

# THE EFFECTIVENESS OF CHINESE ARBORICIDES IN COMBATING BUSH ENCROACHMENT

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## BACKGROUND

Alternative sources of arboricides to combat bush encroachment are investigated. Arboricides with the same active ingredients that occur in local products were obtained from an overseas manufacturer (Zhejiang Hetian Chemical Co. Ltd., China) and their effectiveness tested over a period of three years.

## OBJECTIVE

The objective was to test the effectiveness of imported arboricides with active ingredients Bromacil and Tebuthiuron on *Acacia mellifera* and *Dichrostachys cinerea*, on soils with a clay content varying from 8 % to 25 %. These species are two of the most aggressive bush encroachers in Namibia. When the project was initiated, the imported arboricides were claimed to be cheaper than their local equivalents which are marketed under the commercial names of Molopo, Limpopo, Savanna and Bundu.

## METHODS

Three farms were selected for the trials: Uitkyk, which lies midway between Okahandja and Hochveld; Ombuerendende, between Omitara and Steinhausen; and Neudamm Agricultural College, 40 km from Windhoek on the Gobabis road. Exact location of each plot, plot size, date of treatment, clay content of soil, treatment, treatment mixture, amount of arboricide applied, and the results of the first and last bush count surveys are shown in Table 1. Uitkyk was the only farm with an adequate population of *Dichrostachys cinerea*, which allowed for trials to be carried out on this species.

Arboricides were mixed and applied by hand using a 5 L container and syringe. The syringe was calibrated to emit 2 ml at every application. Arboricide was applied to the soil next to the stem of each bush at a rate of 2 ml if the bush was 0,5 m high, 4 ml/1 m of bush height, and so on.



Figure 1. *Dichrostachys cinerea* treated with a mixture of Bromacil and Tebuthiuron.

Table 1. Trial using Chinese arboricides with active ingredients Bromacil and Tebuthiuron  
(Plant species referred to – with their English and Afrikaans common names – are listed at the end of this article.)

<b>Farm name</b> Rainfall	<b>Uitkyk</b> 2005/6: 646 mm 2006/7: 390 mm 2007/8: 640 mm		
GPS coordinates	21° 48.972 S 17° 29.604 E	21° 48.949 S 17° 29.676 E	21° 48.925 S 17° 29.739 E
Site no	1	2	3
Plot size	0,5 ha	0,5 ha	0,5 ha
Date of treatment	7/11/05	7/11/05	7/11/05
Percentage clay	12–18 %	12–18 %	12–18 %
Treatment	Bromacil 80 % WP	Tebuthiuron 25 % SC	Brom./Teb. mixture
Treatment mixture	1 kg/10 L water	1,5 L/8,5 L water	50:50
Amount applied	12 L	9 L	10 L
Total bush count (Nov. 2005) Primary bush species	4 600/ha <i>D. cinerea</i> : 1 600/ha <i>G. flava</i> : 1 100/ha <i>A. mellifera</i> : 550/ha	5 450/ha <i>M. sericea</i> : 1 150/ha <i>G. flava</i> : 1 050/ha <i>D. cinerea</i> : 950/ha <i>A. mellifera</i> : 100/ha	3 950/ha <i>G. flava</i> : 1 600/ha <i>G. flavescens</i> : 850/ha <i>D. cinerea</i> : 350/ha <i>A. mellifera</i> : 250/ha
Total bush species: percentage dead (May 2008)	51 %	79 %	67 %
<i>D. cinerea</i> : percentage dead (May 2008)	41 %	56 %	60 %
<i>A. mellifera</i> : percentage dead (May 2008)	67 %	93 %	89 %
Botanical composition (Nov. 2005) Primary grass species	90 % bare <i>E. nindensis</i> : 6 %	86 % bare <i>M. caffra</i> : 10 %	89 % bare <i>E. nindensis</i> : 5 %
Botanical composition (May 2008) Primary grass species	0 % bare Annuals: 53 % <i>E. nindensis</i> : 11 % <i>E. lehmanniana</i> : 12 %	0 % bare Annuals: 42 % <i>M. repens</i> : 19 % <i>E. nindensis</i> : 14 %	0 % bare Annuals: 35 % <i>E. lehmanniana</i> : 20 % <i>M. repens</i> : 18 %

