

**The effects of fire of various intensities
on plant regeneration in the arid zone
environment, central Australia.**

Lija Walton 2003

Walton, L. (2003). The effects of fire of various intensities on plant regeneration in the arid zone environment, central Australia. Centralian Land Management Association & St Philips College, Alice Springs.

Abstract

The main objective of this project was to observe and record changes in the regeneration of trees, shrubs and herbage species in the aftermath of fires of different intensity on pastoral land near Alice Springs. The species that responded to rains following the fires were different on the different sites. Ground cover on both the cool and hot burn sites continued to increase over the study. The growth rate of species was higher on the cool burn site, as were the number of plants that seeded and presented flowers. Although the growth rate of plants and shrubs on the hot burn site was steady at first, the mortality of these plants was definitely noticeable.

Introduction

In the past two years, fires have affected many properties in Central Australia. This is due to above-average rainfall conditions creating a lot of fuel. The impact on the land and its plant regeneration depends on the intensity of the fire, and the seasonal conditions that follow. In the fires studied on Bond Springs the cool burn moved slowly, while the hot burn was very intense and fast moving (Grant Heaslip, pers. comm.). Intense burns can get up into the tree canopies and kill fire-intolerant species. On the other hand, cooler burns often allow resprouting of trees and shrubs.

The Heaslip Arid Zone Scholarship allowed me to study some of the effects that various degrees of fire have on the arid zone and its plant regeneration. The results relate to a situation where early summer fires were followed by heavy rainfall at the beginning of summer 2002.

It was predicted that:

- Ground cover would increase faster on the cool burn site than the hot burn site due to less harsh surface conditions.
- Trees and shrubs on the hot burn site were not likely to resprout due to the extensive damage they suffered.

Observations were also made to see which species grew after fire, how fast they grew and if any flowered or seeded. The results were also compared to a site that had not been burnt at all.

Methods

Study Site

Research sites for this project were located on Bond Springs Station, approximately 20km north of Alice Springs. Each site was marked by GPS. The following locations represent the NE corner of each site.

Unburnt Site: S23°33'45.4" E133°53'29.0"

Cool Burn Site: S23°33'54.6" E133°53'22.7"
Hot Burn Site: S23°26'55.3" E133°59'55.9"

Plants found across the three study sites included

Oat grass (*Enneapogon avenaceus*)

Caltrop (*Tribulus terrestris*)

Pea plant (*Swainsona sp.*).

Swainsona sp.

Sida sp.

Indigofera sp.

Eight-Day Grass (*Fimbristylis dichotoma*)

Silky Heads (*Cymbopogon obtectus*)

Mulga Grass (*Aristida contorta*)

Umbrella Grass (*Digitaria coenicola*)

Tar Vine (*Boerhavia coccinea*)

Paddy Melon (*Cucumis myriocarpus*)

Acacia Bush (*Acacia victoriae*)

Whitewood (*Atalaya hemiglauca*)

Caustic Weed (*Euphorbia drummondii*) and

Bush Tomato (*Solanum sp.*)

Data Collection

The three study sites, each 100m² were chosen with the guidance of Grant Heaslip, pastoralist and station owner. The three sites were photographed on each visit from approximately 50m along the road-side length of the site (see Appendices). Site one was classified as 'unburnt' and had been untouched by fire for many years. Site two was classified as a 'cool burn' as the fire, which occurred in November 2002, was of low intensity (Grant Heaslip pers. comm.). Site three was classified as a 'hot burn' as the fire was an intense fire-storm that obliterated most plants in its path, leaving the earth bare and plants charred. Within each of these sites, three 1m² quadrats were randomly selected as the plant sampling locations. Total plant cover within each quadrat was estimated, and any signs of wildlife noted. Site three, where the hot burn featured had been an area with animal activity prior to the fire, as evidenced by the rabbit warrens and hundreds of snail shells present.

The plants in each quadrat were identified and counted, and then depending on how many of each individual species there were, up to five plants were marked with numbered metal pins (Fig.1). The selected plants were measured to the height of their tallest leaf to the nearest 0.1mm, at first using a standard 30cm ruler, then as the plants grew taller a tape measure was introduced. Where shrubs and trees had resprouted, the length of the longest shoot for up to three plants of each species was measured in the same way. The plant measurements were repeated three times: December 3rd 2002, December 12th 2002 and February 26th 2003.



