mann's report found that currant bush 'has reached pest proportions in the Emerald-Capella-Blackwater triangle, and been the subject of complaint for several years'. He also noted that 'The plant occurs in many parts of Western, South-western and Coastal Queensland, but it has not assumed pest proportions, except in the above-mentioned district.'

In central Queensland, currant bush has been observed thickening up (increases in both number of plants and the canopy area of individual plants) for many years over vast areas of cleared and uncleared semi-arid poplar box (*Eucalyptus populnea*), Reid River box (*E. brownii*) and narrow-leaf ironbark (*E. crebra*) woodlands north of the Tropic of Capricorn (Mann 1947; Dyer *et al.* 1997). Mann was of the opinion that '1. the plant is increasing on both improved and unimproved country by virtue of the spreading out and layering of existing plants and not by the development of new plants. 2. this increase does not appear to be significant on hitherto clean country.

Correspondence: P.V. Back, Department of Primary Industries and Fisheries, PO Box 6014, Central Queensland Mail Centre, Queensland 4702, Australia. E-mail: paul.back@dpi.qld.gov.au

3. while it is evident that ringbarking (the trees) benefits the plant, there is not sufficient evidence to justify the view that destroying the timber (trees) causes the plant (currant bush) to increase alarmingly or even rapidly.'

Currant bush was considered a problem in the central highlands (of Queensland) in uncleared or old cleared (ringbarked) eucalypt country, particularly poplar box, but not in developed brigalow and associated species scrubs (Back 1974; Kleinschmidt and Johnson 1977). Later, currant bush was seen as the major woody weed after brigalow regrowth in the brigalow lands (Anderson *et al*. 1984; Milson 1996). It is now widely accepted that extensive and regular burning by Aboriginal people maintained the semi-arid eucalypt woodlands of northern Australia as an open savanna with little dense understorey (Dyer *et al.* 1997). In the early days of European settlement, control of currant bush by grubbing out the plants was successful in some cases but unsatisfactory in others, while burning off showed little success (Mann 1947). Some control of currant bush can be expected from the initial clearing fire following development of brigalow scrubs (Anderson and Beeston 1974).

Currant bush is not a strong competitor with grass, and grass is found growing within old clumps. However, cattle cannot access this feed because of the prickly and dense sprawling nature of the shrub. The presence of grass amongst the currant bush does seem to ensure that there is enough fuel to carry a fire and enough grass seed present to recolonise the area when the currant bush canopy is removed.

Ploughing or chemical application can effectively control currant bush (Anderson and Beeston 1974; Scanlan and Anderson 1981; Back 1998). Queensland's Department of Natural Resources, Mines and Energy recommends the use of mechanical and chemical controls for currant bush (NRM&E 2001); however, under their vegetation management legislation, only previously cleared country (regrowth) can be treated in this way. This leaves managers of the undeveloped box and ironbark woodlands of semi-arid central and north Queensland, which have low natural carrying capacity, little scope other than fire for the control of currant bush. In recent years, fire has been seen as a tool for controlling woody weeds that may be both practical and economically viable (Tothill and Gillies 1992; Partridge 1992; Landsberg 2001). However, its effectiveness at either killing currant bush or reducing its canopy and therefore its competitiveness with pasture was not well understood. The present study was designed to assess the effect of a series of fire regimens on the population density and canopy cover of currant bush.

Materials and methods

Site

The study was carried out on "Pasha" (21°42′S, 147°32′E), a commercial beef cattle grazing property, approximately 40 km south-east of Mount Coolon and 80 km west of Moranbah in the northern Central Highlands Region of central Queensland. The original vegetation was a mixture of open poplar box, Reid River box and blackbutt (*E. cambageana*) with small patches of brigalow. The understorey contained ironwood (*A. excelsa*), scrub leopardwood (*Flindersia dissosperma*), wait-a-while (*Capparis lasiantha*), whitewood (*Atalaya hemiglauca*), false sandalwood (*Eremophila mitchellii*), Leichhardt bean (*Cassia brewsteri*), vine tree (*Ventilago viminalis*) and yellowwood (*Terminalia oblongata*). The soil at the site was a sandy-surfaced red duplex.