<b>Farm name</b> Rainfall	<b>Ombuerendende</b> 2005/6: 801 mm 2006/7: 280 mm 2007/8: 343 mm		
GPS coordinates	22° 10.154 S 17° 50.631 E	22° 10.163 S 17° 50.671 E	22° 10.162 S 17° 50.691 E
Site no	1	2	3
Plot size	0,5 ha	0,5 ha	0,5 ha
Date of treatment	8/11/05	8/11/05	8/11/05
Percentage clay	8 %	8 %	8 %
Treatment	Bromacil 80 % WP	Tebuthiuron 25 % SC	Brom./Teb. mixture
Treatment mixture	1 kg/10 L water	1,5 L/8,5 L water	50:50
Amount applied	6,5 L	9 L	11 L
Total bush count (Nov. 2005) Primary bush species	5 400/ha <i>A. mellifera</i> : 4 250/ha	3 400/ha <i>A. mellifera</i> : 2 800/ha	4 150/ha <i>A. mellifera</i> : 3 300/ha
Total bush species: percentage dead (May 2008) (no <i>D. cinerea</i> in plot)	70 %	86 %	87 %
<i>A. mellifera</i> : percentage dead (May 2008)	76 %	84 %	100 %
Botanical composition (Nov. 2005) Primary grass species	87 % bare <i>E. nindensis</i> : 5 %	86 % bare <i>A. adscensionis</i> : 6 %	85 % bare <i>E. nindensis</i> : 8 %
Botanical composition (May 2008) Primary grass species	1 % bare Annuals: 23 % <i>E. lehmanniana</i> : 21 % <i>E. nindensis</i> : 19 %	0 % bare Annuals: 31 % <i>E. lehmanniana</i> : 27 % <i>E. nindensis</i> : 17 % <i>E. trichophora</i> : 10 %	0 % bare Annuals: 29 % <i>E. lehmanniana</i> : 19 % <i>E. nindensis</i> : 18 % <i>E. trichophora</i> : 7 %



Figure 2. Ombuerendende: Site 2.  
Top – before treatment. Below – after treatment.

Figure 3. Ombuerendende: Site 3.  
Top – before treatment. Below – after treatment.

Farm name	Ombuerendende			
	Site no	4	5	6
Plot size		0,5 ha	0,5 ha	0,5 ha
GPS coordinates		22° 11.466 S 17° 50.057 E	22° 11.532 S 17° 50.078 E	22° 11.598 S 17° 50.106 E
Date of treatment		9/11/05	9/11/05	9/11/05
Percentage clay		14 %	14 %	14 %
Treatment		Bromacil 80 % WP	Tebuthiuron 25 % SC	Brom./Teb. mixture
Treatment mixture		1 kg/10 L water	1,5 L/8,5 L water	50:50
Amount applied		5,6 L	4,8 L	4,7 L
Total bush count (9/11/05)		3 000/ha	1 600/ha	2 100/ha
Primary bush species		<i>A. mellifera</i> : 1 850/ha	<i>A. mellifera</i> : 450/ha	<i>A. mellifera</i> : 1 000/ha
Total bush species: percentage dead (May 2008) (no <i>D. cinerea</i> in plot)		76 %	74 %	77 %
<i>A. mellifera</i> : percentage dead (May 2008)		94 %	100 %	88 %
Botanical composition (May 2005)		93 % bare	86 % bare	89 % bare
Primary grass species		<i>E. rotifer</i> : 4 %	<i>E. lehmanniana</i> : 8 %	<i>E. trichophora</i> : 8 %
Botanical composition (Nov. 2008)		14 % bare	2 % bare	2 % bare
Primary grass species		Annuals: 34 % <i>E. lehmanniana</i> : 28 %	Annuals: 20 % <i>E. lehmanniana</i> : 52 % <i>E. rotifer</i> : 17 %	Annuals: 33 % <i>E. lehmanniana</i> : 29 % <i>E. rotifer</i> : 32 %

