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RELATIONSHIP BETWEEN BURNING AND SPRAYING IN THE CONTROL OF BRIGALOW (ACACIA HARPOPHYLLA) REGROWTH

I. BURNING AS A PRE-SPRAYING TREATMENT

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SUMMARY

Spraying brigalow regrowth following a pasture burn resulted in significantly better control than spraying the unburnt suckers. Using 1·12 kg. acid equivalent (a.e.) 2,4,5–T ester ha^{-1}, reductions in density of 70% and 88% were achieved following aerial spraying and tractor-mounted misting respectively of young regrowth after burning. This compared with reductions of 20% and 16% following spraying of unburnt suckers.

On burnt suckers 0·56 kg a.e. 2,4,5-T ha^{-1} in diesel distillate gave similar results to 1·12 kg a.e. 2,4,5-T ha^{-1} in water.

I. INTRODUCTION

Fire has always been a natural feature of the brigalow country. In the journals of Leichhardt (1847) and Mitchell (1848) numerous references are made to fire and Leichhardt, in one reference noted that a bushfire had recently enlarged a natural opening in brigalow scrub. Many grassy brigalow woodlands are maintained in this state today by accidental and deliberate burning at irregular intervals.

Some of the earliest attempts to clear brigalow forests for improved pastoral production involved the use of fire after preliminary felling (Anon. 1911). Fire was also used to clear dead standing timber following ringbarking and in recent years it has played an integral part in the clearing of brigalow forests for crop and pasture establishment (Johnson 1962, 1964).

Spraying with 2,4,5-T has been used widely for the control of brigalow regrowth. Johnson (1964) showed that although excellent results can be obtained when the suckers are less than one year old, the effectiveness of spraying decreases with age. Kills of approximately 80 to 90% can be expected following the spraying of suckers in their first year of growth after pulling and burning but if spraying is delayed until the suckers are 4 to 5 years old, maximum kills of only 40 to 50% can be expected.

Though it is emphasised that for effective control spraying should be carried out 5 to 6 months after the initial burn, many areas are not treated at this stage. Many graziers show little concern for brigalow regrowth until the suckers begin to grow above the pasture, and at this stage the effectiveness of spraying is considerably reduced. If control measures are delayed for too long the sown grasses disappear and the pasture reverts to a brigalow dominant community.

Fire and spraying can be combined in two ways. Firstly, fire, either accidental or deliberate, can precede spraying. The effectiveness of spraying on older suckers might be improved by burning pastures, while grass is still abundant, and spraying the brigalow regrowth which follows the fire. In this way it might be possible to approach the very good kills obtained by spraying 5 to 6 months after the initial burn. Secondly, fire, either accidental or deliberate, can follow spraying. Fire at this time could enhance or reduce the effectiveness of a spraying treatment.

This paper deals only with the first of these combinations. It describes two experiments aimed at comparing the effectiveness of spraying old established suckers with that of regrowth from these suckers following a pasture burn. The second paper discusses the use of burning after spraying.

II. MATERIALS AND METHODS

As two methods of application, tractor misting and aerial spraying, are used commercially to spray brigalow regrowth where affected areas are large, two experiments were undertaken. They were laid down in different areas under different conditions and no attempt was made to compare the relative efficiency of the methods of application. Both experiments were established on the Brigalow Research Station, 32 km north-west of Theodore. The average annual rainfall is approximately 700 mm, two-thirds of which falls from November to March.

Experiment 1—Tractor Misting

SITE. This experiment was established on an area of 32 ha which originally supported a brigalow-wilga (*Geijera parviflora*) forest community. Some belah (*Casuarina cristata*) was prominent in the canopy while Ellangowan poison bush (*Myoporum deserti*) was common in the understorey. Brigalow grass (*Paspalidium caespitosum*), belah grass (*P. gracile*) and the forbs *Rhagodia nutans* and *Enchylaena tomentosa* were the main species in the ground layer.

The soil is a dark greyish-brown uniform cracking clay (Northcote Ug 5.24) with melonholes well developed in certain areas, particularly where belah was more common. Some patches of a dark brown sandy loam over clay (Northcote Dy2.43) are scattered throughout the area.