The original vegetation was pulled in 1973 using 2 large bulldozers connected by a heavy anchor chain. The regrowth following the initial clearing has been pulled twice since then with the latest treatment in 1992, 4 years prior to imposing the first treatment in this study. The pasture on the site was in good condition and comprised mainly desert blue grass (*Bothriochloa ewartiana*), buffel grass (*Cenchrus ciliaris*), bull Mitchell grass (*Astrebla squarrosa*) and numerous annual and short-lived grasses [*e.g.* winged windmill grass (*Oxychloris scariosa*)] and forbs. Grazing was excluded from plots for a year following the fire treatments to avoid damage to the currant bush plants from trampling and grazing, as cattle tend to congregate on burnt areas and will eat the fresh growth (Everist 1969).

Rainfall

Rainfall was below average for 4 of the 7 years (1996–2002) that burning treatments were in progress (Figure 1). The severe drought conditions prevailing in 1993 and 1994 delayed the

accumulation of enough fuel for the first burn until late summer 1995–96. This was followed by poor years in 1996 and 1997 and relatively good years from 1998 until 2000. Both 2001 and 2002 were well below average years. This variation in rainfall had a subsequent effect on fuel loads as will be discussed later.

The experiment

Seven burning treatments were imposed on 0.5 ha plots (50 m × 100 m) and compared with an unburnt control in a randomised block design with 3 replicates. The treatments (Table 1) were:

Burnt Feb. 1996 (Treat. B1).

Burnt Feb. 1996 and Oct. 1997 (Treat. B1,2).

Burnt Feb. 1996, Oct. 1997 and Oct. 1998 (Treat. B1,2,3).

Burnt Feb.1996 and Oct. 1998 (Treat. B1,3).

Burnt Oct. 1997 and Oct. 1999 (Treat. B2,4).

Burnt Oct. 1998 and Oct. 1999 (Treat. B3,4).

Burn Feb. 1996, Oct. 1998 and Oct. 2001 (Treat. B1,3,5).

Control, no burning treatment (Treat. C).

The experimental plots were fenced to allow control over grazing and fuel build up for burning. A 3 m-wide firebreak was established around all plots and was maintained using a 4-wheel-drive tractor fitted with a front-mounted blade. Only those plots to be burnt had their firebreaks re-graded prior to burning.

Permanent belt transects 50 m long and 4 m wide were located in the centre of each plot to assess the density and canopy cover of currant bush prior to treatment. The number of transects was dictated by the number of currant bush plants falling within each belt. Between 1 and 7 belts were required to obtain a target minimum of 50 plants in each plot. Each extra belt was placed alternately to the left then right of and adjoining the central band. This gave a measured block and ensured the recording area was close to the centre of the plot and far from the plot boundaries, so that the fire would be well established before entering the recording area.

All woody plants within each belt were recorded using the TRAPS (Back *et al.* 1997; 1999) methodology. This involved permanently pegging the centre line of each belt transect, enabling a tape measure to be stretched along this centre line. The position of each woody plant in the transect was recorded by measuring and recording the distance along the transect from the origin and left or right of the centre line to that plant (Figure 2). This position then allowed identification of each individual plant at subsequent recordings and was considered superior to tagging plants as even metal tags would be lost if the whole of a plant was consumed by the fire. The species, height, basal circumference or canopy size and, following fire, the fire effect were recorded for all woody plants. Canopy size was recorded for currant bush plants as it was found impossible to measure the basal circumference due to the low-growing multi-stemmed nature of the plants. This was done by measuring the diameter of the plant perpendicular to, and parallel to, the transect centre line. All plots were assessed in this way before the first burn, one year after burning and immediately before the next burn. A final count was made of all treatments in 2001 except Treatment B1,3,5 which was in 2002.