Farm name	Ombuerendende		
Site no	7	8	9
Plot size	0,5 ha	0,5 ha	0,5 ha
GPS coordinates	22° 10.302 S 17° 51.005 E	22° 10.244 S 17° 50.999 E	22° 10.150 S 17° 50.992 E
Date of treatment	9/11/05	9/11/05	9/11/05
Percentage clay	25 %	25 %	25 %
Treatment	Bromacil 80 % WP	Tebuthiuron 25 % SC	Brom./Teb. mixture
Treatment mixture	1 kg/10 L water	1,5 L/8,5 L water	50:50
Amount applied	0,9 L	0,3 L	1,65 L
Total bush count (Nov. 2005) Primary bush species	610/ha <i>A. mellifera</i> : 610/ha	720/ha <i>A. mellifera</i> : 720/ha	166/ha <i>A. mellifera</i> : 166/ha
Total bush species: percentage dead (May 2008) (no <i>D. cinerea</i> in plot)	40 %	91 %	76 %
<i>A. mellifera</i> : percentage dead (May 2008)	40 %	91 %	76 %
Botanical composition (7/11/05) Primary grass species	100 % bare —	100 % bare —	100 % bare —
Botanical composition (20/5/08) Primary grass species	36 % bare Annuals: 52 %	2 % bare Annuals: 80 % <i>E. lehmanniana</i> : 13 %	29 % bare Annuals: 42 % <i>E. lehmanniana</i> : 8 % <i>S. pappohoroides</i> : 8 % <i>E. rigidior</i> : 8 %

Farm name	Neudamm – GRN		
Rainfall	2005/6: 499 mm 2006/7: 266 mm 2007/8: 226 mm		
GPS coordinates	22° 27.725 S 17° 21.586 E	22° 27.753 S 17° 21.550 E	22° 27.811 S 17° 21.473 E
Site no	1	2	3
Plot size	0,5 ha	0,5 ha	0,5 ha
Date of treatment	22/11/05	22/11/05	22/11/05
Percentage clay	10 %	10 %	10 %
Treatment	Bromacil 80 % WP	Tebuthiuron 25 % SC	Brom./Teb. mixture
Treatment mixture	1 kg/10 L water	1,5 L/8,5 L water	50:50
Amount applied	2 L	2.7 L	4 L
Total bush count (Nov. 2005) Primary bush species	850/ha <i>A. mellifera</i> : 800/ha	1 100/ha <i>A. mellifera</i> : 900/h	2 250/ha <i>A. mellifera</i> : 1 650/ha
Total bush species: percentage dead (May 2008) (no <i>D. cinerea</i> in plot)	28 %	88 %	83 %
<i>A. mellifera</i> : percentage dead (May 2008)	56 %	95 %	96 %
Botanical composition (Nov. 2005) Primary grass species	70 % bare <i>A. meridionalis</i> : 8 %	79 % bare <i>S. pappohoroides</i> : 6%	64 % bare <i>F. africana</i> : 12 %
Botanical composition (May 2008) Primary grass species	0 % bare Annuals: 15 % <i>M. repens</i> : 39 % <i>S. pappohoroides</i> : 15 % <i>E. lehmanniana</i> : 8 % <i>C. ciliaris</i> : 8 %	0 % bare Annuals: 9 % <i>S. pappohoroides</i> : 33 % <i>M. repens</i> : 27 % <i>E. nindensis</i> : 10 %	0 % bare Annuals: 9 % <i>M. repens</i> : 31 % <i>S. pappohoroides</i> : 20 % <i>F. africana</i> : 19 %

