ARBORICIDE TRIAL IN A DIPTEROCARP FOREST IN PENINSULAR MALAYSIA

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MANOKARAN, N., RADZI BIN JAMALUDDIN & MOHD. RASOL BIN ABD. MANAF. 1989. Arboricide trial in a dipterocarp forest in Peninsular Malaysia. Several chemicals, 2,4,5-T, Esteron 720, Garlon 4E, Tordon 22K and Velpar-L, were tested against sodium arsenite in killing unwanted trees in a previously logged dipterocarp forest. Results showed that a solution of 1 part Tordon 22K in 2.5 parts of water was as efficient as a 20% solution of sodium arsenite. However, Tordon 22K will not be available in the market. Of the other chemicals, a 2% solution of 2,4,5-T in diesel, presently used as an arboricide, was still found to be the only suitable alternative to sodium arsenite. Cost of the chemical and diesel being low in comparison to labour, a 4, 6 or even 8% solution of 2,4,5-T in diesel could be used to ensure greater success in tree killing. There may, however, be difficulty in the future in even obtaining sodium arsenite and 2,4,5-T.

Key words: Arboricide trial - dipterocarp forest - sodium arsenite - 2,4,5-T

Introduction

The objective of the girdling operations in the Malayan silvicultural systems was the elimination of inferior species to make way for existing or potential regeneration of commercially valuable species, with as little damage as possible to this regeneration (Wyatt-Smith 1963a). Until the end of 1930, inferior species were ring-barked and deeply girdled in an attempt to kill them but this method was often ineffective and relatively expensive. Then, experiments were restarted to investigate the use of poison in killing trees (Wyatt-Smith 1963a). Earlier in 1918, Sanger-Davies (1919) had applied Atlas Preservative, an arsenical proprietary preparation, to cuts made into sapwood of trees, but the successful method was not adopted because of high costs. The experiments, based on work elsewhere by MacKinney and Korstian (1932) with sodium arsenite, showed that an aqueous solution of sodium arsenite applied to a frill girdle, was a satisfactory method of killing unwanted trees. This method was adopted and was being widely used by 1935, and from the mid-1950s, the concentration used was 0.91 *kg* of sodium arsenite per 4.54 *l* of water.

Wyatt-Smith (1963b) carried out trials in a hill forest to find a poison that could be as effective and cheap as sodium arsenite at 0.91 *kg* per 4.54 *l* of water without being toxic to humans and other animals and preferably one that is water soluble. Different methods of application were also considered, and accounts of these are found in Barnard (1950, 1952), Beveridge (1957), Nicholson (1958) and Wyatt-Smith (1960, 1961, 1963b). Effectiveness of an arboricide was initially defined as a kill of 80% or more 12 months after application (Beveridge 1957). Since less than 15% of all trees required to be treated in an area were usually greater than the minimum felling girth (generally 137 *cm* in girth breast height), Wyatt-Smith (1960) subsequently recommended that a standard of 70% killed in 12 months for all trees of 137 *cm* gbh and above (a figure obtained with sodium arsenite at a concentration of 20%) be adopted in future.

Later experiments by King (1965) in British Guiana and Liew (1971) in Sabah showed that sodium arsenite was still the most effective and economic arboricide. Liew (1971) considered a 2% solution of 2,4,5-T in diesel applied to frill girdles [tested earlier by Beveridge (1957) and Wyatt-Smith (1960, 1961, 1963b)] to be the best alternative as it proved as effective as a 20% solution of sodium arsenite at 18 months after treatment. The impracticability of transporting large quantities of diesel into the forest was noted. Subsequent experiments by Chai (1978) showed that a 6% mixture of 2,4,5-T in water, which overcame transportation problems, was as effective as a 2% solution of 2,4,5-T in diesel, but at a comparatively higher cost.

Although banned for general agricultural use, sodium arsenite continued to be used as the arboricide in poison girdling operations in Peninsular Malaysia into the 1970s. In the late 1970s, however, it was in short supply, (H. T. Tang unpublished report). There was therefore an urgent need to find a suitable alternative arboricide, and in late 1980, a trial was initiated to determine the efficacy of a few chemicals in killing unwanted trees. In the mean time, however, a solution of 2,4,5-T in diesel is being used as a substitute for sodium arsenite in silvicultural operations in Peninsular Malaysia. Presently 2,4,5-T is in short supply too as it is no more being distributed by the chemical company concerned (Imperial Chemical Industry (Malaysia) Sendirian Berhad personal communication).

