The control of bellyache bush (*Jatropha gossypifolia*) monocultures – properties of a bellyache bush burn

Acacio da Costa Guterres[1], Penny Wurm[2], John Janes[1] and Tania Paul[2]
[1] Muresk Institute, Curtin University of Technology, Northam, Western Australia 6845, Australia.
[2] School of Science and Primary Industries, Casuarina Campus, Charles Darwin University, Darwin, Northern Territory 0800, Australia.
Email: acacio.guterres@postgrad.curtin.edu.au

Summary This paper presents work being carried out on the weed bellyache bush (*Jatropha gossypifolia*) in Northern Australia looking at the feasibility of burning as a control method on bellyache bush monocultures, when bellyache bush comprises the available fuel. The aim is to determine the effectiveness of East Timorese control methods (non chemical and non-biological) at sites in northern Australia, and how these might be applied in East Timor. We found bellyache bush monocultures can support a substantial management fire. Burning kills all individuals, but may promote increased establishment of seedlings with subsequent rain. We found that cutting can kill established plants, but it is not completely effective. Mulching kills approximately half the population of small plants and seedlings. We recommend an integrated approach to control methodology that may include burning at a suitable time in the annual wet-dry cycle.

Keywords *Jatropha gossypifolia*, bellyache bush, control burning, fuel curing, soil temperature.

INTRODUCTION

Bellyache bush (*Jatropha gossypifolia L.*) is a major weed in both Northern Australia and East Timor (Wilson 1995), where a wet-dry monsoonal climate occurs. In some areas bellyache bush grows as dense monoculture and has adversely affected pastures, crops and animal production (Kingsbury 1964). Traditionally, hand weeding, burning and slashing are used as control methods in East Timor. Biological control is not yet proven to control bellyache bush in Australia and so has not been trialled in East Timor. Chemical control is not an option as most farmers in East Timor are unable to afford herbicides and the weed is extremely widespread, making the cost of chemical control prohibitive.

Seedlings of bellyache bush are very hardy and many survive traditional control methods; the plants produce new growth immediately after rains and maintain a dense cover during the wet season (Parsons and Cuthbertson 1992). The merits of traditional methods such as mechanical control and burning can reduce the rate of spread and control mature plants in the short term (Bebawi and Campbell 2002a). To achieve satisfactory control, a combination of several methods into an integrated management strategy needs to be considered. However, is burning possible in dense bellyache bush monocultures? The objective of this study is to assess the feasibility of burning as a control tool for managing bellyache bush monocultures, where bellyache bush comprises the majority of available fuel. We study the curing, texture and mass of bellyache bush as a fuel for management burns. We also measure consumption of bellyache bush fuel and soil temperature during a burn. The effects of burning are compared with mechanical treatments.

MATERIAL AND METHODS

This work was carried out in three locations in northern Australia to investigate mechanical and burning control of bellyache bush. Channel Island (12°33'S, 130°51'E), has a mean annual rainfall of 1712 mm, and vegetation consisting of a disturbed monsoon rainforest canopy, with 64% overstorey cover. The Acacia site (12°45'S, 131°09'E), has a mean annual rainfall of 1588 mm and vegetation consisting of disturbed savanna with grasses, herbs, shrubs and scattered trees with canopy cover of 18%. Katherine (14°22'S, 132°09'E) has a mean annual rainfall of 980 mm with vegetation comprising a monoculture of bellyache bush, with scattered emergent eucalyptus trees nearby (overstorey canopy cover of 16%). Mechanical control and fuel curing studies were carried out at Channel Island and Acacia, and experimental burns were conducted at Acacia and Katherine. Mechanical treatments were imposed early in the 2007 dry season in May and burning undertaken in the 2007 late dry season (October). At the time of writing, monitoring was completed to October 2007, but will continue during the ensuing wet season.

Curing of bellyache bush fuel The curing study aimed to determine the moisture status of bellyache bush as a fuel for management burns in locations where it forms a monoculture. At each site, a 10 × 10 m area was divided into 100 quadrats each measuring 1 × 1 m. All bellyache bush plants in the 10 × 10 m plot were cut early in the dry season in May when the biomass

was greatest. Every month fuel was collected from five replicate, randomly selected 1 × 1 m quadrats at each study site. Fuel samples were oven-dried at 70°C until constant weight to determine moisture content.

Mass and texture of bellyache bush fuel Immediately before the management burns, five 25 × 25 cm quadrats were removed from each burning plot at the two sites. Whole samples were dried and weighed to a constant weight to determine fuel biomass. Samples were then divided into fine (<6 mm in diameter), medium (6–25 mm diameter) and coarse (>25 mm diameter) texture classes and reweighed, in order to characterise fuel texture.

Soil temperature Soil temperature was measured during burning using i-Button temperature loggers (Maxim Integrated Products), buried at a soil depth of 5 mm under the canopy of bellyache bush individuals, and retrieved approximately four hours after the fire had passed. Specifications for the i-Buttons indicate a maximum temperature reading of 125°C, but they may record above this.

Management burn Each treatment was replicated in three 10 × 10 m plots. Within each of the three plots 15 individual plants were cut at 30 cm above the ground and tagged. Another 15 individual plants were tagged and left uncut. These plots were burnt in the late dry season to ensure hot fires. Three separate plots remained unburned for the control.

