QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES
DIVISION OF PLANT INDUSTRY BULLETIN No. 374

SANDALWOOD (EREMOPHILA MITCHELLII) CONTROL IN GIDYEA COUNTRY

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SUMMARY

Complete kills were obtained by basal spraying sandalwood 3–10 ft high with 2,4,5-T butyl ester in distillate, irrespective of concentration (1 and 2% a.e.), volume per tree (2·5-5·5 fl oz) and time of the year.

Sandalwood 13–20 ft high was killed by basal spraying with 2,4,5-T butyl ester in distillate at a concentration as low as 1% active ingredient. The addition of dibutyl phthalate (penetrant) increased the kill at the 0·5% 2,4,5-T concentration.

Swabbing the cut stump with distillate, or 2,4,5-T ester at 1 or 2% in water or distillate, was effective in killing sandalwood.

High-volume foliage spraying with the ester of 2,4-D or 2,4,5-T was effective in killing sandalwood below 2 ft in height when carried in water (0·4%) and in water-distillate emulsion (0·2 and 0·4%).

I. INTRODUCTION

Over 750,000 acres of gidyea scrub country have been developed to grassland in the Barcaldine–Blackall–Tambo–Isisford area of central-western Queensland, and about 150,000 acres are now being pulled annually. A problem connected with this development is the growth of associated species after scrub clearing. The most important of these is false sandalwood (*Eremophila mitchellii*), commonly known as sandalwood, which has a very wide distribution in Queensland from north of Hughenden south to the New South Wales border and east to the Great Dividing Range. If left untreated in pulled scrubs, sandalwood may reach a density which severely limits pasture growth and thus animal production.

Although the density of sandalwood can be substantially reduced by a hot timber fire in the pulled scrub (Purcell 1964), some sandalwood usually remains. The remaining infestation may warrant the cost of spelling the whole area and burning again at a later date. However, often the situation will be such as to require control of sandalwood by chemical or mechanical means. Pilot studies and subsequent experiments in this field were conducted in the Blackall district; because of the high cost of labour relative to that of land value, single-application control measures were sought.

II. METHODS AND RESULTS

All concentrations are expressed in terms of 2,4,5-T acid equivalent.

(a) Basal Bark Spraying

In March 1962, a pilot trial was carried out on sandalwood trees 3-5 ft high and with stems 1-1·5 in. thick, applying a low volume of 1 fl oz per tree. The butyl ester of 2,4,5-trichloro-phenoxyacetic acid was used at 1, 2 and 4% concentrations in distillate, water, water plus distillate, and water plus emulsifiable oil. Distillate proved to be the only effective carrier; 1% 2,4,5-T was not effective; 2,4,5-T at 2% and 4% concentrations gave complete kills.

In May 1963, sandalwood of similar size was basal sprayed with distillate and with 2,4,5-T ester at 2% and 4% in distillate, using the same low volume per tree. Both ester concentrates in distillate again gave complete kills; distillate alone was ineffective.

In March 1964, when using 4–5 fl oz on trees of 1–3 in. stem diameter, the addition of sump oil to distillate as a carrier for 2,4,5-T reduced the cost without impairing effectiveness.

In April 1964, application rates ranging from 2 to 5·5 fl oz per tree were used on sandalwood between 1 and 3 in. in stem diameter; the herbicide used was 2,4,5-T ester at 1% and 2% in distillate. All treatments gave complete kills.

Experiment 1: Effect of Concentration, Volume and Time of Application of 2,4,5-T Ester on Small Sandalwood

This experiment was laid down to test the results from the pilot studies, using seedling sandalwood 3–10 ft high located at "Swaylands", 7 miles southwest of Blackall. A factorial design was employed, using two absolute replications of each combination of the following treatments:—

(1) Concentrations: 1% and 2% of 2,4,5-T ester in distillate.

(2) Herbicide volume: Different nozzles were used to give four different volumes of application:

(i) Solid cone spray nozzle with an output of 25 gal/hr at 40 lb/sq in.

(ii) Adjustable cyclone nozzle of 0·25-in. gas-type with interchangeable caps of aperture size 0·046 in.

(iii) Nozzle as in (ii), but with aperture size 0·031 in.

(iv) Nozzle as in (ii), but with aperture size 0·025 in.
These nozzles gave a delivery of from 5 to 5·5 fl oz per tree for nozzle (i) to 2·5 fl oz per tree for nozzle (iv).

(3) Time of treatment: (i) August 5, 1964, after a relatively dry autumn and winter; (ii) December 2, 1964, following good spring rains; (iii) February 25, 1965, during a very dry summer.

Herbicides were applied encircling the stem of the tree from ground level to 6 in. high using a knapsack spray with a bent extension arm and trigger-release attachment. There were 10 trees per plot.