Materials and method

Selection of chemicals

Sodium arsenite, 2,4,5-T (2,4,5-trichlorophenoxyacetic acid), Esteron 720, Garlon 4E, Tordon 22K and Velpar-L were selected for the trial, the former as the control arboricide, The latter three were selected based on the response of various companies in Kuala Lumpur dealing with agricultural chemicals.

Site selection

Compartment 3A of Bukit Belata Forest Reserve, Selangor, Peninsular Malaysia was selected for the trial. The compartment had been logged for dipterocarp and other commercial species in the 1960s. At the time of site selection it comprised mainly of non-commercial trees and hence was considered a poor forest. The area is hilly, rising to an altitude of about 250 *m* above sea level.

Plot establishment

A 201 x 483 *m* plot was established and this was subdivided into four blocks of 201 x 121 *m* dimensions each. Each of the four blocks was further subdivided into subblocks of 201 x 20 *m* dimensions each. Initially, at the time of plot establishment, only six treatments were planned and these were intended to be replicated four times. After plot establishment two more treatments were incorporated. Subsequently, therefore, only five of the treatments were replicated four times while the remaining three treatments were not replicated at all. One subblock remained untreated.

Within each 0.4 *ha* subblock, non-commercial trees (*i.e.* trees not belonging to the regeneration sampling (RS) list (Anonymous 1975)) of poor form and of 7.1 *cm* girth (14.6 *cm* diameter) and above were selected. These were measured for their girth, tagged and identified to genera.

Of the total of 689 test trees, *Eugenia* (kelat) formed 32.2% in the logged-over forest. Similarly, species from the families Lauraceae (Medang), Burseraceae (Kedondong) and Myristicaceae (Penarahan), and *Ochanostachys amentacea* (Petaling) formed 8.6, 7.5, 6.5 and 4.2%, respectively. The remaining 41% of the 689 trees belonged to a wide range of species or species groups different from the above.

Details of the chemicals

Some information on the chemicals used in the trial (other than sodium arsenite) are given in Table 1.

Table 1. Some information on the chemicals used in the trial

Product	Active ingredient	Concentration
2,4,5-T		
i) 2,4,5-T concentrate (liquid)	2,4,5-T butyl ester	4.54 *kg* acid equivalent per 4.54 *l* (80.5% w/w acid equivalent)
ii) Trioxone 50 (emulsifiable concentrate)	2,4,5-T butyl ester	2.27 *kg* acid equivalent per 4.54 *l*
Esteron 720	2,4,5-T butyl ester	75.8% w/w, *i.e.* 758 *g* of 2,4,5-T butyl ester per *kg* of product
Garlon 4E	Triclopyr, butoxy ethylester	480 *g* acid equivalent per litre of product
Tordon 22K	Picloram, as the potassium salt	240 *g* acid equivalent per litre of product
Velpar-L	Hexazinone	240 *g* acid equivalent per litre of product

The treatments

The chemicals were mixed with water or diesel as indicated in Table 2.

Table 2. Mixing ratios of the chemicals used in the trial

Treatment	Mixing ratio	Remarks
20% solution of sodium arsenite in water	0.91 *kg* sodium arsenite powder + 4.54 *l* of water	-
2% solution of 2,4,5-T in diesel	1 part 2,4,5-T concentrate + 49 parts diesel	-
6% emulsion of 2,4,5-T in water	1 part Trioxone 50 + 8 parts water	2,4,5-T concentrate, a liquid, is not miscible with water; so emulsifiable concentrate, Trioxone 50, used here
2.3% mixture of 2,4,5-T concentrate in water	2 parts 2,4,5-T concentrate + 8 parts Lissapol + 32 parts water	Lissapol was added to enable 2,4,5-T concentrate to become miscible with water to an extent; recommendation of chemical company
Esteron 720 in water	1 part Esteron 720 + 9 parts water	Recommendation of chemical company
Garlon 4E in water	1 part Garlon 4E + 7 parts water	Recommendation of chemical company
Tordon 22K in water	1 part Tordon 22K + 2.5 parts water	Recommendation of chemical company
Velpar-L	Liquid formulation used alone	

Chemical application and assessments

The chemicals were applied to the selected trees during an operation from July 22 to 25, 1980. The six subblocks in each of the four blocks were randomly allocated to each treatment. As mentioned earlier, only five of the eight treatments were replicated four times while the remaining three treatments were not replicated at all.

