Will fire help control *Parkinsonia aculeata* L.?

A.C. Grice1,2,3, J.R. McKenzie3, D.M. Nicholas1, M. Pattison3, L.V. Whiteman1, K.E. Steele3 and S.D. Campbell2,3

1 CSIRO Sustainable Ecosystems, Private Bag PO, Aitkenvale, Queensland 4814, Australia  
2 CRC for Australian Weed Management  
3 Queensland Tropical Weeds Research Centre, Department of Natural Resources and Mines, PO Box 187, Charters Towers, Queensland 4820, Australia

**Summary** *Parkinsonia aculeata* L. is an invasive shrub in northern Australia. We examined the responses of this species to seasons of burning (early dry – July, late dry – September, early wet – December) and to different types of fire (head fire versus backburn) in order to consider the potential of fire as a management tool for this weed. We considered the effects of fire on three height classes of plants: small, $H \leq 150$ cm; medium, $150 \text{ cm} < H \leq 300$ cm; and large, $H > 300$ cm. Prescribed fires caused high levels of mortality to plants of all size classes, suggesting that fire could make a useful contribution to the integrated control of *P. aculeata*. Unburned plants of all height classes suffered less than 10% mortality. Burned small, medium and large plants averaged 49%, 51% and 59% mortality respectively. Mortality rates of all height classes under all treatments, except the December head fire, were >30%.

**Keywords** *Parkinsonia aculeata*, fire.

**INTRODUCTION**

The shrub *Parkinsonia aculeata* L. (parkinsonia, Jerusalem thorn) was introduced to Australia from South and Central America. It has become naturalised in Queensland, the Northern Territory, Western Australia and New South Wales where it is a major weed of rangelands. It grows most prolifically in riparian habitats and other low-lying parts of the landscape. It is a Weed of National Significance (Thorp and Lynch 2000).

An important consideration in relation to the management of parkinsonia is that large infestations occur on extensive grazing lands, conservation lands and other areas where there are severe economic constraints to control. Although mechanical and chemical techniques are available (Parsons and Cuthbertson 2001), they can be both expensive and labour intensive. Burning is a possible control method for parkinsonia as it is for some other weeds of rangelands (Grice 1997a, Vitelli 2000) although there is conflicting anecdotal information on how useful fire is for parkinsonia. This paper reports preliminary results of an experiment that aims to examine the effects of different times and types of burning on the mortality of *P. aculeata* to fires.

**MATERIALS AND METHODS**

**Study site** The study site is located approximately 70 km north west of Charters Towers in north Queensland (145°40’E, 19°50’S). It is a floodout area associated with Fletcher Creek, a tributary of the Burdekin River, and supports a dense and relatively uniform population of parkinsonia. The site was destocked in early 2003.

**Experimental design** The experiment used a split plot design. Three contiguous blocks were each divided into five plots, each of approximately 1 ha. In each block, one plot was assigned to each of the five main treatments which covered time of burning: (i) unburned control; (ii) burnt in the wet season (January–February); (iii) burnt in the late wet/early dry season (April–July); (iv) burnt in the late dry season (September–October); and (v) burnt in the early wet season (October–December). The sub-plots covered two types of fire: (i) head fire (with the wind); and (ii) back burn (against the wind); which could be expected to differ in fire intensity. The wet season treatment (ii) had not been completed at the time of writing and is not covered by this paper.

**Sampling** Individual plants ($n = 1613$) tagged on fixed transects were used to document responses to fire. Height, number of stems and diameter of each stem were recorded for each tagged plant in April 2003 using the method of Grice *et al.* (2002). All plants were measured again in March 2004. In March 2004, the condition of all plants on transects (i.e. live or dead) was recorded and the heights of live plants measured. In this paper we consider the effects of burning in terms of three plant height classes. The height (H) classes used were: small, $H \leq 150$ cm; medium, $150 \text{ cm} < H \leq 300$ cm; and large, $H > 300$ cm.

**Burning** Fire breaks were constructed between plots. Plots were burnt on 10 July 2003 (early dry), 23–25 September 2003 (late dry) and 16 December 2003 (early wet). Immediately prior to ignition, herbaceous biomass was estimated using the BOTANAL technique (Tothill *et al.* 1978) and samples were collected to
allow estimation of fuel moisture content. Head fires and back burns were timed so that they met close to the centre of the plot. Weather conditions (temperature, relative humidity, wind speed and direction) were recorded at intervals during each fire. The speed of the fire front was measured by timing how long the fire took to travel between markers set in the plot. Wet season fires (January–February) were not possible in 2003 due to weather conditions.