The forest was pulled to the ground in October 1963, by a heavy chain dragged between two bulldozers and the trash burnt in December 1963. Introduced pasture species, Rhodes grass (*Chloris gayana*), buffel grass (*Cenchrus ciliaris*) and green panic (*Panicum maximum* var. *trichoglume*) were sown from the air on the ash seed bed. Dense suckering followed the initial burn and the resultant pasture was a mixture of native and sown grasses as a consequence of a very patchy burn and grazing during the establishment phase. The area was reburnt in March, 1966.

DESIGN. Three treatments were applied in a randomized block design with four replications. The treatments were:

(1) 2,4,5-T ester at 0·56 kg acid equivalent (a.e.) ha^{-1} in 45 litres of diesel distillate

(2) 2,4,5-T ester at 1·12 kg a.e. ha^{-1} in 45 litres of diesel distillate

(3) 2,4,5-T ester at 1·12 kg a.e. ha^{-1} in 45 litres of water.

Plots were 2 ha in area (100 m x 200 m) with burnt and unburnt subplots within the main plots.

METHOD. The experimental area was grazed by stock up until it was burnt and this resulted in a patchy burn. Because of this, each plot contained burnt and unburnt areas and fixed quadrats were established in each of these areas at the time of spraying. Quadrats consisted of two pegs, 20 m apart, at right angles to the direction of travel of the tractor, and suckers were counted using a 1·5 m stick centred on and at right angles to a rope stretched from peg to peg. Individuals were defined as single stems or groups of stems separated from their nearest neighbour by at least 7·5 cm. Two of these 20 m x 1·5 m quadrats were counted on both burnt and unburnt areas in each plot. An interim count was made 12 months after spraying and a final count 8 months later on 22 July 1968. The burnt area was lightly grazed until 4 weeks before spraying when all stock were removed.

With the particular type of misting machine used, adequate coverage was obtained by driving the tractor along parallel lines 10 m apart. The spray blast was directed to point in the same direction as the wind. Spraying was undertaken during both morning and afternoon, and operations were suspended when wind speed and/or direction became variable. Block I was sprayed on 10 and 11 November 1966 and Blocks II, III and IV on 17 and 18 November. A forward travel speed of approximately 5 km h^{-1} was maintained so that spraying was carried out at a rate of approximately 5 ha h^{-1}.

Experiment 2—Aerial Spraying

SITE. This experiment was established on an area of 115 ha. In 1964, this area was covered by a number of related communities with brigalow, Dawson gum or blackbutt (*Eucalyptus cambagaena*) and belah prominent in the canopy. Wilga and currant bush (*Carissa ovata*) were common in the understorey with brigalow grass, windmill grass (*Enteropogon acicularis*) and lemon scented barb-wire grass (*Cymbopogon refractus*) the most common grasses. These communities had been ravaged several times by bush fires since about 1930 and brigalow and Dawson gum regrowth was very common.

The soil is a mosaic of dark brown uniform cracking clays (Northcote Ug 5.24) and brown sandy loams on medium to heavy clays (Northcote Dbl.43).

The standing vegetation was crushed to the ground with a "Le Tourneau Westinghouse Tree Crusher" in July 1964 and the trash burnt on 19 December 1964. Rhodes grass was sown by aircraft into the ash at the rate of 2·2 kg ha^{-1}.

Brigalow and Dawson gum regrowth was common following the intial burn and in January 1967 the mixed native grass and Rhodes grass pasture was burnt.

DESIGN. Four treatments were applied in a randomized design with four replications. The treatments were:

(1) 2,4,5-T ester at 0·56 kg a.e. ha^{-1} in 28 litres of diesel distillate.
(2) 2,4,5-T ester at 1·12 kg a.e. ha^{-1} in 28 litres of diesel distillate.
(3) 2,4,5-T ester at 1·12 kg a.e. ha^{-1} in 28 litres of water.
(4) 2,4,5-T amine at 0·56 kg a.e. ha^{-1} plus the amine formulation of picloram at 0·14 kg a.e. ha^{-1} in 28 litres of water.