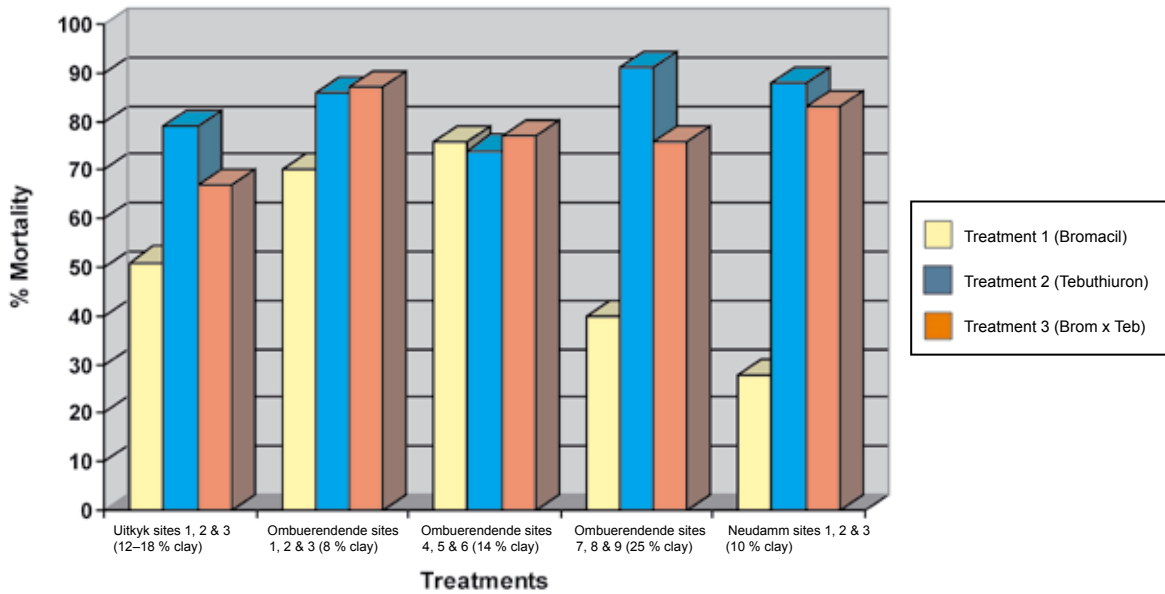


Figure 4. The effect of imported (Chinese) arboricides with active ingredients Bromacil and Tebuthiuron on all encountered bush species.

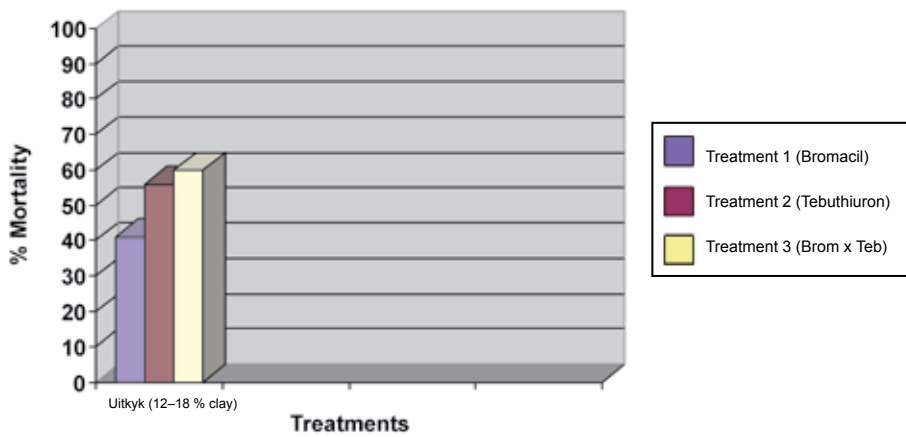


Figure 5. The effect of imported (Chinese) arboricides with active ingredients Bromacil and Tebuthiuron on *Dichrostachys cinerea* (one site only).