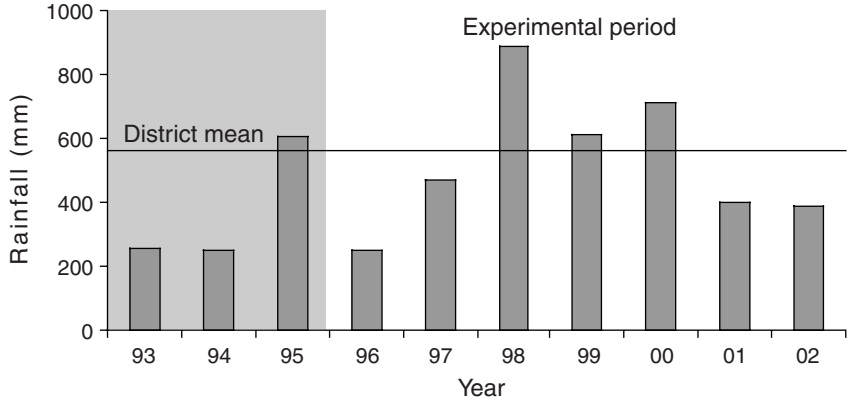


Figure 1. Annual rainfall at 'Pasha' from an on-site automatic weather station prior to and during the trial plus the long-term district mean from 'Australian Rainman' (Clewett *et al*. 1994).

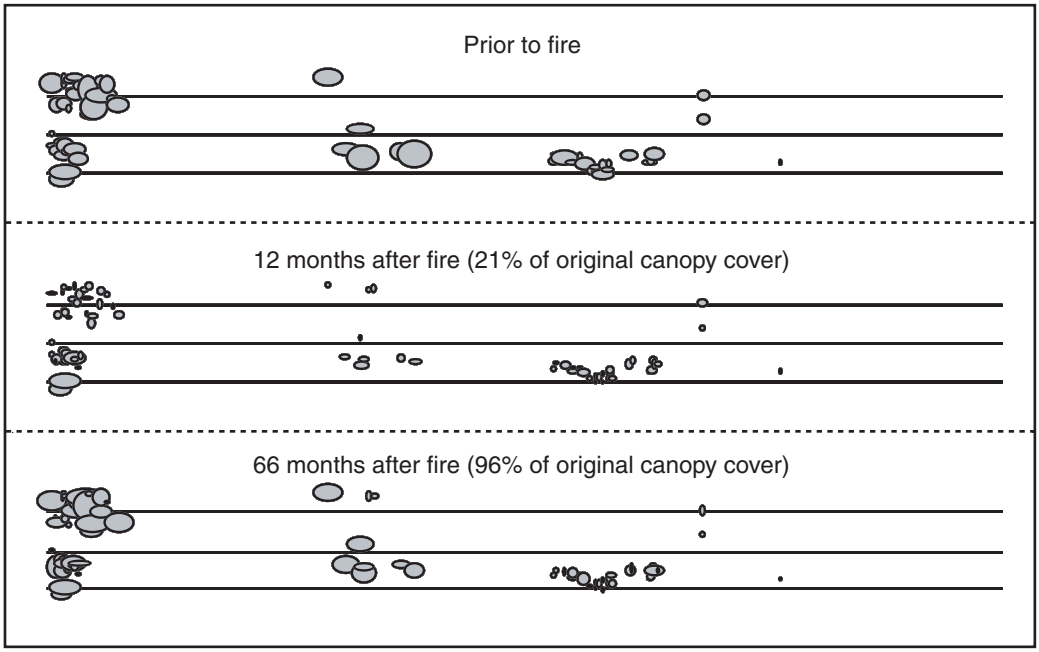


Figure 2. Diagram produced by the 'TRAPS' analysis program, showing the distribution and size of the currant bush plants in Replicate 2 of a treatment burnt only in February 1996 both before and 12 and 66 months after the burn.

The plots were burnt in the afternoon when the humidity was at its lowest and any wind was abating. This is a local method used when burning large paddocks as the fire intensity declines after sundown and it is therefore safer and easier to control. Fires were lit using drip torches along the edges of the plots. The down-wind side was lit first and the fire allowed to burn into the plot for 2–3 m before the remaining sides were lit. This allowed the fire to create its own draught and resulted in fairly clean burns when fuel was sufficient. Where the fuel was patchy, an operator with a drip torch walked around inside the plot and attempted to light the unburnt patches. Each plot took less than 30 minutes to burn. Fire-fighting equipment (knapsacks and fire-fighting trailers with water tanks and pumps) was on site during each burn but was needed only to prevent the fire crossing the graded firebreak. No fires escaped.