The chemicals were mixed at the site on the first day of the trial and the total volume of solution or mixture obtained was noted. The chemicals were applied in each of the four blocks on four consecutive days, and volumes applied each day were noted. Throughout the four days, the weather remained sunny.

Except for Velpar-L, chemicals in all other treatments were applied to a complete frill girdle cut around the stem of the tree, as is commonly done during poison-girdling operations. Velpar-L, a chemical which is uptaken by the root system, was applied with the use of a spotgun to the base of the selected trees on the upslope side to avoid runoff. The spotgun was calibrated to give 4 ml per shot, and volumes applied ranged from a 16 to 120 *ml* per tree.

Assessments were carried out every two months during the initial six months, and then subsequently at three-monthly intervals up to the eighteenth month from chemical application. During assessments, the proportion of leaves in the green, brown and/or shed state was recorded, and whether a cut in the wood of the stem was wet or dry. A tree with all leaves dried or shed was confirmed as dead only when the wood was dry.

Results and discussion

Solutions of sodium arsenite and Tordon 22K in water were more effective than the remaining test chemicals as tree killers. After 12 months, about 90% of the trees tested with sodium arsenite and Tordon 22K were dead (Table 3). Unfortunately, Tordon 22K will not be marketed at all due to subsequent policy decisions of the chemical company concerned (Table 4).

The next best performer in the trials was a 2% solution of 2,4,5-T in diesel: a kill of 69.5% was obtained 12 months after application (Table 3). This is far below that shown by sodium arsenite at the same point in time. After 18 months, however, the kill of 95.3% shown by the 2% solution of 2,4,5-T in diesel was very close to the figure of 98.3% for the sodium arsenite solution. Liew (1971) showed that a 2% solution of 2,4,5-T in diesel was as effective as a 20% solution of sodium arsenite at 18 months after treatment, and hence considered the former to be the best alternative to the latter.

In comparison with sodium arsenite, the other chemicals used proved relatively less effective as tree killers. In any case, Trioxone 50 and Esteron 720 are not available in the market, and Velpar-L, in the volumes used, was totally unsatisfactory as an arboricide.

Table 3. Mortality of trees due to the effect of various chemicals at Compartment 3A Bukit Belata Forest Reserve, Selangor

Chemical	Number of trees tested	% kill						
		Months						
		2	4	6	9	12	15	18
Sodium arsenite in water	119	16.0	33.6	65.5	81.5	89.9	97.5	98.3
2,4,5-T concentrate in diesel	128	3.9	12.5	32.0	53.9	69.5	86.7	95.3
Trioxone 50 (2,4,5-T) in water	120	2.5	8.3	10.0	28.3	36.7	52.5	57.5
2,4,5-T concentrate + Lissapol in water	123	0.8	4.1	13.0	26.0	44.7	54.5	59.3
Esteron 720 in water	112	3.6	8.0	18.8	35.7	64.3	75.9	76.8
Garlon 4E in water	28	3.6	14.3	17.9	35.7	64.3	75.0	85.7
Tordon 22K in water	27	0	11.3	44.4	77.8	92.6	100	100
Velpar-L	32	0	0	0	0	0	6.3	6.3

Note: i) Chemical applications (1) to (5) were replicated four times; (6) to (8) not replicated; and (ii) Velpar-L applied to base of tree with the use of spotgun; all other chemicals applied to complete frill girdle.