When results were finally assessed 17 months after the first application, complete kills were recorded in all treatment combinations.

Experiment 2: Effect of Varying Concentration of 2,4,5-T Ester and of Penetrant on Large Sandalwood

Pilot studies in the spring of 1961 indicated that a basal spraying using 2,4,5-T ester was not effective on trees 12-18 ft high. However, in later trials it was revealed that a subminimal quantity of spray had been used. This experiment was designed to test 2,4,5-T ester at effective amounts.

The experiment was laid down in June 1964 at "Fairfield", 5 miles north of Blackall, on sandalwood trees 13–20 ft in height and with basal diameters of 4–8 in. A factorial design was employed, using two absolute replicates of each combination of the following treatments:—

(1) Concentrations: 0·5, 1·0, 2·0 and 4·0% of 2,4,5-T butyl ester.

(2) Carriers: (i) Distillate; (ii) distillate plus 5% dibutyl phthalate; (iii) distillate plus 10% dibutyl phthalate.

Recent work by de Jonge (personal communication) has indicated that dibutyl phthalate may be an aid to the penetration of 2,4,5-T butyl ester through the bark tissue, and it was considered possible that the use of this penetrant would increase the kill obtained on larger trees at the lower concentrations of 2,4,5-T. Approximately 8·5 fl oz of the mixture was applied per tree, using a knapsack sprayer and a solid-cone, coarse spray nozzle giving an output of 25 gal/hr at 40 lb/sq in. There were 10 trees per treatment.

The results (Table 1) indicated that 0·5% 2,4,5-T ester in distillate alone is not as effective as the other treatments on trees of this size. There was no significant difference between the killing effects of all other combinations of concentrations and carriers when observed 14 months after treatments.

TABLE 1

Experiment 2: PERCENTAGE KILL OBTAINED ON 4–8 in. Diameter, 13–20 ft High *E. mitchellii* at 14 MONTHS AFTER TREATMENT

Percentage of 2, 4, 5–T Ester	Carrier		
	Distillate	Distillate plus 5% penetrant	Distillate plus 10% penetrant
0·5	70	95	100
1·0	95	100	95
2·0	100	100	100
4·0	100	100	100

(b) Mechanical and Chemical Treatments

At monthly intervals from early 1962 to mid 1965, ten sandalwood trees 13 to 20 ft high were chopped down within 2 ft of ground level. Good kills of between 90 and 100% were obtained from summer and autumn treatments. At other times of the year results were variable. In most cases where the chopping-off has been effective, the butts at first showed some regrowth of 3–8 in. before eventually dying.

Shallow and deep frill ringing at waist high has also been carried out over this period. In August 1965, the available results indicated very good kills irrespective of the depth of frilling or of time of treatment, provided the frill completely reached the cambium layer for the full circumference of the stem. Results of the later treatments are not yet available.

Smaller sandalwood from 18 to 30 in. high were chopped off at or just below ground level at approximately monthly intervals from early 1961 to mid 1965. Between December and April, 50–80% kills were common, but winter and spring treatments gave very small percentage kills generally.

Experiment 3: Effect of Chemical Treatment of the Cut Stump on Small Sandalwood

The variable results obtained on the smaller trees prompted further exploratory trials on the effect of swabbing the cut butts with 2,4,5-T in water and in distillate. Success in these trials suggested more detailed study.

An experiment was laid down at "Woodbine", 7 miles north of Blackall. Plots consisted of 20 trees 3–8 ft in height, with two replicates as fully randomized blocks.

(1) *Stump treatments*: (i) Control as cut stump only; (ii) cut stump plus distillate swabbed; (iii) cut stump plus 2,4,5-T ester 1% in water; (iv) cut stump plus 2,4,5-T ester 2% in water; (v) cut stump plus 2,4,5-T ester 1% in distillate; (vi) cut stump plus 2,4,5-T ester 2% in distillate.

(2) *Time of treatment*: (i) April 1964; (ii) July 1964; (iii) December 1964.

Cuts were made as near as possible to, but not below, ground level. The cut surface and all the exposed aboveground parts were swabbed, the amount applied being approximately 1·5 fl oz per butt.

The results are indicated in Table 2. All other treatments gave better kills than "cut stump only". In the treatment of cut stump swabbed with distillate only, one replicate of the December application resulted in a poor kill. All the hormone treatments were highly effective.