Figure 1. The method of marking individual plants with numbered metal pins.

Results

The initial site visit to Bond Springs occurred on 03/12/02. The summer had started dry and many fires had occurred in the Alice Springs area. These fires were followed up by intermittent rains (Fig. 2). It was noticed that many seedlings had germinated and small plants had begun to grow at this early stage in the project. Between the initial site visit and the second visit, the weather was very hot and dry, hence the average height of plants decreased due to shriveling. Some died off completely. Some of the more established plants were noted to have increased in size. Figures 3a, b and c show the average growth rate of various species on each of the sites studied.

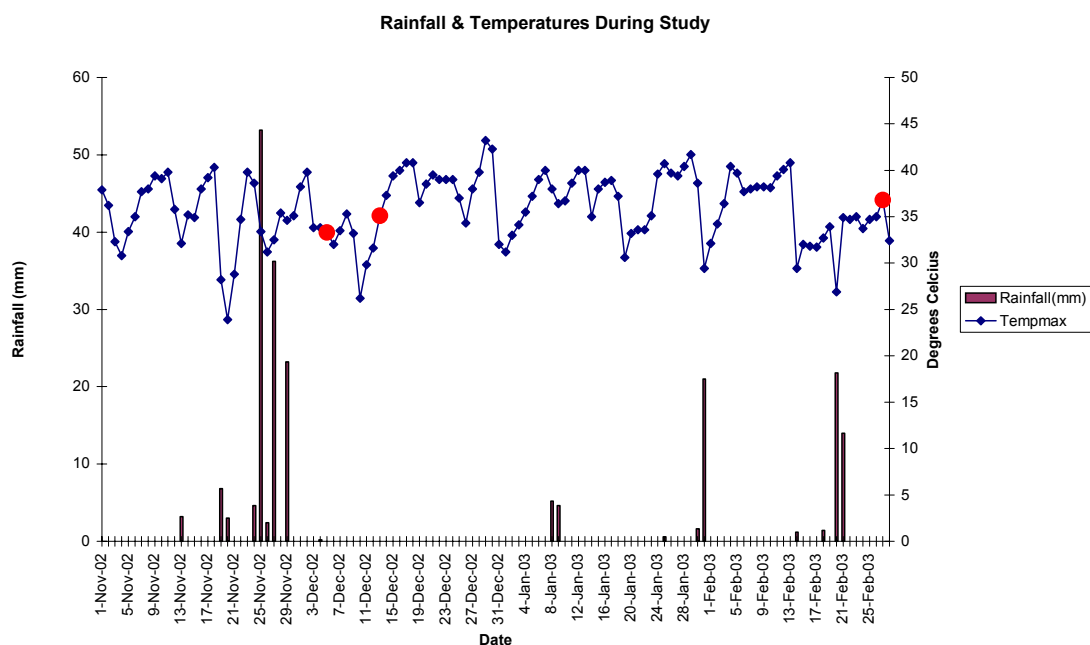
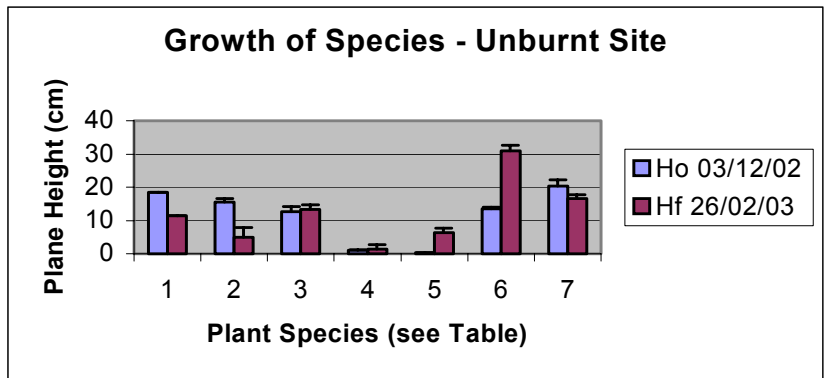
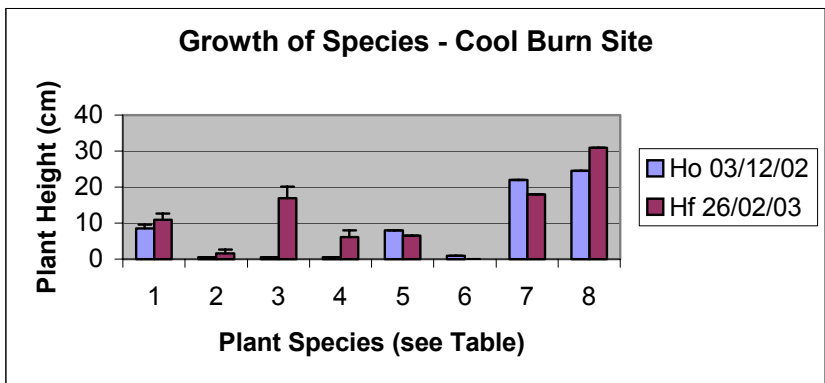