The treatments were imposed over 6 years. The 2 consecutive year burn Treatment B1,2 and the 2-year burn Treatment B1,3 were repeated, B3,4 and B2,4, to allow for different seasonal conditions. The initial burn (B1) was not carried out until February 1996 as intermittent light rain in the early summer period kept the fuel green and made burning impossible. Well below average rainfall following this burn resulted in insufficient fuel to burn in late 1996. Poor burns were obtained in those treatments burnt in February 1996 and again in October 1997 (B1,2 and B1,2,3). However, there was ample fuel available to ensure a good burn for Treatment B2,4. There was sufficient fuel for all other burning treatments.

An assessment of the severity of the fire on individual plants was used as a substitute for recording fuel load, fuel moisture, air temperature and humidity and wind velocity at the time of the fire. Each individual plant was allocated a burn rating 2–4 weeks following the fire. This allowed enough time for leaves to 'brown out' but not drop. Each plant was located and assigned a burn rating between 0 and 3, where 0 = no effect, 1 = all leaves browned, 2 = all leaves consumed and 3 = the whole plant consumed. Intermediate ratings were used where appropriate, *e.g.* a rating of 1.5 for a plant with half of its leaves consumed and the remainder browned. Plots that were not to be re-burnt were kept unstocked to avoid damage to the young regrowth until after the next recording (11–12 months). They were then grazed by cattle.

Results

Burn ratings

The burn ratings for February 1996 showed the fires were quite hot and consumed much of the currant bush plants (Table 2). With the limited fuel supply, the October 1997 burns had minimal effects and generally merely browned the leaves (burn ratings 0.71–0.96) except for Treatment B2,4 (burn rating 1.53) which had not been burnt in February 1996. The October 1998 burn gave a reasonable result although the amount of fuel available was still depressed as a result of the previous very dry years. The good rains in late 1998 and early 1999 ensured plenty of fuel in October 1999, which is reflected in the very effective burns obtained. The burn in October 2001 consumed all of the leaves and some plants.

Population density

Responses in density of the currant bush population varied among treatments (Figure 3a; Figure 4). At the end of the trial, treatments involving a single fire (B1, 38% increase in population density) and 2 alternate yearly burns (B1,3, 39% increase; B2,4, 47% increase) carried significantly ($P = 0.029$) more currant bush plants than the control (15% decrease), B1,2,3 (9% decrease) and B1,3,5 (8% decrease). Burning treatments B1,2 (26% increase) and B3,4 (20% increase) had no significant effect on currant bush population density when compared with the control or the other burning treatments.

When the effect on population density of currant bush from each burning treatment was compared 12 months after the last burn in each treatment, there was no significant difference between the burning treatments (Figure 3b).

Plant canopy area

By the end of the trial, plant canopy area was reduced significantly ($P < 0.001$) compared with the control (35% increase in canopy area) following all the burning treatments (Figure 3a; Figure 5). Treatment B1 (88% of original) was significantly different from all the other burning treatments. Treatment B1,2 (68% of original) had significantly ($P < 0.001$) more regrowth than treatments B1,2,3 (46% of original), B3,4 (26% of original) and B1,3,5 (20% of original). Treat-

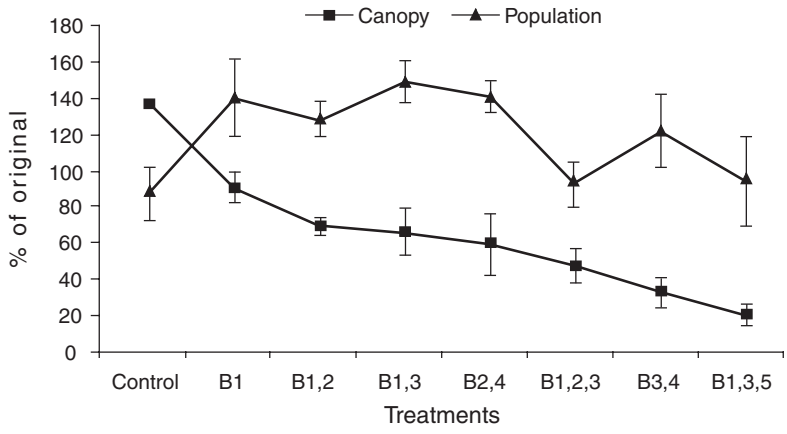
Table 1. Dates for fires in the various treatments.