TABLE 2

Experiment 3: PERCENTAGE KILL OBSERVED IN AUGUST 1965 on 3–8 ft High *E. mitchellii*

2,4,5-T	Carrier	Time of Treatment		
		Apr. 1964	July 1964	Dec. 1964
Nil	Nil	15	8	43
Nil	Distillate	95	93	70
1%	Water	100	100	100
2%	Water	95	100	100
1%	Distillate	98	100	100
2%	Distillate	95	100	100

(c) Foliage Spraying and Misting

Exploratory trials were carried out in spring 1961 and autumn 1962 on high-volume foliage spraying of sandalwood. Both the amine and the ester of 2,4-D and 2,4,5-T were tested on trees less than 2 ft 6 in. in height and on trees from 2 ft 6 in. to 4 ft in height. These herbicides were applied by knapsack spray at the rate of 0·2 and 0·4% in water and in water plus 10% distillate.

These pilot trials indicated that the esters of 2,4-D and 2,4,5-T were more effective than the amines; water plus 10% distillate was a better carrier than water alone; autumn application was better than spring; 0·4% was more effective than 0·2% when water alone was used as a carrier; and trees up to 2 ft 6 in. high were more easily killed than bigger trees.

These results were used to form the basis of the next experiment.

Experiment 4: Effect of High-volume Foliage Spraying of the Esters of 2,4-D and 2,4,5-T on Small Sandalwood

This experiment was laid down at "Fairlea", 17 miles west of Blackall, on sandalwood seedlings and suckers below 2 ft in height in March 1964. Twelve trees were used per plot and there were three replicates as randomized blocks.

(1) *Hormones used:* 2,4-D ester and 2,4,5-T ester.

(2) *Rates and carriers:* (i) 0·2% in 10% distillate; (ii) 0·4% in 10% distillate; (iii) 0·4% in water.

The results (Table 3) indicated that foliage spraying of small sandalwood with high-volume equipment can be effective using the ester of either 2,4-D or 2,4,5-T.

TABLE 3

Experiment 4: Percentage Kill Obtained at 17 Months after Treatment Using the Esters of 2,4-D and of 2,4,5-T on Small *E. mitchellii*

Hormone	Concentration	% Kill, Aug. 1965
2,4-D ester	0·2% in 10% distillate	83
	0·4 in 10% distillate	97
	0·4% in water	97
2,4,5-T ester	0·2% in 10% distillate	100
	0·4% in 10% distillate	100
	0·4% in water	92

Misting Trial

Following some success with high-volume spraying, a pilot trial on misting of sandalwood was laid out in February 1963 at "Fairlea". The tree density was about 350 trees per acre on a heavy regrowth area. Trees ranged from 2 to 10 ft in height, but were mostly between 3 ft 6 in. and 6 ft. Each treatment comprised 0·2 ac, and all sandalwood was treated by misting all the foliage with a knapsack mister at a setting rated by the manufacturers to deliver 1 gal in 7 min.

The hormones used were 2,4-D amine, 2,4-D ester and 2,4,5-T ester. The active concentrations of the hormones were 1·0 and 0·5%. For this particular tree size and density and nozzle setting, the 1·0 and 0·5% concentrations were equivalent to approximately 1·0 and 0·5 lb of active ingredient per acre respectively. The carriers for the esters were water, water plus 20% distillate, and water plus 10% of emulsifiable oil. The amine was applied in water only.

The observed results at 15 months after treatment indicated that the ester of 2,4-D and the ester of 2,4,5-T gave very good kills at the 1% concentration in water plus emulsifiable oil on trees shorter than 4 ft. The 0·5% concentration of both esters was also promising but was not as good as the 1% concentration. The amine of 2,4-D was ineffective.

Water with the emulsifiable oil added was the best carrier for the hormones. Results of the water-distillate emulsion were variable and water alone proved to be an ineffective carrier.

Trees higher than 4 ft were obviously not thoroughly wetted at the top even though the misting arm of the machine was directed towards the top of the tree. Any section of a tree which was not misted continued to grow.

Based on these results, a further experiment is in progress to determine the effectiveness of foliage misting of sandalwood.

III. DISCUSSION

Kills of small sandalwood obtainable from basal spraying under paddock conditions may not give the wholesale kill obtained in experiment 1. Special care was taken to give complete coverage to the circumference of the base of the stem. Under field conditions with hired labour, some stem bases may be poorly sprayed or missed altogether. However, with reasonable care, very good kills can be expected. Robertson (1965) achieved similar results in south-western Queensland, using these concentrations of the ester of 2,4,5-T.

In a supplementary trial applied at Blackall in March 1964, using a cyclone nozzle with 0·046-in. orifice, 0·5% was as effective as 1·0% 2,4,5-T. This nozzle applied 4–4·5 fl oz per tree of 1–2·5 in. diameter. Robertson (1965) obtained good kills on similar sized trees using 2·5–5 fl oz per tree (some of which had more than one stem) at the 0·5% 2,4,5-T concentration. If this concentration proves successful in commercial paddock application, the cost of the required chemicals per tree will be reduced even further.