In addition there were five untreated control plots. Plots were 3 ha in area (100 m x 300 m).

The 2,4,5-T plus picloram treatment was added in this experiment because of the presence of Dawson gum regrowth and the known toxicity of picloram to a number of *Eucalyptus* spp.

Because the burn was patchy, burnt and unburnt subplots could be located in each of the main plots.

METHOD. The experimental area was fenced and the pasture protected from stock through the spring and summer before burning. Following burning, the paddock was heavily grazed from February 1967 to April 1967. Stock kept the grass short but they also grazed some of the brigalow regrowth. Stock were removed four weeks before spraying to allow any grazed suckers to produce fresh growth.

Spraying was undertaken in the early morning and late afternoon of 14 May 1967. A Piper Pawnee covering a 16·5 m swathe was used and each run was defined by markers. Six runs were used on each plot.

Following spraying, stock were not allowed access until the spring.

The technique used to count suckers, before and after treatment, was identical to that described in the previous experiment. Four quadrats were established on areas of burnt suckers and two on areas which remained unburnt. Final counts were made in October 1968.

Because Dawson gum regrowth was less dense and of a larger size than brigalow, records of this species were made in quadrangular quadrats of varying size to enclose at least 10 plants. Four quadrats, two in burnt patches, were established in each control plot and in all plots treated with 2,4,5-T plus picloram and with 1·12 kg 2,4,5-T ha^{-1} in diesel distillate. These quadrats were counted at the same time as the brigalow quadrats.

ADDITIONAL DATA. The results following the spraying of regrowth from a burn will be influenced by the timing of the spraying in relation to the time pattern of emergence of the suckers. If spraying is undertaken before most of the suckers have emerged following burning poor results can be expected. To understand more clearly the results of this experiment and to help determine more precisely the best timing for the spraying operation, the emergence of suckers was monitored.

Ten 20 m x 20 m plots were pegged out on an unsprayed part of the burnt area. In each plot, ten 1 m x 1 m quadrats were permanently marked in a systematic pattern. At approximately monthly intervals from January to July and again in November, the number of brigalow suckers was counted and estimates of the canopy cover of brigalow, Rhodes grass, native grass and native herbage in a 1 m x 0·4 m portion of the quadrat were calculated using the technique of Daubenmire (1959). An estimate of the percentage bare ground was also made.

III RESULTS

Experiment 1—Tractor Misting

Rainfall on the experimental area was below average from the time of burning until spraying. On 8 November 1966, two days before the commencement of spraying, 50 mm of rain were recorded. Rainfall remained below average until January when 175 mm of rain were recorded. However, over the 12 months following spraying rainfall was well below average.

Results given in table 1 show that kills have been improved significantly ($P<0\cdot01$) by burning prior to spraying.

Increasing the rate of 2,4,5-T in distillate from 0·56 kg ha^{-1} to 1·12 kg ha^{-1} resulted in improved kills though with both the unburnt suckers and regrowth from burnt suckers the results were not significant. Where water was used as the carrier, results were more variable. With regrowth from burnt suckers there was little difference in kill between plots treated with 0·56 kg 2,4,5-T ha^{-1} in distillate and 1·12 kg 2,4,5-T ha^{-1} in water while improved kills were obtained where 1·12 kg 2,4,5-T ha^{-1} in distillate was used. However, where unburnt suckers were treated, spraying with 1·12 kg 2,4,5-T ha^{-1} in water gave the best kills.