Treatment	1995/96	1997/98	1998/99	1999/00	2000/01	2001/02
C	Control					
B1	Feb 96					
B1,2	Feb 96	Oct 97				
B1,2,3	Feb 96	Oct 97	Oct 98			
B1,3	Feb 96		Oct 98			
B2,4		Oct 97		Oct 99		
B3,4			Oct 98	Oct 99		
B1,3,5	Feb 96		Oct 98			Oct 01

Table 2. Burn rating[1] for each of the burning treatments (mean of 3 replicates) 2–4 weeks after the burn.

Burn date	Feb 96	Oct 97	Oct 98	Oct 99	Oct 2001
Treatment	B1	B2	B3	B4	B5
B1	2.15				
B1,2	2.11	0.96			
B1,2,3	2.31	0.71	2.17		
B1,3	2.13		1.42		
B2,4		1.53		2.37	
B3,4			1.77	2.33	
B1,3,5	1.91		1.98		2.49
Mean	2.122	1.07	1.835	2.35	2.49

[1] Rating: 0 = no effect; 1 = all leaves browned; 2 = all leaves consumed; 3 = the whole plant consumed.



Canopy area — % of original

Treatment	Mean	Sig. Diff. (P = <0.001)
Control	135.3	A
B1	88.47	B
B1,2	68.23	C
B1,3	57.17	C D
B2,4	56.35	C D
B1,2,3	45.56	D E
B3,4	26.13	E F
B1,3,5	19.71	F

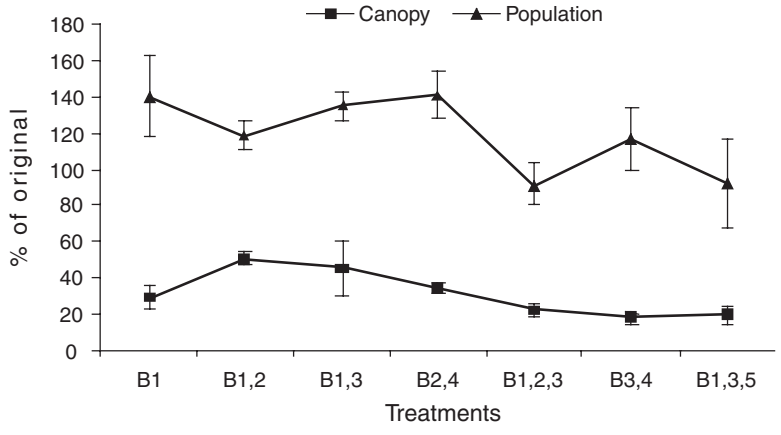
LSD (P = <0.001) 19.73

Population area — % of original

Treatment	Mean	Sig. Diff. (P = 0.029)
Control	84.94	A
B1	138.01	B
B1,2	125.67	A B
B1,3	138.56	B
B2,4	146.89	B
B1,2,3	90.58	A
B3,4	119.70	A B
B1,3,5	92.05	A

LSD (P = 0.029) 41.46

Figure 3a. Canopy area and population density of currant bush at the end of the trial as a percentage of the original. Vertical bars indicate the s.e. of the means. **B1** = burnt Feb 96; **B1,2** = burnt Feb 96 & Oct 97; **B1,2,3** = burnt Feb 96, Oct 97 & Oct 98; **B1,3** = burnt Feb 96 & Oct 98; **B2,4** = burnt Oct 97 & Oct 99; **B3,4** = burnt Oct 98 & Oct 99; **B1,3,5** = burnt Feb 96, Oct 98 & Oct 2001. Within tables, values followed by different letters are significantly different.