If trees are predominantly multi-stemmed, as is often the case with regrowth sandalwood as opposed to seedling sandalwood, twice as much spray per tree may be required to obtain full coverage of all the stems.

Robertson (1965) found that if distillate is used alone as a basal spray, satisfactory kills are obtained on sandalwood with stems less than 1 in. thick but that percentage kill decreases markedly for larger trees. In the pilot trial prior to experiment 1, sandalwood of 1–1·5 in. thickness was not killed by distillate. However, only 1 fl oz was applied per tree in this trial, while Robertson used approximately 2·5 fl oz.

Although the experiment with large trees was conducted at one particular time of the year only, the results suggest that good kills of large sandalwood can be obtained from 1% active ingredient 2,4,5-T in distillate, provided the full circumference of the bottom 9–12 in. of the stem is thoroughly sprayed. This means that if big trees are encountered when basal-spraying smaller sandalwood, then such trees can be treated with the same material and technique.

The inclusion of the penetrant in the 0·5% 2,4,5-T treatment made it as effective as the 1·0% 2,4,5-T treatment in distillate only. However, in a pilot trial carried out in March 1964, on smaller sandalwood from 4 to 8 ft high, a complete kill was obtained in the 0·5% 2,4,5-T treatment whether the hormone was carried in distillate plus penetrant or in distillate only. There is no evidence to suggest that this lower concentration of the butyl ester of 2,4,5-T can be made more effective by using dibutyl phthalate as a penetrating agent on smaller trees. However, this trial suggests that this may be so for larger trees.

The results of butt treatment indicate that 1% 2,4,5-T ester in water is as effective as any other treatment for controlling regrowth from the stumps of young sandalwood. This treatment is also the least expensive apart from the control, where no swabbing is carried out.

This technique could be carried out by one man with an axe and one boy applying the water-herbicide mixture. The heavily multi-stemmed regrowth type of sandalwood would be less suited to this form of control because of the necessity of chopping and treating every individual stem.

In high-volume foliage spraying the sandalwood must be less than 2 ft high to obtain a good kill, and preferably less than 18 in. high. The foliage must be completely covered with the spray liquid, because if one section of a tree is missed then the tree will continue to grow.

On sandalwood 15–18 in. high, thorough wetting was obtained with about 10–12 fl oz per tree. Since the ester of 2,4-D is cheaper than that of 2,4,5-T, the 2,4-D ester at 0·4% active concentration in water is the cheapest treatment.

There has been no quantitative measurement of the decrease in production due to a heavy density of sandalwood in developed scrub. However, in areas badly infested with sandalwood, very little ground herbage is evident, while in well-grassed pulled scrub buffel grass has produced 3,000 lb dry matter per acre in below-average seasons in the Blackall district.

The techniques described in this paper could not be considered inexpensive. However, adherence to a few principles in the use of these chemical control measures offers promise of economic application:—

(1) If, after scrub pulling, burning and seeding, the area is still heavily infested with sandalwood, a practical approach would be to spell the area after a good season to obtain fuel and to burn again. Grass fires will reduce the vigour of sandalwood and will even kill smaller sandalwood. The percentage kill in these subsequent fires will depend to a large degree on the amount of timber available as fuel. The sandalwood population may be reduced to a density where it is economically practicable to use chemical treatments.

(2) Because of high costs, isolated patches of dense sandalwood which might remain after the pulled scrub block has been burnt do not merit treatment. These patches constitute shade and shelter areas for stock.

(3) If the sandalwood infestation is such as to warrant control measures on less than half of the treated scrub area, it would probably be preferable for the sandalwood to be treated chemically rather than spell the whole area at a later date in order to burn this section. Here again, the thickest patches could be left for shade and shelter, and eradication be concentrated on the less dense distribution.

(4) Chemical treatment could be successfully employed in the much more common situation where a scattering of sandalwood is present throughout the area or present on a portion only of the area after a burn.

(5) In the first or second autumn after a burn, high-volume spraying could be employed when the plants are less than 2 ft in height. Knapsack misting could be successfully used into the third summer, although the smaller the plants are, the lower the cost and the better the kill.

For older sandalwood, basal bark spraying is advisable, and would of necessity be used when the tree is taller than 4 ft. This technique could be used to treat both the sucker and seedling type of growth, whereas the cut stump method would only be suited to sandalwood of seedling origin with one or perhaps two stems.

The techniques must not be considered as a substitute for correct developmental procedures, but rather as a subsequent treatment to ensure continued high production over developed areas. The practicability and economics of application of the various techniques are fully discussed elsewhere (Purcell 1966).

IV. ACKNOWLEDGEMENTS

The co-operation of graziers in the central-west of Queensland and the financial support of the Wool Research Trust Fund are gratefully acknowledged.

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(Received for publication February 14, 1966)

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