INTEGRATED CONTROL OF THE SHRUB *DODONAEA ATTENUATA* BASED ON GOAT GRAZING AND HERBICIDE APPLICATION

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Summary. The use of goats to control the woody weed hopbush (*Dodonaea attenuata*) resulted in a shrub mortality of 70%, with their impact being greatest in years of low rainfall and low pasture biomass. After goat destocking and a period of high rainfall, some shrub regeneration occurred. Applications of four rates of glyphosate (Roundup®) to regrowth resulted in an apparent mortality of 66% of all shrubs sprayed at the highest rate. Partial budgeting analysis revealed that under the goat stocking treatment the sheep stocking rate would need to increase twofold for one year or by one fifth for ten years to pay for the displacement of sheep alone, costing at least $3.83/ha. It is unlikely that sheep stocking rates could be increased to the amount required to meet either these costs or the $20.02/ha associated with herbicide treatment.

INTRODUCTION

Woody weed infestation is clearly recognised as one of the most serious problems encountered by landholders in much of Australia's semi arid rangelands. Farm profitability is reduced by woody weed proliferation through increased costs of production and reduced livestock production (4). Heavy infestations can reduce gross margins by as much as 50% compared to relatively open country (1). The low productivity of infested areas dictates that, to be cost effective, management options to control these weeds be of low cost and produce lasting benefits.

Of the management options available, fire is generally seen as the most cost-effective. However, disadvantages are the income forgone when an area is destocked after a fire, low mortality rates for some woody weed species (e.g. *Eremophila* spp.) and impracticality in dense populations due to restricted fuel production. As an alternative, mechanical control (e.g. blade ploughing), is expensive and may also promote seedling regeneration in some species as a result of soil disturbance. However, in areas of dense infestation, pasture biomass is usually low, restricting the opportunity to burn and rendering the cost of mechanical or herbicide treatments prohibitive. This paper describes the defoliation response of hopbush to different concentrations of the herbicide Roundup® following goat grazing on sandy red earths north west of Cobar, and the associated costs of using this control strategy.

METHODS

Four 50 ha paddocks were grazed with goats for three years from June 1988 to June 1991. High goat stocking rates were separated by two destocking events (Table 1). This strategy resulted in an average stocking rate of 1.5 goats/ha/month.

Under the goat stocking treatment six transects (4 m x 100 m) were located in each of the four paddocks. The first 25 shrubs along each transect were monitored on 8 occasions at approximately 6 monthly intervals. Damage and reshooting categories were recorded for each shrub, but the results reported here are for shrubs assessed as dead or no leaves present.

Table 1. Goat grazing treatment and pasture biomass levels at the end of each stocking period commencing June 1988 and ending April 1991.

Stocking rate (/ha)	Stocking period (months)	Pasture biomass (kg/ha)
0.4	18	294
4	11	33
spelling	4	68
1	2	<10

From August 1988 pasture biomass was assessed in each paddock at approximately three monthly intervals and at destocking events using a comparative yield technique (5). At each, destocking exclosures were built to simulate the permanent removal of goats and to allow shrubs to re-shoot. The herbicide Roundup CT® (450 g/L glyphosate) was applied at 0%, 12%, 24%, 50% and 100% of the manufacturers recommended rate for blackberry control (1 L/100 L) with the wetting agent, BS1000 (200 mL/1000 mL) in mid July 1992. Treatments were randomised within 2 stocking histories (12 and 20 months regrowth) on two land-types (dune and swale) within four exclosures built in each paddock. Plants were sprayed in 2 x 30 m sweeps using an Ag-merf® gas gun powered by propane gas. Biomass of individual shrubs was estimated using a double sampling technique on five occasions; prior to herbicide application, and 40, 90, 137 and 175 days after treatment application.

Analyses of variance were used to examine the effect treatment, stocking history and land-type on shrub biomass using initial biomass as a covariate. Analyses were performed using the statistical package SAS (6). Type III sums of squares (3) were used where the sums of squares for each main effect and interaction is adjusted for all other terms. A separate analysis was performed for day 175 where the shrubs were designated as dead (zero biomass) or alive (non-zero biomass). The proportion of surviving plants was employed as the dependent variable (an arc sin transformation being used to stabilise the variable). Average initial biomass was used as a covariate. Models were restricted to main effects, covariates and first-order interactions and least square means (+/- standard error) were estimated for each main effect and interactions. Discounted partial budgeting was used to identify the net present value of each control strategy.

RESULTS AND DISCUSSION

A 70% shrub mortality was observed under our goat grazing treatment (Fig. 1a), goats being most effective at pasture biomass levels below 100 kg/ha (Fig. 1b). Considerable gains could result from this reduction in shrub foliage such as improved visibility for easier mustering and the reduction in shrub canopy (which would limit shrub seed production and thereby encourage future pasture production). However, some heavily defoliated shrubs resprouted when goats were removed, suggesting that the duration of grazing was not sufficient to achieve shrub mortality. A further understanding of the response of shrubs to the frequency, duration and intensity of defoliation, over a range of seasonal conditions would be integral to the development of an effective goat stocking strategy.