Canopy area — % of original

Treatment	Mean	Sig. Diff. (P = 0.022)
B1	29.02	A B
B1,2	50.59	C
B1,3	45.63	B C
B2,4	34.48	A B C
B1,2,3	22.54	A
B3,4	17.80	A
B1,3,5	19.71	A

LSD (P = <0.022) 20.13

Population density — % of original

Treatment	Mean	Sig. Diff.
B1	140.30	A
B1,2	119.23	A
B1,3	135.48	A
B2,4	141.46	A
B1,2,3	91.64	A
B3,4	116.92	A
B1,3,5	92.05	A

Figure 3b. Canopy area and population density of currant bush 12 months following fire treatments. Vertical bars indicate the s.e. of the means. **B1** = burnt Feb 96; **B1,2** = burnt Feb 96 & Oct 97; **B1,2,3** = burnt Feb 96, Oct 97 & Oct 98; **B1,3** = burnt Feb 96 & Oct 98; **B2,4** = burnt Oct 97 & Oct 99; **B3,4** = burnt Oct 98 & Oct 99; **B1,3,5** = burnt Feb 96, Oct 98 & Oct 2001. Within tables, values followed by different letters are significantly different.

ment B1,3 (57% of original) and Treatment B2,4 (56% of original) were significantly ($P < 0.001$) different from B3,4 and B1,3,5.

The canopy areas of currant bush, at 12 months after the last burn in each treatment, were significantly different for some burning treatments (Figure 3b). Treatments B1,2,3 (23% of original), B3,4 (18% of original) and B1,3,5 (20% of original) all had significantly ($P = 0.022$) less canopy area than treatments B1,2 (51% of original) and B1,3 (46% of original) although they were not significantly different from treatments B1 (29% of original) and B2,4 (34% of original).