Figure 2. The rainfall and maximum temperature for the days of the project, with the site visit dates marked with red dots.

- 1 = 8 Day Grass
- 2 = Oat Grass
- 3 = Caltrop
- 4 = Swainsona
- 5 = Copper Burr
- 6 = Mulga Grass
- 7 = Umbrella Grass



- 1 = Oat Grass
- 2 = Caltrop
- 3 = Tar Vine
- 4 = Pea Plant
- 5 = Swainsona
- 6 = Paddy Melon
- 7 = Umbrella Grass
- 8 = Acacia Bush



- 1 = Whitewood
- 2 = Silky Heads
- 3 = Sida
- 4 = Grey Indigo
- 5 = Caustic Weed
- 6 = Bush Tomato
- 7 = Grass 1
- 8 = Grass 2

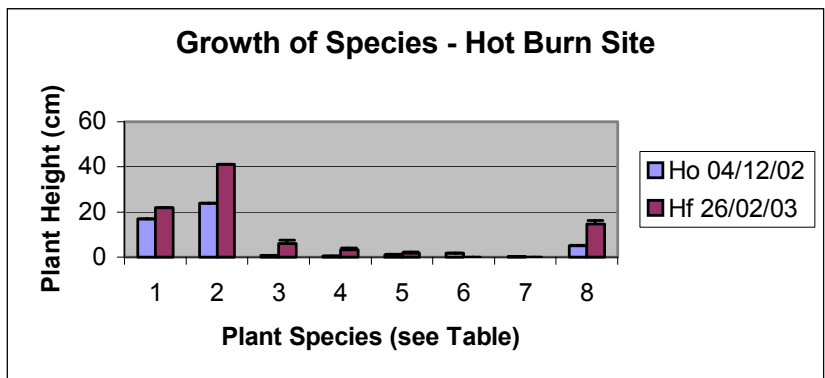


Figure 3a-c. The recorded growth of species specific to their site. Ho represents original average height and Hf represents final average height. Error bars represent Standard Errors.

The percentage of ground cover on all three sites studied at Bond Springs actually increased by quite a margin over the length of the project (Fig. 4). Even though many of the small plants that germinated actually died, the more-established plants, such as the grasses, larger shrubs and resprouting trees continued to grow and thrive.