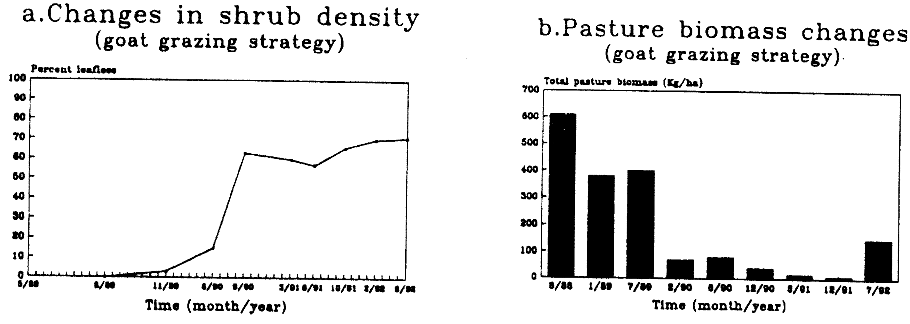

Figure 1. Changes in shrub density as a result of goat grazing (a) and associated pasture levels (b).

The costs associated with this goat stocking treatment are shown in Table 2. Under our grazing treatment the sheep stocking rate would need to increase twofold for one year, by one third for 5 years or by one fifth for ten years to pay for the cost of destocking alone (not including the costs of fencing). To include the costs of fencing the sheep, stocking rate would need to be increased by at least 50% over a ten year period.

Table 2. Costs associated with the goat grazing treatment and increases in stocking rate needed to recover costs.

	Cost $/ha	1 year*	5 years*	10 years*
		extra dse/ha		
with fencing				
100 ha	73.69	10.66	2.13	1.07
1,000 ha	25.92	3.75	0.75	0.38
10,000 ha	10.82	1.57	0.31	0.16
without fencing	3.83	0.55	0.11	0.06

* increase in sheep stocking rate required to pay for cost of goat treatment over a specified time.

Initial observations on a follow-up chemical application to coppicing shrubs suggest potentially good mortality rates can be achieved at higher rates of application (Fig. 2a). Despite favourable growing conditions after herbicide application (Fig. 2b), six months after a winter application of

Glyphosate, 66% of all shrubs sprayed at the highest rate had no leafy biomass These results contrast to unsprayed shrubs where biomass increased by almost 50% over the same period. Actual shrub mortality will be confirmed by monitoring these shrubs for the next 12 months.

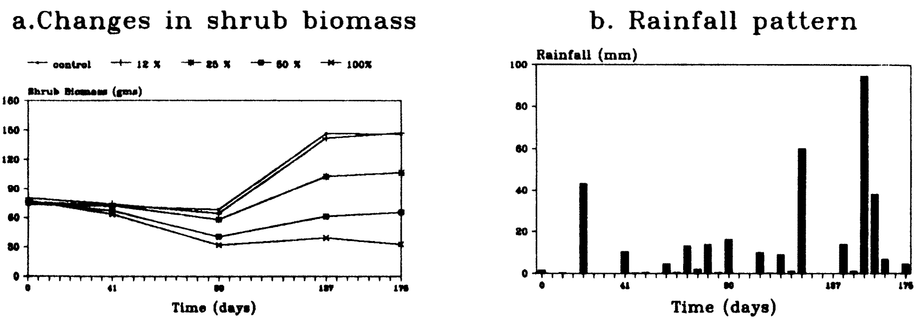

Figure 2. Changes in shrub biomass under different glyphosate rates (a) and rainfall during herbicide treatment (b).

Winter application of glyphosate did not reduce the shrub's susceptibility to this chemical, similar to the results reported by Toft (9) for *Mimosa pigra*. Age of regrowth did not significantly affect shrub biomass at anytime after chemical application, despite older shrubs having an initial higher biomass (113.0 g ± 10.39) than younger growth (80.2 g ± 10.39). At the higher rates of glyphosate the effect of the chemical tended to have a more rapid effect on older shrub regrowth, a result expected as presumably the more actively growing younger regrowth would have a higher chemical tolerance. While shrubs inhabiting the low lying swales always tended to have a greater biomass than those on top of dunes, land-type did not significantly influence the effects of herbicide, suggesting that position within the landscape will not influence this species response to this type of chemical application.

It is unlikely the stocking rates could be increased by the amounts needed to pay back the costs for herbicide treatment. If it is assumed that the stocking rates will be reduced by the amounts indicated in Table 3. This may provide economic justification for this treatment.

An increase in income would be expected as stocking rate increases with the removal of woody weeds. However recovering costs associated with this integrated control strategy are unlikely as stocking rate would have to double over the first five years. It is unlikely that such an increase in stocking rate would result in a sustainable grazing system. Whilst this type of control strategy is expensive, undertaking no shrub control is likely to result in a further decline in stocking rate and subsequent productivity. For this reason and from a national environmental perspective, public may need to decide whether they can support or provide financial assistance for woody weed control in the Western Division.

Table 3. Costs associated with herbicide treatment and increases in stocking rate needed to recover costs.

Glyphosate Rate	Cost/ha ($)	1 year *	5 years *	10 years *
			extra dse/ha	
12%	9.46	1.37	0.27	0.14
25%	11.02	1.59	0.32	0.16
50%	14.02	2.03	0.41	0.20
100%	20.02	2.90	0.58	0.29

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