TABLE 1

EXPERIMENT 1—PERCENTAGE KILL OF BRIGALOW SUCKERS FOLLOWING TRACTOR-MOUNTED MISTING

Chemical	Concentrate kg ha^{-1}	Carrier	Percentage Kill		Main Effect (Chemicals)
			Burnt	Unburnt	
2,4,5-T	0·56	Oil	70·09 (0·992)*	15·59 (0·406)	41·50 (0·699)
2,4,5-T	1·12	Oil	88·22 (1·221)	17·12 (0·427)	53·81 (0·824)
2,4,5-T	1·12	Water	75·87 (1·057)	26·19 (0·537)	51·18 (0·797)
Main Effect (Burning)			78·61 (1·090)	19·43 (0·457)	
			Treatments	Main Effect (Burning)	Main Effect (Chemicals)
Necessary Differences for Significance		5%	(0·302)	(0·174)	(0·397)
		1%	(0·433)	(0·250)	(0·602)

( )* — Inverse sine transformation used in analysis.

It was not possible to undertake all treatments at the one time so that variations in wind velocity and temperature at the time of treatment, and in the time of day could have obscured the final results. An attempt was made to adjust for these factors in analysing the data but these adjustments did not reveal any additional significance. With regrowth from burnt suckers, these adjustments did not affect the order of treatments with the 1·12 kg 2,4,5-T ha^{-1} in distillate being superior to the other two. However, with the unburnt suckers, the order of treatments fluctuated greatly with each adjustment indicating that better results following treatment with 1·12 kg 2,4,5-T ha^{-1} in water may not reflect any real difference between these treatments. Where little reduction in density occurs following treatment, such as in the unburnt plots, sampling error associated with the counting of suckers of this type tends to obscure treatment differences.

Experiment 2—Aerial Spraying

Rainfall was well above average in the first 4 weeks after burning but from the end of January to the end of May only 95 mm of rain was recorded. This was approximately 65% below average.

The pattern of emergence of brigalow suckers following burning can be seen from figure 1. At the time of the initial count 6 weeks after the burn, approximately 87% of the suckers recorded at the final count in November 1967 had emerged. The rate of emergence decreased greatly in succeeding months but it was not until the spring following the summer burn that all suckers had emerged.

In contrast to the pattern of emergence, the canopy coverage of brigalow increased at a substantial rate beyond the eleventh week but from the sixteenth week little further increase was recorded. Both Rhodes grass and native herbs regenerated rapidly after the burn and within about 6 weeks the canopy cover of each had stabilized under moderate grazing pressure.

Rainfall in the 3 months prior to spraying was well below average and soil moisture was low at the time of spraying. Kills following the spraying of brigalow regrowth from the pasture burn were significantly better ($p<0{\cdot}01$) than kills following spraying of unburnt suckers (table 2). Best results were obtained with 1·12 kg a.e. 2,4,5-T ha^{-1} in distillate while the particular 2,4,5-T plus picloram mixture gave significantly poorer results than the three 2,4,5-T treatments.