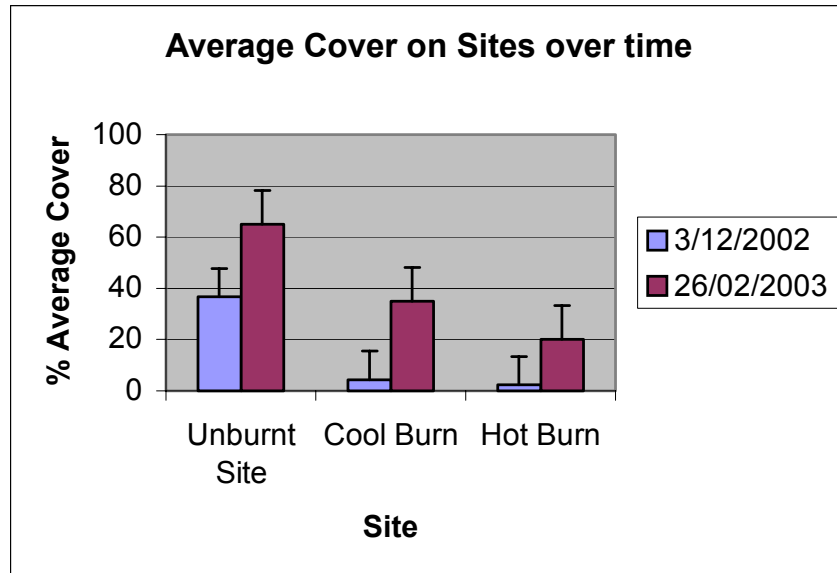


Fig 4. Average vegetation cover across sites. Error bars represent Standard Errors.

Plant mortality was evident through observations of the three sites. The table below shows that, for example, caltrop seedlings had the highest mortality on the unburnt site, whereas 8-day grass was more persistent. The data for the cool burn site shows that oat grass seedlings died at a high rate than other species.

Table 1. Overall plant mortality on a per-site basis

Unburnt Site	Number of Plants 03/12/02	Number of Plants 26/02/03	Mortality (#dead)	Mortality (%)
Oat Grass	52	17	35	67
8-Day Grass	354	273	81	23
Caltrop	96	1	95	99
Pea Plant	258	51	207	80
Cool Burn				
Oat Grass	202	54	148	73
Caltrop	153	51	102	67
Pea Plant	151	52	99	66
Tar Vine	44	20	24	55
Hot Burn				
Grey Indigo	29	29	*note	0
Pea Plant	2	2	0	0
Caustic Weed	8	3	5	63
Unknown grass	55	25	30	55
Sida	31	26	5	16

*NB: On the middle visit (12/12/02) new plants had germinated, then died off.

Information was collected about plants and shrubs setting seed and flowering. Data collected for the first visit on the 2/12/02 at the unburnt site showed that only 8-Day Grass was setting seed. Just ten days later seeds were noticed on Mulga Grass, Oat Grass and Eight-Day Grass. As well as the seeding plants, by the final visit the few surviving Caltrop and Swainsona plants had begun to flower.

Discussion

Species Survival and Germination

It was fortunate that after the severe fires of November 2002, regions on Bond Springs Station received quite good rainfall. The project started soon after these rains, when the daily maximum temperatures were below average and clouds were still dominating the skies. The species that appeared as new germinations on the sites studied include 8-Day Grass, Caltrop, Pea Plant, Sida, Tar Vine and Grey Indigo. Other species, such as the Acacia Bush, Broom Bush and Whitewood were noted to have resprouted after the fires and rains.

In comparing the unburnt site with the cool burn site, quite a difference in species present was found after the fire and rain even though the sites had similar species before the fires (Grant Heaslip, pers. comm.). The main differences were in the decline of grasses and edible plant species on the cool burn site, which would have had a somewhat detrimental effect on the cattle production at Bond Springs at this particular site.

There was a notable difference when comparing the cool burn and hot burn sites. The intensity of these fires affected the land differently, as the cool burn had crept along the ground slowly and only burnt some shrubs completely. The hot burn swept through the land rapidly, due to the Spinifex ground cover and high winds. It managed to burn tall trees as well as destroying the understorey completely.

It was especially interesting to see that on the hot burn site, which was previously all Spinifex, that no Spinifex regeneration occurred at all throughout the project. In this case, the hot burn had made way for other plants to grow and thrive in the arid zone. The hot burn cleared out the relatively unpalatable Spinifex, which will take several years to recover. In the meantime rainfall is predicted to promote a wide range of other species, some of which may be more useful for cattle production. In the absence of rainfall, however, land affected by a hot burn requires a long recovery period and is at risk of soil erosion if cover remains low.