Table 4. Status of the various chemicals as at January 1989

Chemical	Status	Retail cost	Remarks
Sodium arsenite	Not available in market		
2,4,5-T concentrate	Only old stock remain in market		Cock's Head Brand used in these trials is not distributed any more. The manufacturer in New Zealand stopped production several years ago[a]
Trioxone 50 (2,4,5-T)	Not available in market		This was withdrawn from the market subsequent to the initiation of the trials[b]
Esteron 720, Tordon 22K Garlon 4E	First two not available in market. Garlon 4E available in a slightly different form as Garlon 250	Garlon 250 costs $ 15.19 per litre. Sold in 4 *l* packs	All three chemicals had not been introduced to the market when trials began. Subsequently, policy decision taken by chemical company not to market the first two[c]
Velpar-L	Available in market	$ 16.67 per litre. Sold in 4 *l* packs[d]	

All costs in this paper are in us$, today's value (US$ 1 = 2.70 Malaysian Ringgit)
[a] I.C.I. (Malaysia) Private Limited personal communication; [b] I.C.I. (Malaysia) Private Limited personal communication;
[c] Dow Chemical Pacific Limited personal communication; [d] Du Pont Far East personal communication.

Sodium arsenite and Tordon 22K showed high rates of kills throughout the diameter ranges of the trees treated (Table 5). Sample size at the higher diameter classes was low but this was unavoidable since trees were chosen based on presence in a unit area. In the case of 2,4,5-T, effectiveness of the chemical was less at higher diameter classes at 12 months. However, it increased greatly during the last six months, and it appears that larger trees of some species reacted more slowly than smaller ones. Liew (1971) also observed this in Sabah. Chew (1982) showed that effectiveness of 2,4,5-T decreased with increasing tree size at nine months but he did not continue assessment any further.

Table 5. Tree mortality percentage at different diameter classes at 12 and 18 months for three most effective chemicals

Chemical	Months	Diameter class (*cm*)							
		14<20	20<30	30<40	40<50	50<60	60<70	70<80	80<90
20% solution of	12	88	88	89	100	100	100	100	100
sodium arsenite	18	100	97	100	100	100	100	100	100
		(24)	(60)	(19)	(9)	(2)	(2)	(1)	(2)
Tordon 22K in water	12	100	100	67	-	100	100	-	-
	18	100	100	100	-	100	100	-	-
		(5)	(13)	(6)	-	(2)	(1)	-	-
2% solution of 2,4,5 -T	12	72	71	75	73	50	25	-	-
in diesel	18	93	92	100	100	100	100	-	-
		(29)	(52)	(24)	(11)	(8)	(4)	-	-

Note: Figures in parentheses refer to number of trees treated with chemical

Based on the trial, the cost, in February 1984, of killing trees using 2% solution of 2,4,5-T in diesel was calculated to be \$ 3.23 ha^{-1}. This does not include labour cost. Chew (1982) has shown, however, that in such similar operations it is labour which is the main cost. His figures for the cost of girdling and climber cutting (GCl) on an operational scale for group-planting of various indigenous species in Sungai Tekam Forest Reserve in Pahang was \$ 43.33 ha^{-1}. Of this, labour was approximately ten times the cost of either the diesel or the 2,4,5-T concentrate used (\$ 3.75 ha^{-1} for the 2,4,5-T, \$ 3.63 ha^{-1} for the diesel, and \$ 35.93 ha^{-1} for labour, inclusive of climber cutting). Chew's total cost of diesel and 2,4,5-T was more than double the cost of \$ 3.23 for this trial. In his case, however, even saplings below 5 *cm* diameter were poison-girdled whereas in Bukit Belata only trees of 14.6 *cm* diameter (7.1 *cm* girth) and above were treated.

The other chemicals, except for Velpar-L, are not available in the market, and costing is therefore not possible. However, sodium arsenite had previously been shown to be more economical than 2,4,5-T (Wyatt-Smith 1963b, Liew

1971). No costing is given for Velpar-L as it was a failure at the volumes used in the trials.

Conclusion

Based on effectiveness and on availability in the market, 2,4,5-T is still the only suitable alternative to sodium arsenite for killing unwanted forest trees. The concentrate form of the chemical must be mixed with diesel to obtain satisfactory kill of trees at 12 months or more after application. Since costs of the chemical and diesel are low in comparison to labour, the strength of the solution could be increased from 2 to 4, 6 or even 8% to improve the success rate in killing unwanted trees. Presently, however, even this chemical is in short supply, and further trials will have to be carried out to find a suitable alternative.

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