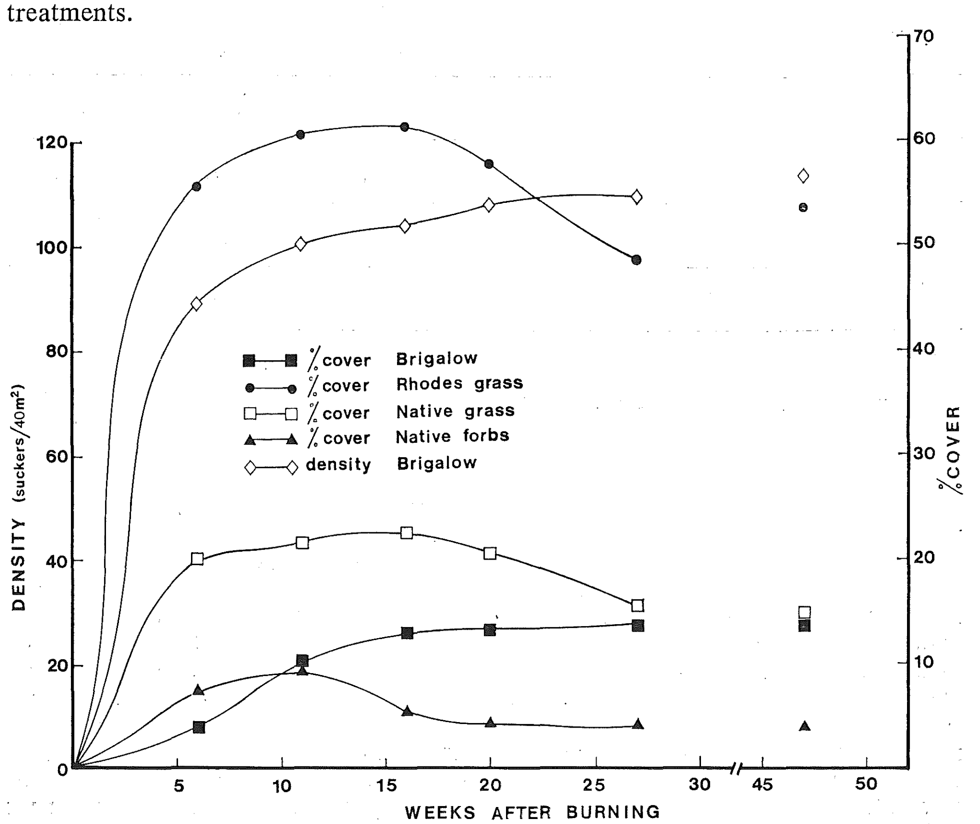

Figure 1. Experiment 2—Regeneration of pastures and brigalow suckers following burning.

TABLE 2

EXPERIMENT 2—PERCENTAGE KILL OF BRIGALOW SUCKERS FOLLOWING AERIAL SPRAYING

Chemical	Rate kg ha^{-1}	Carrier	Percentage Kill Burnt	Percentage Kill Unburnt	Main Effect (Chemicals)
2,4,5-T	0·56	Oil	58·5 (0·871)*	28·8 (0·567)	43·4 (0·719)
2,4,5-T	1·12	Oil	70·5 (0·997)	38·6 (0·671)	54·8 (0·834)
2,4,5-T	1·12	Water	52·1 (0·806)	10·8 (0·336)	29·2 (0·571)
2,4,5-T + picloram	0·56 + 0·14	Water	19·1 (0·452)	0·4 (0·063)	6·5 (0·257)
Main Effect (Burning)			49·6 (0·782)	15·8 (0·409)	
			Treatments	Main Effect (Burning)	Main Effect (Chemicals)
Necessary Differences for Significance 5%			(0·185)	(0·092)	(0·173)
Necessary Differences for Significance 1%			(0·259)	(0·130)	(0·242)

( )* Inverse sine transformation used in anlaysis.

On both burnt and unburnt subplots, the reduction in density was greater following treatment with 0·56 kg 2,4,5-T ha^{-1} in distillate than with 1·12 kg 2,4,5-T ha^{-1} in water. However, only in the unburnt subplots was the difference significant.

Kills of Dawson gum were very low and there was little difference in effectiveness between the 2,4,5-T treatment in distillate and the 2,4,5-T plus picloram treatment in water. A mean reduction of 18% was achieved on burnt suckers and 1% on unburnt suckers. Though these differences were significant no treatment gave satisfactory kills.

IV DISCUSSION

Burning pastures and spraying brigalow regrowth which emerged resulted in kills approaching those which are attainable after spraying regrowth in the first season after the initial burning of pulled brigalow forest. In both experiments, regrowth following burning was two to four times more susceptible to the various treatments than unburnt suckers.

The better results obtained in the tractor misting experiment could in part reflect better soil moisture conditions at time of spraying and differences in habitat.

The first condition for satisfactory control is that most of the suckers must have emerged before spraying. The time pattern of emergence of suckers following burning in the aerial spraying experiment may not be typical because of the atypical rainfall pattern which followed the burn. The wet conditions in the month after burning would have favoured rapid emergence but the subsequent lack of rainfall may have been responsible for the slow emergence of the remaining suckers. In a pilot study in the previous year, maximum emergence was recorded 10 weeks after burning while in this experiment approximately 90% of the suckers had emerged by the tenth week.

Emergence was much more rapid than that recorded following the initial burn of pulled brigalow forests when expected emergences, 10 and 15 weeks after burning, are 50% and 80% (Johnson, 1976). The more rapid initial emergence probably reflects the lower intensity of the grass burn as well as the above average rainfall which followed.