Growth Rate Comparison

The data collected on growth rates of species in this study suggest that plant regeneration is highly dependent on the follow-up rains and the plants themselves. The majority of grasses grew rapidly and herbage species such as Tar Vine and Caltrop continued to grow. From the graphs it can be said that on the unburnt site Mulga Grass showed a significant increase in height, but Umbrella Grass decreased in size, possibly due to grazing. The cool burn site showed a significant increase in the height of Tar Vine and Pea Plant. Paddy Melon and Swainsona showed decreases in average height due to mortality on this site. A significant increase in height on the hot burn site was noted for Silky Heads, Sida and Grass 2. Both the Bush Tomato and Grass 1 died.

The Effect of Fire on Ground Cover

As predicted, the average percentage of ground cover on all three sites increased over the duration of the study. Even though the smaller grasses and some plants died, the overall mass of larger plants and shrubs increased the overall ground cover.

Cover was the highest on the unburnt site for the entire study and the cool burn site, as aforementioned, responded much better than the hot burn site. The rapid growth of ground covering plants on the cool burn site displays that the seed bank persisted which will ensure soil stability and be favourable for pastoral production.

The Effect of Fire on Flowering and Seeding

As the cool burn plants were not as scorched when compared to the hot burn plants, they were able to recover and set seeds and flower at a faster rate. On the unburnt and cool burn sites, the grasses, namely Oat Grass and 8-Day Grass were found to have a quick life cycle. They quickly sprouted, flowered and seeded, before shriveling up and browning off. The final site visit on February 26th showed that Caltrop, Tar Vine and Swainsona had all begun flowering, whilst most other plant species were dead.

The hot burn site hailed different results. The smaller plants which had managed to grow produced no flowers or seeds for the duration of the project. A harsher environment, caused by higher evaporation on the bare soil may have stopped the plants from getting enough moisture to grow to sexual maturity.

The Effect of Fire on Resprouting

Species did resprout on both sites, notably the Acacia Bush on the cool burn site, and Whitewoods on the hot burn. As predicted, more resprouting of plants occurred on the cool burn site. The species that showed basal resprouting included the fork and long-leaf variety of Corkwood, Acacia Bush, Broombush, Witchetty Bush and Whitewood. It was remarkable that some of the shrubs and trees which had been badly burnt at the hot burn site showed signs of basal resprouting by the second site visit on 12/12/02. Unfortunately, the Whitewood trees that had resprouted on the hot burn site seemed to be diseased and were slowly dying.

The Effect of Fire on Plant Mortality

Mortality of plants is frequently expected in the arid zone. In comparing the total species count on the unburnt, cool burn and hot burn sites studied at Bond Springs, it is evident that the mortality rate of plants that had germinated is very high. As soon as the rain fell the plants germinated in large numbers, but as the daily temperature remained high they rapidly died off. From Table 1 it can be seen that fire didn't seem to influence actual survival of plants, as plant mortality was quite high even on the unburnt site. Interestingly, mortality did not appear to be higher on the hot burn site, which might have been expected due to the harshness of the microenvironment around the plants.

Conclusion

Plant regeneration occurred on both the burnt sites studied, with the main difference being overall ground cover and the time taken for plants to regenerate and reproduce.

The cool fire appeared to allow many seeds to survive, which meant that the vegetation might recover more quickly than on the hot burn site. The hot burn decimated the Spinifex but allowed other dormant species to germinate.

Acknowledgments

The Scholarship was sponsored by the Heaslip Family of Bond Springs, and initiated with the help of Dr Dee Walsh from the Centralian Land Management Association, and Mr. Chris Tudor from St. Philip's College. I would like to thank these people for all their help and for giving me the opportunity to be involved in a project of this nature.

References

1. Ballenger, C. (2001), "The Impacts of Grazing on Soil Physical Properties in a Sandy Open Woodland, Central Australia", Range Management Newsletter, No. 01/3, pp. 6-9.
2. Centralian Land Management Association (2001), Fire Ecology in Semi-Arid Rangelands of Australia, Alice Springs.
3. Burning For Profit: Fire as a Pastoral Management Tool in Central Australia, (2001), 1st edn.
4. Urban, A. Wildflowers and Plants of Inland Australia. (1990). Melbourne, Portside Editions.
5. Strong, B.W. Checklist of Preferred Common names of Plants of the Northern Territory. Darwin, Government Printer.
6. Bureau of Meteorology: weather data from November 2002 - February 2003.