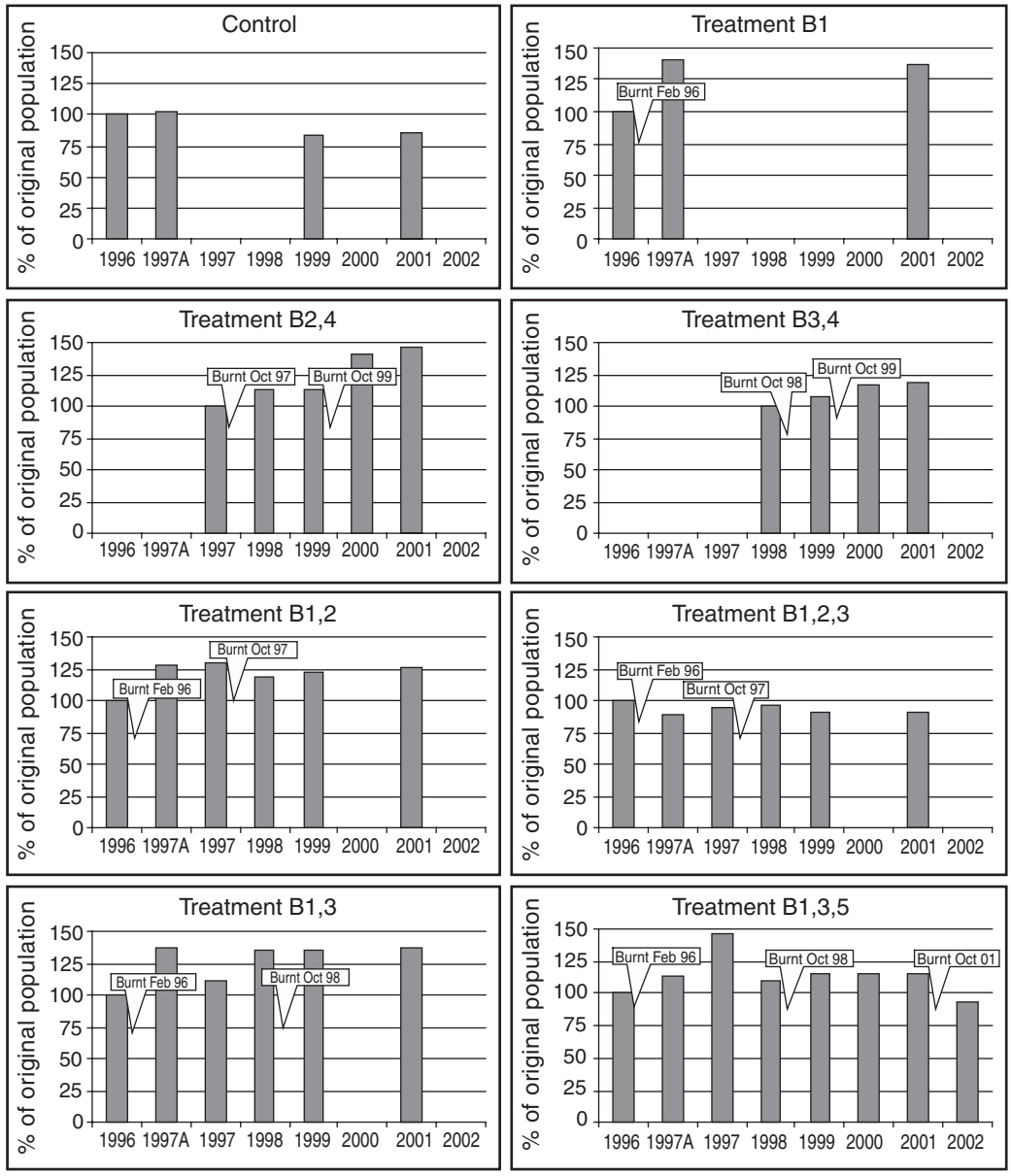


Figure 4. The effect of the various burning regimens on the population density of currant bush (*Carissa ovata)* plants over time as a percentage of the original population (number) (mean of 3 replicates). Note: Those plots burnt in February 1996 were reassessed in February 1997 (shown as 1997A), 12 months after the burn, and those burnt in February 1996 and October 1997 were also reassessed immediately prior to the second burn (shown as 1997).