Though the initial emergence was rapid some suckers did emerge after the winter. In this experiment burning occurred in January, which is later than the normal burning time, and this, combined with the dry autumn could have caused the late emergence of suckers following above average winter rains.

Burning is usually undertaken from October to December and with a late spring-early summer burn it would appear that spraying should be delayed for at least 3 to 4 months after burning. In the tractor-misting experiment an autumn burn was used. Sucker emergence is slow during the winter and spraying in the early summer, 7 months after burning, resulted in very effective control.

Spraying with 2,4,5-T is known to be most effective when soil moisture is high (Johnson and Back, 1973). Having delayed spraying to allow for sucker emergence the spraying operation should then be timed to coincide with a period of high soil moisture.

In both experiments, kills were improved by from 10% to 35% by increasing the rate of application of 2,4,5-T in distillate from 0·56 to 1·12 kg ha^{-1}. While the relative effectiveness of the 0·56 kg ha^{-1} and 1·12 kg ha^{-1} treatments in distillate was consistent both between and within experiments the relative effectiveness of the water-based treatment to the two distillate treatments was variable. On regrowth following burning in both experiments the 1·12 kg 2,4,5-T ha^{-1} treatment in water was as effective as the 0·56 kg 2,4,5-T ha^{-1} treatment in distillate. However, with the unburnt suckers in the tractor-misting experiment the 1·12 kg 2,4,5-T ha^{-1} treatment in water was as effective as the 1·12 kg 2,4,5-T ha^{-1} treatment in distillate, while in the aerial spraying it was inferior to the 0·56 kg 2,4,5-T ha^{-1} treatment in distillate. The inconsistency of the water-based 2,4,5-T treatment in relation to the treatments in distillate supports the general conclusion from other studies with brigalow (Johnson, unpublished data) that results with 2,4,5-T are less predictable when water is used as a carrier.

The 2,4,5-T plus picloram treatment had little effect on the brigalow suckers. The amine formulation of 2,4,5-T is not nearly as toxic as equivalent rates of the ester formulation, while brigalow is fairly resistant to commercial rates of picloram (Johnson, unpublished data). On the other hand, the amine formulation of picloram at the rate used was not effective in controlling the Dawson gum regrowth. Kills of 60% have resulted from directed misting with similar rates but using higher volumes.

In the tractor-misting experiment because of good early summer rain and a light stocking rate it was not necessary to destock the paddock to provide a build up of pasture before burning. In the aerial spraying experiment, stock were excluded to allow an accumulation of fuel for burning. Any loss in income resulting from spelling must be balanced against increased control. The use of burning prior to spraying will be determined largely by an excess of pasture over stock and the availability of stock to maintain the pasture in a well grazed state before spraying. In both trials stock were needed to prevent severe shielding of suckers by pasture.

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REFERENCES

ANON (1911).—Answers to Correspondents—Brigalow. *Qd agric. J.* 27:99.

DAUBENMIRE, R. (1959).—A canopy-coverage method of vegetational analysis. *Northw. Sci.* 33:43-64.

JOHNSON, R. W. (1962).—Clearing the Scrub. *Qd agric. J.* 88:736-50.

JOHNSON, R. W. (1964).—'Ecology and Control of Brigalow in Queensland.' (Qd Dept. of Primary Industries: Brisbane).

JOHNSON, R. W. (1976).—Competition between brigalow (*Acacia harpophylla*) suckers and establishing pastures following pulling and burning. *Qd J. agric. Anim. Sci.* 33:21-43.

JOHNSON, R. W. AND BACK, P. V. (1973).—Influence of environment on methods used to control brigalow (*Acacia harpophylla*). *Qd J. agric. Anim. Sci.* 30:199-211.

LEICHHARDT, L. (1847).—'Journal of an overland expedition in Australia from Moreton Bay to Port Essington.' T. & W. Boone, London.

MITCHELL, T. L. (1848).—'Journal of an expedition into the interior of tropical Australia.' Longman, Brown, Green & Longman, London.

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