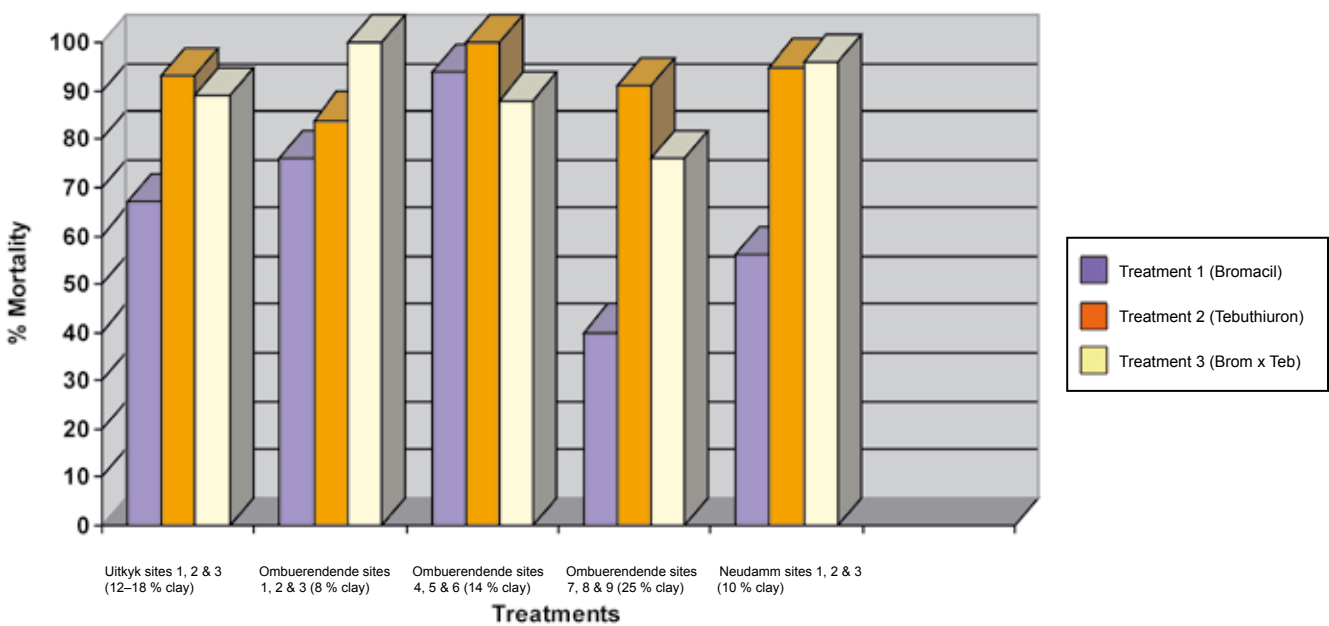


Figure 6. The effect of imported (Chinese) arboricides with active ingredients Bromacil and Tebuthiuron on *Acacia melifera*.

## DISCUSSION

Due to a number of constraints, the trial could not be set up with repetitions, and the results can therefore not be viewed as conclusive. The last surveys to determine bush mortality and changes in botanical composition on these plots were done in May 2008. Bush counts in control plots indicated that on average, 3 % of all bush mortalities is attributable to natural causes. The bulk of the recorded mortality therefore resulted from these arboricide applications. Bush mortality figures in Table 1 include mortalities resulting from natural causes. *Acacia mellifera* and *Dichrostachys cinerea* were the main species targeted, but the following species were also treated: *Acacia hebeclada*, *A. hereroense*, *A. reficiens*, *Catophractes alexandri*, *Combretum apiculatum*, *Commiphora* spp., *Erethia alba*, *Grewia flava*, *G. flavescens*, *Lycium* spp., *Mundulea sericea*, *Phaeoptilum spinosum*, *Rhus marlothii*, *Tarchonanthus camphoratus*, and *Ziziphus mucronata*. The composition of the vegetation naturally varied from site to site: for example, *Catophractes alexandri* occurred (and still occurs) at Uitkyk (400 bush/ha), while, at the time, none were recorded over the nine sites at Ombuerendende.

If all the treated species are taken into account (Figure 4), Bromacil 80 % WP (treatment 1), was less effective than Tebuthiuron and the mixture. It nonetheless achieved a mortality rate of 76 % at Ombuerendende, site 4. Figure 5 and Figure 6 clearly show that Bromacil was consistently less effective than the Tebuthiuron and the mixture treatments when applied to the target species (except at Ombuerendende, site 4). Very similar levels of success were obtained by using Tebuthiuron (treatment 2) and the mixture (treatment 3) (Figure 4). The lowest mortality rates were 74 % and 67 % (from Tebuthiuron and the mixture, respectively), and the best results, 91 % and 87 %, respectively.

It appears to be more difficult to eradicate *Dichrostachys cinerea* than *Acacia mellifera* with these arboricides. The highest *Dichrostachys* mortality rate of 60 % was achieved through the application of the mixture. Higher levels of application may be needed to achieve the desired results in this species.

