The response of bellyache bush (*Jatropha gossypiifolia*) plants cut off at different heights and seasonal times

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Abstract

A study was undertaken to quantify the susceptibility of bellyache bush plants cut off using a brush-cutter at different heights above ground (0, 10, 20 and 40 cm), during either summer or winter. Uncut plants acted as controls. At the time of cutting in summer, plants were fully foliated, flowering and producing seed. In contrast, winter-treated plants were fully defoliated and dormant. The sugar concentration in sap of plants differed significantly between seasons, averaging 23 and 18% sucrose for winter and summer cutting times, respectively.

A significant interaction occurred between the season and height of cutting on plant survival. No plants survived if cut off at ground level, irrespective of season. With cutting at 10 cm, 100% mortality was still achieved during summer, but 40% of winter-cut plants survived. Thereafter, survival increased with increasing height of cutting, with plants more susceptible when actively growing in summer. Winter off-cuts that were stacked in piles were viable 12 months after cutting and a few at the bottom of the piles grew adventitious roots, despite being disconnected from any direct supply of water or nutrients. The susceptibility of bellyache bush to cutting near ground level in summer suggests that the use of tractor-mounted slashers should be investigated as a control option for treating infestations where the terrain is suitable. However, one should not ignore the possible use of brush-cutters and similar equipment for clearing small infestations or 'rougher' sites.

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Introduction

Bellyache bush (*Jatropha gossypiifolia*) is an erect, monoecious, soft-wooded, deciduous, perennial shrub growing to an average height of 2.5 m but exceeding 4 m in some areas. Leaves are sticky, covered with extra-floral nectaries, deeply 3-lobed and bronze when juvenile but green when mature. Flowers are deep red with yellow centres and produce fruit which are trilocular, explosively dehiscent capsules with a single seed per locule. The capsules are green at maturity turning pale green just before dehiscence and are sparsely hairy. Seeds are spherical, carunculate and predominantly greyish-brown with copious starchy endosperm (Dehgan and Webster 1979).

Flowering and seed production can occur all year round, and plants can produce up to 12 000 seeds per year (Bebawi and Campbell, in press). Bellyache bush forms dense thickets, which crowd out useful plant species and reduce productivity (Parsons and Cuthbertson 2001). In addition, it is unpalatable and its seeds are toxic to insects, stock and humans (Chatterjee *et al*. 1980; Parsons and Cuthbertson 2001).

Bellyache bush predominantly infests riparian habitats (Bebawi and Campbell, in press) but can spread into open pastures and rocky areas in regions where rainfall ranges between 200–1500 mm per year (Bebawi *et al*. 2001). The worst infestations in Queensland are currently along the banks of the Burdekin River and its tributaries (Cshures 1999). To date, there have been no formal studies on the plant's environmental, economic and social impact on Queensland. However, Cshures and Edwards (1998) have listed the plant as an environmental weed and Bebawi *et al*. (2001) prioritised it as the third most important weed in north Queensland in terms of its economic, environmental and social impact.

Limited research has been undertaken into the efficacy of potential control options. Only chemical control has been investigated in detail

with 2 registered products currently available (Csurhes 1999). A wider suite of techniques is needed to provide choices for landholders that account for the range of densities and habitats in which bellyache bush grows and the resources available to them.

This paper reports the results of a study designed to investigate the susceptibility of bellyache bush plants to being cut off at different heights and seasonal times. If bellyache bush is found to be susceptible to any of the imposed regimens, the use of tractor-mounted slashers will be investigated further as an option in areas where such machinery can be utilised.

Materials and methods

Site description

The experiment reported in this paper forms one component of a larger study investigating integrated management strategies for bellyache bush growing in riparian and subriparian habitats in north Queensland. The 800m^2 study site was located within a dense infestation of bellyache bush (average density of 53 000 plants/ha) at Larkspur (19° 91' S, 146° 22' E), 23 km NNW of Charters Towers.

The area has a mean annual rainfall of 658 mm with 76% of this occurring during the summer months (December–February) (Bureau of Meteorology 1988). Monthly maximum temperatures in winter average 26°C and in summer average 32°C (Bureau of Meteorology 1988).