**Responses to burning** Plant mortality was determined in March 2004. Plants were recorded as dead if they were leafless and stems were not green.

**Statistical analysis** Results were analysed using REML Variance Components Analysis (Genstat 6.1). Plant height, ‘time of burning’ (including unburned controls) and type of fire were fitted to plant mortality. Height was not a significant effect (P >0.05) and was not included in subsequent analyses.

### RESULTS

**Fire conditions** Fuel loads at the time of burning were in the range of 3000–4000 kg ha⁻¹. Fires were lit in late morning to mid-afternoon when air temperatures were in the range 24–33°C. Air temperatures in December were at the higher end of this range. Relative humidity varied more with season of burning, being greater in December (42–50%) than in June or September (26–40%). Winds were generally light. Head fires spread more rapidly than back burns though all fire speeds were generally low (0.01 m s⁻¹ for back burns and 0.1 m s⁻¹ for head fires).

**Responses to burning** Mortality of *P. aculeata* was higher in all burnt plots than in the unburned controls (Figure 1). Small plants that were not burned had mortality rates of about 10%. Medium and large plants that were not burned had mortality rates of less than 2%. For all but one fire treatment, mortality of all height classes averaged greater than 30%. The exception was for all height classes burned in the head fire in December, where mortality rates were less than 20%. Mortality rates of plants on burned treatments ranged up to 86%, which was for large plants burned by a head fire in September.

‘Time of burning’ was highly significant (P <0.05), driven principally by the differences between burned treatments and the unburned controls. ‘Time’ × ‘fire type’ interactions were highly significant (P <0.001), largely as a result of the large differences in mortality rates produced by head fires and back burns in December (Figure 1).

**Figure 1.** Mortality (%) of small (open bars), medium (grey bars) and large (black bars) *P. aculeata* subject to different times and types of fires. Plots were burned in either June, September or December 2003 with either head fires or back burns.
DISCUSSION
These results suggest that significant mortality of *Parkinsonia aculeata* can be achieved with prescribed fires. They also indicate that fires will vary in their effectiveness in killing *P. aculeata*. In this experiment, the only ineffective fire was the December head fire. It is likely that the critical factor was residence time of the fire, evidenced by the fact that the lowest mortality rates were documented as being associated with what was probably the most intense fire. Mortality rates of unburned plants were low, being <10% for small plants, and <2% for medium and large plants.

The apparent mortality rates achieved with *P. aculeata* in this experiment are comparable with those obtained for some other invasive species for which fire is an accepted control tool. For example, up to 96% mortality has been obtained for small (height <1 m) *Cryptostegia grandiflora* Roxb. ex R.Br., though mortality was much lower (ca. 50%) (Grice 1997b) for larger plants (H >2 m). Mortality rates of 93% have been obtained for *Prosopis pallida* (Humb. & Bonpl. ex Willd.) Kunth subject to experimental prescribed fires (Campbell and Setter 1999).

Importantly, the fact that significant mortality of *P. aculeata* was achieved with fires in the early dry season, late dry season and early wet season, suggests that, at least in some years, there is a broad window of opportunity for effective fires. A key consideration, however, is the amount of fuel available for burning. The site used for this experiment was destocked in early 2003, four months before the first fire. Destocking allowed retention of grass fuel throughout the dry season. The opportunity to impose fires that are effective against *P. aculeata* will be strongly influenced by fuel availability.

The shortest time period between a prescribed fire and assessment of the impacts of that fire was four months, from December 2003 to March 2004. Consideration must be given to the possibility that leafless plants whose stems were no longer green still retained a capacity to sprout. Some individuals of some species may take several months to sprout even if most sprout very soon after topkill (Grice et al. 1999). However, in this experiment with *P. aculeata*, all burned individuals experienced a wet season between burning and assessment and are likely to have sprouted during the wet season had they been alive.

This experiment will continue to document the effects of these and other burning treatments but the preliminary results are promising.

ACKNOWLEDGMENTS
This work was made possible with support from the Natural Heritage Trust, the Dalrymple Landcare Group and the Cooperative Research Centre for Australian Weed Management. We thank Chris and Cathy Allingham of ‘Fletcher Vale’ for use of the site and anonymous referees for their helpful comments on a draft of this paper.

REFERENCES