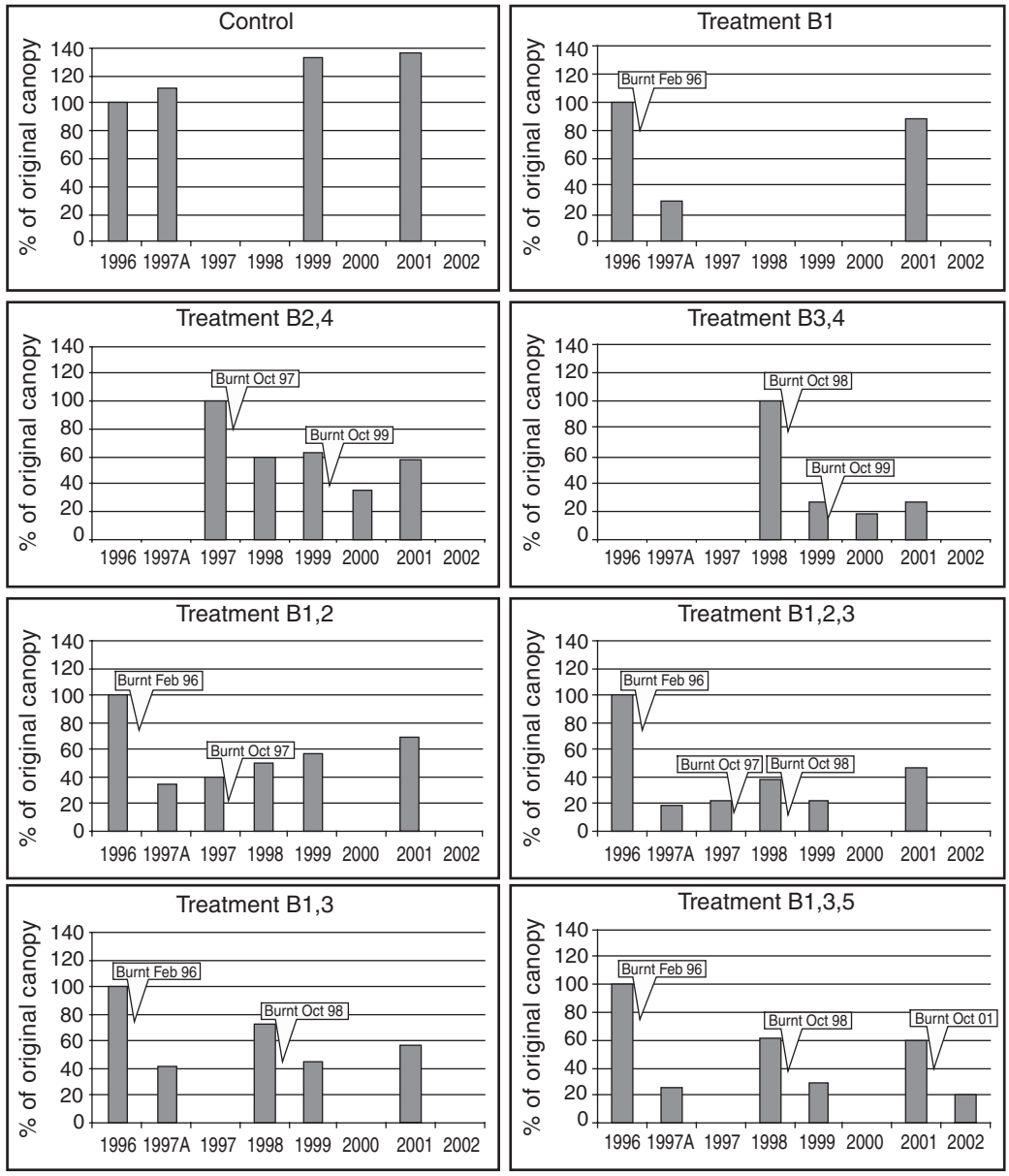


Figure 5. The effect of various burning regimens on the canopy cover of *Carissa ovata* plants over time as a percentage of the original canopy cover (mean of 3 replicates). Plots burnt in February 1996 were reassessed in February 1997 (shown as 1997A), 12 months after the burn, and those burnt in February 1996 and October 1997 were also reassessed prior to the second burn (shown as 1997).

Discussion

This study has confirmed that currant bush is quite resistant to fire, which is hardly surprising, as it has evolved under a regular burning regimen. Fires arising from natural lightning strikes or deliberately lit by aborigines as part of their land management practice (Dyer *et al.* 1997) would have been a regular feature in the region. However, the study has shown that fire can be used effectively to control currant bush. A cursory look at our data would suggest that burning increased the plant population whilst the plant population decreased in the absence of burning. This is apparent rather than real and resulted from the growth habit of the plant, which grows as a ground-hugging, multi-stemmed sprawling shrub. In the absence of fire, adjoining plants can coalesce as they expand, making it difficult to discriminate one from another. They can then be regarded as a single plant. This factor accounted for most of the apparent decrease in population density observed in unburnt plots in the study.

When existing plants are burnt, some of the lateral branches can be partially destroyed leaving a number of smaller plants where the branches have rooted down. When plant counts are made in this situation, one records more plants on the burnt area but they are much smaller plants with smaller total canopy area and are all within the canopy area of the original plants (Figure 2). Even after a single burn, the total original canopy area of currant bush was not reached after 65 months of regrowth. Figure 3a reveals that the more regularly fires were imposed the greater was the reduction in canopy area of the currant bush. This reduction in canopy cover allows grasses to grow much better between the currant bush plants, which increases both the carrying capacity of the pasture and the likelihood of a satisfactory burn to further reduce the currant bush stand.

This work shows that burning at least every 5 years would maintain currant bush canopy, and therefore pasture competition, at or below its original state. In areas where initial currant bush cover is very high, it would be necessary to forgo grazing so that burning could be carried out every one or 2 years for a number of years to obtain some impact on currant bush numbers as well as canopy cover. Stocking rates would need to be reduced over the whole property to allow burning as a management tool. This would be hard in the early years, but the resultant stability in carrying capacity is far more attractive than the downward trend in pasture production expected if the currant bush is not controlled.

I also noted that, unlike with some wattles (*Acacia* spp.) and eucalypts, fire does not encourage seedling establishment of currant bush as no seedling establishment was observed in the recording area during the trial.

Conclusions

I consider that burning in spring, when the chances of follow up rain are highest, is a viable option for halting the spread of currant bush in the semi-arid eucalypt woodlands of central and north Queensland. Burning needs to be carried out at least every 5 years, and the area to be burnt needs to have at least one-year's growth of grass available as fuel for the fire to be successful. The consequent reduction in canopy cover leads to a proportional increase in pasture available for grazing. Currant bush plants are not easily killed by fire, as this work has shown, but fire is the only economical and environmentally acceptable control method available to livestock producers in this environment.

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