The soil of the site had a sandy A horizon of varying thickness over a B horizon that varied from sandy loam to sandy clay. Beneath the canopy of old bellyache bush plants, herbaceous vegetation was virtually non-existent with the exception of a few grasses including feathertop rhodes grass (*Chloris virgata*), black speargrass (*Heteropogon contortus*), white speargrass (*Aristida leptopoda*) and liverseed grass (*Urochloa panicoides*). The shrub stratum was dominated by bellyache bush while a mixture of long-fruited bloodwood (*Eucalyptus dolichocarpa*), narrow-leaved ironbark (*E. crebra*), red ash (*Alphitonia excelsa*), broad-leaved bottle tree (*Brachychiton australis*) and Burdekin plum (*Pleiogynium timorense*) dominated the tree stratum.

Experimental details

A 2-factor experiment replicated 4 times using a randomised complete block design was used to evaluate the effects of cutting on plant survival and re-shooting ability. Factor 1 comprised 2 seasonal cutting times: in winter (July); and in summer (December). Factor 2 comprised 5 cutting treatments: control (uncut); and cut 0, 10, 20 and 40 cm above ground level.

An experimental unit was a group of 5 plants. The location of each plant was marked with a uniquely numbered metal tag to facilitate retrieval after cutting. Prior to treatment, the basal stem diameter of and sucrose concentration in sap of individual plants were measured. At 9 months after treatment, the number of plants remaining alive and the number of re-shoots on live plants were recorded.

A digital calliper was used to measure basal stem diameter at ground level. A hand-held refractometer was used to determine sugar concentration (percent sucrose) in cell sap released by cutting shoot tips of each plant with a sharp blade. Number of re-shoots per plant was recorded at 0–40 cm height above ground. As many bellyache bush plants were leafless at the time of recording in winter, plants were classified as alive if the bark was green and they exuded watery sap when struck with a sharp knife at the base of the stem.

In addition to monitoring treatment effects on rooted plants, off-cuts were stacked in piles adjacent to the treatment site and monitored for foliation, flowering and seed setting.

Plants were cut off with a portable Stihl FS420 brush-cutter, which developed 3.8 brake horsepower and weighed 14 kg. A fuel capacity of 0.7L provided approximately 50 minutes operational time before refuelling. In a high population density situation (*e.g.* 32 000 plants per hectare), up to 580 plants per hectare per hour could be treated using this method.

Statistical analysis

For all variables measured, analysis of variance was performed to detect differences between treatments. Percentages were arcsine-transformed prior to statistical analysis and later back-transformed. Correlation analysis was performed on the number of live plants per experimental unit in relation to cutting height.

Results

Stems of treated bellyache bush plants averaged 3.8 ± 1.9 cm (± s.e.) in diameter. At the time of cutting in summer, they were fully foliated, flowering and producing seed. In contrast, winter-treated plants were fully defoliated and dormant. The sugar concentration in plant sap also differed significantly ($P < 0.05$) between seasons, averaging 23 and 18% sucrose for winter and summer cutting times, respectively.

A significant interaction ($P < 0.05$) occurred between the season and height of cutting on plant survival (Figure 1). No plants remained alive 9 months after cutting if cut off at 0 cm (ground level), irrespective of season. When cut at 10 cm, 100% mortality was still achieved during summer, but 40% of winter-cut plants remained alive. Thereafter, survival increased with increasing height of cutting, but plants remained more susceptible when actively growing in summer. There was a positive correlation between number of surviving bellyache bush plants and cutting height ($r = 0.98$). Of the plants remaining alive 9 months after treatment, significantly more re-shoots were present on those cut in winter than on summer-cut plants, with an average of 2.2 ± 1.5 and 1.3 ± 0.6 re-shoots per plant, respectively.

Most winter off-cuts started to foliate, flower and set seed 6 months after cutting and remained active for 12 months. Two winter off-cuts located at the bottom of stacks had produced adventitious roots at the cutting point and were still alive after 14 months. Few summer off-cuts flowered and set seed 4 weeks after manual removal of all foliage, flowers and capsules from off-cuts. Not one summer off-cut remained active more than 6 months after cutting. Seeds obtained from capsules produced on both winter and summer off-cuts were germinable.

Discussion

This study has shown that bellyache bush plants are highly susceptible to being cut off, particularly during summer. With a mortality of 100% at a cutting height of zero and 10 cm during summer, the use of tractor-mounted slashers could be an option for treating infestations where the terrain is suitable. Further research using commercial slashers during the summer season is now needed to collect efficacy and economic data.