Except in the case of Ombuerendende, site 4, Tebuthiuron and the mixture performed consistently better than Bromacil on *Acacia mellifera*. Tebuthiuron and the mixture are almost equally effective (Figure 6); their poorest results

measured 84 % and 76 % respectively, and their best results, 100 % for both applications.

The high clay content (25 %) of Ombuerendende sites 7, 8 and 9 may explain the poor performance of Bromacil on *Acacia mellifera*. However, at none of the other sites did the clay content appear to have had the expected restrictive effect.

## CONCLUSION

Clay content of the soil does not seem to influence the effect of Tebuthiuron and the mixture on any of the species treated. However, the poor performance of Bromacil at sites 7, 8 and 9 on all the species that were treated (including *Acacia mellifera*), may well be attributed to the high clay content (25 %).

Although it would seem that *Dichrostachys cinerea* is more resistant to all the treatments than the other bushes, the results are not conclusive, since *D. cinerea* was only treated at one site.

From the results achieved, Tebuthiuron, and the mixture (Tebuthiuron x Bromacil) are almost equally effective, against *Acacia mellifera* in particular, but also against all the other treated species. Acceptably high levels of mortality were achieved with both of these treatments, especially in *A. mellifera*.

## ACKNOWLEDGEMENTS

The authors wish to thank the owners of Uitkyk and Ombuerendende, Mr. D. Swanepoel, and Mr. S. Baas respectively, for availing their farms for this trial. A special word of thanks is due to the owners and their labourers who assisted in the application of the arboricides, since researchers in the field of pasture science are extremely thin on the ground.

Lastly, the authors wish to dedicate this report to the memory of the late Director of the Division Agricultural Research and Training in the Ministry of Agriculture, Water and Forestry, Dr Paul Jessen. This was his last assignment to the sub-division pasture science, and we wish that he was still with us, so that we could assure him of the fact that here, at pasture science, "we are serious".

Appendix 1: Tree/bush species referred to in this article

Scientific name	English name	Afrikaans name
<i>Acacia hebeclada</i>	candle-pod Acacia	trassiebos
<i>Acacia hereroense</i>	mountain thorn	—
<i>Acacia mellifera</i>	black-thorn	swarthaak
<i>Acacia reficiens</i>	red-thorn	rooihaak
<i>Albizia anthelmintica</i>	worm-cure Albizia	aroe
<i>Catophractes alexandri</i>	trumpet-thorn	ghabbabos
<i>Combretum apiculatum</i>	kudu-bush	koedoebos
<i>Commiphora</i> spp.	corkwood spp.	kanniedood spp.
<i>Dichrostachys cinerea</i>	sickle-bush	sekelbos
<i>Erethia alba</i>	white puzzle-bush	deurmekaarbos
<i>Grewia flava</i>	velvet raisin	fluweelrosyntjie
<i>Grewia flavescens</i>	sandpaper raisin	skurwerosyntjie
<i>Lycium</i> spp.	box-thorn spp.	kriedoring spp.
<i>Mundulea sericea</i>	silverbush	visgif
<i>Phaeoptilum spinosum</i>	brittle-thorn	brosdoring
<i>Rhus marlothii</i>	bitter karee	bitterkaree
<i>Tarchonanthus camphoratus</i>	camphorbush	vaalbos
<i>Ziziphus mucronata</i>	buffalo-thorn	blinkblaarwag-'n-bietjie

Appendix 2 : Grass species referred to in this article

Scientific name	English name	Afrikaans name
<i>Aristida adscensionis</i>	annual bristle-grass	eenjarige steekgras
<i>Aristida meridionalis</i>	giant bristle grass	leeusteekgras
<i>Eragrostis lehmanniana</i>	Lehmann's love-grass	krietjiesgras
<i>Eragrostis nindensis</i>	perennial love-grass	agtdaepluimgras
<i>Eragrostis rotifer</i>	vlei love-grass	vleipluimgras
<i>Eragrostis trichophora</i>	hairy love-grass	behaarde pluimgras
<i>Fingerhuthia africana</i>	thimble grass	vingerhoedgras
<i>Microchloa caffra</i>	sickle grass	elsgras
<i>Schmidtia pappophoroides</i>	Kalahari sand quick	Kalaharisandkweek