Mechanical control treatment This study was imposed on three different size classes of bellyache bush: established plants, small plants and seedlings. There were four experiments undertaken in three 10 × 10 m plots at each of two sites. The treatments in the experiment included cutting and cutting in combination with mulching of established plants, mulching and hand pulling of small plants, and mulching for seedlings. Mulching was done how/what is it?

RESULTS

Cut bellyache bush stems can retain high moisture content well into the dry season (Table 1). In addition, over 50% of cut stems re-sprouted leaves during the dry season although it is not yet known if these re-sprouted stems can re-establish as plants.

High levels of fuel consumption indicate a hot fire which spread over most of the study plots (Table 2). High levels of fuel consumption also indicate that bellyache bush fuel can support a management fire if adequate fuel curing occurs. Soil temperatures of up to 126°C were recorded and soil temperature remained elevated for up to three hours after the fire (Table 3).

Established plants, small plants and seedlings were killed by burning. However, a preliminary site inspection less than one month after the fire indicated seedling emergence has been higher in burnt plots than control plots, after initial wet season rains.

Different cutting treatments for established plants at the Acacia site killed bellyache bush plants by October. In contrast, some individual plants cut above 0 cm at Channel Island still remained alive (Table 4a). This may be due to the greater canopy cover at Channel Island. Hand-pulling completely killed small plants (Table 4b). Mulching treatment had significant impact but not completely control small plants and seedlings (Table 4b,c).

DISCUSSION

Cutting bellyache bush stems early in the dry season gives the longest time for fuel curing in order to

Table 1. Percentage moisture of cut bellyache bush fuel.

Site	Month	% moisture
Acacia	May	69.3 ± 0.5
	August	11.5 ± 2.4
Channel Island	May	72.7 ± 0.9
	August	62.2 ± 1.3

Table 2. Fuel biomass and consumption of bellyache bush fuel for each texture class.

Site	Fuel texture	Biomass (t ha^{-1})	Consumption (%)
Acacia	Fine	54.6 ± 0.7	99.2 ± 0.8
	Med	4.2 ± 0.9	90.3 ± 7.4
	Coarse	1.3 ± 0.7	90.0 ± 6.4
Katherine	Fine	2.7 ± 0.5	95.7 ± 4.3
	Med	1.5 ± 0.4	89.8 ± 4.3
	Coarse	1.4 ± 0.9	90.0 ± 4.1

Table 3. Soil temperatures.

Site	Maximum soil temp (°C)	Period for which soil temp >40°C
Acacia	112	3 h 37 min
	123	3 h 32 min
	126	3 h 33 min
	126	3 h 30 min
Katherine	63	1 h 19 min
	87	1 h 29 min
	126	1 h 32 min
	126	1 h 42 min

Table 4a. Proportion of bellyache bush plants surviving after mechanical treatments at two sites for established plants (1.0–3.0 m tall).

Site	Cutting height above ground	Proportion alive at March	Proportion alive at October
Acacia	Control	1.00 ± 0	0.98 ± 0.01
	0 cm	0	0
	20 cm	0.18 ± 0.06	0
	40 cm	0.89 ± 0.08	0
Channel Island	Control	1.00 ± 0	1 ± 0
	0 cm	0.07 ± 0.07	0
	20 cm	0.93 ± 0.04	0.13 ± 0.04
	40 cm	1.00 ± 0	0.13 ± 0.04

Table 4b. Proportion of bellyache bush plants surviving after mechanical treatments at two sites for small plants (10–50 cm tall).

Site	Hand-pulling and mulching	Proportion alive at March	Proportion alive at October
Acacia	Control	1.00 ± 0	0.88 ± 0.05
	Handpull	0	0
	Mulch	0.30 ± 0.05	0.19 ± 0.04
Channel Island	Control	1.00 ± 0	0.90 ± 0.09
	Handpull	0	0
	Mulch	0.93 ± 0.04	0.92 ± 0.04

Table 4c. Proportion of bellyache bush plants surviving after mechanical treatments at two sites for seedlings (<10 cm).

Site	Mulching	Proportion alive at March	Proportion alive at October
Acacia	Control	0.83 ± 0.07	0.33 ± 0.07
	Mulch	0.13 ± 0.04	0.06 ± 0.03
Channel Island	Control	0.92 ± 0.05	0.70 ± 0.11
	Mulch	0.44 ± 0.08	0.25 ± 0.04

produce higher fire intensity. Fire completely killed individual established plants, small plants and seedlings. However, with the first rains the seed bank produced new seedlings in large numbers, as was also found by Bebawi and Campbell (2002b). Therefore, we need to plan for subsequent management of seedling emergence, including understanding how long bellyache bush seeds persist in the soil and ongoing mechanical or burning control of new seedlings.

Mechanical control is only partially successful in killing established plants, depending on shade levels and cutting heights. As supported by other studies (Bebawi and Campbell 2002b), cutting stems above 0 cm can still result in re-shooting. Therefore cutting needs to be at ground level to control established plants. Seed bank management is a longer term control issue, as preliminary observations indicate emergence after fire treatments does occur.

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