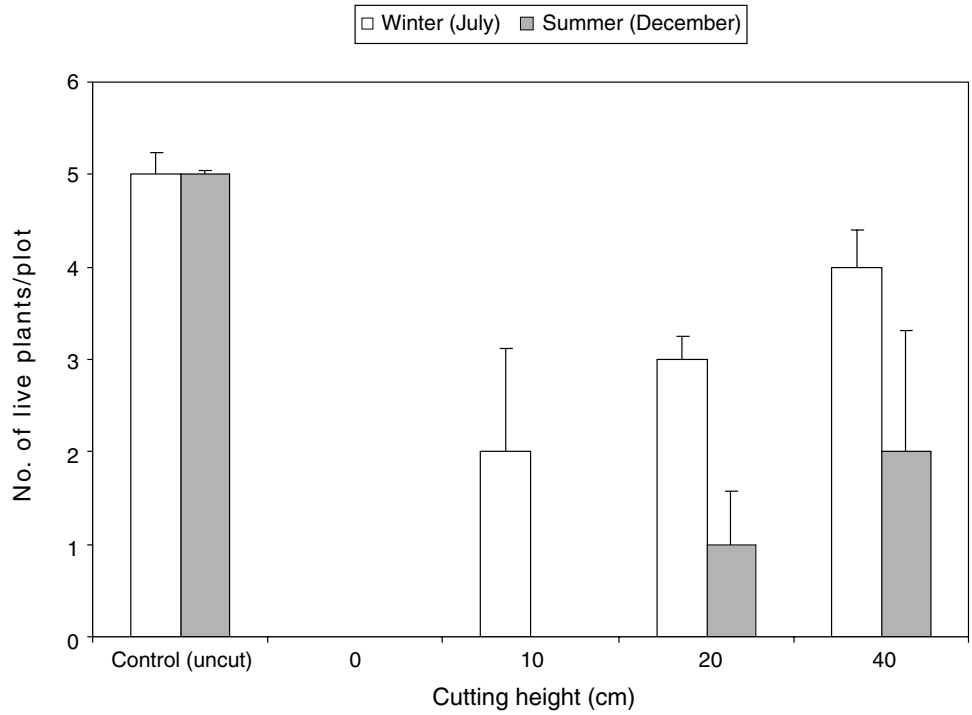

Figure 1. Mean number of plants remaining alive after 9 months following cutting in winter or summer at different heights. Bars indicate the s.e. of the mean.

Slashing has been undertaken on only a few weed species invading rangeland areas in northern Australia with mixed results. For example, Vitelli (1992) reported that mortality of large rubber vine plants (*Cryptostegia grandiflora*) of greater than 8 cm basal diameter averaged 30% after a single slashing undertaken during the dry season. A second slashing a year later increased mortality to 70%. Visual observations of the woody weed chinee apple (*Ziziphus mauritiana*) suggest that it is even more tolerant of slashing. A decapitation experiment on chinee apple undertaken by Grice *et al.* (1999) at monthly intervals throughout the year found that mortality was minimal (<5%) irrespective of when cutting was undertaken.

The marked difference in efficacy between the 2 seasonal cutting times in the current study could possibly be associated with the physiological status of the plants at the time of treatment. Kramer and Kozlowski (1979) found that, in North American forests, re-shooting was least abundant from stumps cut in early summer when trees had just fully leafed out and carbohydrate reserves were low, compared with abundant re-shooting from stumps of trees that were cut during the dormant season. Bellyache bush demonstrated a similar response, with maximum mortality in plants cut during summer at ≤ 10 cm height when plants were in full leaf and sucrose levels were low. In contrast, mortality of dormant winter plants was poor unless cut at ground level. This could also help explain the re-foliation, flowering and seed setting arising from winter off-cuts that received no water or nutrients while stacked in piles on site. These off-cuts may have substantial carbohydrate reserves available to sustain growth long after they are disconnected from the parent plant. The use of commercial tractor-mounted slashers would possibly reduce the chance of this happening by breaking off-cuts into many small pieces. This warrants investigation.

If effective, the use of slashing as a primary treatment for bellyache bush will be restricted mainly to relatively flat, treeless or open woodland areas away from water courses and where there is little timber material or stone lying on the ground. It may be more appropriate as a secondary treatment, particularly in areas where stickraking/bulldozing has been undertaken initially to remove the original infestation and clean up any woody debris. Where inaccessible areas are involved or smaller areas are concerned, hand-cutting below 10 cm in summer or cutting at ground level in winter should give excellent results. However, treatment of the off-cuts (*e.g.* burning) is essential to destroy any potential seeds.

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